SECTION E

GROUNDWATER MONITORING

Revision No.
5.0

SECTION E

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TABLE OF CONTENTS

LIST OF APPENDICES

SECTION E

GROUNDWATER MONITORING

E-1 Organization of Section E

This section describes the hydrogeologic setting of the Facility, the development of the groundwater monitoring system at the Facility and the groundwater monitoring programs for implementation under a permit as required under the Alabama Hazardous Waste Management and Minimization Act of 1978. The information provided in the text of this section includes references to historical documents that are appropriately cited in the text or are provided in the appendices to this section. Additional supporting documents, not specifically related to studies conducted at the Facility, are also provided as appendices to this section.

E-2 Hydrogeological Setting

West Central Alabama is underlain by over 2,000 feet of Upper Cretaceous Period sediments. The uppermost aquifer underlying the Facility, as defined under ADEM Administrative Code Rule 335-14-1-.02 (40 CFR 260.10), is the Eutaw Formation. This formation is overlaid and confined by more than 600 feet of Selma Chalk (Section 3.4 of Document 1 in Appendix E-3). The Eutaw Formation is first underlain by the Gordo Formation, then the Coker Formation. A detailed discussion of the regional hydrogeology is provided in Appendix E-3 and Appendix E-4.

The Eutaw Formation consists of approximately 400 feet of inter-layered clays, silts and sands. The lower portion of the formation consists of fine to coarse grained, very glauconitic sand and sandstone with inter-bedded clays and shales. The middle portion of the Eutaw Formation consists of clay, shale and thin sand beds. The upper portion of the Eutaw Formation, sometimes referred to as the Tombigbee Sand Member, consists of fossiliferous fine to medium grained glauconitic sand with layers of chalk, claystone and calcareous sandstone occurring near the base of the Selma Chalk (Appendix E-3, Section 3.3.2 of Document 1).

The potentiometric surface of the upper portion of the Eutaw Formation generally ranges in elevation from 127 feet mean sea level (ft MSL) to 130 ft MSL under the Facility (Appendix E-11). The top of the Eutaw Formation ranges from -510 ft MSL to -450 ft MSL under the Facility (Appendix E-5, Document 1, Figure 3). The resultant confining condition results in flowing wells in low lying areas, as occurred in the Eutaw monitoring wells 1 and 4 (Appendix E-1, Figure E-1.1). Calculations of the estimated linear groundwater velocity in the Eutaw Aquifer (Tombigbee Sand Member) based on potentiometric surface elevations from the July 2018 monitoring event are provided in Table E-2.6. As shown in these calculations, the average linear groundwater velocity in the Eutaw Aquifer (Tombigbee Sand Member) is approximately 0.02 feet/day, based on a hydraulic conductivity of 4.4 x 10^{-3} cm/sec and an effective porosity of 15% (Appendix E-5, Document 1, Page 14). The potentiometric surface of the Eutaw Aquifer is shown on Figure E-1.3 of Appendix E-1.

As explained in Appendix E-4, the Selma Chalk Formation under the Facility is saturated through all or most of its depth. This saturated zone is not, however, an "aquifer", as defined in ADEM Administrative Code Rule 355-14-1-.02 (40 CFR 260.10), because, with its extremely low hydraulic conductivity, it is not "capable of yielding a significant amount of groundwater to wells or springs". While local historical records show that cisterns have been completed in the Selma Chalk to store water, no water supply wells derive their water from the Selma Chalk.

The occurrence of fractures in the chalk was recognized early in the development of the Facility (Appendix E-15). The potential for the migration of hazardous waste constituents to surface waters through these fractures has been addressed by early studies completed at the Facility. In early 1979, fracture systems observed in trenches were tested for hydraulic conductivity using packer testing equipment installed in two angled (45°) and one vertical core holes in early 1979 (Appendix E-6, Document 1). An evaluation of the testing results indicated that the fractures "have a very high resistance to flow and are no less resistant than the non-faulted chalk except within a few feet of the ground surface" (Appendix E-6, Document 1, pg. 12). The calculated hydraulic conductivity based on these packer tests of the fractures ranged from 4.0×10^{-8} to 5.5×10^{-7} cm/sec. This work was later expanded to include a lineament study of the whole Facility (Appendix E-7). In May-June, 1982, the Facility contracted to conduct detailed mapping of the discontinuities within the chalk (Appendix E-3). These studies were conducted from outcrops around the Facility and from Trenches 15 and 16, which were open during this period. Six (6) prominent joint sets were identified at the Facility during this investigation. The orientation of these sets correlated with the lineament study completed earlier. Additional packer tests to evaluate the hydraulic conductivity were performed in June 1999. The packer tests were performed in a 45° angled borehole completed near Cell 3 of Trench 22. This borehole was completed to 150 ft along the borehole. Three packer tests were performed in this borehole, and yielded hydraulic conductivities of 6.0×10^{-8}, 2.0×10^{-8}, and 1.8×10^{-9} cm/sec. A report detailing this study is included in Document 2 of Appendix E-6.

Investigations of the hydrogeology of the chalk showed that a water table occurs in the Selma Chalk (Appendix E-4). Three well recovery tests were conducted in the wells constructed during this study. The results of these tests indicate a hydraulic conductivity of the chalk ranging from 2.0×10^{-8} to 5.7×10^{-8} cm/sec (Appendix E-4, Document 1, Section 4.3.1). The estimated flow velocity, using a very conservative assumed effective porosity of 10 percent, was estimated to be between 0.05 and 0.17 feet per year (ft/yr).

In a separate study (Golder 1984a and Golder 1984b), the hydraulic response to the dewatering of Trench 20 was observed using a set of piezometers. In effect, this study was a test of an extremely large diameter well (500 feet x 600 feet x 115 feet), including all of the fractures intercepted by the excavation. For the duration of the test, the inflow rate into the trench was 0.44 gallons per minute (gpm). Calculations based on this response supported previous studies indicating a hydraulic conductivity of the Selma Chalk of 1 x 10^{-7} cm/sec.

Since the hydrogeologic report presented in Appendix E-4 was submitted, a more detailed laboratory tracer test was performed to calculate the effective porosity of the Selma Chalk. The tracer test showed the effective porosity of the Selma Chalk was 33.4%. Using the highest reported value of hydraulic conductivity for the Selma Chalk (1.0 x 10^{-7} cm/sec), the effective porosity of 33.4%, and the groundwater gradient as shown on the Selma Chalk potentiometric surface map from groundwater elevations measured in October 2018 (Figure E-1.4), the estimated flow velocity was estimated to be approximately 0.00002 ft/day, or 0.006 ft/year as calculated in Table E-2.7.

The Selma Chalk at the Facility actually consists of, from the ground surface downward, the Demopolis Chalk, the Arcola Limestone, and the Mooreville Chalk. The feasibility of using the Arcola Limestone as a zone to monitor for vertical migration of contaminants in the chalk has been evaluated. This evaluation has concluded that there is no advantage to locating a monitoring well in the Arcola Limestone instead of the overlying Demopolis Chalk (Appendix E-5, Document 1).

A review of geologic literature describes the Arcola Limestone as a light gray dense fossiliferous limestone inter-bedded with light gray to pale olive chalky clay. The Arcola member is composed of two dense limestone beds, each approximately 1 foot thick, inter-bedded with low permeability clays. The entire formation is described as approximately ten (10) feet thick (Appendix E-5, Document 1).

During sub-surface investigations at the Emelle Facility, three borings were made in the Selma chalk to a depth that likely penetrated the Arcola Limestone. These borings were not carried out for the purpose of investigating the Arcola, but they were carefully completed and continuously sampled. These borings did not provide any indication of voids or increased transmissivity with the chalk, including the Arcola Limestone (Appendix E-5, Document 1).

The Arcola Limestone is very difficult to detect during drilling, and many driller's logs do not mention the existence of this limestone. Geophysical logs can be used to detect the Arcola Limestone. During sub-surface investigations for the proposed Shuqualak Mountain Facility in Noxubee County, Mississippi, three borings were completed which penetrated the Arcola Limestone. Using geophysical logs, the thickness of the Arcola was determined to be 4.5 feet, 2.0 feet, and 6.0 feet, respectively, in the three borings. In each of the three borings, the Arcola Limestone was described as an "Un-weathered, massive, dense, fine-grained bluish white limestone with minor rip-up clasts". No indication of any voids or increased transmissivity was associated with the Arcola Limestone observed in these borings.

To confirm the evaluation of the Arcola Limestone, specific investigative techniques were employed during the 1998 installation of a new RCRA-10 Monitoring Well at the Facility. The installation of RCRA-10 failed. RCRA-10R was installed to replace RCRA-10, however, foreign material obstructed the well, and RCRA-10A was then installed. RCRA-10 and RCRA-10R were properly plugged and abandoned and are shown on Figure E-1.1 along with the active RCRA-10A. During the installation of RCRA-10, RCRA-10R, and RCRA-10A, chalk was sampled continuously beginning at an elevation 20 feet above the anticipated Arcola Limestone elevation and continuing for 40 feet. During the drilling of RCRA-10, the thickness of Arcola Limestone was measured to be approximately 5 feet. During the drilling of RCRA-10R, the thickness of Arcola Limestone was measured to be approximately 8 feet. During the installation of RCRA-10A, the thickness of the Arcola Limestone was measured to be 5.3 feet. Reports prepared at the time of the completions of RCRA-10, RCRA-10R, and RCRA-10A indicate that the limestone beds and interbedded chalk of the Arcola Limestone are visually similar to the overlying and underlying chalk; that no voids, cavities, or factures were observed in the limestone beds; and that the Arcola Limestone and the chalks of the Selma Group form a single hydrostratigraphic unit (Appendix E-13, Document 1). Additional supporting documents are provided as Documents 2 through 4 of Appendix E-13.

In conclusion, review has not revealed any evidence that indicates that the hydraulic conductivity of the Arcola Limestone at the Emelle Facility is significantly different from that of the overlying Demopolis Formation or the underlying Mooreville Formation. Therefore, there is no advantage in locating a monitoring well in the Arcola Limestone as opposed to the Demopolis Chalk.

When considering the potential for the migration of hazardous constituents to migrate from a facility, it is important to consider the impact on any sensitive receptors of such migration. For groundwater studies, these sensitive receptors would include surface water bodies and water supply wells.

The closest surface water body to the active portion of the Facility is Bodka Creek. Bodka Creek is approximately 1,000 feet from the northwestern corner of the active area of the Facility. Given the gradients at the Facility and the low permeability of the chalk and fractures within the chalk, it would be extremely unlikely for waste constituents to migrate from the trenches to Bodka Creek within the active, closure, and post-closure care periods.

The closest water supply well to the Facility is located near Geiger, Alabama, approximately 10,500 feet from the nearest Facility boundary, and is completed in the Coker Formation. The Coker Formation is a confined aquifer that is stratigraphically much lower (approximately 750 feet lower) than the Eutaw Formation (Appendix E-4). The public supply well is screened between 1,912 feet and 1,982 feet below the ground surface.

The Eutaw, Gordo, and Coker Formations are all confined aquifers. Because of the upward water pressure within each of the three aquifers, there is a barrier to flow from the Selma Chalk into these formations. Also, the presence of Bodka Creek between the Facility and the public supply well serves as a hydraulic barrier in the Selma Chalk between the Facility and this well. Given the distance to the well from the Facility, the occurrence of Bodka Creek, the depth of this well, and the presence of confined aquifers between the Selma Chalk and the well screen, it would be highly unlikely for waste constituents to impact this water supply.

E-3 Current Groundwater Monitoring System

E-3a Eutaw Aquifer Monitoring System Development

The purpose of the Eutaw Aquifer monitoring system is to monitor conditions in the uppermost aquifer beneath the facility (the Eutaw Aquifer). Table E-2.3 presents a summary of all monitoring wells for the facility, including the RCRA wells screened in the Eutaw Aquifer. Appendix E-12 contains all available boring logs and well construction diagrams for the monitoring wells at the facility. Prior to July of 1983, four groundwater monitoring wells, Wells 1 through 4, were maintained as the Facility's interim status groundwater monitoring system. All of these wells were constructed prior to 1978 using standard practices of the time. Available information on these wells is presented in Appendix E-12 and Table E-2.3. Based on the reported depth of these wells, Wells 1, 3 and 4 are believed to have penetrated and monitored the Eutaw aquifer. Well 2 may have possibly penetrated and monitored the Gordo aquifer. In all cases, however, it is believed that these wells were only cased and sealed in the upper 20 to 25 feet of the well and therefore monitored a combination of saturated units.

At the time these wells were constructed, it was assumed that the groundwater gradient was toward the southwest, parallel to the regional stratigraphic dip. Thus, Well 1 was designated as the upgradient well, and Wells 2, 3, and 4 were designated as downgradient wells.

It was discovered, during the investigations required for the original EPA Part B Permit Application, that the gradients in the Eutaw Formation were more likely to be toward the east than the southwest as had originally been assumed (Appendix E-4 and Appendix E-11). As a result, the Facility met with the ADEM in late 1982 to discuss a revised RCRA interim status groundwater monitoring program. In July of 1983 the Facility verbally presented a plan for the installation of four new wells to the ADEM and the EPA. This new plan was subsequently approved in the EPA Part B Permit Application. The new wells, RCRA-5 through RCRA-8, were completed and added to the interim status monitoring program for the July 1983 sampling event (Table E-2.3 and Appendix E-12).

On December 19, 1984, the Facility, the ADEM and the EPA entered into a consent agreement (1984 Consent Agreement) to resolve, among other things, various RCRA compliance issues. One of the requirements of the 1984 Consent Agreement was the modification of Well RCRA-5. RCRA-5 was initially screened in the lower aquifer of the Eutaw Formation. The 1984 Consent Agreement provided for RCRA-5 to be re-screened in the Tombigbee Sand Member of the Eutaw Formation. It also allowed for the re-evaluation of the gradients in the upper aquifer of the Eutaw Formation given this new data point.

The 1984 Consent Agreement also provided for the construction of a new Eutaw Aquifer monitoring well at one of two locations that had been marked on the ground. RCRA-9 was constructed in November of 1985 and became part of the groundwater monitoring system for the first semi-annual sampling event in March of 1986 (Table E-2.3 and Appendix E-12).

With the installation of RCRA-9, the Facility proposed, and the EPA and the ADEM agreed, that Wells 1 through 4 would be abandoned. Well 4 was plugged and sealed on September 18, 1985, during the field work associated with the re-screening of RCRA-5 and the installation of RCRA-9. Wells 2 and 3 were plugged and sealed shortly thereafter. The sampling of Well 1 was discontinued with the abandonment of Wells 2, 3 and 4, but it was not plugged and sealed.

In 1998, the facility began installation of a new Eutaw Aquifer monitoring well, as required by the facility's Operating Permit. The installation of the original monitoring well, RCRA-10, failed and the borehole was properly plugged and abandoned. Subsequently, RCRA-10R was installed approximately 250 feet northwest of the abandoned RCRA-10 boring (Figure E-1.1). Due to foreign material obstructing RCRA-10R, RCRA-10R was properly abandoned and RCRA-10A was installed (Appendix E-13, Documents 2 through 4). As required by the facility's Operating Permit, an evaluation of the of the Arcola Limestone was also completed using the borings for RCRA-10 and RCRA-10R, and the boring and well installation of RCRA-10A (Appendix E-13, Document 1). Details of the results of the Arcola Limestone evaluation study are contained in Section E-2.

Monitoring wells RCRA-5 through RCRA 10A represent the current Detection Monitoring System at the Facility. RCRA-6, RCRA-7, RCRA-9, and RCRA-10A are the current point of compliance monitoring wells for the facility as indicated on Figure E-1.1. RCRA-8R is the upgradient (background) monitoring well for the Eutaw Aquifer. RCRA-8R was installed on August 19, 2015 and is a replacement for the previous upgradient well, RCRA-8, which was abandoned due to an obstruction. A description of this groundwater monitoring system, including the modifications described above, is provided with Appendix E-5 and Appendix E-13.

E-3b Selma Chalk Groundwater Monitoring System Development

As explained in Appendix E-4, the Selma Chalk Formation under the Facility is saturated through all or most of its depth. This saturated zone is not, however, an "aquifer", as defined in ADEM Administrative Code Rule 355-14-1-.02 (40 CFR 260.10), because, with its extremely low hydraulic conductivity, it is not "capable of yielding a significant amount of groundwater to wells or springs". The Selma Chalk wells are located adjacent to landfill trenches and are intended to provide early warning of potential migration of landfill constituents. The Selma Chalk monitoring system is not a part of the RCRA groundwater monitoring network and is not subjected to the same interpretive and evaluation criteria as the RCRA detection monitoring system (Appendix E-8, Document 2, Section 2.0).

The purpose of the Selma Chalk monitoring wells was to maintain the demonstration that waste constituents would not reach the Eutaw Formation or the nearest surface waters in less than 1,000 years (Appendix E-8, Document 1, Section 1.0).

Selma Chalk groundwater monitoring was initiated with the 1984 Consent Agreement. Subparagraph IX-C-5 of this agreement allowed for the development of a demonstration for a waiver of groundwater monitoring requirements as was allowed under 40 CFR 265.91(a)(2). The resulting demonstration (Appendix E-8, Document 2) provided for the monitoring of the Selma Chalk while continuing to monitor the Eutaw Formation.

The plan for the construction of the Selma Chalk wells was completed, including a review of comments from EPA, in April of 1985. The coring of the bore holes for Phase I of this two phase installation process was completed in July of 1985. The twenty-eight (28) monitoring wells constructed during Phase II of this plan are shown on Figure E-1.1 and Figure E-1.2. Table E-2.3 is a summary of monitoring well information, and available boring logs are incorporated in Appendix E-12. Descriptions of the installation procedures and construction details of the existing Selma Chalk monitoring wells are provided in Appendix E-8.

As the facility expanded, additional Selma Chalk monitoring wells were installed adjacent to newly constructed trenches and were intended to monitor these trenches. Table E-2.3 shows the complete listing of all active and abandoned Selma Chalk monitoring wells. Currently, the facility has fifty-nine (59) wells within the Selma Chalk. Fifty-two (52) wells are active shallow surveillance wells within the Selma Chalk as shown on Figures E-1.1 and E-1.2. In accordance with Part XI of the RCRA Permit and as part of the Corrective Measure Implementation Plan, monitoring wells CMI-1, CMI-2, and CMI-3 which are also located within the Selma Chalk, were installed as sentry wells for potential contamination migration and to monitor progress of natural attenuation. Three (3) Selma Chalk monitoring wells (SMBG-01, SM-25, and SM-26) have been abandoned. SM-25 and SM-26 were used to monitor surface impoundments L-6 and L-7 (later referred together as L-3 when the original surface impoundments L-3, and L-4 were closed).

Following clean closure of L-3 in August 1989, SM-25 and SM-26 were properly plugged and abandoned on December 9, 1994. A letter summarizing abandonment of monitoring wells SM-25 and SM-26 is included in Appendix E-14. SMBG-01 was the original Selma Chalk background monitoring well prior to the construction of T-22 (SMBG-02 is the current background well). SMBG-01 was abandoned as it was in the footprint of T-23. Well abandonment documentation for SMBG-01, SM-25, and SM-26 is provided in Appendix E-14.

E-3c Eutaw Aquifer Groundwater Quality Testing and Analysis

The first interim status groundwater monitoring samples were collected in 1982. Wells 1 through 4 were sampled on February 19, April 26, July 22, and October 20, 1982. All samples were analyzed for those parameters required by 40 CFR 265.92(c). Four (4) aliquots of each sample were taken and separately analyzed for total organic carbon (TOC), total organic halides (TOX), pH, and Specific Conductance. The 1982 sampling event indicated that the sampling results from Wells 2 and 3 are significantly different and exhibit significantly more variability than those for Wells 1 and 4. The Facility believes that the explanation for this was lack of adequate quality control in sampling procedures. However, assessment of the results from Wells 1 and 4 indicates that the groundwater of the Eutaw is moderately mineralized but otherwise is of good quality and meets the Interim Primary Drinking Water Standards.

Wells RCRA-5 through RCRA-8 were first sampled in July of 1983, which was recorded as the first quarter sampling for the purpose of developing background groundwater quality data. The second quarter sampling occurred in October of 1983, the third quarter, January of 1984, and the fourth quarter, April 1984. The first semi-annual monitoring for Wells RCRA-5 through RCRA-8 was conducted in July of 1984. Concurrently with the development of the quarterly data for Wells RCRA-5 through RCRA-8, the semi-annual monitoring for Wells 1 through 4 was conducted in May of 1983, July of 1983, January of 1984, and July of 1984.

The statistical evaluations of indicator parameters performed prior to 1986 were completed in accordance with 40 CFR 264.97(h)(i)(ii). The statistical analyses indicated that certain wells exhibited significant changes in pH and specific conductance, and consequently, these wells had failed the statistical test. Well 4, an upgradient well, showed a statistically significant decrease in the parameter pH. Naturally, since this is an upgradient well, the change in pH could not possibly represent an effect on the groundwater due to the operation of the Facility.

On April 12, 1984, the Facility submitted a report entitled "1983 Groundwater Monitoring Annual Report." Because of the well-documented weaknesses of the required statistical analyses when applied to this type of data, the Facility concluded that the results constituted a "false positive." Consequently, no assessment plan was submitted.

However, at the request of the ADEM, the Facility prepared the "Groundwater Quality Assessment Plan," which was submitted on June 28, 1984 (CWM 1984). This assessment plan was found acceptable by the EPA and the ADEM on October 11, 1984. The implementation of the plan was described and allowed in paragraph XI-C of the 1984 Consent Agreement discussed previously (TSCA Docket No. 84H03). After negotiations with the EPA and the ADEM, it was agreed that the Facility would sample the eight Eutaw Aquifer wells for the parameters contained in 40 CFR Part 261, Appendix VIII and ADEM Administrative Code Rule 335-14-2-.01.

The first sampling event under the assessment plan was conducted on November 13-14, 1984, using the eight Eutaw Aquifer groundwater monitoring wells. The results indicated that certain compounds were present in these samples at very low concentrations. The results of the analyses were discussed with the EPA and the ADEM, but no concrete conclusions as to the meaning of the results were reached during the discussion.

Subsequently, it was decided that the Facility should re-sample the wells. It was also decided that the ADEM and the EPA would collect samples concurrently and analyze these samples for the same compounds.

Four aliquot samples were obtained from each well during the assessment study. Each time the results varied, and each sampling event seemed to introduce new inconsistencies. Various research projects were conducted to try to determine the reasons for the erratic results.

After much effort, the exercise focused on finding the source of small quantities of toluene and acetone in the samples. It was determined that the source of the acetone was from the original construction of the wells. The wells are cased with threaded black steel pipe, and it was learned that thread cutting oil was used on the ends of these pipes. Because of concerns about the possible introduction of contaminants to the well from the cutting oil, the oil was removed by washing the pipe ends with acetone. Apparently not all of the acetone was removed during the steam cleaning, prior to installation.

Tests on samples of the acetone that had been saved in archival storage revealed that the acetone was heavily contaminated with toluene. Therefore, the source of the toluene was the acetone. Thus, the conclusion of the Groundwater Quality Assessment Plan was that the contaminants were introduced as a result of well construction and installation; therefore, the Eutaw aquifer was uncontaminated and had not been affected by the operations of the Facility. The report describing the results of the Groundwater Quality Assessment Plan was submitted to the EPA and the ADEM on July 1, 1985, and subsequently approved by the EPA and the ADEM in letters dated September 6, 1985, and August 15, 1985. The conclusion of this effort was that the Eutaw Formation was not impacted by the operations of the Emelle Facility.

Toluene was also detected in groundwater samples collected from RCRA-10A starting in June 1999. The detections of toluene in June 1999, October 1999, and April 2000 were 1.3 µg/L, 2.8 µg/L, and 1.5 µg/L, respectively. All of these detections are much less than the Maximum Contaminant Level (MCL) for toluene which is 1,000 µg/L. A report evaluating the toluene detections was prepared in July 2000 and provided evidence for a non-waste basis for the toluene detections. Specifically, the report concluded that the likely source of the toluene detections was naturally occurring petroleum in the Eutaw Aquifer. These findings were accepted by ADEM in an October 27, 2000 letter.

As mentioned previously, Wells 1 through 4 were no longer used for monitoring after late 1985. Well RCRA-5 was also taken out of the water quality monitoring system after it was reworked to change the screen location during this period. Since this time, Wells RCRA-6 through RCRA-10A have been evaluated and reported to ADEM in annual groundwater monitoring reports. The results of these analyses indicate that the Eutaw Formation has not been affected by the activities at the Facility, and therefore, due to the lack of detections in the Eutaw Aquifer, there are no contaminant plumes or other constituent detections in the Eutaw Aquifer with the exception of the toluene in RCRA-10A as discussed in the above paragraph. Table E-2.4 is a summary of groundwater detections from all wells at the facility recorded during the previous permit period.

E-3d Selma Chalk Groundwater Quality Testing and Analysis

The evaluation of the Selma Chalk groundwater quality was begun with the 1984 Consent Agreement discussed previously. Table E-2.4 summarizes the groundwater detections recorded during the previous permit period in the Selma Chalk wells. The purpose of the Selma Chalk monitoring wells was to maintain the demonstration that waste constituents would not reach the Eutaw Formation or the nearest surface waters in less than 1,000 years (Appendix E-8, Document 1, Section 1.0). In this regard, the Selma Chalk wells act as an “early warning system”. The Selma Chalk saturated zone is not an "aquifer", as defined in ADEM Administrative Code Rule 355-14-1-.02 (40 CFR 260.10), because, with its extremely low hydraulic conductivity, it is not "capable of yielding a significant amount of groundwater to wells or springs". The Selma Chalk wells are located adjacent to landfill trenches and are intended to provide early warning of potential migration of landfill constituents. The Selma Chalk monitoring system is not a part of the RCRA groundwater monitoring network and is not subjected to the same interpretive and evaluation criteria as the RCRA detection monitoring system (Appendix E-8, Document 2, Section 2.0).

In August 1993, a groundwater sample collected from SM-05 was measured to have 1,1-dichloroethane (1,1-DCA) at 160 µg/L. The groundwater was resampled in October 1993, and was found to contain 1,1-DCA at a concentration of 250 µg/L. As stated in condition IX.B.5 of the USEPA Part B operating permit in effect at the time, a constituent detected greater than or equal to 50 µg/L requires an assessment study to evaluate the rate of migration of the constituent and the extent of any contamination plume.

A study plan for the SM-05 well cluster was submitted in November 1993 and approved by the EPA on February 24, 1994. The study was completed, and a final report was submitted in January 1995. The report concluded that the detections in the SM-05 well cluster could not conclusively be identified as originating from Trench T-9. Surficial soil contamination due to past loading practices as well as contamination from a sampling pump were also identified as possible sources of the contamination (JJG 1995). The low-level detections are limited to the vicinity of SM-05. The SM-05 well cluster is currently sampled semi-annually as part of the routine facility monitoring.

During routine groundwater sampling in shallow monitoring well SM-18, the compound 1,1-DCA was detected in September 1993 at a concentration of 62 ppb. The presence of this compound was confirmed in a sample collected in October 1993. The detected concentrations of 1,1-DCA in these samples exceeded the “trigger” concentration of 50 ppb established in Section IX.B.5.e of the Emelle facility USEPA Part B Permit. CWM-Emelle initiated a study of groundwater conditions in the SM-18 area. The results of this study were reported to ADEM in September 1997 (JJG 1997). The status of SM-18 was also reviewed as part of the RCRA Facility Investigation (RFI) reported to ADEM in July 2000, where it was clearly stated that the hazardous constituents detected in SM-18 originated from constituents inadvertently released into the soil adjacent to well SM-18 while trenches T-4 through T-7 were active from August 1977 until August 1979. In July 2005, a Corrective Measures Implementation Plan was submitted to ADEM detailing recommended corrective measures to be taken in this area (JJG 2005). CWM-Emelle continues to monitor SM-18 semi-annually as part of the routine facility monitoring.

The RCRA Facility Investigation also determined that hazardous constituents have been released from trenches T-1 and T-3 through T-7 to the shallow groundwater inside the compacted chalk cutoff wall constructed downgradient of the trenches. The cutoff wall was installed to contain potential contaminant migration from the trenches. The Corrective Measures Implementation Plan provides further details regarding construction of the cutoff wall and the wall’s success in containing contaminant migration from the trenches (JJG 2005). The cutoff wall is reported to have been constructed at the time of closing Trenches 1 through 7. Shallow monitoring wells constructed after the cutoff wall construction were located further downgradient, so that the cutoff wall is located between the trenches and the shallow monitoring wells. The RFI Report (July 2000) and the Corrective Measures Implementation Plan (July 2005) concluded that the chalk cutoff wall effectively buffers the lateral migration of these hazardous constituents.

The RCRA Facility Investigation also determined that low levels of hazardous constituents were present at a groundwater sampling point downgradient of former Lagoon L-4. The two VOC’s detected, 1,1-DCA and vinyl chloride, both have high mobility, and both were detected in the samples collected from within the confines of Former Lagoon L-4. This suggests that the low levels of constituents observed might be a result of migration of groundwater that has been in contact with the hazardous constituents contained within the former lagoons. The Corrective Measures Study report (July 2003) and the Corrective Measures Implementation Plan (July 2005) recommended appropriate corrective measures.

E-4 Detection Monitoring Program (Eutaw Aquifer)

E-4a Monitoring Wells

The Detection Monitoring Program well system, as required under ADEM Administrative Code Rule 335-14-5-.06(9) (40 CFR 264.98), consists of four downgradient monitoring wells (RCRA-6, RCRA-7, RCRA-9 and RCRA-10A) and one upgradient (background) monitoring well (RCRA-8R), as depicted on Figure E-1.1. RCRA-5 is used for potentiometric surface measurements only. This groundwater monitoring system is further described in Appendix E-5 and Appendix E-13. RCRA-8R was installed on August 19, 2015 and replaced previous upgradient well RCRA-8, which was abandoned due to an obstruction. RCRA-8R was installed directly adjacent to RCRA-8 and is screened in the same zone of the Tombigbee Sand Member of the Eutaw Aquifer as RCRA-8. The point of compliance for the Detection Monitoring Program is shown on Figure E-1.1.

The low permeability of the Selma Chalk provides significant protection to the environment. The installation of monitoring wells through the Selma Chalk results in a breach of the confining layer protecting the Eutaw Formation because the permeability of the sealed borehole annulus is likely to be higher than the intact chalk. This potential problem, and the fact that the confining layer is over 600 feet thick, has apparently been considered by the ADEM and the EPA in the placement of the existing Eutaw Aquifer monitoring wells.

In addition to the existing Eutaw monitoring wells, a separate shallow monitoring well system exists at the Facility. The shallow well system, described in Section E-5 of the Application, is located much closer to the landfill trenches than the Eutaw monitoring wells. This location allows the shallow wells to serve as an "early warning system" for possible constituent movement from landfills.

The Facility has long believed that the location of Eutaw aquifer monitoring wells very near landfills would greatly increase the potential for vertical migration of hazardous waste constituents through the Selma Chalk into the Eutaw Aquifer. The Facility has been under the impression that this belief has been shared by ADEM since the initiation of disposal operations at this Facility in the late 1970's. Both ADEM and EPA have previously approved the location of Eutaw aquifer monitoring wells at the Facility boundary. Therefore, the Facility is requesting that ADEM approve the continuing use of an alternate point of compliance through the existing Eutaw monitoring wells, except for RCRA-5, as indicated on Figure E-1.1 of this Application.

E-4b Sampling Methodology

The five (5) Eutaw Aquifer groundwater monitoring wells (RCRA-6, -7, -8, -9, and -10A) have been permanently fitted with dedicated high flow-rate submersible pumps. These pumps are installed near the static potentiometric surface in each well and are electrically operated, have all stainless-steel construction, and have sealed bearings. Electrical power for pumping is provided by a portable gasoline-powered generator. The wells will be purged using the higher rate submersible pump. The groundwater samples will then be obtained using a separate dedicated, air-operated, bladder-type sampling pump, which is permanently installed approximately 10 to 20 feet below the purge pump. A schematic diagram of the sampling system is presented in Figure E-1.1 and E-1.2.

Details of groundwater purging and sampling procedures and equipment, field QAQC protocols, and recordkeeping procedures are provided in the CWM Manual for Groundwater Sampling (Appendix E-9). The Facility uses an environmental laboratory certified under the National Environmental Laboratory Accreditation Program. The selection of sample bottles and analytical procedures follow the laboratory methods as specified in Test Methods for Evaluating Solid Waste: Physical/Chemical Methods SW-846 (latest edition).

E-4c Chemical Parameters

The Detection Monitoring Program must utilize indicator parameters, waste constituents or reaction products that provide a reliable indication of the presence of hazardous constituents in the groundwater (ADEM Administrative Code Rule 335-14-5-.06(9)(a) and 40 CFR 264.97(d)). The Facility uses waste constituents identified in leachate collected from the active monitoring trench to identify the parameters used in the Detection Monitoring Program. Table E-2.5 provides a summary of leachate data collected from the facility from the previous permit period. The facility also monitors for and reports for informational purposes only the indicator parameter pH, Specific Conductance, TOC and TOX, but does not subject these indicator parameters to statistical tests.

Use of these indicator parameters (pH, specific conductance, TOC, and TOX) and the Cochran's Approximation to the Behren's-Fisher Student's t Test (CABF) have yielded a large percentage of false positives (i.e., suggestions of groundwater contamination where none has occurred). False positives have been shown to occur in the annual groundwater reports where organic analyses of groundwater from monitoring wells show no contamination.

This high percentage of false positives at the Facility is not surprising and has been experienced nation-wide. Appendix E-10, Synoptic Summary of Indicator Parameter Studies Utilizing the

Lockheed/EPA-EMSL-LV Hazardous Waste Ground-Water Database, presents a study performed by Dr. Russell H. Plumb, a recognized expert in the field of geochemistry, that concludes that the "RCRA Indicator Parameters" function poorly and are more likely to yield an incorrect assessment of changing groundwater conditions than a correct assessment.

At the Emelle Facility, the inappropriateness of the RCRA Indicator Parameters is further indicated because they exhibit spatial and temporal variations in the natural groundwater. Groundwater from different wells can be hundreds of years different in age from the time that water entered the groundwater recharge system. It is unreasonable to expect groundwater quality to be homogeneous for naturally occurring parameters.

Since the use of the indicator parameters pH, Specific Conductance, TOC and TOX at this Facility does not provide a reliable indication of the presence of hazardous constituents in groundwater as required under ADEM Administrative Code Rule 335-14-5-.06(9)(a) and 40 CFR 264.97(d), the Facility uses the waste constituents in Table E-2.1 in Appendix E-2, be used to indicate groundwater contamination. The organic compounds selected tend to be the more mobile compounds in soil and groundwater environments, have a low potential for absorption, and are not naturally occurring. The inorganic parameters selected, while naturally occurring, are some of the more mobile of the metals. Consequently, these parameters offer an excellent choice by which any impact on the groundwater due to Facility operations can be determined. The parameters and methods presented in Table E-2.1 in Appendix E-2, are therefore to be used in the Detection Monitoring Program as required under ADEM Administrative Code Rule 335-14-5-.06(9)(a) and (40 CFR 264.98(a)).

E-4d Statistical Methods

For the Eutaw aquifer, ADEM Administrative Code Rule 335-14-5-.06(8)(h) and 40 CFR 264.97(h) require that a statistical method be used in evaluating groundwater monitoring data for each hazardous constituent that is specified in the permit, listed in Table E-2.1.

As stated in ADEM Administrative Code Rule 335-14-5-.06(8)(h), “The owner or operator will specify one of the following statistical methods to be used in evaluating groundwater monitoring data for each hazardous constituent which, upon approval by the Department, will be specified in the permit. The statistical test chosen shall be conducted separately for each hazardous constituent in each well.” ADEM Administrative Code Rule 335-14-5-.06(8)(h)1. through 5. further specifies the specific statistical procedures that may be utilized.

With the exception of metals with naturally occurring concentrations, no confirmed constituents have been detected in groundwater samples from the Eutaw aquifer monitoring wells; therefore, statistical evaluations have not been required. Should detections of constituents in the Eutaw aquifer monitoring wells (with the exception metals at naturally occurring concentrations) be confirmed as described in E-4e(1), the Facility will implement one of the specific statistical methods that are listed in ADEM Administrative Code Rule 335-14-5-.06(8)(h)1. through 5. Prior to implementation of a statistical evaluation, the Facility will notify ADEM of the selected statistical method in writing.

E-4e Assessment Plan

E-4e(1) MDL Exceedances

The method detection limit (MDL) is the concentration that can be identified by a given method and reported with 99% confidence that the true concentration is greater than zero. Therefore, the MDL is variable in nature and is reliable to 99% confidence that the actual concentration is above zero. MDLs are susceptible to matrix interferences, and therefore vary from sample-to-sample. MDLs are typically two (2) to ten (10) times below the practical quantification limit (PQL).

In the event that an MDL is exceeded for a respective Eutaw Formation groundwater parameter listed in Table E-2.1, in Appendix E-2, the Facility will implement the following groundwater quality assessment plan.

1. An investigation of the data and sampling event, transportation arrangements, and laboratory procedures will be investigated. If there is a possibility of contamination of the sample, every effort will be made to identify the error, correct it, and avoid it in future samplings. This investigation will be a review of the machine calibration information, assessment of the arithmetic calculations, a review of the recoveries measured on spiked samples, and a review of all information on blanks tested on that day. If significant matrix interference is thought to be the cause of the exceedance of the MDL, steps will be taken to determine the extent of the matrix interference and the impact that the matrix interference had on the compounds observed. In addition, a detailed review of the chain-of-custody records for the sampling, shipping and preparation of the samples will be carried out to determine if there is any appropriate reason for invalidating the analytical results. If an error is found, the Facility will provide the notification of its determination along with the investigation report to the ADEM, within 7 days of the determination. With concurrence from ADEM, the Facility will consider the analytical results as a false positive, with no further action needed.
2. If the results cannot be attributed to an error and conclusively identified as a false positive, then the Facility will compare the change with other data and historical data from that well. This review of the Facility data will include an inspection of analytical data of Facility-specific blanks and up-gradient wells to determine if there is any non-waste basis for the exceedance of the limit. If that comparison yields an up-gradient relationship or a similar event in the past which is determined to be a

false positive, then the Facility will provide notification of its determination, along with the investigation report, to the ADEM in writing, within 7 days of the determination. With concurrence from the ADEM, the Facility will consider the analytical results as a false positive, with no further action needed.

3. If unresolved in accordance with paragraphs E-4e(1)1. and E-4e(1)2., the Facility will re-sample the well or wells, as appropriate, where the result was obtained. This sampling will occur within 15 days after this determination, but no longer than 90 days from the initial sampling of the well or wells during the most recent semi-annual event, unless otherwise approved by the ADEM. However, no re-sampling will be carried out if the results of the review indicate that the exceedance of the limit is the result of a calculation error, a data transcription error, or a confirmed laboratory or field artifact. Also, if the Facility determines that there is no false positive under paragraphs E-4e(1)1. and E-4e(1)2., the Facility will re-sample the well or wells where limits were exceeded. The sample(s) will be analyzed for the constituent (or constituents) with suspected exceedance. If the same constituent (or constituents) is not in exceedance, the original results will be declared a false positive, and the assessment plan and activities will end. The assessment plan results will be submitted to the ADEM, within 7 days of receipt of the results. If the limit exceedance is confirmed, the Facility will notify the ADEM in writing, within 7 days of the receipt of the confirmation.

4. If a constituent has been confirmed to exceed its MDL, pursuant to paragraphs E-4e(1)1. through E-4e(1)3. in two (2) consecutive semi-annual sampling events, the Facility will resample the affected well or wells and analyze for all constituents identified in the ADEM Admin. Code R. 335-14-5-Appendix IX List (herein defined as the Appendix IX List). The assessment of the results shall follow the protocol of paragraphs E-4e(1)1. through E-4e(1)3.

5. If any constituent analyzed in paragraphs E-4e(1)4. is confirmed to exceed its respective MDL, that constituent will be added to the semi-annual monitoring list in Table E-2.1. If any constituent, which was added to the original Table E-2.1 pursuant to paragraphs E-4e(1)4. and E-4e(1)5. is not present above its respective MDL, for three (3) consecutive years, then that constituent may be removed from the Table E-2.1 list. Addition or subtraction of constituents from the Table E-2.1 list shall require a permit modification.

<u>E-4e(2) PQL Exceedances</u>

The practical quantification limit (PQL) is the concentration that can be achieved within specified limits of precision and accuracy under routine lab conditions. The PQL is typically the lowest non-zero standard in the calibration curve. It does not typically vary from sample-to-sample with the frequency of MDLs and the PQL is typically two (2) to ten (10) times the MDL concentration.

Table E-2.1 presents the PQLs for Eutaw Formation groundwater monitoring parameters. In addition, Table E-2.1 provides the respective groundwater protection standard (GWPS) for each constituent in accordance with ADEM Admin. Code Rule 335-14-5-.06(3). MCLs are used as the GWPS for each constituent, where applicable, in accordance with ADEM Admin. Code Rule 335-14-5-.06(5)(a)2. Per the Alabama Risk-Based Corrective Action Guidance Manual (ARBCA) (Revision 3.0 or most current version), if a constituent does not have an MCL, the GWPS will be established using a USEPA Regional Screening Level (RSL) tapwater value (TR=1E-06; THQ=0.1). USEPA RSLs are generic risk-based levels; therefore, a site-specific alternate concentration limit (ACL) may be established in accordance with ADEM Admin. Code Rule 335-14-5-.06(5)(b). Additionally, if the established GWPS is below a constituent's background value, the background value can be used as the applicable GWPS for the constituent per ADEM Admin. Code Rule 335-14-5-.06(5)(a).

In the event that the PQL limits provided in Table E-2.1 in Appendix E-2 are exceeded, the Facility will implement the following groundwater quality assurance plan.

1. Implement E-4e(1)1., using PQL as the exceedance level.
2. Implement E-4e(1)2., using PQL as the exceedance level.
3. Implement E-4e(1)3., using PQL as the exceedance level.
4. Within thirty (30) days following mailing of the written confirmation in paragraph E-4e(2)3., the Facility will submit to the ADEM a plan and schedule to identify which hazardous constituents (utilizing the ADEM Admin. Code R. 335-14-5-Appendix IX list, herein defined as the Appendix IX List), if any, are in the Eutaw aquifer, the rate of migration of these constituents and the extent of any plume. The migration study outlined in the plan shall commence upon approval of the plan and schedule by the ADEM.
5. Within thirty (30) days of completing the contaminant migration study, the Facility will submit to the ADEM a report of its findings, and if necessary, an application for a permit modification.
6. The Facility need not submit the application for a permit modification required by paragraph E-4e(2)5., if the Facility, with concurrence from the ADEM, determines that the presence of hazardous constituents in groundwater is not due to a release from a regulated unit or Solid Waste Management Unit (SWMU).
7. Subsequent to implementation of the migration study required under paragraph E-4e(2)4., the Facility will continue to comply with the routine monitoring and data evaluation requirements of this subsection.

8. Once the presence of hazardous constituents in a given well has been confirmed by a re-test, and the Facility has identified the affected well(s) in its notification to the ADEM, the Facility need not repeat the re-test and notification steps for previously reported wells following each subsequent, scheduled, sampling event.
9. If a constituent is confirmed to exceed its established GWPS, the Facility will submit a permit modification to the agency to establish a corrective action program pursuant to ADEM Admin. Code Rule 335-14-5-.06(10)(h).

E-5 Selma Chalk Groundwater Surveillance Program

E-5a Surveillance Wells

The current shallow surveillance system consists of an array of fifty-two (52) wells, designated as SM-wells, installed adjacent to the completed landfill trenches as shown on Figure E-1.1 and Figure E-1.2 in Appendix E-1. Both the EPA and the ADEM have approved the number and location of these wells as discussed previously. The purpose of the Selma Chalk monitoring wells was to maintain the demonstration that waste constituents would not reach the Eutaw Formation or the nearest surface waters in less than 1,000 years (Appendix E-8, Document 1, Section 1.0). The Selma Chalk wells are located adjacent to landfill trenches and are intended to provide early warning of potential migration of landfill constituents. The Selma Chalk monitoring system is not a part of the RCRA groundwater monitoring network and is not subjected to the same interpretive and evaluation criteria as the RCRA detection monitoring system (Appendix E-8, Document 2, Section 2.0).

During the construction of landfill cells, the sidewalls of the trench excavation will be examined for the presence of fractures in the chalk. The purpose of locating and documenting fractures in the chalk is to consider this information in locating new monitoring wells in the Selma Chalk. Therefore, the fracture mapping procedure outlined below will focus on observed fractures with the greatest potential for providing preferential pathways of groundwater movement. Fracture mapping will be conducted before installing new Selma Chalk surveillance wells adjacent to a new landfill cell. Fractures mapped will be added to the compilation of historical information prior to the submission of proposed new Selma Chalk well locations, as described below.

During the excavation of new landfill cells, a geologist will examine the side walls of the excavation. During this examination, the geologist will determine the following:

1. The depth of the weathered/un-weathered chalk interface. Depth determinations will be based on color, since the weathered chalk is tan or light brown, and the un-weathered chalk is gray. The interface depth is typically very uniform and will be

observed and recorded at intervals no greater than 100 feet along the length of the side wall. Any anomalies observed in the interface depth will be recorded.

2. The geologist will examine and describe observed fractures, fracture sets and zones of fracturing according to acceptable field mapping procedures as determined by the examining geologist. Measurements and observations regarding the apparent dip of the fracture, and the fracture roughness, planarity, and in-filling will be made. The length of the exposed fracture will be estimated. The exposed fracture's relation to the interface will also be noted, as well as any discoloration which may be evident on, or adjacent to, the fracture. The strike and dip of the excavated side wall will also be measured.

Prior to beginning installation of a new Selma Chalk surveillance well, the proposed location(s) for such wells will be submitted to ADEM for approval. Proposed well locations will be recommended by the Facility based on the mapping of fractures in the trench side wall, as described above, and on the location of the leachate collection system sumps for the new cell. The documentation resulting from the fracture mapping will be attached to the proposed well locations submitted to ADEM. Upon approval from the ADEM, the Facility will proceed with the installation of the new surveillance wells.

New Selma Chalk surveillance wells will be completed in two phases in a manner similar to the construction of the previous Selma Chalk surveillance wells (Appendix E-8). The first phase of new monitoring well installation will consist of core drilling each surveillance well location to a depth of approximately 25 feet below the elevation of the base of the cell it will be monitoring. Once the core hole is completed, it will be protected and temporarily sealed to prevent damage and contamination of the hole. The core obtained from the drilling program will be cleaned, photographed and logged in the field, then preserved for future reference. All naturally occurring fractures observed in the core will be described in the log. The nature, location and spacing of the fractures observed in the core will then be used in the design of the surveillance well to be constructed at this surveillance point. A surveillance well construction plan will be submitted to the ADEM once the core has been evaluated. This plan will include detailed construction specifications for each well to be completed. The design will attempt to maximize the number of discontinuities intercepted by the screened interval and optimize the anticipated recovery rate of the well while considering the potential dilution of contaminants. Upon approval from the ADEM, the Facility will proceed with the second phase of well construction. After construction, the wells will be added to the groundwater surveillance program described herein.

At least one surveillance well will be completed for each cell, and each well will be located along the outside limits of the trench. The wells will be placed as close as reasonably possible to the outer limit of the final closure cover and in accordance with the well locations submitted to, and approved by, ADEM as described in the preceding paragraphs.

E-5b Sampling Methodology

Each Selma Chalk surveillance well has or will be outfitted with a dedicated sampling pump. The pumps are air-operated, bladder-type pumps. The Selma Chalk surveillance wells installed in the Selma Chalk require a unique purging process. The transmissivity of the Selma Chalk is extremely low; therefore, recharge rates into wells installed in this geologic unit cannot sustain purging at any practical rate (Appendix E-8, Document 3). Groundwater purging and sampling procedures and equipment, field QAQC protocols, and recordkeeping procedures are provided in the CWM Manual for Groundwater Sampling (Appendix E-9). The Facility uses an environmental laboratory certified under the National Environmental Laboratory Accreditation Program. The selection of sample bottles and analytical procedures follow the laboratory methods as specified in Test Methods for Evaluating Solid Waste: Physical/Chemical Methods SW-846 (latest edition).

E-5c Chemical Parameters

It is mutually advantageous to the Facility, the regulatory agencies, and the public to have a surveillance program that can provide a reliable indication of the water quality of the Selma Chalk and that can quickly and accurately evaluate changes in this quality. With this in mind, the Facility will implement the Selma Chalk groundwater quality data evaluation methodology as discussed in Section E-5d.

The volatile organic and inorganic parameters listed in Table E-2.2 in Appendix E-2, will be the constituents evaluated in the shallow surveillance wells. These parameters were selected based on a review of the constituents present in leachate, their physical properties, and background concentrations. The organic compounds selected tend to be the more mobile compounds in soil and groundwater environments, have a low potential for absorption, and are not naturally occurring. The inorganic parameters selected are naturally occurring, but they are the more mobile metals in groundwater and serve as early indicators should a release occur. These constituents have been previously approved by the ADEM and the EPA in the current EPA permit (EPA ALD-000-622-464). Table E-2.2 also provides the respective GWPS for each constituent in accordance with ADEM Admin. Code Rule 335-14-5-.06(3). MCLs are used as the GWPS for each constituent, where applicable, in accordance with ADEM Admin. Code Rule 335-14-5-.06(5)(a)2. Per the Alabama Risk-Based Corrective Action Guidance Manual (ARBCA) (Revision 3.0 or most current version), if a constituent does not have an MCL, the GWPS will be established using a USEPA RSL tapwater value (TR=1E-06; THQ=0.1). USEPA RSLs are generic risk-based levels; therefore, a site-specific ACL may be established in accordance with ADEM Admin. Code Rule 335-14-5-.06(5)(b). Additionally, if the established GWPS is below a constituent's background value, the background value can be used as the applicable GWPS for the constituent per ADEM Admin. Code Rule 335-14-5-.06(5)(a).

E-5d Data Evaluation

The Selma Chalk surveillance system is not a part of the RCRA groundwater monitoring network and is not subjected to the same interpretive and evaluation criteria as the RCRA detection monitoring system (Appendix E-8, Document 2, Section 2.0). The Selma Chalk surveillance wells will be sampled, and the results will be compared against the following criteria:

1. If the results are greater than the respective GWPS for the constituent, initiate procedures outlined in Subsection E-5e(1).
2. If a constituent is detected that does not have an established GWPS, and the constituent concentration is greater than the criteria listed below, initiate the procedures outlined in Subsection E-5e(1)1. through E-5e(1)3.
   - i. if three (3) or more volatile organic compounds (VOCs) present in concentrations greater than 20 µg/L for each compound; or
   - ii. if two (2) or more VOCs present in concentration greater than 30 µg/L for each compound; or
   - iii. if one (1) or more VOCs present in concentrations greater than 50 µg/L for each compound.
3. An ACL may be calculated for compounds that exceed the GWPS if approved by ADEM. This ACL will be calculated in accordance with ADEM Administrative Code Rule 335-14-5-.06(5)(b) and (40 CFR 264.94). If the results are greater than the calculated ACL, initiate procedures outlined in Subsection E-5e(1).
4. If results of the resample pursuant to E-5e(1) are greater than the GWPS or if there is not an established GWPS and the results are greater than the criteria listed below, initiate procedures outlined in Subsection E-5e(2).
   - i. if three (3) or more volatile organic compounds (VOCs) present in concentrations greater than 20 µg/L for each compound; or
   - ii. if two (2) or more VOCs present in concentration greater than 30 µg/L for each compound; or
   - iii. if one (1) or more VOCs present in concentrations greater than 50 µg/L for each compound.

In addition, as previously reported to the ADEM in connection with Facility closure activities, the Facility has determined that to-date the background levels for these metals in the Facility's chalk matrix are as follows: Arsenic, total: 2-12 ppm; Chromium, total: 9-49 ppm; and Nickel, total: 12-13 ppm. The background concentration of the metals in the pore water of the Selma Chalk is as follows: Arsenic, total: 3.5 ppm; Chromium, total: 10.9 ppm; Nickel, total: 18.1 ppm; Vanadium, total: 2.6 ppb.

E-5e Assessment Plan

E-5e(1) GWPS Exceedances

In the event that the concentration of a monitoring constituent exceeds its established GWPS, the Facility will implement the following plan:

1. An investigation of the data and sampling event, transportation arrangements, and laboratory procedures will be investigated. If there is a possibility of contamination of the sample, every effort will be made to identify the error, correct it, and avoid it in future samplings. This investigation will be a review of the machine calibration information, assessment of the arithmetic calculation, a review of the recoveries measured on spiked samples, and a review of all information on blanks tested on that day. If significant matrix interference is thought to be the cause of the exceedance, steps will be taken to determine the extent of the matrix interference and the impact that the matrix interference had on the compounds or parameters observed. In addition, a detailed review of the chain of custody records for the sampling, shipping and preparation of the samples will be carried out to determine if there is any appropriate reason for invalidating the analytical results. If an error is found, the Facility will provide the notification of its determination. With concurrence from ADEM, the Facility will consider the analytical results as a false positive, with no further action needed.

2. If the results cannot be attributed to an error or conclusively identified as a false positive, then the Facility will compare the current values with data from adjacent wells. This review of the Facility data would include an inspection of analytical data of Facility-specific blanks and up-gradient wells to determine if there is any non-waste basis for the exceedance of the thresholds. If that comparison yielded an upgradient relationship or a similar event in the past which was determined to be a false positive, then the Facility will provide notification of its determination to the ADEM and the EPA in writing, within 7 days of the determination. With the concurrence of the ADEM, the Facility will consider the analytical results as a false positive, with no further action needed.

3. If unresolved in accordance with paragraphs E-5e(1)1. and E-5e(1)2. above, the Facility will re-sample the affected well or wells within 15 days after this determination, but no longer than 90 days from the initial sampling of the well or wells during the most recent semi-annual event, unless otherwise approved by the ADEM. The sample(s) will be analyzed, and the results compared to the criteria as presented in E-5d(2). If the criteria for the same constituent (or constituents) are not exceeded,

the original results will be declared a false positive, and the assessment plan and activities will end. The assessment plan results will be submitted to the ADEM, within 7 days of receipt of the results.

4. If any constituents are confirmed to exceed their respective GWPS, (or if a constituent that does not have an established GWPS exceeds the triggers listed in E-5d(2)) the Facility will report the exceedance to the ADEM, within 7 days of the confirmation, and resample the affected wells and analyze for all the constituents identified in the ADEM Admin. Code R. 335-14-5-Appendix IX List (herein defined as the Appendix IX List).

5. If any constituents identified in the Appendix IX List are confirmed present above their respective PQL (or above their respective GWPS if the PQL is above the GWPS), pursuant to E-5e(1)1. through E-5e(1)3., then those constituents shall be added to the Table E-2.2 list. (Note: The Facility will not repeat the Appendix IX List sampling triggered by the same constituent in the same well after the initial event until the criteria in the Subsection E-5d4 is exceeded or that constituent has been removed from the list as outlined in E-5e(1)6.).

6. If any constituent, which was added to Table E-2.2 pursuant to E-5e(1)5., has not been present above its respective PQL (or above the respective GWPS if the PQL is above the GWPS), for three (3) consecutive years, then that constituent may be removed from the Table E-2.2 list. Addition or subtraction of constituents from the Table E-2.2 list shall require a permit modification.

E-5e(2) Procedures for GWPS Exceedances

In the event that the concentration of a monitoring constituent exceeds its GWPS or any of the threshold levels identified in Subsection E-5d(4), the Facility will implement the following plan.

1. If the exceedance of the criteria is confirmed in the resample, the Facility will notify the ADEM in writing within 7 days of making this determination and continue the assessment plan. Within thirty (30) days following mailing of the written confirmation, the Facility will submit to the ADEM a plan and schedule to identify which hazardous constituents are in the groundwater (utilizing all the constituents listed in the Appendix IX List) and the rate and extent of contaminant migration. The assessment study outlined in the plan will commence upon approval of the plan and schedule by the ADEM.

2. Within sixty (60) days of completing the study, the Facility will submit to the ADEM a report of its findings including an engineering report with recommendations on mitigation of continued migration of contaminants, and a proposed implementation schedule of mitigation measures. Any constituents from the Appendix IX List, that are confirmed present above their respective PQL (or above their respective

GWPS if the PQL is above the GWPS), through resampling, in the affected wells, will be added to the Table E-2.2 list. The mitigation of continued migration of contaminants will commence upon approval of the plan and schedule by ADEM.

3. The facility shall continue the semi-annual sampling. The Appendix IX sampling of the affected wells will be repeated at a five-year interval, commencing from the initial sampling of the Appendix IX constituents outlined in the study identified in E-5e(2)1. Subsequent sampling of the Appendix IX constituents may be conducted during a regularly scheduled sampling event, prior to the five-year limit, from the previous Appendix IX constituent sampling. Any additional constituents from the Appendix IX List that are confirmed present, above their respective PQL (or above the respective GWPS if the PQL is above the GWPS), through resampling, shall be added to the Table E-2.2 list.

4. If any constituent, which was added to the original Table E-2.2 list, has not been detected above its respective PQL (or above the respective GWPS if the PQL is above the GWPS), for three (3) consecutive years, that constituent may be removed from the Table E-2.2 list. If the criteria in Subsection E-5d(2) is not exceeded for three (3) consecutive years, that constituent may be removed from the Table E-2.2 list. If the criteria in Subsection E-5d(2) is not exceeded for three (3) years, the Appendix IX sampling frequency of once every five (5) years will cease.

5. Subsequent to implementation of the assessment study required under paragraph E-5e(2)1., the Facility will continue to comply with the routine monitoring and data evaluation and the reporting record keeping and responses requirements of this subsection.

6. Once the presence of hazardous constituents in a given well has been confirmed by a re-test and the Facility has identified the well(s) in its notification to the ADEM, the Facility need not repeat the re-test and notification steps for previously reported wells following each subsequent, scheduled, sampling event.

E-6 References

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Golder 1984a. ADEM Requested Data, Emelle Facility, Golder Associates, August 21, 1984

Golder 1984b. Finite Element Groundwater Model, CWM Emelle Facility, Golder Associates, August 24, 1984

JJG 1995. Evaluation Report for Shallow Monitoring Well SM-5, Emelle Facility, EPA Permit No. ALD 000 622 464, Volume 1 of 2, Jordan, Jones & Goulding, Inc., January 1995

JJG 1997. Evaluation Report for the SM-18 Well Cluster, Jordan, Jones & Goulding, Inc., September 1997

JJG 2005. Corrective Measures Implementation Plan, Trenches T-1, T-3 through T-7 and Lagoons L-3 and L-4, Jordan, Jones & Goulding, Inc., July 2005

[End of Section E Text]

APPENDIX E-1

SECTION E

FIGURES

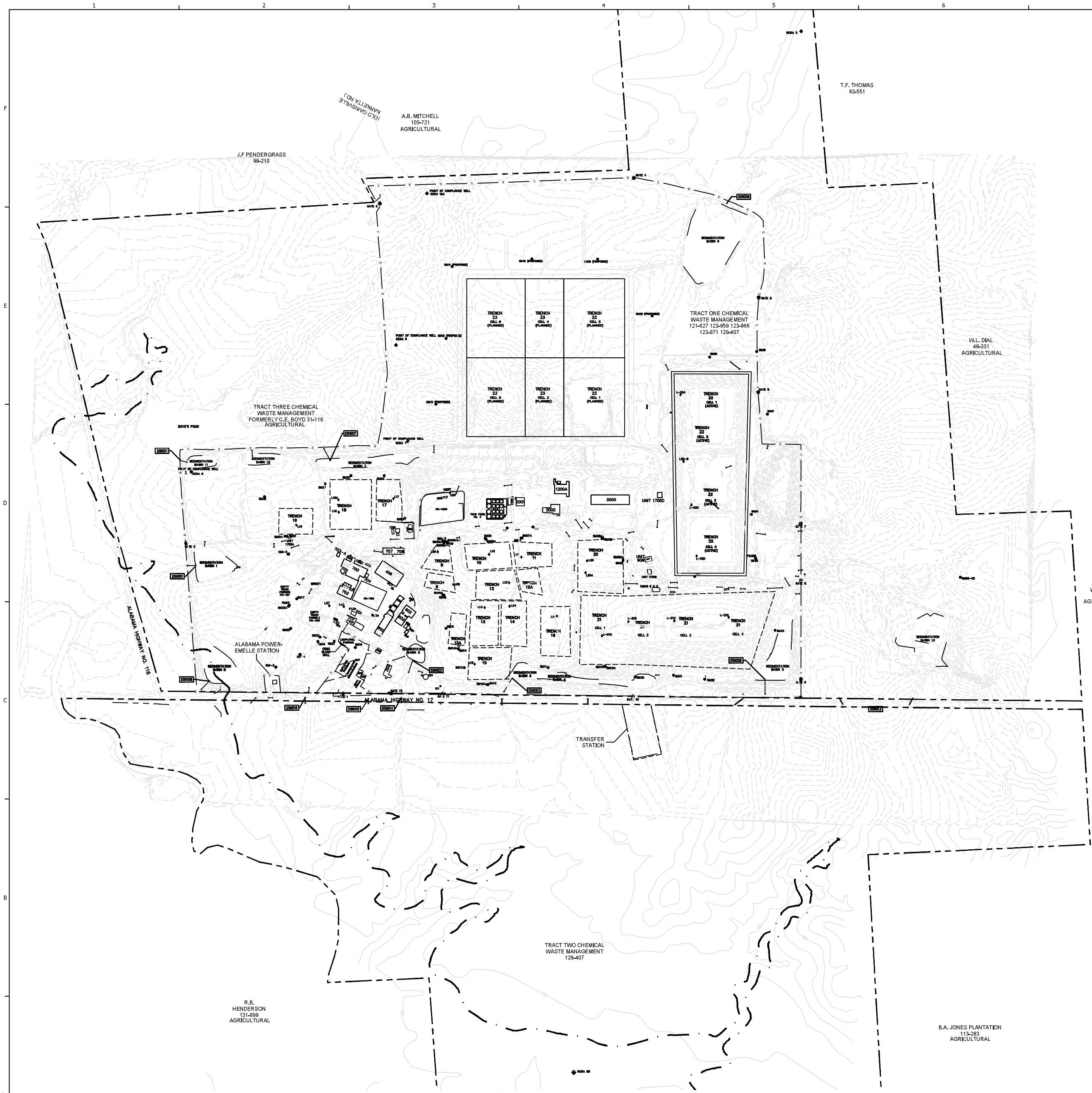
Revision No.

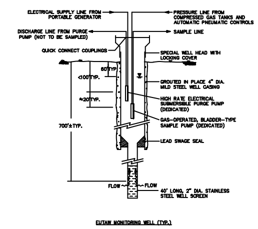
5.0

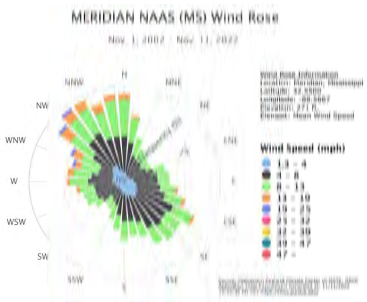
APPENDIX E-1

SECTION E

LIST OF FIGURES







LEGEND

- 100YR FLOOD PLAIN
- BUILDING/SOLID WASTE MANAGEMENT UNIT
- CLOSED LANDFILL/LAGOON
- ACTIVE LANDFILL
- DSN016 NPDES OUTFALL
- SEDIMENTATION BASIN
- PROPERTY LINE
- FENCE
- SM23 SHALLOW MONITORING WELL LOCATION
- RCRA 8R RCRA MONITORING WELL LOCATION (EUTAW AQUIFER)
- L-21B LEACHATE RISER WELL LOCATION
- CMI-1 CMI PLAN SENTRY WELL LOCATION

UNIT IDENTIFICATION LEGEND

NO.	IDENTIFICATION
200	ADMINISTRATIVE OFFICE
201	ADMINISTRATIVE OFFICE
207	GUARD HOUSE/SCALES
224	FIRE SYSTEM PUMP HOUSE/TANK
300	HEAVY EQUIPMENT MAINT.
302	DOCUMENT STORAGE
401	PAINT & WASH BUILDING
402	TRANSPORTATION SHOP
404	SHOWER, LOCKER FACILITY & CAFETERIA
*☆ 406	CONTAINER STORAGE UNIT
*☆ 520	CONTAINER AND TANK MANAGEMENT UNIT
*☆ 600	TANK MANAGEMENT UNIT
*☆ 602	CONTAINER STORAGE UNIT
*☆ 603	CONTAINER STORAGE UNIT
*☆ 604	CONTAINER MANAGEMENT UNIT
605	CENTRAL INVENTORY
606	FACILITY MAINTENANCE SHOP
608	C.I. FLAMMABLE STORAGE BUILDING
*☆ 700	CONTAINER MANAGEMENT UNIT
701	OPERATION OFFICE
*☆ 702	CONTAINER MANAGEMENT UNIT
*[1]☆ 703	ORGANIC CONTAINER & TANK MANAGEMENT UNIT (INACTIVE)
*[1]☆ 703A	CONTAINER MANAGEMENT UNIT
704	AIR COMPRESSOR BUILDING
707	CONSOLIDATED TECH SERVICES BLDG.
☆ 708	LABORATORY & TANK STORAGE UNIT
☆ 900	WHEEL WASH & TANK STORAGE UNIT
901	REFUELING STATION
908	TRANSPORTATION FUELING
909	HEAVY EQUIPMENT FUELING
1000	BULK SAMPLING STATION
1001	UNIT 1000 BREAKROOM/OFFICE/LAB
1002	UNIT 1000 SHED
*☆ 1200A	CONTAINMENT BUILDING/ CONTAINER & TANK MANAGEMENT UNIT
1300	WHEEL WASH CLEAN WATER STORAGE
☆ 1400	TANK MANAGEMENT UNIT
☆ 1700	LEACHATE TANK STORAGE UNITS (MULTIPLE LOCATIONS – A, B & C)
☆ 2000	CONTAINER MANAGEMENT UNIT
2001	LEACHATE TREATMENT PLANT
*☆ 2200	CONTAINER STORAGE UNIT

* TSCA REGULATED UNIT
*[1] TSCA REGULATED UNIT – LOADING STATION ONLY
☆ RCRA REGULATED UNIT

NOTES:

1. TOPOGRAPHIC SURVEY FLOWN BY SOUTHERN RESOURCES MAPPING DATED 1/19/2020 AND 5/14/2020.
2. FEMA 100 YEAR FLOOD PLAIN FIRM #01119C0075D EFFECTIVE 4/3/2012.
3. PROPERTY BOUNDARY SURVEY CONDUCTED BY EP & ASSOCIATES, CERTIFIED 12/13/2022.

CREATED: 1/4/2023 LAST SAVED: 1/5/2023 BY: BANNIERM PLOT DATE: 1/10/2023

Jacobs
10 Tenth Street
Suite 1400
Atlanta, GA 30309 | 404.978.7600

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY

SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	12/22	UPDATE PROPERTY BOUNDARY
5.0	08/22	RCRA PART B PERMIT RENEWAL

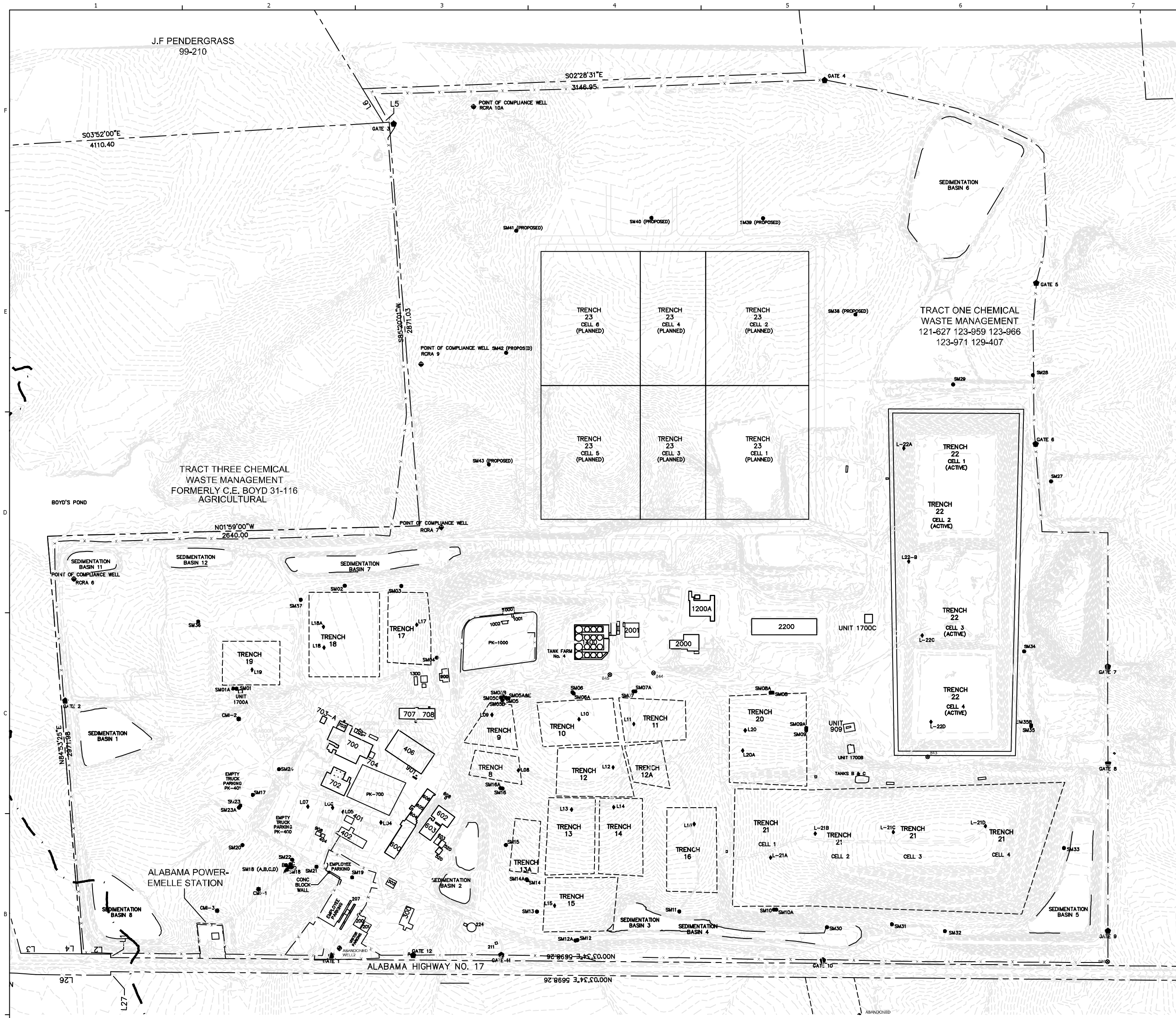
THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022
DISC. LEAD: MTF | DESIGNER: MRC | CHECKER: SBT

SHEET TITLE
SITE PLAN

SHEET
FIGURE E-1.1



LEGEND

EXISTING BUILDING/PROPOSED BUILDING
SEDIMENTATION BASIN
PROPERTY LINE
FENCE
SELMA CHALK MONITORING WELL LOCATION ● SM32
CMI PLAN SENTRY WELL LOCATION CMI-1
RCRA MONITORING WELL LOCATION (EUTAW AQUIFER) RCRA 8R
LEACHATE RISER LOCATION ♦ L-21B

UNIT IDENTIFICATION LEGEND

	NO.	IDENTIFICATION
	200	ADMINISTRATIVE OFFICE
	201	ADMINISTRATIVE OFFICE
	207	GUARD HOUSE/SCALES
	224	FIRE SYSTEM PUMP HOUSE/TANK
	300	HEAVY EQUIPMENT MAINT.
	302	DOCUMENT STORAGE
	401	PAINT & WASH BUILDING
	402	TRANSPORTATION SHOP
	404	SHOWER, LOCKER FACILITY & CAFETERIA
*☆	406	CONTAINER STORAGE UNIT
*☆	520	CONTAINER AND TANK MANAGEMENT UNIT
*☆	600	TANK MANAGEMENT UNIT
*☆	602	CONTAINER STORAGE UNIT
*☆	603	CONTAINER STORAGE UNIT
*☆	604	CONTAINER MANAGEMENT UNIT
	605	CENTRAL INVENTORY
	606	FACILITY MAINTENANCE SHOP
	608	C.I. FLAMMABLE STORAGE BUILDING
*☆	700	CONTAINER MANAGEMENT UNIT
	701	OPERATION OFFICE
* ☆	702	CONTAINER MANAGEMENT UNIT
*1 ☆	703	ORGANIC CONTAINER & TANK MANAGEMENT UNIT (INACTIVE)
*1 ☆	703A	CONTAINER MANAGEMENT UNIT
	704	AIR COMPRESSOR BUILDING
	707	CONSOLIDATED TECH SERVICES BLDG.
☆	708	LABORATORY & TANK STORAGE UNIT
☆	900	WHEEL WASH & TANK STORAGE UNIT
	901	REFUELING STATION
	908	TRANSPORTATION FUELING
	909	HEAVY EQUIPMENT FUELING
	1000	BULK SAMPLING STATION
	1001	UNIT 1000 BREAKROOM/OFFICE/LAB
	1002	UNIT 1000 SHED
*☆	1200A	CONTAINMENT BUILDING/ CONTAINER & TANK MANAGEMENT UNIT
	1300	WHEEL WASH CLEAN WATER STORAGE
☆	1400	TANK MANAGEMENT UNIT
☆	1700	LEACHATE TANK STORAGE UNITS (MULTIPLE LOCATIONS – A, B & C)
☆	2000	CONTAINER MANAGEMENT UNIT
	2001	LEACHATE TREATMENT PLANT
*☆	2200	CONTAINER STORAGE UNIT

* TSCA REGULATED UNIT
*1 TSCA REGULATED UNIT – LOADING STATION ONLY
☆ RCRA REGULATED UNIT

NOTES:

1. TOPOGRAPHIC SURVEY FLOWN BY SOUTHERN RESOURCES MAPPING DATED 1/19/2020 AND 5/14/2020.
2. FEMA 100 YEAR FLOOD PLAIN FIRM #01119C0075D EFFECTIVE 4/3/2012.

0 300' 600'

Jacobs
10 Tenth Street
Suite 1400
Atlanta, GA 30309 404.978.7600

RCRA PART B PERMIT APPLICATION

CHEMICAL WASTE MANAGEMENT INC.
EMELLE, ALABAMA TREATMENT FACILITY
SUMTER COUNTY, AL

REV	DATE	REVISION DESCRIPTION
5.0	08/22	RCRA PART B PERMIT RENEWAL

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: D3279702
DATE: AUGUST 2022

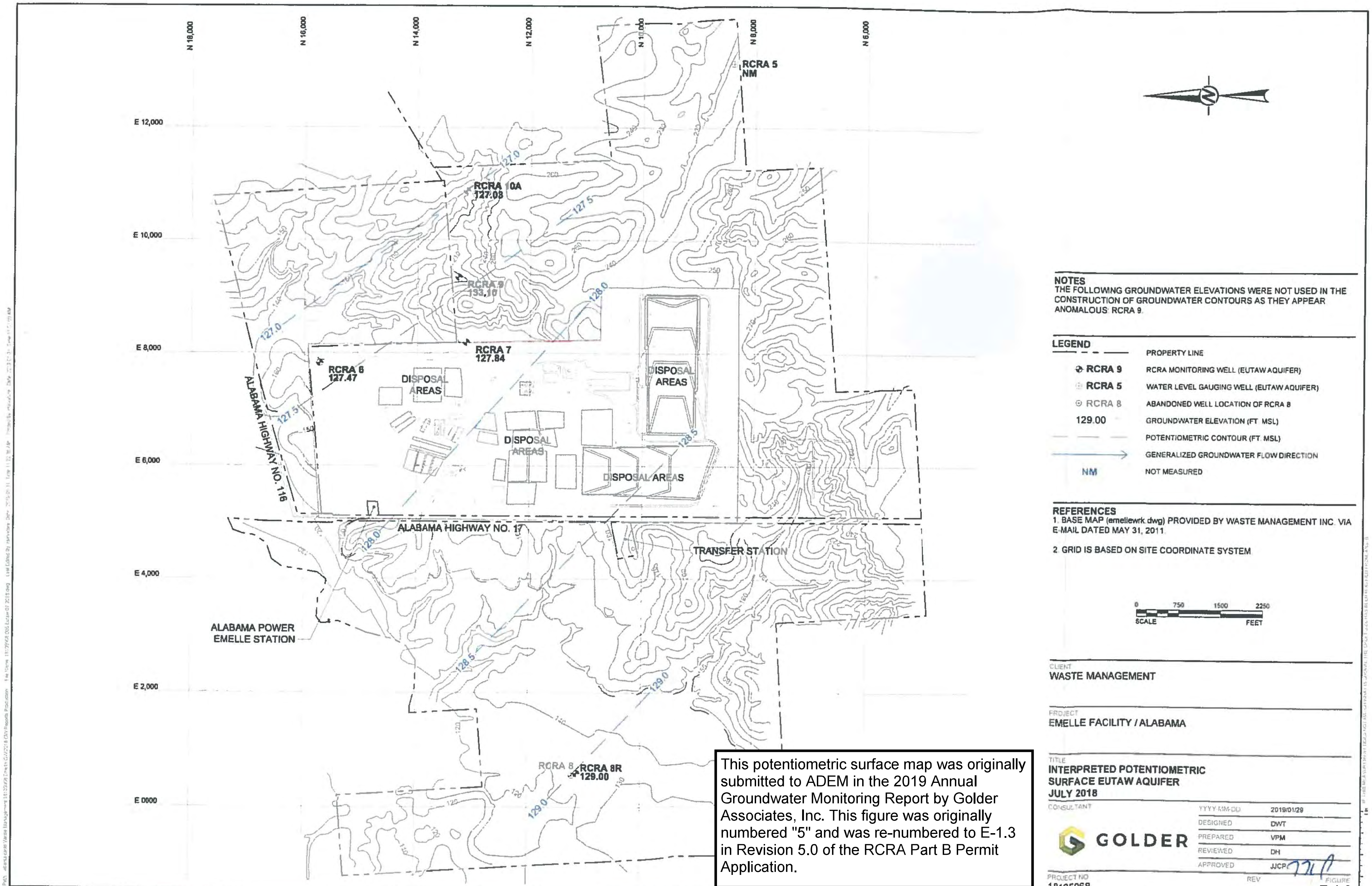
DISC. LEAD:	DESIGNER:	CHECKER:
MTF	MRC	SBT

SHEET TITLE

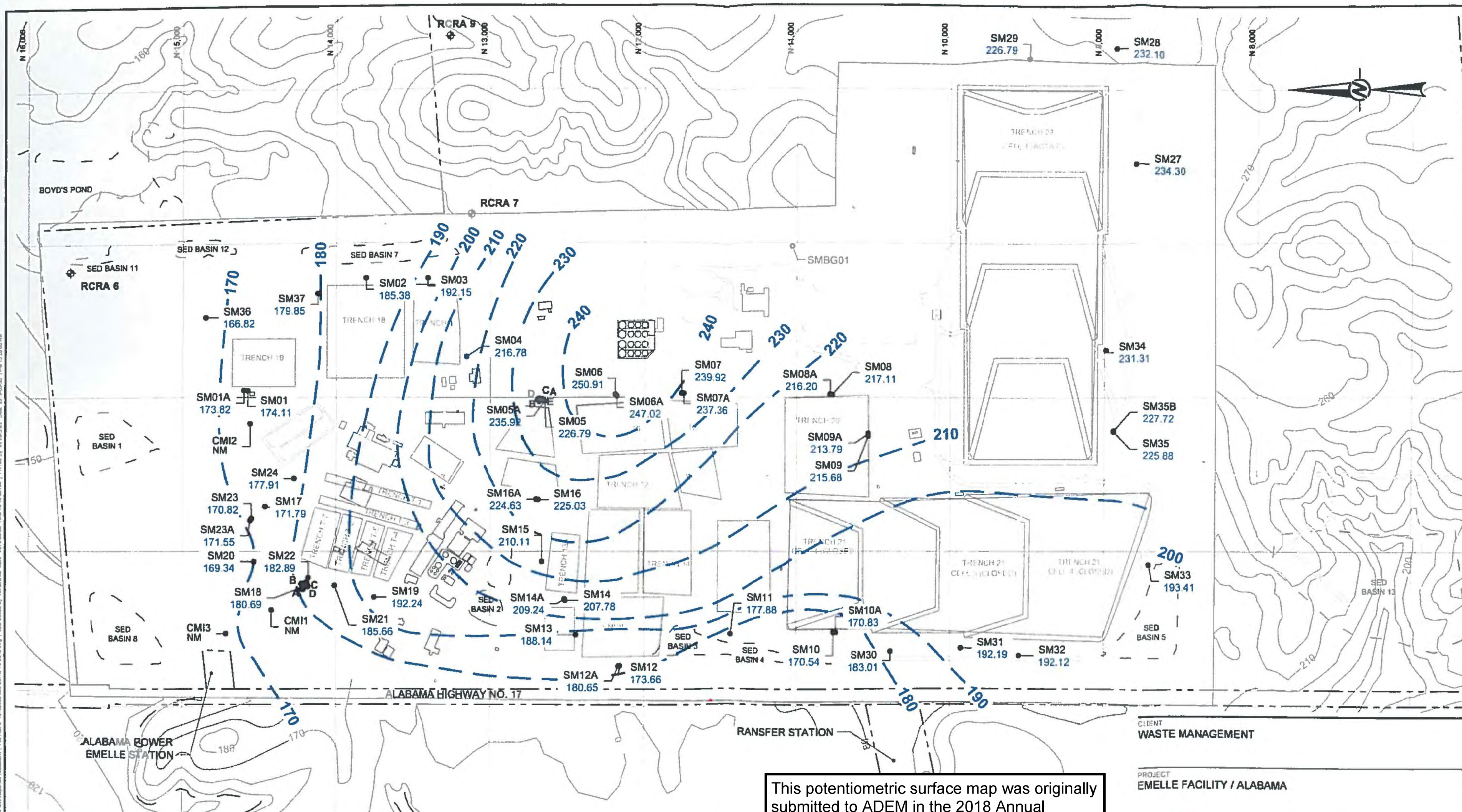
MONITORING WELL LOCATIONS

SHEET FIGURE E-1.2

CREATED: 10/12/2020 LAST SAVED: 3/5/2021 BY: COSNERM PLOT DATE: 7/22/2022



This potentiometric surface map was originally submitted to ADEM in the 2019 Annual Groundwater Monitoring Report by Golder Associates, Inc. This figure was originally numbered "5" and was re-numbered to E-1.3 in Revision 5.0 of the RCRA Part B Permit Application.



LEGEND

— - —	PROPERTY LINE
⊕ RCRA 9	RCRA MONITORING WELL (EUTAW AQUIFER)
● SM01	SHALLOW MONITORING WELL (SELMA CHALK)
NM	NOT MEASURED
○ SMBG01	ABANDONED WELL
172.82	GROUNDWATER ELEVATION (FT. MSL)
— — —	POTENTIOMETRIC CONTOUR (FT. MSL)

REFERENCES

1. BASE MAP (emellewrk.dwg) PROVIDED BY WASTE MANAGEMENT INC. VIA E-MAIL DATED MAY 31, 2011.
2. GRID IS BASED ON SITE COORDINATE SYSTEM.

NOTE

1. SM12 AND SM05 DATA NOT USED FOR CONTOURING.

This potentiometric surface map was originally submitted to ADEM in the 2018 Annual Groundwater Monitoring Report by Golder Associates, Inc. This figure was originally numbered "8" and was re-numbered to E-1.4 in Revision 5.0 of the RCRA Part B Permit Application.

SCALE 0 300 600 900 FEET

CLIENT
WASTE MANAGEMENT

PROJECT
EMELLE FACILITY / ALABAMA

TITLE
INTERPRETED POTENTIOMETRIC SURFACE SELMA AQUIFER OCTOBER 2018

CONSULTANT: GOLDER

YYYY-MM-DD	2019/01/29
DESIGNED	DWT
PREPARED	VPM
REVIEWED	DH
APPROVED	JJCP

PROJECT NO. 18105968 REV. - FIGURE E-1.4

APPENDIX E-2

SECTION E

TABLES

Revision No.
5.0

APPENDIX E-2

SECTION E

LIST OF TABLES

Table E-2.1
Eutaw Formation
Groundwater Monitoring Parameters

ORGANIC COMPOUNDS[1]	MDL[3] (µg/L)	PQL[3] (µg/L)	GWPS[4] (µg/L)
Benzene	0.0896	1	5
Chloroform	0.086	1	80
1,1-Dichloroethane	0.114	1	2.8[5]
1,2-Dichlorobenzene	0.101	1	600
1,2-Dichloroethane	0.108	1	5
trans-1,2-Dichloroethylene	0.152	0.50	100
Methylene Chloride	1.07	2.50	5
Tetrachloroethylene	0.199	1	5
Toluene	0.412	1	1,000
1,2,4-Trichlorobenzene	0.355	0.50	70
Trichloroethylene	0.153	1	5
Vinyl Chloride	0.118	1	2
INORGANIC ELEMENTS[2]	**MDL[3] (µg/L)**	**PQL[3] (µg/L)**	**GWPS[4] (µg/L)**
Arsenic	6.5	10	10
Chromium	1.4	10	100
Nickel	4.9	40	100
Vanadium	2.4	8.6	8.6[5]

Notes:

1 All organics analyzed by GC/MS VOC Method 8260b as defined in EPA Report SW 846 "Test Methods for Evaluating Solid Waste". Other methods may be used if they are approved by ADEM and the Facility.

2 Inorganics analyzed by ICP method or ICP trace recommended for Arsenic. Other methods may be used if they are approved by ADEM and the Facility.

3 Method Detection Limits (MDLs) and Practical Quantitation Limits (PQLs) provided by Pace Analytical Services laboratory.

4 The groundwater protection standard (GWPS) for each constituent is the Maximum Contaminant Level (MCL) in accordance with ADEM Admin. Code Rule 335-14-5-.06(5)(a)2. For constituents that do not have an MCL, the GWPS will be established using USEPA Regional Screening Level (RSL) tapwater values (TR=1E-06; THQ=0.1; May 2022) in accordance with the Alabama Risk-Based Corrective Action Guidance Manual (ARBCA) (Revision 3.0 or most current version). Additional details to establish applicable GWPSs are provided in Subsection E-4 of Section E of this Permit Application.

5 GWPS established using RSL per the ARBCA.

Table E-2.2
Selma Chalk
Groundwater Monitoring Parameters

ORGANIC COMPOUNDS[1]	METHOD	GWPS[3] (µg/L)
Benzene	8260b	5
Bromodichloromethane	8260b	80[4]
Bromoform	8260b	80[4]
Bromomethane	8260b	0.75[5]
Carbon Tetrachloride	8260b	5
Chlorobenzene	8260b	100
Chloroethane	8260b	830[5]
2-Chloroethylvinyl ether	8260b	NE[6]
Chloroform	8260b	80[4]
Chloromethane	8260b	19[5]
Dibromochloromethane	8260b	80[4]
Dichlorodifluoromethane	8260b	20
1,2-Dichlorobenzene	8260b	600
1,1-Dichloroethane	8260b	2.8[5]
1,2-Dichloroethane	8260b	5
1,1-Dichloroethylene	8260b	7
trans-1,2-Dichloroethylene	8260b	100
cis-1,2-Dichloroethene	8260b	70
1,2-Dichloropropane	8260b	5
cis-1,3-Dichloropropylene	8260b	0.47[5]
trans-1,3-Dichloropropylene	8260b	0.47[5]
Ethylbenzene	8260b	700
Methylene Chloride	8260b	5
1,1,2,2-Tetrachloroethane	8260b	0.076[5]
Tetrachloroethylene	8260b	5
Toluene	8260b	1,000
1,1,1-Trichloroethane	8260b	200
1,1,2-Trichloroethane	8260b	5

Table E-2.2 Selma Chalk Groundwater Monitoring Parameters		
ORGANIC COMPOUNDS[1]	**METHOD**	**GWPS[3] (µg/L)**
Trichloroethylene	8260b	5
Trichlorofluoromethane	8260b	520[5]
Vinyl Chloride	8260b	2
INORGANIC ELEMENTS[2]	**METHOD**	**GWPS[3] (µg/L)**
Arsenic	6020	10
Barium	6010b	2,000
Chromium	6010b	100
Manganese	6010b	43[5]
Nickel	6010b	100
Vanadium	6010b	8.6[5]

Notes:

1 All organics analyzed by GC/MS VOC Method 8260b as defined in EPA Report SW 846 "Test Methods for Evaluating Solid Wastes". Other methods may be used if they are approved by ADEM and the Facility.

2 Inorganics analyzed by ICP method or ICP trace recommended for Arsenic. Other methods may be used if they are approved by the ADEM and the Facility.

3 The groundwater protection standard (GWPS) for each constituent is the Maximum Contaminant Level (MCL) in accordance with ADEM Admin. Code Rule 335-14-5-.06(5)(a)2. For constituents that do not have an MCL, the GWPS will be established using USEPA Regional Screening Level (RSL) tapwater values (TR=1E-06; THQ=0.1; May 2022) in accordance with the Alabama Risk-Based Corrective Action Guidance Manual (ARBCA) (Revision 3.0 or most current version). Additional details to establish applicable GWPSs are provided in Subsection E-5 of Section E of this Permit Application.

4 The total MCL for trihalomethanes is 80 µg/L.

5 GWPS established using RSL per the ARBCA.

6 Not Established. No MCL or USEPA RSL exists. An ACL will be established if a detection is confirmed in accordance with Subsection E-5 of Section E of this Permit Application.

Table E-2.3
Monitoring Well Details[1]
Chemical Waste Management, Inc. - Emelle Facility

Well Number	Well Type[2]	Applicable Permit	Date of Installation	Date of Abandonment (Archives)	Northing[7]	Easting[7]	Unit(s) Monitored[3]	Depth (ft)	Ground Elevation (ft. MSL)	Top-of-Casing Elevation (ft. MSL)	Screened Interval (ft. MSL)	Monitored Zone	Sampling Frequency[4]
ACTIVE MONITORING WELLS													
RCRA5	PGM	RCRA	9/13/1985	Active	8390.4	13120.98	Entire Site	736	213	214.04	(-) 480 - 520	Eutaw Aquifer	Groundwater elevations only
RCRA6	POC/BDY	RCRA	5/24/1983	Active	15729.3	7821.6	Entire Site	645	164	163.20	(-) 442 - 482	Eutaw Aquifer	Semi-annually
RCRA7	POC/BDY	RCRA	5/30/1983	Active	13121.9	8187	Entire Site	724	206	207.70	(-) 476 - 516	Eutaw Aquifer	Semi-annually
RCRA8R	BKG	RCRA	9/10/2015	Active	11126.82	590.5	Entire Site	710	132	136.83	(-) 558 - 518	Eutaw Aquifer	Semi-annually
RCRA9	POC/BDY	RCRA	10/15/1985	Active	13266.18	9345.02	Entire Site	734	209	216.65	(-) 482 - 522	Eutaw Aquifer	Semi-annually
RCRA10A	POC/BDY	RCRA	5/4/1999	Active	12893.63	11170.28	Entire Site	726	219.06	221.31	(-) 359.94 - 502.54	Eutaw Aquifer	Semi-annually
SMBG02	BKG	RCRA	2/8/1986	Active	6475.8	6551.1	Entire Site	100.6	260.22	263.22	172.52 - 162.62	Selma Chalk	Semi-annually
SM01	CSM	RCRA	2/4/1986	Active	14575.15	7043.23	T-19	56.29	174.26	179.33	128.01 - 123.16	Selma Chalk	Semi-annually
SM01A	CSM	RCRA	2/4/1986	Active	14601.06	7045.05	T-19	74.71	174.17	179.75	115.02 - 105.17	Selma Chalk	Semi-annually
SM02	CSM	RCRA	1/14/1986	Active	13808.05	7773.32	T-18	153.46	198.7	202.08	58.60 - 48.75	Selma Chalk	Semi-annually
SM03	CSM	RCRA	1/20/1986	Active	13406.69	7771.48	T-18	88.81	205.8	207.53	128.76 - 118.91	Selma Chalk	Semi-annually
SM04	CSM	RCRA	1/17/1986	Active	13153.53	7262.67	T-17	119.5	230.9	238.92	129.85 - 120.0	Selma Chalk	Semi-annually
SM05	CSM	RCRA	3/6/1986	Active	12663.26	6978.19	T-9, T-10	61.84	253.2	255.14	198.11 - 193.26	Selma Chalk	Semi-annually
SM05A	CSM	RCRA	3/6/1986	Active	12645.81	6975.44	T-9, T-10	107.21	253.6	255.85	158.43 - 148.58	Selma Chalk	Semi-annually
SM05B	CSM	RCRA	9/10/1986	Active	12684.41	6990.77	T-9, T-10	75	254.36	256.56	182.4 - 202.4	Selma Chalk	Semi-annually
SM05C	CSM	RCRA	9/11/1986	Active	12700.06	6980.79	T-9, T-10	59.9	252.64	253.95	192.9 - 197.9	Selma Chalk	Semi-annually
SM05D	CSM	RCRA	9/15/1986	Active	12689.51	6962.42	T-9, T-10	73.8	252.49	255.34	181.0 - 191.0	Selma Chalk	Semi-annually
SM05E	CSM	RCRA	9/16/1986	Active	12645.81	6975.44	T-9, T-10	45	253.9	259.02	211.9 - 221.9	Selma Chalk	Semi-annually
SM06	CSM	RCRA	3/3/1986	Active	12192.43	7018.19	T-10	100.1	272.5	275.89	180.65 - 175.80	Selma Chalk	Semi-annually
SM06A	CSM	RCRA	3/6/1986	Active	12182.83	7008.59	T-10	141.43	273.1	276.21	144.64 - 134.79	Selma Chalk	Semi-annually
SM07	CSM	RCRA	3/13/1986	Active	11759.02	7023.96	T-11	108.16	274.4	278.05	174.82 - 169.94	Selma Chalk	Semi-annually
SM07A	CSM	RCRA	3/11/1986	Active	11746.54	7024.22	T-11	123.3	274.5	277.06	163.61 - 153.76	Selma Chalk	Semi-annually
SM08	CSM	RCRA	2/4/1986	Active	10772.61	7015.2	T-20	132.9	263.4	265.53	142.49 - 132.64	Selma Chalk	Semi-annually
SM08A	CSM	RCRA	2/4/1986	Active	10786.37	7015.77	T-20	186.31	263.4	265.97	89.54 - 79.69	Selma Chalk	Semi-annually
SM09	CSM	RCRA	2/21/1986	Active	10533.7	6748.51	T-20	155.4	247.4	252.10	101.55 - 96.70	Selma Chalk	Semi-annually
SM09A	CSM	RCRA	2/20/1986	Active	10533.45	6764.36	T-20	170.7	247.9	252.68	91.81 - 81.96	Selma Chalk	Semi-annually

Table E-2.3
Monitoring Well Details[1]
Chemical Waste Management, Inc. - Emelle Facility

Well Number	Well Type[2]	Applicable Permit	Date of Installation	Date of Abandonment (Archives)	Northing[7]	Easting[7]	Unit(s) Monitored[3]	Depth (ft)	Ground Elevation (ft. MSL)	Top-of-Casing Elevation (ft. MSL)	Screened Interval (ft. MSL)	Monitored Zone	Sampling Frequency[4]
SM10	CSM	RCRA	2/5/1986	Active	10762.21	5476.44	T-21A	88.76	191.26	228.07	144.71 - 139.8	Selma Chalk	Semi-annually
SM10A	CSM	RCRA	2/7/1986	Active	10746.23	5476.2	T-21A	146.9	191.27	228.67	92.4 - 82.5	Selma Chalk	Semi-annually
SM11	CSM	RCRA	1/21/1986	Active	11434.22	5463.58	T-16	103.45	197.66	200.83	107.56 - 97.7	Selma Chalk	Semi-annually
SM12	CSM	RCRA	2/12/1986	Active	12156.54	5261.04	T-15	66.14	191.88	195.68	134.78 - 129.88	Selma Chalk	Semi-annually
SM12A	CSM	RCRA	2/12/1986	Active	12170.82	5258.13	T-15	132.08	191.46	195.56	75.36 - 65.46	Selma Chalk	Semi-annually
SM13	CSM	RCRA	3/5/1986	Active	12444.4	5462.61	T-15	145.39	209.5	212.69	77.42 - 67.57	Selma Chalk	Semi-annually
SM14	CSM	RCRA	3/18/1986	Active	12512.25	5683.45	T-15	72.96	222.1	223.32	155.6 - 150.6	Selma Chalk	Semi-annually
SM14A	CSM	RCRA	3/17/1986	Active	12515.93	5692.07	T-15	83.6	221.5	222.61	149.14 - 139.3	Selma Chalk	Semi-annually
SM15	CSM	RCRA	3/5/1986	Active	12664.01	5935.02	T-13	93.5	223.8	226.39	142.88 - 133.08	Selma Chalk	Semi-annually
SM16	CSM	RCRA	2/26/1986	Active	12688.02	6335.4	T-8	90.2	250.5	251.91	167.0 - 162.2	Selma Chalk	Semi-annually
SM16A	CSM	RCRA	2/27/1986	Active	12702.56	6337.77	T-8	101.5	249.7	251.09	159.6 - 149.8	Selma Chalk	Semi-annually
SM17	CSM/EFF	RCRA	9/1986	Active	14460.62	6290.44	T-4, T-5, T-6, T-7	34	176.6	179.62	179.04 - 169.04	Selma Chalk	Semi-annually
SM18	CSM/EFF	RCRA	9/1986	Active	14205.56	5777.16	T-4, T-5, T-6, T-7	41.5	201.04	204.56	172.04 - 162.04	Selma Chalk	Semi-annually
SM19	CSM/EFF	RCRA	9/1986	Active	13754.82	5704.98	T-4, T-5, T-6, T-7	78.5	198.92	202.32	133.92 - 123.92	Selma Chalk	Semi-annually
SM20	CSM/EFF	RCRA	9/1986	Active	14533.04	5934.21	T-4, T-5, T-6, T-7	68.5	176.13	179.55	121.13 - 111.13	Selma Chalk	Semi-annually
SM21	CSM/EFF	RCRA	9/1986	Active	14008.17	5780.48	T-4, T-5, T-6, T-7	93.5	197.08	200.51	117.08 - 107.08	Selma Chalk	Semi-annually
SM22	CSM/EFF	RCRA	9/1986	Active	14180.28	5830.04	T-4, T-5, T-6, T-7	93.5	197.02	200.42	117.02 - 107.02	Selma Chalk	Semi-annually
SM23	CSM/EFF	RCRA	9/1986	Active	14548.28	6213.5	T-4, T-5, T-6, T-7	55	172.89	175.78	135.89 - 120.89	Selma Chalk	Semi-annually
SM23A	CSM/EFF	RCRA	1987	Active	14557.82	6200.43	T-4, T-5, T-6, T-7	68.5	172.64	176.03	117.64 - 107.64	Selma Chalk	Semi-annually
SM24	CSM/EFF	RCRA	9/1986	Active	14274.36	6472.32	T-4, T-5, T-6, T-7	58.5	180.19	183.58	135.19 - 125.19	Selma Chalk	Semi-annually
SM27	CSM	RCRA/TSCA	11/4/1997	Active	8796.86	8513.93	T-22	107.5	254	255.69	184 - 179 166.5 - 161.5	Selma Chalk	Semi-annually
SM28	CSM	RCRA/TSCA	11/11/1997	Active	8925.47	9266.76	T-22	97	238.9	242.55	176.9 - 169.9 154.9 - 144.9	Selma Chalk	Semi-annually
SM29	CSM	RCRA/TSCA	11/10/1997	Active	9491.47	9200.56	T-22	103	244.37	247.72	169.37 - 164.37 154.37 - 144.37	Selma Chalk	Semi-annually
SM30	CSM	RCRA	12/15/1998	Active	10386.92	5351.478	T-21	122.94	192.4	195.34	82.4 - 72.4	Selma Chalk	Semi-annually
SM31	CSM	RCRA	12/17/1998	Active	9926.53	5372.605	T-21	125.43	207.8	211.23	140.8 - 134.8 95.8 - 85.8	Selma Chalk	Semi-annually
SM32	CSM	RCRA	12/21/1998	Active	9550.473	5323.801	T-21	120.19	209.7	212.89	152.7 - 147.7 102.7 - 92.7	Selma Chalk	Semi-annually
SM33	CSM	RCRA	12/23/1998	Active	8705.229	5913.173	T-21	112.95	204.43	208.38	125.43 - 95.43	Selma Chalk	Semi-annually

Table E-2.3
Monitoring Well Details[1]
Chemical Waste Management, Inc. - Emelle Facility

Well Number	Well Type[2]	Applicable Permit	Date of Installation	Date of Abandonment (Archives)	Northing[7]	Easting[7]	Unit(s) Monitored[3]	Depth (ft)	Ground Elevation (ft. MSL)	Top-of-Casing Elevation (ft. MSL)	Screened Interval (ft. MSL)	Monitored Zone	Sampling Frequency[4]
SM34	CSM	RCRA	5/6/2005	Active	8988.06	7307.31	T-21	93.5	249.1	252.26	166.10 - 156.10	Selma Chalk	Semi-annually
SM35	CSM	RCRA	2/15/2012	Active	8938.37	6777.5	T-22	105.0	256.6	259.89	95 - 105	Selma Chalk	Semi-annually
SM35B	CSM	RCRA	5/1/2012	Active	8937.88	6782.73	T-22	89.0	256.6	259.78	59 - 64 84 - 89	Selma Chalk	Semi-annually
SM36	CSM	RCRA	1/13/2012	Active	14847.10	7519.47	T-19	84.0	192.4	195.08	74 - 84	Selma Chalk	Semi-annually
SM37	CSM	RCRA	1/12/2012	Active	14120.58	7674.03	T-18, T-17	156.0	194.9	198.08	146 - 156	Selma Chalk	Semi-annually
CMI-1	CMI/EFF	RCRA	1/12/2012	Active	14419.69	5221.66	T-1, T-3, T-4, T-5, T-6, T-7	39.0	194.4	197.77	29 - 39	Selma Chalk	Annually
CMI-2	CMI/EFF	RCRA	1/18/2012	Active	14560.18	6829.53	L-3, L-4	18.4	174.6	177.07	8.4 - 18.4	Selma Chalk	Annually
CMI-3	CMI/EFF	RCRA	6/28/2013	Active	14712.42	5468.91	T-1, T-3, T-4, T-5, T-6, T-7	22.0	174.0	176.41	12 - 22	Selma Chalk	Annually
INACTIVE & ABANDONED MONITORING WELLS													
RCRA1	Inactive	RCRA	10/1964	Inactive	16391.31	559.91	Entire Site	940	N/A	N/A	N/A	Eutaw Aquifer	N/A[6]
RCRA2	ABN	RCRA	1978	Abandoned	13844.99	5202.96	Entire Site	1085	N/A	N/A	N/A	Eutaw Aquifer	N/A
RCRA3	ABN	RCRA	1960	Abandoned	10158.15	4723.5	Entire Site	670	N/A	N/A	N/A	Eutaw Aquifer	N/A
RCRA4	ABN	RCRA	1960	Abandoned	11276.74	579.18	Entire Site	700	N/A	N/A	N/A	Eutaw Aquifer	N/A
RCRA8	ABN	RCRA	5/13/1983	9/14/2015	11212	552.54	Entire Site	719	N/A	N/A	N/A	Eutaw Aquifer	N/A
RCRA10	ABN	RCRA	1/20/1998	3/1998	13223.17	11146.06	Entire Site	725	237.56	N/A	N/A	Eutaw Aquifer	N/A
RCRA10R	ABN	RCRA	3/22/1998	1999	13280.89	10965.25	Entire Site	725	229.8	N/A	N/A	Eutaw Aquifer	N/A
M-3	ABN	TSCA	1983	7/20/2017	14413.07	6200.32	T-4, T-5, T-6, T-7	61.66	173.71	N/A	N/A	Selma Chalk	N/A
M-54	ABN	TSCA	1986	7/20/2017	11091.35	6684.71	T-20	154.8	242.06	N/A	N/A	Selma Chalk	N/A
M-55	ABN	TSCA	1983	7/20/2017	10823.63	6295.65	T-21A	170.25	245.85	N/A	N/A	Selma Chalk	N/A
M-56	ABN	TSCA	1983	7/20/2017	14112.86	5860.67	T-4, T-5, T-6, T-7	96.48	201.88	N/A	N/A	Selma Chalk	N/A
M-57	ABN	TSCA	1986	7/20/2017	13795.75	7112	T-18	156.59	204.28	N/A	N/A	Selma Chalk	N/A
M-58	ABN	TSCA	1983	7/20/2017	12688.55	7047.96	T-9	110.5	249.95	N/A	N/A	Selma Chalk	N/A
M-59	ABN	TSCA	1983	7/20/2017	13883.75	5673.26	T-4, T-5, T-6, T-7	102.4	196.87	N/A	N/A	Selma Chalk	N/A
M-61	ABN	TSCA	1983	7/20/2017	12994.73	6349.21	T-9	104.47	215.02	N/A	N/A	Selma Chalk	N/A
M-62	ABN	TSCA	1986	7/20/2017	12499.47	6279.17	T-8	158.6	257.97	N/A	N/A	Selma Chalk	N/A
M-64	ABN	TSCA	7/28/1986	7/20/2017	12288.77	6997.77	T-10	151.2	271.6	N/A	N/A	Selma Chalk	N/A
M-65	ABN	TSCA	1983	7/20/2017	11624.82	7156.02	T-11	130.24	275.66	N/A	N/A	Selma Chalk	N/A

Table E-2.3
Monitoring Well Details[1]
Chemical Waste Management, Inc. - Emelle Facility

Well Number	Well Type[2]	Applicable Permit	Date of Installation	Date of Abandonment (Archives)	Northing[7]	Easting[7]	Unit(s) Monitored[3]	Depth (ft)	Ground Elevation (ft. MSL)	Top-of-Casing Elevation (ft. MSL)	Screened Interval (ft. MSL)	Monitored Zone	Sampling Frequency[4]
M-66	ABN	TSCA	1986	7/20/2017	11422.69	6535.25	T-12A	118.62	249.99	N/A	N/A	Selma Chalk	N/A
M-68	ABN	TSCA	1986	7/20/2017	12463.18	5267.95	T-15	117.6	198.93	N/A	N/A	Selma Chalk	N/A
M-69	ABN	TSCA	1986	7/20/2017	13711.44	7441.22	T-17	143.3	230.69	N/A	N/A	Selma Chalk	N/A
PM-17	ABN	TSCA	1986	7/20/2017	11388.82	5509.26	T-16	112.02	201.82	N/A	N/A	Selma Chalk	N/A
PM-18	ABN	TSCA	1986	7/20/2017	11104.51	5837.66	T-16	163.58	222.62	N/A	N/A	Selma Chalk	N/A
SM18A	Inactive	RCRA	12/1994	Inactive	14217.12	5759.15	T-4, T-5, T-6, T-7	48.6	203.3	206.27	158.3 - 148.3	Selma Chalk	N/A
SM18B	Inactive	RCRA	12/1994	Inactive	14222.8	5791.05	T-4, T-5, T-6, T-7	47.7	201.7	204.72	158.7 - 147.7	Selma Chalk	N/A
SM18C	Inactive	RCRA	12/1994	Inactive	14193.01	5798.89	T-4, T-5, T-6, T-7	43.6	198.9	201.93	159.9 - 149.9	Selma Chalk	N/A
SM18D	Inactive	RCRA	12/1994	Inactive	14184.5	5776.88	T-4, T-5, T-6, T-7	43.8	200.1	203.14	160.6 - 150.6	Selma Chalk	N/A
SM25	ABN	RCRA	1988	12/9/1994	14384.68	6562.59	Lagoon 3 (clean closed 8/1989)	N/A	N/A	N/A	N/A	Selma Chalk	N/A
SM26	ABN	RCRA	1988	12/9/1994	14452.71	6654.19	Lagoon 3 (clean closed 8/1989)	N/A	N/A	N/A	N/A	Selma Chalk	N/A
SMBG01	ABN	RCRA	2/4/1986	7/27/2017	11030.32	7976.1	Entire Site	100.7	293.4	N/A	N/A	Selma Chalk	N/A

[1] All wells added to the monitoring system(s) puruant to Part XI of this permit and/or as stipulated in Section E-5a and Appendix E-1, Figure E-1.2 of the permit application shall be added to this table upon installation.

[2] Well Type:
- PGM - Piezometers and/or General Monitoring Wells
- POC - Point of Compliance Wells
- BDY - Boundary Monitoring Wells
- BKG - Background Wells
- CSM - Selma Chalk Surveillance Monitoring Wells
- EFF - Effectiveness Monitoring Wells
- CMI - CMI Plan Sentry Wells
- ABN - Abandoned Wells

[3] "Unit(s) Monitored" indicates primary unit(s) monitored by the well; however, the well may also monitor other unit(s) in the area.

[4] Groundwater elevation measurements are required quarterly pursant to Condition XI.B.2.a.

[5] Well SMBG01 was operated as a background monitoring well for data collected prior to May 1996 (opening of Cell 1 of Trench 22)

[6] N/A - Not Applicable - the well is abandoned or inactive.

[7] Northing and Easting coordinates based on site coordinate system.

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SMBG-02

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	0.0495
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-01

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-02

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-03

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.1	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-05

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-05A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	24	25	31	30	33	29	22	18	27.1
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-05C

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-05D

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	1.1	-	-	2.22
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	1.1	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	17	23	29	22	31	20	-	25	17
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	1.1	1.2	1.4	1.5	2.4	2.1	-	2.6	1.68
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	11	9.8	18	9.5	15	7.8	-	18	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-05E

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	23	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	2.2	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	6.9	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-06

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.5	1.1	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-06A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.4	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-07

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.7	1.2	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-07A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.5	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.2	-	1.8	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-08A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.4	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-09

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.3	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-09A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.3	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-10

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.2	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-10A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-11

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-12

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-12A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Bromide	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.3	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-13

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.1	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-14

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-14A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.1	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-15

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-16

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-16A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-17

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.3	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-18

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	790	750	850	660	820	750	650	670	611
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	35	39	31	-	30	-	28	30.3
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	1.56
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	5.38
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	21	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	4.12
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	1.72
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	24	33	-	-	29	-	-	33.4
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-19

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.3	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	0.96
Nickel, total	µg/L	-	-	-	-	-	-	-	-	0.999
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	0.975

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-20

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.2	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-21

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.5	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-22

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.5	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-23

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-23A

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-24

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	1.4	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-27

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-28

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	0.0482
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-29

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-30

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-31

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.2	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-32

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.3	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	*	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-33

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	1.5	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	0.0491
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-34

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-35

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	*	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	*	-	-
1,2-Dichloroethane	µg/L	-	8.9	-	-	-	-	*	49	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	*	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	*	-	-
Benzene	µg/L	-	-	-	-	-	-	*	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	*	-	-
Bromoform	µg/L	-	-	-	-	-	-	*	-	-
Bromomethane	µg/L	-	-	-	-	-	-	*	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	*	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	*	-	-
Chloroethane	µg/L	-	-	-	-	-	-	*	-	-
Chloroform	µg/L	-	-	-	-	-	-	*	-	-
Chloromethane	µg/L	-	-	-	-	-	-	*	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	*	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	*	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	*	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	*	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	*	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	*	-	-
Toluene	µg/L	-	8.5	-	-	-	-	*	49	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	*	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	*	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	*	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	*	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	*	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	*	-	-
Chromium, total	µg/L	-	-	-	-	-	-	*	-	-
Nickel, total	µg/L	-	-	-	-	-	-	*	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	*	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-35B

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	*	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	*	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	*	-	-
1,2-Dichloroethane	µg/L	12	-	-	-	-	-	*	49	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	*	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	*	-	-
Benzene	µg/L	-	-	-	-	-	-	*	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	*	-	-
Bromoform	µg/L	-	-	-	-	-	-	*	-	-
Bromomethane	µg/L	-	-	-	-	-	-	*	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	*	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	*	-	-
Chloroethane	µg/L	-	-	-	-	-	-	*	-	-
Chloroform	µg/L	-	-	-	-	-	-	*	-	-
Chloromethane	µg/L	-	-	-	-	-	-	*	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	*	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	*	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	*	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	*	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	*	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	*	-	-
Toluene	µg/L	12	-	-	-	-	-	*	48	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	*	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	*	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	*	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	*	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	*	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	*	-	-
Chromium, total	µg/L	-	-	-	-	-	-	*	-	-
Nickel, total	µg/L	-	-	-	-	-	-	*	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	*	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-36

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	55	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	49	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well SM-37

Compounds Detected	Unit	4/25/2016	10/24/2016	4/24/2017	10/25/2017	4/30/2018	10/26/2018	4/29/2019	11/4/2019	4/22/2020
Organic Compunds										
1,1,1-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	-
2-Chloroethylvinyl ether	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Bromodichloromethane	µg/L	-	-	-	-	-	-	-	-	-
Bromoform	µg/L	-	-	-	-	-	-	-	-	-
Bromomethane	µg/L	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	µg/L	-	-	-	-	-	-	-	-	-
Chlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroethane	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Chloromethane	µg/L	-	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Dibromochloromethane	µg/L	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Ethylbenzene	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	50	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well RCRA-06

Compounds Detected	Unit	5/5/2016	10/31/2016	5/3/2017	11/8/2017	5/8/2018	11/1/2018	5/3/2019	11/8/2019	5/1/2020
Organic Compunds										
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	2	1.9	19	8.24
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well RCRA-07

Compounds Detected	Unit	5/5/2016	10/31/2016	5/3/2017	10/31/2017	5/8/2018	11/1/2018	5/3/2019	11/8/2019	5/1/2020
Organic Compunds										
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	3	-	-	-	-	-	-	15	12.4
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well RCRA-08R

Compounds Detected	Unit	5/5/2016	10/31/2016	5/3/2017	11/8/2017	5/8/2018	11/1/2018	5/3/2019	11/8/2019	5/1/2020
Organic Compunds										
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	7.3	16.3
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Compounds Detected	Unit	5/5/2016	10/31/2016	5/3/2017	10/31/2017	5/8/2018	11/1/2018	5/3/2019	11/8/2019	5/1/2020
Organic Compunds										
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	2.2	-	-	-	-	-	-	2.7	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	-
Nickel, total	µg/L	-	-	-	-	-	-	-	-	-
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	-

"-" = below detection limits
"*" = Not reported

Table E-2.4
Summary of Groundwater Detections
Monitoring Well RCRA-10A

Compounds Detected	Unit	5/5/2016	10/31/2016	5/3/2017	10/31/2017	5/8/2018	11/1/2018	5/3/2019	11/8/2019	5/1/2020
Organic Compunds										
1,1-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	µg/L	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	µg/L	-	-	-	-	-	-	-	-	-
Benzene	µg/L	-	-	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	-	-	-	-	-	-
Methylene Chloride	µg/L	-	-	-	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	-
Toluene	µg/L	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Trichloroethene	µg/L	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-
Inorganic Elements										
Arsenic, total	µg/L	-	-	-	-	-	-	-	-	-
Chromium, total	µg/L	-	-	-	-	-	-	-	-	0.955
Nickel, total	µg/L	-	-	-	-	-	-	-	-	1.01
Vanadium, total	µg/L	-	-	-	-	-	-	-	-	0.955

"-" = below detection limits
"*" = Not reported

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22A

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,1-Dichloroethane	µg/L	17	19	34	17	11	12	8.6	6.4	13	8.4
1,2-Dichloroethane-d4	µg/L	440	120	460	62	99	130	110	12	97	520
4-Bromofluorobenzene	µg/L	410	100	480	47	110	110	110	11	110	490
Chlorobenzene	µg/L	-	3.1	-	1.7	-	1.9	-	0.4	2.3	-
Decachlorobiphenyl	µg/L	0.015	0	0	0.037	0	0	0.088	0	0	0
Dibromofluoromethane	µg/L	440	110	500	58	99	130	110	11	100	470
Methylene Chloride	µg/L	-	-	29	41	-	-	-	0.34	-	-
Tetrachloro-m-xylene	µg/L	0.035	12	34	0.11	0.73	1.2	0.74	0.63	0.21	0.58
Toluene-d8	µg/L	420	100	520	51	110	120	110	11	100	480
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	6.9	-	-	-	3.2
Vinyl Chloride	µg/L	9.2	8.8	-	9.4	-	7.4	-	2.7	11	8.1

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22ASL

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,1-Dichloroethane	µg/L	-	-	-	-	0.53	-	-	-	-	-
1,2-Dichloroethane-d4	µg/L	10	11	11	11	9.7	13	11	9.4	52	50
4-Bromofluorobenzene	µg/L	10	11	10	9.5	11	12	12	10	53	49
Chloromethane	µg/L	-	-	-	-	2.5	2.5	-	-	-	-
Decachlorobiphenyl	µg/L	0.13	0.17	0.2	0.2	0.21	0.19	0.2	0.14	0.18	0.13
Dibromofluoromethane	µg/L	11	10	10	11	9.8	13	11	9.8	55	45
Methylene Chloride	µg/L	-	-	-	8	-	-	-	-	-	-
Tetrachloro-m-xylene	µg/L	0.095	0.16	0.2	0.15	0.2	0.18	0.17	0.15	0.17	0.14
Toluene-d8	µg/L	10	11	9.8	10	11	12	11	11	51	49
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	-	-	-	-	-	-	-

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22B

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,1-Dichloroethane	µg/L	-	-	-	4.5	6.1	-	-	3.6	5.4	2.9
1,2-Dichloroethane-d4	µg/L	21	2500	1100	230	110	630	450	100	100	500
4-Bromofluorobenzene	µg/L	19	2100	1100	190	110	560	500	98	110	490
Chloromethane	µg/L	-	-	-	9.5	-	-	-	-	-	-
Decachlorobiphenyl	µg/L	0.034	0	0.079	0.083	0	0	0.086	0	0.11	0.06
Dibromofluoromethane	µg/L	20	2100	1000	220	110	630	490	100	100	470
Methylene Chloride	µg/L	-	93	-	150	-	-	-	-	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	-	0.53	-
Tetrachloro-m-xylene	µg/L	0.09	1.1	0.3	0.086	0.94	0.56	0.41	0	0.4	0.36
Toluene-d8	µg/L	19	2100	1000	200	120	600	520	100	100	490
trans-1,3-Dichloropropene	µg/L	-	-	-	-	-	-	-	-	0.94	-
Trichloroethene	µg/L	-	40	20	4.2	4.5	11	10	1.8	8.9	2.7
Vinyl Chloride	µg/L	-	-	-	-	-	-	4.8	1.7	4.4	4.4

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22BSL

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,2-Dichloroethane-d4	µg/L	2000	15	11	12	11	52	52	9.6	51	250
4-Bromofluorobenzene	µg/L	1900	11	9	9.2	11	46	63	11	53	240
Chlorobenzene	µg/L	-	0.26	0.37	0.22	-	-	-	-	-	-
Decachlorobiphenyl	µg/L	0.043	0	0.072	0.091	0.081	0.11	0.13	0.057	0.045	0.03
Dibromofluoromethane	µg/L	2000	12	9.5	11	9.9	52	52	9.9	57	230
Methylene Chloride	µg/L	-	-	-	6	-	-	-	-	-	-
Tetrachloro-m-xylene	µg/L	0.25	0.43	0.16	0.12	3.2	0.15	0.16	0.088	0.15	0.14
Toluene-d8	µg/L	2000	11	8.7	9.7	11	49	54	9.8	51	240
Trichloroethene	µg/L	49	-	-	-	-	-	-	-	-	-

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22C

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,1-Dichloroethane	µg/L	-	-	-	1.9	-	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	2.4	-	-	-	-	-	-
1,2-Dichloroethane-d4	µg/L	4000	120	420	32	100	130	110	41	490	250
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	5.3	-
4-Bromofluorobenzene	µg/L	3900	110	410	19	100	110	110	39	480	240
Decachlorobiphenyl	µg/L	0.047	0	0	0.089	0.035	0	0.081	0	0.059	0.012
Dibromofluoromethane	µg/L	4100	110	410	21	80	120	110	39	480	240
Methylene Chloride	µg/L	-	-	-	29	13	4.1	3.4	1.6	-	-
Tetrachloroethene	µg/L	-	-	-	0.51	-	3.9	6.3	1.1	-	-
Tetrachloro-m-xylene	µg/L	0.25	0.22	0.1	0.13	0.19	0.25	0.21	0.036	0.28	0.11
Toluene-d8	µg/L	3900	100	400	21	110	120	110	42	500	240
trans-1,2-Dichloroethene	µg/L	-	-	-	0.33	-	-	-	-	-	-
Trichloroethene	µg/L	-	1.8	-	1.3	1.8	6.4	9.3	2.1	-	-
Vinyl Chloride	µg/L	-	-	-	1.9	-	1.5	2.5	1.2	-	-

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22CSL

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,2-Dichloroethane-d4	µg/L	10	13	42	12	9.9	13	11	10	51	49
4-Bromofluorobenzene	µg/L	9.4	11	44	9.3	11	11	12	10	52	48
Chloromethane	µg/L	-	-	-	-	-	0.77	-	-	-	-
Decachlorobiphenyl	µg/L	0.077	0.11	0.12	0.081	0.12	0.13	0.14	0.088	0.13	0.063
Dibromofluoromethane	µg/L	11	11	46	11	9.7	12	11	10	57	45
Methylene Chloride	µg/L	-	-	-	1.4	-	-	-	-	-	-
Tetrachloro-m-xylene	µg/L	0.12	0.18	0.28	0.13	0.16	0.17	0.17	0.073	0.17	0.17
Toluene-d8	µg/L	10	11	47	9.8	11	12	10	9.5	50	48
trans-1,3-Dichloropropene	µg/L	0.16	-	-	-	-	-	-	-	-	-
Vinyl Chloride	µg/L	4.4	3.6	-	-	-	0.11	-	-	0.58	0.44

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22D

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,1-Dichloroethane	µg/L	-	-	-	0.52	-	-	-	0.32	-	-
1,1-Dichloroethene	µg/L	-	-	94	-	-	2.4	3	-	-	-
1,2-Dichloroethane-d4	µg/L	1000	110	400	11	100	130	120	15	490	250
1,2-Dichloropropane	µg/L	-	-	-	-	-	-	-	-	5.7	-
4-Bromofluorobenzene	µg/L	990	96	430	9.8	97	110	120	11	490	240
Aroclor 1260	µg/L	3.5	-	4.2	-	-	-	-	-	-	-
Chloroform	µg/L	-	-	-	0.45	-	-	-	-	-	-
Decachlorobiphenyl	µg/L	0.12	0	0.22	0.12	0.032	0	0.13	0	0.11	0.097
Dibromofluoromethane	µg/L	1100	98	430	1.5	78	120	120	2.1	480	230
Methylene Chloride	µg/L	-	43	69	8.2	17	3.3	-	2.8	-	-
Tetrachloroethene	µg/L	-	3	-	0.39	-	-	-	-	-	-
Tetrachloro-m-xylene	µg/L	0.24	0	0.31	0.09	0.061	0.051	0.19	0.52	0.31	0.28
Toluene-d8	µg/L	1000	100	470	9.9	110	130	130	10	500	240
Trichloroethene	µg/L	-	2.4	-	0.27	-	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	0.88	-	1.3	1.8	0.39	-	1.8

"-" = Below Detection Limit

Table E-2.5
Leachate Monitoring Detections
Leachate Riser L22DSL

Compounds Detected	Unit	5/13/2015	12/2/2015	6/6/2016	11/7/2016	6/26/2017	11/29/2017	7/6/2018	12/3/2018	6/4/2019	10/31/2019
Organic Compunds											
1,1-Dichloroethane	µg/L	-	0.22	-	-	0.23	-	-	-	-	-
1,1-Dichloroethene	µg/L	-	-	-	-	0.64	-	-	-	-	-
1,2-Dichloroethane-d4	µg/L	31	13	100	22	10	51	49	12	51	250
4-Bromofluorobenzene	µg/L	35	10	99	19	10	46	52	9.7	52	240
Decachlorobiphenyl	µg/L	0.11	0	0.63	0.072	0.14	0.036	0.12	0	0.071	0.12
Dibromofluoromethane	µg/L	42	4.8	98	21	9.8	51	50	11	56	240
Methylene Chloride	µg/L	-	3.6	-	2.7	-	-	-	0.44	-	-
Tetrachloroethene	µg/L	-	-	-	-	-	-	-	1.2	-	-
Tetrachloro-m-xylene	µg/L	0.13	0	0.19	0.12	0.24	0.12	0.17	0.18	0.082	0.25
Toluene-d8	µg/L	39	10	100	19	11	48	53	10	51	240
Trichloroethene	µg/L	-	0.42	-	-	0.21	-	-	-	-	-
Vinyl Chloride	µg/L	-	-	-	4	2.4	-	-	-	1.5	-

"-" = Below Detection Limit

Table E-2.6
Chemical Waste Management
Emelle, Alabama Facility
Eutaw Aquifer Groundwater Velocity Calculation
July 2018 Sampling Event

BY:	RAK	DATE:	February 2021
CHK'D:	SBT	DATE:	March 2021

Equation

$$v = \frac{k\,(dh/dL)}{n_e}$$

where:
v = groundwater velocity (ft/day)
k = hydraulic conductivity (ft/day)
dh/dL = hydraulic gradient
n_e = effective porosity

Values Used in Calculation

k = 4.4E-03 12.5	cm/sec ft/day	(Reference 1)
dh/dL = 0.0002	unitless	Hydraulic Gradient through RCRA 7 (normal to 127.5 and 128.5 countour lines): *Distance = 4850 feet; Height = 1 feet* (Reference 2)
P_e = 15%	unitless	(Reference 1)

Calculation   v = (12.5 * 0.0002) / (0.15))

	ft/day	ft/yr
v =	1.71E-02	6.3

References
1) Eutaw Aquifer Groundwater Monitoring System Emelle, Alabma, Golder Associates, Inc., February 1986 (Appendix E-5, Document 1)
2) July 2018 Interpreted Potentiometric Surface Eutaw Aquifer (Appendix E-1, Figure E-1.3)

Table E-2.7
Chemical Waste Management
Emelle, Alabama Facility
Selma Chalk Groundwater Velocity Calculation
October 2018 Sampling Event

BY:	RAK	DATE:	February 2021
CHK'D:	SBT	DATE:	March 2021

Equation

$$v = \frac{k\,(dh/dL)}{n_e}$$

where: v = groundwater velocity (ft/day)
k = hydraulic conductivity (ft/day)
dh/dL = hydraulic gradient
n_e = effective porosity

Values Used in Calculation

k =	1.0E-07 0.0003	cm/sec ft/day	(Reference 1)
dh/dL =	0.021	unitless	Hydraulic Gradient SM05 to SM19: *Distance = 1680 feet; Height = 34.55 feet* (Reference 2)
P_e =	33.4%	unitless	(Reference 1)

Calculation v = (0.0003 * 0.021) / (0.334))

	ft/day	ft/yr
v =	1.75E-05	0.006

References

1)Trench 20 Study (Appendix E-5, Document 1)
2) October 2018 Interpreted Potentiometric Surface Selma Chalk (Appendix E-1, Figure E-1.4)

APPENDIX E-3

SECTION E

GEOLOGIC AND GEOTECHNICAL EVALUATION OF THE EMELLE FACILITY

<u>Revision No.</u>
5.0

APPENDIX E-3

SECTION E

LIST OF DOCUMENTS

Document 1: Geological and Geotechnical Evaluation of the Emelle Facility, prepared by Golder Associates, revised June 1983.

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

Report on

GEOLOGIC AND GEOTECHNICAL EVALUATION OF THE EMELLE FACILITY

Submitted to:

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2110 Newmarket Parkway, Suite 111
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CONSULTING GEOTECHNICAL AND MINING ENGINEERS

December 31, 1982 824-1308

Chemical Waste Management, Inc.
2110 Newmarket Parkway
Suite 111
P. O. Box 3065
Marietta, Georgia 30061

Attn: Mr. Don R. McCombs, P.E.

RE: GEOLOGIC AND GEOTECHNICAL EVALUATION
OF THE EMELLE FACILITY

Gentlemen:

Please find attached our report on the Geologic and Geotechnical Evaluation of the Emelle, Alabama site. This report presents and documents the characteristic features of the site such as thickness of Selma chalk, thickness of chalk proved by drilling and sampling, general groundwater conditions and the relevant engineering properties of recompacted chalk.

All the data reviewed support the view that the Emelle, Alabama site possess many geological and hydrogeological characteristics which make it well suited to the safe disposal of hazardous waste.

If you have any questions or need additional information, please contact us.

Very truly yours,

GOLDER ASSOCIATES

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1.0 INTRODUCTION

Chemical Waste Management, Inc. (hereinafter referred to as CWM) owns and operates a hazardous waste disposal site north of Emelle, Sumter County, Alabama.

Development of the site began in 1977 and at present some 300 acres have been or are currently being used for various aspects of the waste disposal program. The disposal methods employed by CWM include incineration, neutralization, solidification, evaporation and landfilling. Initially, landfilling consisted of the disposal of containerized solid and/or solidified waste in a series of narrow trenches ranging in depth from 30 to 50 ft. Current disposal comprises the burial of non-liquid containerized and non-containerized waste in trenches up to 175 ft. deep and covering plan areas of up to 8 acres. Containers of chemically compatible waste are placed in individual lifts extending over practically the full plan area of the trenches with each additional lift being separated from the previous lift by a blanket of chalk.

From the viewpoint of hazardous waste disposal the major attraction of the Emelle, Alabama site is the presence of a massive, thick, homogeneous deposit of relatively impermeable and structurally competent chalk formation; all the disposal trenches are excavated into this competent stratum.

Golder Associates was retained in April 1982 to assist CWM as their overall geotechnical consultant to integrate all previous geotechnical studies and to augment the exiting data base where required. Golder Associates was asked to prepare several reports to document the general conditions at the site and to demonstrate the technical viability of the Emelle site as a hazardous waste disposal site.

The main purpose of this report is to present and document the characteristic features of the site such as thickness of the chalk formation, thickness of chalk proved by drilling and sampling, general groundwater conditions and the relevant engineering properties of recompacted chalk that will be used particularly for the reclamation cover. It is envisaged that this report will constitute a geological/geotechnical reference document with respect to the main features that characterize the uniqueness of the Emelle, Alabama site.

2.0 SITE LOCATION

The CWM hazardous waste disposal facility is located about 5 miles north of Emelle in west Sumter County, Alabama adjacent to Highway 17 and immediately to the south of Highway 116, as shown in Figure 1.

The site, which covers an area of approximately 2,500 acres, occurs on the Black Prairie belt of the East Gulf Coastal Plain section of the Coastal Plain physiographic province. The site is bounded on the northwest by the flood plain of Bodka Creek at an elevation of approximately EL 130 ft. MSL. To the east of this flood plain the topography consists of rolling hills with a maximum elevation around EL 300 ft. MSL.

Surface water on the site drains in an angulate pattern; a northeast trending surface drainage divides the site as indicated in Figure 2. Precipitation falling northwest of this divide flows to the Bodka Creek drainage basin. Precipitation to the southeast of the drainage divide flows into Factory Creek drainage basin.

The portion of the site to the west of Highway 17 has a ground surface elevation ranging from EL 270 to EL 120 ft. MSL; this land is presently under cultivation. To the east of Highway 17 the site varies from EL 140 ft. MSL to about EL 290 ft. MSL; the vegetation in the higher ground to the east consists primarily of a mix of cedar prairie and deciduous forest.

Natural exposures of Selma chalk on the site are limited to washes and erosion gullies seldom more than about 20 ft. deep. Macrofossils are fairly abundant throughout the eastern portion of the site with Exogyra ponderosa and

Exogyra costata being the most predomiant species. The geological literature suggests that these two fossil types are abundant in the upper one-third to one-half of the Selma chalk.

3.0 REGIONAL GEOLOGY

3.1 Introduction

The purpose of this section is to describe the general stratigraphy of the Upper Cretaceous sediments of west central Alabama with particular reference to the Selma chalk. Use is made of the available literature in order to outline the general geology in the vicinity of the CWM site. The section goes on to examine the local geology of the site and for this purpose information has been collated from a number of sources, and includes the logs of deep wells drilled in the vicinity of the site and previous investigations on the site by other parties.

3.2 Historical Review

Interest in the Cretaceous rocks of Alabama, and particularly the deposits of Selma chalk, goes back approximately 150 years to 1829 when Morton (Ref. 1) first drew attention to the presence of rocks of Cretaceous age in the state. During the next century Morton's observations provided the stimulus for some 100 scientific papers dealing with the identification and classification of the Cretaceous deposits of Alabama.

Not all the early interest in these deposits was on a scientific plane; a report prepared by the State Geologist published in 1858 (Ref. 2), drew attention to the suitability of the Selma chalk in Sumter County as a raw material for the manufacture of hydraulic lime or cement. The Selma chalk unit is being mined today for cement manufacturing near Demopolis some 60 miles north of the CWM site. Interest in chalk resources was further stimulated around the turn of the century with the publication of several reports concerning raw materials for cement manufacture.

A general review of the geology and geography of the Coastal Plain sediments in Alabama was published in 1929 which drew attention to the prospects of discovering oil and gas reserves (Ref. 3).

A major step forward in the mapping of the stratigraphy of the Cretaceous deposits of the eastern Gulf region was taken in 1914 when Stephenson (Ref. 4) demonstrated the importance of the fossil species, Exogyra cancellata, as a correlation index. Today fossil species provide a convenient means of determining approximate location within the stratigraphic horizon.

The early geological investigations also included a number of references to groundwater in Alabama; for example, in the first biennial report (Ref. 5) of the State Geologist published in 1850 mention was made of artesian wells drilled in the Eutaw Formation exposed on the Black Warrior River near Eutaw, Greene County. Another account of the water resources of the Coastal Plain of Alabama was presented in 1904 (Ref. 6) which included descriptions of a number of artesian wells in the State.

The Arcola limestone member (commonly termed "bored rock") of the Selma chalk appears to have been identified as early as 1850. Where exposed in outcrops, this stratigraphic unit consists of limestone infilled with small pockets of marl which, upon weathering, were washed out leaving a somewhat perforated structure which gave rise to the common description of "bored rock".

Interest in the Coastal Plain sediments of Alabama has accelerated over the last forty years, and particularly in the last decade, with the publication of several significant studies which have brought to light not only the potential natural resources of the region but also drawn attention on the many unique characteristics of the geological environment.

3.3 Principal Features of the Upper Cretaceous Sediments

In Alabama the Upper Cretaceous sediments outcrop in a crescent-shaped belt some 40 to 75 miles wide which trends westward in the eastern part of the State before swinging to the northwest in the west end of the State. The length of the belt is approximately 275 miles and it is estimated that the sediments are exposed over an area of about 10,000 sq. miles, see Figure 3. The surficial geology of Sumter County, Alabama is shown in Figure 3.

The sedimentary deposits of the Upper Cretaceous Series consist predominantly of beds of sand, gravel, clay and chalk which were laid down mostly in shallow marine water, although some of the sediments (e.g. the Tuscaloosa Formation) were deposited by streams on low flood plains bordering the coast. The chalk, for example, was deposited as a calcareous ooze in relatively clear sea water of only moderate depth. The total thickness of the Upper Cretaceous sediments is estimated at 2,300 ft. (Ref. 7).

The bedding planes of the Upper Cretaceous sediments dip to the west in the northwest corner of the State, to the southwest in the west central region, to the south in the central part and to the southeast in the vicinity of the Chattahoochee River. Bedding plane dips are typically about 40 ft. per mile although locally steeper dips do occur.

Sedimentation was initiated on a peneplaned surface of Paleozoic and older rocks; sands, gravels and clays were first laid down in shallow marine waters, lagoons and estuaries to form the Tuscaloosa Group. The deposition of the Upper Cretaceous sediments was discontinuous, probably because of changes in sea level, resulting in at least four unconformities throughout the series. The depositional environment was of deeper marine origin than that associated with the older Tuscaloosa sediments except towards the ends of of the crescent-shaped band where the fine gravels, sands and clays are partly non-marine and partly of shallow marine origin.

The first interruption in the deposition process occurs between the Tuscaloosa and the overlying Eutaw sediments and is marked by an undulating bed of fine gravel. This unconformity has been traced throughout the eastern Gulf region. The next unconformity separates the Tombigbee sand member of the Eutaw Formation from the younger Selma chalk above. This sedimentation break is characterized by the fact that the bottom 3 ft. to 6 ft. of the Selma chalk is sandy and contains fossils which were reworked from the underlying Tombigbee sand. The next stratigraphic break occurred during marine deposition some 300 ft. above the base of the Selma chalk at the Arcola limestone member.

In 1938, Stephenson and Munroe (Ref. 8) divided the Upper Cretaceous sediments in west central Alabama into four formational units consisting of about 1,000 ft. of Tuscaloosa Formation, some 300 ft. of Eutaw sediments, nearly 900 ft. of massive Selma chalk and approximately 50 ft. of Prairie Bluff chalk at the top of the series.

More recently, the Upper Cretaceous sediments have been reorganized into seven stratigraphic formations, of which six are condensed into the Tuscaloosa and Selma Groups; a summary of the principal stratigraphic units and lithology is given in Table 1.

3.3.1 Tuscaloosa Group

The Tuscaloosa Group, which comprises the Coker and Gordo Formations, ranges in thickness from 1,100 ft. to 1,350 ft. and rests unconformably on Pennsylvanian rocks in western Alabama. The unconformity varies from a fairly uniform surface to an irregular feature with relief of more than 100 ft. in northwest Alabama.

The deposits of the Tuscaloosa Group consist predominantly of sands, gravels and clays laid down in shallow marginal seas, lagoons, marshes and deltas. The Coker Formation, which accounts for some 70 percent of the Tuscaloosa Group sediments, typically comprises fine to coarse grained glauconitic micaceous sands with some carbonaceous clay and shale generally near the surface and massive basal beds of coarse grained sand and gravel.

The younger Gordo Formation sediments range in thickness from 300 ft. to 450 ft. and consist mainly of fine to very coarse grained sands and carbonaceous, micaceous clay and shale. Massive clay and lenticular sand beds predominate in the upper part of the Gordo Formation while poorly sorted coarse grained sands characterize the lower part.

The elevation of the top of the Tuscaloosa Group sediments in the region of the CWM site occurs around EL -900 ft. MSL or some 1,200 ft. below existing ground surface.

3.3.2 Eutaw Formation

The Eutaw Formation unconformably overlies the Tuscaloosa Group sediments and includes all the strata between the overlying chalk of the Selma Group and the massive clay and sand beds of the Gordo Formation underneath. The stratigraphic boundary between the Eutaw and Gordo Formations occurs at the interface of the upper glauconitic sands and the much more irregularly bedded sands, gravels and clays of estuarine and shallow water origin underneath.

The thickness of the Eutaw Formation is about 400 ft. and consists predominantly of fine to medium grained glauconitic and sometimes micaceous sands which were deposited in a shallow water marine environment. The lower half or more of the Eutaw Formation is characterized by interstratified sands with laminae of clay and some fairly massive clay layers present while the higher portions of the formation are typified by cross bedded glauconitic sands and laminated sands and clays. The uppermost 100 ft. of the Eutaw Formation, referred to as the Tombigbee sand member, consists mainly of massive (occasionally somewhat cross bedded) glauconitic sands with scattered calcareous and concretionary layers.

The base of the Eutaw Formation in Sumter County dips to the southwest at approximately 45 ft. per mile and strikes northwest, see Figure 4 reproduced from Ref. 9.

3.3.3 Selma Group

The name Selma was first used in 1894 for the Cretaceous chalk of Alabama. Until about 1937 the name

Selma chalk included all the Upper Cretaceous age rocks above the Eutaw Formation but since that time the name has been restricted to the relatively pure chalk. Today the lithology of the Selma Group is divided into an unnamed lower marly member and the thin Arcola limestone member, which make up the lower Mooreville Chalk Formation, and the upper Demopolis Chalk Formation which includes the Bluffport Marl member.

The Selma Group sediments consist of chalky limestone ranging in composition from about 85 percent calcium carbonate to less pure chalky sand; the maximum recorded thickness of this group is 956 ft. at the town of Livingston, Alabama. The unnamed lower marly member of the Selma chalk is estimated to be about 250 ft. thick and consists mainly of relatively uniform thinly bedded chalky marl except for the bottom few feet which comprise compact calcareous sandstone.

The Arcola limestone member is made up of two or more beds of almost pure limestone interbedded with soft marl; in western Alabama this member is seldom more than 2 ft. thick. The Arcola limestone rests conformably on the lower marly member of the Selma Chalk but is overlain with a distinct unconformity by the Demopolis Formation of the Selma Group.

The Demopolis Formation is approximately 550 ft. thick and extends from the Mississippi State line through the northern part of Sumter County in a belt some 10 miles wide. The lower part of the Demopolis Formation comprises a thin band of marly chalk very similar to that underlying the Arcola limestone member. The overlying sediments are the most pure portion of the Selma chalk with calcium carbonate contents ranging from 75 to 90 percent. The pure chalk facies grades upward into more clayey chalk which in turn is overlain by the very calcerous micaceous sand of the Ripley Formation which outcrops along a narrow belt to the south and east of Livingston, Alabama.

3.3.4 Macrofossils

That portion of the Upper Cretaceous which includes the upper third of the Tombigbee sand member of the Eutaw Formation and the Selma chalk includes two significant fossil zones. The Tombigbee sand and the lower two-thirds of the Selma chalk are characterized by Exogyra ponderosa while the remainder of the Selma chalk occurs within the Exogyra costata zone.

The Selma chalk beneath the Arcola limestone member is comparatively poor in fossils but there is a narrow and persistent fossil zone, typified by Diploschiza cretacea, within the Selma chalk about 180 ft. above the Arcola limestone. In west central Alabama the boundary between the Exogyra ponderosa and Exogyra costata zones occurs about 150 ft. above the persistent Diploschiza cretacea zone (i.e. approximately 330 ft. above the Arcola limestone member). This broad delineation of the major fossil zones provides a convenient means of identifying approximate location within the stratigraphic column.

3.3.5 Physiographic Expression

The area of outcrop of the Selma chalk is referred to as the Black Prairie belt because in the northern part of the belt the lower marly member of the Selma has been weathered to produce deep black residual soils. The topography is relatively flat with upland slopes ranging between 1 and 10 percent. The southern boundary of the Black Prairie belt is evidenced by a small scarp slope caused by the protruding Arcola limestone. The outcrop of the Selma chalk in the area of the site is up to 25 miles wide in places.

The Demopolis Formation constitutes the middle and southern portions of the Black Prairie belt with the purer middle part of the Demopolis often giving rise to large bare patches of chalk because the weatherizing process produces very little soil residuum. Cedar trees, which are able to survive upon very little soil, are a common feature of this region of the Black Prairie belt.

3.3.6 Structural Geology

The major structural feature evident in the Upper Cretaceous sediments is the Livingston fault zone which is confined to the Selma chalk in Sumter and Marengo Counties, Alabama. This fault zone which was first identified in 1937 (Ref. 10) comprises a number of horsts and grabens flanked by reverse faults. These structural defects dip both to the northeast and southwest at between 40° and 45° and strike about S 64° E. The fault zone is generally accepted as being relatively narrow but drainage patterns shown on topographic maps suggest that the fault zone may extend to the northeast as far as the Tombigbee River.

The Livingston fault zones does not appear to be associated with deep-seated late Paleozoic faulting identified in the subsurface Paleozoic rocks; rather a depositional, non-tectonic origin is most reasonable. Seismic data and field relations of exposed discontinuities indicates that faulting developed as uncompacted, unlithified, incompetent sediments collapsed into the trough of a syncline (Jones Flexure) beneath the basin of deposition, where subsequent lithification occurred, as described by Schneeflock (Ref. 10).

3.4 Local Geology and Previous Investigations

3.4.1 Elevations and Thickness of Chalk

The review of the general geology suggests that the Upper Cretaceous sediments are approximately 2,300 ft. thick with the Selma chalk accounting for up to 900 ft. The objective in this section is to focus attention on the subsurface stratigraphy, thickness and quality of the Selma chalk in the vicinity of the CWM site. This work was considered necessary for two reasons. First, it was judged desirable to correlate the work from several previous investigations covering various aspects such as site stratigraphy, chalk structure and in situ mass permeability and, second, to provide a data base to assist in the planning of the additional exploratory drilling program described in Chapter 4.

The Geological Survey of Alabama publication dealing with water availability and geology of Sumter County, Alabama (Ref. 9) contains a comprehensive well inventory together with sample and driller's logs. Three deep exploratory oil wells are of particular importance, and are shown in plan on Figure 5. Driller's and sample logs are included in Appendix A.

Well N-8 lies some 10 miles southeast of the CWM site approximately along the strike of the Upper Cretaceous beds. This well was drilled to a maximum depth of 3,080 ft. through some 710 ft. of Selma chalk and 360 ft. of Eutaw Formation sediments. The approximate ground surface elevation at this well site was EL 200 ft. MSL suggesting that the base of the chalk is around EL -510 ft. MSL.

Well M-3 was put down near Emelle approximately 3 miles south of the CWM site and roughly 4 miles down dip of Well N-8. The sample log for Well M-3 shows that the thickness of Selma chalk is about 840 ft. The ground surface elevation at this well is EL 215 ft. MSL implying that the base of the Selma chalk occurs at EL -625 ft. MSL.

Well I-2 is some 10 miles up dip of Well M-3 and the sample log indicates that the Selma chalk extends to a depth of 480 ft. below ground surface at EL 110 ft. MSL; therefore, the base of the chalk is around EL -370 ft. MSL.

The difference in elevation of the base of the chalk in Wells M-3 and I-2 suggests that the dip of the Upper Cretaceous sediments is approximately 27 ft. per mile in the vicinity of the CWM site, which is slightly less than the typical regional dip of about 40 ft. per mile.

Three other deep wells are located around the site and are included in the State of Alabama well inventory. However, the quality of the sample descriptions is much less comprehensive than those for Wells N-8, M-3 and I-2 and hence the level of confidence attached to estimates of chalk thickness at these locations is considered somewhat lower. Driller's and sample logs of these 3 wells are included in Appendix A. Well J-14 was sunk just beyond the southeast corner of the CWM site and the driller's log records "limestone" to a depth of 704 ft. The ground surface elevation is given as EL 249 ft. MSL suggesting that the base on the chalk may be around EL -455 ft. MSL. The average dip of the base of the Selma chalk between Wells I-2 and J-14 is about 18 ft. per mile compared with an average dip of almost 40 ft. per mile between Wells J-14 and M-3.

To the north of the CWM site there are a further two water wells (Wells J-3 and J-5) which provide additional evidence regarding the thickness of the Selma chalk. The driller's log for Well J-3 notes "limerock" to a depth of 503 ft. implying the base of the chalk is around EL -388 ft. MSL while at Well J-5 about a mile further west the use of the term "limestone" suggests that the chalk extends to about EL -385 ft. MSL.

A summary of the pertinent details of the deep wells is given in Table 2. With respect to the thickness of chalk underlying the CWM site, it is considered that the data from Well N-8 are the most representative of the CWM site since this well is located approximately along the direction of strike of the Upper Cretaceous sediments. The base of the chalk in Well N-8 occurs at EL -510 ft. Wells M-3 and I-2 are located approximately along the dip direction. Using an average dip of 27 ft. per mile the logs for these two wells suggest that the base of the chalk on the CWM property ranges from about EL -488 ft. MSL at the north end of the site adjacent to Highway 116 to approximately EL -543 ft. MSL along the southern boundary of the site. These data compare favorably with that obtained in Well J-14 which indicated the base of the chalk was at EL -455 ft. MSL. These data suggest that the highest elevation of the base of the Selma at the CWM site is EL -450 ft. MSL.

Ground surface elevations on the CWM site vary from about EL 130 ft. MSL to EL 300 ft. MSL suggesting that the thickness of Selma chalk at the site ranges from about 600 ft. to 750 ft. These thicknesses are in reasonable agreement with those deduced from the information given in Figure 4. The elevation of the base of the Eutaw Formation on the CWM site is EL -900 ft. MSL and since this formation is typically 400 ft. thick then the base of the Selma chalk is around EL -500 ft. MSL.

Figures 6 and 7 show cross sections parallel to the strike direction and normal to the direction of strike through the principal geological strata compiled from the sample descriptions for Wells N-8, M-3 and I-2 in the vicinity of the CWM site. Some general indication of the uniformity of the Selma chalk can be obtained by examining the geophysical logs of some of the deep wells. The records for spontaneous potential and resistivity geophysical logs in Well N-8 are typical of those examined and serve to illustrate the homogeneity of the chalk compared with the Eutaw and deeper formations.

3.4.2 Shallow Borings by Tuscaloosa Testing Laboratory

Over the past few years a substantial number of shallow exploratory borings have been drilled on the CWM site, some of which were completed as monitoring wells. Most of this early work was done by Tuscaloosa Testing Laboratory, Inc. (TTL) of which a summary is given below. The approximate plan locations of these borings are shown on Figure 8 and copies of the boring logs are presented in Appendix B.

TTL submitted a report on June 6, 1977 describing a shallow drilling program carried out to establish subsurface stratigraphy and to permit the installation of observation and monitoring wells. Eight borings (denoted W-1 through W-8) were drilled to a maximum depth of 75 ft. These borings were advanced through about a foot of black organic topsoil and between 3 ft. and 14 ft. of tan colored weathered chalk before encountering fresh Selma chalk described as gray-blue silty clay. The plan locations of these borings were not given in the TTL report so they are not shown on Figure 8.

The logs of a further six borings (OW-1 through OW-6) ranging in depth from 50 ft. to 100 ft. were presented in a report dated July 14, 1977. These borings indicated that the average depth to the gray-blue chalk was about 8 ft. and ranged between 2 ft. to 12 ft. Monitoring wells were installed in each of these borings. Water levels were measured one day after well installation in borings OW-4 (8 ft. below ground surface) and OW-5 (43 ft. below ground surface). However, these water readings are not considered representative of steady-state levels due to the low permeability of the chalk.

On December 5, 1977 TTL presented the results of a further 17 shallow auger borings (referred to as borings 9 through 25) put down in the vicinity of disposal Trenches 1 and 3. The primary purpose of these borings was to establish the depth to competent unweathered chalk and consequently the maximum depth of drilling did not exceed about 30 ft. The gray-blue chalk was encountered at an average depth of 11 ft. and varied from zero to a maximum of 20 ft.

TTL was asked to investigate a major undeveloped portion of the site to the southeast of the then active disposal area in early 1978. This work, which was reported by TTL on June 29, 1978, included drilling an additional eight continuous flight auger borings (denoted LM-1 through LM-8) to a maximum depth of 25 ft. below natural ground level. The main purpose of this drilling work was to verify the presence of the Selma chalk and to determine the thickness of topsoil and/or weathered chalk overburden. Examination of the boring logs indicates that competent gray-blue chalk was encountered at an average depth of about 11 ft. and ranged between 4.5 ft. to 20 ft.

Borings LM-1, LM-4, LM-7 and LM-8 were subsequently extended to a depth of 75 ft. in September 1978 (see TTL report dated October 18, 1978) to permit recovery of representative samples of chalk for laboratory determination of index properties, grain size characteristics and compaction behavior. No water levels were indicated on the boring logs of the redrilled borings.

In connection with the development of waste disposal Trenches 8 and 9 a further eight borings were drilled by TTL, as presented in their report dated June 26, 1979. Four of these borings were converted into permanent observation wells. Borings 39-1 through 39-4 were augered to depths ranging from 5 ft. to 25 ft. and after installation of temporary casing, these holes were then cored to total depths of between 54 ft. and 58.5 ft. Core recovery was typically 100 percent despite the fact that many joints (described as tight) were intersected.

The four observation wells (denoted as 39-OW1 through 39-OW4) were advanced to depths ranging from 35 ft. to

108.5 ft. Observation wells installed by drilling an 8 in. diameter hole to about 30 ft., setting a 6 in. diameter PVC casing and grouting to the surface. In all but one boring, a 4 in. hole was then advanced through the surface casing and left uncased.

Although limited in depth (because of the relatively shallow waste disposal trenches then in use) the exploratory drilling work undertaken by TTL over a two year period from June 1977 to June 1979 included the drilling of 49 borings ranging from 6 ft. to 108.5 ft. in depth and confirms that competent Selma chalk underlies the CWM site, the thickness of weathered chalk overburden is typically less than 20 ft.

3.4.3 Geotechnical Studies by Woodward Clyde Consultants

During the period May 1979 to December 1980, Woodward-Clyde Consultants (WCC) reported on two investigations of various aspects of the in situ structure and permeability of the chalk at the Emelle, Alabama site.

The first report, submitted to CWM on May 1, 1979, dealt with the results of in situ packer permeability tests conducted in vertical and inclined boreholes in the vicinity of waste disposal Trenches 1, 3 and 7. One vertical rotary cored borehole (V-1) was sunk from the bottom of Trench 7 at EL 138 ft. MSL to a maximum depth of 100.6 ft. The other two boreholes (denoted as D1 and D2) were drilled from natural ground level (EL 183 ft. MSL) at an inclination of 45 degrees to the horizontal; rotary cored drilling extended to about 90 ft. below ground level. The location of these borings and boring logs for each hole are given in Appendix C.

WCC ran pneumatic packer permeability tests in each of the above borings. The results of these tests are given in Appendix C. The in situ permeability tests run in the inclined boreholes indicated the formation was tight (i.e. no water could be pumped into the hole). Permeability tests were run in the vertical borehole in two zones containing fractures or joints in the formation. The WCC test results presented indicate the coefficient of permeability in the fractured zones is about $3x10^{-7}$ cm./sec.

Following their identification of discontinuities in the chalk in waste disposal Trench 7, WCC undertook a lineament study in the general area of the Emelle, Alabama site. Use was made of LANDSAT images, high and low altitude photography and topographic maps in order to assist in the identification of linear features which might be associated with faults in the Selma chalk. Although several linear features were identified, WCC concluded that most of them were not associated with faulting in the chalk; for example, two backhoe trenches which were cut across two large scale map lineaments failed to reveal any corresponding discontinuities within the chalk.

Although the lineament study was largely inconclusive, WCC did observe several discontinuities in waste disposal Trenches 7, 8 and 9 with the most prominent strike being west-northwest. These discontinuities were relatively minor since they could only be identified on low altitude photography and 1:1200 topographic maps.

The work of WCC is significant because while it drew attention to the presence of discontinuities within the chalk, the in situ packer tests established that the mass permeability of the chalk is very low.

4.0 GEOTECHNICAL WORK BY GOLDER ASSOCIATES

4.1 Introduction

As mentioned previously, Golder Associates was asked by CWM in April 1982 to serve as the general geotechnical consultant for the Emelle Landfill site. One of the initial work requirements was to prepare a base geotechnical/geological report pulling together all previous studies and data on this site. In addition, Golder Associates undertook limited additional field studies to augment the geotechnical data base where required.

The additional work which was deemed necessary included the verification of the lateral and vertical continuity of the Selma Chalk at the Emelle site. Previous borings extended to a maximum depth of 108.5 ft. In view of the substantial amount of reliable regional geological data available it was not considered necessary or desirable to penetrate the full thickness of Selma chalk beneath the site. However, it was considered necessary to prove the existence of a massive chalk deposit to a depth of at least 500 ft. at the site.

In addition to the deep hole drilling program, it was considered desirable to map the exposed joints, faults and other discontinuities visible in the chalk in Trenches 15 and 16 (the only trenches open during this period) and in other outcrop areas.

To assist in the near term planning of future trenches, additional geotechnical data was necessary in the approximately 60 acre area south of Trench 16 (see Figure 8 for the location of this area). This information was considered necessary to verify, on a smaller scale, the nature and consistency of the chalk in the immediate area of future trenches.

4.2 Mapping Discontinuities

The first phase of the field work done in May-June 1982 consisted of detailed mapping of discontinuities within the chalk. Good exposures were available in the sidewalls of the active waste disposal Trenches 15 and 16 and in chalk outcrops elsewhere on the site.

The fresh Selma chalk as exposed in the side walls of active disposal trenches consists of a gray-blue virtually intact calcareous material. The surficial chalk has weathered to varying depths across the site. The weathered chalk becomes a reddish-tan or yellowish silty clay. The depth of weathering varies from almost nothing to tens of feet in places. The degree of weathering is influenced by topography and the presence of drainage channels. Some oxidation or weathering has occurred along the joint sets or other structural defects near the surface of the sound chalk. Some staining along fractures extends from about 5 ft. to as much as 40 ft. in places. Although there are minor discontinuities within the fresh chalk they are generally tightly closed and healed with calcite cement below the surficial weathered zone. The overall integrity and competency of the Selma chalk are dramatically illustrated by the fact that near vertical excavations over 100 ft. deep are currently being made.

Discontinuities are fairly widespread on the site and displacements are generally less than a few feet. Almost all of the discontinuities are tightly closed and frequently recemented or welded by calcite infilling. The integrity of the discontinuities is demonstrated by the relatively low permeabilities measured by WCC in borehole packer tests and by the fact that, in some cases, core samples could not be broken along the rehealed discontinuities.

Field mapping of discontinuities within the Selma chalk has led to the identification of several prominent joint sets. Because of extensive rehealing of most of the discontinuities it was only possible to expose short sections of the joint surfaces for measurement purposes with the result that there is some scatter among individual observations within a single major joint set. The scatter is due largely to the inherent waviness of many of the discontinuous surfaces. The dominant joint sets measured were as follows:

Strike	Dip
N 62° W	44° to NE
N 60° W	86° to NE
N 52° E	85° to NW
N 58° E	42° to NW
N 14° E	82° to NW
N 58° E	58° to SE

These observed joint sets agree reasonably well with the findings of the Woodward-Clyde Consultants lineament study. Also, the joint set striking S 62° E is similar in direction and dip to the Livingston Fault.

4.3 Verification of Area South of Trench 16

The second phase of the field investigation, undertaken in May 1982, was designed to verify the lateral and vertical continuity of the competent chalk over an approximately 60 acre area to the south of Trench 16. This area will be utilized in the near future for the construction of additional waste disposal pits.

One rotary cored borehole (G16-1) was put down in the southwest corner of Trench 16 to a depth of 83.5 ft. below the floor of the pit together with a further two 150 ft. deep boreholes (referred to as SWC and SEC) at the south end of the proposed development area. All the boreholes were drilled by Tuscaloosa Testing Laboratory, Inc. using a CME 55 rig equipped with 4 in. diameter solid stem augers and an NX size core barrel. Borehole G16-1 was augered to about 5.5 ft. before setting a temporary steel casing and resuming drilling with the NX size core barrel.

Borehole SWC at the southwest corner of the 60 acre area was augered to about 85 ft. depth before inserting a steel casing and advancing the hole to 150 ft. below ground level using coring techniques. Standard Penetration Test (SPT) split spoon samples were recovered at approximately 10 ft. intervals between 40 and 80 ft. where the SPT "N" values (blows per foot of advance of the sampler) were in excess of 100. The same procedure was adopted in borehole SEC with the exception that the split spoon sampling was confined to the upper 15 ft. of weathered and fresh chalk.

All three boreholes were bailed dry of drilling water after completion of drilling before being backfilled with sand/cement/bentonite grout.

Boreholes SWC and SEC encountered fresh competent chalk at depths of 5 ft. and 12 ft. below ground level, respectively. Core recovery in all three boreholes was typically around 100 percent. The plan locations of these three boreholes are shown on Figure 8 and the logs are included in Appendix D.

4.4 Deep Hole Drilling Program

4.4.1 Purpose and Location

The major portion of the Golder Associates field exploratory program was concerned with verifying the vertical and lateral continuity of the Selma chalk on the CWM site indicated by the review of general geology and deep wells in the immediate vicinity of the site. In this phase of the field program, three 500 ft. deep borings were put down at the plan positions indicated on Figure 8. The drilling work was confined to the property to the east of Highway 17 since future development of the waste disposal facilities will probably be concentrated in this area for many years. This deep drilling work was done in June and July 1982.

The depth of the borings (denoted as DB1, DB2 and DB3 on Figure 8) was based on the need to confirm a substantial thickness of Selma chalk beneath the site but without penetrating into the underlying Eutaw Formation. Considerations of access, water supply and ground surface elevation were the factors in determining the locations of the deep borings.

DB1 was positioned near a small lake in the northeast corner of the site immediately south of Highway 116. The drilling procedure consisted of solid stem augering to about 10 ft. depth to permit the installation of temporary casing. The hole was then advanced to 500 ft. below ground level using an NQ sized core barrel fitted with a Longyear carbide bit. The rate of advance ranged from about 14 in./min. near the surface to 2 in./min. towards the bottom of the hole with an overall average rate of advance of 5.6 in./min. Upon completion of drilling a PVC casing was installed to the top of competent chalk and the annulus backfilled with cuttings and drilling mud. It was decided not to backfill the deep borings but rather leave the holes open to serve as groundwater monitoring holes.

The second deep boring (DB2) was positioned adjacent to a small creek in the extreme southeast corner of the site. The drilling and completion techniques were essentially the same as those adopted in DB1 with the exception that the carbide bit was replaced with a coarse diamond bit. Rates of advance during coring were practically the same as those achieved in DB1.

DB3 was put down immediately east of Highway 17 on the southern boundary of the CWM site. The borehole was augered over the upper 8 ft. to permit the installation of temporary casing and the hole was advanced to 500 ft. using an NQ size core barrel fitted with a very fine diamond bit. The average rate of advance was 5.4 in./min. Upon completion of drilling, PVC casing was installed to the top of chalk and the annular space backfilled with cuttings and drilling mud.

All the core recovered was photographed in the field. The logs for the three deep boreholes are presented in Appendix D together with photographs of representative samples of the core for approximately 100 ft. intervals of drilling.

4.4.2 Stratigraphy

The Selma chalk cores recovered from the deep borings is typically a mottled medium blue-gray to green-gray fossiliferous chalk exhibiting varying degrees of bioturbation or evidence of stirring of the sediment by organisms during deposition. Pyrite was occasionally encountered usually in the form of nodules. Glauconitic sand, in the form of thin lenses of glauconitic sandy chalk, was rarely intersected at depths in excess of 300 ft. below ground level.

Very few discontinuities were intersected in the three deep borings. In DB1 a narrow (approximately 3 in. wide) fractured zone around EL -164 ft. MSL (324 ft. below ground surface) only became evident upon drying out of the rock core which resulted in splitting along the slickensided fault surface. Four fault planes were identified in DB3 at depths ranging from 40 ft. to about 140 ft. below ground level. The shallow discontinuities were only lightly cemented but those at 130 ft. and 137 ft. depth were so strongly cemented that breakage of the rock core occurred through the intact chalk and not along the joint plane.

In general, the joints at depth are very tightly closed and at depths in excess of about 100 ft. below ground level practically all the joints have been completely healed by cementing with the result that they no longer constitute planes of weakness.

The quality of the core recovered from the deep borings was excellent with rock quality designation (RQD) consistently greater than 95 percent. The few core runs associated with an RQD of less than 95 percent were the result of accidental damage due either to overdrilling and/or in the process of removing the chalk from the core barrel. In none of the deep borings was there any evidence that poor RQD values (less than 95 percent) were fault related.

4.4.3 Density, Water Content, Degree of Saturation Profile

In addition to photographing every core run in the deep hole drilling program, sealed jar samples of core were kept at about 10 ft. intervals. These jar samples were returned to Golder Associates office in Atlanta for detailed visual examination and testing. Gravimetric water content determinations were made on many of these samples to determine the water content profile with depth. Also dry density measurements were made on core samples from boring DB1 to ascertain if there was any density increase in the chalk with depth below ground surface. The results of this testing program is shown in Figure 9.

As can be seen in Figure 9, the chalk becomes somewhat more compact or denser with depth. The dry density increased from about 105 pcf near the surface of the unweathered chalk to about 109 pcf at a depth of almost 500 ft. The water content data suggests the gravimetric water content in the chalk decreases about 23% near ground surface to about 18% at a depth of 500 ft. Although there is some scatter in the water content data the trend of decreasing water content with depth is unmistakable. Golder Associates has fitted a trend line through both the water content and dry density data which, in our opinion, represents the typical or average conditions in the chalk.

The degree of saturation for the chalk samples tested was also determined. Figure 9 also shows the relationship of degree of saturation with depth using the average dry density/depth, water content/depth relationships, and a specific gravity of solids of 2.76. These data suggest that the degree of saturation in the chalk decreases from about 98% near the top of unweathered chalk to about 84% at a depth of 500 ft. It must be recognized, however, that all these data were determined on laboratory samples. Therefore, any in situ hydrostatic pressure which may have been present in the field was released during the sampling process. This release of hydrostatic pressure permits air, which is in solution in the formation pore water, to come out of solution in the sample as air bubbles. The degree of saturation with depth relationship shown in Figure 9, therefore, must be corrected to account for the air which came out of solution because of the release of hydrostatic pressure. The corrected degree of saturation relationship is also shown on Figure 9. The corrected data does indicate that the Selma chalk at the Emelle site is fully saturated below a depth of about 50 ft.

5.0 REGIONAL GEOHYDROLOGY

5.1 Introduction

The Emelle, Alabama waste disposal site is underlain by at least 600 ft. of competent, intact low permeability Selma chalk which overlies more permeable beds of the Coker, Gordo and Eutaw Formations. The site exists on a topographic high which is traversed by a major surface water divide with drainage in the western two-thirds being predominantly northwest towards Bodka Creek. In the eastern third of the site surface water drains into Factory Creek.

The major aquifers in Sumter County, Alabama are the sand strata within the Coker, Gordo and Eutaw Formations all of which are capable of yielding substantial quantities of water to wells. In contrast, the relatively impermeable Selma chalk does not yield sufficient water to wells to serve as a water supply source although they do affect regional groundwater conditions because they confine water in the deeper aquifers. In some areas of the CWM site the upper portion of the Selma chalk is weathered with the result that this upper weathered zone is more permeable than the unweathered chalk below. The effect of this weathered zone is to permit some infiltration of surface water during periods of heavy precipitation resulting in occasionally observed flow along the interface between weathered and unweathered chalk.

The groundwater resources of Sumter County, Alabama have been the subject of a recently completed study undertaken by the Geologial Survey of Alabama (Ref. 9). This study concluded that the greatest potential sources of supplies of groundwater are the major aquifers of the

Coker, Gordo and Eutaw Formations where yields of up to 1.5 mgd per well are common.

5.2 General Description of the Major Aquifers

All the major aquifers in Sumter County, Alabama consist of Upper Cretaceous deposits which outcrop in the northern part of the State with a regional strata dip southwards. In Sumter County these aquifers are confined by a considerable thickness of the younger, very low permeability Selma chalk. A confined or artesian aquifer is one in which the elevation of the piezometric surface is above the top of the aquifer. Water enters the confined aquifers in recharge areas where the overlying confining Selma chalk terminates at or close to ground surface. The lowlying areas where the piezometric surface is above ground level, wells penetrating the aquifer will be free flowing.

The major aquifers of the Coker, Gordo and Eutaw Formations are all under artesian pressure with the result that substantial portions of Sumter County are located in areas of artesian flow (Ref. 9).

The sand and gravel beds of the Coker Formation constitute a potential major aquifer in Sumter County but because of the great depths to this formation (in excess of 2,200 ft. in the vicinity of the CWM site) and the availability of water from the shallower aquifers it is not currently used for water supply.

Similar strata within the Gordo Formation comprise a major aquifer in the northern part of Sumter County where some two dozen wells tap this aquifer. The piezometric head in the Gordo Formation is around EL 145 ft. MSL at the CWM site. Because of the regional dip of the Upper Cretaceous sediments to the southwest the Gordo Formation is too deep to be used as a water supply source in central and southern Sumter County. At the CWM site it is estimated that the base of the major aquifer of the Gordo Formation is some 1,400 ft. below ground level.

The coarse grained sand and gravel beds in the lower 200 ft. of the Eutaw Formation represent the major aquifer in central Sumter County and at the CWM site. The depth to the base of the Eutaw Formation aquifer at the CWM site is estimated at approximately 1,100 ft. Examination of the well records given in Ref. 9 suggest that in the immediate vicinity of the CWM site the water in the Eutaw Formation is under artesian pressure with a piezometric head around EL 140 ft. MSL. This implies that the Bodka Creek floodplain to the north and northwest of the CWM site is being partly recharged by a very small amount of artesian flow from the Eutaw Formation aquifer. However, this recharge is low enough to be readily evaporated.

Chemical analyses of water from wells in Sumter County suggest that water from the Gordo and Eutaw aquifers at the CWM site has a chloride content in excess of 500 mg/l (Ref. 9). However, the chloride content of the water from a well in the Eutaw Formation at the CWM site is slightly less than 500 mg/l. In contrast, water from most of the streams in Sumter County contains less than 30 mg/l chloride.

6.0 LABORATORY TESTING OF CHALK

6.1 Introduction

The principal objectives of the laboratory testing program were as follows:

a) To determine the index properties, grain size characteristics and mineralogy of the chalk. Samples of both relatively fresh chalk and chalk from an existing stockpile were used for these tests.

b) Laboratory compaction tests were carried out on a number of samples in order to study the effects of grain size characteristics and testing procedure on the relationship between compacted dry density and molding water content. The results of these tests provide general guidelines for appropriate quality control procedures to be used when placing reclamation covers and other areas requiring compacted fill.

c) Because of the importance of permeability of the recompacted chalk an extensive laboratory testing program was initiated in order to examine the relationship between compaction water content and permeability.

6.2 Results of Previous Laboratory Tests

Over the past few years both Tuscaloosa Testing Laboratory, Inc. (TTL) and Woodward-Clyde Consultants (WCC) have undertaken modest laboratory studies of the principal mechanical properties of the unweathered chalk as part of their respective investigations.

Both WCC and TTL have run Atterberg limit tests on cuttings of the unweathered chalk. Thirteen sets of data were reviewed. The average liquid limit was determined to be 31.8% and the range of values varied between 28% and 40%. The mean plastic limit was 15.9% and varied between 15% and 17%.

WCC ran a Standard Proctor compaction test (ASTM D698) on a sample of the unweathered chalk. Their reported results indicated a maximum dry density of 114.5 pcf and an optimum moisture content of 16.5%.

Some permeability testing was done by others in the past. TTL reports the results of two falling head permeability results on recompacted chalk samples. Their results are as follows:

Dry Density (pcf)	Water Content (%)	Coefficient of Permeability (cm./sec.)
106.5	21.5	$5.1x10^{-8}$
107.0	19.5	$1.5x10^{-7}$

No details are provided for the above tests on how the samples were prepared, how long the tests were run, etc. WCC reports the results of a permeability test on recompacted chalk which was run in a triaxial cell under back pressure saturated conditions. WCC also ran a permeability test on an intact piece of chalk core in a similar manner. The results of these two permeability tests are as follows:

Sample Type	Dry Density (pcf)	Water Content (%)	Coefficient of Permeability (cm./sec.)
Compacted	109.0	18.2	$1.2x10^{-8}$
Core	114.5	10.8	$1.2x10^{-8}$

Golder Associates considers the WCC permeability test results to be more reliable because of the procedures used in running the tests.

6.3 Origin of Samples Used in Golder Associates' Testing Program

Two large bulk samples of sound chalk were supplied by CWM. The first sample, which was received on April 21, 1982 and subsequently referred to as Drum #1, consisted of backfill material from Trench 15 about 70 ft. below ground level. The second bulk sample, referred to as Drum #2, consisted of relatively fresh chalk excavated from the bottom of Trench 16; this sample was delivered on May 20, 1982.

Other samples of chalk used in the laboratory testing program included both auger cuttings and core samples from some of the borings described in Chapter 4 as well as bulk samples of the fill material used in the trench immediately behind the southwest corner of Trench 15. A more complete description of the quality control testing carried out by Golder Associates in this area plus that done during the construction Trench 16 is given in our report on quality control dated September 3, 1982.

6.4 Index Properties, Grain Size Characteristics and Mineralogy

The average as-received water content of the chalk backfill from Trench 15 (Drum #1) was 21% while the relatively fresh chalk from the bottom of Trench 16 had an average water content of only 10.7%.

The in situ water content of the chalk was measured on auger cuttings from borehole SWC and intact samples of the core recovered from all three deep borings. The results are presented in Figure 9 where it can be seen that there is a general trend of decreasing water content with depth.

Atterberg limits of representative samples of the Drum #1 and Drum #2 materials together with those for samples recovered from borehole SWC are presented in Table 3. The index properties cover approximately the same range as that indicated by previous testing while the average plasticity index of about 19 is only slightly higher than that obtained in the previous work.

Two specific gravity determinations made on samples of the Drum #1 material yielded an average specific gravity, G_s, of 2.76.

The grain size distributions of the chalk material from Drums #1 and #2 and the auger cuttings tested by WCC are presented in Figure 10. The differences in grain size characteristics are probably a reflection of the history of the two samples. The chalk from Drum #1 has been subjected to much greater breakdown of individual fragments because of excavation, handling, possible breakdown due to exposure to the elements and the effects of compaction equipment. In contrast the Drum #2 sample, which was excavated from the bottom of Trench 16, was relatively fresh and somewhat coarser grained. The intensity of fragmentation due to auger drilling of the chalk is well illustrated by the grain size districution curve for the auger cuttings tested by WCC.

Two small representative samples of the chalk from Drums #1 and #2 and two nontypical core samples from the deep borings were submitted to the School of Geophysical Sciences at Georgia Institute of Technology for mineralogical analyses and the results are presented in Table 4. The X-ray diffraction analyses are used to determine the amounts of various minerals present in the samples. The clay minerals present consist predominantly of mixed layer illite/smectite with small amounts of illite and kaolinite. The quantity of exchangeable cations required to balance the charge deficiency of a clay is known as cation exchange capacity (CEC) expressed as milliequivalents per 100 grams (Meg/100g) of dry clay. As can be seen in Table 4, the chalk from the two drum samples consists of about 76% calcium carbonate, approximately 21% clay minerals, and about 3% quartz. The clay content of the two core samples tested are significantly higher (33% and 55%) than the drum samples. This corresponds with the observation from the gas and oil exploration well geophysical logs that the chalk tends to have a higher clay content at the bottom and top of the formation. The cation exchange capacity of the core samples is also higher than that measured from the drum samples, as is expected from the higher clay content.

Although the chalk contains a significant quantity of colloidal-sized particles, both the plasticity index and the cation exchange capacity are relatively low because of the small clay mineral component and probably because of the large number of cations, particularly calcium in the matrix. The presence of the excess multivalent cations tends to decrease the soils plasticity and reduce the cation exchange capacity.

6.5 Laboratory Compaction Testing

A large portion of the chalk excavated in the construction of waste disposal trenches is re-used in the development, operation and reclamation stages of waste disposal pit management. The major areas of utilization of recompacted chalk include the following:

a) The development of waste disposal trenches involves the removal of all overburden materials and the weathered chalk overlying the fresh, competent chalk. If necessary to control surface water or for other reasons, recompacted chalk berms are constructed around the top of the trench.

b) Recompacted chalk is also used in the construction of the closure cover which is integrated with the recompacted chalk berms described above. The specific requirements of this top cover upon completion of waste disposal demand low permeability and high plasticity to minimize the possibility of cracking due to differential settlements caused by movements in the disposal trench. The permeability of the reclamation cover must be low to minimize possible future infiltration into the completed waste disposal trench.

Because of the widespread use of recompacted chalk in trench development it was considered necessary to determine the engineering properties of compacted chalk samples for various conditions. Of particular interest was the variation of permeability with molding water content.

The first laboratory compaction tests were carried out using the Drum #1 material and because of the chalk grain size distribution shown in Figure 10, three different testing procedures were utilized. These procedures, referred to subsequently as Methods A, C-76 and C-78 are briefly described below.

<u>Method A</u> follows that recommended in ASTM D 698-78 Method A, which uses only that fraction of the material passing a No. 4 sieve and a 4 in. diameter compaction mold. No oversize correction is made except where the amount of material retained on the No. 4

sieve exceed 7% in which case ASTM D 698-78 Method C should be adopted.

Method C-76 was previously included in ASTM D 698-76 Method C, and permitted the use of material passing a 3/4 in. sieve in a 4 in. diameter mold. This testing procedure is no longer recommended in the most recent relevant standard (ASTM D 698-78) which requires the use of a 6 in. diameter mold for material passing 3/4 in. sieve. However, Method C-76 was used in the laboratory testing program for comparison purposes because of the greater flexibility it offered with respect to the preparation of compacted chalk samples for permeability testing.

Method C-78 is described in ASTM D 698-78 Method C and permits the testing of material passing a 3/4 in. sieve in a 6 in. diameter mold. No overside correction need be made unless the amount of material retained on the 3/4 in. sieve is 10% or more.

In all three methods each specimen was compacted in three layers of approximately equal height using a 5.5 lb. manual hammer allowed to operate in free fall through 12 in. In the 4 in. mold each layer received 25 blows while the number of blows was increased to 56 for compaction in the 6 in. mold. In both cases the compactive effort is 12,375 ft.-lb./cu. ft. corresponding to Standard Proctor compactive effort.

The variation in compacted dry density with molding water content for each of the three testing procedures is illustrated in Figure 11 where it can be seen that the dry density water content relationship for the Drum #1 material is comparatively insensitive to testing method. Also included in Figure 11 is the laboratory compaction curve for the Drum #2 material tested in accordance with Method C-78 described in ASTM D 698-78.

In the control of field compaction emphasis is frequently placed on achieving a specific dry density or degree of compaction as expressed as a proportion of the maximum dry density measured in laboratory compaction tests. In this respect, it is important to appreciate that significant changes in soil structure and hence the engineering properties of plastic soils are associated with mechanical compaction. These changes are strongly dependent on the method of compaction, the compactive effort used and the molding water content. For the same type of compaction equipment and compactive effort, the molding water content is the single most important factor influencing the principal engineering properties of compacted plastic soils such as permeability, compressibility and strength. The main reason for this is associated with the changes in soil fabric. For the same compactive effort, the soil fabric becomes increasingly oriented as the molding water content is increased.

One of the most beneficial effects of changes in soil fabric is that the permeability of the compacted soil decreases dramatically with increasing molding water content; this aspect will be discussed further in Section 6.6.

From Figure 11 it can be seen that the maximum dry density, corresponding to Standard Proctor compactive effort, ranged from about 103 lb./cu. ft. to approximately 107 lb./cu. ft. while the optimum water content varies from about 19 to 21 percent for the samples tested. Also, the data in Figure 11 suggests the Proctor curve is insensitive to the particular method of sample preparation.

6.6 Laboratory Permeability Testing

The material used in the permeability testing program was taken from the Drum #1 bulk sample. Most of the permeability tests were carried out using material passing the 3/4 in. sieve (Method C-76) but one test was conducted with finer material passing the #4 sieve (Method A) in order to investigate the effect of chalk fragment size on mass permeability.

Samples for permeability testing were prepared by compacting chalk in 4 in. molds to a dry density of approximately 95% of Standard Proctor maximum dry density and at molding water contents ranging from about 3% dry to 3% wet of optimum. Prior to sample preparation The inside of the mold was coated with a thin bentonite film in order to provide a seal and prevent piping along the sides of the mold. The samples were then allowed to saturate under a water head equivalent to 5 $lb./in.^2$ and readings were taken of water inflow and outflow.

The results of a typical test are presented in Figure 12 where it can be seen that the ratio of cumulative inflow to cumulative outflow steadily increases to a maximum of about 0.98. Generally, between 7 and 14 days were needed to reach practical steady state conditions. Figure 12 also illustrates the variation in permeability (calculated from cumulative outflow) with time and shows that the permeability remains essentially constant for cumulative inflow/outflow ratios in excess of about 0.95.

In order to verify the simplified testing technique described above, one specimen of recompacted chalk was subjected to backpressure saturation in a 4 in. diameter triaxial cell. The permeability from this test fits the overall pattern of the other determinations and is in good agreement with the coefficient of permeability measured on an almost identical sample tested in the compaction mold. The results of the permeability tests are presented in Table 5. Note the agreement in permeability values obtained from Test 1 in the Proctor set-up with that obtained in the triaxial cell under back pressure saturated conditions (Test No. 7).

The variation in permeability with compaction water content is illustrated in Figure 13. The coefficient of permeability of the recompacted chalk varies by about two orders of magnitude within the range of plus and minus 3% of optimum water content. The coefficient of permeability drops dramatically for compaction water contents in excess of the optimum moisture corresponding to Standard Proctor compactive effort. These data suggest that in order to achieve a low permeability recompacted chalk fill the molding water content should be wet of optimum; for these conditions, and for compacted dry densities greater than 95 percent of the Standard Proctor dry density (ASTM D698), coefficients of permeability on the order of 6.0×10^{-8} cm./sec. should be achievable in the field.

7.0 SUMMARY OF GEOLOGICAL AND GEOTECHNICAL CONDITIONS AT EMELLE, ALABAMA SITE

The CWM hazardous waste disposal site is located in a unique geological setting comprising massive deposits of extremely competent, low permeability saturated Selma chalk. Our review of the geological literature and the records of previous deep borings indicate that the Selma chalk at the CWM site is at least 600 ft. thick.

Three deep borings put down near the limits of the CWM property have confirmed the lateral and vertical continuity of some 500 ft. of Selma chalk. Some near surface weathering of the chalk has occurred but all the data reviewed suggest that the depth to sound unweathered chalk is probably no more than 20 ft. to 30 ft. below natural ground level. Both the weathered and unweathered chalk include discontinuities although visual inspection of the chalk exposed in the side walls of active disposal trenches suggests that the joints in the fresh chalk are tightly closed, often calcite filled or otherwise rehealed. Few discontinuities were intersected in almost 1,500 ft. of deep rock coring and in some instances rehealing was so strong that it was not possible to break the core along the joint. Consequently although the chalk is fractured, very few of the discontinuities can be described as inherent planes of weakness.

The Selma chalk is underlain by the deposits of the Eutaw Formation which constitute the uppermost aquifer at the CWM site. The piezometric head in the Eutaw Formation, in the vicinity of the site, is around EL 140 ft. MSL. Groundwater levels measured in wells in the chalk suggest the groundwater in the chalk in places is higher than EL 140 ft. MSL. Laboratory analyses on core samples confirm that the chalk is saturated below the stabilized groundwater levels in the unweathered chalk.

Laboratory permeability tests have shown that the permeability of recompacted chalk is sensitive to molding water content. For chalk compacted to 95 percent of the Standard Proctor maximum dry density (ASTM D698) at or wet of the optimum water content the resulting coefficient of permeability will be about 6.0×10^{-8} cm./sec.

The work described in this document confirms that the Emelle, Alabama site is underlain by at least 600 ft. of relatively impermeable, saturated and structurally competent Selma chalk. All the data reviewed support the view that the Emelle, Alabama site possesses many geological and hydrogeological characteristics which make it well suited to the safe disposal of hazardous waste.

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LIST OF SYMBOLS

I. GENERAL

π = 3.1416

e = base of natural logarithms 2.7183

$\log_e a$ or $\ln a$, natural logarithm of a

$\log_{10} a$ or $\log a$, logarithm of a to base 10

t time

g acceleration due to gravity

V volume

W weight

M moment

F factor of safety

II. STRESS AND STRAIN

u pore pressure

σ normal stress

σ' normal effective stress ($\bar{\sigma}$ is also used)

τ shear stress

ϵ linear strain

ϵ_{xy} shear strain

ν Poisson's ratio (μ is also used)

E modulus of linear deformation (Young's modulus)

G modulus of shear deformation

K modulus of compressibility

η coefficient of viscosity

III. SOIL PROPERTIES

(a) *Unit weight*

γ unit weight of soil (bulk density)

γ_s unit weight of solid particles

γ_w unit weight of water

γ_d unit dry weight of soil (dry density)

γ' unit weight of submerged soil

G_s specific gravity of solid particles $G_s = \gamma_s/\gamma_w$

e void ratio

n porosity

w water content

S_r degree of saturation

(b) *Consistency*

w_L liquid limit

w_P plastic limit

I_P plasticity index

w_S shrinkage limit

I_L liquidity index = $(w - w_P)/I_P$

I_C consistency index = $(w_L - w)/I_P$

e_{max} void ratio in loosest state

e_{min} void ratio in densest state

D_r relative density = $(e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

h hydraulic head or potential

q rate of discharge

v velocity of flow

i hydraulic gradient

k coefficient of permeability

j seepage force per unit volume

(d) *Consolidation (one-dimensional)*

m_v coefficient of volume change $= -\Delta e/(1+e)\Delta\sigma'$

C_c compression index $= -\Delta e/\Delta \log_{10} \sigma'$

c_v coefficient of consolidation

T_v time factor $= c_v t/d^2$ (d, drainage path)

U degree of consolidation

(e) *Shear strength*

τ_f shear strength

c' effective cohesion intercept; ϕ' effective angle of shearing resistance, or friction — in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$

c_u apparent cohesion*; ϕ_u apparent angle of shearing resistance, or friction — in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$

μ coefficient of friction

S_t sensitivity

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

Form ... U.S.A.

LIST OF ABBREVIATIONS

The abbreviations and terms commonly employed on each Boring Log, on the Figures, and in the text of the report, are as follows:

C	- Coarse	RES	- Residual
CA	- Casing	RX	- Rock
F	- Fine	SA	- Sample
FRAG	- Fragments	SAT	- Saturated
M	- Medium	SM	- Some
MIC	- Micaceous	TR	- Trace
NP	- Non-plastic	WL	- Water level
PH	- Pressure hydraulic	WH	- Weight of hammer
PM	- Pressure manual		

TERMS AND DESCRIPTIONS

Soil Description	Range of Proportion
Trace (tr.)	0 - 5%
Little	5 - 12%
Some	12 - 30%
And	30 - 50%

Relative Density of Cohesionless Soils	N (blows/ft.)
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

Consistency of Cohesive Soils	Cu (psf)
Very soft	less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

SAMPLE TYPES

AS	Auger Sample
CS	Chunk Sample
DO	Drive Open
DS	Denison sample
PS	Pitcher sample
RC	Rock core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

SOIL TESTS

C	Consolidation test
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial
H	Hydrometer analysis
M	Sieve analysis
MH	Sieve & hydrometer analysis
U	Unconfined compression
UU	Unconsolidated undrained triaxial
V	Vane Shear

PENETRATION RESISTANCE

Standard Penetration Resistance, "N" = the number of blows required to drive a 2 in. OD splitspoon sampler one foot using a 140 lb. hammer falling 30 in.

TABLE 1

SUMMARY OF GEOLOGIC UNITS AND LITHOLOGY
IN SUMTER COUNTY, ALABAMA

SYSTEM	SERIES	GEOLOGIC UNIT	THICKNESS (Feet)	LITHOLOGY
CRETACEOUS	UPPER CRETACEOUS	Prairie Bluff Chalk	70+	Chalk, white, fossiliferous sandy.
		Ripley Formation	35-220	Sandy, gray, very fine to fine grained micaceous, calcareous, fossiliferous, dark gray calcareous fossiliferous sandy clay; light gray chalk. Locally contains a few thin beds of micaceous calcareous hard sandstone in lower part.
		Demopolis Chalk	450-520	Chalk, light gray, silty, micaceous, fossiliferous.
		Mooreville Chalk	225-360	Chalk, light gray, silty, fossiliferous.
		Eutaw Formation	400+	Sand, light gray to yellowish brown, fine to medium grained, glauconitic; light gray to green micaceous laminated clay and shale; thin to massive beds of fine to coarse grained glauconitic sands and beds of light gray to gray shale in lower part. A massive bed of fine to medium grained glauconitic sand and locally a few thin beds of light gray glauconitic sandstone and sandy chalk occurs in the upper part.
		Gordo Formation	300-450	Sand, fine to very coarse grained; carbonaceous micaceous clay and shale; chert gravel; poorly sorted coarse grained sand in lower part; upper part consists of massive clay and lenticular sand beds.
		Coker Formation	800-900	Sand, fine to coarse grained, glauconitic, micaceous; chert gravel; carbonaceous clay and shale; fine to coarse grained sandstone; basal part consists of massive beds of coarse grained sand and gravel; clay predominates in upper part, locally sand and gravel beds are present.

TABLE 2

SUMMARY OF DATA ON THE ELEVATION OF THE BASE
OF THE SELMA CHALK FROM DEEP WELLS IN SUMTER COUNTY

Well Number	Ground Surface Elevation, ft. MSL	Elevation of Base of Selma Chalk, ft. MSL	Location of Well	Reliability of Well Data
N-8	200	-510	±10 miles SE	Good
M-3	215	-625	± 3 miles S	Good
I-2	110	-370	± 5 miles NE	Good
J-14	249	-455	SE Corner	Fair
J-3	115	-388	± 2 miles N	Fair
J-5	124	-385	± 2 miles N	Fair

TABLE 3

SUMMARY OF ATTERBERG LIMITS OF CHALK

Origin of Sample	Sample Depth (ft.)	ATTERBERG LIMITS W_L (%)	W_P (%)	I_P (%)
Drum #1	N/A	36	20	16
Drum #2	N/A	38	18	20
		37	22	15
BH SWC	25-28	48	18	30
BH SWC	50-51	32	20	12

TABLE 4

MINERALOGICAL ANALYSES OF CHALK SAMPLES

Sample Number	Calcite	Mineralogical Composition, % Quartz	MLI/S*	Illite	Kaolinite	Bulk CEC Meq/100g
Drum #1(A)	73	3	18	3	3	6.0
Drum #1(B)	71	3	19	4	3	6.0
Drum #2(A)	77	4	12	3	4	4.0
Drum #2(B)	82	2	10	3	3	4.0
DB-1**	64	3	24	7	2	7.6
DB-2***	37	8	35	14	6	13.2

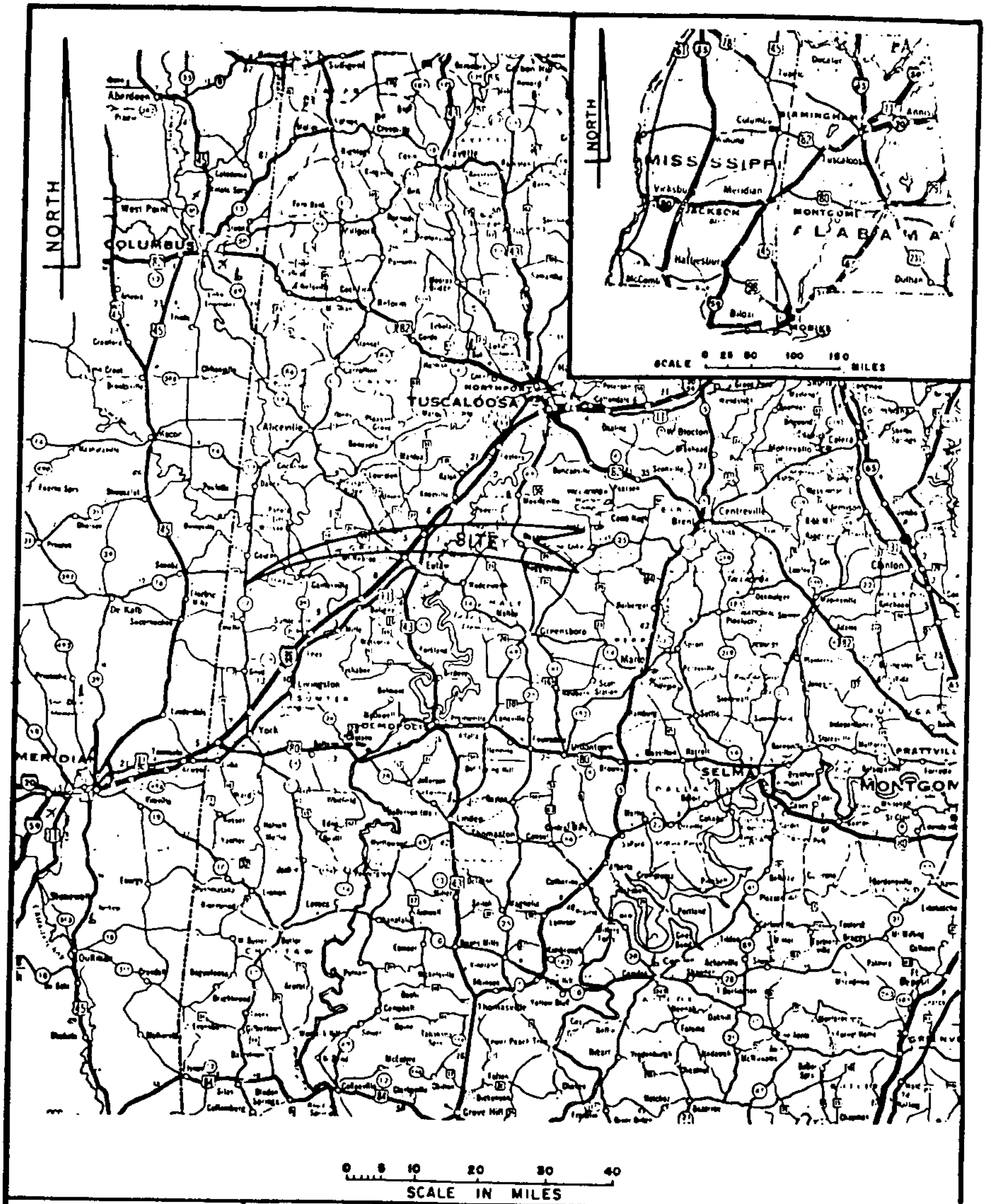
*Mixed layer illite/smectite with 50% smectite layers.
**Sandy core sample at 497 ft. depth.
***Clayey core sample at 45 ft. depth.

TABLE 5

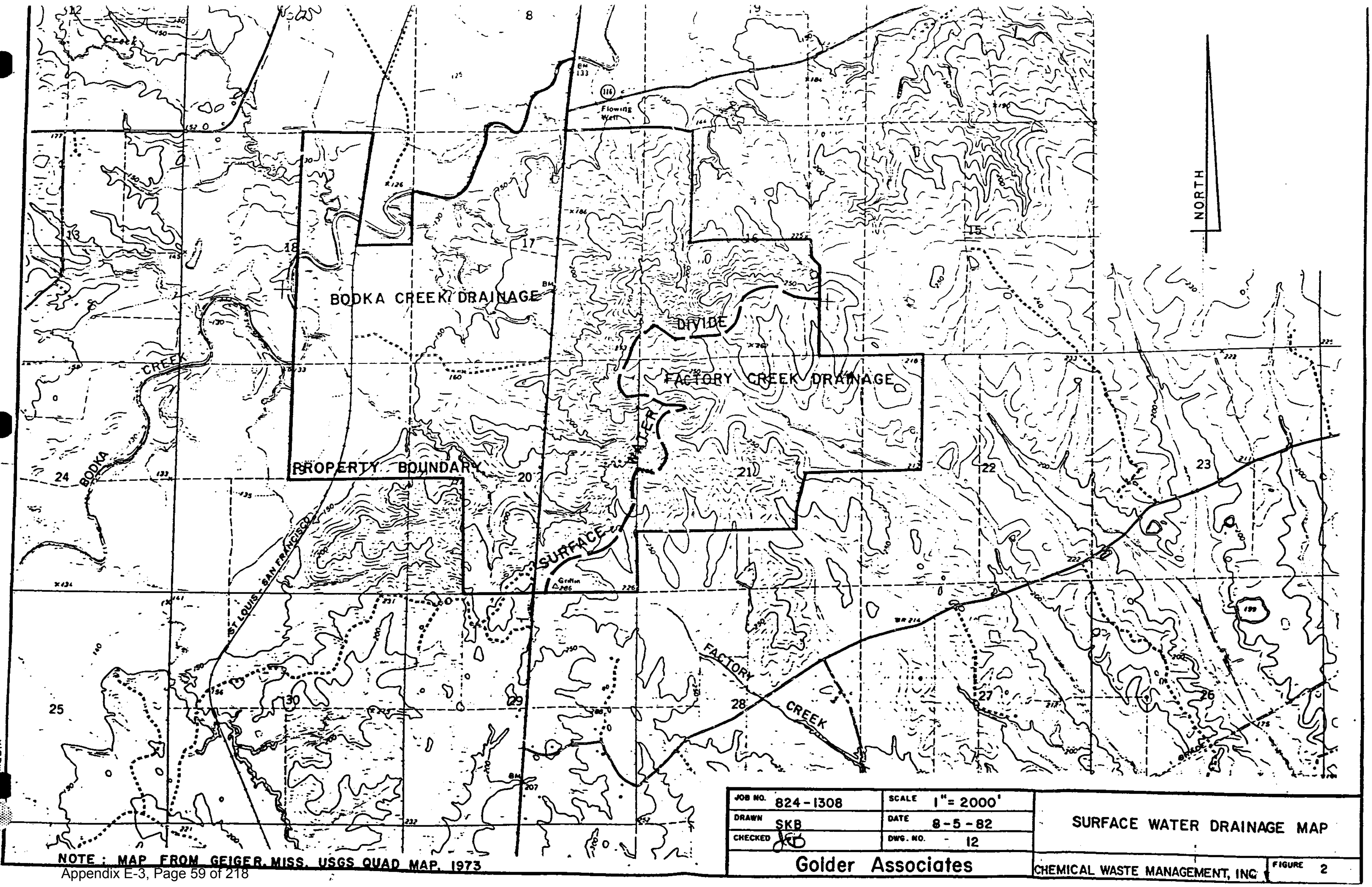
SUMMARY OF PERMEABILITY TESTS
ON RECOMPACTED CHALK

Test No.	Material Description	Compacted Dry Density (lb./ft.^{3})	Molding Water Content (%)	Permeability (cm./sec.)
1	Passing 3/4 in sieve	97.3	24.3	$5.4x10^{-8}$
2	Passing #4 sieve	98.2	23.7	$3.6x10^{-8}$
3	Passing 3/4 in sieve	101.3	22.0	$4.0x10^{-6}$
4	Passing 3/4 in sieve	100.6	19.8	$1.9x10^{-6}$
5	Passing 3/4 in sieve	98.3	20.7	$2.5x10^{-6}$
6	Passing 3/4 in sieve	98.3	18.8	$1.5x10^{-6}$
7*	Passing 3/4 in sieve	97.9	24.9	$6.0x10^{-8}$*

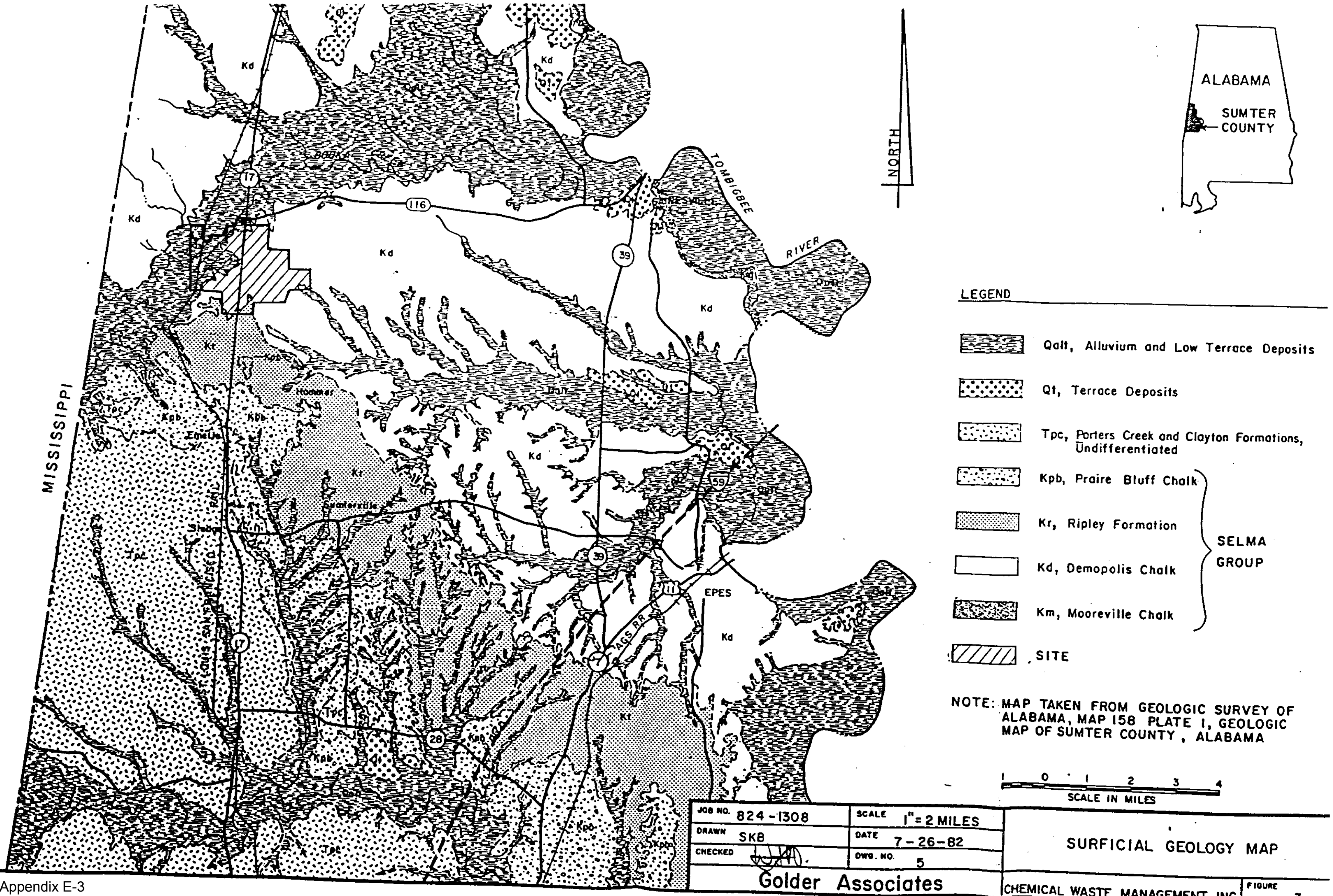
* Measured in backpressure saturation test in triaxial apparatus.



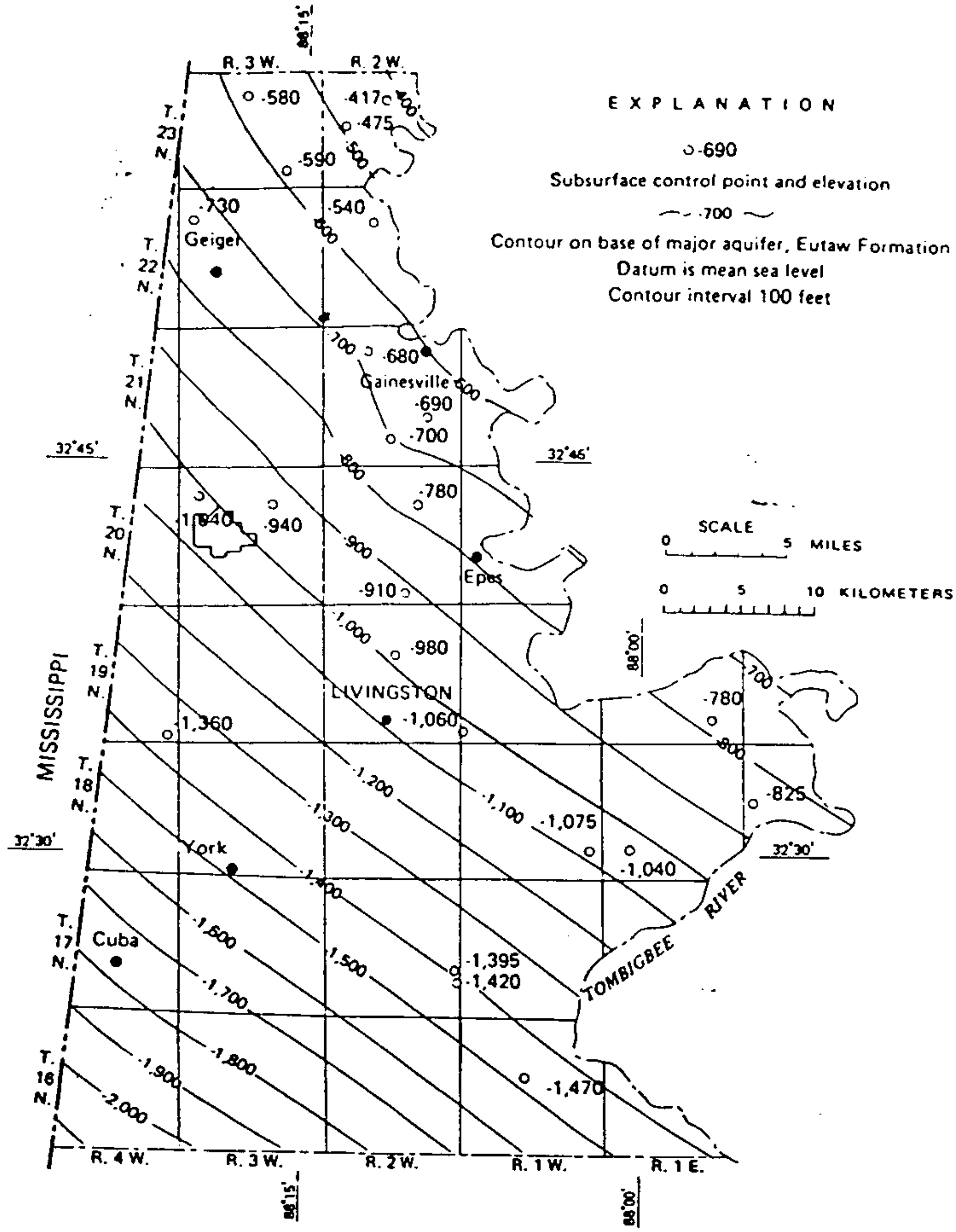
JOB NO. 824 - 1308	SCALE AS SHOWN	SITE LOCATION MAP EMELLE FACILITY
DRAWN SKB	DATE 8-5-82	
CHECKED WB	DWG. NO. 11.	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 1



NORTH
BODKA CREEK DRAINAGE
DIVIDE
FACTORY CREEK DRAINAGE
PROPERTY BOUNDARY
SURFACE WATER
BODKA CREEK
FACTORY CREEK
ST LOUIS - SAN FRANCISCO
Flowing Well
NOTE: MAP FROM GEIGER, MISS. USGS QUAD MAP, 1973
JOB NO. 824-1308
SCALE 1" = 2000'
DRAWN SKB
DATE 8-5-82
CHECKED
DWG. NO. 12
Golder Associates
SURFACE WATER DRAINAGE MAP
CHEMICAL WASTE MANAGEMENT, INC.
FIGURE 2


ALABAMA
SUMTER COUNTY
NORTH
MISSISSIPPI
TOMBIGBEE RIVER
GAINESVILLE
EPES
LEGEND
Qalt, Alluvium and Low Terrace Deposits
Qt, Terrace Deposits
Tpc, Porters Creek and Clayton Formations, Undifferentiated
Kpb, Praire Bluff Chalk
Kr, Ripley Formation
Kd, Demopolis Chalk
Km, Mooreville Chalk
SELMA GROUP
SITE
NOTE: MAP TAKEN FROM GEOLOGIC SURVEY OF ALABAMA, MAP 158 PLATE 1, GEOLOGIC MAP OF SUMTER COUNTY, ALABAMA
1 0 1 2 3 4
SCALE IN MILES
JOB NO. 824-1308
SCALE 1" = 2 MILES
DRAWN SKB
DATE 7-26-82
CHECKED
DWG. NO. 5
Golder Associates
SURFICIAL GEOLOGY MAP
CHEMICAL WASTE MANAGEMENT, INC.
FIGURE

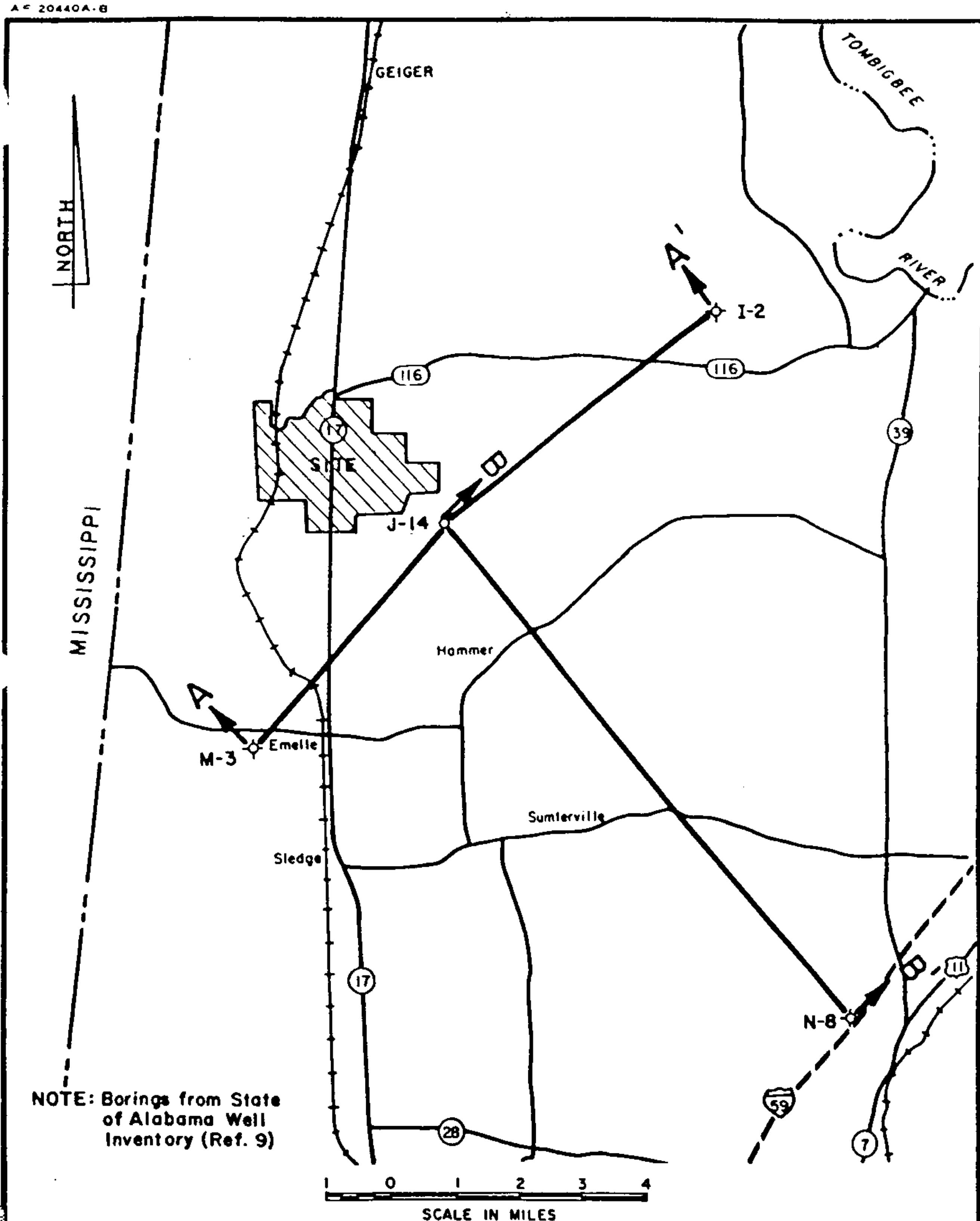
AF 20440A-B



From "Water availability and geology of Sumter County, Alabama", Ref. 9.

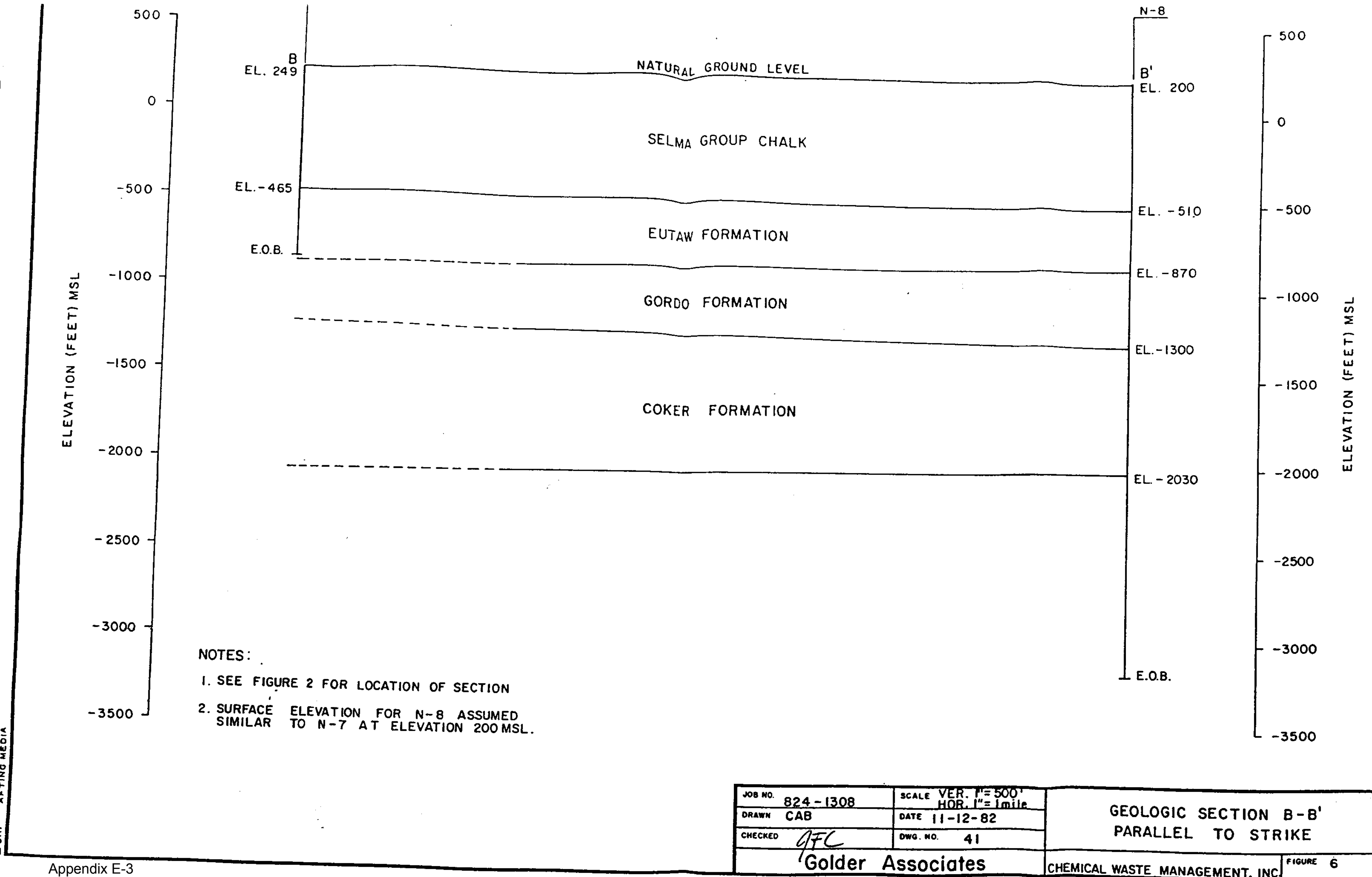
JOB NO. 824-1308	SCALE AS SHOWN	ELEVATION OF BASE OF EUTAW AQUIFER
DRAWN SKB	DATE 8-18-82	
CHECKED	DWG. NO. 21	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 4

TGAF DRAFTING MEDIA

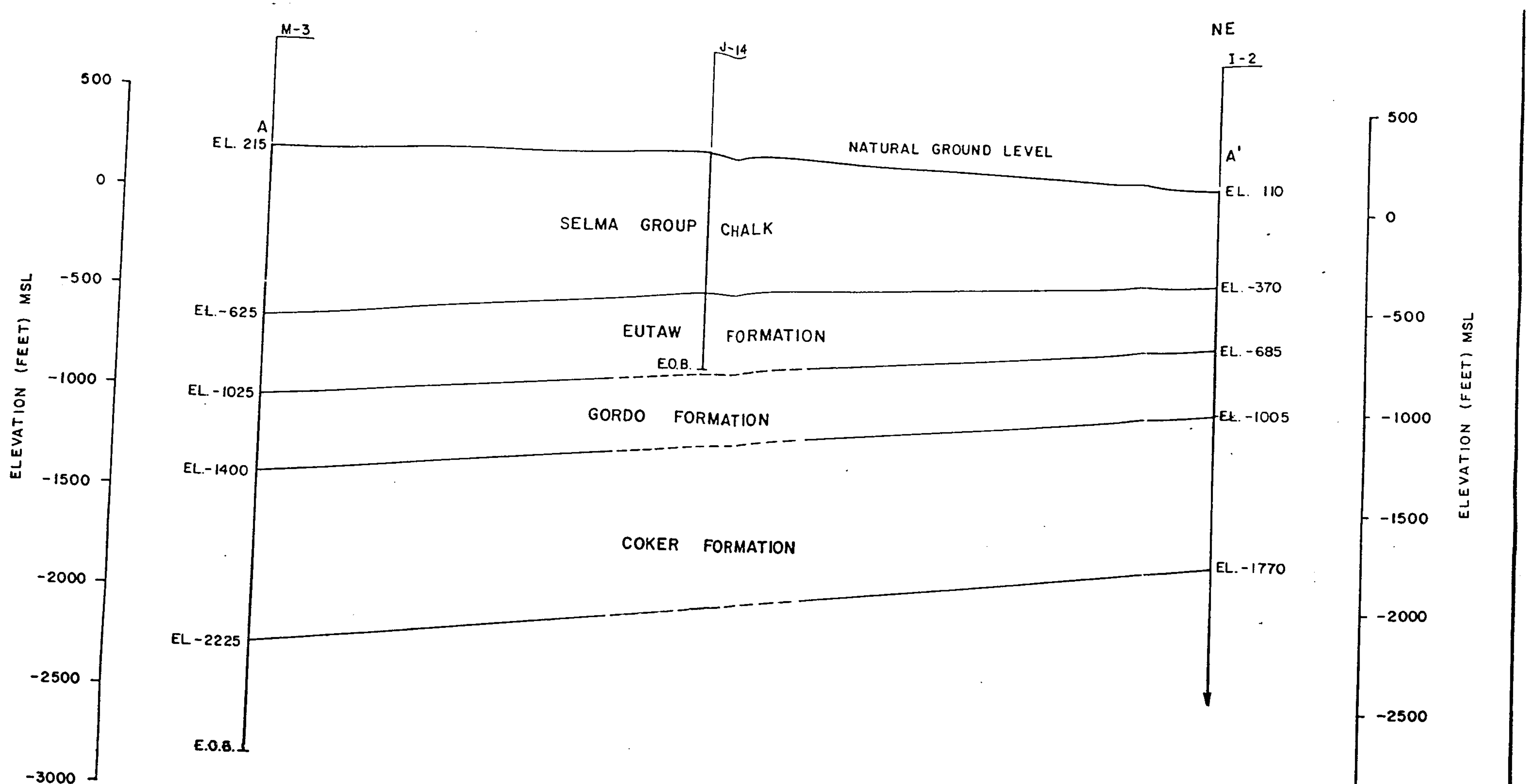


JOB NO. 824-1308	SCALE 1" = 2 MILES	LOCATION OF DEEP WELL BORINGS AND GEOLOGIC SECTIONS		
DRAWN SKB	DATE 8-18-82			
CHECKED [signature]	DWG. NO. 22			
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE	5

TGAF DRAFTING MEDIA



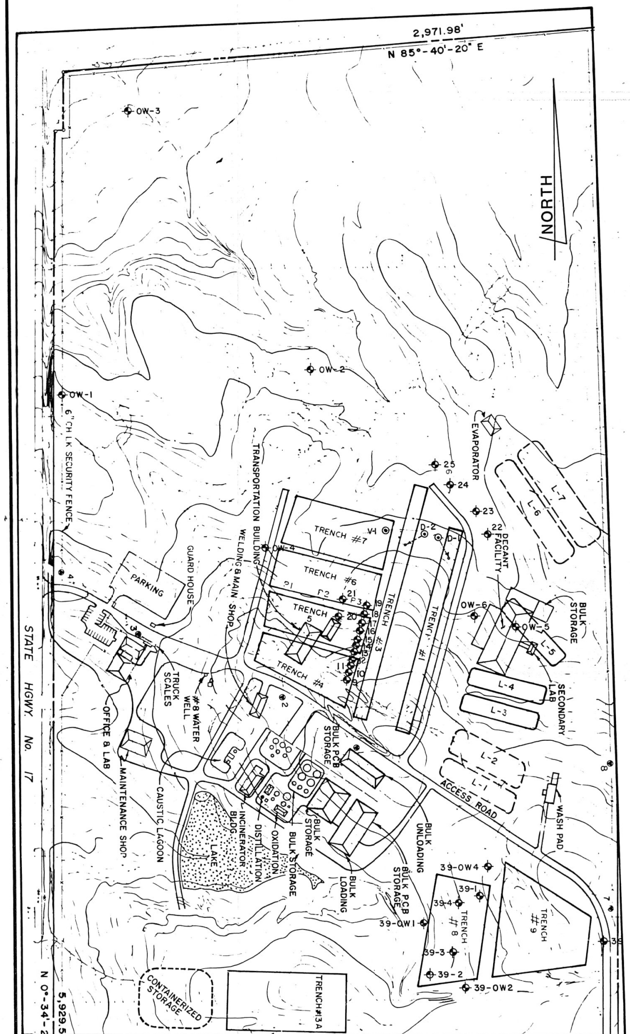
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
ELEVATION (FEET) MSL
N-8
B
EL. 249
NATURAL GROUND LEVEL
B'
EL. 200
SELMA GROUP CHALK
EL.-465
EL. -510
EUTAW FORMATION
E.O.B.
EL. -870
GORDO FORMATION
EL.-1300
COKER FORMATION
EL. - 2030
E.O.B.
NOTES:
1. SEE FIGURE 2 FOR LOCATION OF SECTION
2. SURFACE ELEVATION FOR N-8 ASSUMED SIMILAR TO N-7 AT ELEVATION 200 MSL.
JOB NO. 824-1308
SCALE VER. 1"=500' HOR. 1"=1mile
DRAWN CAB
DATE 11-12-82
CHECKED JFC
DWG. NO. 41
Golder Associates
GEOLOGIC SECTION B-B' PARALLEL TO STRIKE
CHEMICAL WASTE MANAGEMENT, INC.
FIGURE 6



NOTE:
SEE FIGURE 2 FOR LOCATION OF SECTION

JOB NO. 824-1308	SCALE VER. 1"= 500' HOR. 1"= 1 mile	GEOLOGIC SECTION A-A' NORMAL TO STRIKE	
DRAWN CAB	DATE 11-12-82		
CHECKED	DWG. NO. 40		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 7

FIGURE 8



DETAIL

1" = 200'

KEY

- RESERVED BUFFER AREAS
- BUILDING OR STRUCTURE
- ACTIVE SURFACE IMPOUNDMENT AREA WITH PROCESS IDENTIFIER NUMBER
- INACTIVE SURFACE IMPOUNDMENT AREA WITH PROCESS IDENTIFIER NUMBER
- ACTIVE LAND DISPOSAL TRENCH WITH THE DISPOSAL IDENTIFIER NUMBER
- COMPLETED LAND DISPOSAL TRENCH WITH THE DISPOSAL IDENTIFIER NUMBER
- TRIANGULATION MONUMENT
- MONITORING WELL WITH IDENTIFIER NUMBER
- FENCE
- SECTION CORNER WITH SECTION NUMBERS
- PROPERTY BOUNDARIES

LEGEND:

- TUSCALOOSA TESTING LABORATORY BORINGS
- WOODWARD-CLYDE BORINGS
- GOLDER ASSOCIATES BORINGS
- 60 ACRE NEAR TERM DEVELOPMENT AREA

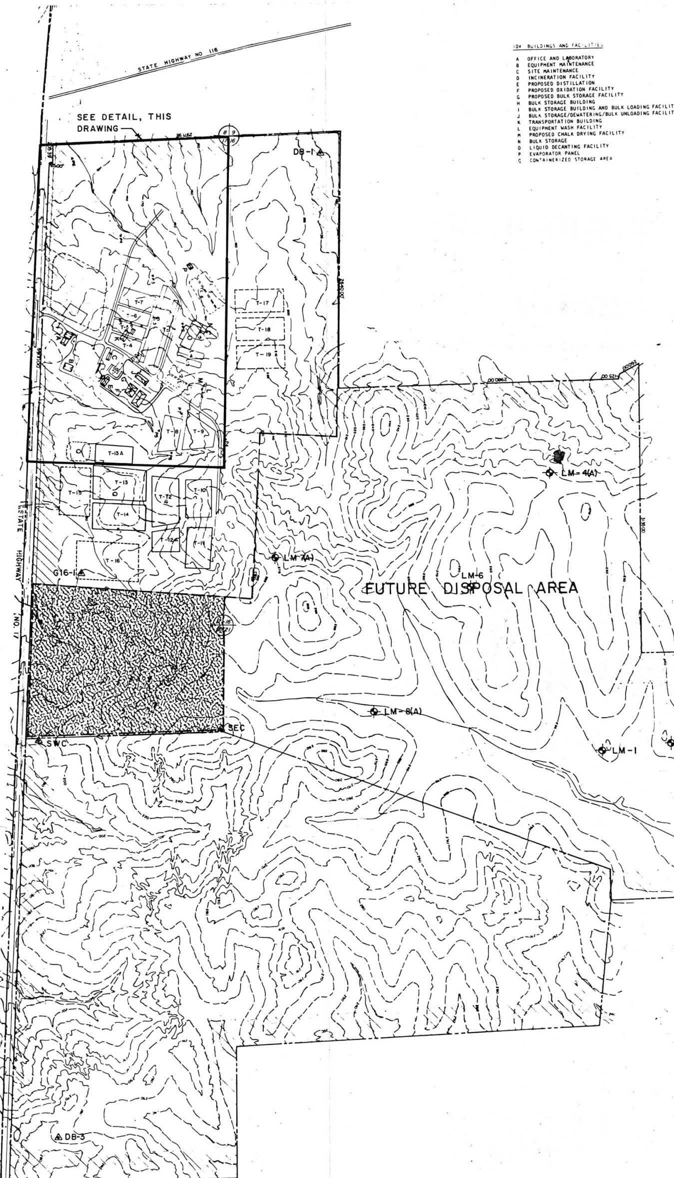
NOTES:

1. BORING LOCATIONS ARE APPROXIMATE.
2. BASEMAPS PROVIDED BY CHEMICAL WASTE MANAGEMENT, INC.
3. SEE APPENDIX B FOR TUSCALOOSA TESTING LABORATORY BORING LOGS.
4. SEE APPENDIX C FOR WOODWARD-CLYDE BORING LOGS.
5. SEE APPENDIX D FOR GOLDER ASSOCIATES BORING LOGS.

ID#	BUILDINGS AND FACILITIES
A	OFFICE AND LABORATORY
B	EQUIPMENT MAINTENANCE
C	SITE MAINTENANCE
D	INCINERATION FACILITY
E	PROPOSED DISTILLATION
F	PROPOSED OXIDATION FACILITY
G	PROPOSED BULK STORAGE FACILITY
H	BULK STORAGE BUILDING
I	BULK STORAGE BUILDING AND BULK LOADING FACILITY
J	BULK STORAGE/DEWATERING/BULK UNLOADING FACILITY
K	TRANSPORTATION BUILDING
L	EQUIPMENT WASH FACILITY
M	PROPOSED CHALK DRYING FACILITY
N	BULK STORAGE
O	LIQUID DECANTING FACILITY
P	EVAPORATOR PANEL
Q	CONTAINERIZED STORAGE AREA

ID#	DISPOSAL TRENCHES (APPROX. DIMENSIONS)
T-1	COMPLETED TRENCH (50' x 700' x 50' x 700')
T-3	COMPLETED TRENCH (50' x 800' x 50' x 700')
T-4	COMPLETED TRENCH (340' x 150' x 340' x 150')
T-5	COMPLETED TRENCH (340' x 120' x 340' x 120')
T-6	COMPLETED TRENCH (340' x 120' x 340' x 120')
T-7	COMPLETED TRENCH (340' x 170' x 350' x 110')
T-8	COMPLETED TREHCN (190' x 320' x 200' x 400')
T-9	COMPLETED TRENCH (330' x 170' x 320' x 400')
T-10	COMPLETED TRENCH (270' x 380' x 270' x 440')
T-11	COMPLETED TREHCN (270' x 420' x 280' x 440')
T-12	COMPLETED TRENCH (325' x 450' x 300' x 500')
T-12A	COMPLETED TRENCH (300' x 250' x 290' x 218')
T-13	COMPLETED TRENCH (560' x 300' x 550' x 330')
T-13A	COMPLETED TRENCH (400' x 200' x 410' x 200')
T-14	COMPLETED TRENCH (550' x 250' x 550' x 280')
T-15	ACTIVE TRENCH (320' x 520' x 320' x 520')
T-16	ACTIVE TRENCH (635' x 400' x 640' x 385')
T-17	PROPOSED TRENCH (500' x 250' x 500' x 250')
T-18	PROPOSED TRENCH (500' x 250' x 500' x 250')
T-19	PROPOSED TRENCH (500' x 250' x 500' x 250')

ID#	DISPOSAL SURFACE IMPOUNDMENTS (APPROX. DIMENSIONS)
L-1	ACTIVE IMPOUNDMENT (260' x 85' x 300' x 75')
L-2	ACTIVE IMPOUNDMENT (260' x 75' x 275' x 100')
L-3	COMPLETED IMPOUNDMENT (270' x 60' x 270' x 60')
L-4	COMPLETED IMPOUNDMENT (270' x 60' x 270' x 60')
L-5	COMPLETED IMPOUNDMENT (60' x 270' x 60' x 270')
L-6	ACTIVE IMPOUNDMENT (90' x 400' x 90' x 400')
L-7	ACTIVE IMPOUNDMENT (90' x 400' x 90' x 400')

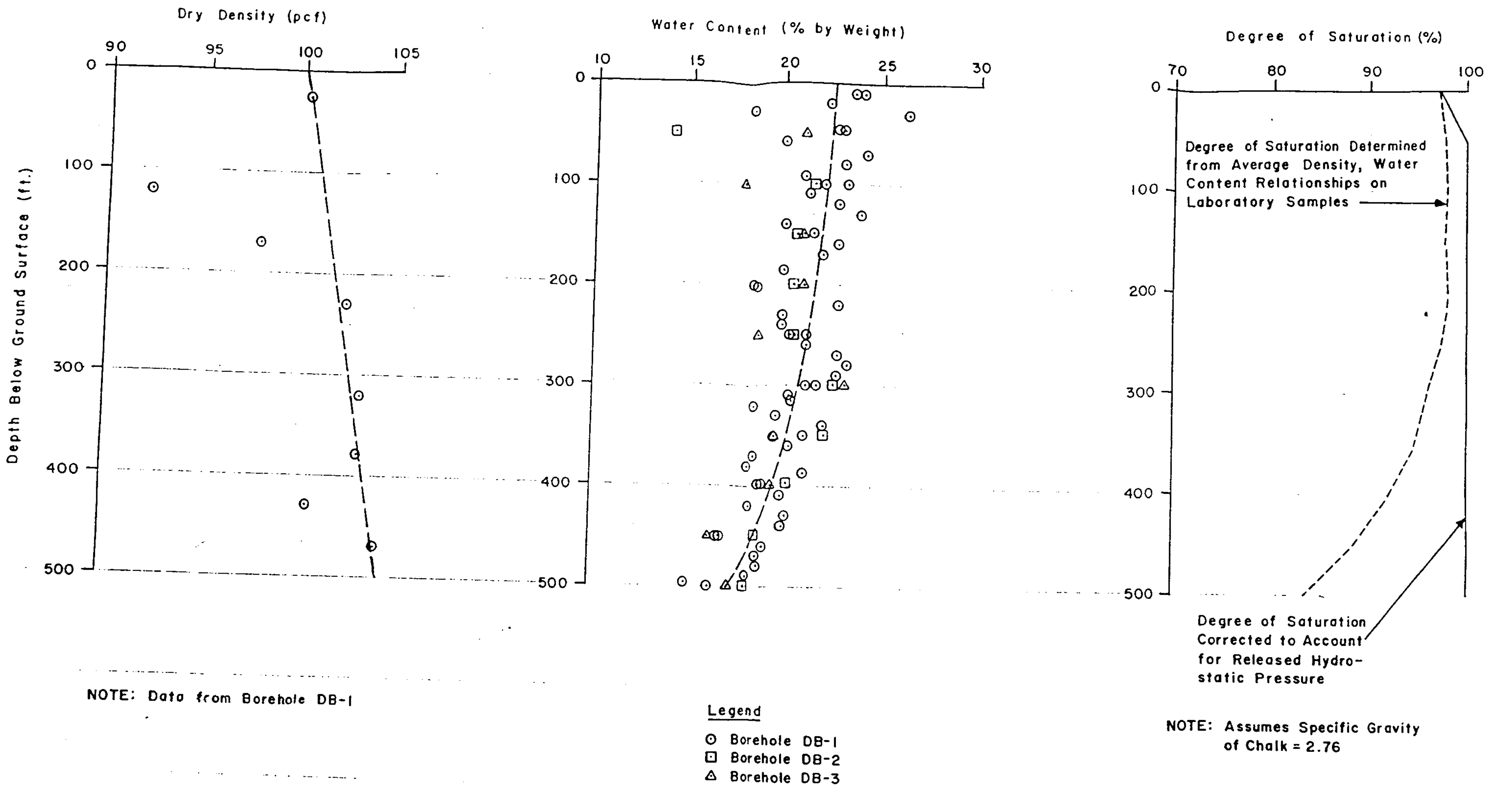


REVISIONS		
DESCRIPTION	BY	DATE
Revise Dwg. No.(54); Remove OW-7 Boring	SKB	6-14-83

CHEMICAL WASTE MANAGEMENT, INC.
EMELLE DISPOSAL FACILITY

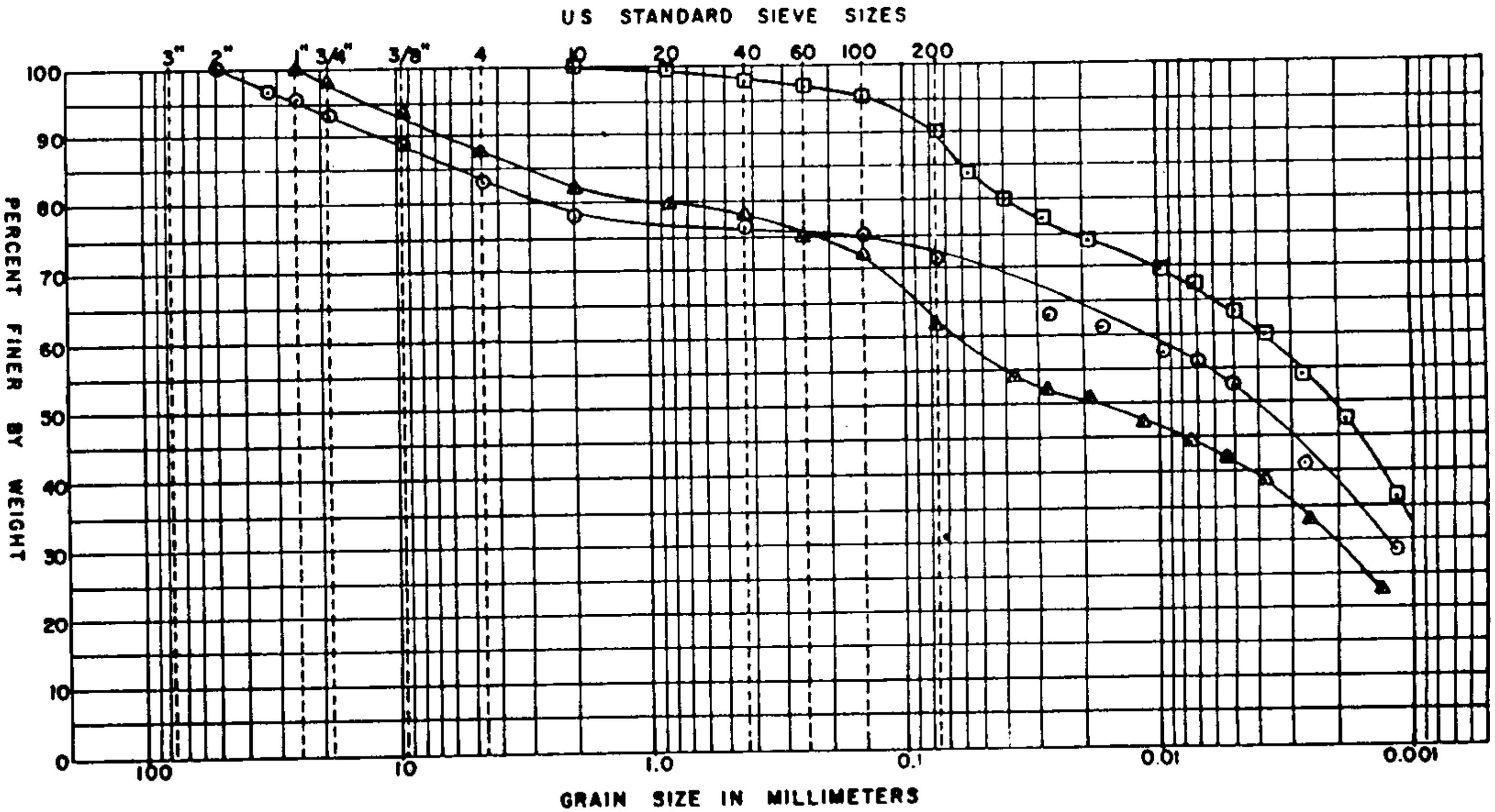
TITLE: BORING LOCATION PLAN

DRAWN: SKB	SCALE: AS SHOWN	DATE: 12-31-82	
CHECKED: JEB WHD	REVIEWED: JEB	JOB NO. 824-1308	
Golder Associates		DWG. NO. 00-150-001	FIGURE 8



JOB NO. 824-1308	SCALE AS SHOWN	VARIATION IN DENSITY, WATER CONTENT AND DEGREE OF SATURATION OF CHALK WITH DEPTH
DRAWN LJW	DATE 12-31-82	
CHECKED JEB	DWG. NO. 53	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 9

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.		ELEV. OR DEPTH	W_n	W_L	W_p	I_p	DESCRIPTION OR CLASSIFICATION
Drum #1	⊙		21.0	36	20	16	Gray SILTY CLAY with some fine to coarse gravel (chalk fragments)
Drum #2	△		10.7	38	18	20	Gray SILTY CLAY with some fine to coarse sand and some gravel (chalk fragments)
WCC	⊡		18	31	16	15	Gray medium plastic SILTY CLAY with trace of fine sand (chalk cuttings)

FIGURE 10

Golder Associates

Date 8-9-82
Job No. 824-1308

Drawn SKB
Checked WJN
Reviewed SEB

COMPACTION TEST RESULTS

FIGURE 11

BOREHOLE NUMBER N/A

SAMPLE NUMBER Drum #1, Drum #2

DEPTH OF SAMPLE

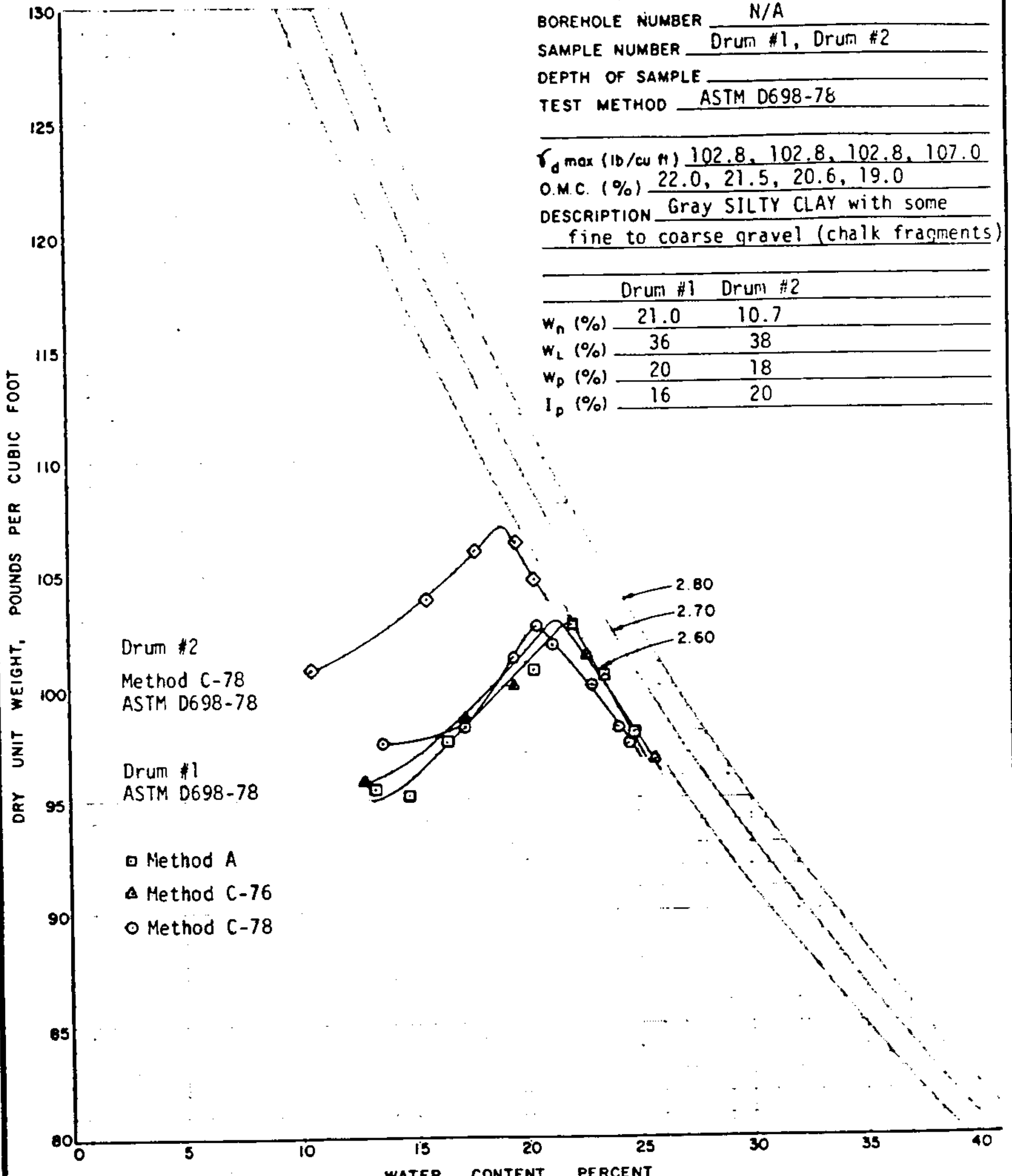
TEST METHOD ASTM D698-78

γ_d max (lb/cu ft) 102.8, 102.8, 102.8, 107.0

O.M.C. (%) 22.0, 21.5, 20.6, 19.0

DESCRIPTION Gray SILTY CLAY with some fine to coarse gravel (chalk fragments)

	Drum #1	Drum #2
W_n (%)	21.0	10.7
W_L (%)	36	38
W_p (%)	20	18
I_p (%)	16	20



Date 8-9-82

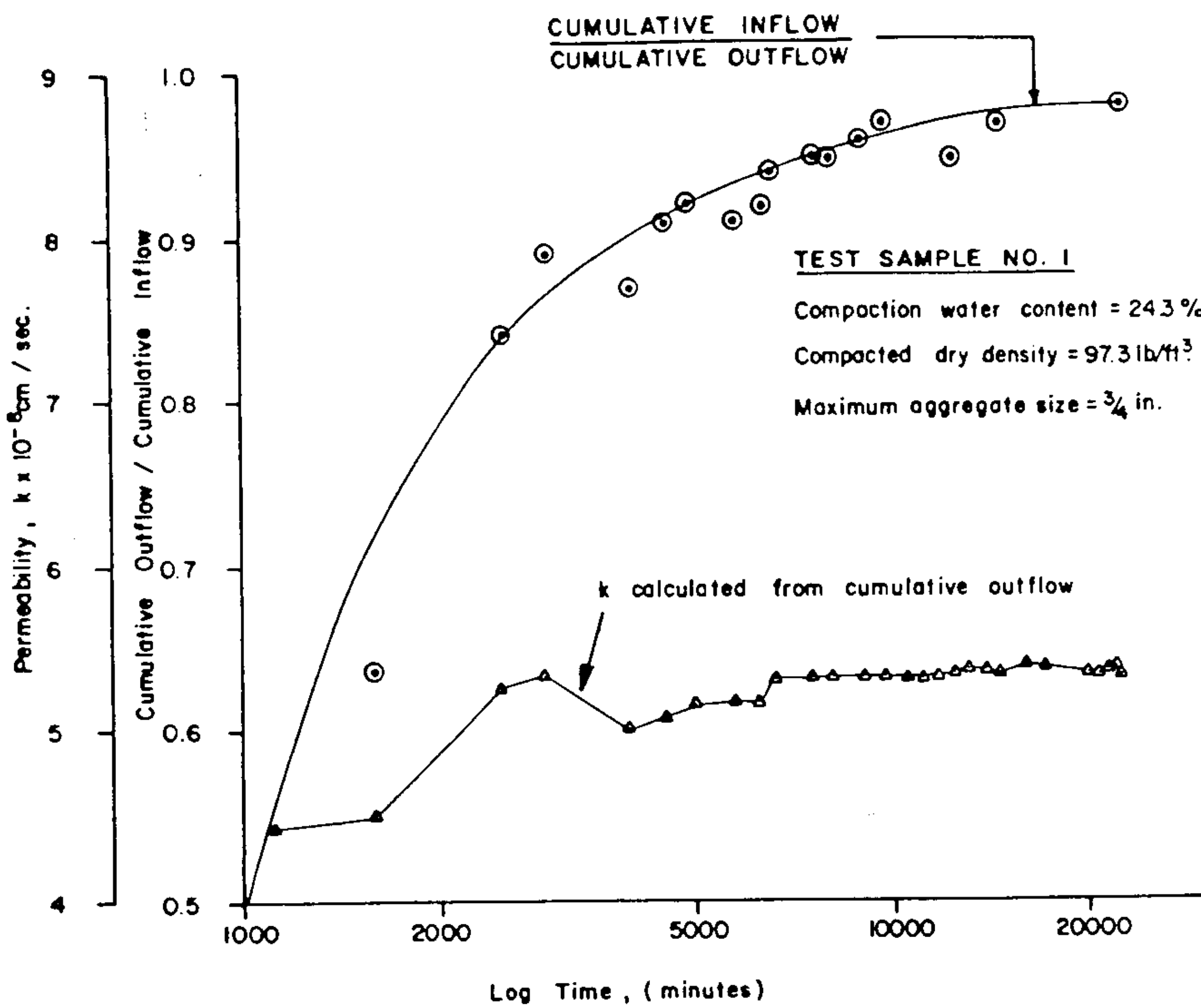
Job No. 824-1308

Golder Associates

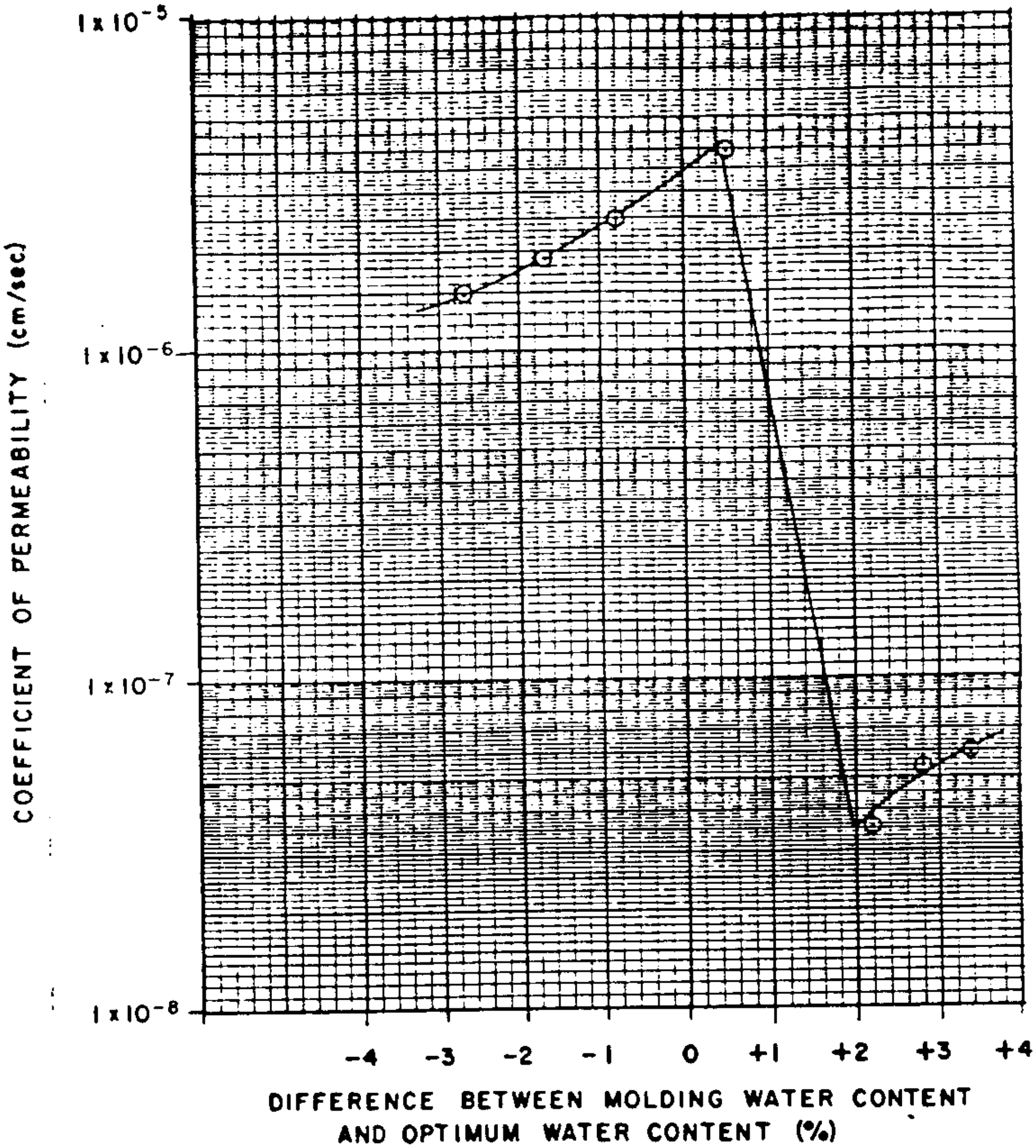
Drawn SKB

Checked WJN

Approved JEB



JOB NO. 824-1308	SCALE AS SHOWN	TYPICAL RESULTS FROM PERMEABILITY TESTS
DRAWN SKB	DATE 8-25-82	
CHECKED	DWG NO. 24	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 12



NOTES:

1. OPTIMUM MOISTURE CONTENT = 21.5%
2. PERMEABILITY RESULTS TABULATED IN TABLE 5

JOB NO. 824-1308	SCALE AS SHOWN	VARIATION OF PERMEABILITY WITH MOLDING WATER CONTENT
DRAWN SKB	DATE 12-31-82	
CHECKED WTO	DWG NO. 52	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 13

GOLD DRAFTING MEDIA

APPENDIX A

Driller's and Sample Logs
from
State of Alabama Well Survey

APPENDIX A
TABLE OF CONTENTS

Well I-2
Sample log
Owner: James B. Hill

	Thickness (feet)	Depth (feet)
No record	70	70
Demopolis Chalk		
Chalk, light-gray, silty, fossiliferous, microfossils	50	120
Mooreville Chalk		
Chalk, light-gray, silty, fossiliferous; medium-light-gray highly calcareous siltstone, very light gray limestone, saccharoidal in appearance	10	130
Chalk, light-gray, silty, fossiliferous; microfossils	145	275
Chalk, light-gray, silty, fossiliferous; quartz grains; pyrite	15	290
Chalk, light-gray, silty, fossiliferous; shell fragments	70	360
Chalk, light-gray, silty, fossiliferous; abundant microfossils; pyrite; aragonite prisms; shell fragments	60	420
Chalk, light-gray, silty, fossiliferous; trace of glauconite	15	435
Chalk, light-gray, silty, fossiliferous; trace of light-gray fine- to medium-grained sandy glauconitic poorly indurated siltstone	15	450
Chalk, light-gray, silty, fossiliferous; trace of yellowish-gray sandy chalky marl	30	480
Eutaw (?) Formation		
Chalk, light-gray, silty, fossiliferous; medium-gray silty slightly micaceous shale; very light to yellowish-gray weathered fine-grained quartzitic silty glauconitic sideritic sandstone	15	495
Sand, light-gray, fine- to medium-grained, subangular to subrounded, quartzose, glauconitic, fossiliferous; lignite; phosphate nodules; siderite; shell fragments; microfossils	15	510
Sand, light-gray, fine- to medium-grained, subangular to subrounded, quartzose, glauconitic, fossiliferous; light-gray micaceous shale; sideritic sandstone; lignite and phosphate; shell fragments	45	555
Sand, light-gray, fine- to medium-grained, subangular to subrounded, quartzose, glauconitic, fossiliferous; light-gray micaceous partly glauconitic shale; shell fragments	10	565
Shale, light-gray, micaceous, partly carbonaceous; light-gray fine- to medium-grained subangular to subrounded quartzose glauconitic fossiliferous sand	30	595
Shale, light-gray, micaceous, partly carbonaceous; light-gray fine- to medium-grained subangular to subrounded quartzose glauconitic fossiliferous sand; grayish-yellow-green silty micaceous shale	45	640
Shale, light-gray, micaceous, partly carbonaceous; light-gray fine- to medium-grained subangular to subrounded quartzose glauconitic fossiliferous sand; grayish-yellow-green silty micaceous shale; lignite	15	655
Shale, light-gray to light-olive-gray, micaceous, partly carbonaceous; light-gray fine- to medium-grained subangular to subrounded quartzose glauconitic fossiliferous sand	140	795
Gordo Formation		
Shale, light-gray to light-olive-gray, micaceous, partly carbonaceous; light-gray fine- to medium-grained subangular to subrounded quartzose glauconitic fossiliferous sand; light-gray coarse-grained quartzose frosted sand; sideritic sandstone	30	825

	Thickness (feet)	Depth (feet)
Well I-2 – Continued		
Gordo Formation – Continued		
Sand, light-gray, fine- to coarse-grained, subangular to rounded, in part frosted, quartzose, glauconitic; light-gray to light-olive-gray micaceous partly carbonaceous shale; rounded chert grains; abundant siderite; sideritic micaceous glauconitic quartzose pale-yellowish-orange sandstone; lignite	50	875
Shale, light-gray and light-olive-gray, silty, micaceous, partly carbonaceous; sideritic crystals and nodules; lignite	15	890
Shale, light-gray and light-olive-gray, silty, micaceous, partly carbonaceous with coarse and very coarse quartz and chert grains; abundant siderite; sideritic sandstone; phosphate nodules	15	905
Shale, light-gray and light-olive-gray, silty, micaceous, partly carbonaceous; coarse and very coarse quartz and chert grains; dusky-red shale fragments	15	920
Shale, grayish-yellow-green, silty, micaceous; abundant coarse to very coarse quartz and chert grains; abundant sideritic nodules and concretions; trace of dusky-red shale	55	975
Sand, light-gray, coarse and very coarse grained, subrounded, quartzose, frosted with varicolored chert; grayish-yellow-green silty micaceous shale; abundant siderite; quartz pyrite clusters	45	1,020
Shale, grayish-yellow-green, silty, micaceous; light-gray coarse and very coarse grained subrounded quartzose frosted sand with varicolored chert; quartz-pyrite clusters; abundant siderite and sideritic sandstone; trace of dusky-red shale	15	1,035
Sand, light-gray, coarse and very-coarse grained, subrounded, quartzose, frosted with varicolored chert; grayish-yellow-green silty micaceous shale; sideritic sandstone; chert gravels	80	1,115
Coker Formation		
Shale, greenish-gray, silty, micaceous with fragments of fine sandy glauconitic marl	180	1,295
Shale, greenish-gray, silty, micaceous; light-gray fine-grained quartzose glauconitic very calcareous sandstone	15	1,310
Shale, greenish-gray, dusky-red, and dusky-red-purple; coarse and very coarse grained varicolored rounded quartzose sand; fine quartz; chert gravel	60	1,370
Shale, greenish-gray, dusky-red, and dusky-red-purple; light-gray very fine to fine-grained quartzose micaceous slightly glauconitic sandstone	25	1,395
Sand, varicolored, coarse, subrounded, frosted in part, quartzose, slightly micaceous; chert	15	1,410
Shale, greenish-gray and light-gray, silty, micaceous, in part carbonaceous	15	1,425
Sand, light-gray and varicolored, coarse-grained, subangular to subrounded, frosted in part, quartzose, slightly micaceous; moderate-orange-pink fine- to medium-grained semiconsolidated sand aggregates	45	1,470
Shale, greenish-gray and light-gray, silty, micaceous, in part carbonaceous	15	1,485
Shale, greenish-gray and light-gray, silty, micaceous; pyrite and quartz clusters; moderate-orange-pink very fine and medium-grained semiconsolidated sandstone	60	1,545
Shale, greenish-gray and light-gray, silty, micaceous; abundant lignite; siderite	15	1,560
Shale, greenish-gray and light-gray, silty, micaceous; light-gray to pale-yellowish-orange fine- to medium-grained quartzitic micaceous in part glauconitic, semiconsolidated sandstone	45	1,605
Shale, greenish-gray, in part sandy and glauconotic, silty, micaceous; lignite; light-gray to pale-yellowish-orange fine- to medium-grained sandstone	15	1,620

	Thickness (feet)	Depth (feet)
Well I-2 -- Continued		
Coker Formation -- Continued		
Sand, very light-gray, coarse-grained, subrounded, in part frosted, quartzose; greenish-gray, in part sandy and glauconitic silty micaceous shale, light-gray to pale-yellowish-orange fine- to medium-grained sandstone	15	1,635
Sand, very light gray, medium- to coarse-grained, subangular to subrounded, in part frosted, quartzose, greenish-gray silty micaceous slightly carbonaceous shale	130	1,765
Shale, greenish-gray, silty, micaceous, in part carbonaceous; very light gray medium- to coarse-grained subangular to subrounded quartzose sand with fine quartz and chert gravel	15	1,780
Gravel, fine quartz and chert; greenish-gray to light-gray, silty, micaceous, in part carbonaceous, fine quartz and chert gravel	10	1,850
Sand, moderate-pink-orange, fine- to coarse-grained, subangular to subrounded, moderate red silty micaceous partly mottled shale; quartz-pyrite aggregates	30	1,880
Lower Cretaceous rocks		
Shale, moderate-red, and greenish-gray mottled; moderate-orange-pink medium- to coarse-grained subangular to subrounded sand; light-red dense poorly indurated limestone; pink lime nodules	20	1,900
Sand, very light gray and moderate-pink, medium to very coarse grained, subangular to rounded, in part frosted, quartzose; moderate-red and greenish-gray mottled shale; light-red dense poorly indurated limestone	15	1,915
Shale, moderate-red and greenish-gray mottled; very light gray and moderate-pink medium to very coarse grained subangular to rounded, in part frosted, quartzose sand; trace of light-red dense poorly indurated limestone	15	1,930
Sand, very light gray and moderate-pink, medium to very coarse grained, subangular to rounded, in part frosted, quartzose; moderate-red and greenish-gray mottled shale, fine quartz and chert gravel; siderite, trace of light-red dense poorly indurated limestone	40	1,970
Sand, moderate-orange-pink, coarse-grained, subrounded, in part frosted, quartzose, trace of moderate-red and greenish-gray mottled shale	10	1,980
Sand, moderate-orange-pink, coarse-grained, subrounded, in part frosted, quartzose; trace of light-pink limestone	10	1,990
Sand, moderate-orange-pink, coarse-grained, subrounded, in part frosted, quartzose; semiconsolidated aggregates of light-red fine quartz sand; trace of light-pink limestone	20	2,010
Sand, moderate-reddish-orange, coarse to very coarse grained, subrounded, in part frosted, quartzose; some chert grains; trace of pink limestone	70	2,080
Sand, moderate-reddish-orange, coarse to very coarse grained, subrounded, in part frosted, quartzose; some chert grains; moderate-red and greenish-gray mottled shale; trace of pink limestone	10	2,090
No record	5	2,095
Sand, varicolored, coarse and very coarse grained; fine- to medium quartz and chert gravel; oolitic chert pebbles	75	2,170
Sand, very pale orange, fine- to coarse-grained, subangular to subrounded, in part frosted, quartzose; trace of glauconite	20	2,190
Sand, very pale orange, coarse to very coarse grained, subrounded, frosted in part, quartzose; fine to medium quartz and chert gravel and oolitic chert gravel; moderate-red and greenish-gray shale; pink limestone	20	2,210

	Thickness (feet)	Depth (feet)
Well I-2 -- Continued		
Lower Cretaceous rocks -- Continued		
Shale, moderate-red and dusky-red, very pale orange coarse to very coarse grained subrounded, in part frosted quartzose sand; fine- to medium-grained quartz and chert gravel, pink limestone	40	2,250
Shale, moderate-red and dusky-red; very pale orange coarse to very coarse grained subrounded, in part frosted, quartzose sand; fine- to medium-grained quartz and chert gravel; dark-yellowish-orange fine- to medium-grained quartzose calcareous indurated sandstone, trace of pink limestone	100	2,350
Sand, very pale orange, medium to very coarse grained, subangular to subrounded, quartzose; moderate-pink and pale-yellowish-orange fine- to medium-grained quartzose sandstone, moderate-red and dusky-red shale, fine- to medium-grained quartz and chert gravel; trace of pink limestone	20	2,370
Sand, very pale orange, medium to very coarse grained, subangular to subrounded, quartzose; fine- to medium-grained quartz and chert gravel; moderate-red and dusky-red shale, very light gray silty indurated limestone; trace of pink limestone; pyrite cemented quartz aggregates	80	2,450
Limestone, white to yellowish-gray, silty, in part porous and sandy	10	2,460
Limestone, white to yellowish-gray, silty, indurated	10	2,470
Limestone, white to yellowish-gray, silty, indurated, in part sandy	10	2,480
Limestone, very pale orange, silty, indurated	10	2,490
Limestone, very pale orange, silty, indurated, in part dolomitic and porous	10	2,500
Limestone, very pale orange, silty, indurated, in part dolomitic and porous; medium-dark-gray fine- to medium-grained quartzose pyrite-cemented sandstone	30	2,530
Limestone, very pale orange, silty, indurated, in part dolomitic and porous; medium-dark-gray fine- to medium-grained quartzose sandstone, white to very light gray fine-grained quartzose calcareous sandstone	10	2,540
Pottsville Formation		
Sandstone, very light gray, fine- to medium-grained, quartzose, contains few rock fragments and apatite grains, well indurated, in part slightly pyritic	10	2,550

(Incomplete)

Modified from sample description by Charles Copelend, Geological Survey of Alabama

Well J-3
Driller's log
Owner: Charles Hutcherson
Driller: Terry Drilling Co.

	Thickness (feet)	Depth (feet)
Clay, yellow	12	12
Limerock	491	503
Sand and rock	84	587
Tough mud and shale	189	776
Sand	85	861

Well J-5
Driller's log
Owner: Roger Watt
Driller: S. D. Smith

	Thickness (feet)	Depth (feet)
Topsoil and clay	13	13
Limestone	496	509
Sand	73	582
Shale and gumbo	209	791
Sand	112	903

Well J-14
Driller's log
Owner: Frank Watson
Driller: S. D. Smith

	Thickness (feet)	Depth (feet)
Topsoil, clayey	4	4
Limestone	700	704
Sand	68	772
Gumbo and shale	209	981
Sand	106	1,087

Well M-3
Sample log
Owner: Mrs. B. A. Jenkins

	Thickness (feet)	Depth (feet)
Prairie Bluff Chalk and Ripley Formation undifferentiated		
Sand, glauconitic; sandy lime; phosphatic material	40	40
Demopolis Chalk		
Chalk, light-gray, sandy	40	80
Shale, light-gray, sandy	20	100
Chalk, gray, sandy, glauconitic	20	120
Chalk, gray, shaly	80	200
Chalk, light-gray, soft	60	260
Chalk, light-gray	140	400
Shale, gray, chalky	20	420
Chalk, light-gray, soft	100	520
Shale, gray, chalky	40	560
Mooreville Chalk		
Chalk, gray, shaly	20	580
Chalk, gray, shaly, glauconite	20	600
Chalk, gray, shaly	240	840
Eutaw Formation		
Chalk, gray, shaly, glauconitic; glauconitic sandstone	20	860
Sand, medium-grained, glauconitic	20	880
Sand, medium-grained, glauconitic; sandstone; phosphatic material	20	900
Sand and sandstone, gray and yellow, medium-grained, very glauconitic; brown claystone	100	1,000
Sand and sandstone, gray and yellow, medium-grained, very glauconitic; brown claystone; green shale	20	1,020
Sand and sandstone, gray and yellow, fine- and medium-grained, very glauconitic; green shale	40	1,060
Sand and sandstone, gray and yellow, fine- and medium-grained, very glauconitic; gray shale	20	1,080
Sand and sandstone, gray and yellow, medium-grained, very glauconitic; grown claystone	20	1,100
Sand and sandstone, gray and yellow, medium-grained, very glauconitic; brown claystone; carbonaceous shale	100	1,200
Sand and sandstone, gray and yellow, medium- and coarse-grained, very glauconitic; brown claystone; carbonaceous shale; chert gravel	40	1,240
Gordo and Coker Formations, undifferentiated		
Sand, medium- to coarse-grained; abundant siderite concretions; pyrite	20	1,260
Sand, coarse-grained; siderite concretions; rose and yellow sand grains	30	1,290
Sand, coarse-grained; siderite concretions; chert	50	1,340
Sand, medium- to coarse-grained; siderite concretions	10	1,350
Sand, medium-grained; mica	10	1,360

	Thickness (feet)	Depth (feet)
Well M-3 -- Continued		
Gordo and Coker Formations, undifferentiated -- Continued		
Sand, coarse-grained; yellow and rose grains	10	1,370
Sand, variegated, coarse-grained; chert	10	1,380
Gravel, chert, sand, dark-gray micaceous carbonaceous shale	10	1,390
Shale, gray, micaceous, carbonaceous; glauconitic sandstone fragments	20	1,410
Sand, medium-grained, fragments of dark-red shale	10	1,420
Shale, dark-gray, micaceous, carbonaceous; fragments of glauconitic sandstone, dark-red shale	40	1,460
Shale, gray, micaceous, carbonaceous; pink soft clay; dark-red clay	20	1,480
Sand, variegated, medium- to coarse-grained	10	1,490
Shale, dark-gray, micaceous, carbonaceous, pink clay	10	1,500
Sand, variegated, medium-grained	10	1,510
Shale, dark-gray, micaceous, carbonaceous; pink and dark-red clay	10	1,520
Sand, variegated, fine- to medium-grained, pink and red clay; mica	50	1,570
Sand, variegated, medium- to coarse-grained	70	1,640
Shale, dark-red, variegated fine- to coarse-grained sand	20	1,660
Shale, dark-gray, carbonaceous; siderite concretions cementing fine-grained sand, medium-grained sand	30	1,690
Shale, dark-gray, micaceous, carbonaceous, dark-red and purple clay; chert gravel	30	1,720
Sand, medium-grained; chert gravel; dark-red clay; siderite concertions; coarse mica	30	1,750
Sand, medium-grained, gray carbonaceous shale; pink clay	20	1,770
Sandstone, yellow, medium-grained, coarse-grained sand; gravel and red clay	30	1,800
No record	10	1,810
Clay, dark-red, pink, and purple	20	1,830
Clay, dark-red, pink, and purple; yellow medium-grained sand and sandstone; red and green mottled clay	20	1,850
Clay, dark-red and pink; abundant small siderite concretions; green clay	20	1,870
Clay, dark-red and pink; abundant small siderite concretions; mottled red and green clay; fragments of glauconitic sandstone; pyrite; partly oolitic chert gravel	10	1,880
Clay, green; small siderite concertions; brown claystone; gray glauconitic micaceous carbonaceous sandy shale; carbonaceous material	50	1,930
Clay, green; fine- to medium-grained sand; fragments of glauconitic sandstone; shell fragments	30	1,960
Shale, gray; sand; dark-red clay; gray hard medium-grained glauconitic sandstone; brown claystone; carbonaceous shale	80	2,040
Sand, medium- to coarse-grained, subangular; glauconitic sand and sandstone; gravel	40	2,080

	Thickness (feet)	Depth (feet)
Well M-3 -- Continued		
Gordo and Coker Formation, undifferentiated -- Continued		
Sand, medium- to coarse-grained, subangular; gravel; medium-grained sandstone, gray carbonaceous shale; pink and dark-red clay; pyrite	40	2,120
Sand, variegated, coarse-grained, subangular; gravel; gray carbonaceous shale; green and red shale.	80	2,200
Sand and gravel, variegated; siderite concretions; dark-red and purple clay	30	2,230
Sand, medium- to coarse-grained, subangular; siderite concretions; reddish-brown and purple clay; gravel.	150	2,380
Sand, coarse-grained, subangular; brown and purple clay.	50	2,430
Sand, yellow, coarse-grained, subangular; reddish-brown and purple clay	90	2,520
Clay, dark-reddish-brown and yellow, glauconitic; yellow subangular sand	20	2,540
Lower Cretaceous rocks		
Clay, dark-reddish-brown and yellow, glauconitic; pink nodular lime; coarse grained subangular sand.	20	2,560
Sand, yellow, coarse-grained, subangular; reddish-brown and yellow mottled clay; pink lime; pink calcareous sandstone; chert gravel.	110	2,670
Sand, coarse-grained, subangular; reddish-brown clay	30	2,700
Sand, medium- to coarse-grained; reddish-brown clay	60	2,760
Sand, very coarse grained, subangular; reddish-brown clay, lime, and chert; reddish-brown clay, lime, and chert; reddish-brown and yellow mottled clay.	110	2,870
Gravel; reddish-brown clay; pink and red nodular lime; coarse-grained sand	20	2,890
Gravel; coarse-grained sand; reddish-brown and purple clay; pink and gray nodular lime	20	2,910
Gravel, variegated, chert, partly oolitic; reddish-brown and purple clay; nodular lime	15	2,925
No record	35	2,960
Gravel, reddish-brown and variegated, in part chert; coarse-grained sand and sandstone; pink lime; brick-red shale; siderite concretions	70	3,030
Clay, brick-red; pink medium-grained sandstone; gravel.	10	3,040

Modified from sample description by Winnie McGlamery, Geological Survey of Alabama

Well N-8
Sample log
Owner: M. G. Larkin

	Thickness (feet)	Depth (feet)
Demopolis Chalk		
Chalk, light-gray	55	65
Chalk, light-gray, hard	15	70
Chalk, light-gray	70	140
Chalk, light-gray; pyrite	5	145
Chalk, light-gray, hard	15	160
Chalk, light-gray	75	235
Chalk, light-gray, impure	145	380
Chalk, gray, impure; *Kyphopyxa christneri*	30	410
Chalk, gray, impure; *Kyphopyxa christneri*	20	430
Chalk, light-gray, granular	30	460
Chalk, gray	230	690
Chalk, gray; glauconite	20	710
Eutaw Formation		
Sand, medium-grained, glauconitic; sandy glauconitic chalk; phosphatic material	10	720
Sand, medium-grained, glauconitic, fossiliferous; phosphatic material; gray micaceous carbonaceous shale; brown hard glauconitic sandstone	50	770
Sandstone, medium-grained, glauconitic; sandy lime	20	790
Sandstone, medium-grained, glauconitic; sand; gray micaceous carbonaceous shale	40	830
Sand, fine-grained, glauconitic; dark-gray and green micaceous shale	40	870
Shale, dark-gray to green; mica; brown claystone; glauconitic sand and sandstone	20	890
Lignite; micaceous sandstone; brown claystone; fine-grained glauconitic sand; dark-gray shale; pyritized wood	20	910
Lignite; pyritized wood; glauconitic sand; dark-gray carbonaceous shale	10	920
Sand, medium-grained, glauconitic; dark-gray carbonaceous shale; lignite; glauconitic sandy shale; brown claystone	20	940
Sand, glauconitic; brown claystone; gray carbonaceous shale; brown glauconitic sandstone	50	990
Sand, glauconitic; glauconitic sandy shale; gray carbonaceous shale; brown glauconitic sandstone; lignite	20	1,010
Shale, dark-gray and green; glauconitic sandy shale; coarse grained sand, in part chert and slightly variegated	60	1,070
Gordo Formation		
Shale, dark-gray; abundant siderite concretions; dark-red clay; sand	40	1,110
Clay, dark-red; sand; siderite concretions; purple clay	110	1,220
Clay, purple; fine- to medium-grained micaceous porous sandstone	10	1,230

	Thickness (feet)	Depth (feet)
Well N-8 – Continued		
Gordo Formation – Continued		
Clay, purple and gray; variegated fine- to coarse-grained sand; yellow sandstone; yellow sand and gravel; conglomerate fragments	90	1,320
Gravel, variegated, chert; purple clay and sand	50	1,370
Shale, gray, micaceous, carbonaceous; glauconitic sandy shale; glauconitic sandstone fragments; purple clay	10	1,380
Clay, purple; gray sandy carbonaceous glauconitic shale	20	1,400
Gravel; light-gray medium-grained sandstone; gray micaceous carbonaceous shale	10	1,410
Sandstone, light-gray, medium-grained; gravel; purple clay	40	1,450
Shale, gray, micaceous carbonaceous; glauconitic sand	40	1,490
No record	10	1,500
Coker (?) Formation		
Clay, dark-red and purple; dark-gray micaceous carbonaceous shale; glauconitic sand	70	1,570
Clay, purple; dark-greenish-gray shale; fine-grained sandstone; sandy clay	30	1,600
Sandstone, fine-grained; sandy clay with mica; gray soft clay; purple clay; gravel	70	1,670
Clay, gray and green; lignite; pyritized wood; carbonaceous shale	20	1,690
Clay, green and gray; lignite	20	1,710
Shale, gray, carbonaceous; lignite; green clay	30	1,740
Sandstone, glauconitic, very fossiliferous; lignite; carbonaceous shale	20	1,760
Sandstone, gray, hard, glauconitic; dark-gray shale	20	1,780
Shale, dark-gray; gray hard glauconitic sandstone; brown claystone; lignite	50	1,830
Shale, dark-gray to black, micaceous, carbonaceous, splintery	20	1,850
Sand, medium- to coarse-grained; lignite	20	1,870
Sand, medium- to coarse-grained; abundant siderite concretions	20	1,890
Sand, fine- to coarse-grained; gravel; siderite concretions	60	1,950
Gravel, variegated; conglomerate; medium- to coarse-grained sand; sandstone; siderite cconcretions	40	1,990
Sand, coarse-grained, rounded; dark-red clay; gravel	20	2,010
Sandstone, light-gray, hard, medium-grained, calcareous	10	2,020
Sand, coarse-grained, subangular; gravel; siderite concretions	80	2,100
Gravel; variegated sand; dark-red clay; coarse-grained sandstone fragments; reddish-brown clay	40	2,140
Sand, coarse-grained; subangular; variegated gravel and sand; reddish-brown clay	50	2,190
Clay, reddish-brown, green, and yellow	20	2,210
Sand, variegated, coarse-grained, subangular	10	2,220
Clay, reddish-brown and yellow; coarse-grained sand	10	2,230

Well N-8 – Continued

	Thickness (feet)	Depth (feet)
Lower Cretaceous rocks		
Clay, reddish-brown and yellow; coarse-grained sand; pink mottled clay; pink nodular lime	50	2,280
Sand, variegated, coarse-grained, subangular; gravel; dark-red and purple clay	160	2,440
Sandstone, pink, medium-grained, calcareous; variegated gravel	10	2,450
Sand, coarse-grained, variegated, reddish-brown concretions; reddish-brown clay; pink nodular lime	30	2,480
Clay, reddish-brown and gray; pink nodular lime; medium- to coarse-grained variegated sand; gravel	60	2,540
Sandstone, pink, medium-grained, green conglomerate; variegated gravel; coarse-grained sand; reddish-brown clay	100	2,640
Clay, reddish-brown, sandy, with small red concretions; gravel and coarse-grained sand	50	2,690
Gravel, variegated; some chert; coarse-grained subangular sand; gray nodular lime	60	2,750
Gravel, gray to yellow; medium-grained sandstone; pink lime; red and green mottled clay	10	2,760
Clay, dark-red and purple; coarse-grained sand; conglomerate fragments	40	2,800
Gravel, variegated, coarse-grained sandstone; dark-red clay; pink lime	30	2,830
Clay, red, gray, and green; coarse gravelly sand; medium-grained soft porous sandstone	5	2,835
Conglomerate, reddish-green; coarse-grained soft porous sandstone; dark-red and green clay	5	2,840
Sand, coarse; reddish brown and yellow clay; pink lime	20	2,860
Clay, reddish-brown and green	20	2,880
Sandstone, light-gray and pink, coarse-grained, calcareous; pink lime	20	2,900
Clay, red and green; conglomerate fragments	10	2,910
Clay, reddish-brown, pink and green; light-gray coarse-grained sandstone; gray and pink lime	40	2,950
Clay, pink or brick colored; reddish-brown micaceous clay; pink nodular lime	30	2,980
Sand, coarse-grained, subangular, in part chert; pink nodular lime; conglomerate; chert gravel	40	3,020
Limestone, light-gray, dense; coarse-grained sandstone fragments	40	3,060
Limestone, light-gray, dense; green and dark-red sandy clay; chert	10	3,070
Ordovician (?) rocks		
Dolomite, light-gray	10	3,080

(Incomplete)

Modified from sample description by Winnie McGlamery, Geological Survey of Alabama.

APPENDIX B

Tuscaloosa Testing Laboratory Boring Logs

APPENDIX B
TABLE OF CONTENTS

December 1982 824-1308

*Exact location unknown, not plotted on Figure 8.

BORING LOG — GREGORY - GRACE & ASSOCIATES, INC. — Sheet 1 of 1 sheets

1. Project: RESOURCE INDUSTRIES OF ALABAMA	10. Size and type of bit: 4" FISHTAIL
2. Location: GEIGER, ALABAMA SITE#1	12. Manufacturer's designation of drill: CME-55
3. Drilling agency: TUSCALOOSA TESTING LAB., INC.	13. Total no. of over-burden samples taken
4. Hole no.: W-1	14. Total number core boxes
5. Name of driller: JEB BARKSDALE & CREW	15. Elevation ground water
6. Direction of hole: ☒ Vertical ☐ Inclined	16. Date hole: Started 6-3-77, Completed 6-3-77
7. Thickness of overburden	17. Elevation top of hole
8. Depth drilled into rock	18. Total core recovery for boring
9. Total depth of hole: 50 FEET	19. Signature of inspector: JAMES C. BAMBARGER

Depth	Classification of materials (Description)
0–1.0	Grayish Black Organic SILTY CLAY (OL)
1.0–2.5	GRAYISH TAN SILTY CLAY (CH)
2.5–4.0	INTERLAYERED TAN AND GRAY SILTY CLAY (CH)
4.0–12.5	GRAY SILTY CLAY (CH) -DAMP-
12.5–14.0	GRAYISH BLUE SILTY CLAY (CH) -DAMP-
14.0–50.0	GRAYISH BLUE SILTY CLAY (CH) -DRY- DAMP @ 41.5 FEET
50.0	BOTTOM OF HOLE

BORING LOG — GREGORY-GRACE & ASSOCIATES, INC — SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISH TAIL
2. LOCATION: GEIGER, ALABAMA SITE #1	11. DATUM FOR ELEVATION SHOWN
3. DRILLING AGENCY: TUSCALOOSA TESTING LAB., INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: W-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: VERTICAL / INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 6-3-77 / COMPLETED 6-3-77
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 50 FEET	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
	1.0	GRAYISH TAN ORGANIC SILTY CLAY (OL)	
	3.5	GRAYISH TAN SILTY CLAY (CH)	
	11.0	MIXED GRAY AND TAN SILTY CLAY (CH) -DAMP-	
	15.5	GRAY SILTY CLAY (CH)	
	50.0	GRAYISH BLUE SILTY CLAY (CH) -DRY-	
		BOTTOM OF HOLE	

BORING LOG — GREGORY-GRACE & ASSOCIATES — Sheet 1 of 1 sheets

RESOURCE INDUSTRIES OF ALABAMA

GEIGER, ALABAMA SITE #1

TUSCALOOSA TESTING LAB., INC.

W-3

JEB BARKSDALE & CREW

50 FEET

4" FISHTAIL

CME-55

6-3-77 | 6-3-77

JAMES C. BAMBARGER

Depth	Classification of Materials (Description)
1.0	GRAYISH BLACK ORGANIC SILTY CLAY (OL)
3.0	GRAYISH BROWN SILTY CLAY (CH)
4.5	TAN SILTY CLAY (CH)
14.5	MIXED TAN AND GRAY SILTY CLAY (CH)
50.0	GRAYISH BLUE SILTY CLAY (CH) -DRY-
	BOTTOM OF HOLE

BORING LOG

GREGORY - GRACE & ASSOCIATES

Sheet 1 of 1 sheets

Project	RESOURCE INDUSTRIES OF ALABAMA
Location	GEIGER, ALABAMA SITE # 1
Drilling agency	TUSCALOOSA TESTING LABORATORY, INC
Hole no.	W-4
Name of driller	JEB BARKSDALE & CREW
Direction of hole	[X] Vertical [ ] Inclined
Total depth of hole	50 FEET
Size and type of bit	4" FISH-TAIL
Manufacturer's designation of drill	CME-55
Date hole	Started 6-3-77 / Completed 6-3-77
Signature of inspector	JAMES C. BAMBARGER

Depth	Classification of materials (Description)
0.5	BLACK ORGANIC SILTY CLAY (OL)
2.5	GRAYISH TAN & WHITE SILTY CLAY (CH)
9.5	GRAYISH TAN SILTY CLAY (CH)
0.0	GRAYISH BLUE SILTY CLAY (CH) -DRY-
	BOTTOM OF HOLE

BORING LOG — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

PROJECT: RESOURCE INDUSTRIES OF ALABAMA	SIZE AND TYPE OF BIT: 4" FISHTAIL
LOCATION: GEIGER, ALABAMA SITE #1	MANUFACTURER'S DESIGNATION OF DRILL: CME-55
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	
HOLE NO.: W-5	
NAME OF DRILLER: JEB BARKSDALE & CREW	DATE HOLE: STARTED 6-3-77, COMPLETED 6-3-77
DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	
TOTAL DEPTH OF HOLE: 75.0 FEET	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
	0.5	BROWN ORGANIC SILTY CLAY (OL)	
	2.0	BROWN SILTY CLAY (CH)	
	4.0	TAN & WHITE SILTY CLAY (CH)	
	11.0	TANISH GRAY SILTY CLAY (CH)	
	16.0	GRAYISH WHITE SILTY CLAY (CH)	
	61.0	GRAYISH BLUE SILTY CLAY (CH) -DRY-	
	75.0	GRAYISH WHITE CLAYEY SILT (MH) -DAMP & SPONGY	
		BOTTOM OF HOLE	

BORING LOG — GREGORY-GRACE & ASSOCIATES — Sheet 1 of 1 sheets

Project	RESOURCE INDUSTRIES OF ALABAMA
Location	GEIGER, ALABAMA SITE #1
Drilling agency	TUSCALOOSA TESTING LABORATORY INC.
Hole no.	W-6
Name of driller	JEB BARKSDALE & CREW
Direction of hole	Vertical
Total depth of hole	50 FEET
Size and type of bit	4" FISHTAIL
Manufacturer's designation of drill	CME-55
Date hole	Started 6-3-77; Completed 6-3-77
Signature of inspector	JAMES C. BAMBARGER

Depth	Classification of materials (Description)
0 – 2.0	GRAYISH TAN SILTY CLAY WITH ORGANIC MATERIAL @ SURFACE (OL)
2.0 – 9.5	TAN, GRAY & WHITE SILTY CLAY (CH)
9.5 – 50.0	GRAYISH BLUE SILTY CLAY (CH) -DRY-
50.0	BOTTOM OF HOLE

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS
PROJECT: RESOURCE INDUSTRIES OF ALABAMA	SIZE AND TYPE OF BIT: 4" FISHTAIL	
LOCATION: GEIGER, ALABAMA SITE # 2	MANUFACTURER'S DESIGNATION OF DRILL: CME-55	
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY INC.	TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	
HOLE NO.: W-7	TOTAL NUMBER CORE BOXES	
NAME OF DRILLER: JEB BARKSDALE & CREW	ELEVATION GROUND WATER	
DIRECTION OF HOLE: VERTICAL	DATE HOLE: STARTED 6-4-77	COMPLETED 6-4-77
THICKNESS OF OVERBURDEN	ELEVATION TOP OF HOLE	
DEPTH DRILLED INTO ROCK	TOTAL CORE RECOVERY FOR BORING	
TOTAL DEPTH OF HOLE: 50 FEET	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER	

Depth	Classification of Materials (Description)
1.5	BLACK ORGANIC SILTY CLAY (OL)
4.0	GRAYISH BLACK SILTY CLAY (CH) PERCHED WATER @ 3.5 FEET
13.0	GRAYISH TAN SILTY CLAY (CH)
20.5	INTERLAYERED GRAY, TAN & BLUE SILTY CLAY (CH) -DAMP @ 13.5 FEET
50.0	GRAYISH BLUE SILTY CLAY (CH) -DAMP-
	BOTTOM OF HOLE

BORING LOG — GREGORY-GRACE & ASSOCIATES — Sheet 1 of 1 sheets

Project	RESOURCE INDUSTRIES OF ALABAMA
Location	GEIGER, ALABAMA — SITE # 2
Drilling agency	TUSCALOOSA TESTING LABORATORY INC
Hole no.	B-8
Name of driller	JEB BARKSDALE & CREW
Direction of hole	Vertical
Total depth of hole	50 FEET
Size and type of bit	4" FISHTAIL
Manufacturer's designation of drill	CME-55
Date hole	Started 6-4-77; Completed 6-4-77
Signature of inspector	James C. Bamberger

Depth	Classification of materials (description)
0.5	BLACK ORGANIC SILTY CLAY (OL)
3.0	TAN & WHITE SILTY CLAY (CH)
9.0	WHITE SILTY CLAY (CH) -DAMP BECOMING DRYER-
50.0	GRAYISH BLUE SILTY CLAY (CH) -DRY-
	BOTTOM OF HOLE

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION (Coordinates or Station): GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO. (As shown on drawing title and file number): OW-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: DRY 7-8-77
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 7-7-77; COMPLETED 7-7-77
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 50.0 FT	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD PENE-TRATION	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
		0.5		BLACK ORGANIC SILTY CLAY (OL)				
		3.5		TAN & WHITE SILTY CLAY (CH)				
		9.0		TAN SILTY CLAY (CH)				
		12.0		GRAYISH WHITE SILTY CLAY (CH)				
		50.0		GRAYISH BLUE SILTY CLAY (CH) -DRY-				
				BOTTOM OF HOLE				

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION (Coordinates or Station): GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO. (As shown on drawing title and file number): OW-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: DRY 7-8-77
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 7-7-77 COMPLETED 7-7-77
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 50.0 FT	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD PASSES	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
		1.5		BLACK ORGANIC SILTY CLAY (OL)				
		8.0		TAN & WHITE SILTY CLAY (CH)				
		50.0		GRAYISH BLUE SILTY CLAY (CH) -DRY-				
				BOTTOM OF HOLE				

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO. (As shown on drawing title and file number): OW-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: DRY (7-8-77)
	16. DATE HOLE: STARTED 7-7-77; COMPLETED 7-7-77
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE: 50.0 FT	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD CLASS-ESS	% CORE REC.	BOX OR SAMPL NO.	REMARKS
		1.0		BROWN ORGANIC SILTY CLAY (OL)				
		2.5		TAN & WHITE SILTY CLAY (CH)				
		8.0		WHITE SILTY CLAY (CH)				
		50.0		GRAYISH BLUE SILTY CLAY (CH) -DRY-				
				BOTTOM OF HOLE				

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION (Coordinates or Station): GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO. (As shown on drawing title and file number): OW-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: PWL -8' 7-8-77
	16. DATE HOLE: STARTED 7-7-77; COMPLETED 7-7-77
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE: 100.0 FT	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD HARD-NESS	% CORE REC.	BOX OR SMPL NO.	REMARKS
		1.0		BLACK ORGANIC SILTY CLAY (OL)				
		5.0		BROWN SILTY CLAY (CH)				
▼		8.0		TAN SILTY CLAY (CH) -DAMP BECOMING DRYER- -PERCHED WATER SEAMS-				
		11.0						
		100.0		GRAYISH BLUE SILTY CLAY (CH) -DRY-				

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS
1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISHTAIL	
2. LOCATION (Coordinates or Station): GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55	
4. HOLE NO. (As shown on drawing title and file number): OW-5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: PWL -43' 7-8-77	
	16. DATE HOLE: STARTED 7-7-77; COMPLETED 7-7-77	
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE: 50.0 FT	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER	

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD READINGS	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
		2.0		WHITE SILTY CLAY (CH)				
				GRAYISH BLUE SILTY CLAY (CH)				
		17.0		DAMP AT 17.0 FT				
				-DRY-				
▼		43.0						
		50.0		BOTTOM OF HOLE				

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS
1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA	10. SIZE AND TYPE OF BIT: 4" FISHTAIL	
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55	
4. HOLE NO. (As shown on drawing title and file number): OW-6	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: DRY 7-8-77	
	16. DATE HOLE: STARTED 7-7-77 COMPLETED 7-7-77	
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE: 50.0 FT	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER	

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD PASSES	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
				WHITE SILTY CLAY (CH)				
		5.0		GRAYISH BLUE SILTY CLAY (CH)				
				-DRY-				
		50.0		BOTTOM OF HOLE				

BORING LOG-E	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA, INC.	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN:
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: #9	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES:
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 9-24-77 / COMPLETED 9-24-77
7. THICKNESS OF OVERBURDEN:	17. ELEVATION TOP OF HOLE:
8. DEPTH DRILLED INTO ROCK:	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 6 FT	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYM	CLASSIFICATION OF MATERIALS (DESCRIPTION)				REMARKS
				TAN & WHITE SILTY CLAY (CH)				
		4.0		GRAYISH BLUE SILTY CLAY (CH)				
		6.0		BOTTOM OF HOLE				

BORING LOG-S	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC.	6" FISHTAIL
GEIGER, ALABAMA SITE #2	
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
#10	
JEB BARKSDALE & CREW	
[X] VERTICAL [ ] INCLINED	9-24-77 / 9-24-77
6 FT	JAMES C. BAMBARGER

				GRAYISH BLUE SILTY CLAY (CH)				
		6.0		BOTTOM OF HOLE				

BORING LOG-S — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

Project	RESOURCE INDUSTRIES OF ALABAMA, INC.
Location	GEIGER, ALABAMA SITE #2
Drilling agency	TUSCALOOSA TESTING LABORATORY, INC
Hole no.	#11
Name of driller	JEB BARKSDALE & CREW
Direction of hole	[X] Vertical [ ] Inclined
Total depth of hole	10 FT
Size and type of bit	6" FISHTAIL
Manufacturer's designation of drill	CME-55
Date hole	Started 9-24-77; Completed 9-24-77
Signature of inspector	JAMES C. BAMBARGER

W/C %	Elevation	Depth	Legend	Classification of materials (Description)	Remarks
		0–6.0		TAN & WHITE SILTY CLAY (CH)	
		6.0–10.0		GRAYISH BLUE SILTY CLAY (CH)	
		10.0		BOTTOM OF HOLE	

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC	4" FISHTAIL
GEIGER, ALABAMA SITE #2	
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
#12	
JEB BARKSDALE & CREW	
VERTICAL	DATE HOLE: STARTED 9-24-77; COMPLETED 9-24-77
TOTAL DEPTH OF HOLE: 10 FT	JAMES C. BAMBARGER

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
	2.0		TAN & WHITE SILTY CLAY (CH)	
	10.0		GRAYISH BLUE SILTY CLAY (CH)	
			BOTTOM OF HOLE	

BORING LOG-S

GREGORY-GRACE & ASSOCIATES

SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC.

GEIGER, ALABAMA SITE #2

TUSCALOOSA TESTING LABORATORY, INC.

#13

JEB BARKSDALE & CREW

6" FISHTAIL

CME-55

9-24-77 9-24-77

6 FT

JAMES C BA-BARGER

DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)
	TAN & WHITE SILTY CLAY (CH)
5.0	GRAYISH BLUE SILTY CLAY (CH)
6.0	BOTTOM OF HOLE

BORING LOG-1 GREGORY-GRACE & ASSOCIATES — Sheet 1 of 1 sheets

1. Project: RESOURCE INDUSTRIES OF ALABAMA, INC	10. Size and type of bit: 6" FISHTAIL
2. Location: GEIGER, ALABAMA SITE #2	11. Datum for elevation shown
3. Drilling agency: TUSCALOOSA TESTING LABORATORY, INC	12. Manufacturer's designation of drill: CME-55
4. Hole no.: #14	13. Total no. of overburden samples taken
5. Name of driller: JEB BARKSDALE & CREW	14. Total number core boxes
6. Direction of hole: vertical	15. Elevation ground water
7. Thickness of overburden	16. Date hole: Started 9-24-77, Completed 9-24-77
8. Depth drilled into rock	17. Elevation top of hole
9. Total depth of hole: 31 FT	18. Total core recovery for boring
	19. Signature of inspector: JAMES C. BAMBERGER

Depth	Classification of Materials (Description)
	TAN & WHITE SILTY CLAY (CH)
18.0	DAMP
20.0	DRY
	GRAYISH BLUE SILTY CLAY (CH)
31.0	BOTTOM OF HOLE

BORING LOG-6 | GREGORY-GRACE & ASSOCIATES | SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA, INC.	10. SIZE AND TYPE OF BIT: FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: #15	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 9-24-77 / COMPLETED 9-24-77
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 26 FT	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYMBOL	CLASSIFICATION OF MATERIALS (DESCRIPTION)				REMARKS
		0–15.5		BROWN TO TAN SILTY CLAY (CH)				
		15.5–20.0		TAN & WHITE SILTY CLAY (CH)				
		20.0–26.0		GRAYISH BLUE SILTY CLAY (CH)				
		26.0		BOTTOM OF HOLE				

BORING LOG	GREGORY-GRACE & ASSOCIATES
Sheet	1 of 1 sheets
Project	RESOURCE INDUSTRIES OF ALABAMA, INC.
Location	ELIGER, ALABAMA SITE #2
Drilling agency	TUSCALOOSA TESTING LABORATORY, INC.
Hole no.	#16
Name of driller	JED BARKSDALE & CREW
Direction of hole	Vertical
Total depth of hole	21 FT
Size and type of bit	6" FISHTAIL
Manufacturer's designation of drill	CME-55
Date hole	Started 9-24-77; Completed 9-24-77
Signature of inspector	JAMES C. BAMBARGER

Depth	Classification of materials (description)
0–12.5	BROWN TO TAN SILTY CLAY (CH)
12.5–16.0	TAN & WHITE SILTY CLAY (CH)
16.0–21.0	GRAYISH BLUE SILTY CLAY (CH)
21.0	BOTTOM OF HOLE

BORING LOG-S — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC.	6" FISHTAIL
GEIGER, ALABAMA SITE #2	
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
#17	
JEB BARKSDALE & CREW	
[X] VERTICAL [ ] INCLINED	9-26-77 / 9-26-77
21 FT	JAMES C. BAMBARGER

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
		BROWN TO TAN SILTY CLAY (CH)	
	10.5	TAN & WHITE SILTY CLAY (CH)	
	14.0	GRAYISH BLUE SILTY CLAY (CH)	
	21.0	BOTTOM OF HOLE	

BORING LOG-B	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA, INC.	10. SIZE AND TYPE OF BIT: 6" FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: #18	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 9-24-77 COMPLETED 9-24-77
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 16 FT	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: JAMES E. BAMBARGER

W/C %	ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD SAMPL.	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
				BROWN TO TAN SILTY CLAY (CH)				
		5.0		TAN & WHITE SILTY CLAY (CH)				
		7.0		GRAYISH BLUE SILTY CLAY (CH) SLIGHTLY DAMP				
				DRY				
		16.0		BOTTOM OF HOLE				

BORING LOG-B | GREGORY-GRACE & ASSOCIATES | SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC.

GEIGER, ALABAMA SITE #2

TUSCALOOSA TESTING LABORATORY, INC.

#19

JEB BARKSDALE & CREW

6" FISHTAIL

CME-55

9-24-77 | 9-24-77

JAMES C. BAMBARGER

6 FT

Depth	Description
5 C	BROWN TO TAN SILTY CLAY (CH)
6 D	GRAYISH BLUE SILTY CLAY (CH)

BORING LOG-B GREGORY-GRACE & ASSOCIATES

SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC.

GEIGER, ALABAMA SITE #2

TUSCALOOSA TESTING LABORATORY, INC.

#20

JEB BARKSDALE & CREW

6" FISHTAIL

CME-55

9-24-77

9-24-77

21 FT

JAMES E. BAMBARGER

Depth	Classification of Materials (Description)
	BROWN TO TAN SILTY CLAY (CH)
15.0	GRAYISH BLUE SILTY CLAY (CH)
21.0	BOTTOM OF HOLE

BORING LOG — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

Project	RESOURCE INDUSTRIES OF ALABAMA, INC.
Location	GEIGER, ALABAMA SITE #2
Drilling agency	TUSCALOOSA TESTING LABORATORY, INC.
Hole No.	#21
Name of driller	JEB BARKSDALE & CREW
Size and type of bit	4" FISHTAIL
Manufacturer's designation of drill	CME-55
Date hole	Started 9-24-77; Completed 9-24-77
Total depth of hole	16 FT
Signature of inspector	JAMES C. BAMBARGER

Elevation	Depth	Classification of materials (description)	Remarks
		BROWN TO TAN SILTY CLAY (CH)	
	12.0	TAN & WHITE SILTY CLAY (CH)	
	13.5	GRAYISH BLUE SILTY CLAY (CH)	
	16.0	BOTTOM OF HOLE	

BORING LOG B — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

- Project: RESOURCE INDUSTRIES OF ALABAMA, INC
- Location: GEIGER, ALABAMA SITE #2
- Drilling agency: TUSCALOOSA TESTING LABORATORY, INC
- Hole no.: #22
- Name of driller: JEB BARKSDALE & CREW
- Direction of hole: vertical
- Total depth of hole: 26 FT
- Size and type of bit: 4" FISHTAIL
- Manufacturer's designation of drill: CME-55
- Date hole: Started 9-24-77; Completed 9-24-77
- Signature of inspector: JAMES C. BAMBARGER

Elevation	Depth	Classification of materials (description)
	0.0–4.0	BLACK SILTY CLAY WITH ORGANIC MATERIAL NEAR SURFACE (OL)
	4.0–16.0	BROWN TO TAN SILTY CLAY (CH)
PWL (at 8.0)		
	16.0–19.0	TAN & WHITE SILTY CLAY (CH)
	19.0–26.0	GRAYISH BLUE SILTY CLAY (CH)
	26.0	BOTTOM OF HOLE

BORING LOG-5 — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

RESOURCE INDUSTRIES OF ALABAMA, INC.

GEIGER, ALABAMA SITE #2

TUSCALDOSA TESTING LABORATORY, INC.

#23

JEB BARKSDALE & CREW

21 FT

4" FISHTAIL

CME-55

9-24-77 9-24-77

JAMES C. BAMBARGER

Elevation	Depth	Classification of Materials (Description)
	3.0	BLACK SILTY CLAY WITH ORGANIC MATERIAL NEAR SURFACE (OL)
PWL	7.0	BROWN TO TAN SILTY CLAY (CH)
	16.0	TAN & WHITE SILTY CLAY (CH) WET
	21.0	GRAYISH BLUE SILTY CLAY (CH)
		BOTTOM OF HOLE

BORING LOG-5 — GREGORY-GRACE & ASSOCIATES — SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA, INC.	10. SIZE AND TYPE OF BIT: [illegible] FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: #24	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 9-24-77, COMPLETED 9-24-77
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 21 FT	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	SYM.	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD SAMPLES	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
		0–6.5		BLACK SILTY CLAY WITH ORGANIC MATERIAL NEAR SURFACE (OL)				
	F.W.L. ▼	6.5–12.5		BROWN TO TAN SILTY CLAY (CH)				
		12.5–17.0		TAN & WHITE SILTY CLAY (CH)				
		17.0–21.0		GRAYISH BLUE SILTY CLAY (CH)				
		21.0		BOTTOM OF HOLE				

BORING LOG	GREGORY-GRACE & ASSOCIATES	SHEET 1 OF 1 SHEETS

1. PROJECT: RESOURCE INDUSTRIES OF ALABAMA, INC.	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #2	11. DATUM FOR ELEVATION SHOWN:
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: #25	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: JEB BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES:
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 9-26-77 COMPLETED 9-26-77
7. THICKNESS OF OVERBURDEN:	17. ELEVATION TOP OF HOLE:
8. DEPTH DRILLED INTO ROCK:	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 6 FT	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

R/C %	ELEVATION	DEPTH	TYPE	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD CLASS.	% MOIST.	BLOWS PER FT.	REMARKS
				TAN & WHITE SILTY CLAY (CH)				
		5.0		GRAY SH BLUE SILTY CLAY (CH)				
		6.0		BOTTOM OF HOLE				

BORING LOG — RESOURCE INDUSTRIES OF ALABAMA — Sheet 1 of 1 sheets

Project: HAZARD WASTE MANAGEMENT SYSTEM	Size and type of bit: 4" FISHTAIL
Location: GEIGER, ALABAMA SITE #3	Datum for elevation shown: MSL
Drilling agency: TUSCALOOSA TESTING LABORATORY, INC.	Manufacturer's designation of drill: CME-55
Hole no.: LM-1	Total no. of overburden samples taken: 4
Name of driller: J. BARKSDALE & CREW	Total number core boxes:
Direction of hole: Vertical	Elevation ground water: NONE
Thickness of overburden:	Date hole: Started 6-22-78; Completed 6-22-78
Depth drilled into rock:	Elevation top of hole:
Total depth of hole: 20.0 FEET	Total core recovery for boring:
	Signature of inspector: JAMES C. BAMBARGER

R/C %	Elevation	Depth	Legend	Classification of materials (Description)	Remarks
21		4.0		RED, TAN AND GRAY SILTY CLAY (CL) -DRY-	
26		10.0		TAN AND GRAY SILTY CLAY (CH) -DRY-	
19		13.5		GRAY SILTY CLAY (CH) -DRY-	
19		20.0		GRAYISH BLUE SILTY CLAY (CHALK) -DRY-	
				BOTTOM OF HOLE	

Hole no. LM-1

BORING LOG	RESOURCE INDUSTRIES OF ALABAMA	SHEET 1 of 1 SHEETS
PROJECT: HAZARD WASTE MANAGEMENT SYSTEM	SIZE AND TYPE OF BIT: 4" FISHTAIL	
LOCATION: GEIGER, ALABAMA SITE # 3	DATUM FOR ELEVATION SHOWN: MSL	
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC	MANUFACTURER'S DESIGNATION OF DRILL: CME-55	
HOLE NO.: LN-2	TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 1	
NAME OF DRILLER: J. BARKSDALE & CREW	TOTAL NUMBER CORE BOXES	
DIRECTION OF HOLE: VERTICAL	ELEVATION GROUND WATER: NONE	
THICKNESS OF OVERBURDEN	DATE HOLE: STARTED 6-22-78, COMPLETED 6-22-78	
DEPTH DRILLED INTO ROCK	ELEVATION TOP OF HOLE	
TOTAL DEPTH OF HOLE: 20.0 FEET	TOTAL CORE RECOVERY FOR BORING %	
	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER	

W/C %	ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
		0.0–1.0		BROWN ORGANIC SILTY CLAY (OL)	
		1.0–7.0		TAN AND GRAY SILTY CLAY (CH) -DRY-	
		7.0–10.0		GRAYISH TAN SILTY CLAY (CH) -DRY-	
		10.0–13.0		GRAY SILTY CLAY (CH) -DRY-	
19		13.0–20.0		GRAYISH BLUE SILTY CLAY (CH) (CHALK) -DRY-	
		20.0		BOTTOM OF HOLE	

HOLE NO. LN-2

BORING LOG — RESOURCE INDUSTRIES OF ALABAMA — SHEET 1 OF 1 SHEETS

PROJECT	HAZARD WASTE MANAGEMENT SYSTEM
LOCATION	GEIGER, ALABAMA SITE #3
DRILLING AGENCY	TUSCALOOSA TESTING LABORATORY, INC.
HOLE NO.	LH-3
NAME OF DRILLER	J. BARKSDALE & CREW
DIRECTION OF HOLE	VERTICAL
TOTAL DEPTH OF HOLE	20.0 FEET
SIZE AND TYPE OF BIT	4" FISHTAIL
DATUM FOR ELEVATION SHOWN	MSL
MANUFACTURER'S DESIGNATION OF DRILL	CME-55
TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	1
ELEVATION GROUND WATER	NONE
DATE HOLE	STARTED 6-22-78; COMPLETED 6-22-78
SIGNATURE OF INSPECTOR	JAMES C. BAMBARGER

REC %	ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)
		0.5	BROWN ORGANIC SILTY CLAY (CL)
			TAN SILTY CLAY (CH)
		4.0	GRAY AND TAN SILTY CLAY (CH)
		7.0	GRAY SILTY CLAY (CH)
19		11.0	GRAYISH BLUE SILTY CLAY (CH) (CHALK)
		20.0	BOTTOM OF HOLE

HOLE NO. LH-3

BORING LOG RESOURCE INDUSTRIES OF ALABAMA — Sheet 1 of 1 sheets

HAZARD WASTE MANAGEMENT SYSTEM	4" FISHTAIL
GEIGER, ALABAMA SITE #3	MSL
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
LM-4	2
J. BARKSDALE & CREW	NONE
	6-22-78 / 6-22-78
20.0 FEET	JAMES C. BAMBARGER

%	Elevation	Depth	Classification of materials (description)
		0.5	BROWN ORGANIC SILTY CLAY (OL)
			TAN AND WHITE SILTY CLAY (CH)
		4.0	
			GRAYISH TAN AND TAN SILTY CLAY (CH)
		10.0	
27			GRAYISH TAN AND GRAY SILTY CLAY (CH)
		13.5	
19			GRAYISH BLUE SILTY CLAY (CH) (CHALK)
		20.0	BOTTOM OF HOLE

BORING LOG — RESOURCE INDUSTRIES OF ALABAMA — SHEET 1 OF 1 SHEETS

1. PROJECT: HAZARD WASTE MANAGEMENT SYSTEM	10. SIZE AND TYPE OF BIT: 4" FISHTAIL
2. LOCATION: GEIGER, ALABAMA SITE #3	11. DATUM FOR ELEVATION SHOWN: MSL
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: LM-5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2 ; UNDISTURBED
5. NAME OF DRILLER: J. BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: VERTICAL / INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: NONE
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 6-22-78 ; COMPLETED 6-22-78
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE: 11.0 FEET	18. TOTAL CORE RECOVERY FOR BORING: %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
		0.5		BROWN ORGANIC SILTY CLAY				
23				GRAY SILTY CLAY (CH)				
		4.5						
26				GRAYISH BLUE SILTY CLAY (CH) (CHALK)				
		11.0		BOTTOM OF HOLE				

HOLE NO. LM-5

BORING LOG | RESOURCE INDUSTRIES OF ALABAMA | SHEET 1 OF 1 SHEETS

PROJECT: HAZARD WASTE MANAGEMENT SYSTEM	SIZE AND TYPE OF BIT: 4" FISHTAIL
LOCATION: GEIGER, ALABAMA SITE #3	DATUM FOR ELEVATION SHOWN: MSL
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	MANUFACTURER'S DESIGNATION OF DRILL: CME-55
HOLE NO.: LM-6	TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 2
NAME OF DRILLER: J. BARKSDALE & CREW	TOTAL NUMBER CORE BOXES:
DIRECTION OF HOLE: VERTICAL	ELEVATION GROUND WATER: NONE
	DATE HOLE: STARTED 6-22-78, COMPLETED 6-22-78
THICKNESS OF OVERBURDEN:	ELEVATION TOP OF HOLE:
DEPTH DRILLED INTO ROCK:	TOTAL CORE RECOVERY FOR BORING: %
TOTAL DEPTH OF HOLE: 20.0 FEET	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER

O/C %	ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)				REMARKS
		0.5		BROWN ORGANIC SILTY CLAY [illegible]				
		4.0		REDISH TAN AND TAN SILTY CLAY (CL)				
		10.0		TAN AND WHITE SILTY CLAY (CH)				
23		14.0		GRAYISH TAN AND GRAY SILTY CLAY (CH)				
22		20.0		GRAYISH BLUE SILTY CLAY (CH) (CHALK)				
				BOTTOM OF HOLE				

HOLE NO. LM-6

BORING LOG — RESOURCE INDUSTRIES OF ALABAMA — Sheet 1 of 1 sheets

HAZARD WASTE MANAGEMENT SYSTEM	4" FISHTAIL
GEIGER, ALABAMA SITE #3	MSL
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
LR-7	2
J. BARKSDALE & CREW	NONE
	6-22-78 / 6-22-78
26.0 FEET	JAMES C. BAMBARGER

W/C %	ELEVATION	DEPTH		CLASSIFICATION OF MATERIALS (DESCRIPTION)				REMARKS
		0.5		BROWN ORGANIC SILTY CLAY (OL)				
				TAN SILTY CLAY (CL)				
		9.0		TAN AND WHITE SILTY CLAY (CH)				
		15.0						
26				GRAYISH TAN AND GRAY SILTY CLAY (CH)				
		20.0						
21				GRAYISH BLUE SILTY CLAY (CH) (CHALK)				
		26.0		BOTTOM OF HOLE				

BORING LOG RESOURCE INDUSTRIES OF ALABAMA

Sheet 1 of 1 sheets

HAZARD WASTE MANAGEMENT SYSTEM

GEIGER, ALABAMA SITE #3

TUSCALOOSA TESTING LABORATORY, INC.

LM-8

J. BARKSDALE & CREW

20.0 FEET

4" FISHTAIL

MSL

CME-55

2

NONE

6-22-78 6-22-78

JAMES C. BAMBARGER

W/C %	Elevation	Depth	Classification of materials (Description)
			BROWNISH BLACK ORGANIC SILTY CLAY (OL)
		1.0	GRAYISH BROWN SILTY CLAY (CH)
		5.0	TAN SILTY CLAY (CH)
21		11.0	GRAYISH TAN AND GRAY SILTY CLAY (CH)
19		15.0	GRAYISH BLUE SILTY CLAY (CH) (CHALK)
		20.0	BOTTOM OF HOLE

Hole No. L

BORING LOG	RESOURCE INDUSTRIES OF ALABAMA	SHEET 1 OF 1 SHEETS

Project: HAZARD WASTE MANAGEMENT SYSTEM	Size and type of bit: 4" FISHTAIL
Location: GEIGER, ALABAMA SITE #3	Datum for elevation shown: MSL
Drilling agency: TUSCALOOSA TESTING LABORATORY, INC	Manufacturer's designation of drill: CME-55
Hole no.: LM-1 (A)	Total no. of overburden samples taken: 3
Name of driller: J. BARKSDALE & CREW	Elevation ground water: NONE
Direction of hole: ☐ Vertical ☐ Inclined ____ deg. from vert.	Date hole: Started 9-8-78 Completed 9-8-78
Thickness of overburden	Elevation top of hole
Depth drilled into rock	Total core recovery for boring %
Total depth of hole: 75.0 FEET	Signature of inspector: JAMES C. BAMBARGER, P.E.

Depth	Classification of materials (description)	Remarks
0–4.0	RED, TAN AND GRAY SILTY CLAY (CL) -DRY-	
4.0–10.0	TAN AND GRAY SILTY CLAY (CH) -DRY-	
10.0–13.5	GRAY SILTY CLAY (CH) -DRY-	
13.5–75.0	GRAYISH BLUE SILTY CLAY (CHALK) -DRY-	SAMPLED 15'-25' SAMPLED 25'-50' SAMPLED 50'-75'
75.0	BOTTOM OF HOLE	

BORING LOG	RESOURCE INDUSTRIES OF ALABAMA	SHEET 1 OF 1 SHEETS

HAZARD WASTE MANAGEMENT SYSTEM	4" FISHTAIL
GEIGER, ALABAMA SITE #3	MSL
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
LM-4 (A)	3
J. BARKSDALE & CREW	NONE
VERTICAL	9-8-78 / 9-8-78
75.0 FEET	JAMES C. BAMBARGER, P.E.

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
	0.5	BROWN ORGANIC SILTY CLAY (CL)	
	4.0	TAN AND WHITE SILTY CLAY (CH)	
	10.0	GRAYISH TAN AND TAN SILTY CLAY (CH)	
	13.5	GRAYISH TAN AND GRAY SILTY CLAY (CH)	SAMPLED 13.5'-25.0'
	75.0	GRAYISH BLUE SILTY CLAY (CH) (CHALK) -DRY-	SAMPLED 50'-75'
		BOTTOM OF HOLE	

BORING LOG — RESOURCE INDUSTRIES OF ALABAMA — SHEET 1 OF 1 SHEETS

PROJECT	HAZARD WASTE MANAGEMENT SYSTEM
LOCATION	GEIGER, ALABAMA SITE 43
DRILLING AGENCY	TUSCALOOSA TESTING LABORATORY, INC.
HOLE NO.	LH-7 (A)
NAME OF DRILLER	J. BARKSDALE & CREW
DIRECTION OF HOLE	VERTICAL
THICKNESS OF OVERBURDEN	
DEPTH DRILLED INTO ROCK	
TOTAL DEPTH OF HOLE	75.0 FEET
SIZE AND TYPE OF BIT	4" FISH AL.
DATUM FOR ELEVATION SHOWN	MSL
MANUFACTURER'S DESIGNATION OF DRILL	CME-55
TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	3
TOTAL NUMBER CORE BOXES	
ELEVATION GROUND WATER	NONE
DATE HOLE	STARTED 9-8-78 COMPLETED 9-8-78
ELEVATION TOP OF HOLE	
TOTAL CORE RECOVERY FOR BORING	%
SIGNATURE OF INSPECTOR	JAMES C. BAMBARGER, P.E.

DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)	REMARKS
0.5	BROWN ORGANIC SILTY CLAY (OL)	
	TAN SILTY CLAY (CL)	
9.0	TAN AND WHITE SILTY CLAY (CH)	
15.0	GRAYISH TAN AND GRAY SILTY CLAY (CH)	
20.0	GRAYISH BLUE SILTY CLAY (CH) (CHALK)	SAMPLED 20'-50' SAMPLED 50'-75'
75.0	BOTTOM OF HOLE	

HOLE NO. LH-7 (A)

BORING LOG	RESOURCE INDUSTRIES OF ALABAMA	SHEET 1 OF 1 SHEETS

PROJECT: HAZARD WASTE MANAGEMENT SYSTEM	SIZE AND TYPE OF BIT: 4" FISHTAIL
LOCATION: GEIGER, ALABAMA SITE #3	DATUM FOR ELEVATION SHOWN: MSL
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	MANUFACTURER'S DESIGNATION OF DRILL: CME-55
HOLE NO.: LM-8 (A)	TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 3 / UNDISTURBED
NAME OF DRILLER: J. BARKSDALE & CREW	TOTAL NUMBER CORE BOXES
DIRECTION OF HOLE: VERTICAL / INCLINED ____ DEG. FROM VERT.	ELEVATION GROUND WATER: NONE
THICKNESS OF OVERBURDEN	DATE HOLE: STARTED 9-8-78 / COMPLETED 9-8-78
DEPTH DRILLED INTO ROCK	ELEVATION TOP OF HOLE
TOTAL DEPTH OF HOLE: 75.0 FEET	TOTAL CORE RECOVERY FOR BORING %
	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER, P.E.

E/C %	ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	[illegible]	[illegible]		REMARKS
		1.0		BROWNISH BLACK ORGANIC SILTY CLAY (OL)				
				GRAYISH BROWN SILTY CLAY (CH)				
		5.0		TAN SILTY CLAY (CH)				
		11.0		GRAYISH TAN AND GRAY SILTY CLAY (CH)				
		15.0		GRAYISH BLUE SILTY CLAY (CH) (CHALK)				SAMPLED 15'-25' SAMPLED 25'-50' SAMPLED 50'-75'
		75.0		BOTTOM OF HOLE				

BORING LOG — WASTE MANAGEMENT OF ALABAMA, INC — SHEET 1 OF 2 SHEETS

1. PROJECT: PROPOSED TRENCH #8	10. SIZE AND TYPE OF BIT: 4" FISHTAIL, NV[illegible]
2. LOCATION: NORTHEAST CORNER OF PROPOSED TRENCH	11. DATUM FOR ELEVATION SHOWN: EXISTING GROUND SURFACE (5-17-79)
3. DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55
4. HOLE NO.: 39-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11 / UNDISTURBED
5. NAME OF DRILLER: J. BARKSDALE & CREW	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: VERTICAL [X] INCLINED [ ]	15. ELEVATION GROUND WATER:
7. THICKNESS OF OVERBURDEN:	16. DATE HOLE: STARTED 5-17-79 / COMPLETED 5-18-79
8. DEPTH DRILLED INTO ROCK:	17. ELEVATION TOP OF HOLE: SEE 11
9. TOTAL DEPTH OF HOLE: 58.5 FEET	18. TOTAL CORE RECOVERY FOR BORING: %
	19. SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER, P.E.

E/C %	ELEVATION	DEPTH	USC	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD SAMPLE	% CORE REC	BOX OR SAMPLE NO.	REMARKS
		0.5		TAN SILTY CLAY (CH)				
		3.6		GRAYISH WHITE AND TAN MIXED SILTY CLAY (CL) -WEATHERED CHALK-				
		5.0		GRAYISH WHITE WEATHERED CHALK (CL)				
		6.0						
		9.0						
		12.0		BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK-				
		15.0		GEOLOGIC GROUP: DEMOPOLIS FORMATION OF THE SELMA GROUP				
		18.0						
		20.5						(SET CASING AND BEGIN CORING)
		21.0						
		24.0					#1	
		27.0		-CONTINUE-				

HOLE NO. 39-1

BORING LOG (Cont Sheet) WASTE MANAGEMENT OF ALABAMA INC.

PROJECT: PROPOSED TRENCH #8 — SHEET 2 OF 2 SHEETS

O/C %	ELEVATION	DEPTH	SYMBOL	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD SAMPLE SIZE	% CORE RECOVERY	RUN NO.	REMARKS
						100		
				DEMOPOLIS CHALK -CONTINUED-				
		30.0		(30.4' TIGHTLY FITTED FOSSIL JOINT)				
				(32.0' TIGHTLY FITTED FOSSIL JOINT)			#2	
		33.0						
		36.0						
						100		
		39.0						
		42.0					#3	
		45.0						
				(46.9' TIGHTLY FITTED FOSSIL JOINT)				
		48.0				100		
				(49.5' TIGHTLY FITTED FOSSIL JOINT)				
		51.0					#4	
		54.0						
		57.0						
						100		
		58.5		BOTTOM OF HOLE				
		60.0						

HOLE NO. 39-1

BORING LOG — WASTE MANAGEMENT OF ALABAMA INC. — SHEET 1 OF 2 SHEETS

PROJECT: PROPOSED TRENCH #8	SIZE AND TYPE OF BIT: F.S.-TAIL NX DIA C
LOCATION: SOUTHWEST CORNER OF PROPOSED TRENCH	DATUM FOR ELEVATION SHOWN: EXISTING GROUND SURFACE (5-18-79)
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC.	MANUFACTURER'S DESIGNATION OF DRILL: CME-55
HOLE NO.: 39-2	TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: 11
NAME OF DRILLER: J. BARKSDALE & CREW	TOTAL NUMBER CORE BOXES: 3
DIRECTION OF HOLE: VERTICAL	ELEVATION GROUND WATER:
THICKNESS OF OVERBURDEN:	DATE HOLE: STARTED 5-18-79, COMPLETED 5-21-79
DEPTH DRILLED INTO ROCK:	ELEVATION TOP OF HOLE: SEE 11
TOTAL DEPTH OF HOLE: 54.0 FEET	TOTAL CORE RECOVERY FOR BORING:
	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER, P.E.

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)	BOX OR SAMPLE NO.	REMARKS
	0–1.0	TAN SILTY CLAY (CH)		
	1.0–3.0	GRAYISH WHITE AND TAN MIXED SILTY CLAY (CL)		
	3.0–5.0	GRAYISH WHITE SILTY CLAY (CL) (WEATHERED CHALK)		
	5.0–27.0	BLUE GRAY SILTY CLAY (CL) (NON-WEATHERED CHALK) GEOLOGIC GROUP: DEMOPOLIS FORMATION OF THE SELMA GROUP		
	25.0			(SET CASING AND BEGIN CORING)
	27.0	-CONTINUED-	#1	

Depth scale marks: 1.0, 3.0, 5.0, 6.0, 9.0, 12.0, 15.0, 18.0, 21.0, 24.0, 25.0, 27.0

HOLE NO. 39-2

BORING LOG (Cont Sheet) WASTE MANAGEMENT OF ALABAMA INC

Sheet 2 of 2 sheets

Project: PROPOSED TRENCH #8

O/C %	Elevation	Depth	[illegible]	Classification of Materials (Description)	[illegible]	[illegible]	[illegible]	Remarks
				(28.5' TIGHTLY FITTED SHEER FACE FAULT)				
		30.0		DEMOPOLIS CHALK -CONTINUED- (30.4 TIGHTLY FITTED SHEER FACE FAULT)			91	
		33.0				100		
		36.0		(36.7' TIGHTLY FITTED FOSSIL JOINT)				
		39.0					92	
		42.0		(42'-42.5' HEAVILY FRACTURED, TIGHT)		100		
		45.0						
		48.0		(48.7'-52' CONTINUING SERIES OF HEAVILY FRACTURED SHEER FACE FAULTS TIGHT)			93	
		51.0						
		54.0		BOTTOM OF HOLE		95		
		57.0						
		60.0						

HOLE NO. 39-2

BORING LOG — WASTE MANAGEMENT OF ALABAMA INC — SHEET 1 OF 2 SHEETS

PROJECT: PROPOSED TRENCH #8	SIZE AND TYPE OF BIT: 4" FISHTAIL, NX DIA CB
LOCATION: SOUTH CENTRAL AREA OF TRENCH	DATUM FOR ELEVATION SHOWN: EXISTING GROUND SURFACE (6-7-79)
DRILLING AGENCY: TUSCALOOSA TESTING LABORATORY, INC	MANUFACTURER'S DESIGNATION OF DRILL: CME-55
HOLE NO.: 39-3	TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN:
NAME OF DRILLER: J. BARKSDALE & CREW	TOTAL NUMBER CORE BOXES: 5
DIRECTION OF HOLE: VERTICAL	ELEVATION GROUND WATER:
THICKNESS OF OVERBURDEN:	DATE HOLE: STARTED 6-7-79, COMPLETED 6-7-79
DEPTH DRILLED INTO ROCK:	ELEVATION TOP OF HOLE: SEE 11
TOTAL DEPTH OF HOLE: 54.5 FEET	TOTAL CORE RECOVERY FOR BORING: %
	SIGNATURE OF INSPECTOR: JAMES C. BAMBARGER, P.E.

W/C %	ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD SAMP.	% CORE REC.	BOX OR SAMPLE NO.	REMARKS
				BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK-				
		3.0		GEOLOGIC GROUP: DEMOPOLIS FORMATION OF THE SELMA GROUP				
		5.0						(SET CASING AND BEGIN CORING)
		6.0						
				(7.1' TIGHTLY FITTED SHEER FACE FAULT)				
		9.0					#1	
		12.0						
		15.0				100		
		18.0		(18.6' TIGHTLY FITTED FOSSIL JOINT)			#2	
		21.0		(21.9' TIGHTLY FITTED FOSSIL JOINT)				
		24.0				100		
		27.0		(26.5' TIGHTLY FITTED FOSSIL JOINT)				
				-CONTINUED-				

HOLE NO. 39-3

BORING LOG (Cont Sheet) WASTE MANAGEMENT OF ALABAMA INC.

PROJECT: PROPOSED TRENCH #8 SHEET 2 OF 2

W/C %	ELEVATION	DEPTH FT	SYM	CLASSIFICATION OF MATERIALS (DESCRIPTION)	FIELD	% CORE REC	BOX OR SAMP NO	REMARKS
				DEMOPOLIS CHALK -CONTINUED-				
				(29.3' TIGHTLY FITTED SHEER FACE FAULT)				
		30.0					#3	
				(32.0' TIGHTLY FITTED SHEER FACE FAULT)				
		33.0						
				(34.5'-34.7' TIGHTLY FITTED VERTICAL FAULT)		100		
		36.0						
		39.0						
							#4	
		42.0						
						100		
		45.0						
		48.0						
		51.0					#5	
				(53.1' TIGHTLY FITTED SHEER FACE FAULT)				
		54.0				100		
		54.5		BOTTOM OF HOLE				
		57.0						
		60.0						

HOLE NO. 59.3

BORING LOG — WASTE MANAGEMENT OF ALABAMA, INC. — SHEET 1 OF 1 SHEETS

PROPOSED TRENCH #8	4" FISHTAIL, NX DIA CB
NORTH CENTRAL AREA OF TRENCH	EXISTING GROUND SURFACE (6-8-79)
TUSCALOOSA TESTING LABORATORY, INC.	CME-55
39-4	
J. BARKSDALE AND CREW	5
VERTICAL	6-8-79 / 6-8-79
	SEE 11
54.5 FEET	JAMES C. BAMBARGER, P.E.

Depth	Classification of materials (description)	% core recovery	Box or sample no.	Remarks
	BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK-			
3.0	GEOLOGIC GROUP: DEMOPOLIS FORMATION OF THE SELMA GROUP			
5.0				(SET CASING AND BEGIN CORING)
6.0				
9.0			#1	
	(11.3' TIGHTLY FITTED FOSSIL JOINT)			
12.0	(13.35' TIGHTLY FITTED SHEER FACE FAULT)	100%		
15.0				
18.0			#2	
21.0		100%		
24.0				
27.0	(CONTINUED)		#3	

HOLE NO.

BORING LOG (Cont Sheet) | WASTE MANAGEMENT OF ALABAMA, INC

PROPOSED TRENCH #9 | SHEET 2 OF 2 SHEETS

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		30.0		DEMOPOLIS CHALK -CONTINUED-			#3	
		33.0						
		34.5				100%		
		36.0						
		39.0					#4	
		42.0						
		44.5				100%		
		45.0						
		48.0						
		51.0					#5	
		54.0						
		54.5		BOTTOM OF HOLE		100%		
		57.0						
		60.0						

HOLE NO. 39-4

BORING LOG — WASTE MANAGEMENT OF ALABAMA, INC. — Sheet 1 of 1 sheets

OBSERVATION WELL FOR TRENCHES #8 & #9

MIDDLE OF WEST SIDE OF TRENCH #8

TUSCALOOSA TESTING LABORATORY, INC.

39-OW1 (PCB-1)

J. BARKSDALE AND CREW

TOTAL DEPTH OF HOLE: 108.5 FEET

8" WINGS (2/4" FISHTAIL)

EXISTING GROUND SURFACE (6-8-79)

CME-55

NONE

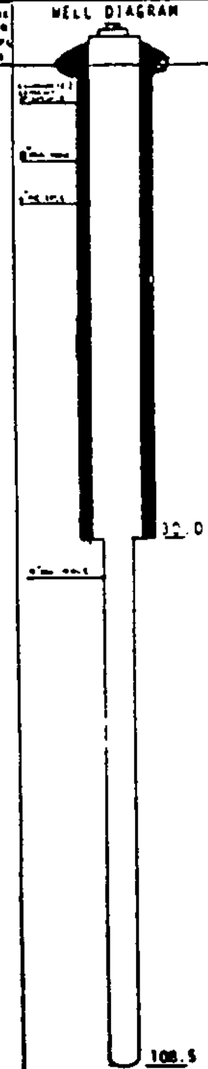
6-8-79 — 6-11-79

SEE 11

JAMES C. BAMBARGER, P.E.

Depth	Classification of materials (description)
1.0	BLACK ORGANIC SILTY CLAY (OL)
5.0	BROWN TO TAN SILTY CLAY (CH)
6.0 / 9.0	GRAYISH WHITE SILTY CLAY (CL) -WEATHERED CHALK-
30.0	BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK- GEOLOGIC GROUP: DEMOPOLIS FORMATION OF THE SELMA GROUP
108.5	BOTTOM OF HOLE

WELL DIAGRAM

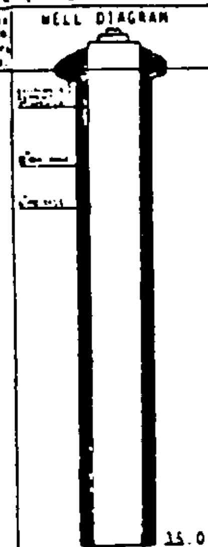


HOLE NO. 39-OW1

BORING LOG	WASTE MANAGEMENT OF ALABAMA, INC.	SHEET 1 OF 1 SHEETS
OBSERVATION WELL FOR TRENCHES #8 & #9	8" BIND?P/4" FISHTAIL	
MIDDLE OF SOUTH END OF TRENCHES #8 & #9	EXISTING GROUND SURFACE (6-12-79)	
TUSCALOOSA TESTING LABORATORY, INC.	CME-55	
39-OW2 (PCB-6)		
J. BARKSDALE AND CREW	NONE	
VERTICAL	6-12-79	
	SEE 11	
35.0 FEET	JAMES C. BAMBARGER, P.E.	

Depth	Classification of Materials (Description)
	GRAY AND BLUE GRAY MIXED SILTY CLAY (CL) -WEATHERED AND NON-WEATHERED CHALK- COMPACTED EMBANKMENT FILL
6.0	
16.0	BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK- GEOLOGIC GROUP. DEMOPOLIS FORMATION OF THE SELMA GROUP
35.0	BOTTOM OF HOLE

WELL DIAGRAM



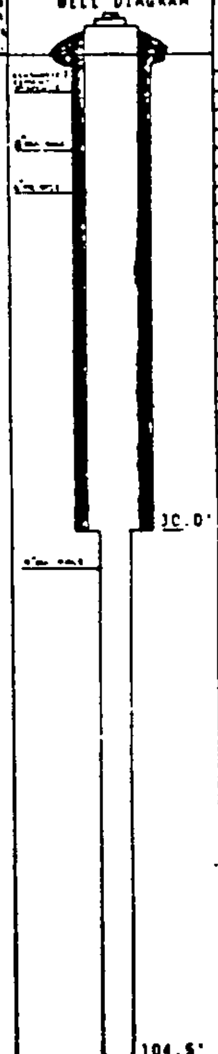
HOLE NO. 39-OW2

BORING LOG — WASTE MANAGEMENT OF ALABAMA, INC. — Sheet 1 of 1 sheets

OBSERVATION WELL FOR TRENCHES #8 & #9	8" WING TIP/4" FISHTAIL
MIDDLE WEST SIDE OF TRENCH #9	EXISTING GROUND SURFACE (6-12-79)
TUSCALOOSA TESTING LABORATORY, INC	CME-55
39-OW3 (PCB-5)	
J. BARKSDALE AND CREW	
X Vertical	NONE
	Started 6-12-79 Completed 6-12-79
	SEE 11
104.5 FEET	JAMES C. BAMBARGER, P.E.

Depth	Classification of Materials (Description)
0–6.0	GRAYISH TAN AND TAN MIXED SILTY CLAY (CH)
6.0–104.5	BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK- GEOLOGIC GROUP. DEMOPOLIS FORMATION OF THE SELMA GROUP
104.5	BOTTOM OF HOLE

WELL DIAGRAM

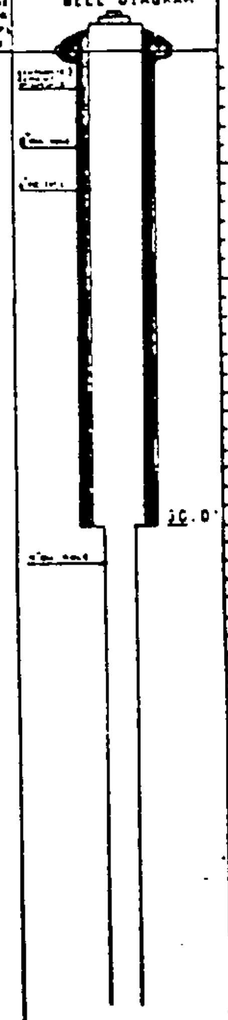


HOLE NO. 39-OW3

BORING LOG	WASTE MANAGEMENT OF ALABAMA, INC. — SHEET 1 OF 1 SHEETS
OBSERVATION WELL FOR TRENCHES #8 & #5	8" WING (?) 3/4" FISHTAIL
MIDDLE NORTH END OF TRENCHES #8 & #5	EXISTING GROUND SURFACE (6-12-79)
TUSCALOOSA TESTING LABORATORY, INC	CME-55
39-OW4 (PCB-4)	
J. BARKSDALE AND CREW	NONE
VERTICAL	STARTED 6-12-79 COMPLETED 6-22-79
	SEE 11
104.5 FEET	JAMES C. BAMBARGER, P.E.

DEPTH	CLASSIFICATION OF MATERIALS (DESCRIPTION)
0–6.0	GRAYISH TAN SILTY CLAY (CH) -WEATHERED CHALK-
6.0–104.5	BLUE GRAY SILTY CLAY (CL) -NON-WEATHERED CHALK- GEOLOGIC GROUP: DEMOPOLIS FORMATION OF THE SELMA GROUP
30.0	
104.5	BOTTOM OF HOLE

WELL DIAGRAM

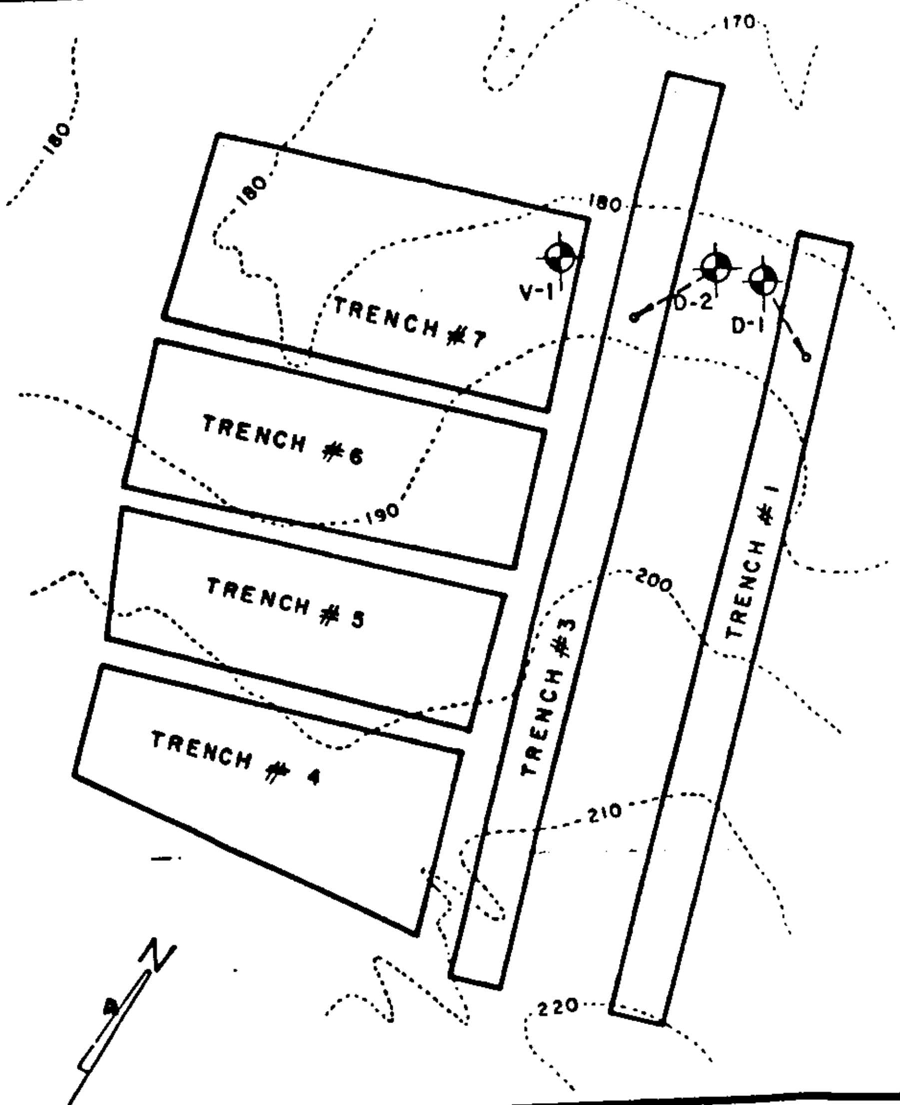


HOLE NO. 39-OW4

APPENDIX C

Woodward-Clyde Data

APPENDIX C
TABLE OF CONTENTS



NOTES

1. GENERAL SITE LAYOUT FROM GREGORY-GRACE AND ASSOCIATES, INC. DRAWING G-1, "MASTER PLAN, HAZARDOUS WASTE MANAGEMENT SYSTEM, SUMTER COUNTY, ALABAMA", DATED 6 FEBRUARY 1978 WITH 1 AND 26 MARCH 1979 REVISIONS.
2. LOCATION OF BORINGS FOR THIS PROJECT SELECTED BY WOODWARD-CLYDE CONSULTANTS. BORING LOCATIONS WERE STAKED IN FIELD BY SURVEYORS UNDER CONTRACT TO CHEMICAL WASTE MANAGEMENT, INC.

LEGEND

V-1 — INDICATES CORE HOLE NUMBER AND LOCATION OF CORING

D-2 — INDICATES THAT CORING WAS DRILLED ON AN ANGLE OF 45 DEGREES WITH RESPECT TO THE HORIZONTAL. DASH LINE INDICATES PROJECTION OF CORE HOLE

200 — INDICATES GROUND SURFACE CONTOUR & ELEVATION IN FEET (MEAN SEA LEVEL)

SCALE - FEET

100 0 50 100 200

WASTE DISPOSAL SITE
EMELLE, ALABAMA

CHEMICAL WASTE
MANAGEMENT, INC.

WOODWARD-CLYDE CONSULTANTS

SITE PLAN AND
BORING LOCATIONS

1

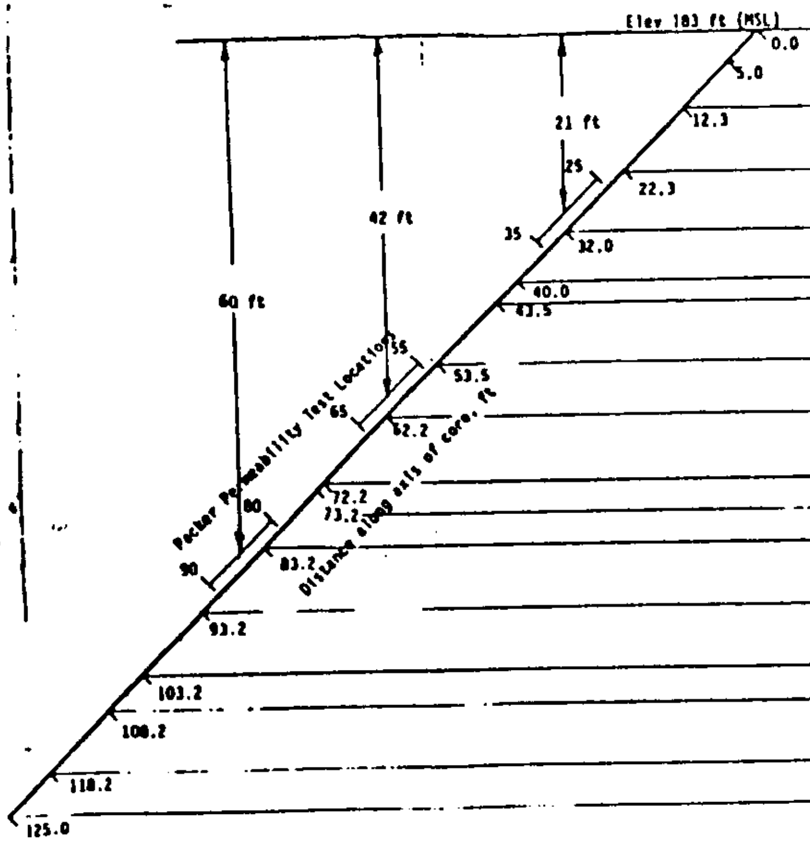
Depth ft	Run No	Length of Run ft	Recovery %	RQD %	Description and Remarks
0–3.7					Augered and set surface pipe. Trench at Elev 138 ft
9.3	1	5.6	89	100	Grey soft to med Ls (Chalk). Three pieces of core, 0.9 to 2.1 ft.
14.3	2	5.0	100	97	Grey soft to med Ls (Chalk). Three pieces of core 0.9 to 2.1 ft. Tight jointed seam at 10.8 ft.
24.3	3	10.0	100	100	Grey soft to med Ls (Chalk). Three pieces of core, 2.5 to 5.0 ft long.
35 34.3	4	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 2.5 and 7.5 ft
45 44.3	5	10.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 10 ft.
55 54.3	6	10.0	100	97	Grey m. hard Ls (Chalk). Three pieces of core, 0.1 to 9.3 ft.
65 64.3	7	10.0	100	96	Grey m. hard Ls (Chalk). Five pieces of core 0.1 to 4.6 ft. Straited core surface at 60.0 and 60.4 ft.
74.3	8	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 4.2. anc 5.8 ft.
85 84.3	9	10.0	100	99	Grey m. hard Ls (Chalk). Three pieces of core, 0.1 to 7.9 ft.
95 94.3	10	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core 4.2 and 5.8 ft.
100.6	11	6.3	100	99	Grey m. hard Ls (Chalk). Three pieces of core 0.1 to 5.5 ft long.

Note: (1) m. indicates medium and Ls indicates limestone.

(2) I indicates packer permeability test location.

Summary Log of Core Hole CWM V-1 (Under Trench 7)

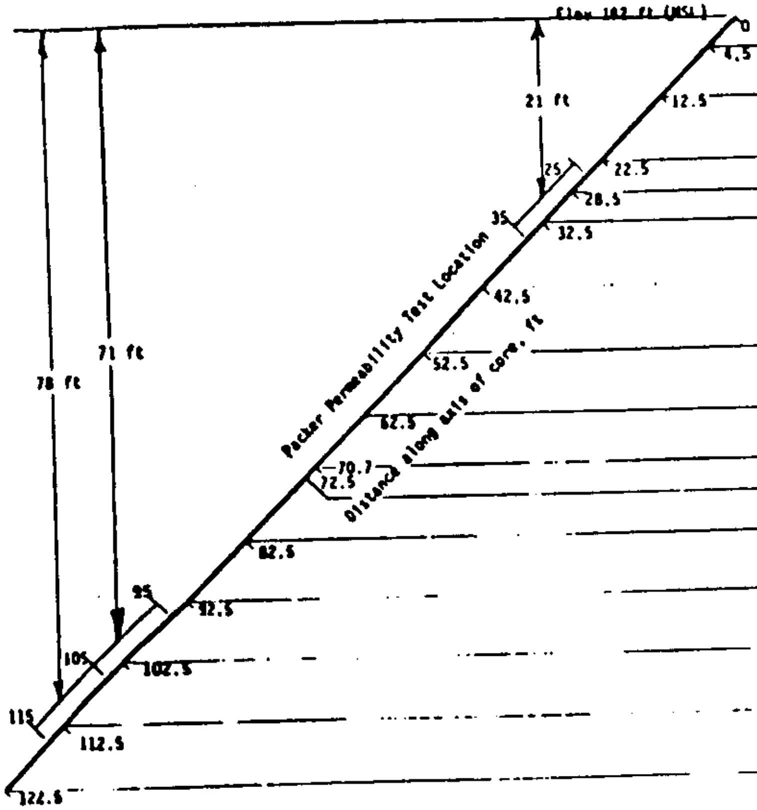
Figure 2



Run No	Length of run ft	Recovery %	RQD %	Description and Remarks
				Grey soft Ls (Chalk). Set surface pipe.
1	7.3	58	43	Grey soft Ls (Chalk). Note core barrel dropped from 6.0 to 8.7 ft. Two pieces of core, 0.7 and 2.7 ft.
2	10.0	90	99	Grey, med to soft Ls (Chalk). Three pieces of core, 0.1 to 7.6 ft
3	9.7	74	70	Grey m. hard Ls (Chalk), becomes softer at 27.0 ft. Four pieces of core 0.4 to 4.8 ft. Straitions at 27.0 and 27.4 ft.
4	8.0	100	93	Grey m. hard Ls (Chalk) with softer zone from 37.7 to 38.3 ft. Eight pieces of core 0.3 to 3.2 ft.
5	3.5	100	100	Grey m. hard Ls (Chalk). Three pieces of core, 0.1 to 1.3 ft.
6	10.0	100	100	Grey m. hard Ls (Chalk). Seven pieces of core, 0.4 to 4.3 ft.
7	8.7	89	80	Grey m. hard Ls (Chalk). Seven pieces of core, 0.3 to 4.0 ft.
8	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 1.8 and 8.2 ft.
9	1.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 1.0 ft.
10	10.0	100	100	Grey m. hard Ls (Chalk). Four pieces of core, 0.5 to 5.5 ft.
11	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 0.4 and 9.6 ft.
12	10.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 10 ft.
13	5.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 5 ft.
14	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 0.1 and 9.9 ft.
15	6.8	100	100	Grey m. hard Ls (Chalk). One piece of core 6.8 ft.

Summary Log of Core Hole CWM O-1 (Under Trench 1)

Figure 3



Run No	Length of run ft	Recovery %	RQD %	Description and Remarks
				Tan weathered soft Ls (Chalk); Set Surface pipe
1	8.0	75	52	Grey m Hard Ls (Chalk) with soft brown clay from 6.8 to 9.5 ft, Striations at 12.0 ft.
2	10.0	92	85	Tan highly weathered Ls to 14.0 ft, becomes grey m hard Ls (Chalk) after 14.0 ft. Many striations from 12.5 to 14.0 ft and one at 15.5 ft.
3	6.0	83	100	Grey m hard Ls (Chalk). Two pieces of core, 1.0 and 4.0 ft.
4	4.0	100	100	Grey m hard Ls (Chalk). One piece of core, 4.0 ft.
5	10.0	100	100	Grey m hard Ls (Chalk). Three pieces of core, 2.6 to 6.0 ft
6	10.0	100	100	Grey m hard Ls (Chalk). Three pieces of core, 1.2 to 5.4 ft.
7	10.0	100	100	Grey m hard Ls (Chalk). Two pieces of core, 2.7 and 7.3 ft.
8	8.2	100	100	Grey m hard Ls (Chalk). One piece of core, 8.2 ft.
9	1.8	100	100	Grey m hard Ls (Chalk). One piece of core, 1.8 ft.
10	10.0	100	100	Grey m hard Ls (Chalk). One piece of core, 10.0 ft.
11	10.0	100	100	Grey m hard Ls (Chalk). One piece of core, 10.0 ft.
12	10.0	100	100	Grey m hard Ls (Chalk). Two pieces of core, 4.6 and 5.4 ft. Striations at 97.6 ft.
13	10.0	100	100	Grey m hard Ls (Chalk). Six pieces of core, 0.5 to 3.5 ft. Striations at 106.0, 108.8 and 111.5 ft.
14	10.0	100	100	Grey m hard Ls (Chalk). One piece of core, 10.0 ft.

Summary Log of Core Hole CMR D-2 (Under Trench 3)

Figure 4

Table 1
Results of Packer Permeability Tests
Sheet 1 of 2

Core Hole	Packer Location Along Axis of Hole, ft [(1)]	Pump Pressure psi	Pressure Head ft	Total Head ft [(2)]	Flow gal	Time min	Flow Rate gal/min	Flow Rate ft³/min	F [(3)] ft	Coefficient of Permeability, k ft/min	Coefficient of Permeability, k cm/sec
CWM V-1	40	5	11.6	59.1	0	0	0	0			
		10	23.1	70.1	0	0	0	0			
		15	34.6	82.1	0	0	0	0			
		20	46.2	93.7	0	0	0	0			
		25	57.8	105.3	0.05	20	0.0025	3.34×10^{-4}	47.8	0.7×10^{-7}	0.4×10^{-7}
	60	10	23.1	90.6	0.05	20	0.0025	3.34×10^{-4}	28.1	1.3×10^{-7}	0.7×10^{-7}
		15	34.6	102.1	0.10	20	0.0050	6.68×10^{-4}	33.8	1.9×10^{-7}	1.0×10^{-7}
		20	46.2	113.7	0.45	20	0.0225	3.01×10^{-3}	37.5	7.1×10^{-7}	3.6×10^{-7}
		25	57.8	125.3	0.75	20	0.0375	5.01×10^{-3}	41.2	9.7×10^{-7}	4.8×10^{-7}
	90	5	11.6	109.1	0	5	0	0			
		10	23.1	120.6	0.55	20	0.0275	3.68×10^{-3}	27.5	11.1×10^{-7}	5.5×10^{-7}
		15	34.6	132.1	0.45	20	0.0225	3.01×10^{-3}	31.2	7.5×10^{-7}	3.8×10^{-7}
		20	46.2	143.7	0.70	20	0.0350	4.68×10^{-3}	32.5	10.6×10^{-7}	5.0×10^{-7}
		25	57.8	155.3	0.25	10	0.0250	3.34×10^{-3}	35.0	6.1×10^{-7}	3.1×10^{-7}
CWM D-1	30	5	11.6	39.3	0	20	0	0			
		10	23.1	50.8	0	20	0	0			
		15	34.6	62.3	0.15*		20	0			
		20	57.8	85.5	0.10*		20	0			
	60	5	11.6	60.6	**	20	0	0			
		10	23.1	72.1	**	20	0	0			
		15	34.6	83.6	0	20	0	0			
		20	57.8	106.8	0	20	0	0			
	85	5	11.6	78.2	0	20	0	0			
		10	23.1	89.7	**	20	0	0			
		15	34.6	101.2	0	20	0	0			
		20	57.8	124.4	0	20	0	0			

Core Hole	Packer[1] Location Along Axis of Hole, ft	Pump Pressure psi	Pressure Head ft	Total[2] Head ft	Flow gal	Time min	Flow Rate gal/min	Flow Rate ft³/min	F[3] ft	Coefficient of Permeability, k ft/min	Coefficient of Permeability, k cm/sec
CWM	30	5	11.6	39.3	0	20	0	0			
D-2		10	23.1	50.8	0	20	0	0			
		15	34.6	62.3	0	20	0	0			
		20	57.8	85.5	0	20	0	0			
	100	5	11.6	88.5	0	20	0	0			
		10	23.1	100.3	0	20	0	0			
		15	34.6	111.8	0	20	0	0			
		20	57.8	135.0	0	20	0	0			
	110	5	11.6	95.9	0	20	0	0			
		10	23.1	107.4	0	20	0	0			
		15	34.6	118.9	0	20	0	0			
		20	57.8	142.1	0	20	0	0			

Notes:

(1) Distance from top of core hole to midpoint of test section.

(2) Total head at bottom packer.

(3) Shape factor for test for calculating coefficient of permeability according to United States Bureau of Reclamation analysis method for constant head test above the water table, and unsaturated for an unlined test section with two packers. Reference is USBR, 1951, "Permeability Tests Using Drill Holes and Wells", Geology Report G-97.

* indicates measured flow occurred during the first 10 seconds only of 20 minute test. Considered as no flow.

** indicates measured flow was slightly negative. Considered as no flow.

Table 1 824-1308
Results of Packer Permeability Tests
Sheet 2 of 2

APPENDIX D

Golder Associates Boring Logs

APPENDIX D
TABLE OF CONTENTS

BORING LOG G16-1

SHEET 1 OF 3

SURFACE ELEV. Approx. 129.4 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/18/82 DATE COMPLETED 5/18/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT	REMARKS
129.4 / 0.0		Light gray CHALK fossiliferous							
123.9 / 5.5		Mottled light and dark gray CHALK, fossiliferous, trace sand with occasional small pyrite nodules encountered			1	NQ RC	RQD-100%	4.5/4.5	
10.0					2	NQ RC	RQD-100%	5.0/5.0	
15.0					3	NQ RC	RQD-100%	5.0/5.0	
20.0					4	NQ RC	RQD-100%	5.0/5.0	
25.0					5	NQ RC	RQD-100%	5.0/5.0	
30.0					6	NQ RC	RQD-100%	5.0/5.0	
35.0					7	NQ RC	RQD-100%	5.0/5.0	
91.9 / 37.5									Match Sheet 2

Job No. 824-1308 **Golder Associates** Drawn CAB

Scale 1"=5' Checked WJN

BORING LOG G16-1

SHEET 2 OF 3

SURFACE ELEV. Approx. 129.4 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/18/82 DATE COMPLETED 5/18/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
91.9 / 37.5		Mottled light and dark gray CHALK, fossiliferous, trace sand with occasional small pyrite nodules encountered			7	NQ RC			
40.0					8	NQ RC	RQD-100%	10.0/10.0	
50.0					9	NQ RC	RQD-100%	5.0/5.0	
55.0					10	NQ RC	RQD-100%	5.0/5.0	
60.0					11	NQ RC	RQD-100%	5.0/5.0	
65.0					12	NQ RC	RQD-100%	5.0/5.0	
70.0					13	NQ RC	RQD-100%	5.0/5.0	
54.40 / 75.0									Match Sheet 3

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

WJN

BORING LOG G16-1

SHEET 3 OF 3

(SU)RFACE ELEV. Approx. 129.4 ft. PROJECT Chemical Waste/Livingston/Alabama

(D)ATUM MSL DATE STARTED 5/18/82 DATE COMPLETED 5/18/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
54.40 / 75.0		Mottled light and dark gray CHALK, fossiliferous, trace sand with occasional small pyrite nodules encountered			14	NQ RC	RQD-100%	8.5/8.5	Slickensided fault at 82'. Dip 60° from horizontal.
45.9 / 83.5		END OF BORING Hole grouted on completion with cement/sand/bentonite							

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG G16-2

SHEET 1 OF 1

SURFACE ELEV. Approx. 151.8 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/20/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger

ELEV. / DEPTH (151.8)	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC./ATT.	REMARKS
0.0		Gray SILTY CLAY, some coarse to fine gravel (rock frag.), little coarse to fine sand	CL						
147.3 / 4.5		Blue-gray CHALK fossiliferous							
141.8 / 10.0		END OF BORING Hole grouted 5/20/82.							

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG G16-3

SHEET 1 OF 1

SURFACE ELEV. Approx. 163.8 ft.
PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL
DATE STARTED 5/20/82
DATE COMPLETED 5/20/82

DRILL RIG CME 55
DRILLING METHOD Solid Stem Auger

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT.	REMARKS
163.8 / 0.0		Gray SILTY CLAY, some coarse to fine gravel (rock frag.), little coarse to fine sand	CL						
161.3 / 2.5		Yellowish orange mottled gray SILTY CLAY	CL						
1.8 / 15.0		Bluish-gray CHALK, fossiliferous							
143.8 / 20.0		END OF BORING Hole grouted 5/20/82.							

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG G16-4 SHEET 1 OF 2

SURFACE ELEV. Approx. 180.2 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/20/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC./ATT.	REMARKS
180.2 / 0.0		Gray SILTY CLAY, some coarse to fine gravel (rock frag.), little coarse to fine sand	CL						
178.2 / 2.0		Orange brown SILTY CLAY	CL						
143.2 / 37.0									Match Sheet 2

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG G16-4

SHEET 2 OF 2

SURFACE ELEV. Approx. 180.2 ft. PROJECT Chemical Waste/Livingston/Alabama

TUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/20/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT.	REMARKS
142.7 / 37.5		Bluish gray fossiliferous CHALK							
140.2 / 40.0		END OF BORING Hole grouted 5/20/82.							

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SWC

SHEET 1 OF 5

SURFACE ELEV. Approx. 205.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/21/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT.	REMARKS
205.0 / 0.0		Yellowish and orange brown mottled gray SILTY CLAY	CL						
200.0 / 5.0		Dark gray mottled light gray CHALK fossiliferous							
195.0 / 10.0		Light gray CHALK fossilferous							
167.5 / 37.5									Match Sheet 2

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SWC

SHEET 2 OF 5

SURFACE ELEV. Approx. 205.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/21/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
167.5 / 37.5									
40.0				156	1	DO	16-46-110	18/18	
50.0				>140	2	DO	50-50-90*	17/17	*Number of blows for 5 inches.
		Light gray CHALK fossiliferous							
60.0				130	3	DO	29-30-100	18/18	
70.0				>159	4	DO	28-59-100*	16/16	*Number of blows for 4 in. penetration.
130.0 / 75.0									Match Sheet 3

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SWC

SHEET 3 OF 5

SURFACE ELEV. Approx. 205.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/21/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
130.0 / 75.0									
80.0		Light gray CHALK fossiliferous		150	5	DO	16-50-100	18/18	
120.0 / 85.0		Light and medium gray CHALK, bioturbated, fossiliferous with pyrite nodules encountered			6	NQ RC	RQD-100%	3.3/3.3	
88.3					7	NQ RC	RQD-100%	5/5	
93.3					8	NQ RC	RQD-96%	4.8/5	
98.3					9	NQ RC	RQD-100%	10/10	
108.3					10	NQ RC			
92.5 / 112.5									Match Sheet 4

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SWC

SHEET 4 OF 5

SURFACE ELEV. Approx. 205.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/21/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
92.5 / 112.5					10	NQ RC	RQD-100%	10/10	
118.3					11	NQ RC	RQD-100%	10/10	Slickensided fault at 120 ft. Angle 60° from horizontal
128.3		Light and medium gray CHALK, bioturbated, fossiliferous with pyrite nodules encountered			12	NQ RC	RQD-100%	5/5	
133.3					13	NQ RC	RQD-100%	5/5	Slickensided fault at 133.4 ft. Angle 50° from horizontal
138.3					14	NQ RC	RQD-100%	10/10	
148.3					15	RC		2/2	Match Sheet 5

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SWC **SHEET** 5 **OF** 5

SURFACE ELEV. Approx. 205.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/20/82 DATE COMPLETED 5/21/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT.	REMARKS
151.0 / 54.0		Light and medium gray CHALK, biotrubated, fossiliferous with pyrite nodules encountered			15	RC		2/2	
		END OF BORING							
		Hole grouted upon completion with sand/cement/bentonite mix = 3 bags/2 bags/0.5 bags							

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SEC

SHEET 1 OF 4

SURFACE ELEV. Approx. 282.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/28/82 DATE COMPLETED 5/29/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT.	REMARKS
282.0 / 0.0		Orange brown SILTY CLAY, little fine sand	CL						
2.0				6	1	DO	2-2-4	9/18	
5.0				12	2	DO	4-4-8	16/18	
8.5				18	3	DO	6-8-10	18/18	
270.0 / 12.0		Blue gray to light gray CHALK fossiliferous, occasional pyrite nodules encountered							
13.5				44	4	DO	11-17-27	18/18	
244.5 / 37.5									Match Sheet 2

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN

BORING LOG SEC

SHEET 2 OF 4

SURFACE ELEV. Approx. 282.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/28/82 DATE COMPLETED 5/29/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC./ATT.	REMARKS
244.5 / 37.5									
		Blue gray to light gray CHALK fossiliferous, occasional pyrite nodules encountered							
207.0 / 75.0									Match Sheet 3

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SEC

SHEET 3 OF 4

SURFACE ELEV. Approx. 282.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 5/28/82 DATE COMPLETED 5/29/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
207.0 / 75.0									
90.8		Blue gray to light gray CHALK fossiliferous, occasional pyrite nodules encountered			5	NQ RC	RQD-100%	10/10	
98.8					6	NQ RC	RQD-100%	5/5	
103.8					7	NQ RC	RQD-100%	5/5	
108.8					8	NQ RC			
169.5 / 112.5									Match Sheet 4

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG SEC

SHEET 4 OF 4

JRFACE ELEV. Approx. 282.0 ft. PROJECT Chemical Waste/Livingston/Alabama

TUM MSL DATE STARTED 5/28/82 DATE COMPLETED 5/29/82

DRILL RIG CME 55 DRILLING METHOD Solid Stem Auger and Coring

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT.	REMARKS
169.5 / 112.5					8	NQ RC	RQD-100%	10/10	
118.8					9	NQ RC	RQD-100%	10/10	
		Blue gray to light gray CHALK fossiliferous, occasional pyrite nodules encountered							
128.8					10	NQ RC	RQD-100%	10/10	
138.8					11	NQ RC	RQD-100%	10/10	
					12	RC		1/1	
132.0 / 150.0		END OF BORING							

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN

BORING LOG DB1

SHEET 1 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
160.0									
159.0 / 0.0		Dark gray brown fine SANDY SILT	ML						Note: NQ Core is approximately 1 7/8 inches in diameter.
1.0		Orange SILTY CLAY, trace fine sand	CL						
151.0 / 9.0									
10.0		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			1	NQ RC	RQD-N/A	3.5'/4.5'	Rock core had to be broken to remove from core barrel.
14.5					2	NQ RC	RQD-N/A	9'/10'	Rock core had to be broken to remove from core barrel.
24.5					3	NQ RC	RQD-40%	7.3'/10'	
34.5					4	NQ RC			
122.5 / 37.5									Match Sheet 2

Job No. 824-1308 Scale 1"=5'

Golder Associates

Drawn CAB Checked WJN

BORING LOG DB1

SHEET 2 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH 122.5	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
37.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			4	NQ RC	RQD-63%	8'/8'	
42.5					5	NQ RC	RQD-100%	2'/2'	
44.5					6	NQ RC	RQD-52%	5.2'/10'	Hit pyrite zone at 49.5 ft. lost core below
54.5					7	NQ RC	RQD-N/A	2'/2'	Lost core and core catcher in hole
56.5					8	NQ RC	RQD-100%	8'/8'	
74.5					9	NQ RC	RQD-80%	9'/10'	
74.5 / 75.0									Match Sheet 3

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN

BORING LOG DB1

SHEET 3 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
85.0 / 75.0					10	NQ RC	RQD-90%	9'/10'	
84.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			11	NQ RC	RQD-100%	10'/10'	
94.5					12	NQ RC	RQD-100%	10'/10'	
55.5 / 104.5		Mottled light gray and greenish gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			13	NQ RC	RQD-100%	10'/10'	
47.5 / 112.5									Match Sheet 4

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 4 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
47.5 / 112.5					13				
114.5					14	NQ RC	RQD-100%	10'/10'	
124.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			15	NQ RC	RQD-100%	10'/10'	
134.5					16	NQ RC	RQD- 80%	8'/10'	
144.5					17	NQ RC	RQD-N/A	10'/10'	Core damaged while removing it from core barrel
10.0 / 150.0									Match Sheet 5

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 5 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH (10.0)	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
150.0					17	NQ RC			
154.5					18	NQ RC	RQD- 55%	5.5' / 10'	Lost bottom portion of core while removing core barrel from hole
164.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			19	NQ RC	RQD- 20%	1' / 5'	
169.5					20	NQ RC	RQD- 50%	5' / 5'	
179.5					21	NQ RC	RQD- 55%	7.5' / 10'	Core from 178.5 ft. to 184.5 dropped back in hole. Attempted to recover core, much of sample broken.
184.5					22	NQ RC	RQD- 80%	4' / 5'	
-27.5 / 187.5									Match Sheet 6

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 6 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH (-27.5)	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
187.5					22				Pulled drill stem. Ports on Carbide bit clogged. Replaced bit.
189.5					23	NQ RC	RQD -50%	6' / 10'	Core fell past core catcher into hole upon extraction. Recovered some of core
199.5					24	NQ RC	RQD- 90%	4.5' / 5'	
204.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			25	NQ RC	RQD-N/A	8' / 10'	Some core fell out of barrel. Recovered 2 ft. with some falling out again. Core is soft on outside because it is being worked by drill bit.
214.5					26	NQ RC	RQD-80%	5' / 5'	Water holes in bit clogged at 216 ft.
219.5					27	NQ RC	RQD-100%	5' / 5'	
224.5									Match Sheet 7
225.0									

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 7 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
-65.0 / 225.0					28	NQ RC	RQD- 40%	6' / 10'	Dropped core on retrieval. Recovered 6 ft. on first attempt.
234.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			29	NQ RC	RQD-60%	10' / 10'	
244.5					30	NQ RC	RQD- 65%	6.5' / 10'	
254.5					31	NQ RC	RQD-100%	10' / 10'	Modified core extraction procedure from core barrel. Used water pressure to help ease core from barrel.
-102.5 / 262.5									Match Sheet 8

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 8 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT.	REMARKS
-102.5 / 262.5					31				
264.5					32	NQ RC	RQD-100%	10'/10'	
274.5		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			33	NQ RC	RQD-85%	8.5'/10'	
284.5					34	NQ RC	RQD-80%	10'/10'	Bit on core barrel clogging again.
294.5					35	NQ RC	RQD-90%	9.5'/10'	
-140.0 / 300.0									Match Sheet 9

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 9 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
-140.0 / 300.0		Medium to light gray CHALK, heavily bioturbated, fossiliferous, with occasional pyrite nodules			35				
304.5					36	NQ RC	RQD-95%	9.5'/10'	
314.5		0.5 in. thick glauconitic sandy CHALK layer encountered at 315.0 ft.			37	NQ RC	RQD-100%	10'/10'	Changed to a coarse diamond drill bit.
324.5		Two fractures at angles of 30° from horizontal noted after sample dried at depth of 324 ft. Pyrite disseminated in healed fault			38	NQ RC	RQD-100%	10'/10'	
-170.0 / 330.0		Greenish gray CHALK bioturbated, fossiliferous, glauconitic with occasional pyrite nodules							
334.5					39				
-177.5 / 337.5									Match Sheet 10

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 10 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
-177.5 / 337.5					39	NQ RC	RQD-75%	9.5'/10'	
344.5		Greenish gray CHALK bioturbated, fossiliferous, glauconitic with occasional pyrite nodules			40	NQ RC	RQD-100%	10'/10'	
354.5					41	NQ RC	RQD-100%	10'/10'	
364.5					42	NQ RC	RQD-90%	4.5'/5'	
369.5					43	NQ RC	RQD-100%	5'/5'	
-215.0 / 375.0		See description on next page							Match Sheet 11

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 11 OF 14

SURFACE ELEV. Approx. 160.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 6/23/82 DATE COMPLETED 7/1/82
DRILL RIG CME 55
DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
-215.0 / 375.0					44	NQ RC	RQD-100%	10'/10'	
384.5					45	NQ RC	RQD-60%	3'/5'	
389.5		Greenish gray CHALK bioturbated, fossiliferous, with occasional pyrite nodules			46	NQ RC	RQD-100%	5'/5'	
394.5					47	NQ RC	RQD-95%	9.5'/10'	
404.5		– 0.5 in. thick pyritic clay lense encountered at depth of 404.0 ft.			48	NQ RC	RQD-95%	9.5'/10'	
-252.5 / 412.5									Match Sheet 12

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 12 OF 14

SURFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT.	REMARKS
-252.5 / 412.5					48				
414.5					49	NQ RC	RQD-95%	9.5'/10'	
424.5		Greenish gray CHALK bioturbated, fossiliferous, with occasional pyrite nodules			50	NQ RC	RQD-95%	9.5'/10'	
434.5					51	NQ RC	RQD-99%	9.9'/10'	
444.5					52	NQ RC	RQD-100%	10'/10'	
-290.0 / 450.0									Match Sheet 13

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 13 OF 14

SURFACE ELEV. Approx. 160.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 6/23/82
DATE COMPLETED 7/1/82
DRILL RIG CME 55
DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC./ATT.	REMARKS
-290.0 / 450.0		Greenish gray CHALK bioturbated fossiliferous, with occasional pyrite nodules			52	NQ RC			
454.5					53	NQ RC	RQD-100%	10'/10'	
464.5					54	NQ RC	RQD-100%	10'/10'	
474.5					55	NQ RC	RQD-100%	10'/10'	
484.5					56	RC			Match Sheet 14
-327.5 / 487.5									

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB1

SHEET 14 OF 14

URFACE ELEV. Approx. 160.0 ft. PROJECT Chemical Waste/Livingston/Alabama

TUM MSL DATE STARTED 6/23/82 DATE COMPLETED 7/1/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT.	REMARKS
-327.5 / 487.5		Greenish gray CHALK bioturbated, fossiliferous, with occasional pyrite nodules			56	NQ RC	RQD-N/A	10'/10'	Core sample crushed in core barrel by overdrilling.
494.5		– 3.0 in. thick sandy clay zone in CHALK encountered at a depth of 497.0 ft.			57	NQ RC	RQD-100%	5.5'/5.5'	
-340.0 / 500.0		END OF BORING Hole left open. A 4 inch diameter PVC casing inserted to depth of 11.0 ft. sealed with cuttings. Hole to be used for water level monitoring.							

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 1 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
213.0 / 0.0 – 201.0 / 12.0		Gray brown SILTY CLAY, trace fine sand	CL						Note: NQ core is approximately 1 7/8 inches in diameter.
201.0 / 12.0 – 195.0 / 18.0		Light gray SILTY CLAY, trace fine sand	CL						
195.0 / 18.0 – 193.5 / 19.5		Light greenish gray SILTY CLAY trace fine sand	CL						
193.5 / 19.5 – 175.5 / 37.5		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			1	NQ RC	RQD-100%	5'/5'	
25.0					2	NQ RC	RQD-100%	10'/10'	
35.0					3	RC			

Match Sheet 2

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 2 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
175.5 / 37.5					3	NQ RC	RQD-70%	7' / 10'	Core fractured by dry drilling.
45.0		— Slickensided fractures at 48.0 ft. angle 60° from hor. at 48.2 ft. angle 30° from hor. at 48.7 ft. angle 30° from hor. at 48.9 ft. angle 45° from hor. at 49.2 ft. angle 50° from hor.			4	NQ RC	RQD-85%	10' / 10'	
55.0		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			5	NQ RC	RQD-100%	10' / 10'	New coarse diamond drill bit installed.
65.0					6	NQ RC	RQD-100%	10' / 10'	
138.0 / 75.0									Match Sheet 3

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 3 OF 14

SURFACE ELEV. Approx. 213.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/1/82
DATE COMPLETED 7/13/82
DRILL RIG CME 55
DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
138.0 / 75.0					7	NQ RC	RQD-100%	10' / 10'	
85.0		Light to medium gray CHALK, bioturbated fossiliferous with occasional pyrite nodules			8	NQ RC	RQD-100%	10' / 10'	
95.0					9	NQ RC	RQD-100%	10' / 10'	
105.0					10	NQ RC	RQD-100%	10' / 10'	
100.5 / 112.5									Match Sheet 4

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 4 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
100.5 / 112.5					10	NQ RC			
115.0					11	NQ RC	RQD-100%	10'/10'	
125.0		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			12	NQ RC	RQD-100%	10'/10'	
135.0					13	NQ RC	RQD-100%	10'/10'	
145.0					14	NQ RC	RQD-97%	9.7'/10'	Core fractured by dry drilling last few inches.
63.0 / 150.0									Match Sheet 5

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 5 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH (63.0)	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
150.0					14	NQ RC			
155.0					15	NQ RC	RQD-100%	10'/10'	
165.0		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			16	NQ RC	RQD-100%	10'/10'	
175.0					17	NQ RC	RQD-98%	10'/10'	Mechanical crushing of core caused by slight overdrilling.
185.0					18	RC			
25.0 / 187.5									Match Sheet 6

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 6 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES HAMMER BLOWS PER 6 IN.	SAMPLES REC/ATT.	REMARKS
25.5 / 187.5		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			18	NQ RC	RQD-100%	10'/10'	
195.0					19	NQ RC	RQD-100%	10'/10'	
205.0					20	NQ RC	RQD-100%	10'/10'	
215.0									
-7.0 / 220.0		Greenish gray to light gray mottled CHALK, bioturbated, glauconitic, fossiliferous, with occasional pyrite nodules			21	NQ RC	RQD-100%	10'/10'	
-12.0 / 225.0									Match Sheet 7

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 7 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
-12.0 / 225.0					22	NQ RC	RQD-98%	10'/10'	
235.0		Greenish gray to light gray mottled CHALK, bioturbated, glauconitic, fossiliferous with occasional pyrite nodules			23	NQ RC	RQD-70%	10'/10'	Core mechanically crushed by drill rig overcoring. No faults or joints noted.
245.0					24	NQ RC	RQD-80%	10'/10'	
255.0					25	NQ RC	RQD-90%	5'/5'	
260.0					26	NQ RC	RQD-98%	5'/5'	Match Sheet 8
-49.5 / 262.5									

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 8 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
-49.5 / 262.5					26	NQ RC			
265.0					27	NQ RC	RQD-100%	10'/10'	
275.0		Greenish gray to light gray mottled CHALK, bioturbated, glauconitic, fossiliferous, with occasional pyrite nodules			28	NQ RC	RQD-100%	10'/10'	
285.0					29	NQ RC	RQD-100%	10'/10'	
295.0					30	NQ RC	RQD-100%	10'/10'	
-87.0 / 300.0									Match Sheet 9

Job No. 824-1308 Golder Associates Drawn CAB

Scale 1"=5' Checked WJN

BORING LOG DB2

SHEET 9 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
-87.0 / 300.0					30	NQ RC			
305.0					31	NQ RC	RQD-100%	10'/10'	
315.0		Greenish gray to light gray mottled CHALK, bioturbated, glauconitic, fossiliferous, with occasional pyrite nodules			32	NQ RC	RQD-100%	10'/10'	
325.0					33	NQ RC	RQD-100%	10'/10'	
335.0					34	NQ RC			
-124.5 / 337.5									Match Sheet 10

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 10 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
-124.5 / 337.5					34	NQ RC	RQD-100%	10'/10'	
345.0					35	NQ RC	RQD-100%	10'/10'	
		Greenish gray to light gray mottled CHALK, bioturbated, glauconitic, fossiliferous, with occasional pyrite nodules							
355.0					36	NQ RC	RQD-100%	5'/5'	
360.0					37	NQ RC	RQD-100%	5'/5'	
365.0									Mechanically crushed core because of over-drilling.
370.0		Shaley zone in CHALK encountered between depth of 370.0 and 374.0			38	NQ RC	RQD-75%	10'/10'	
-162.0 / 375.0									Match Sheet 11

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 11 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
-162.0 / 375.0					39	NQ RC	RQD-100%	5'/5'	
380.0					40	NQ RC	RQD-100%	5'/5'	
		Greenish gray to light gray mottled CHALK, bioturbated, glauconitic, fossiliferous, with occasional pyrite nodules			41	NQ RC	RQD-100%	10'/10'	
395.0					42	NQ RC	RQD-96%	9.6'/10'	
-190.0 / 403.0		Greenish gray CHALK, bioturbated, glauconitic, fossiliferous, with occasional pyrite nodules							
405.0									
-194.5 / 407.5		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			43	NQ RC	RQD-90%	10'/10'	Mechanically crushed core because of overdrilling.
-199.5 / 412.5									Match Sheet 12

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 12 OF 14

SURFACE ELEV. Approx. 213.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/1/82
DATE COMPLETED 7/13/82
DRILL RIG CME 55
DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
-199.5 / 412.5					43	NQ RC			
415.0					44	NQ RC	RQD-93%	7.8'/10'	Core left out overnight. Rain storm occurred. Moisture content of core may be in error.
425.0					45	NQ RC	RQD-100%	6.5'/5'	Recovered some core previously lost. Adjusted previous RQD.
430.0		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			46	NQ RC	RQD-100%	5'/5'	
435.0					47	NQ RC	RQD-100%	10'/10'	
445.0					48	NQ RC	RQD-100%	10'/10'	
-237.0 / 450.0									Match Sheet 13

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2 SHEET 13 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
-237.0 / 450.0					48	NQ RC			
455.0					49	NQ RC	RQD-100%	10'/10'	
465.0		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			50	NQ RC	RQD-100%	10'/10'	
475.0					51	NQ RC	RQD-95%	9.5'/10'	
485.0		— Fracture noted at depth of 484.5 ft. Angle from horizontal 40°. Infilled with calcite.			52	NQ RC			
-274.5 / 487.5									Match Sheet 14

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB2

SHEET 14 OF 14

SURFACE ELEV. Approx. 213.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/1/82 DATE COMPLETED 7/13/82

DRILL RIG CME 55 DRILLING METHOD Hollow Stem Auger and Triple Tube Core

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT.	REMARKS
-274.5 / 487.5		Light to medium gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			52	NQ RC	RQD-100%	10' / 10'	
495.0					53	NQ RC	RQD-100%	5' / 5'	
-287.0 / 500.0		END OF BORING Set 4 inch diameter PVC casing 21.0 ft. into ground. Sealed with cuttings. Hole left open to serve as water level monitoring hole.							

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN

BORING LOG DB3

SHEET 1 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
267.0									
266.5 / 0.5		Brown SILTY CLAY, trace fine sand	CL						Note: NQ Core is approximately 1 7/8 inches in diameter.
266.0 / 1.0		Tan SILTY CLAY, micaceous	CL						
8.0					1	NQ RC	RQD-90%	6' / 6.5'	Washed down to 8.0 ft., set casing and started coring.
14.5		Dark gray shaly CHALK, fossiliferous			2	NQ RC	RQD-100%	10' / 10'	
24.5					3	NQ RC	RQD-100%	10' / 10'	Switched to double tube core barrel.
34.5					4	NQ RC			
229.5 / 37.5									Match Sheet 2

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 2 OF 14

SURFACE ELEV. Approx. 267.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/13/82
DATE COMPLETED 7/23/82
DRILL RIG CME 55
DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
229.5 / 37.5		— Fracture at 40 ft. Angle from horizontal equals 51°, slickensided, some pyrite evident			4	NQ RC	RQD-100%	10'/10'	
44.5		Dark gray shaly CHALK, fossiliferous			5	NQ RC	RQD-100%	10'/10'	
54.5					6	NQ RC	RQD-100%	10'/10'	
64.5					7	NQ RC	RQD-95%	9.5'/10'	
197.0 / 70.0		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules							
74.5									
75.0									Match Sheet 3

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked MTF

BORING LOG DB3

SHEET 3 OF 14

SURFACE ELEV. Approx. 276.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH (192.0)	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
75.0					8	NQ RC	RQD- 90%	4.5'/5'	
79.5					9	NQ RC	RQD- 70%	3.5'/5'	
84.5		—Fracture at depth 86.5 ft. Angle from hor. is 49°			10	NQ RC	RQD-95%	9.5'/10'	
		Medium to light gray CHALK, bioturbated fossiliferous with occasional pyrite nodules							
94.5					11	NQ RC	RQD-100%	10'/10'	
104.5					12	NQ RC	RQD- 98%	9.8'/10'	
154.5 / 112.5									Match Sheet 4

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN

BORING LOG DB3

SHEET 4 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH 154.5	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
112.5					12	RC			
114.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			13	NQ RC	RQD-98%	9.8'/10'	
124.5		— Fractures noted at a depth of 130.0 ft. at angle of 40° from hor. and at 137.0 ft. at angle of 45° from hor. Joints well healed with calcite cement; cannot be broken by hand.			14	NQ RC	RQD-100%	10'/10'	
134.5					15	NQ RC	RQD-100%	10'/10'	
144.5					16	NQ RC	RQD-100%	10'/10'	
117.0 / 150.0									Match Sheet 5

Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN

BORING LOG DB3

SHEET 5 OF 14

SURFACE ELEV. Approx. 267.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/13/82
DATE COMPLETED 7/23/82
DRILL RIG CME 55
DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT	REMARKS
117.0 / 150.0					16	NQ RC			
154.5					16	NQ RC	RQD-100%	10'/10'	
164.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			17	NQ RC	RQD-100%	10'/10'	
174.5					18	NQ RC	RQD- 95%	9.5'/10'	
184.5					19	NQ RC			
79.5 / 187.5									Match Sheet 6

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 6 OF 14

SURFACE ELEV. Approx. 267.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/13/82
DATE COMPLETED 7/23/82
DRILL RIG CME 55
DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
79.5 / 187.5					19	NQ RC	RQD-100%	6' / 10'	Core mechanically crushed by over-drilling.
194.5					20	NQ RC	RQD-100%	9' / 5'	Recovered some core previously lost. Adjusted previous RQD.
199.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			21	NQ RC	RQD-100%	5' / 5'	
204.5					22	NQ RC	RQD-95%	9.5' / 10'	
214.5					23	NQ RC	RQD- N/A	10' / 10'	Mechanically crushed core. Interlock problems encountered with equipment.
224.5 / 225.0									Match Sheet 7

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 7 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
42.0 / 225.0					24	NQ RC	RQD-90%	8'/8'	Mechanically crushed end of core.
232.5					25	NQ RC	RQD-100%	2'/2'	
234.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			26	NQ RC	RQD-100%	9'/10'	
244.5					27	NQ RC	RQD-100%	6'/5'	Recovered some core previously lost. Adjusted previous RQD.
249.5					28	NQ RC	RQD-65%	4.5'/5'	
234.5					28	NQ RC	RQD-100%	9.5'/10'	
4.5 / 262.5									Match Sheet 8

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 8 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH 4.5	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
262.5					28	NQ RC			
264.5					29	RC	RQD- N/A	10.5' / 10'	Portion of core mechanically crushed by drill rig. Recovered some core previously lost. Adjusted previous RQD.
274.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			30	NQ RC	RQD-100%	9' / 10'	
284.5					31	NQ RC	RQD-100%	6' / 5'	Recovered some core previously lost. Adjusted previous RQD.
289.5					32	NQ RC	RQD-100%	5' / 5'	
294.5					33	NQ RC	RQD-100%	5' / 5'	
299.5									
300.0									Match Sheet 9

Job No. 824-1308 Scale 1"=5'

Golder Associates

Drawn CAB Checked WJN

BORING LOG DB3

SHEET 9 OF 14

SURFACE ELEV. Approx. 267.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/13/82
DATE COMPLETED 7/23/82
DRILL RIG CME 55
DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
-33.0 / 300.0					34	NQ RC	RQD-100%	5'/5'	
304.5					35	NQ RC	RQD-90%	10'/10'	
314.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			36	NQ RC	RQD-100%	6'/10'	Lost core on retrieval.
324.5					37	NQ RC	RQD-100%	9'/5'	Recovered some core previously dropped. Adjusted previous RQD.
329.5					38	NQ RC	RQD-100%	5'/5'	
334.5					39	NQ RC			
-70.5 / 337.5									Match Sheet 10

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 10 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT	REMARKS
-70.5 / 337.5					39	NQ RC	RQD- N/A	6'/10'	Dropped core and crushed it on second attempt to recover sample.
344.5					40	NQ RC	RQD-100%	9'/5'	Recovered some core previously dropped. Adjusted RQD.
349.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			41	NQ RC	RQD-90%	3'/5'	Mechanically broke core. Core fell from core barrel during retrieval.
354.5					42	NQ RC	RQD-100%	4.5'/5'	
359.5					43	NQ RC	RQD-100%	7.5'/5'	Recovered some core previously dropped. Adjusted previous RQD.
364.5					44	NQ RC	RQD-100%	10'/10'	
374.5									
375.0									Match Sheet 11

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 11 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
-108.0 / 375.0		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			45	NQ RC	RQD-100%	10'/10'	
384.5					46	NQ RC	RQD-50%	5'/10'	Lost retaining clips and core in hole.
394.5					47	NQ RC	RQD- 90%	5'/5'	Mechanically crushed core. Changed core catcher spring.
399.5					48	NQ RC	RQD-100%	9'/4'	Recovered some core previously lost. Adjusted RQD.
403.5					49	RC	RQD-100%	0'/1'	
404.5					50	NQ RC	RQD-100%	6'/5'	Recovered some core previously lost. Adjusted previous RQD.
409.5					51	NQ RC	RQD-100%	4.5'/5'	
-145.5 / 412.5									

Match Sheet 12

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3

SHEET 12 OF 14

SURFACE ELEV. Approx. 267.0 ft. PROJECT Chemical Waste/Livingston/Alabama

DATUM MSL DATE STARTED 7/13/82 DATE COMPLETED 7/23/82

DRILL RIG CME 55 DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: HAMMER BLOWS PER 6 IN.	SAMPLES: REC/ATT	REMARKS
-145.5 / 412.5					51	NQ RC			
414.5					52	NQ RC	RQD-100%	10.5'/10'	Recovered some core previously lost. Adjusted previous RQD.
424.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			53	NQ RC	RQD-100%	7'/10'	
434.5					54	NQ RC	RQD-100%	8'/5'	Recovered some core previously lost. Adjusted previous RQD.
439.5					55	NQ RC	RQD-100%	5'/5'	
444.5					56	NQ RC	RQD-100%	10'/10'	
-183.0 / 450.0									Match Sheet 13

Job No. 824-1308 Golder Associates Drawn CAB

Scale 1"=5' Checked WJN

BORING LOG DB3

SHEET 13 OF 14

SURFACE ELEV. Approx. 267.0 ft.
PROJECT Chemical Waste/Livingston/Alabama
DATUM MSL
DATE STARTED 7/13/82
DATE COMPLETED 7/23/82
DRILL RIG CME 55
DRILLING METHOD Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC/ATT.	REMARKS
-183.0 / 450.0		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			56	NQ RC			
454.5					57	NQ RC	RQD-100%	10'/10'	
464.5					58	NQ RC	RQD-100%	7.5'/10'	
474.5					59	NQ RC	RQD-100%	7.5'/5'	Recovered some core previously lost. Adjusted previous RQD.
479.5					60	NQ RC	RQD-100%	3.25'/5'	
484.5					61	NQ RC	RQD-100%	6.75'/5'	Recovered some core previously lost. Adjusted previous RQD.
-220.5 / 487.5									Match Sheet 14

Job No. 824-1308
Scale 1"=5'

Golder Associates

Drawn CAB
Checked WJN

BORING LOG DB3 **SHEET** 14 **OF** 14

SURFACE ELEV. Approx. 267.0 ft. **PROJECT** Chemical Waste/Livingston/Alabama

DATUM MSL **DATE STARTED** 7/13/82 **DATE COMPLETED** 7/23/82

DRILL RIG CME 55 **DRILLING METHOD** Wash Boring/Triple Tube Core/Double Tube Core Barrel

ELEV. / DEPTH	STRAT. PLOT	DESCRIPTION	UNIFIED CLASS.	BLOWS / FOOT	SAMPLES NUMBER	TYPE	HAMMER BLOWS PER 6 IN.	REC./ATT.	REMARKS
-220.5 / 487.5		Medium to light gray CHALK, bioturbated, fossiliferous, with occasional pyrite nodules			61	NQ RC			
489.5					62	NQ RC	RQD-100%	5'/5'	
494.5					63	NQ RC	RQD-100%	5.5'/5.5'	
-233.0 / 500.0		END OF BORING Completed hole by setting 4 inch diameter PVC pipe 38.0 ft. in hole and sealing with cuttings. Hole left open to serve as water level monitoring hole.							

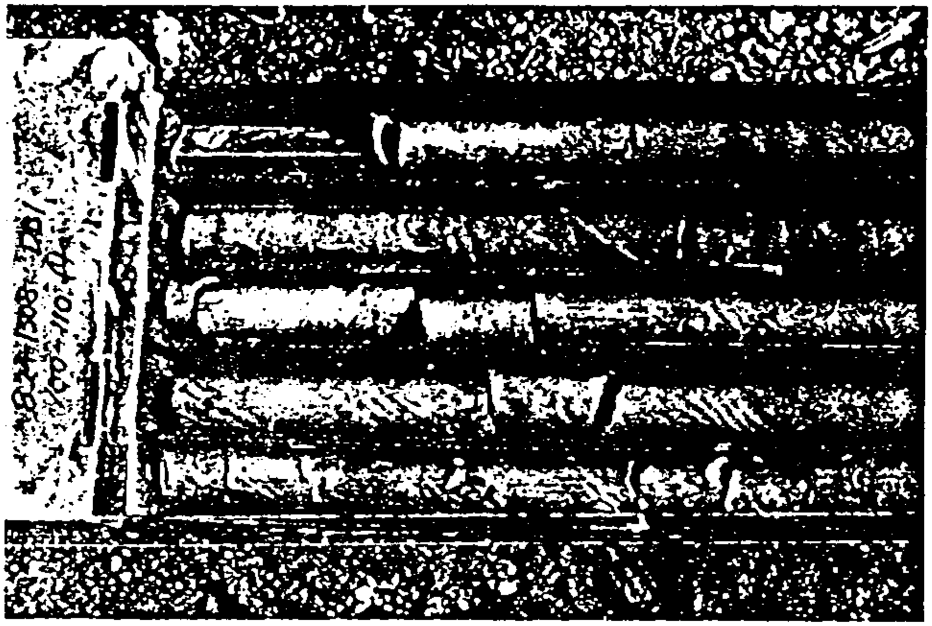
Job No. 824-1308

Scale 1"=5'

Golder Associates

Drawn CAB

Checked WJN



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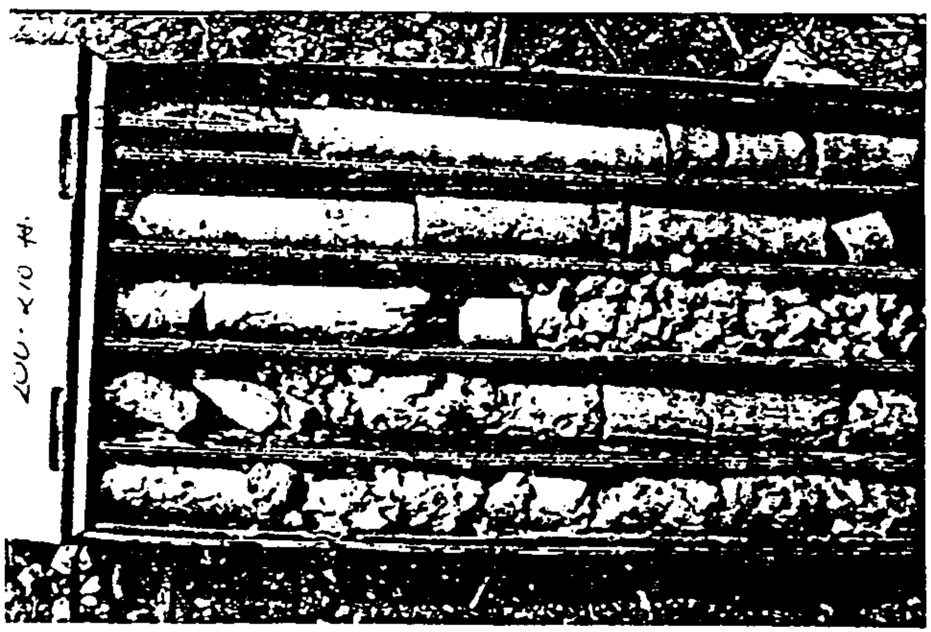

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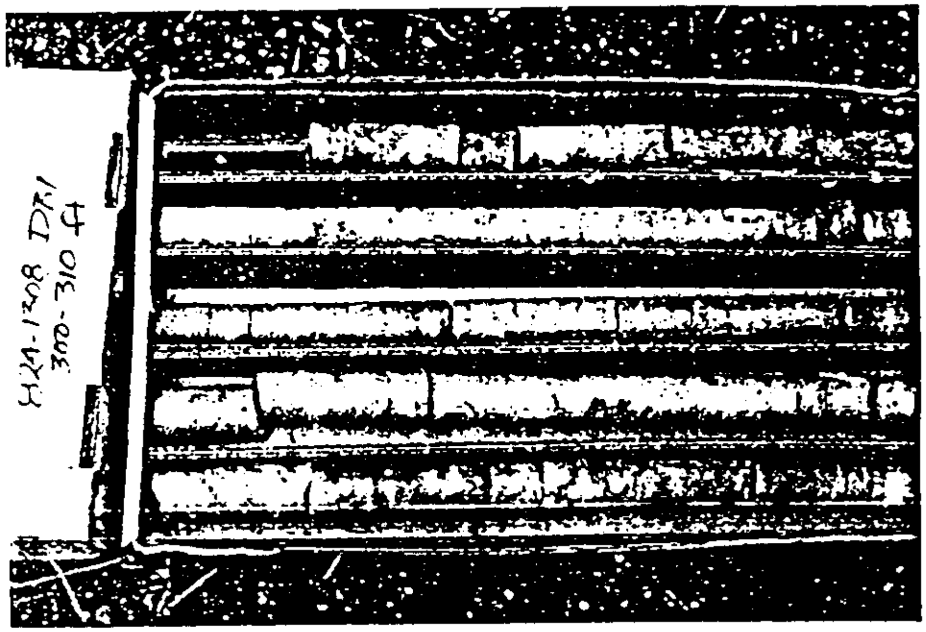

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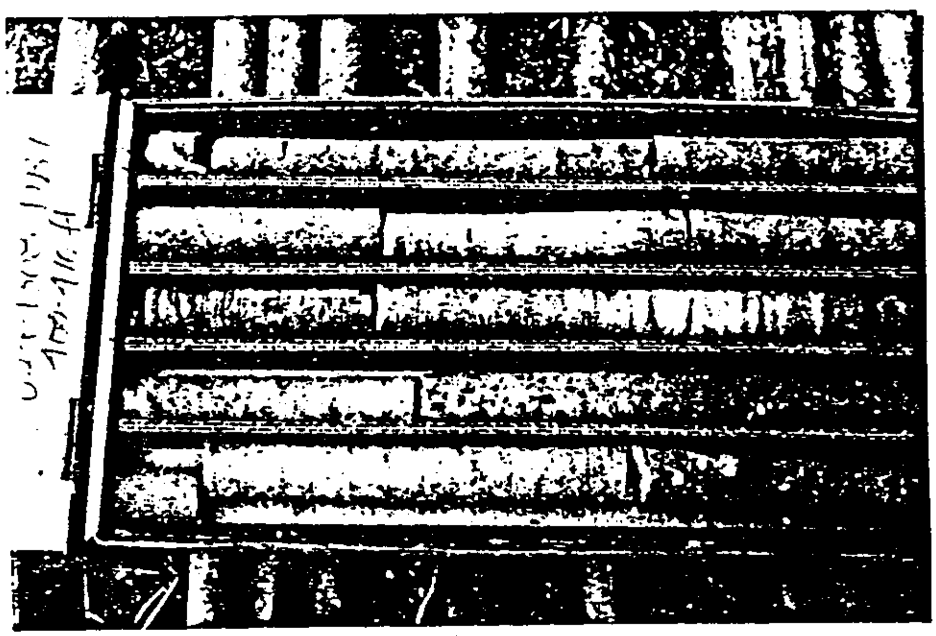

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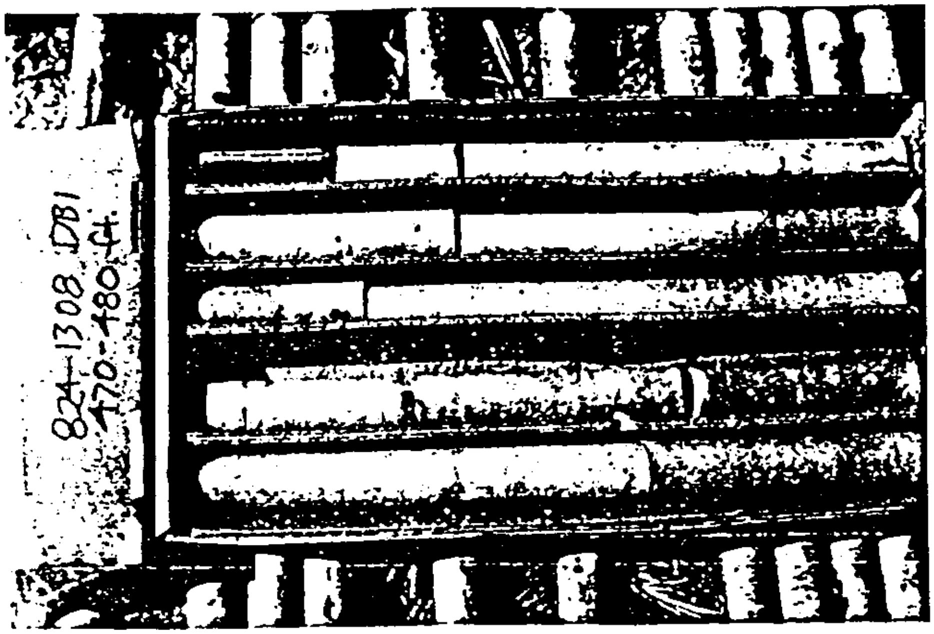

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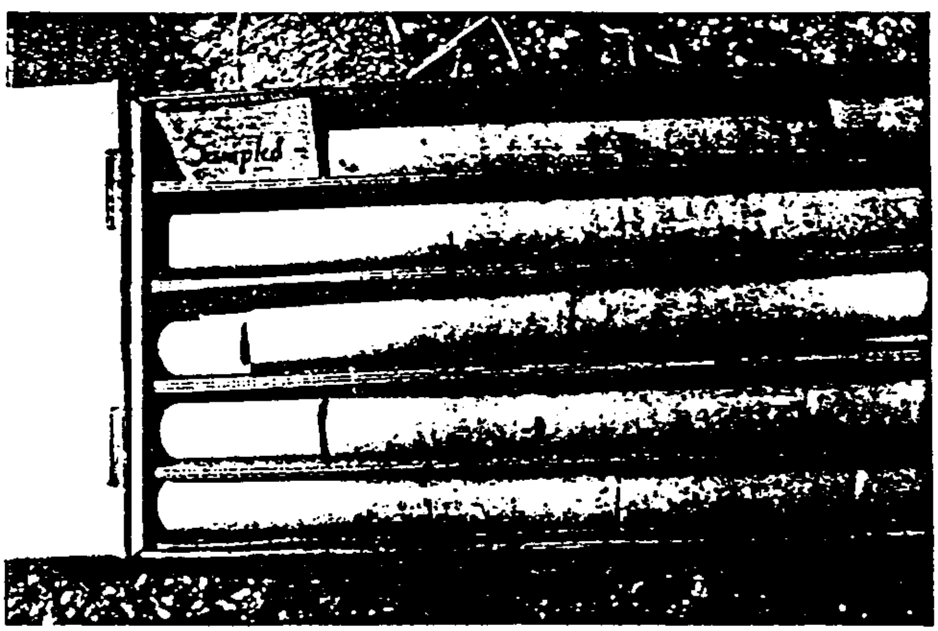

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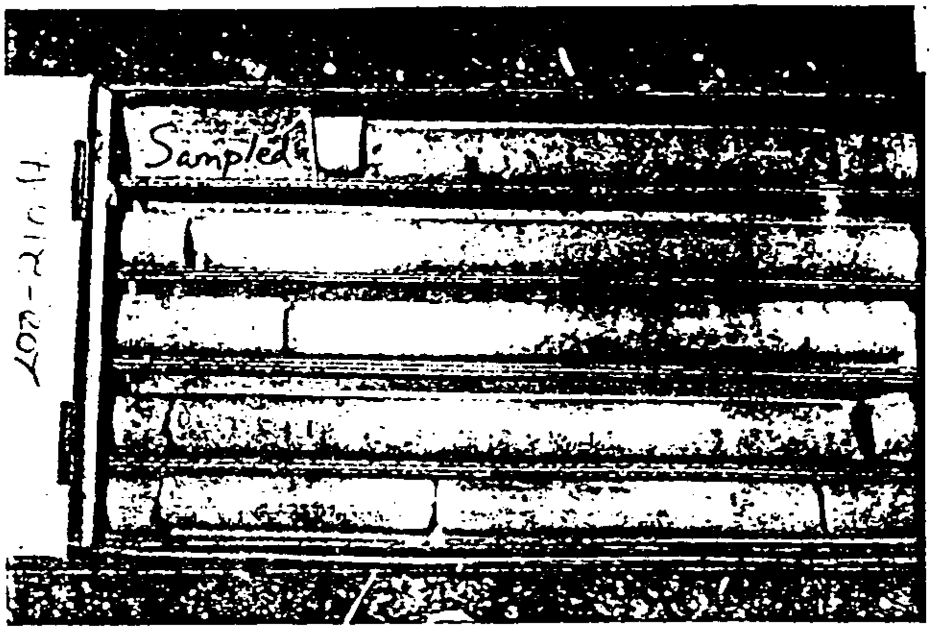
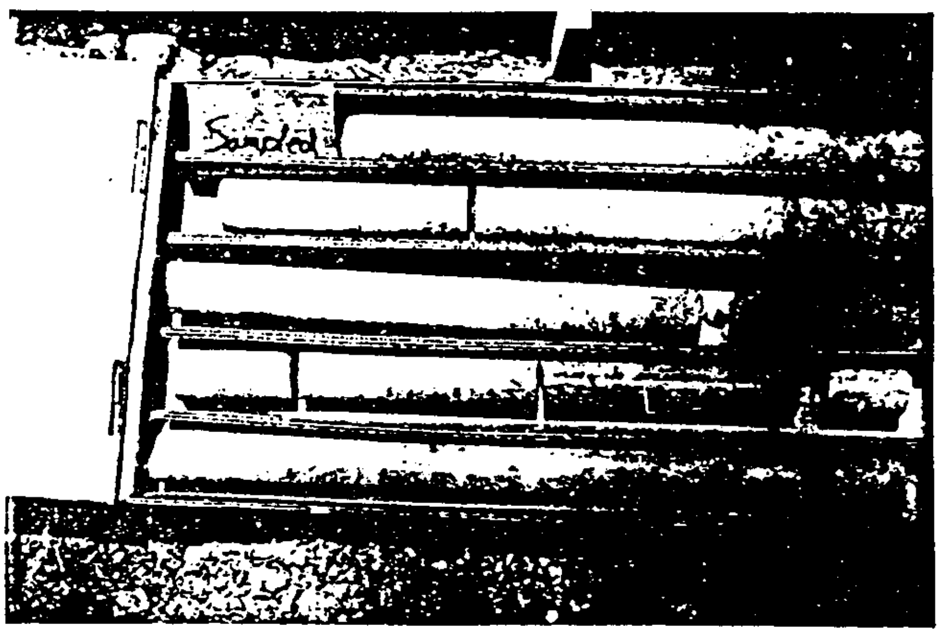
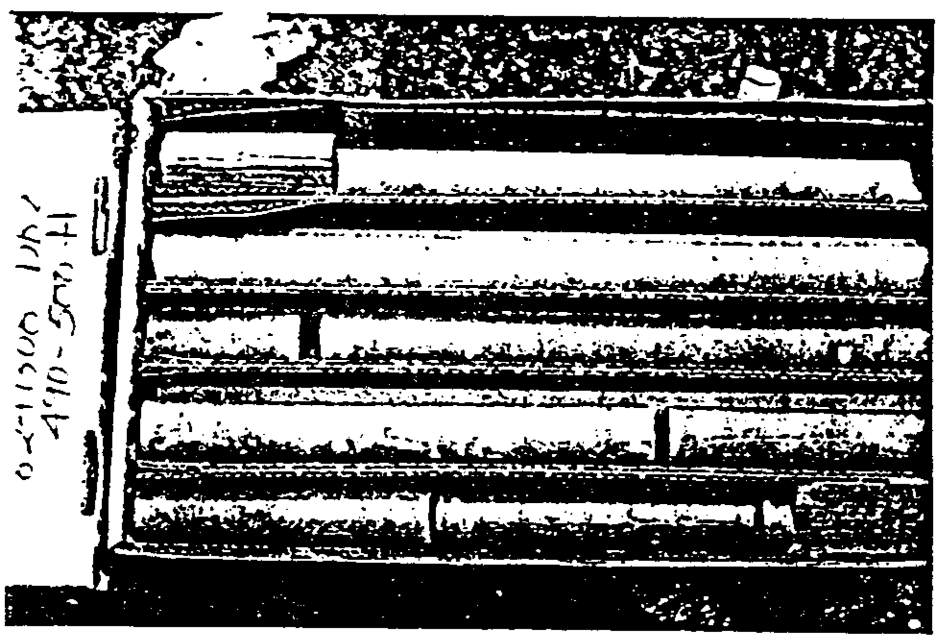


DB2 200-210 ft.



DB2 300-310 ft.

DB2 400-410 ft.



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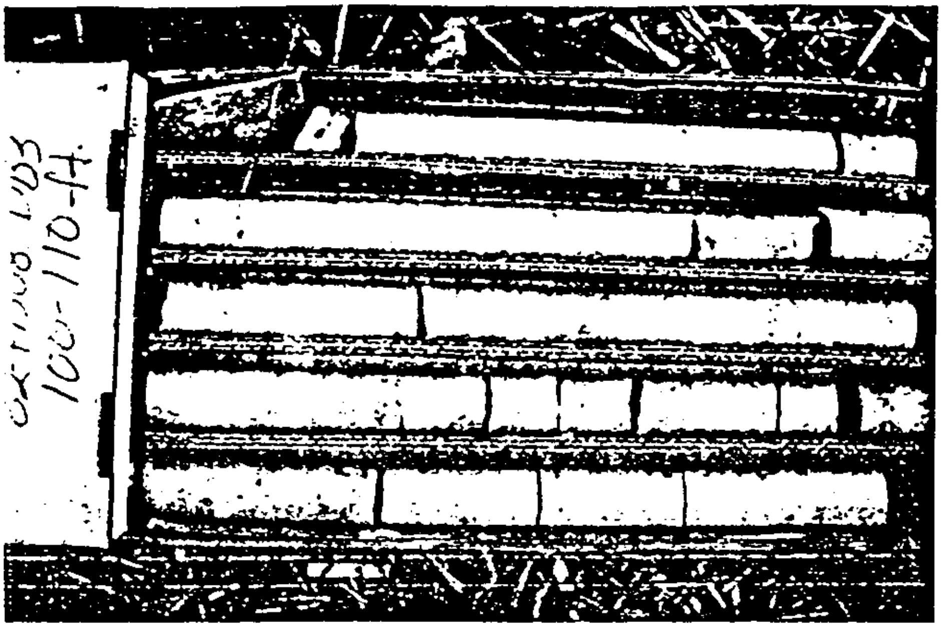
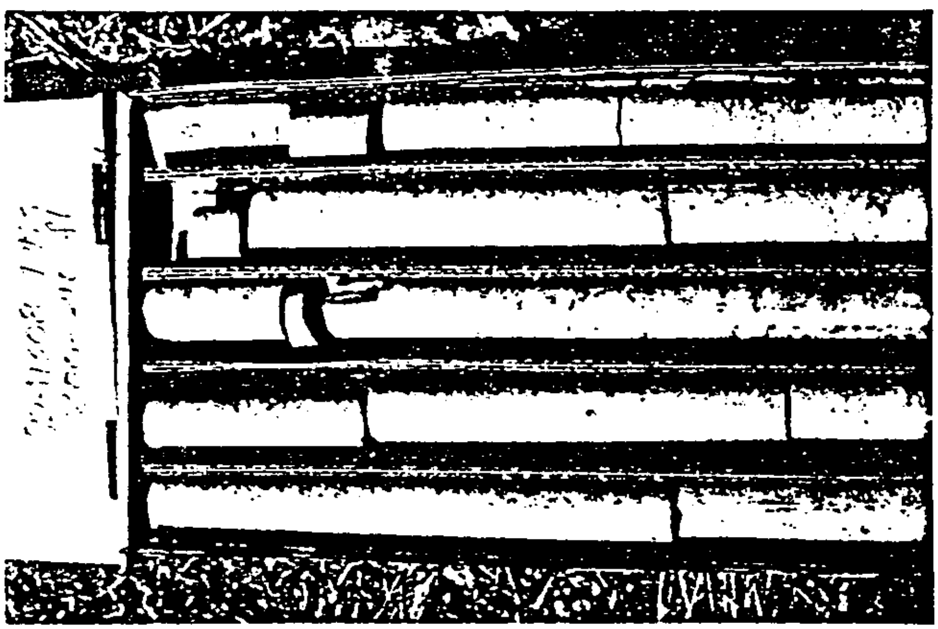


DB3 100-110 ft.



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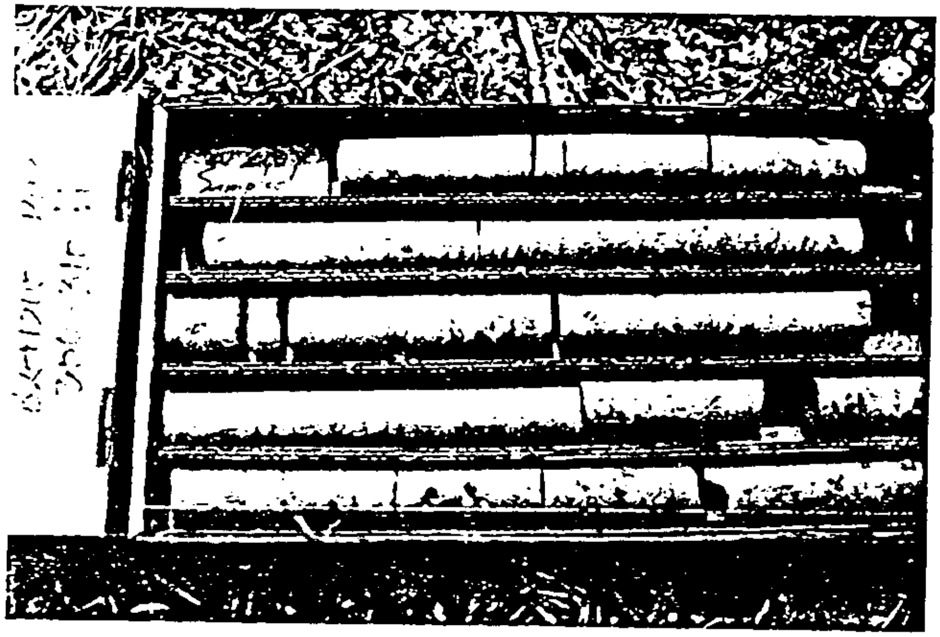

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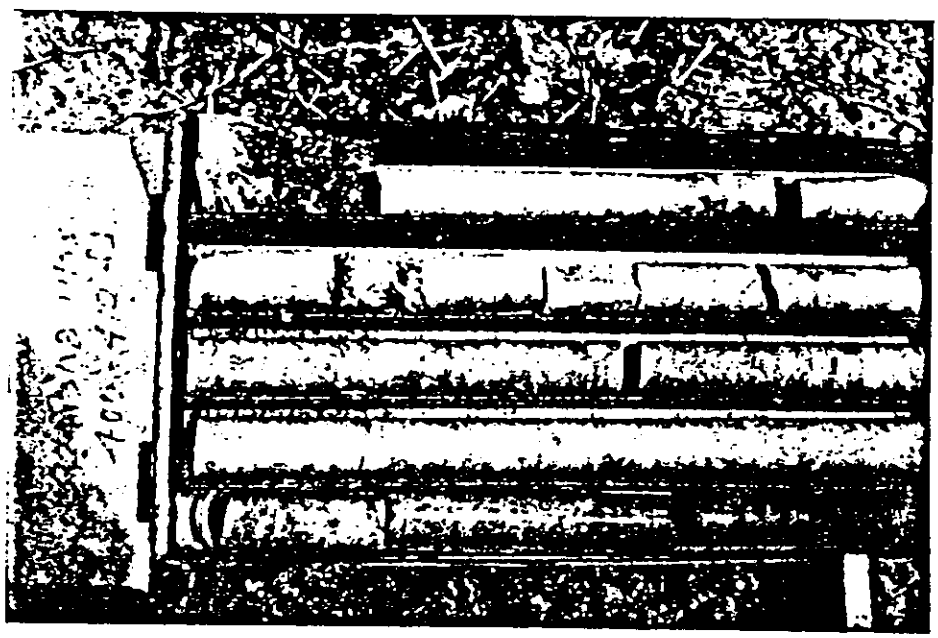

DB3 400-410 ft.

APPENDIX E-4

SECTION E

HYDROGEOLOGIC CHARACTERIZATION

EMELLE FACILITY

Revision No.
5.0

APPENDIX E-4

SECTION E

LIST OF DOCUMENTS

Document 1: Hydrogeologic Characterization, Emelle Facility, prepared by Golder Associates, revised June 1983.

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

Report on

HYDROGEOLOGIC CHARACTERIZATION
EMELLE FACILITY

Submitted to:

Chemical Waste Management, Inc.
2110 Newmarket Parkway, Suite 111
P. O. Box 3065
Marietta, Georgia 30061

DISTRIBUTION:

1 copy - Chemical Waste Management, Inc.
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December 1982
Revised June 1983

824-1308

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Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

December 24, 1982 824-1308

Chemical Waste Management
2110 Newmarket Parkway
Suite 111
P. O. Box 3065
Marietta, Georgia 30061

Attn: Mr. Don McCombs

RE: HYDROGEOLOGIC CHARACTERIZATION
EMELLE FACILITY

Gentlemen:

Attached is our report on the Hydrogeologic Characterization report for the Emelle, Alabama facility. This report represents our present understanding of the hydrogeology of the Emelle site based on the data presently available. However, additional data is being collected; therefore, the findings presented in this report may be modified as the additional data is analyzed.

We appreciate the opportunity to work with Chemical Waste Management on this effort.

Very truly yours,

GOLDER ASSOCIATES

J. Edmund Baker, P.E.
Associate

JEB:dap

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1.0 INTRODUCTION

Chemical Waste Management, Inc. (CWM) owns and operates a hazardous waste disposal site north of Emelle, Sumter County, Alabama as shown on Figure 1, Site Location Map. The Emelle site has been in use since 1977 and at present approximately 300 acres are in use for various aspects of waste disposal. The primary method of disposal is landfilling in trenches which initially ranged in depth from 30 to 50 ft. Current landfilling practice consists of burial of non-liquid containerized and non-containerized wastes in trenches up to 175 ft. deep with plan areas of up to 8 acres. Containers of chemically compatible wastes are placed in individual layers and separated by a 1.0 ft. to 1.5 ft. blanket of soil.

The Emelle, Alabama site is very attractive with respect to hazardous waste disposal because of the properties of the host chalk formation in which the waste is placed. In the vicinity of the Emelle site the chalk extends to a depth of about 600 ft. to 750 ft. below ground surface. Although the Selma chalk formation is known to have some joints and fractures, these discontinuities are infilled with calcite cement below a depth of about 100 ft. to 150 ft. and exhibit very low values of secondary permeability.

Golder Associates was retained in April 1982 to assist CWM as their overall geotechnical consultant. The first step of this effort was to review and integrate all previous studies and investigations followed by augmenting the existing data base where required. This effort resulted in 2 major data baseline reports; the Geological and Geotechnical Evaluation report and this Hydrogeological Characterization report. These documents present the general geologic and hydrogeologic conditions at the Emelle site and demonstrate its technical viability as a hazardous waste disposal area.

The primary purpose of this report is to present the available data on groundwater and surface water hydrology and to present an integrated picture of the hydrogeology of the site. This picture or characterization of the site hydrogeology includes the existence and movement of water in the chalk formation, the underlying Eutaw Formation and to lesser degrees, the deeper Gordo and Coker Formations. In addition, conclusions are presented regarding groundwater monitoring and future operation of the Emelle hazardous waste landfill.

As hydrogeologic data were collected from various sources it became evident that certain aspects of the data were not as conclusive as others. In particular, additional data are required concerning the existence and movement of water in the Selma chalk. Therefore this document should be be viewed as dynamic in nature and will probably be refined as additional data are collected. However, the basic hydrogeologic assessment presented in this report is not expected to undergo major modification. Additional data are expected to increase the confidence in our overall hydrogeologic characterization and improve the accuracy of various hydraulic and hydrogeologic parameters.

This document is divided into four primary sections. The first outlines the regional hydrogeology, the second discusses the various sources of data used in this report, the third presents the specific aspects of the hydrology of the Emelle site, and the last section presents conclusions and an overall summary of the site hydrogeology. As previously stated, the Emelle site appears to be very well suited for the disposal of hazardous waste.

2.0 HYDROGEOLOGIC DATA SOURCES

2.1 General

This hydrogeologic characterization is based on a thorough review of the existing information, previous studies and reports by others and field investigations and reports by Golder Associates. In the following sections, each source of data is presented and the conclusions pertinent to this effort discussed.

2.2 Published Hydrogeologic Literature

Two publications proved to be very useful in the characterization of the hydrogeolgy of the Emelle site. The first of these was published in 1980 and is entitled "Water Availability and Geology of Sumter County, Alabama" by M. E. Davis, et al (Reference 1). This study was undertaken as a part of a statewide study of the geology and availability of water resources in Alabama, and was performed as a cooperative effort between the Geological Survey of Alabama and the U.S. Geological Survey. The stated purpose of the report was to present:

1. The basic information on the water resources of Sumter County in such a manner that a rapid appraisal and comparison with the water resources of other counties can be made.
2. A geological map at the scale 1 inch =1 mile.

The geologic portion of this report presents the most thorough and accurate assessment of the geology of Sumter County published to date.

The information presented in the report which was utilized in this hydrogeologic characterization is listed below.

1. The general characteristics, including stratigraphy and groundwater yield of the three primary aquifers underlying Sumter County.

2. The variation of groundwater quality across Sumter County for each of the three primary aquifers.

3. A generalized water budget, including both groundwater and surface water, for Sumter County.

The second hydrogeologic report used in this effort was published in 1981 and is entitled "Model of the Groundwater Flow System of the Gordo and Eutaw Aquifers in West-Central Alabama" by R. A. Gardner (Reference 2). The stated objective of this study was to:

> "...determine the cause of the observed depressions in the potentiometric surface, whether from natural discharge of the aquifers to the rivers, pumpage, discharge of uncontrolled flowing wells or a combination of these stresses and to assess the effect of changes in these stresses on the flow systems in the aquifers."

The report presented the calibration and application of a computerized finite-difference groundwater flow model which simulated the Eutaw and Gordo aquifers and their interaction with the Selma chalk and the major rivers in the area. The information and conclusions included in Reference 2 which were used in preparing this hydrogeologic assessment of the Emelle facility are listed below.

1. A general assessment of the manner in which the Gordo and the Eutaw aquifers interact with one another, the overlying Selma chalk, and the surface water system.

2. An indication as to the net precipitation infiltration which flows through the Selma chalk and recharges the underlying Eutaw aquifer.

3. The potentiometric surface of the Eutaw aquifer in West Central Alabama and the corresponding direction and gradient of flow in the Eutaw aquifer in the vicinity of the Emelle site.

2.3 Previous Geotechnical and Geologic Site Investigations

Tuscaloosa Testing Laboratory (TTL) has performed several soils and subsurface investigations at the Emelle site. These efforts included numerous soil borings, installation of several groundwater monitoring wells, and laboratory tests on samples of Selma chalk. The pertinent hydrogeologic data resulting from these efforts are listed below.

1. The numerous soil borings verified the existence of the Selma chalk throughout the Emelle site and gave indications of the thickness of overburden.

2. Water levels were observed in some of the boreholes after a period of 24 hours. It was unclear whether these water levels were measuring a water table in the underlying chalk or were due to perched water in the overburden.

3. The hydraulic conductivity (coefficient of permeability) of recompacted chalk is approximately 1.0×10^{-8} cm./sec.

Woodward-Clyde Consultants (WCC) produced three reports summarizing:

1. The results of packer permeability tests,

2. Results of laboratory permeability tests on intact and disturbed chalk samples, and

3. Results of a lineament study performed in the general vicinity of the Emelle site.

These studies are reviewed in detail in the Golder geology report (Reference 3) and are presented as references 7, 8 and 9 to this report. The conclusions of these three WCC reports which were utilized in this hydrogeologic characterization are:

1. In the majority of the packer permeability tests no measurable flow was observed. In those tests where measurable flow was observed the reported values of hydraulic conductivity ranged from 5.5×10^{-7} cm./sec. to 4×10^{-8} cm./sec.

2. The discontinuities observed near the surface of the Selma chalk and in the cores obtained by WCC have a hydraulic conductivity which is very low, and is no higher than the massive chalk itself.

3. Laboratory tests performed on undisturbed chalk cores and recompacted samples of chalk cuttings produced a hydraulic conductivity of about 1.2×10^{-8} cm./sec. for both materials.

4. The lineament study did locate several linear features in the vicinity of the Emelle site but backhoe excavation showed no joints or faults in the chalk, indicating that the Livingston Fault Zone does not pass through the Emelle site.

2.4 Hydrometeorologic Data

A rainfall gaging station was installed by CWM at the Emelle site at some time in the past. However, continuous record of rainfall exists for this gage only since early 1982. The nearest rainfall gaging station to the Emelle facility with a period of record of several years is located at the U.S.G.S. streamflow gaging station on Jones Creek at Highway 39 near Epes, Alabama (U.S.G.S. #02449400). Both daily rainfall and daily streamflow measurements are available at this gage from 1959 through 1965. Both the rainfall and streamflow data collected at the Jones Creek gaging station were used in the site specific water balance computations and are included in the Appendix.

2.5 Water Chemistry Data

Water samples have been obtained for chemical analysis periodically from both the chalk monitoring wells at the Emelle facility and from four deep wells which penetrate into the Eutaw aquifer. The water samples obtained from the chalk monitoring wells were usually divided and laboratory analyses performed by both CWM and the State of Alabama. The water samples obtained from the Eutaw aquifer wells were tested and the results reported in compliance with the interim preliminary EPA Hazardous Waste Disposal System regulations and are called RCRA wells. The results of the water chemistry analyses performed on water samples collected from both the chalk and the Eutaw aquifer wells were reviewed as a part of this hydrogeologic assessment. However, several apparent discrepancies were noted as discussed later in this report.

3.0 REGIONAL HYDROGEOLOGY AND HYDROLOGY

3.1 General Hydrogeologic Setting

The majority of the Emelle site is located on a topographic high which functions as a groundwater recharge area. The uppermost aquifer used for groundwater supplies in the region is the Eutaw aquifer which is confined by the overlying Selma chalk, the surficial geologic formation at the site. The potentiometric surface in the Eutaw aquifer is at about elevation 140 ft. MSL in the vicinity of the Emelle site. The measured water table in the Selma chalk on the Emelle site ranges from elevation 240 ft. MSL to 120 ft. MSL.

The areas across the Emelle site where the water table in the chalk is higher than the potentiometric head in the Eutaw aquifer, the movement of groundwater in the chalk is downward and laterally away from high point of the chalk water table. Where this head difference is large, the flow in the chalk is virtually vertical and recharge to the Eutaw aquifer takes place. However, where the water table in the chalk drops below the Eutaw aquifer potentiometric surface, upward flow takes place. This upward flow takes place both from the chalk and the Eutaw aquifer, constituting a groundwater discharge area.

The concept of groundwater recharge and discharge areas is fundamental in understanding the hydrogeology of the Emelle site. In the recharge areas, precipitation infiltrates into the Selma chalk and produces the measured water table, below which the chalk is saturated. In the discharge areas, groundwater flows upward through the chalk. However, the permeability of the chalk is sufficiently low to prevent springs from appearing because the upward flow evaporates as quickly as it is replenished. It is important to note that these discharge areas limit the lateral movement of groundwater in the chalk.

3.2 Regional Surface Water Hydrology

The Emelle, Alabama site is located in the Tombigbee River basin. The site itself is located on the drainage divide between Bodka Creek and Factory Creek, both of which are tributaries to the Tombigbee River. Figure 2 shows the Emelle facility, the surface topography and the watershed divide between the Bodka Creek and Factory Creek drainage areas. Annual rainfall averages about 50 in. in Sumter County and is fairly evenly distributed throughout the year (Reference 1). A small portion of this average annual rainfall recharges the underlying Eutaw aquifer while the remainder is available to evapotranspiration and surface runoff. Figure 3 presents a generalized water budget for Sumter County. From this figure it is evident that a relatively small portion of the overall rainfall recharges the underlying groundwater system. The total rainfall is estimated to be approximately 2,170 millions gallons per day (mgd) of which only 140 mgd or 6.5% is attributable to groundwater recharge. It should be noted that this groundwater recharge is over areas which include both Selma chalk and alluvium in lowlying terrace deposits and is higher than the recharge estimated for the Emelle site. A detailed water balance for a small watershed consisting almost exclusively of surficial chalk was computed and is presented later in Section 4.0.

3.3 Stratigraphy

The Emelle site is located in the Black Prairie Belt of the East Gulf Coastal Plain section of the Coastal Plain physiographic province. The rocks of west central Alabama consists of Upper Cretaceous sediments with bedding planes which dip approximately 45 ft. per mile to the southwest. The general stratigraphy of the Upper Cretaceous sediments consists of the Tuscaloosa Group (Gordo and Coker Formations) overlain by the Eutaw Formation which is overlain by Selma chalk. The Selma chalk is overlain by weathered chalk and relatively thin residual soils and alluvium or low terrace deposits. Based on the drillers logs of deep exploratory oil wells included in Reference 1, simplified geologic sections have been prepared. Figure 4 shows the locations of the deep oil well locations for which records are available. To our knowledge, these records provide the most reliable deep geologic data in this area. Figures 5 and 6 present deep geologic sections in the vicinity of the Emelle site. The following sections discuss the pertinent hydrogeologic aspects of these three primary lithologic units.

3.4 Hydrogeology of the Coker Formation

The base of the Coker formation is at about 2,000 ft. below mean sea level and ranges in thickness from 800 to 900 ft. in the vicinity of the Emelle site (Reference 1). The formation is composed of sand, gravel and shale with the thicker and coarser grained sand beds in the lower part of the formation comprising the major aquifer. Due to its excessive depth, the Coker Formation is not utilized for water supply in Sumter County. However, a municipal well in Hale County reportedly produces 200 gpm with a drawdown of 25 ft., producing a specific capacity of about 8 gpm per foot of drawdown. Data from oil test wells in the county indicate that the lower gravel and sand aquifer unit of the Coker Formation is about 250 ft. thick. Neglecting well losses, the specific capacity of the Hale County well indicates a hydraulic conductivity (coefficient of permeability) of approximately 2.0×10^{-3} cm./sec. in the Coker aquifer. Due to the scarcity of wells which tap the Coker Formation, a regional potentiometric head map is not available. In the vicinity of the Emelle site the chloride content of the Coker aquifer is estimated to be slightly less than 500 milligrams per liter (mg/l) (Reference 1). In the southern part of the county the Coker aquifer is known to be highly mineralized, further detracting from its use as a water resource.

3.5 Hydrogeology of Gordo Formation

The Gordo Formation overlies the Coker Formation with a base elevation of about 1200 ft. below mean sea level in the vicinity of the Emelle site. The Gordo Formation ranges in thickness from about 300 to 450 ft. The upper portion of the Gordo Formation consists of massive clay and lenticular sand beds, while the lower 150 to 200 ft. consists primarily of poorly sorted sands and gravels (Reference 1). These lower sand and gravel beds constitute the major aquifer of the Gordo Formation. The Gordo Formation is used as a water resource in the northern part of Sumter County. However, due to its excessive depth and high chloride content in the southern portion of the county, this aquifer is not commonly used for water resources in that region. A municipal well in Pickens County produces about 640 gpm with a 55 ft. drawdown for a specific capacity of 12 gpm per foot. This specific capacity indicates a hydraulic conductivity of about 4.0×10^{-3} cm./sec. over the lower 200 ft. of the Gordo Formation.

Potentiometric surface data collected in 1907 and between 1955 and 1970 shows a significant depression in the potentiometric surface of the Gordo aquifer at the confluence of the Tombigbee and Black Warrior Rivers in eastern central Sumter County (Reference 2). Figure 7 shows the potentiometric surface of the Gordo aquifer in Sumter and surrounding counties. As can be seen from this figure the approximate potentiometric surface of the Gordo aquifer in the vicinity of the Emelle site is about 145 ft. above mean sea level. The depression in the potentiometric surface shown on Figure 5 causes the water in the Gordo aquifer in the vicinity of the Emelle site to flow to the southeast under a gradient of about 0.6 ft./mile.

The chloride content of the water from the Gordo aquifer is generally in excess of 500 mg/l except in the northern and eastern most parts of the county (Reference 1). Chloride content of the Gordo aquifer in the vicinity of the Emelle site is anticipated to be slightly in excess of 500 mg/l. The water from this aquifer is generally soft to moderately hard and generally contains less than 0.3 mg/l of iron.

3.6 Hydrogeology of the Eutaw Formation

The Eutaw Formation overlies the Tuscaloosa Group with a base elevation in the vicinity of the Emelle site of about 950 ft. below mean sea level. The formation is about 400 ft. thick and generally consists of thin clay and sand beds with thicker and coarser grained sand and gravel beds in the lower 200 ft., which comprise the major aquifer (Reference 1). Two municipal wells at the city of Eutaw yield 250 and 460 gpm with drawdowns of 23 and 33 ft. respectively, producing specific capacities of 11 and 14 gpm per foot of drawdown. Use of an average specific capacity of 12.5 gpm per foot of drawdown indicates a hydraulic conductivity of about 4.0×10^{-3} cm./sec. over the lower 200 ft. of the Eutaw Formation.

Based on potentiometric head data obtained in 1907 and between 1955 and 1977, a potentiometric surface map was prepared (Reference 2) and is shown in Figure 8. These data indicate that the potentiometric surface of the Eutaw aquifer in the vicinity of the Emelle site is approximately 140 ft. above mean sea level. The potentiometric surface of the Eutaw aquifer also shows a significant depression along the Tombigbee and Black Warrior Rivers in the central eastern portion of Sumter County. This depression results in an easterly flow direction in the Eutaw aquifer in the vicinity of the Emelle site under a gradient of approximately 2.5 ft./mile.

Due to the fact that the underlying Gordo aquifer outcrops further to the north and at a higher elevation than the overlying Eutaw aquifer, the potentiometric head in the Gordo aquifer is generally higher than that in the Eutaw aquifer. This condition produces upward leakage from the Gordo aquifer into the Eutaw aquifer but is retarded by the massive clay beds in the upper portion of the Gordo Formation.

The quality of the water from the Eutaw Formation is very similar to that of the underlying Gordo Formation. The water in the southern part of the county is highly mineralized with decreasing concentrations of dissolved minerals occurring in the north and eastern parts of the County. Chloride contents from the Eutaw aquifer in the vicinity of the Emelle site are expected to be approximately 500 mg/l (Reference 1). However, chemical analysis of flowing wells from the Eutaw Formation on the Emelle site indicates chloride contents ranging from 443 mg/l to 392 mg/l. The chemical composition of the water from the Eutaw aquifer is further discussed in Section 4.

The Eutaw aquifer is confined by the overlying low permeability Selma chalk formation, i.e. the water level in a well which penetrates the Selma chalk into the Eutaw aquifer will rise to a level higher than the top of the Eutaw aquifer itself. In areas where the surface topography is at a lower elevation than the potientiometric surface in the Eutaw aquifer wells into the Eutaw Formation will flow. Figure 9 is taken from Reference 1 and shows the location of various hydrologic data, including those areas where wells which tap the Eutaw Formation will flow under artesian pressure.

3.7 Hydrogeology of the Selma Chalk

The chalk material of the Selma Group overlies the Eutaw Formation and is the primary surficial geologic unit in the vicinity of the Emelle site. In the site vicinity the base of the chalk is estimated to be at elevation EL -450 ft. MSL with a thickness varying between 600 ft. and 750 ft. The residual soil cover overlying the chalk is thin to non-existent in the highlands and varies up to 40 ft. in thickness in the lowlying valleys. The upper portion of the Selma chalk is known to have some fractures and other discontinuities but below about 100 ft. to 150 ft. these discontinuities are infilled with calcite cement and are as impermeable as the host formation. The mineralogy of the Selma chalk is about 76% calcium carbonate, about 21% clay minerals and approximately 3% quartz sand (Reference 3),

Rainfall infiltration which seeps into the Selma chalk produces a water table below which the chalk is saturated. In areas where the chalk water table is higher than the head in the Eutaw aquifer, flow in the chalk is downward.

In areas where the chalk water table, and usually the ground surface elevation, is below the head in the Eutaw aquifer, the artesian head in the Eutaw causes upward groundwater flow through the chalk. This condition exists in the shaded areas shown in Figure 9. However, due to the thickness of and low permeability of the Selma chalk, this upward flow rate is very low and evapotranspiration prevents the formation of springs.

The contact between the surficial outcrop of the Selma chalk and the Eutaw Formation runs through Pickens, Green and Hale Counties to the north and east of Sumter County, about 20 miles from the Emelle site. Southwest of this contact line the Eutaw aquifer is confined by the Selma chalk. Due to its extremely low permeability the chalk does not yield sufficient flow to wells for use as a water resource aquifer. In addition to its confining nature the Selma chalk significantly retards the downward percolation of rainfall infiltration into the underlying Eutaw aquifer. A significant depression exists in the potentiometric surface of the Eutaw aquifer in the vicinity of the confluence between the Tombigbee and Black Warrior Rivers, as shown in Figure 8. A recent study performed by the Alabama Geological Survey (Reference 2) used a finite difference steady-state groundwater model in order to estimate the cause of the depressurization of the Eutaw aquifer. The findings of this study indicated that neither controlled municipal wells or uncontrolled flowing artesian wells produce sufficient flow to cause the level of depressurization observed in the Eutaw in this area. The findings of the modelling study indicate that the primary cause of the observed depressurization of the Eutaw aquifer is regional upward flow of water from the Eutaw through the chalk in the groundwater discharge areas.

4.0 DETAILED HYDROGEOLOGIC ASSESSMENT

4.1 General

As stated in Section 1, the primary objective of this report is to present our evaluation of the hydrogeology of the Emelle Hazardous Waste Disposal Site as we presently understand it. Of particular importance is an understanding of the existence and movement of water in the Selma chalk formation, in which the Emelle facility is located. This requires an understanding of the surface water balance, i.e. what percent of the rainfall infiltrates into the Selma chalk, in addition to a thorough understanding of how the chalk interacts with the underlying Eutaw aquifer.

4.2 Detailed Surface Water Hydrology

As shown on Figure 2 the Emelle Facility is located on the upland ridge which separates the Bodka Creek and Factory Creek drainage basins. Similar to most areas in the vicinity, the primary surface geologic unit of the Emelle site is Selma chalk. This unit produces high annual surface runoff and low infiltration.

In order to understand the relative magnitudes of surface runoff, evapotranspiration, and infiltration, a site specific water balance was computed. Such a water balance requires the evaluation of coincident rainfall and streamflow data for a period of several years. Since no such data exist on the Emelle site, a nearby watershed of similar size and physiographic setting was selected. The U.S.G.S. at one time maintained a stream gage on Jones Creek at Highway 39 and has data on record from 1959 to 1965. These data are included in Appendix A. The location of the rainfall and streamflow gaging station and the outline of the Jones Creek watershed are shown on Figure 9.

This watershed is considered to be similar to the hydrology of the Emelle facility due to its large percentage of surficial chalk and close proximity to the facility. In addition, the fact that rainfall data are collected at the same location as the streamflow gage eliminates the common problem of non representative rainfall.

Water balance calculations are essentially based on the equation of continuity, as shown below:

$$\text{Inflow} = \text{Outflow} \pm \text{Change in Storage}$$

By computing the water balance on an annual basis and using several years to arrive at average annual values, steady state conditions can be assumed and the "change in storage" term in the above equation can be omitted. The various components of inflow and outflow are then defined in average annual values computed or estimated for each, keeping in mind that continuity must be honored. The hydrologic component of most interest in this study is the net infiltration of rainfall into the Selma chalk. Therefore the number of hydrologic components to be considered in the above equation is relatively small. The only inflow to be considered is precipitation and the outflow components consist of evapotranspiration, stream flow, and infiltration into the chalk. Therefore the above equation can be rewritten as follows:

$$\text{Precipitation} = \text{Streamflow} + \text{Evapotranspiration} + \text{Chalk Infiltration}$$

As previously stated, average annual values in inches per year over the entire period of record are used in the above equation.

Rainfall and streamflow are actual measured parameters and are the two most accurate components in the water balance equation. The average annual precipitation at the Jones Creek rain gage over the period of record is 54.3 in./yr. which is slighly higher than the Sumter County average annual precipitation of 50 in./yr. reported by Davis (Reference 1). By distributing the average annual streamflow volume which passes the Jones Creek gage over the contributing drainage area of 11.7 square miles, an effective streamflow of 20.8 inches per year is computed. Since site specific evapotranspiration data is not available, the Sumter County average value was used. Davis indicates that this value is 33.4 inches per year (Reference 1). This value is considered to be reasonable since evapotranspiration does not vary widely over a single county. However, as stated in Section 3.7, some of the total evapotranspiration is from upward flow in the chalk.

The net infiltration into the Selma chalk was computed as the difference between the average annual precipitation and the sum of the streamflow and evapotranspiration. Therefore the net infiltration into the chalk is estimated to be 0.1 in./yr. This value was then divided into the amount which ultimately recharges the Eutaw aquifer and the amount which is added to evapotranspiration. Based on the Geological Survey of Alabama report on the groundwater modeling study of the Eutaw and Gordo aquifers as presented by Gardner (Reference 2), the areal recharge from the Selma chalk into the Eutaw aquifer is estimated to be 0.02 in./yr. The remaining 0.08 in./yr. net infiltration into the chalk flows to a discharge area and is evaporated. Figure 10 graphically presents the above outlined hydrologic water balance of Jones Creek and is considered to be representative of the water balance at the Emelle facility.

4.3 Selma Chalk Hydrogeology

4.3.1 Water Table

Prior to the commencement of this investigation, it was generally accepted that the Selma chalk is unsaturated, at least to depths of 100-200 ft. Although disposal trench excavations into the Selma chalk appear to be dry, several of the groundwater monitoring wells which extend from 50 to 150 feet below ground level into the chalk show relatively stable, consistent water levels above the elevation of the trench bottoms. These water levels suggest that below some depth the chalk may be saturated.

The dry nature of the newly opened waste disposal trenches can be explained by computing the probable rates of flow of groundwater through the low permeability chalk and comparing this number to the potential evapotranspiration. From these calculations it is evident for trenches of the depth common at the Emelle facility, groundwater will evaporate from the trench floor and walls quicker than it can flow in, causing the host chalk to appear dry or unsaturated.

All the chalk monitoring wells completed prior to August 1982 were installed in such a manner that inflow from the overlying soil or weathered chalk may occur. Therefore, the free water levels in the chalk monitoring wells were not considered to be a conclusive indication of saturated conditions in the chalk. To prevent this possible source of inflow, three monitoring wells were sealed by installing a 2" diameter PVC piezometer in the existing open borehole and filling the annulus with bentonite. The lower slotted PVC pipe was surrounded with coarse sand. Figure 11 shows the recompletion details of these wells.

The water levels in the three sealed piezometers was pumped down and their recovery was closely monitored. The water level recovery curves for these three wells are shown in Figures 12, 13 and 14. Analysis of these data by Hvorslev's method yield permeability values ranging from 2.0×10^{-8} cm./sec. to 5.7×10^{-8} cm./sec., which is consistent with the permeability values of the chalk from borehole packer and laboratory tests. The water levels in these three wells stabilized at the levels observed prior to recompletion and pumping.

The conclusions drawn from this series of field tests are that:

1) that the chalk is saturated below the water levels recorded in the chalk monitoring wells,

2) the static water levels recorded in the other open chalk boreholes are valid measurements of the chalk water table.

Between July 16 and July 23, 1982 water levels in all of the monitoring wells and leachate wells at the Emelle facility were measured. These water levels were converted to elevation in feet above mean sea level and invalid wells (such as those which had been silted in) were omitted. A total of 34 water level elevations from monitoring wells and leachate wells were located on a topographic map of the Emelle Facility. By considering these data in conjunction with surface topography and the condition of each trench, (i.e. empty, filling or covered) a contour map of the measured water table in the Selma chalk was developed. Figure 15 shows the elevation contours of the estimated water table in the chalk and the water level data points from which they were developed. Based on the trends in the measured chalk groundwater elevations and 3 monitoring wells at the perimeter of the site, these water level contours were extrapolated across the entire Emelle site. These contours are shown on Figure 16. Wells are presently being installed to gather data to finalize the water level elevation contours.

As can be seen from Figure 15, a groundwater ridge exists in the Selma chalk centered under the topographic high or ridge which projects northwest through the present center of the facility. The water table shows a maximum water level of EL 240 ft. MSL at the high point of this groundwater mound. In the northwest corner of the area shown on Figure 15 the estimated groundwater levels in the chalk drop to EL 120 ft. MSL. Also of importance is the shape of the groundwater table in the chalk in the vicinity of trenches 11 through 16. Leachate well levels indicate that the water table in trenches 11, 12, and 12A have very nearly reached steady state conditions. The groundwater level in trench 13 appears to be somewhere between elevation EL 160 and EL 180 ft. MSL, while the groundwater level in trench 14 is estimated to be between EL 120 and EL 140 ft. MSL. At the time these groundwater levels were measured, trench 15 was in the process of being filled and trench 16 had been recently developed to its minimum bottom elevation of EL 100 ft. MSL. Therefore, the groundwater table in the chalk is estimated to be above the floor of both of these trenches.

4.3.2 Groundwater Movement

As can be seen in Figures 15 and 16, the water table in the Selma chalk in the upland portions of the site is greater than EL 140 ft. MSL, which is the potentiometric surface in the Eutaw aquifer at the site. This condition results in a positive head difference between the chalk water level and the potentiometric head in the Eutaw. This condition produces some flow from the chalk into the Eutaw. A reverse condition exists in areas where the groundwater table in the chalk drops below the potentiometric surface of the Eutaw. However, this upward head difference is a maximum of 20 ft. in the undisturbed land around the Emelle facility. This relatively small driving head and the low permeability of the Selma chalk effectively precludes any measurable concentrated inflow to the surrounding creeks from the chalk or the underlying Eutaw aquifer. The upward head difference between the Eutaw and chalk water levels does yield an areally distributed discharge which is readily dissipated through evapotranspiration. Streamflow records at Jones Creek (included in Appendix A) show that the flow goes to zero during the dry periods of the year, indicating that essentially none of the groundwater discharge from the Selma chalk or the underlying Eutaw Formation reaches the surface streams.

There is also a small horizontal component of groundwater movement in the Selma chalk which is governed by the slope of the water table in the chalk itself. By computing the vector direction of these flow components, an idealized set of flow paths or flow net can be prepared in cross section. Figure 17 shows section A-A', (location shown on Figure 15) which is taken along the axis of the groundwater ridge which extends from the high point of the water table ridge east of trench 12 down to Bodka Creek. Figure 17 shows that along section A-A' the flow path in the Selma chalk reverses from downward to upward in the vicinity of Highway 17. The flow paths shown in Figure 17 are conceptual; while the flow liner does indicate general direction and paths of movement, they do not consider such effects as anisotropy between vertical and horizontal permeability in the chalk and the difference between flow directions in the chalk and the Eutaw. The gradient in the Eutaw aquifer does not coincide with the direction of Section A-A', therefore some flow out the plane shown is occurring in the Eutaw aquifer.

One of the values of presenting flow paths in the manner shown on Figure 17 is in helping plan the placement of ground water monitoring wells. As can be seen from the idealized flow vectors in the chalk, a groundwater monitoring well placed adjacent to a waste disposal trench must extend deep into the chalk to intersect the near vertical flow lines. It should also be noted that until the trenches have filled to a steady-state static water level, groundwater flows will be into the trench rather than outward. Also, relatively flat slopes in the groundwater table in the Selma chalk in the vicinity of the trenches produces a composite flow direction vector which is essentially vertical. These phenomena suggest that both the direction of flow and the driving head can to some degree be controlled in the vicinity of the trenches through various design and closure practices.

In order to assess these flow directions in the proper perspective, it is of value to estimate the velocity of flow through the Selma chalk. It is estimated that a typical value for hydraulic conductivity in the upper 100 ft. to 150 ft. of Selma Chalk is 1.0×10^{-7} cm./sec. and generally ranges between 3.0×10^{-7} cm./sec. and 4.0×10^{-8} cm./sec. It is estimated that a typical value for hydraulic conductivity for the lower portion of the chalk is 3.0×10^{-8} cm./sec. and ranges between 5×10^{-8} cm./sec. and 7.0×10^{-9} cm./sec. Using a downward gradient of 0.17, which exists in the high point of the groundwater table mound to the east of trench 12, and using an effective porosity of 10%, a flow velocity of between 0.05 ft./yr. and 0.17 ft./yr.is calculated.

To estimate residence times in the Selma chalk various flow paths were investigated. The minimum flow path is vertically downward through the chalk and into the underlying Eutaw Formation. This will occur only in areas where the water table in the Selma chalk is horizontal and higher than the head in the Eutaw. Assuming a depth of the Selma chalk of approximately 600 ft. and an estimated flow velocity of 0.05 ft./yr. (typical of the lower chalk), the estimated residence time in the Selma chalk is in excess of 10,000 years. This estimate is made assuming an effective transport porosity of 10%. Testing will be done on intact core samples to determine this parameter in the near future. As shown in Figure 17, some flow paths in the chalk are considerably longer than 600 ft., and most of the gradients are less than 0.17; therefore, significantly longer residence times in the chalk are expected. In conclusion, the massive, low permeability nature of the chalk suggests that any fluid leaving the waste disposal trenches will take many years to be intercepted by monitoring wells, even those placed relatively close to waste disposal trenches, and any such fluid leaving the waste disposal trenches will require thousands of years to exit the Selma chalk formation.

4.3.3 Retardation and Attenuation in Chalk

The flow velocities and residence times reported above assume that chemical constituents are transported at the same velocity as the groundwater itself. However, some species of dissolved constituents are retarded as they pass through a porous media and will move at a slower velocity than the fluid which carries them. In addition, adsorption and chemical attenuation processes can quite often neutralize or bind chemical constituents in the porous media itself.

The attenuation and reduction of dissolved materials by a porous media is dependent upon the geochemistry of the porous media and the chemical makeup of the fluid. The Selma chalk is comprised of about 76% calcium carbonate, 21% clay minerals and 3% quartz sand (Reference 3). The calcium carbonate provides pH buffering capacity while the clay minerals provide adsorption capacity. The attenuative capacity of these minerals is discussed below relative to various types of waste materials.

Various types of inorganic solutes, such as sulphates, move with the groundwater and are essentially unretarded. However, the movement of heavy metals may be significantly retarded due to the high electrochemical adsorption capacity of the clay minerals and the relatively high pH of the groundwater maintained by the calcium carbonate. The high pH increases the adsorptive capacity of the clays and minimizes the solubility of heavy metals. Also, any heavy metals which are in solution in the deposited waste products would likely be precipitated as carbonates.

The mobility of organic solutions, however, is difficult to characterize due to the high degree of interaction between organic substances. Many organic materials are highly soluble in water and will move at nearly the same velocity as the groundwater itself. Two processes which would retard this movement are biodegradation and adsorption. The details of the biodegradation process are complex and depend heavily on the aquatic environment and interaction between organic compounds. Any natural organics present in the porous media will tend to adsorb organics from solution. However, the chalk is considered to have very little, if any, natural organic carbon content. Therefore, in the absence of detailed information to date, organic solutes have been assumed to move at the same rate as the groundwater.

4.4 Water Chemistry

Water chemistry data have been routinely collected for two to three years in the chalk monitoring wells. These water samples are commonly split and analyzed by both Chemical Waste Management and the State of Alabama. In addition, four deep wells (RCRA wells) in the Eutaw aquifer have been monitored. The results of these chemical analyses were tabulated and reviewed.

Table 1 was prepared to summarize the results of the many chemical analyses performed by the State of Alabama and Chemical Waste Management on the water samples taken from the chalk monitoring wells and the RCRA monitoring wells. This table presents the mean, maximum and minimum values and the number of samples tested for seven parameters. These results were combined for all the water samples taken from the chalk monitoring wells and presented separately for each of the four RCRA wells. The water chemistry data were reviewed in an attempt to discern a time or spatial pattern; however, there is significant scatter in the data. In general, the results of the water chemistry analyses presented in Table 1 show the water in both the chalk and the Eutaw Formations to be of relatively good quality.

It should be noted that chloride concentrations in the RCRA wells range from 24.6 mg/l to 409.0 mg/l. However, it would be expected that wells which tap the Eutaw aquifer would show cloride concentrations of approximately 500 mg/l. Only RCRA well number 4 shows values of cloride concentration near this level. RCRA number 2 was pumped for an extended period of time (about 900 gallons removed) to ensure that the water being samples was from the Eutaw Formation. Water samples taken shortly thereafter show a chloride concentration of 119 mg/l.

The water chemistry data from analyses of groundwater samples from both the chalk and the Eutaw Formation at this time do not provide significant information regarding the overall hydrogeologic system. However, the data summarized in Table 1 may be of future value when attempting to identify sources of water in monitoring wells and in surface streams which surround the area.

5.0 SUMMARY AND CONCLUSIONS

This hydrogeologic characterization of the CWM Emelle, Alabama site is based on review of published information, review of previous investigations, a geologic investigation and report performed by Golder Associates and a brief hydrogeologic field investigation performed by Golder Associates. Several key points became evident during this effort.

1. Most of the Emelle facility is located on a topographic high which functions as a groundwater recharge area. This is the case in the present active disposal area but not in the northwest corner of the facility which borders Bodka Creek. The natural net infiltration recharging the groundwater is estimated to be about 0.1 in./yr.

2. Groundwater discharge areas border the site to the north and west. To the south and east, groundwater discharge areas are located 10 to 20 miles from the facility.

3. At the Emelle site, the uppermost aquifer is the Eutaw Formation. The potentiometric head in the Eutaw aquifer is at about EL 140 ft. MSL. The direction of flow in the Eutaw aquifer beneath the Emelle site is to the east.

4. Steady-state free water levels at the Emelle site have been measured in the Selma chalk between EL 120 ft. MSL and EL 240 ft. MSL and follow a logical pattern governed by the surface topography. The chalk below these measured free water levels is saturated.

5. The measured shape of the phreatic surface in the chalk indicates that both vertical and horizontal flow is occurring at very low gradients. In those areas where vertical flow occurs, interaction between the Eutaw aquifer and the overlying chalk takes place. The areas of horizontal flow in the chalk are bounded by the groundwater discharge regions, beyond which no horizontal flow in the chalk occurs.

6. Using an effective porosity of 10% and measured gradients, it is estimated that the flow velocities in the chalk range from 0.05 ft./yr. to 0.17 ft./yr. In most places the flow velocity is substantially less. Therefore, residence time in the Selma formation is expected to be on the order of 10,000 years.

The results of this hydrogeologic characterization lead to several conclusions regarding waste disposal trench design and reclamation. In addition, several points are significant in light of the recently released EPA Hazardous Waste Management System regulations. These conclusions are listed below.

1. The potential for using or altering the existing water table in the Selma chalk to eliminate the movement of leachate is very real. This aspect of the site hydrogeology should be considered in designing future waste disposal trenches.

2. Upon final reclamation of existing and future waste disposal trenches, the chalk hydrogeology should be carefully considered when designing the surface cover and regrading plan.

3. Due to the downward flow direction and very slow flow velocities, future groundwater monitoring wells in the chalk must be carefully designed and located if they are to effectively monitor potential leachate movement.

4. Due to the competency and low permeability of the chalk formation and the very long travel time from the chalk to the Eutaw aquifer, Golder Associates does not consider monitoring of the Eutaw aquifer necessary.

This hydrogeologic characterization is preliminary and represents our understanding gained from thorough review of existing information and a review of hydrogeologic data which has only recently become available. Although we do not foresee major variations in the characterization presented herein, refinements and possibly minor revisions are anticipated as incoming data are reviewed. Some of the items which Golder Associates considers necessary are:

1. Additional observation wells to improve the accuracy of the measured water table in the chalk and determine its seasonal fluctuation.

2. Accurate survey control on the location and elevation of each observation well.

3. Accurate, periodically updated topographic mapping of the site.

4. Resolve some of the apparent anomalies in the water chemistry data from both the chalk and the Eutaw aquifer monitoring wells.

5. Better definition of the mass parameters of the chalk, such as hydraulic conductivity, storativity, effective porosity and net recharge. These data may be required to support groundwater modeling efforts and may be obtained through detailed monitoring around a prototype trench under development.

Golder Associates is presently reviewing in detail the above listed needs in light of the new EPA Hazardous Waste Management regulations and the incoming groundwater data. Therefore, this list may be modified in the near future.

In summary, the CWM Emelle, Alabama hazardous waste disposal facility is located in an attractive geologic formation which, although saturated at depth, has hydraulic characteristics which essentially isolate the disposed waste from the surrounding water supplies. This hydrogeologic characterization, and its future revisions, should provide valuable information for the design and reclamation of waste disposal trenches and potential groundwater monitoring wells.

GOLDER ASSOCIATES

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Associate

William F. Brumund, P.E.
Principal

JEB:WFB:dap

REFERENCES

1. Davis, Marvin E., T. H. Sanford, Jr. and P. O. Jefferson, "Water Availability and Geology of Sumter County, Alabama", Geological Survey of Alabama, Map 158, 1980.

2. Gardner, Richard A., "Model of the Ground-Water Flow System of the Gordo and Eutaw Aquifers in West-Central Alabama", Geological Survey of Alabama, Bulletin 118, 1981.

3. Golder Associates, "Geologic and Geotechnical Evaluation at the Emelle, Alabama Facility", for Waste Management of Alabama, 1982.

4. Tuscaloosa Testing Laboratory, "Soil Investigation, Hazardous Waste Management System, Sumter County, Alabama", for Resource Industries of Alabama, Inc., 1977.

5. Tuscaloosa Testing Laboratory, "Soil Foundation Report, Industrial Waste Land Fill Site #3, Geiger, Alabama", for Resource Industries of Alabama, Inc., 1978.

6. Tuscaloosa Testing Laboratory, "Soil Reconnaissance, Proposed Industrial Waste Land Fill Trenches Number 8 & 9", for Waste Management of Alabama, Inc., 1979.

7. Woodward-Clyde Consultants, "Results of Packer Permeability Tests, Emelle, Alabama Waste Disposal Site", for Resource Industries of Alabama, Inc., 1979.

8. Woodward-Clyde Consultants, "Results of Laboratory Permeability Tests Chalk from Trench 8, Emelle, Alabama Waste Disposal Facility", for Waste Management of Alabama, Inc., 1979.

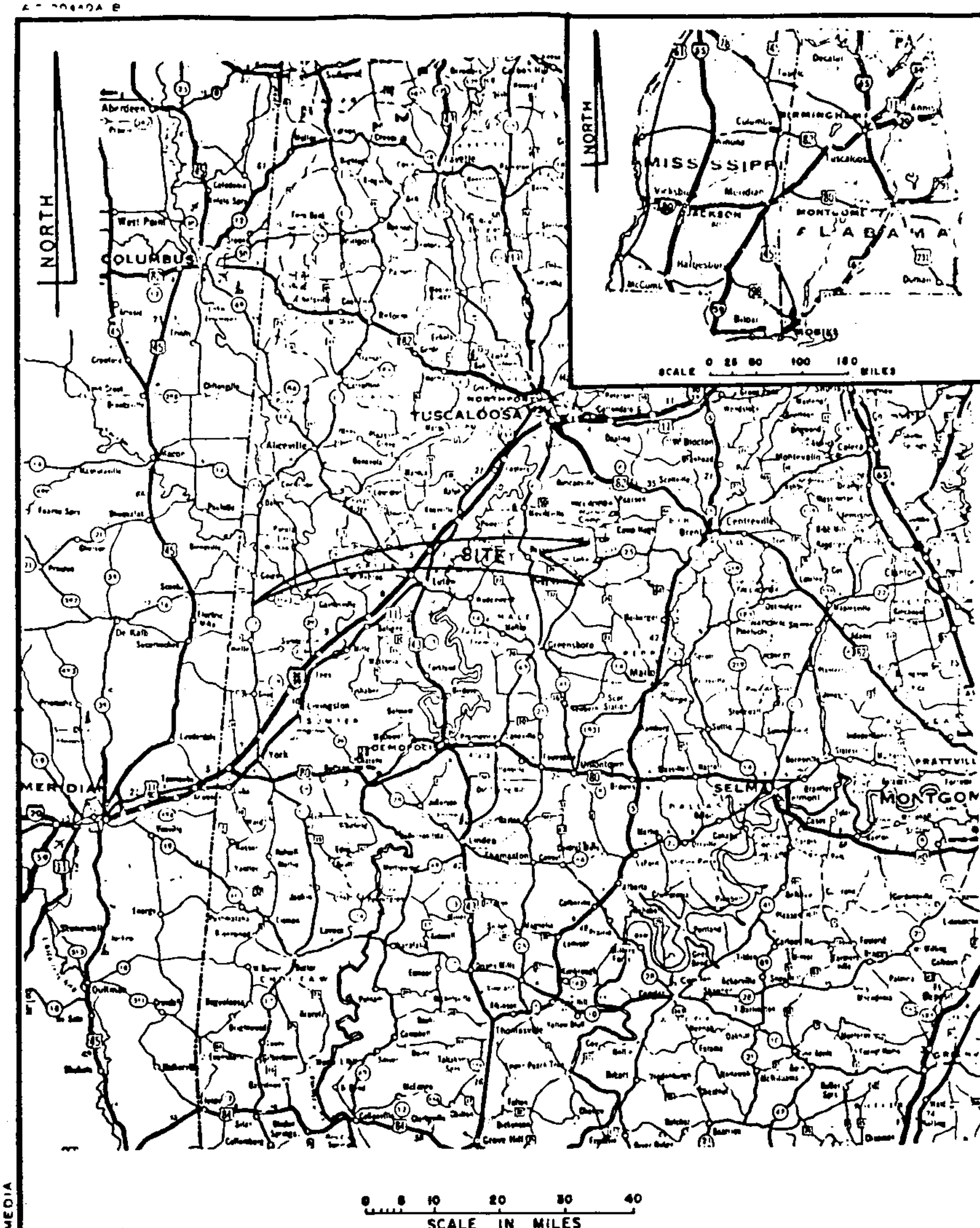
9. Woodward-Clyde Consultants, "Lineament Study, Emelle, Alabama Waste Disposal Site", for Waste Management of Alabama, Inc., 1980.

TABLE 1

SUMMARY OF WATER CHEMISTRY DATA

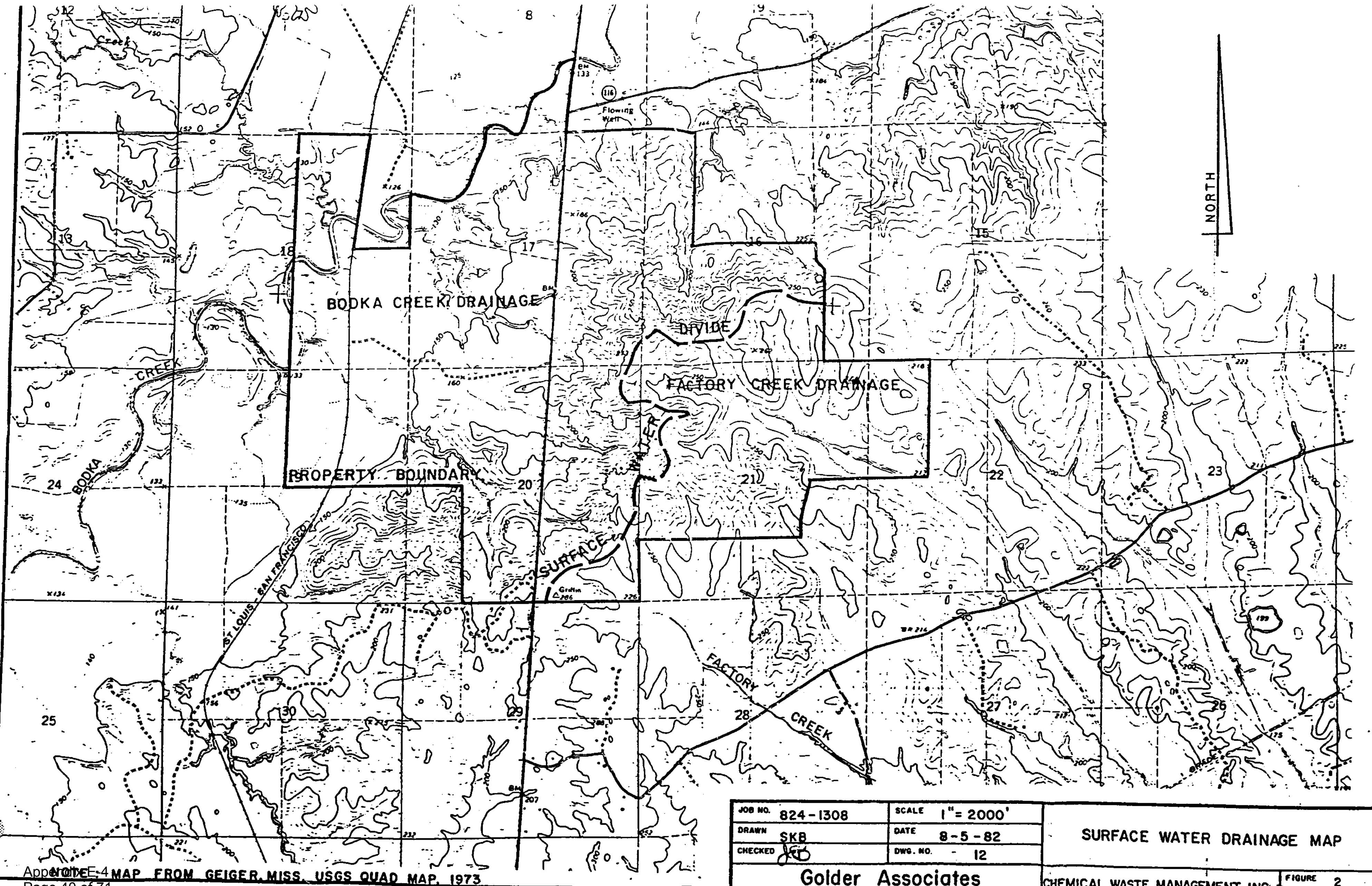
Well	Statistic	pH	Chloride (mg/l)	Sodium (mg/l)	Total N (mg/l)	Sulfide (ppb)	Conductivity (10^3 mmho/cm)	Total Alkalinity (mg/l)
11 Chalk Wells	Mean	7.26	62.8	128.7	1.89	<100	5.41	296
	Maximum	10.46	371.0	364	15.60	<100	70.00	514
	Minimum	6.50	0.1	0.3	0.04	0.2	0.24	152
	No. of Samples	95	22	29	11	20	95	6
CRA #1	Mean	8.34	242.0	197.0	1.06	<50	5.38	67
	Maximum	10.23	443.0	318.0	1.09	<50	21.00	67
	Minimum	8.08	40.0	64.0	1.00	<20	1.60	67
	No. of Samples	13	2	3	3	5	13	1
CRA #2	Mean	7.26	24.6	100.1	0.63	<50	1.60	27
	Maximum	7.74	58.7	164.0	1.02	<50	8.60	27
	Minimum	6.85	8.1	43.3	0.05	<20	0.50	27
	No. of Samples	12	4	5	4	3	12	1
CRA #3	Mean	7.17	107.0	132.0	1.26	<50	1.00	-
	Maximum	7.39	182.0	217.0	4.30	<50	1.40	-
	Minimum	6.87	32.5	46.5	0.18	<20	0.80	-
	No. of Samples	5	2	2	4	3	5	-
CRA #4	Mean	8.09	409.0	258.0	1.21	<20	1.80	-
	Maximum	8.10	425.0	311.0	1.85	<20	1.90	-
	Minimum	8.07	392.0	205.0	1.00	<20	1.70	-
	No. of Samples	4	2	2	4	2	4	-

Note: See Figure 16 for well locations.

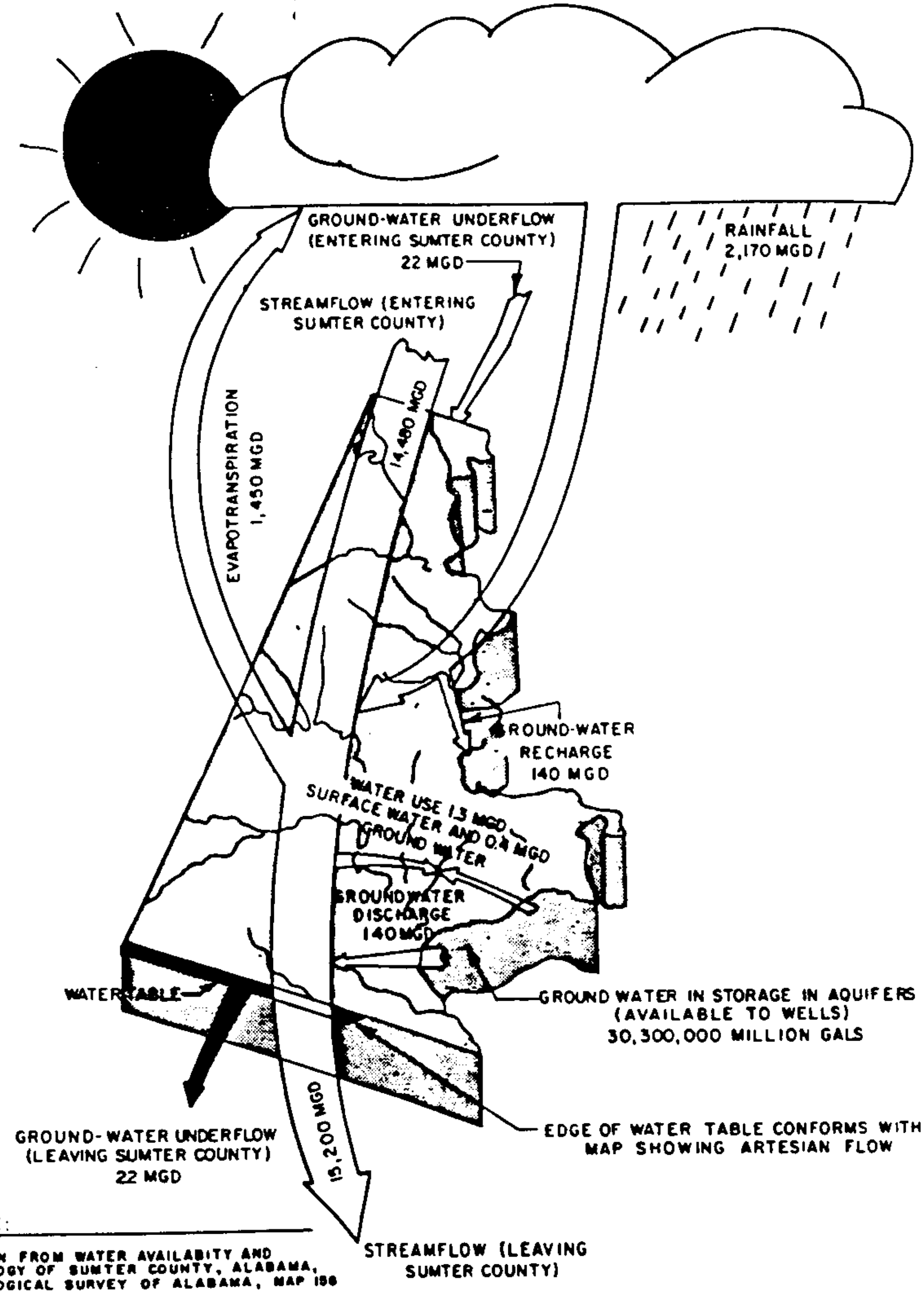


JOB NO. 824 - 1308	SCALE AS SHOWN	SITE LOCATION MAP EMELLE FACILITY
DRAWN SKB	DATE 8-5-82	
CHECKED WB	DWG NO. 11.	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 1

GAF DRAFTING MEDIA


NORTH
BODKA CREEK DRAINAGE
DIVIDE
FACTORY CREEK DRAINAGE
SURFACE WATER
PROPERTY BOUNDARY
BODKA CREEK
FACTORY CREEK
ST LOUIS - SAN FRANCISCO
Flowing Well
8
9
12
13
15
16
17
18
20
21
22
23
24
25
26
27
28
29
30
JOB NO. 824-1308
SCALE 1" = 2000'
DRAWN SKB
DATE 8-5-82
CHECKED
DWG. NO. - 12
Golder Associates
SURFACE WATER DRAINAGE MAP
CHEMICAL WASTE MANAGEMENT, INC.
FIGURE 2
MAP FROM GEIGER, MISS. USGS QUAD MAP, 1973

A F 20440A-B

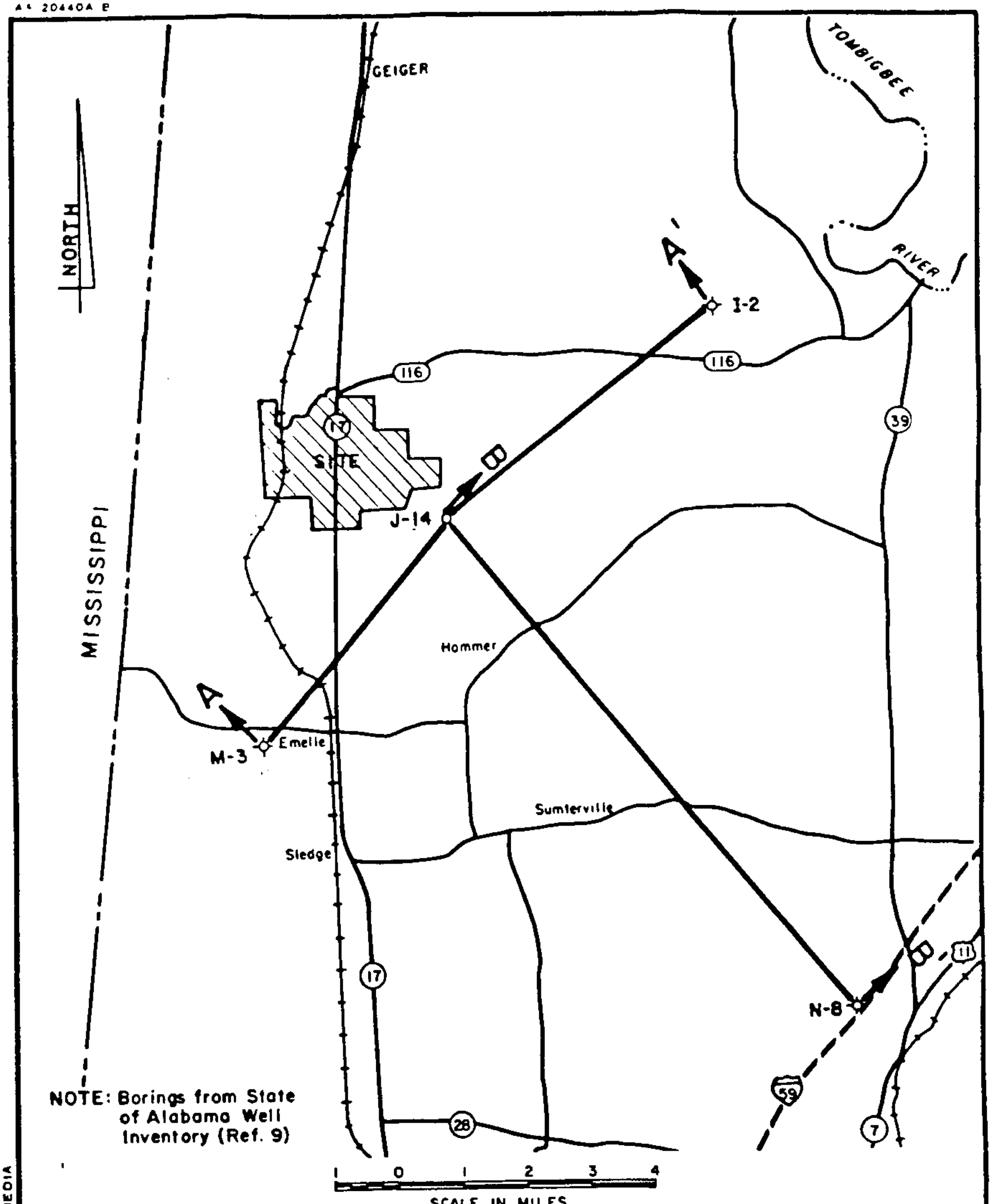


NOTE:

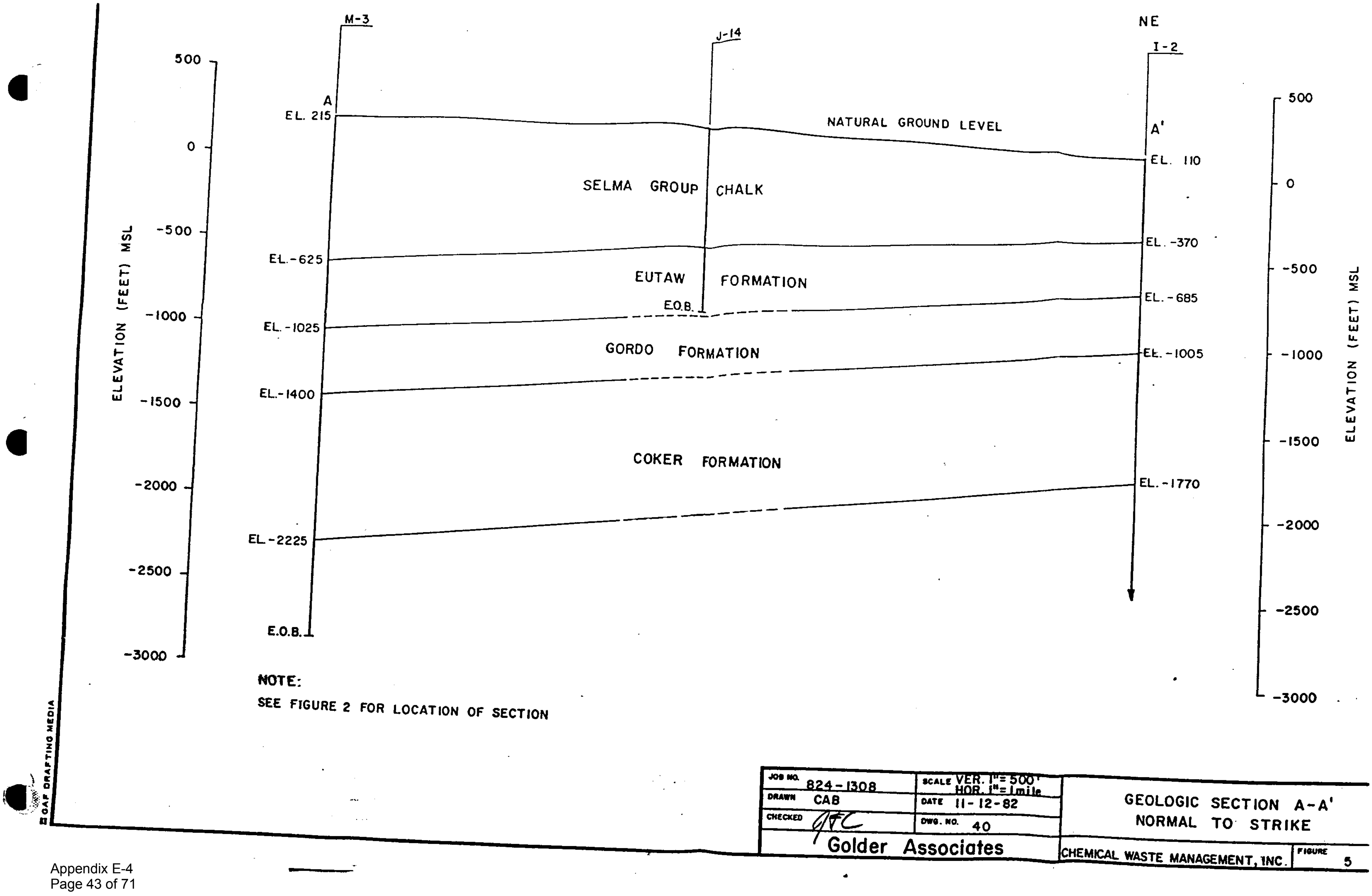
TAKEN FROM WATER AVAILABITY AND GEOLOGY OF SUMTER COUNTY, ALABAMA, GEOLOGICAL SURVEY OF ALABAMA, MAP 186 (REFERENCE 1)

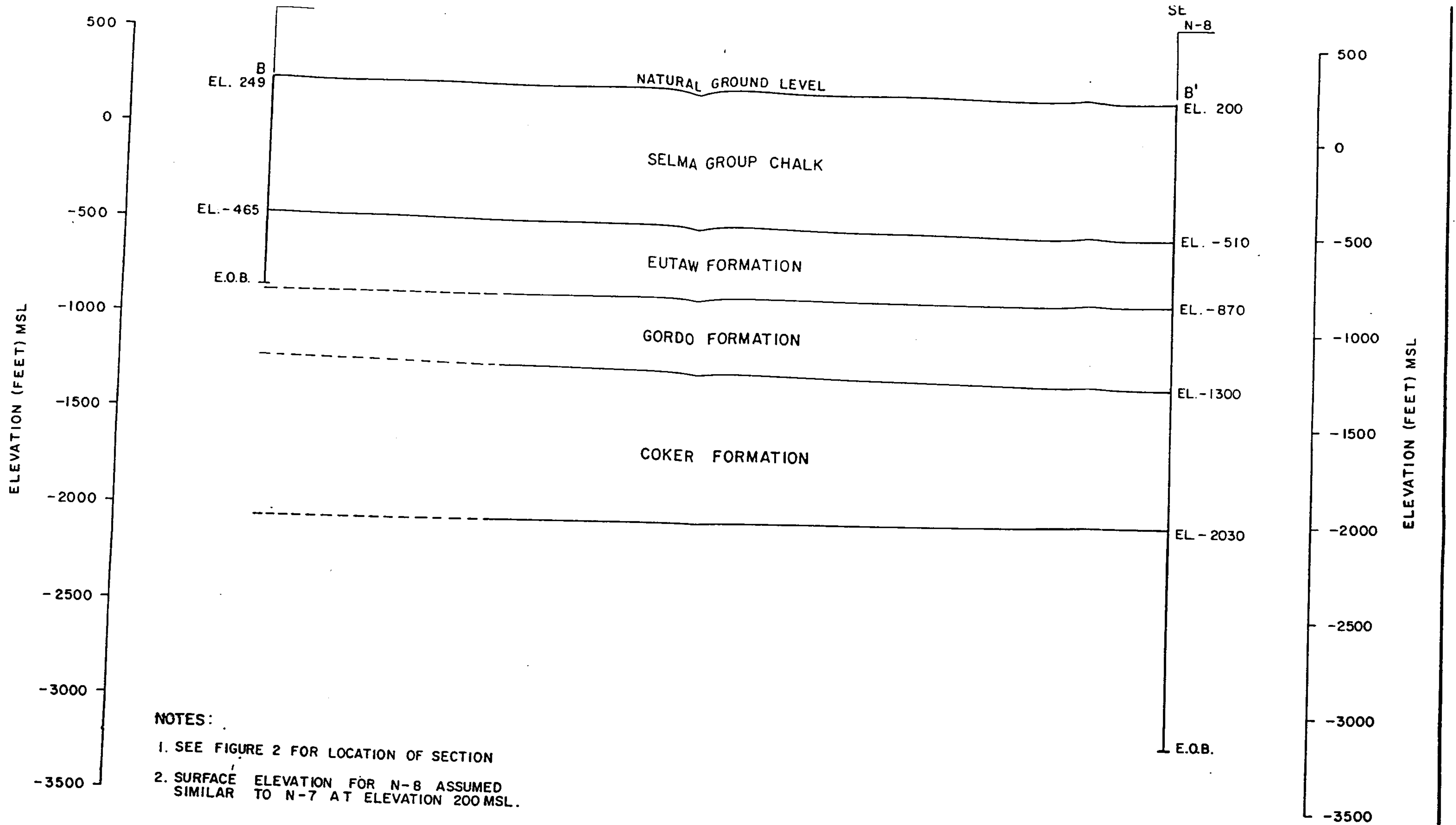
JOB NO. 824-1308	SCALE NOT TO SCALE	GENERALIZED WATER BUDGET FOR SUMTER COUNTY
DRAWN SKB	DATE 8-13-82	
CHECKED [signature]	DWG. NO. 18	FIGURE 3
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC

GAF DRAFTING MEDIA



JOB NO. 824-1308	SCALE 1"=2 MILES	LOCATION OF DEEP WELL BORINGS AND GEOLOGIC SECTIONS
DRAWN SKB	DATE 8-18-82	
CHECKED	DWG NO 22	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 4


M-3
J-14
NE
I-2
A
EL. 215
NATURAL GROUND LEVEL
A'
EL. 110
SELMA GROUP CHALK
EL.-625
EL. -370
EUTAW FORMATION
E.O.B.
EL. -685
EL. -1025
GORDO FORMATION
EL. -1005
EL.-1400
COKER FORMATION
EL. -1770
EL. -2225
E.O.B.
ELEVATION (FEET) MSL
500
0
-500
-1000
-1500
-2000
-2500
-3000
NOTE:
SEE FIGURE 2 FOR LOCATION OF SECTION
JOB NO. 824-1308
SCALE VER. 1"= 500' HOR. 1"= 1 mile
DRAWN CAB
DATE 11-12-82
CHECKED
DWG. NO. 40
Golder Associates
GEOLOGIC SECTION A-A'
NORMAL TO STRIKE
CHEMICAL WASTE MANAGEMENT, INC.
FIGURE 5
GAF DRAFTING MEDIA

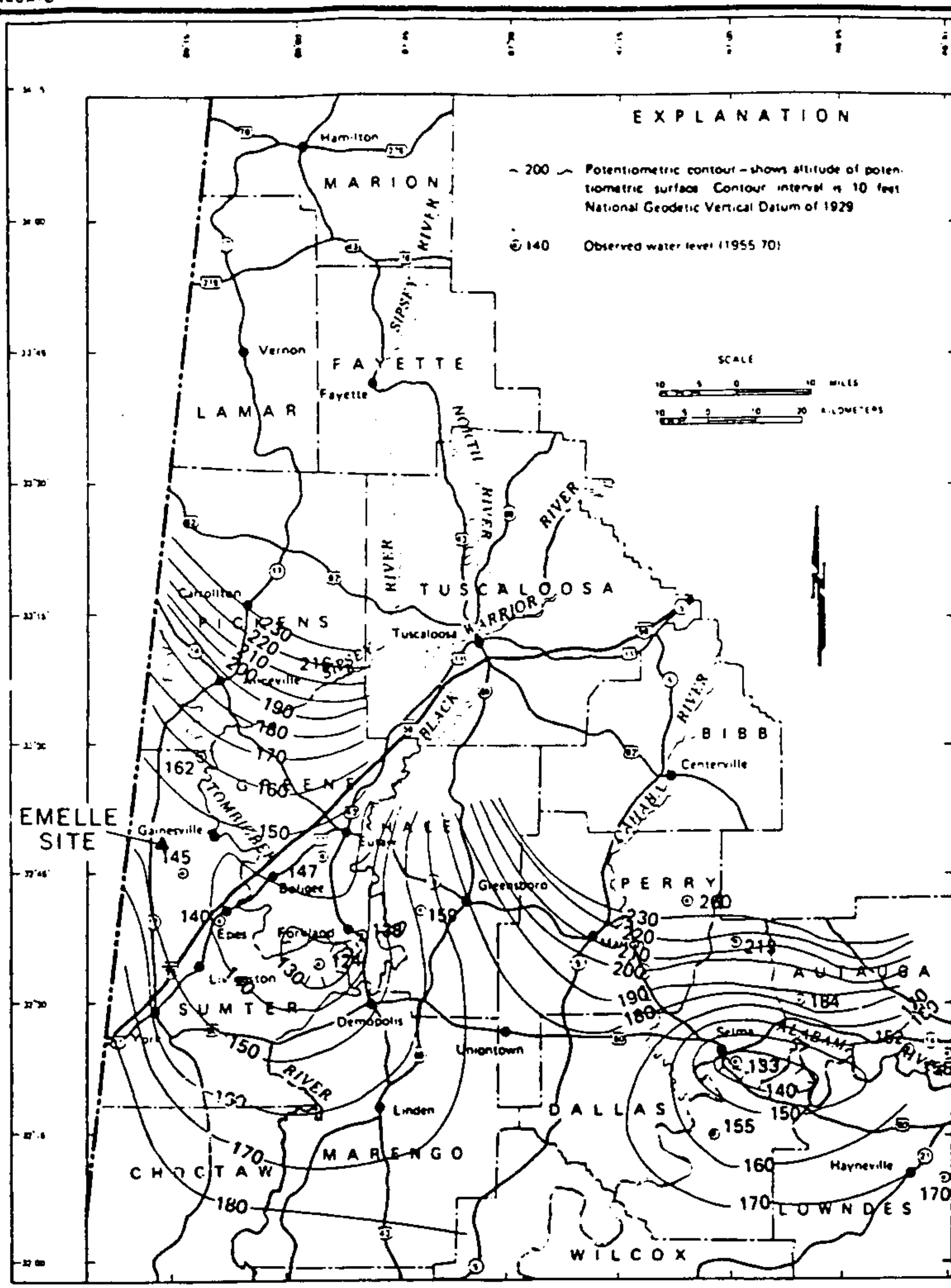


NOTES:

1. SEE FIGURE 2 FOR LOCATION OF SECTION
2. SURFACE ELEVATION FOR N-8 ASSUMED SIMILAR TO N-7 AT ELEVATION 200 MSL.

JOB NO. 824-1308	SCALE VER. 1"=500' HOR. 1"=1mile	GEOLOGIC SECTION B-B' PARALLEL TO STRIKE
DRAWN CAB	DATE 11-12-82	
CHECKED JFC	DWG. NO. 41	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 6

A F 20440A B

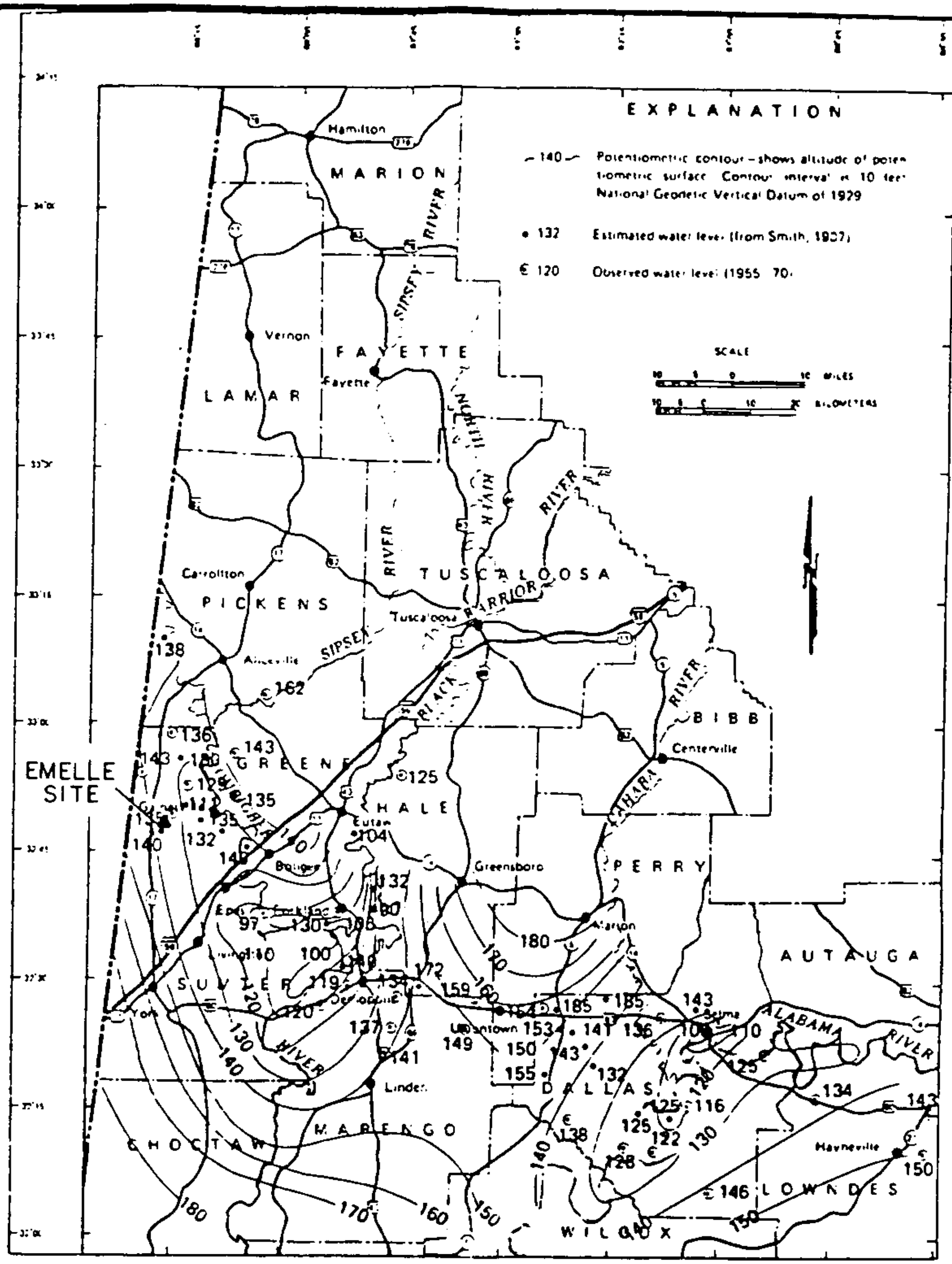


NOTE:

TAKEN FROM GEOLOGICAL SURVEY OF ALABAMA, BULLETIN 118 (REFERENCE 2)

JOB NO. 824-1308	SCALE AS SHOWN	POTENTIOMETRIC SURFACE IN THE GORDO AQUIFER
DRAWN SKB	DATE 8-13-82	
CHECKED JEB	DWG. NO. 20	
Golder Associates	CHEMICAL WASTE MANAGEMENT, INC	FIGURE 7

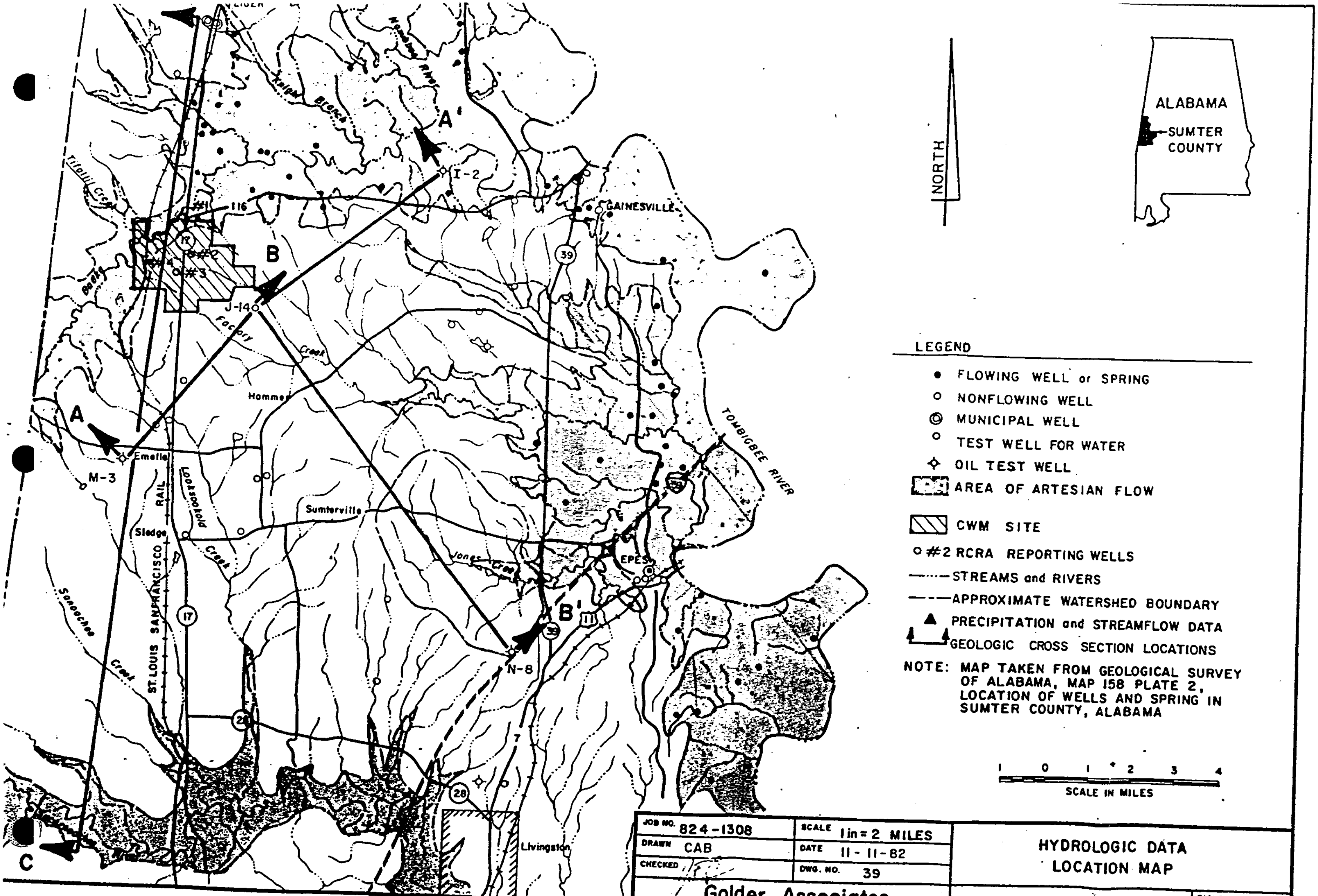
AF 20440A P



NOTE:
TAKEN FROM GEOLOGICAL SURVEY OF ALABAMA, BULLETIN 118 (REFERENCE 2)

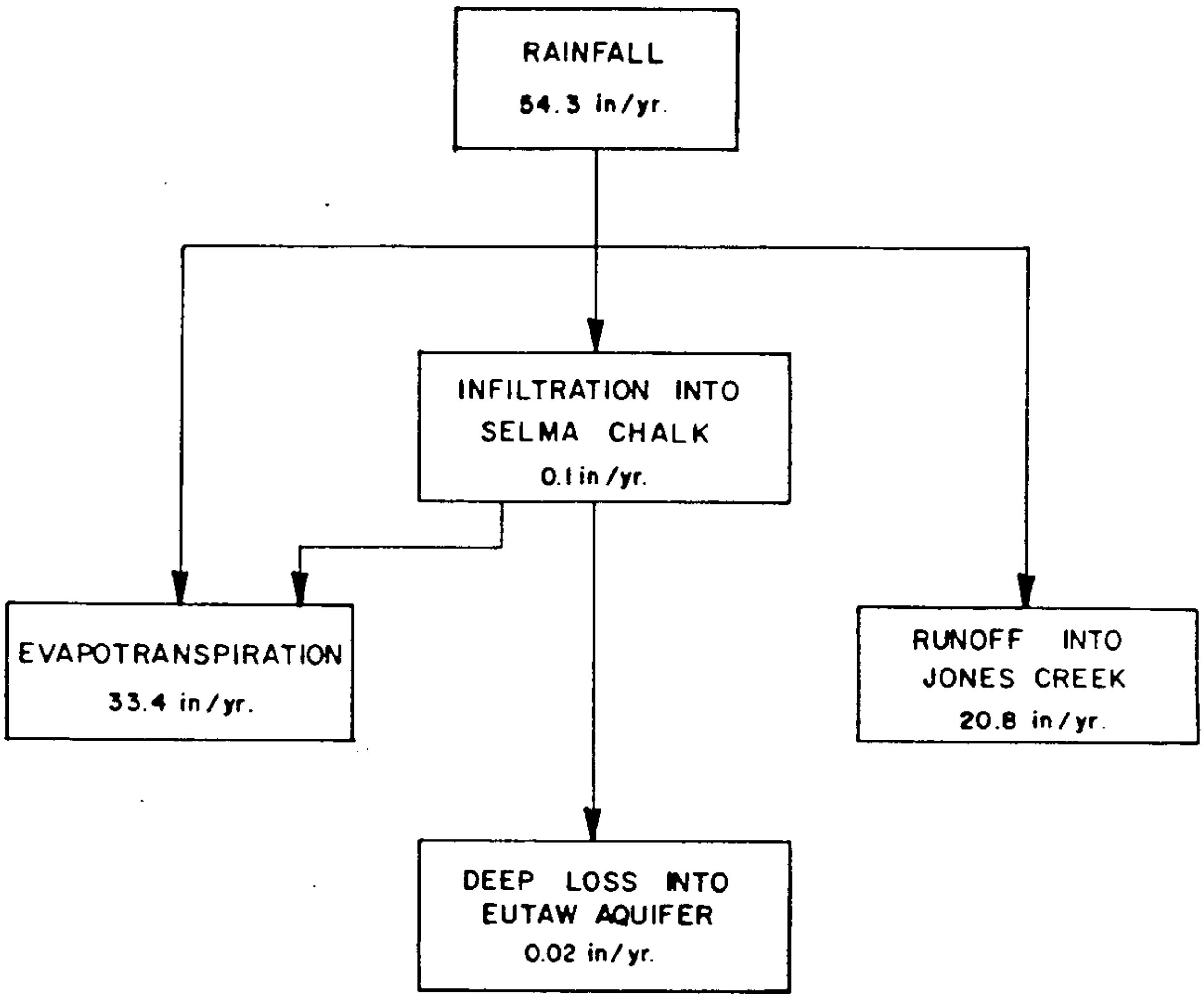
JOB NO. 824-1308	SCALE AS SHOWN	POTENTIOMETRIC SURFACE IN THE EUTAW AQUIFER
DRAWN SKB	DATE 8-13-82	
CHECKED JEB	DWG NO 19	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 8

GAF DRAFTING MEDIA



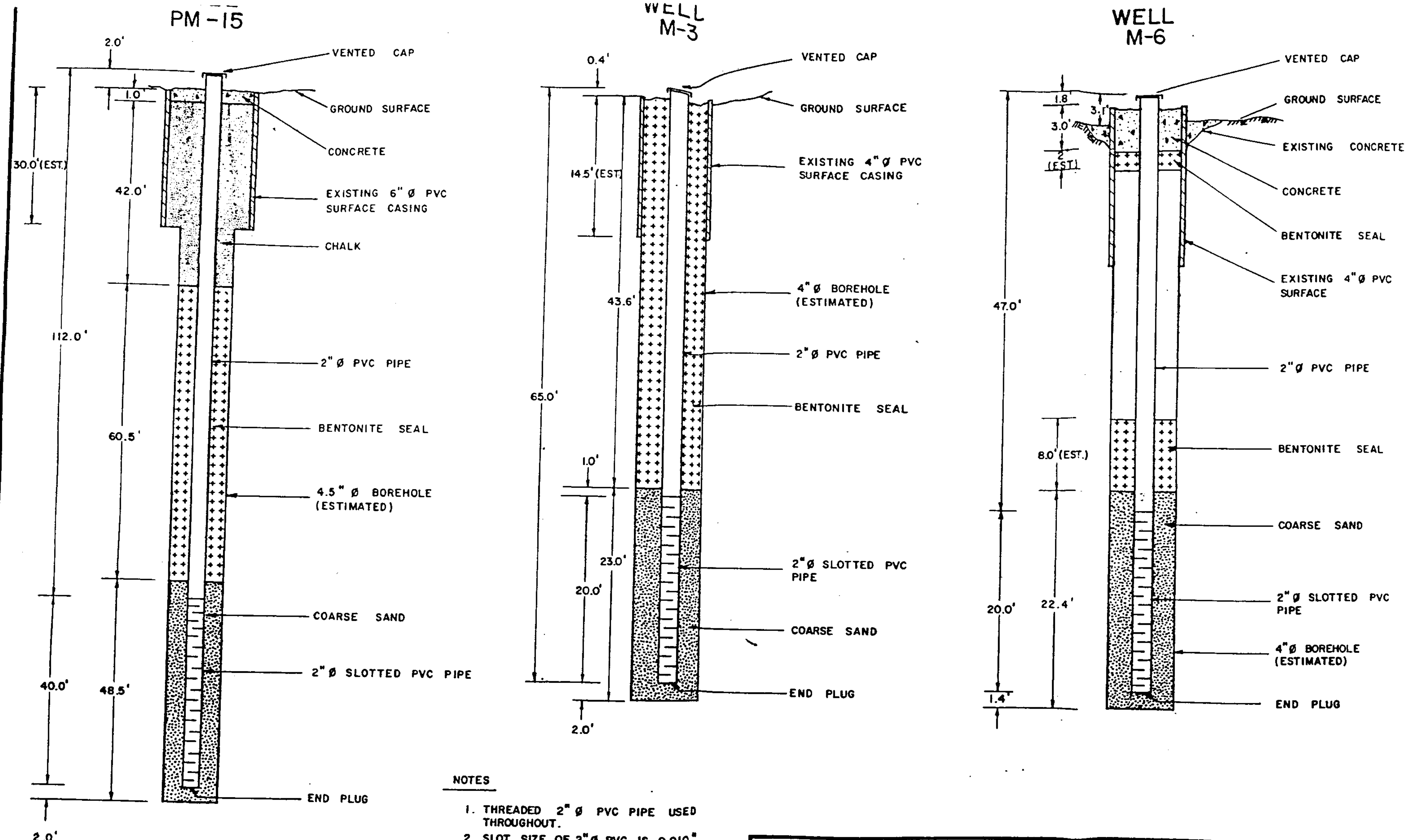
JOB NO. 824-1308	SCALE 1 in = 2 MILES	HYDROLOGIC DATA LOCATION MAP
DRAWN CAB	DATE 11-11-82	
CHECKED	DWG. NO. 39	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC — FIGURE 9

AF 20440A-B



JOB NO. 824-1308	SCALE NONE	JONES CREEK WATER BUDGET
DRAWN CAB	DATE 9-2-82	
CHECKED JRB	DWG NO. 29	
Golder Associates		CHEMICAL WASTE MANAGEMENT — FIGURE 10

GAF DRAFTING MEDIA



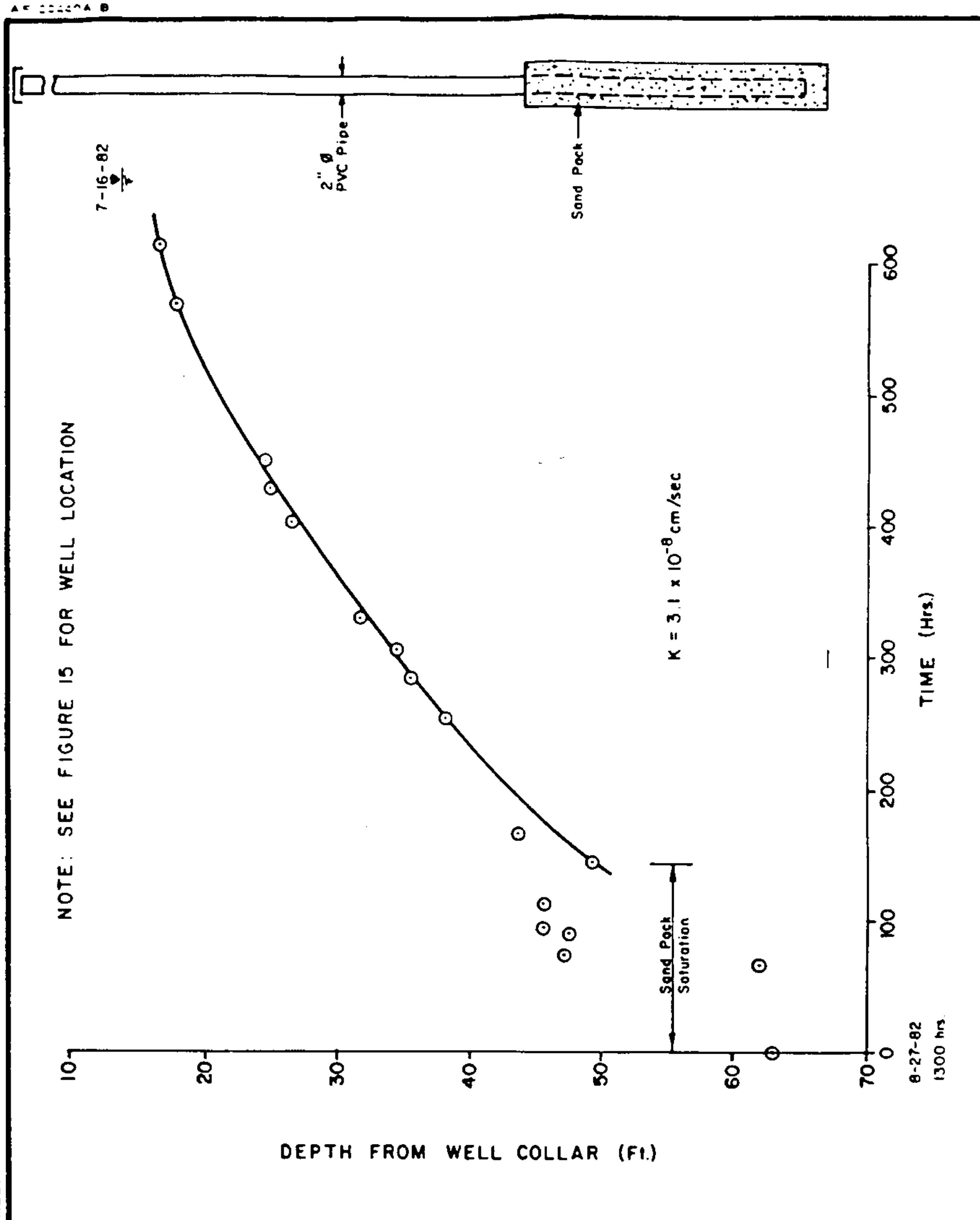
NOTES

1. THREADED 2" Ø PVC PIPE USED THROUGHOUT.
2. SLOT SIZE OF 2" Ø PVC IS 0.010"
3. ADDITIONAL 4.1' UNATTACHED 6" Ø PVC SURFACE CASING ON WELL PM-15 NOT SHOWN.
4. A 1.5' LENGTH OF 4" Ø PVC SURFACE REMOVED FROM WELL M-3.

JOB NO. 824-1308	SCALE NOT TO SCALE
DRAWN CAB	DATE 9-2-82
CHECKED JEB	DWG. NO. 30
Golder Associates	

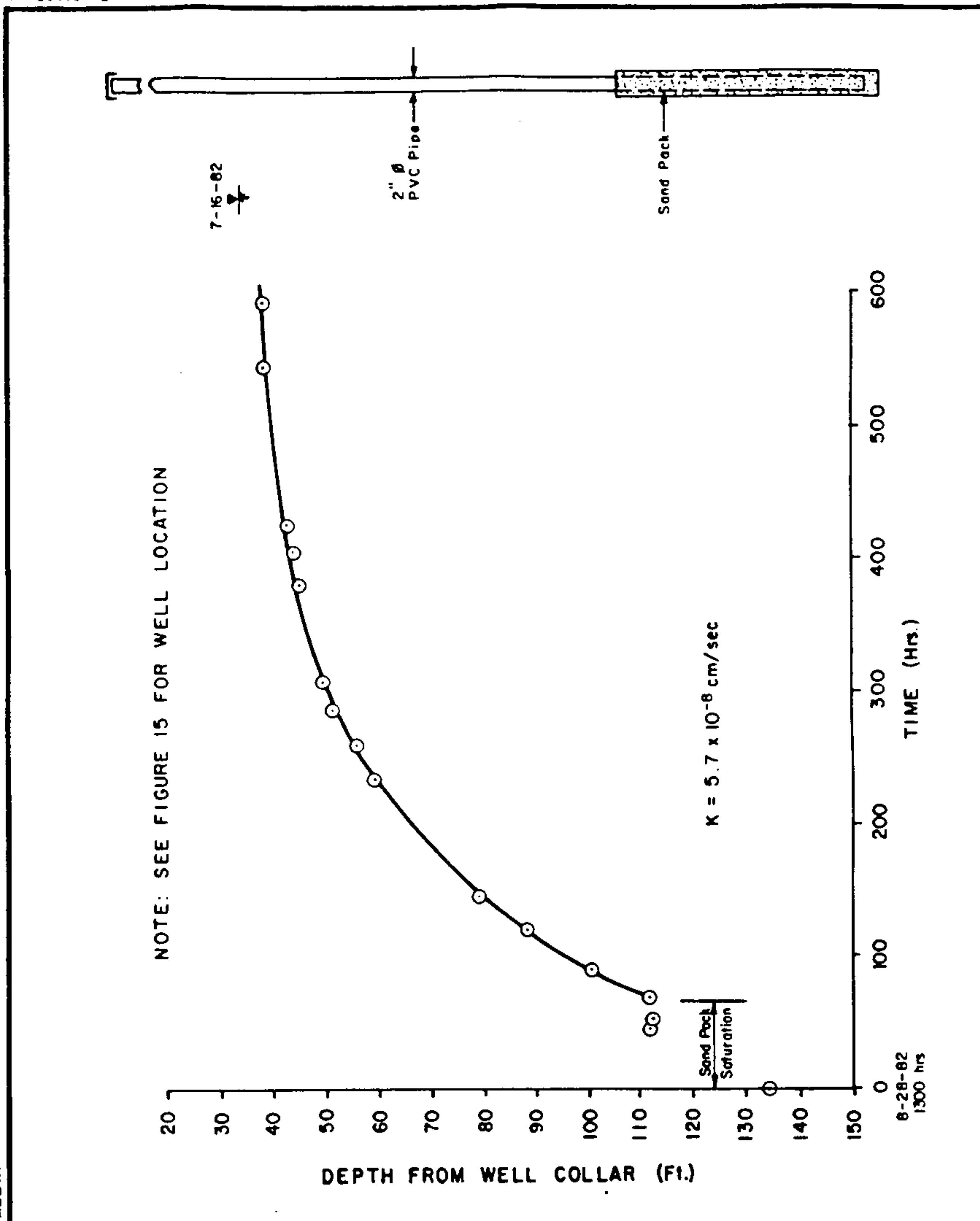
RECOMPLETION DETAILS OF MONITORING WELLS

CHEMICAL WASTE MANAGEMENT INC. FIGURE 11



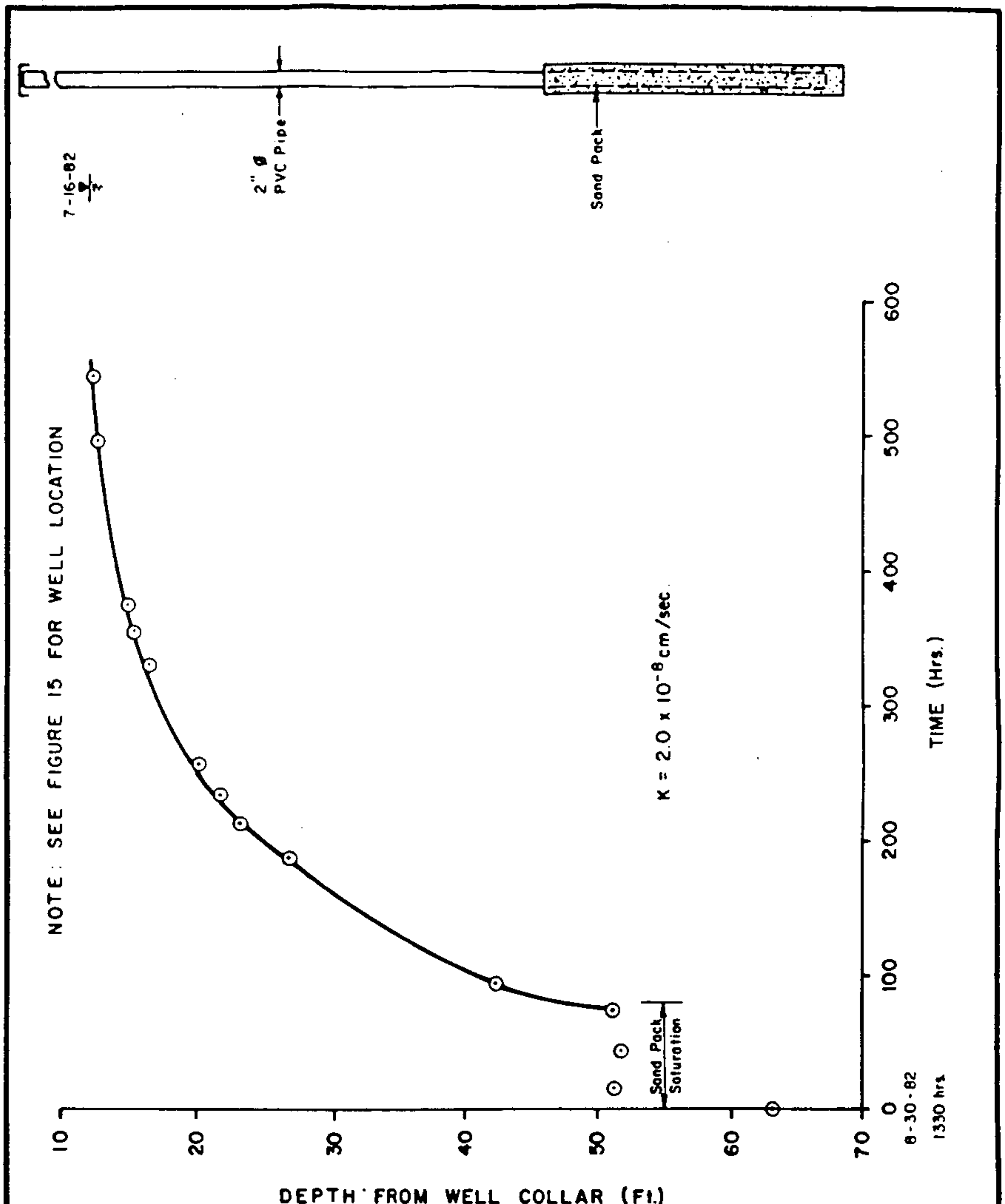
JOB NO. 824 - 1308	SCALE AS SHOWN	SEALED WELL RECOVERY MONITORING WELL M-3
DRAWN SKB	DATE 12-13-82	
CHECKED JEB	DWG NO 49	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 12

AF 2044CA B



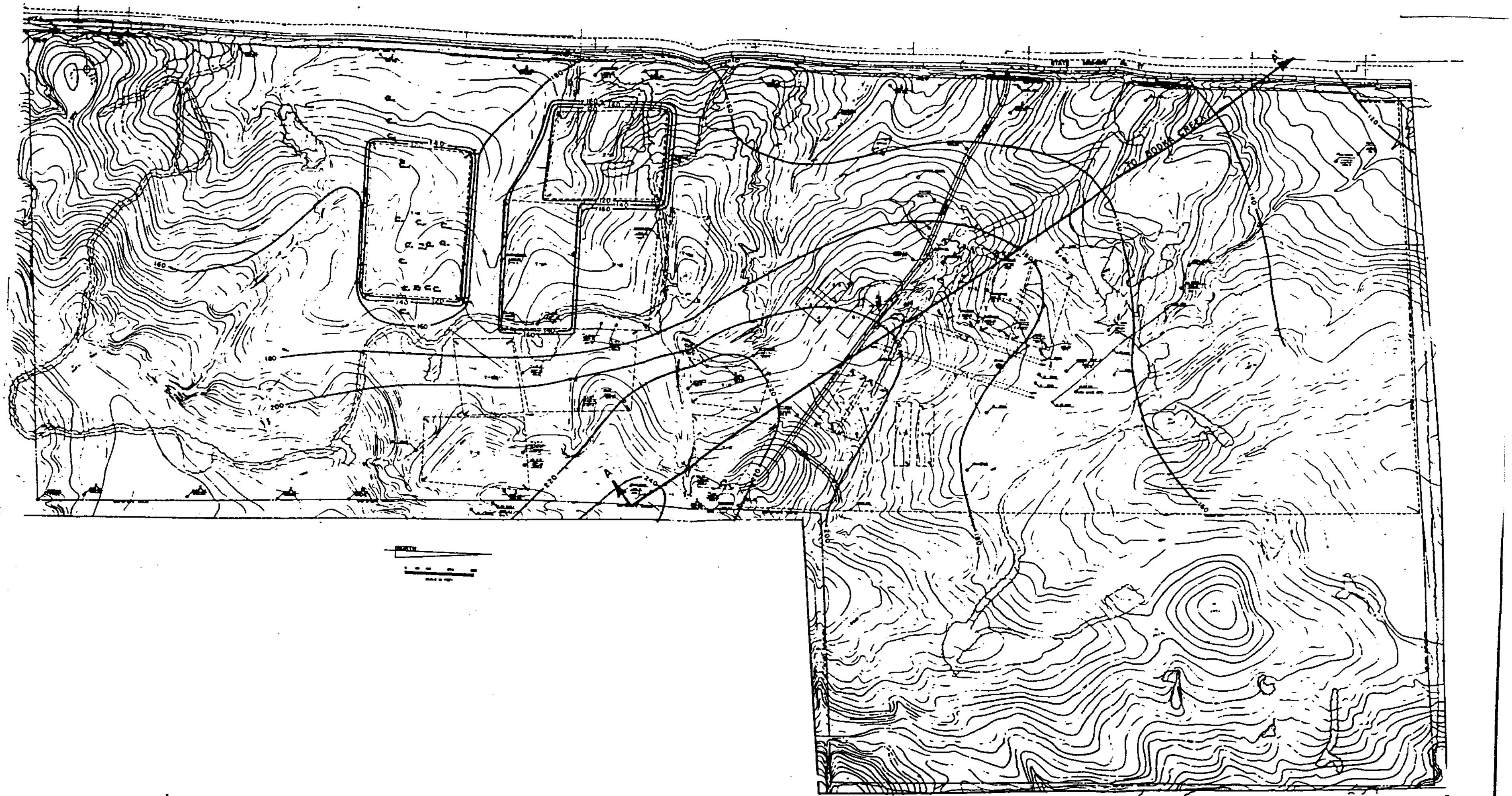
JOB NO 824-1308	SCALE AS SHOWN	SEALED WELL RECOVERY MONITORING WELL PM-15
DRAWN SKB	DATE 12-10-82	
CHECKED JEB	DWG NO 47	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 13

AF 20440A



JOB NO. 824 - 1308	SCALE AS SHOWN	SEALED WELL RECOVERY MONITORING WELL M-6
DRAWN SKB	DATE 12 - 13 - 82	
CHECKED JEB	DWG NO 48	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 14

DRAFTING MEDIA



LEGEND

WELL POINT — #P9 (815) / (269.2) / 180.2 — IDENTIFIER; COORDINATE NUMBER; COLLAR ELEVATION; GROUNDWATER ELEVATION

REF MONUMENT — #316 CM (256.47)

COORDINATE POINT + 539 (117.0)

A — A' CROSS SECTION LINE

—180— GROUNDWATER ELEVATION CONTOURS IN CHALK (Ft MSL)

NOTES

1. BASE MAPPING PROVIDED BY CHEMICAL WASTE MANAGEMENT, INC DATED MARCH 22, 1978.

2. GROUNDWATER ELEVATIONS FROM FIELD SURVEY BETWEEN JULY 16 AND JULY 23, 1982

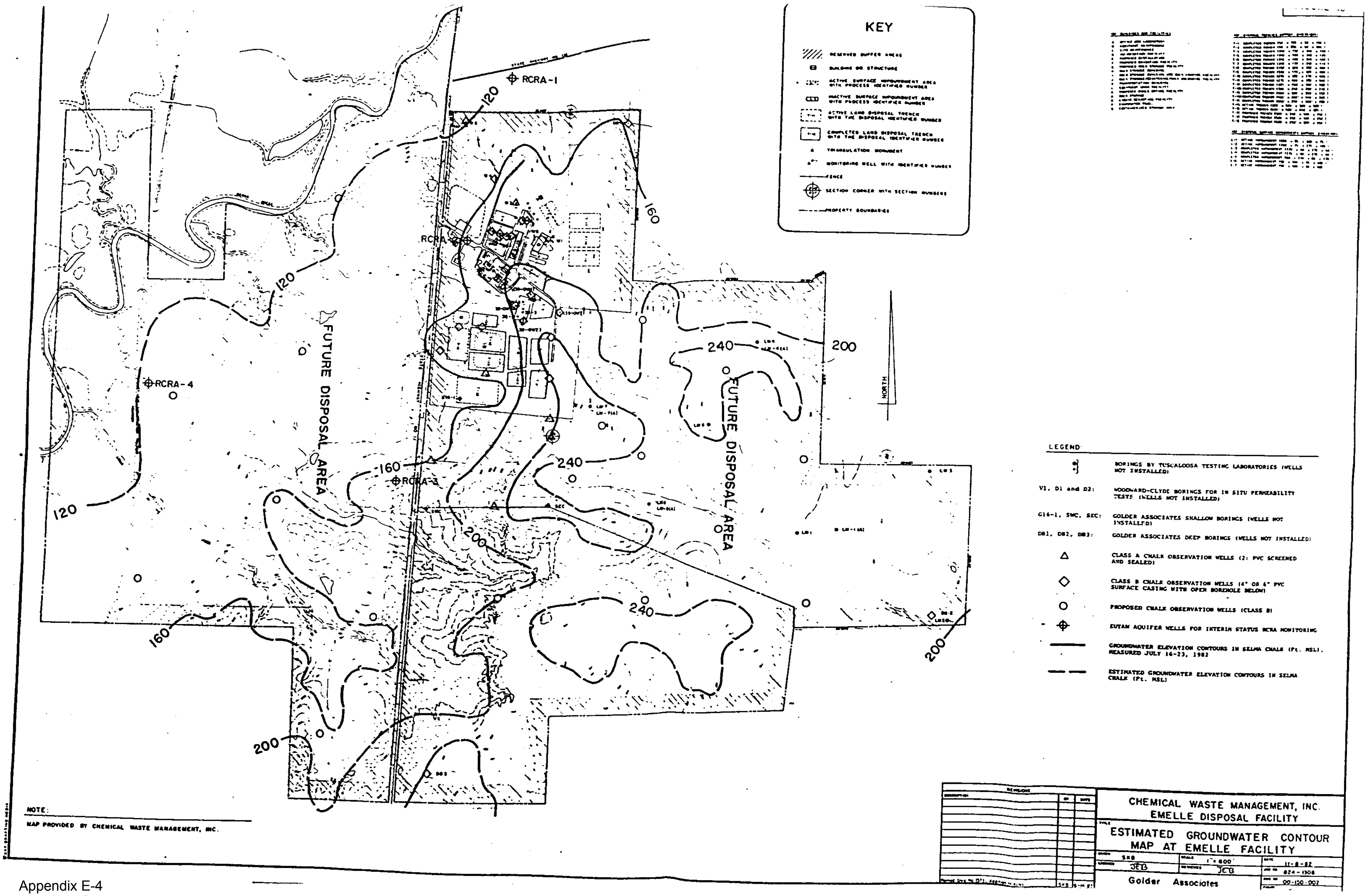
3. SECTION A-A SHOWN ON FIGURE 17, DRAWING NO 00-200-001

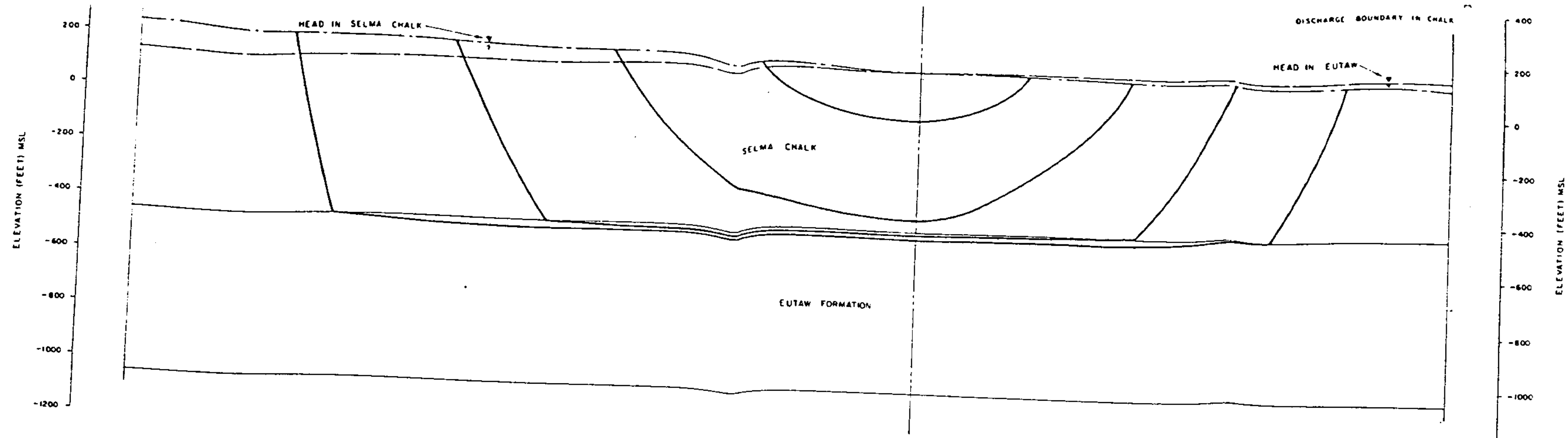
CHEMICAL WASTE MANAGEMENT, INC.
EMELLE DISPOSAL FACILITY

GROUNDWATER CONTOUR MAP IN ACTIVE AREA OF EMELLE FACILITY

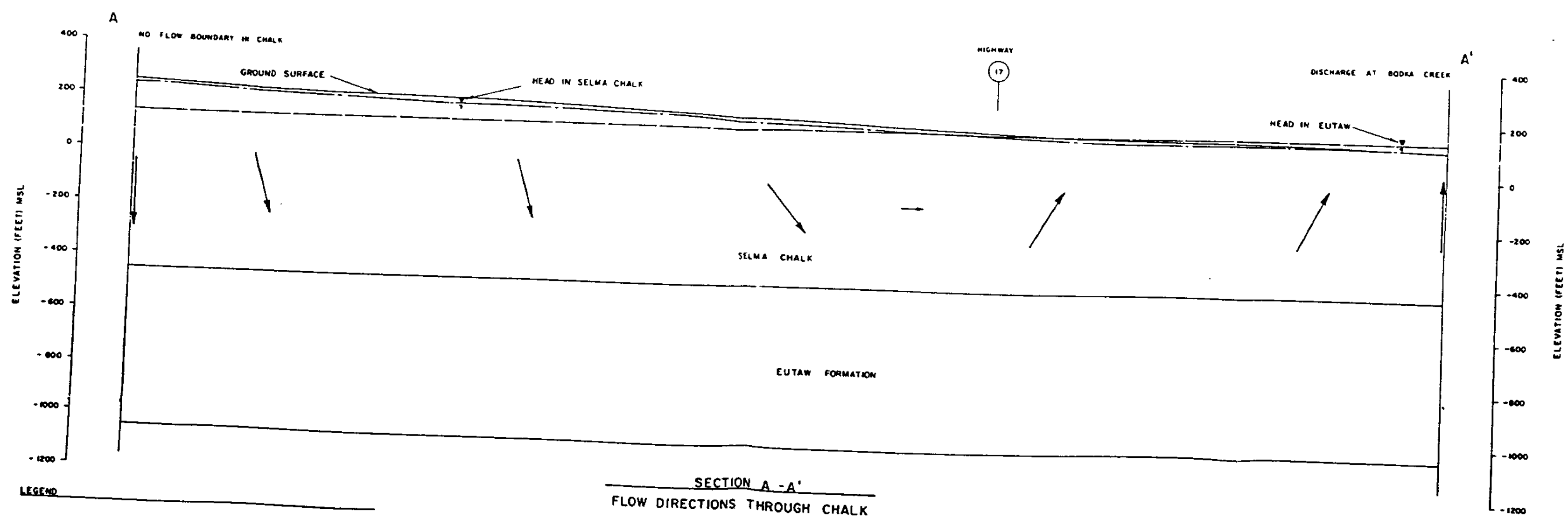
SKB	1" = 200'	12-24-82
JRB	JRB	824-1308
Golder Associates		00-150-005
		15

[redacted]


KEY
FENCE
SECTION CORNER WITH SECTION NUMBERS
PROPERTY BOUNDARIES
RCRA-1
RCRA-2
RCRA-3
RCRA-4
120
160
200
240
FUTURE DISPOSAL AREA
FUTURE DISPOSAL AREA
NORTH
LEGEND
BORINGS BY TUSCALOOSA TESTING LABORATORIES (WELLS NOT INSTALLED)
V1, D1 and D2: WOODWARD-CLYDE BORINGS FOR IN SITU PERMEABILITY TESTS (WELLS NOT INSTALLED)
G16-1, SWC, SEC: GOLDER ASSOCIATES SHALLOW BORINGS (WELLS NOT INSTALLED)
DB1, DB2, DB3: GOLDER ASSOCIATES DEEP BORINGS (WELLS NOT INSTALLED)
CLASS A CHALK OBSERVATION WELLS (2: PVC SCREENED AND SEALED)
CLASS B CHALK OBSERVATION WELLS (4" OR 6" PVC SURFACE CASING WITH OPEN BOREHOLE BELOW)
PROPOSED CHALK OBSERVATION WELLS (CLASS B)
EUTAW AQUIFER WELLS FOR INTERIM STATUS RCRA MONITORING
GROUNDWATER ELEVATION CONTOURS IN SELMA CHALK (Ft. MSL), MEASURED JULY 16-23, 1982
ESTIMATED GROUNDWATER ELEVATION CONTOURS IN SELMA CHALK (Ft. MSL)
NOTE:
MAP PROVIDED BY CHEMICAL WASTE MANAGEMENT, INC.
CHEMICAL WASTE MANAGEMENT, INC.
EMELLE DISPOSAL FACILITY
ESTIMATED GROUNDWATER CONTOUR MAP AT EMELLE FACILITY
SKB
1" = 600'
11-8-82
JEB
JEB
824-1308
Golder Associates
00-150-002



SECTION A - A'
IDEALIZED FLOW NET



SECTION A - A'
FLOW DIRECTIONS THROUGH CHALK

LEGEND

- GROUNDWATER POTENTIOMETRIC SURFACE IN SELMA CHALK
- GROUNDWATER POTENTIOMETRIC SURFACE IN EUTAW FORMATION
- IDEALIZED FLOW LINES
- APPROXIMATE FLOW DIRECTIONS

NOTE:

1. FLOW DIRECTION IN EUTAW FORMATION DOES NOT CONSIDER THE REGIONAL GRADIENT DIRECTION WHICH IS APPROXIMATELY TO THE NORTHEAST
2. SECTION LOCATION ON FIGURE 15, DRAWING NO. 00-150-003

CHEMICAL WASTE MANAGEMENT, INC.
EMELLE DISPOSAL FACILITY

IDEALIZED FLOW NET AND CHALK FLOW DIRECTIONS

JFC, SKB — 1" = 200' — 12-24-92
824-1308
Golder Associates — 00-200-00
17

APPENDIX

APPENDIX

The following data represents daily measurements of rainfall and streamflow at a combined gaging station on Jones Creek at Highway 39, about 10 miles southeast of the Emelle facility (shown on Figure 9). The gaging station is operated by the U.S. Geological Survey and the following data tables were retrieved from the USGS WATSTORE computer database. Coincident rainfall and streamflow records exist for water years (October through September) 1959 through 1965 and are presented in this Appendix.

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
W	01	USGS	02449400			00045	1959	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	MTV SEQ NO	REG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.020	0.180	0.050	0.350	0.000	0.400	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	1.170	0.000	0.000	0.000	0.000	0.600	0.000	0.100
3	0.000	0.000	0.000	0.000	0.060	0.750	0.000	0.000	0.000	0.000	0.000	0.100
4	0.000	0.000	0.000	0.000	0.520	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.210	0.000	0.000	0.400	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.500	0.000
8	0.000	0.000	0.000	0.200	0.460	0.000	0.000	0.000	0.100	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.020	0.000	0.930	0.000	0.800	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.370	0.000	0.640	0.400	0.600	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.210	0.470	0.180	0.070	1.700	0.000	0.000	0.100
12	0.000	0.000	0.000	0.000	0.320	0.000	0.140	0.230	0.000	0.000	0.000	0.200
13	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500
14	0.000	0.000	0.000	0.000	0.140	0.350	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	1.050	0.050	0.010	0.000	0.000	0.000	0.000	0.300	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.000	0.200	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.170	0.000	0.000	2.100	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.000	0.800	0.000	0.000
20	0.000	0.000	0.000	0.650	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	1.170	0.000	1.020	0.680	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.650	0.000	0.100	0.000	0.000
23	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.190	0.000	0.300	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.270	0.000	0.200	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.450	0.000	0.050	0.100	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200
28	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.040	999999	0.060	0.000	0.300	0.000	0.000	0.700	0.000
30	0.000	0.000	0.000	0.620	999999	0.000	0.000	0.100	0.100	0.000	0.200	0.000
31	0.000	999999	0.000	0.000	999999	0.000	999999	0.200	999999	0.200	0.000	999999

PROVISIONAL DATA FLAG = * *

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
W	01	USGS	02444400			00045	1960	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	HTV SEQ NO	REG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EVES AL		103.00	03160106	01	10	SW	324125	0861002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.300	0.000	0.920	0.400	0.000	0.400	0.000	0.000	0.200
2	0.000	0.000	0.100	0.600	0.000	1.880	0.500	0.000	0.600	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	1.100	0.000	0.200	0.000	0.000	0.000
4	0.000	0.400	0.000	0.000	1.500	0.000	0.000	0.000	0.000	0.000	0.100	0.100
5	0.000	0.300	0.300	0.100	0.400	0.000	0.000	0.400	0.000	0.200	0.100	0.000
6	0.700	0.000	0.000	0.500	0.000	0.000	0.000	1.200	0.000	0.000	0.000	0.000
7	0.000	0.700	0.000	0.100	0.000	0.000	0.000	0.500	0.000	0.000	0.000	0.000
8	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.300
9	0.000	0.000	0.000	0.000	0.000	1.100	0.200	0.300	0.000	0.000	0.300	0.100
10	0.000	0.000	0.000	0.100	0.050	0.000	0.000	0.000	0.000	0.000	0.300	1.300
11	0.000	0.000	0.500	0.100	0.000	0.300	0.000	0.100	0.000	0.000	0.600	0.000
12	0.000	0.000	0.400	0.000	0.350	0.000	0.000	0.000	0.000	0.000	0.600	0.000
13	1.100	0.000	0.000	0.000	0.280	0.000	0.000	0.000	0.000	0.000	1.300	0.000
14	0.300	0.560	0.000	0.100	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.200	0.020	0.400	0.000	0.000	0.000	0.000	0.000	0.200
16	0.100	0.000	0.000	0.000	0.020	0.200	0.000	0.000	0.000	0.000	0.000	2.100
17	0.100	0.000	0.700	1.300	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000
18	0.000	0.300	0.100	0.000	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.300	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.100	0.000
21	1.400	0.000	0.000	0.000	1.360	0.000	0.100	0.000	0.000	0.000	1.800	0.000
22	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.500	0.000
23	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000
24	0.000	0.000	0.000	0.000	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.010	0.100	0.000	0.000	0.800	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.100	0.000	1.400
27	0.000	0.700	0.100	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.100	0.000	0.200	0.000	0.190	0.400	0.000	0.000	0.000	0.000	0.000	0.000
29	0.100	0.000	0.000	1.600	0.390	0.900	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.200	999999	0.000	0.000	0.000	0.000	0.200	0.000	0.000
31	0.100	999999	0.000	0.000	999999	0.000	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = * * *

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
6	01	USGS	02449400			00045	1961	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	WTR SEQ NO	REG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.000	0.900	0.100	0.000
2	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.800	0.000	0.450
3	0.000	0.000	0.000	0.000	0.000	0.000	0.300	0.000	0.000	0.500	0.790	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.140
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.000	0.000
6	0.400	0.000	0.000	0.000	0.000	1.400	0.000	0.000	0.000	0.000	0.990	0.000
7	0.190	0.000	0.000	0.100	0.300	0.200	0.070	0.000	0.000	0.000	0.040	0.000
8	0.000	0.800	0.200	0.000	0.000	0.100	0.000	0.200	0.000	0.700	1.350	0.000
9	0.000	0.300	0.000	0.000	0.000	0.000	0.800	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.830	0.500	0.000	0.210
11	0.000	0.000	0.300	0.000	0.000	0.000	0.600	0.000	0.600	1.200	0.050	0.050
12	0.000	0.000	0.000	0.000	0.000	0.100	0.100	0.000	0.010	0.600	0.020	0.070
13	0.000	0.000	0.000	0.500	0.000	0.400	0.000	0.000	0.250	1.800	0.000	0.450
14	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.080	0.000	0.060	0.270
15	0.000	0.000	0.400	0.100	0.000	0.000	0.000	0.000	0.060	0.000	0.050	0.000
16	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	1.200	2.000	0.000	0.000	0.390	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	1.400	0.100	0.000	0.000	0.030	0.200	0.000	0.000
19	0.100	0.000	0.000	0.400	2.200	0.000	0.000	0.000	1.240	0.100	0.000	0.000
20	0.000	0.000	0.700	0.000	1.600	0.400	0.000	0.000	1.250	0.500	0.750	0.000
21	0.000	0.000	0.000	0.000	7.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.400	0.000	0.000	1.100	0.000	0.000	0.000	0.000	0.300	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.000
24	0.000	0.000	0.100	0.300	0.600	0.000	0.000	0.000	0.600	0.000	0.400	0.000
25	0.000	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.150	0.000	0.000	0.600
26	0.000	0.000	0.000	0.200	0.000	0.000	0.000	0.000	2.160	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.300	1.400	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.400	1.900	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.200	0.000	999999	0.500	0.000	0.000	0.100	0.000	0.000	0.000
30	1.700	0.000	0.000	0.000	999999	1.900	0.000	0.000	0.000	0.000	0.000	0.000
31	0.200	999999	1.100	0.000	999999	0.900	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = ' '

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
W	01	USGS	02449400			00045	1962	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	RIV SEQ NO	REG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.100	0.000	0.200	0.000	0.000	0.300	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.100	0.000	0.000	0.000
3	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.100	0.400	1.200	0.000	0.000	0.800	0.000	0.000	0.000	1.000	0.000
6	0.000	0.000	0.400	0.100	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.100	0.000	0.000	0.700	0.000	0.000	0.000	0.100	0.000	0.000
8	0.000	0.000	0.400	0.000	0.000	0.200	0.000	0.000	0.200	0.000	0.000	0.000
9	0.000	0.000	1.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	2.500	0.000	0.000	0.000	2.800	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	2.600	0.000	0.000	0.000	1.300	0.000	0.000	0.800	0.000	0.000
13	0.000	2.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	2.500	3.100	0.100	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.300	1.200	0.500	0.000	0.000	0.000	0.000	0.000	1.600	0.000
16	0.000	0.400	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.000
17	0.000	0.000	4.500	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.000
18	0.000	0.000	0.000	2.100	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.200	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000
21	0.000	0.000	0.000	0.000	1.200	0.100	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	2.000	0.000	0.000	0.700	0.000	0.000	0.000	0.000	0.100	0.000	0.000
23	0.000	0.200	0.000	0.300	0.100	0.000	0.000	0.000	0.200	0.000	0.000	0.000
24	0.000	0.000	0.700	0.000	0.000	0.000	1.600	0.000	0.100	0.400	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.900	0.100	0.000	2.000	0.500	0.000	0.000
26	0.000	0.000	0.000	2.000	0.000	0.000	0.000	0.000	0.700	0.000	0.000	0.000
27	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.100	0.000	1.400	0.000	0.100	2.200	0.000	0.000
29	0.000	0.000	0.000	0.000	999999	0.000	0.000	0.000	0.000	1.300	0.000	0.000
30	0.000	0.000	0.000	0.000	999999	0.400	0.000	0.500	0.000	0.000	0.000	0.000
31	0.000	999999	1.000	0.000	999999	2.500	999999	0.000	999999	0.200	0.000	999999

PROVISIONAL DATA FLAG = * *

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARA-METER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
0	01	USGS	02449400			00045	1963	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	MTY SEQ NO	BEG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.100	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.100	0.100	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.900	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	1.600	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.200	0.200	1.100	0.000	0.000	0.000	0.000	0.800	0.200
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000
14	0.000	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.300	0.000	1.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.300	0.000	0.400
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.200	0.000	0.000
17	0.000	0.100	0.000	0.700	0.000	0.000	0.000	0.000	0.600	0.100	0.000	0.000
18	0.000	0.500	0.000	0.200	1.100	0.000	0.000	0.000	0.100	0.000	0.900	0.000
19	0.000	0.100	0.000	2.500	0.000	0.700	0.000	0.000	0.100	0.000	0.000	0.000
20	0.000	0.500	0.000	0.500	0.000	0.000	0.600	0.000	1.200	0.100	0.900	0.000
21	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.100	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.700	0.000	0.000	0.000
23	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.700	0.000	0.000	0.000
24	0.000	0.000	0.700	0.000	0.300	0.000	0.200	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.200	0.100	1.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.100	0.200	0.000	0.100	0.000	1.300	0.000	0.000	0.000	0.500
27	0.000	0.000	0.000	0.000	0.000	0.000	0.100	2.600	0.000	0.000	0.100	0.100
28	0.000	0.000	0.200	0.000	0.000	0.000	1.000	1.400	0.000	0.000	0.000	0.000
29	0.000	0.000	0.400	0.200	999999	0.000	1.400	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.800	999999	0.000	0.100	0.000	0.000	0.400	0.000	0.000
31	0.000	999999	0.000	0.000	999999	0.000	999999	0.000	999999	0.200	0.000	999999

PROVISIONAL DATA FLAG = ' '

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
9	01	USGS	02449600			00045	1964	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	RIV SEQ NO	REG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	STATION LOCATOR LONG-ITUDE	STATION LOCATOR SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.600	0.000	0.100	0.000	0.300	0.000	0.000	0.000	0.200	0.000	0.000
2	0.000	0.000	0.300	0.000	0.000	2.500	0.000	0.400	0.000	0.200	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.900	0.200	0.000	0.700	0.000	0.600	0.000	0.500	0.500	0.000
5	0.000	0.000	0.000	0.000	0.300	0.000	1.900	0.600	0.000	0.000	0.100	0.000
6	0.000	0.100	0.000	0.600	0.000	0.000	2.800	0.000	0.900	0.000	0.000	0.300
7	0.000	0.000	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.000	0.600	0.000
8	0.000	0.000	0.200	0.900	0.000	0.000	0.700	0.000	0.000	0.600	0.000	0.000
9	0.900	0.000	0.000	0.400	0.000	0.600	0.000	0.000	0.000	0.800	0.000	0.600
10	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.900	0.000	0.100	0.000	0.000	0.000	0.400	1.400	0.000	0.000
12	0.000	0.000	0.100	0.200	0.000	0.000	2.200	1.200	0.000	0.100	0.900	0.000
13	0.000	0.000	0.700	0.000	0.500	0.000	1.300	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.500	0.000	0.000	1.300	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.500	1.600	0.000	0.000	0.000	0.000	0.700	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.600	0.000
17	0.000	0.000	0.000	0.000	1.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.600	0.000	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.400
19	0.000	0.000	0.000	0.100	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	1.200	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.000
23	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.300	0.000	0.100	0.000
24	0.000	0.000	0.000	1.200	0.000	0.000	0.500	0.000	0.000	2.000	0.000	0.000
25	0.000	0.000	0.000	0.600	0.900	0.600	2.200	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.600	0.000	0.200	2.400	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	1.300	0.000	0.000	0.000	0.000	0.200	0.300	0.000	1.500	0.000	0.800
29	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.100	0.000	1.800
30	0.000	0.000	0.000	0.000	999999	0.000	0.000	0.000	0.200	0.000	0.000	2.000
31	0.000	999999	0.000	0.300	999999	0.000	999999	0.100	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = ' '

Rainfall

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
R	01	USGS	02449600			00045	1965	00006	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	HTV SEQ NO	BEG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.500	0.000	0.000	0.000	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.200	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	2.500	0.000	0.000	0.100	0.700	0.000	0.000	0.000	0.000	0.000
4	0.500	0.000	0.400	0.000	0.000	0.000	0.100	0.000	0.000	0.400	0.000	0.200
5	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.700	0.000	0.000	0.000	0.100	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.800	0.500	0.000
8	0.000	0.000	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.900	0.000
9	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.600	0.000
10	0.000	0.000	0.000	0.000	1.400	0.000	0.000	0.000	1.500	0.000	0.000	0.000
11	0.000	0.000	1.000	0.000	2.100	0.300	0.000	0.000	0.300	0.000	0.000	0.000
12	0.000	0.000	0.300	0.000	0.100	0.400	0.000	0.000	0.000	0.000	0.100	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
14	1.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000
15	0.400	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.200	0.400	0.000	0.000
16	0.000	0.000	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.900	0.500	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000
19	0.000	1.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.320	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400
22	0.000	0.000	0.000	1.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	1.400	0.000	0.000	0.000	0.400	0.000	0.100	0.000	0.000
24	0.000	2.100	0.100	0.000	0.600	0.000	0.000	0.000	0.100	0.100	0.000	0.000
25	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.100	1.400	0.000	0.000	0.500	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.200	0.100	0.000	1.200	0.000
28	0.400	0.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.000
29	0.000	0.000	0.200	0.000	999999	1.500	0.000	0.000	0.000	0.000	0.000	0.100
30	0.000	0.000	0.400	0.000	999999	0.000	0.000	0.000	2.000	0.000	0.000	0.900
31	0.000	999999	0.400	0.000	999999	0.000	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG * * *

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
[illegible]	01	USGS	02449400			00060	1959	00003	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	MTV SEQ NO	REG NO	SITE CODE	STATION LOCATOR LATITUDE	STATION LOCATOR LONGITUDE	STATION LOCATOR SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR [illegible]		101.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	999999	999999	999999	999999	999999	999999	999999	999999	5.500	0.200	0.200	0.000
2	999999	999999	999999	999999	999999	999999	999999	999999	7.400	0.200	0.100	0.000
3	999999	999999	999999	999999	999999	999999	999999	999999	1.900	0.300	0.100	0.000
4	999999	999999	999999	999999	999999	999999	999999	999999	1.000	0.200	0.000	0.000
5	999999	999999	999999	999999	999999	999999	999999	999999	1.400	0.100	0.000	0.000
6	999999	999999	999999	999999	999999	999999	999999	999999	1.300	0.100	0.200	0.000
7	999999	999999	999999	999999	999999	999999	999999	999999	0.800	0.100	0.200	0.000
8	999999	999999	999999	999999	999999	999999	999999	999999	0.600	0.000	0.100	0.000
9	999999	999999	999999	999999	999999	999999	999999	999999	31.000	0.000	0.000	0.000
10	999999	999999	999999	999999	999999	999999	999999	999999	87.000	0.000	0.000	0.000
11	999999	999999	999999	999999	999999	999999	999999	999999	187.000	0.000	0.000	0.000
12	999999	999999	999999	999999	999999	999999	999999	999999	170.000	0.000	0.000	0.000
13	999999	999999	999999	999999	999999	999999	999999	999999	9.500	0.000	0.000	0.100
14	999999	999999	999999	999999	999999	999999	999999	999999	5.100	0.000	0.000	0.000
15	999999	999999	999999	999999	999999	999999	999999	999999	3.400	0.000	0.000	0.000
16	999999	999999	999999	999999	999999	999999	999999	999999	2.600	0.000	0.000	0.000
17	999999	999999	999999	999999	999999	999999	999999	999999	2.000	0.200	0.000	0.000
18	999999	999999	999999	999999	999999	999999	999999	999999	1.500	84.000	0.000	0.000
19	999999	999999	999999	999999	999999	999999	999999	999999	1.100	48.000	0.000	0.000
20	999999	999999	999999	999999	999999	999999	999999	999999	0.800	8.300	0.000	0.000
21	999999	999999	999999	999999	999999	999999	999999	999999	0.700	1.900	0.000	0.000
22	999999	999999	999999	999999	999999	999999	999999	999999	0.600	0.800	0.000	0.000
23	999999	999999	999999	999999	999999	999999	999999	999999	0.500	1.100	0.000	0.000
24	999999	999999	999999	999999	999999	999999	999999	999999	0.500	1.400	0.000	0.000
25	999999	999999	999999	999999	999999	999999	999999	999999	0.600	0.600	0.000	0.000
26	999999	999999	999999	999999	999999	999999	999999	999999	0.500	0.400	0.000	0.000
27	999999	999999	999999	999999	999999	999999	999999	999999	0.400	0.300	0.000	0.000
28	999999	999999	999999	999999	999999	999999	999999	999999	0.300	0.200	0.000	0.000
29	999999	999999	999999	999999	999999	999999	999999	999999	0.200	0.200	0.000	0.000
30	999999	999999	999999	999999	999999	999999	999999	999999	0.100	0.100	0.000	0.000
31	999999	999999	999999	999999	999999	999999	999999	999999	999999	0.100	0.000	999999

PROVISIONAL DATA FLAG = ***

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
8	01	USGS	02449400			00060	1960	00003	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	RIV SEG NO	SEG NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.520	2.700	16.000	10.000	6.200	0.080	0.000	0.000	0.000	0.000
2	0.000	0.000	0.570	23.000	8.000	320.000	44.000	0.020	3.800	0.000	0.000	0.000
3	0.000	0.000	0.570	57.000	7.000	29.000	318.000	0.010	1.100	0.000	0.000	0.000
4	0.000	0.000	0.310	5.400	214.000	10.000	15.000	0.010	0.110	0.000	0.000	0.000
5	0.000	0.170	0.310	4.900	256.000	7.000	8.000	0.020	0.020	0.000	0.000	0.000
6	0.000	0.200	0.770	95.000	15.000	5.600	5.400	3.000	0.000	0.000	1.000	0.000
7	0.000	0.110	0.570	13.000	11.000	5.400	4.200	18.300	0.000	0.000	0.000	0.000
8	0.000	0.110	0.400	4.300	8.000	4.500	3.500	1.800	0.000	0.000	0.000	0.000
9	0.000	0.040	0.310	6.500	6.000	138.000	3.590	0.770	0.000	0.000	0.100	0.000
10	0.000	0.000	0.270	6.800	6.000	13.000	3.100	1.200	0.000	0.000	0.200	0.120
11	0.000	0.800	0.400	7.300	5.000	50.000	2.500	0.480	0.000	0.000	0.300	0.070
12	0.000	0.000	57.000	5.500	4.000	10.000	2.100	0.360	0.000	0.000	0.400	0.000
13	0.000	0.000	4.700	5.600	7.000	6.400	1.900	0.360	0.000	0.000	2.800	0.000
14	0.000	0.010	3.100	5.900	4.000	13.000	1.700	0.200	0.000	0.000	0.500	0.000
15	0.000	0.060	2.500	21.000	3.000	198.000	1.500	0.110	0.000	0.000	0.000	0.000
16	0.000	0.180	2.100	6.500	2.000	193.000	1.300	0.070	0.000	0.000	0.000	16.000
17	0.000	0.070	55.000	261.000	2.000	12.000	1.100	0.060	0.000	0.000	0.000	1.800
18	0.000	0.020	8.000	22.000	2.000	7.600	1.100	0.040	0.000	0.000	0.000	0.400
19	0.000	0.000	4.200	4.100	3.000	5.600	0.770	0.020	0.000	0.000	0.000	0.070
20	0.000	0.000	3.000	6.500	2.000	4.200	1.000	0.010	0.000	0.000	0.000	0.010
21	2.200	0.000	2.500	5.200	270.000	3.700	1.300	0.010	0.000	0.000	35.000	0.010
22	0.550	0.000	2.000	4.500	20.000	3.300	0.840	0.010	0.000	0.000	107.000	0.000
23	0.040	0.000	1.800	3.800	10.000	3.000	0.720	0.000	0.000	0.000	3.100	0.000
24	0.000	0.000	1.500	3.800	10.000	2.400	0.520	0.000	0.000	0.000	0.620	0.000
25	0.000	0.000	1.300	3.300	6.000	3.100	0.400	0.000	0.000	0.000	0.090	0.000
26	0.000	0.000	1.500	3.000	5.000	3.000	0.310	0.000	0.000	0.200	0.000	2.400
27	0.000	13.000	1.600	20.000	4.000	2.700	0.620	0.000	0.000	0.000	0.000	1.400
28	0.000	2.700	6.200	8.300	5.000	1.700	0.310	0.000	0.000	0.000	0.000	0.620
29	0.000	3.100	3.000	314.000	7.000	105.000	0.200	0.000	0.000	0.000	0.000	0.440
30	0.000	0.470	2.100	113.000	999999	23.000	0.100	0.000	0.000	0.000	0.000	0.200
31	0.000	999999	1.700	17.000	999999	7.000	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = '*'

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
4	01	USGS	02449400			00060	1961	00003	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	RIV SEG NO	BEG NO	SITE CODE	STATION LOCATOR LATITUDE	LONGITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR LYES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.040	4.500	0.440	15.000	4.500	10.000	15.000	0.820	0.000	8.200	0.000	0.000
2	0.040	2.700	0.310	8.100	22.000	8.100	8.600	0.620	0.000	14.000	0.000	0.000
3	0.000	1.400	0.310	6.200	35.000	7.100	11.000	0.480	0.000	12.000	0.000	0.000
4	0.000	1.300	0.160	4.900	9.300	6.500	11.000	0.440	0.000	7.300	0.000	0.000
5	267.000	1.000	0.310	4.700	6.500	5.400	6.500	0.360	0.000	2.700	0.000	0.000
6	70.000	0.620	0.270	4.200	6.200	124.000	5.200	0.230	0.000	2.100	1.000	0.000
7	25.000	0.420	0.270	4.200	17.000	350.000	4.500	0.200	0.000	1.500	0.060	0.000
8	8.000	0.320	0.310	5.400	9.700	16.000	3.700	0.180	0.000	2.400	0.000	0.000
9	4.500	0.440	0.520	3.700	6.500	5.800	56.000	0.200	0.000	3.000	0.000	0.000
10	2.800	2.600	0.360	3.100	4.900	4.400	6.500	0.160	0.000	84.000	0.000	0.000
11	2.000	1.100	2.700	1.000	4.000	4.000	4.700	0.200	0.000	127.000	0.000	0.000
12	1.500	0.770	1.200	2.800	3.700	4.000	88.000	0.160	0.000	214.000	31.000	3.000
13	1.000	0.620	0.670	12.000	3.100	57.000	7.600	0.130	0.000	346.000	1.700	0.000
14	0.720	0.520	0.570	29.000	2.700	6.800	4.900	0.090	0.000	30.000	0.040	0.000
15	0.570	0.440	3.400	10.000	2.500	4.100	3.800	0.090	0.000	9.700	1.900	0.000
16	0.440	0.480	3.000	7.100	2.200	1.400	3.000	0.060	0.000	4.500	1.400	0.000
17	0.310	0.770	1.800	5.900	91.000	140.000	2.400	0.040	0.000	3.000	0.060	0.000
18	0.200	0.620	1.500	5.200	639.000	289.000	2.100	0.020	0.000	12.000	0.000	0.000
19	0.130	0.440	1.300	25.000	451.000	9.700	1.900	0.000	0.000	55.000	0.000	0.000
20	0.230	0.310	9.400	9.300	376.000	31.000	1.800	0.000	0.540	4.700	0.350	0.000
21	0.110	0.200	24.000	5.600	1530.00	23.000	1.500	0.000	1.800	4.000	0.310	0.600
22	0.070	0.270	5.200	4.700	560.000	6.700	1.400	0.000	0.200	8.700	0.000	0.000
23	0.040	8.900	4.800	4.900	10.000	4.800	1.300	0.000	0.060	13.000	0.000	0.000
24	0.010	2.300	3.400	5.200	124.000	3.800	1.100	0.000	0.000	4.700	5.400	0.000
25	0.010	1.600	3.300	11.000	82.000	3.100	1.000	0.000	26.000	2.000	1.600	0.000
26	0.010	1.200	3.300	95.000	15.000	2.400	7.500	0.000	364.000	1.100	0.010	0.000
27	0.010	1.100	2.700	16.000	11.000	4.600	1.400	0.000	8.000	0.670	0.000	0.000
28	0.010	1.100	2.300	9.300	22.000	378.000	0.890	0.000	3.100	0.480	0.000	0.000
29	0.010	0.880	2.400	7.300	999999	147.000	0.670	0.000	1.600	0.230	0.000	0.000
30	1.700	0.620	4.700	5.400	999999	167.000	0.620	0.000	0.940	0.010	0.000	0.000
31	74.000	999999	156.000	4.900	999999	529.000	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = 'C'

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
*	01	USGS	02449400			00060	1982	00003	999999.0000	01	119		11.70

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	RIV SEC NO	REG NO	SITE CODE	STATION LOCATOR LATITUDE	LONGITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EMES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	1.400	74.000	5.200	3.800	14.000	4.000	0.000	0.000	0.000	0.000
2	4.400	0.000	1.600	10.000	4.200	4.700	6.800	3.300	0.000	0.000	0.000	0.000
3	1.400	0.000	1.500	7.000	3.700	4.000	5.200	2.500	0.000	0.000	0.000	0.000
4	0.000	4.400	1.400	5.600	3.500	3.500	4.200	1.900	0.000	0.000	0.000	0.000
5	0.000	0.420	22.000	154.000	3.300	3.000	19.000	1.500	0.000	0.000	5.000	0.000
6	0.000	0.000	44.000	150.000	2.700	2.700	80.000	1.100	0.000	0.000	2.600	0.000
7	0.000	0.000	12.000	12.000	2.300	2.600	13.000	0.770	0.000	0.000	0.000	0.000
8	0.000	0.000	4.700	8.000	2.400	2.500	8.300	0.620	0.000	0.000	0.000	0.000
9	0.000	0.000	159.000	6.500	2.700	85.000	5.400	0.440	0.000	0.000	0.000	0.000
10	0.000	0.000	117.000	5.600	1.900	12.000	4.200	0.310	0.000	0.000	0.000	0.000
11	0.000	1.000	404.000	4.400	1.700	11.000	118.000	0.230	0.000	0.000	0.000	0.000
12	0.000	0.000	586.000	4.200	1.700	6.900	725.000	0.200	0.000	0.000	0.000	0.000
13	0.000	65.000	22.000	3.400	1.700	4.200	15.000	0.130	0.000	0.000	0.000	0.000
14	0.000	60.000	560.000	75.000	1.560	3.500	8.300	0.110	0.000	0.000	0.700	0.430
15	0.000	6.600	82.000	292.000	1.500	5.400	5.903	0.110	0.000	0.000	0.040	0.030
16	0.000	25.000	28.000	24.000	3.700	3.300	4.500	0.110	0.000	0.000	0.000	21.000
17	0.000	4.100	1050.00	14.000	1.800	2.700	4.000	0.090	0.000	0.000	0.000	17.000
18	0.000	1.900	211.000	280.000	1.500	2.500	3.700	0.040	0.000	0.000	0.000	0.000
19	0.000	1.400	18.000	384.000	1.900	2.400	3.100	0.020	0.000	0.000	0.000	0.000
20	0.000	0.940	10.000	24.000	1.300	2.300	2.700	0.020	0.000	0.000	0.000	0.000
21	0.000	0.470	6.800	22.000	77.000	2.400	2.100	0.000	0.000	0.000	0.000	0.000
22	0.000	54.000	5.400	20.000	144.000	1.800	1.800	0.000	0.000	0.000	0.000	0.000
23	0.000	266.000	5.000	54.000	23.000	1.800	1.600	0.000	0.000	0.000	0.000	0.000
24	0.000	4.300	4.500	11.000	14.000	1.700	21.000	0.000	0.000	0.000	0.000	0.000
25	0.000	4.200	4.000	22.000	6.800	53.000	22.000	0.000	3.100	0.000	0.000	0.000
26	0.000	3.100	3.500	270.000	5.600	4.500	3.100	0.000	0.440	0.000	0.000	0.000
27	0.000	2.700	9.000	177.000	4.900	3.000	2.100	0.000	0.210	0.000	0.000	0.000
28	0.000	2.000	6.200	34.000	3.100	2.400	96.000	0.000	1.000	45.000	0.000	0.000
29	0.000	1.600	4.000	10.000	999999	1.900	15.000	0.000	0.000	16.000	0.000	0.000
30	0.000	1.300	3.300	7.600	999999	3.700	6.500	0.000	0.000	0.450	0.000	0.000
31	0.000	999999	107.000	5.400	999999	460.000	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = '*'

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
#	01	USGS	02449400			00060	1963	00003	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	RIV SEQ NO	REG NO	SITE CODE	STATION LOCATOR LATITUDE	LONGITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EPES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.000	11.000	77.000	0.900	5.600	1.200	0.300	0.000	0.000
2	0.000	0.000	0.000	0.000	12.000	11.000	0.800	3.500	0.600	0.600	0.000	0.000
3	0.000	0.000	0.000	0.000	45.000	6.800	0.800	2.500	0.400	13.000	0.000	0.000
4	0.000	0.000	0.000	0.000	9.700	6.500	0.500	1.700	0.300	2.000	0.000	0.000
5	0.000	0.000	0.000	0.000	7.400	602.000	0.400	1.100	0.200	0.500	0.000	0.000
6	0.000	0.000	0.000	0.000	6.600	62.000	0.500	0.700	0.400	0.200	0.000	0.000
7	0.000	0.000	0.000	0.000	5.200	14.000	0.600	0.500	0.200	0.100	0.000	0.000
8	4.100	0.000	0.000	0.000	4.200	9.000	0.400	0.400	0.100	0.100	0.000	0.000
9	0.400	0.000	0.000	0.000	3.800	8.100	0.400	0.300	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	3.700	7.000	0.400	0.200	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	66.000	4.700	6.200	0.300	0.200	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	7.000	5.400	164.000	0.300	0.100	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	6.400	4.200	19.000	0.200	0.100	0.000	2.500	0.000	0.000
14	0.000	0.000	0.000	2.300	3.300	9.700	0.100	0.100	0.000	0.800	0.000	0.000
15	0.000	0.000	0.000	1.100	2.800	7.300	0.100	0.000	0.000	0.300	0.000	0.000
16	0.000	0.000	0.000	1.400	2.500	6.800	0.100	0.000	0.000	70.000	0.000	0.000
17	0.000	0.000	0.000	1.000	2.500	6.400	0.100	0.000	1.300	3.500	0.000	0.000
18	0.000	0.000	0.000	44.000	38.000	5.900	0.100	0.000	0.300	1.700	0.000	0.000
19	0.000	0.000	0.000	614.000	63.000	14.000	0.100	0.000	0.100	1.200	0.005	0.000
20	0.000	0.000	0.000	83.000	9.700	14.000	1.400	0.000	9.200	0.200	0.000	0.000
21	0.000	0.600	0.000	15.000	6.500	4.700	0.600	0.000	1.600	0.100	0.000	0.000
22	0.000	0.000	0.000	8.100	4.200	3.800	0.200	0.000	173.000	0.000	0.000	0.000
23	0.000	0.000	0.000	9.000	4.500	3.500	0.100	0.000	151.000	0.000	0.000	0.000
24	0.000	0.000	0.000	5.000	8.600	3.100	0.000	0.000	16.000	0.000	0.000	0.000
25	0.000	0.000	0.000	4.000	5.400	3.900	0.100	0.100	5.200	0.000	0.000	0.000
26	0.000	0.000	0.000	6.500	4.000	4.200	0.100	25.000	3.300	0.000	0.000	0.000
27	0.000	0.000	0.000	7.000	3.100	2.400	0.100	223.000	2.500	0.000	0.000	0.000
28	0.000	0.000	0.000	4.200	3.100	2.200	130.000	215.000	1.500	0.000	0.000	0.000
29	0.000	0.000	1.400	4.200	999999	1.700	142.000	15.000	0.800	0.000	0.000	0.000
30	0.000	0.000	0.200	96.000	999999	1.100	26.000	4.200	0.500	0.700	0.000	0.000
31	0.000	999999	0.000	21.000	999999	1.100	999999	2.500	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = '*'

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
3	01	USGS	02449400			00060	1964	00003	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	MTV SEQ NO	MED NO	SITE CODE	STATION LOCATOR LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR [illegible] AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.000	0.000	0.000	0.400	4.200	6.400	2.500	3.100	0.000	0.000	0.800	0.000
2	0.000	0.100	0.600	1.100	3.100	674.000	2.000	8.600	0.000	0.000	0.300	0.000
3	0.000	0.000	0.000	26.000	2.600	30.000	2.000	4.500	0.000	0.000	0.200	0.000
4	0.000	0.000	0.000	31.000	2.300	113.000	2.000	2.500	0.000	0.000	0.100	0.000
5	0.000	0.000	0.000	4.100	11.000	25.000	98.000	1.900	0.000	0.000	0.400	0.000
6	0.000	0.000	0.000	56.000	7.200	8.500	825.000	1.500	0.300	0.000	0.200	0.000
7	0.000	0.000	0.000	14.000	4.000	19.000	26.000	1.200	1.000	0.000	0.200	0.000
8	0.000	0.000	0.000	12.000	3.300	12.000	111.000	1.000	0.000	0.000	0.300	0.000
9	0.000	0.000	0.000	274.000	2.800	76.000	16.000	0.900	0.000	3.700	3.100	0.000
10	0.000	0.000	0.000	8.600	2.300	32.000	6.200	0.800	0.000	0.800	2.100	0.600
11	0.000	0.000	0.000	6.500	2.200	12.000	4.400	0.700	0.000	11.000	0.100	0.000
12	0.900	0.000	0.900	8.400	2.000	5.600	375.000	19.000	0.000	3.700	4.300	0.000
13	0.000	0.000	8.000	4.700	13.000	6.900	345.000	4.400	0.000	1.000	0.900	0.000
14	0.000	0.000	15.000	3.500	11.000	145.000	24.000	1.200	0.000	0.100	0.200	0.000
15	0.000	0.000	1.100	3.800	70.000	537.000	10.000	0.800	0.000	0.000	1.300	0.000
16	0.000	0.000	[illegible]	4.000	16.000	18.000	6.200	0.600	0.000	0.000	5.500	0.000
17	0.000	0.000	0.100	4.900	26.000	10.000	4.400	0.500	0.000	0.000	0.900	0.000
18	0.000	0.000	0.000	1.500	283.000	7.300	3.100	0.400	0.000	0.000	0.400	0.000
19	0.000	0.000	0.000	1.300	16.000	16.000	2.600	0.300	0.000	0.000	0.300	0.000
20	0.000	0.000	0.000	1.700	8.000	12.000	1.900	0.200	0.000	0.000	0.200	0.000
21	0.000	0.000	0.000	2.100	5.900	8.600	1.700	0.100	0.000	0.000	0.200	0.000
22	0.000	0.000	0.100	2.200	4.900	5.100	1.600	0.100	0.000	0.000	0.100	0.000
23	0.000	0.000	5.000	2.500	3.700	4.200	1.200	0.000	0.000	0.000	0.100	0.000
24	0.000	0.000	1.400	330.000	1.500	1.400	1.900	0.000	0.000	17.000	0.000	0.000
25	0.000	0.000	0.700	44.000	110.000	4.000	164.000	0.000	0.000	2.500	0.000	0.000
26	0.000	0.000	0.500	9.000	17.000	57.000	420.000	0.000	0.000	0.200	0.000	0.000
27	0.000	0.000	0.400	5.900	11.000	8.200	209.000	0.000	0.000	0.100	0.000	0.000
28	0.000	0.000	0.200	4.500	12.000	5.400	14.000	0.000	0.000	7.200	0.000	0.000
29	0.000	0.000	0.200	3.500	6.500	4.000	7.400	0.000	0.000	2.800	0.000	152.000
30	0.000	0.000	0.100	3.300	999999	3.000	4.400	0.000	0.000	0.800	0.000	2.800
31	0.000	999999	0.200	5.900	999999	2.800	999999	0.000	999999	3.600	0.000	999999

PROVISIONAL DATA FLAG = [illegible]

Streamflow

FILE TYPE	STATE CODE	AGENCY CODE	STATION IDENTIFICATION NUMBER	CROSS SECTION	SAMPLING DEPTH	PARAMETER CODE	YEAR	STAT CODE	NO VALUE INDICATOR	DIST CODE	COUNTY CODE	DRAINAGE AREA	CONTRIB. DRAINAGE AREA
W	01	USGS	02444400			00060	1965	00003	999999.0000	01	119	11.70	

STATION NAME OR LOCAL WELL NUMBER	WELL DEPTH	DATUM	HYDROLOGIC UNIT CODE	MTV SEC NO	NEG NO	SITE CODE	STATION LOCATION LAT-ITUDE	LONG-ITUDE	SEQ NO	GEOLOGIC UNIT CODE
JONES CREEK NEAR EMES AL		103.00	03160106	01	10	SW	324125	0881002	00	

DAY	10	11	12	01	02	03	04	05	06	07	08	09
1	0.400	0.100	4.500	16.000	5.800	136.000	7.100	0.600	0.000	2.500	0.000	0.000
2	0.400	1.200	4.000	15.000	5.700	57.000	5.300	0.500	0.000	0.000	0.000	0.000
3	.600	1.200	50.000	20.000	2.500	14.000	77.000	0.400	0.000	0.000	0.000	0.000
4	105.000	0.200	560.000	8.400	2.500	13.000	41.000	0.300	0.000	3.000	0.000	0.000
5	14.000	0.200	22.000	6.800	2.000	7.900	12.000	0.200	0.000	0.400	0.000	0.300
6	1.600	0.200	15.000	6.000	100.000	6.[illegible]	6.601	0.100	0.000	0.000	0.000	0.030
7	[illegible]	0.200	13.000	5.300	22.000	5.000	5.000	0.100	0.000	3.200	0.000	0.000
8	.500	0.200	11.000	4.400	11.000	3.900	3.700	0.000	0.000	0.000	0.000	0.000
9	0.500	0.200	10.000	43.000	21.000	3.000	2.500	0.000	0.000	0.000	0.000	0.000
10	0.400	0.200	4.200	160.000	346.000	2.500	2.200	0.000	1.700	0.000	0.000	0.000
11	0.400	0.100	707.000	12.000	304.000	2.500	1.900	0.000	2.800	0.000	0.000	0.600
12	0.300	0.100	59.000	8.500	269.000	186.000	1.600	0.000	0.000	0.000	0.000	0.000
13	0.300	0.100	17.000	7.400	16.000	16.000	1.500	0.000	0.000	0.000	0.000	0.000
14	0.400	0.100	10.000	5.800	9.600	8.500	1.400	0.000	0.000	0.000	0.000	0.000
15	121.000	0.100	8.200	12.000	7.100	6.300	1.300	0.000	3.600	0.000	0.000	0.000
16	3.800	0.100	7.100	9.200	9.600	4.800	1.200	0.000	0.000	0.300	0.000	0.000
17	1.600	0.100	20.000	4.400	244.000	37.000	1.200	0.000	0.000	0.000	0.000	0.000
18	1.000	0.100	25.000	4.900	20.000	11.000	1.100	0.000	0.000	0.000	0.000	0.000
19	0.600	2.400	9.200	4.100	10.000	4.800	1.000	0.000	0.000	0.000	0.000	0.000
20	0.600	3.500	11.000	3.700	7.400	2.800	1.000	0.000	0.000	0.000	0.000	0.000
21	.600	0.500	15.000	3.200	7.100	2.200	0.900	0.000	0.000	0.000	0.000	0.000
22	0.500	0.300	12.000	112.000	4.600	2.000	0.900	0.000	0.000	0.000	0.000	0.000
23	0.500	0.300	11.000	554.000	3.900	2.000	0.800	0.000	0.000	0.000	0.000	0.000
24	0.4[illegible]	260.000	9.500	24.000	80.000	2.300	0.700	0.000	0.000	0.000	0.000	0.000
25	0.300	26.000	10.000	14.000	10.000	1.600	0.700	0.000	0.000	0.000	0.000	0.000
26	0.300	8.000	7.400	9.200	5.800	1.400	0.600	0.000	0.000	2.000	0.000	0.000
27	0.300	5.400	4.800	5.500	4.600	4.400	2.600	0.000	0.000	0.000	0.000	0.000
28	0.400	91.000	4.400	4.800	3.700	9.800	0.900	0.000	0.000	0.000	0.000	0.000
29	0.400	9.200	3.400	3.900	999999	152.000	0.800	0.000	0.000	0.000	0.000	0.000
30	0.500	5.800	53.000	3.200	999999	102.000	0.700	0.000	1.900	0.000	0.000	0.000
31	0.300	999999	153.000	1.900	999999	12.000	999999	0.000	999999	0.000	0.000	999999

PROVISIONAL DATA FLAG = ***

20 RECORDS HAVE BEEN RETRIEVED FOR RETRIEVAL NO. 1

APPENDIX E-5

SECTION E

EUTAW AQUIFER GROUNDWATER MONITORING SYSTEM

EMELLE, ALABAMA

<u>Revision No.</u>
5.0

APPENDIX E-5

SECTION E

LIST OF DOCUMENTS

Document 1: Eutaw Aquifer Groundwater Monitoring System, Emelle, Alabama, prepared by Golder Associates, revised February 1986.

Document 2: Eutaw Aquifer Monitoring Well Installation and Abandonment Report Chemical Waste Management, Emelle, Alabama, prepared by Golder Associates, dated December 4, 2015.

APPENDIX E-5

DOCUMENT 1

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

Report on

EUTAW AQUIFER GROUNDWATER MONITORING SYSTEM EMELLE, ALABAMA

Submitted to

Chemical Waste Management, Inc.
2600 Delk Road, Suite 200
Marietta, Georgia 30067

Distribution:

2 Copies - Chemical Waste Management, Inc.
1 Copy - Golder Associates

November 1985
Revised February 1986

853-3107

New Page
February 24, 1986

3772 PLEASANTDALE ROAD, SUITE 185, ATLANTA, GEORGIA 30340, U.S.A. • TELEPHONE (404) [illegible]
OFFICES IN UNITED STATES • CANADA • UNITED KINGDOM • AUSTRALIA

Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

February 13, 1986 853-3107

Chemical Waste Management, Inc.
2600 Delk Road, Suite 200
Marietta, Georgia 30067

Attn: Mr. Don R. McCombs, P.E.

RE: EUTAW AQUIFER GROUNDWATER MONITORING SYSTEM
EMELLE, ALABAMA

Gentlemen:

Please find attached the report on the Eutaw aquifer groundwater monitoring system at the Emelle Facility. This report includes the groundwater level data from the system with Well 9, a detailed geologic overview, sealing records for Well 4 and a certification by a qualified geohydrologist regarding the compliance of the facility with the applicable groundwater regulations.

We appreciate the opportunity to work with CWM on this project and should you have any questions, please contact us.

Very truly yours,

GOLDER ASSOCIATES

J. Edmund Baker, P.E.
Principal

JEB:mrs

Attachments

3772 PLEASANTDALE ROAD, SUITE 185, ATLANTA, GEORGIA 30340, U.S.A. • TELEPHONE (404) 496-1893

New Page
February 24, 1996

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New Page

1.0 INTRODUCTION

Chemical Waste Management, Incorporated (CWM) owns and operates a hazardous waste disposal facility near the town of Emelle, Sumter County, Alabama (referred to herein as the Emelle site). In accordance with regulations set forth under the Resource Conservation and Recovery Act (RCRA), CWM maintains a network of groundwater monitoring wells in the Eutaw Formation, which is the uppermost aquifer beneath the site. This report contains a description of the existing well network with recent modifications, an interpretation of geophysical logs run the wells and other borings, a description of the relevant site geology and hydrogeology, and a compilation of geological and well completion information pertaining to the well network. This report also contains certification that the monitoring well program is in compliance with the requirements set out in 40 CFR 265, Subpart F.

2.0 GEOLOGY AND HYDROGEOLOGY

2.1 Regional Geology

The geologic units of primary concern at the Emelle site are the Eutaw Formation, which is the uppermost aquifer at the site, and the Selma Group which is the surficial geologic formation. The Selma Group overlies the Eutaw Formation, acts as a confining bed to the Eutaw Formation, and prevents migration of wastes into the aquifer.

The Eutaw Formation, of Late Cretaceous age, consists of sands and clay approximately 400 feet thick. The lower part of the Eutaw Formation has been mapped separately as the McShan Formation in the outcrop area in Tuscaloosa and Pickens counties, but is referred to as the "Lower Eutaw" in the subsurface (ref. 1, p. 19). It consists of fine to coarse grained very glauconitic sands and sandstones with interbedded clays and shales. The upper sand unit in the Eutaw Formation has been referred to as the Tombigbee Sand Member (ref. 2, p. 235). It is composed of fossiliferous fine to medium grained glauconitic sand. Chalk, claystone, and calcareous sandstone beds may be present in the upper part of the unit near the contact with the overlying Mooreville Formation. The middle part of the Eutaw Formation consist of clay, shale, and relatively thin sand beds.

The Eutaw formation is overlain by the Selma Group, a deposit of semiconsolidated chalk and marl of Late Cretaceous age. At the site, the Selma Group is about 650 feet thick. Although the Selma Group has been subdivided into formations based on fossil assemblages, marker horizons, and minor variations in lithology, the essential character of the group, that of a dense, fine grained, semiconsolidated chalk or marl, is preserved throughout the sequence with little variation either laterally or with depth.

The oldest and lowest formation in the Selma Group is the Mooreville Formation, which unconformably overlies the Eutaw Formation. The Mooreville Formation is a medium gray marl, clay or clayey chalk. The basal unit has been described as a compact calcareous sandstone (ref. 3, p. 90), however this unit is not continuous in the subsurface at the Emelle Facility. The presence of increased glauconite in the chalk (referred to in driller's logs as "chalk with pepper") has been found to be a reliable indicator of the base of the Mooreville Formation. The top of the Mooreville Formation is defined by the Arcola Limestone Member, a bed of soft to hard, very light colored high-calcium chalk or limestone. The low clay content and relatively high porosity of the Arcola Limestone Member make it easily distinguishable on geophysical logs. The Mooreville Formation is about 270 feet thick and the Arcola Member is about 10 feet thick at the Emelle site. *

The Mooreville Formation is overlain by the Demopolis Formation. The Demopolis Formation is a light gray chalk which is somewhat more indurated and contains less clay than the Mooreville Formation (ref. 1, p. 20). Fossils, bioturbation and pyrite filled burrows are abundant in places. The upper unit of the Demopolis Formation, the Bluffport Marl Member, contains less clay than the lower member, and outcrops over much of the Emelle Facility. The thickness of the Demopolis Formation varies from about 335 feet at the north end of the site, where the Bluffport Marl Member has been removed by erosion, to about 500 feet at the south end of the site.

The Demopolis Formation is overlain conformably by the Ripley Formation, which outcrops at the southern most (down dip) edge of the site. Elsewhere, the Ripley Formation has been removed by erosion. At the outcrop, the Ripley Formation consists of a sandy clayey chalk containing abundant fossils (ref. 4, p. 2742). Recent alluvial and terrace deposits occur in the floodplain of Bodka Creek, at the western edge of the site.

2.2 Site Geology

The sites specific geology at the Emelle Facility has been investigated in detail through a series of deep continuously cored boreholes, drillers logs from the installation of deep Eutaw Aquifer monitoring wells, and a series of geophysical logs. This information was utilized to determine the elevations at which various geologic formations and members were encountered at the site. The information used in this site specific geologic characterization includes three continuously cored holes with depths of approximately 500 feet each, five Eutaw Aquifer monitoring wells, and down hole geophysical logs run in two of the coreholes and three monitoring wells. All of the data was collected under the direct supervision of Golder Associates with the exception of the geophysical logs run in Eutaw monitoring wells 2 and 3 which were run by the Geological Survey of Alabama. Table 1 shows the data collected for each of the coreholes and monitoring wells.

The drillers logs for Eutaw Aquifer monitoring wells 5 through 9 are included in this report as Appendix A and the geophysical logs are included in Appendix B, with the exception of those run by the Geological Survey of Alabama. The detailed geotechnical logs of the three continuously

February 1986 853-3107

TABLE 1
SUMMARY OF GEOLOGIC DATA TYPES

Well	Drillers Log	Core & Core Log	Electric Log	Gamma Log	Neutron or Bulk Density Log	Caliper Log
MW1						
MW2			***		***	***
MW3			***		***	***
MW4						
MW5	*					
MW6	*					
MW7	*					
MW8	*					
MW9	*		*	*	*	
DB1		**	*			
DB2		**				
DB3		**	*			

* Included in this report
** Included in Golder Report entitled "Geological and Geotchnical Evaluation of the Emelle Facility", revised June, 1983.
*** Available from the Geologic Survey of Alabama

New Page
February 24, 1986

cored holes are included in Golder Associates report entitled "Geological and Geotechnical Evaluation of the Emelle Facility" revised June, 1983. The cores themselves are stored at the Emelle Facility and representative photographs of the core are included in the previously mentioned report.

The geophysical logs, drillers logs and corehole logs were interpreted to obtain the following information:

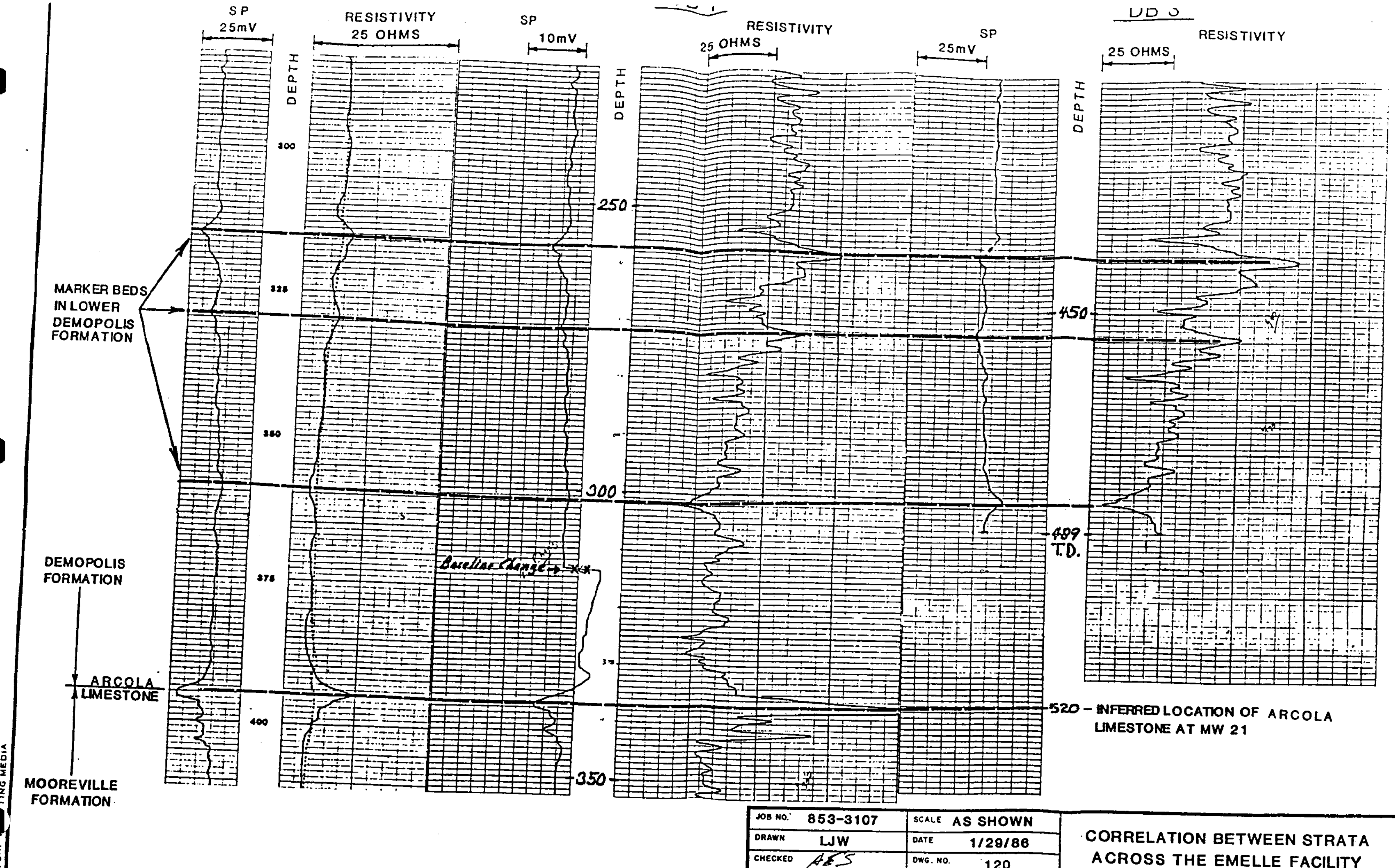
1) to assess the continuity and homogeneity of the various strata within the Selma Group;

2) to locate specific marker beds including the Arcola Limestone and the top of the Tombigbee Sand Member of the Eutaw Aquifer;

3) to verify the regional depth and thickness of the various geologic formations; and

4) to determine the lithology of the Tombigbee Sand Member in which the Eutaw Aquifer monitoring wells are completed.

An example of the correlation between the electric logs (self potential and resistivity) of Eutaw Monitoring Well 9, Deep Boring 1 and Deep Boring 3, is shown in Figure 1. This figure shows the location of three undifferentiated marker beds in the lower Demopolis Formation of the Selma Chalk and the location of the Arcola Limestone which serves as the marker bed differentiating the Demopolis Formation from the Mooreville Formation. As shown in this figure, the Arcola Limestone causes a distinct increase in the resistivity and a decrease in the self-potential logs. Deep Boring 2, which



JOB NO. 853-3107	SCALE AS SHOWN	CORRELATION BETWEEN STRATA ACROSS THE EMELLE FACILITY
DRAWN LJW	DATE 1/29/86	
CHECKED AES	DWG. NO. 120	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 1

is located at the southern boundary of the site near Highway 17 or downdip, was cored to a depth of 489 feet without encountering the Arcola Limestone. However, by correlating marker beds in the lower Demopolis Formation between these three wells it is possible to infer that the Arcola Limestone lies at a depth of about 520 feet at the location of Deep Boring 3.

To illustrate the correlation between the drillers logs and the geophysical logs, a lithologic interpretation of the upper Tombigbee Sand Member of the Eutaw Aquifer is presented in Figure 2. Based on the gamma log signature, which measures clay content, and the neutron log signature, which measures porosity, the following lithologic interpretation can be made:

High gamma, high neutron - soft clay

High gamma, low neutron - hard clay

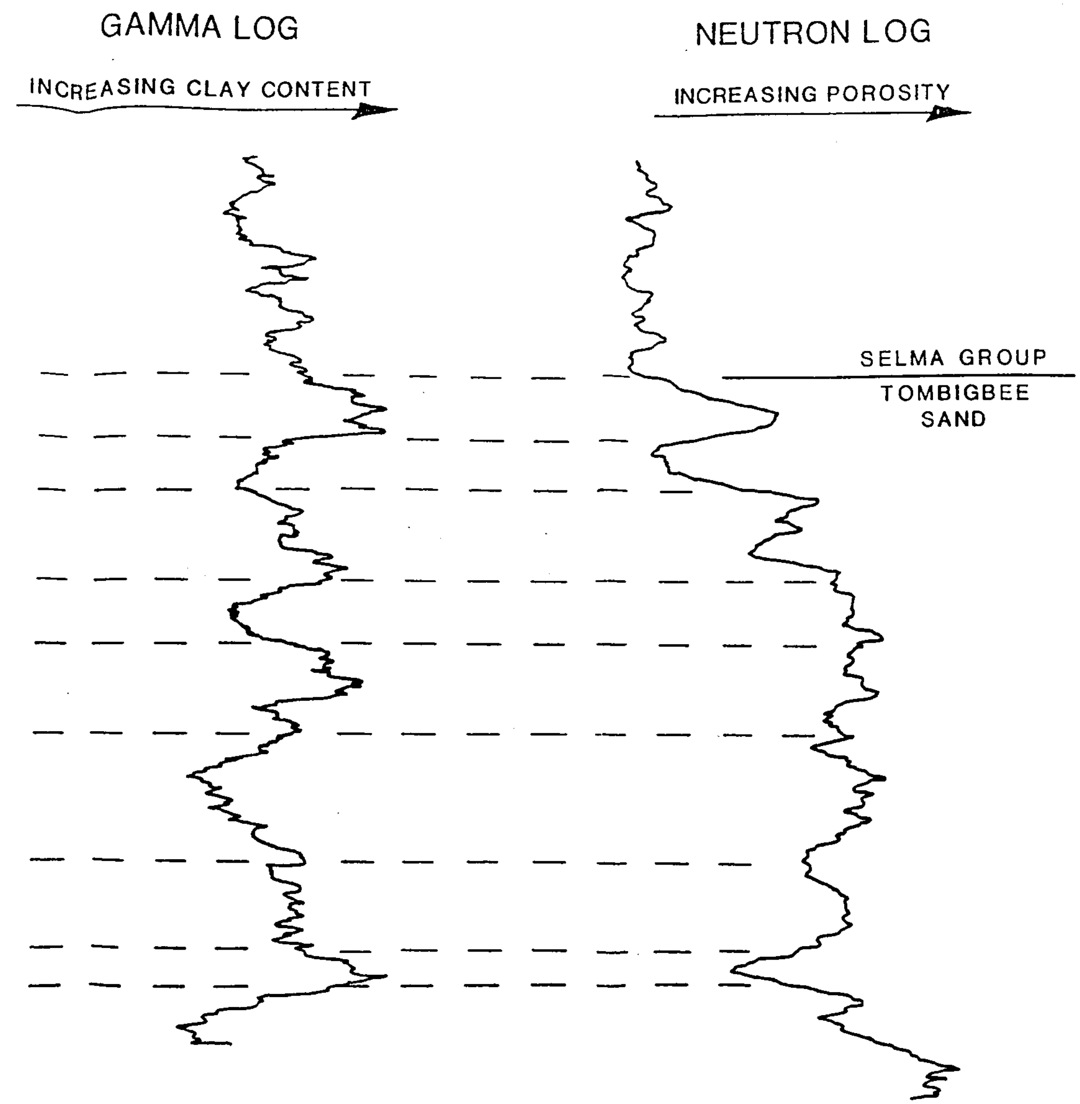
Low gamma, low neutron - chalk or dense sand

Low gamma, high neutron - loose sand

Medium gamma, low to medium neutron - clayey chalk

Medium gamma, high neutron - clayey sand

It can be seen from Figure 2, there is generally a good correlation between the lithologic description in the drillers logs and the physical interpretation of the geophysical logs. By interpreting the drillers logs and the geophysical logs together, the two sources of information are corroborated, ambiguous description in drillers logs such as "rock seam" can be further interpreted, and relatively thin beds which are not differentiated in the drillers logs can be identified.



DEPTH	DESCRIPTION MODIFIED FROM DRILLER'S LOG	GEOPHYSICAL LOG INTERPRETATION
	STICKY CHALK	SOFT CLAY
670	HARD CHALK	HARD CHALK OR CHALKY SAND
	MEDIUM TIGHT TO TIGHT SAND AND CLAYEY SAND	SOFT CLAY AND CLAYEY SAND
680	TIGHT TO LOOSE CLAYEY SAND	LOOSE SAND
	ROCK SEAM	CLAY AND CHALK
690	MEDIUM TIGHT TO LOOSE SAND	LOOSE SAND
700		CLAYEY SAND
710	MEDIUM TIGHT TO TIGHT SAND	HARD CLAY
		VERY LOOSE SAND

JOB NO. 853-3107	SCALE N.T.S.	LITHOLOGY OF TOMBIGBEE SAND AT WELL 9	
DRAWN LJW	DATE 1/29/86		
CHECKED AES	DWG. NO. 121		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 2

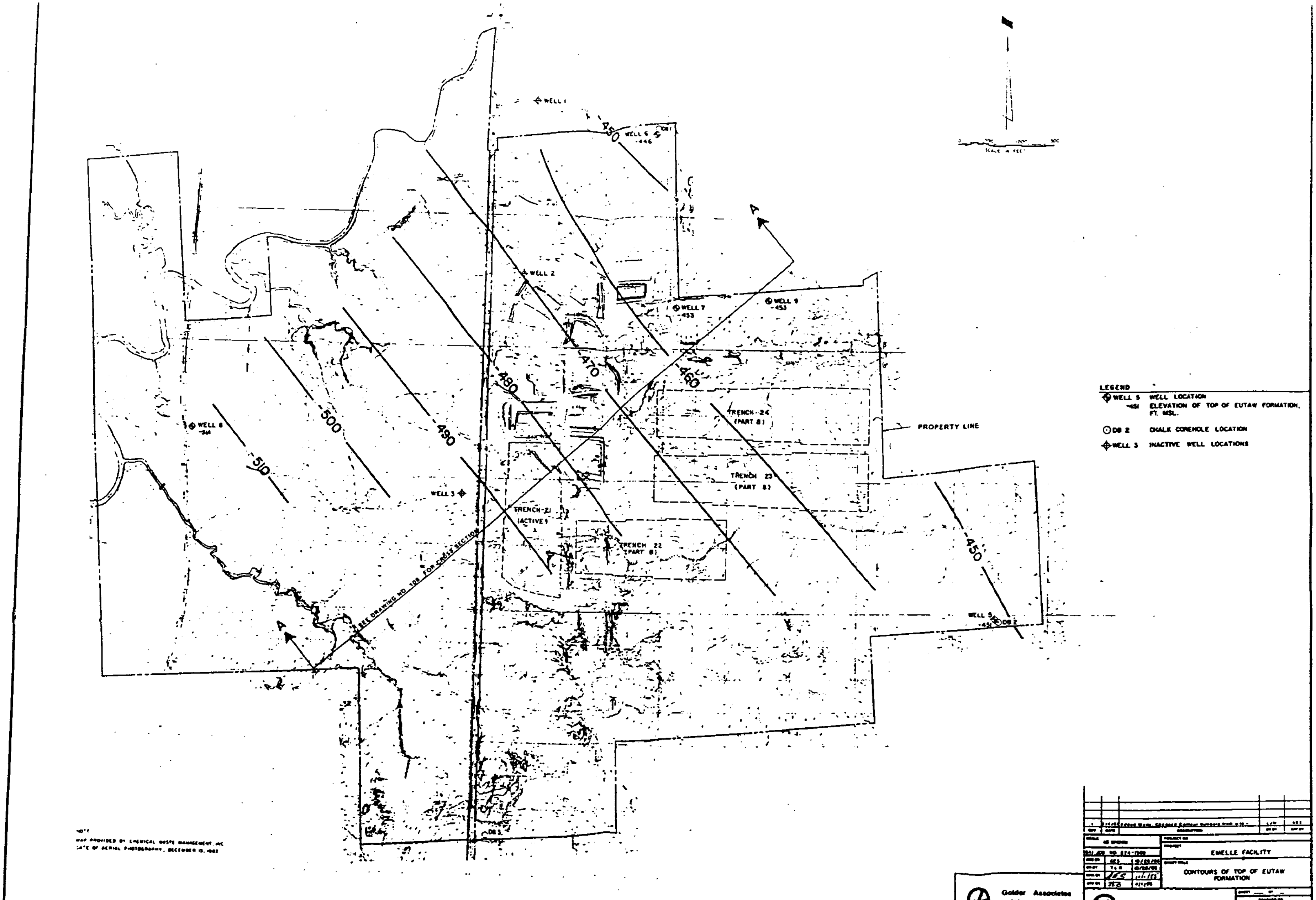
GAF DRAFTING MEDIA

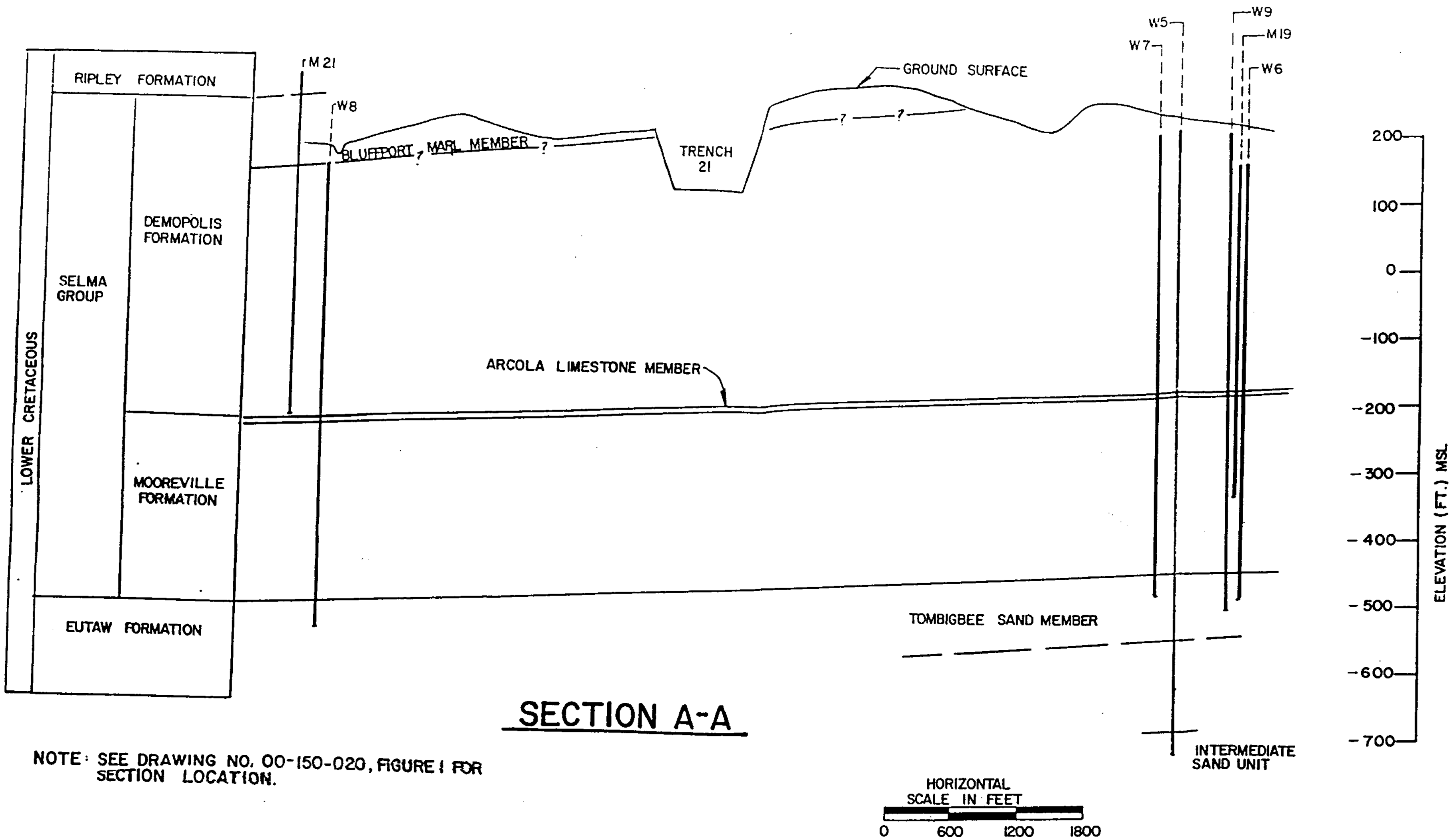
The interpretation performed on the geologic information described in this section was used to construct a structural contour map of the top of the Eutaw Formation as shown in Figure 3. A geologic section of the site taken in the downdip direction is shown on Figure 4. As shown on Figures 2 and 4 and the contour map of the top of the Eutaw Formation, excellent correlation between the marker beds across the site was observed indicating the absence of faulting or significant change in thickness of the geologic formation. This indicates that the strata were deposited under relatively stable conditions and have not been greatly deformed since deposition.

2.3 Hydrogeology

The Tombigbee Sand Member of the Eutaw Formation comprises the upper aquifer at the Emelle Facility and will be referred to in this section as the Eutaw Aquifer. The Eutaw Aquifer is recharged in its outcrop area, north of the Emelle site, where it forms an unconfined aquifer. Where the Eutaw Aquifer dips below the Selma Group, it becomes an artesian (confined) aquifer. Because the outcrop area of the Eutaw Aquifer is topographically higher than the Emelle area, the potentiometric level (height to which water will rise in a cased well) is above the ground surface in low-lying areas in and near the site. In these areas, a well drilled into the Eutaw Aquifer will flow without having to be pumped (ref. 5, p. 7). The relative potentiometric head in the Eutaw Aquifer and phreatic surface in the Selma Chalk is shown in Figure 5.

Reported hydraulic conductivity of the Eutaw Aquifer range from 7.4 to 10.2 x 10^{-3} cm/sec in areas east of the Emelle site, and 1.4 to 3.5 x 10^{-3} cm/sec in areas west of the site (ref. 6, p. 11).

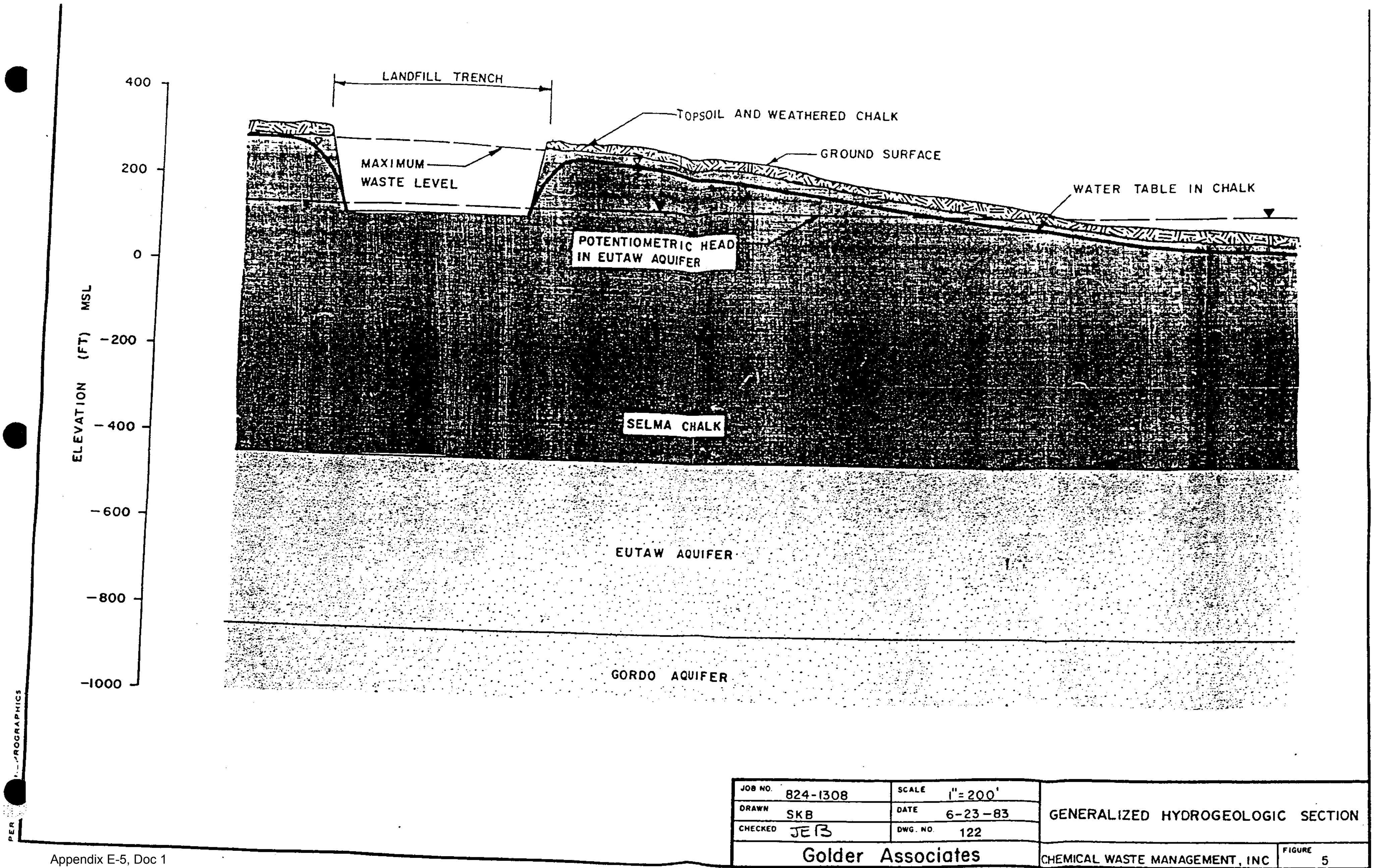

WELL 1
WELL 6
446
WELL 2
WELL 7
453
WELL 9
453
WELL 8
WELL 3
WELL 5
DB 2
DB 1
450
460
470
480
490
500
510
A
A
SEE DRAWING NO 108 FOR CROSS SECTION
TRENCH 24 (PART B)
TRENCH 23 (PART B)
TRENCH 22 (PART B)
TRENCH 21 (ACTIVE)
PROPERTY LINE
SCALE IN FEET
LEGEND
WELL 5 WELL LOCATION
ELEVATION OF TOP OF EUTAW FORMATION, FT. MSL.
DB 2 CHALK COREHOLE LOCATION
WELL 3 INACTIVE WELL LOCATIONS
EMELLE FACILITY
CONTOURS OF TOP OF EUTAW FORMATION
Golder Associates
Atlanta, Georgia
Chemical Waste Management, Inc



SECTION A-A

NOTE: SEE DRAWING NO. 00-150-020, FIGURE 1 FOR SECTION LOCATION.

JOB NO. 824-1308	SCALE AS SHOWN	GEOLOGIC STRUCTURE SECTION, EMELLE FACILITY
DRAWN T.s.R.	DATE 10/28/85	
CHECKED AES	DWG. NO. 108	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 4


LANDFILL TRENCH
TOPSOIL AND WEATHERED CHALK
GROUND SURFACE
MAXIMUM WASTE LEVEL
WATER TABLE IN CHALK
POTENTIOMETRIC HEAD IN EUTAW AQUIFER
SELMA CHALK
EUTAW AQUIFER
GORDO AQUIFER
ELEVATION (FT) MSL
400
200
0
-200
-400
-600
-800
-1000
JOB NO. 824-1308
SCALE 1"=200'
DRAWN SKB
DATE 6-23-83
CHECKED JEB
DWG. NO. 122
Golder Associates
GENERALIZED HYDROGEOLOGIC SECTION
CHEMICAL WASTE MANAGEMENT, INC
FIGURE 5

Chloride content of the Eutaw Aquifer water increases to the southwest. At the Emelle Facility, chloride content is about 400 to 450 mg/l. To the north of the site, the Eutaw Aquifer is utilized for domestic, livestock, and agriculture water supply, while to the south of the site, the Eutaw Aquifer water is too mineralized for these purposes and most wells tap deeper aquifers (ref. 5, p. 17).

Groundwater flow in the Eutaw Aquifer in western Sumter County is to the east, toward the Tombigbee River valley, as shown in Figure 6. Based on a series of five monitoring wells completed in the Tombigbee Sand Member of the Eutaw Aquifer, the potentiometric surface in the Eutaw Aquifer in the eastern part of the Emelle site slopes to the east at 1.3 feet per mile, which is consistent with regional trends. This corresponds to a seepage velocity (using an average permeability of 4.4 x 10^{-3} cm/sec and assuming an effective porosity of 15%) of 0.02 feet per day. In the northern most part of the site, the potentiometric surface in the Eutaw Aquifer slopes to the north at 5.9 feet per mile. This corresponds to a seepage velocity of 0.09 feet/day, using the same parameters as above. The location of the Emelle site monitoring wells and the potentiometric surface contours are shown in Figure 6 and Plate 2.

The northerly gradient in the north part of the site is considered to be due to discharge from the Eutaw Aquifer in the Bodka Creek valley immediately north of the site. A well survey conducted in 1964 found 12 flowing artesian wells in this area, flowing at a combined rate of 192 gpm (ref. 5, p. 27). The location of these wells are shown in Figure 7. In addition, upward seepage through the Selma Group occurs in this area. Calculations indicate that the

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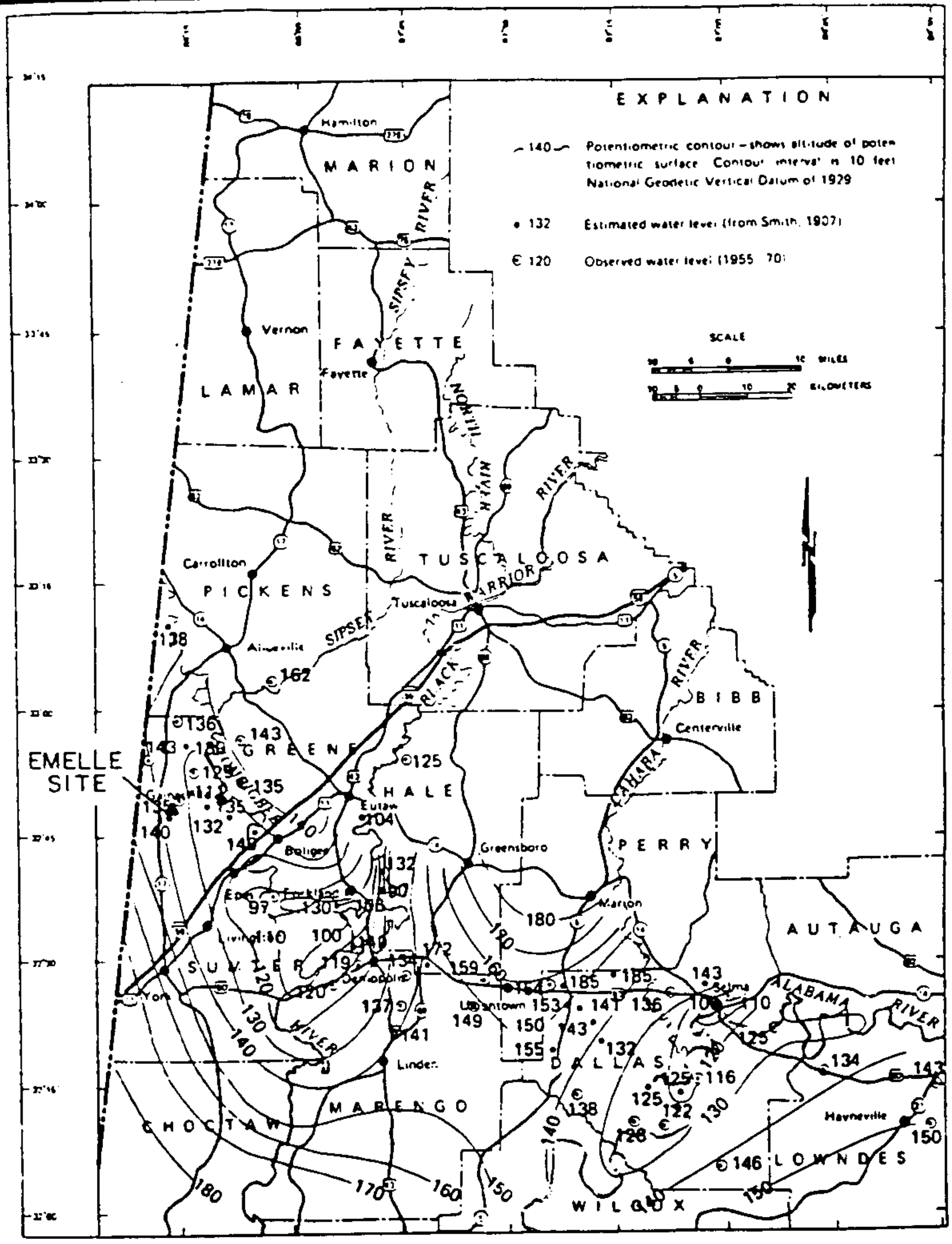
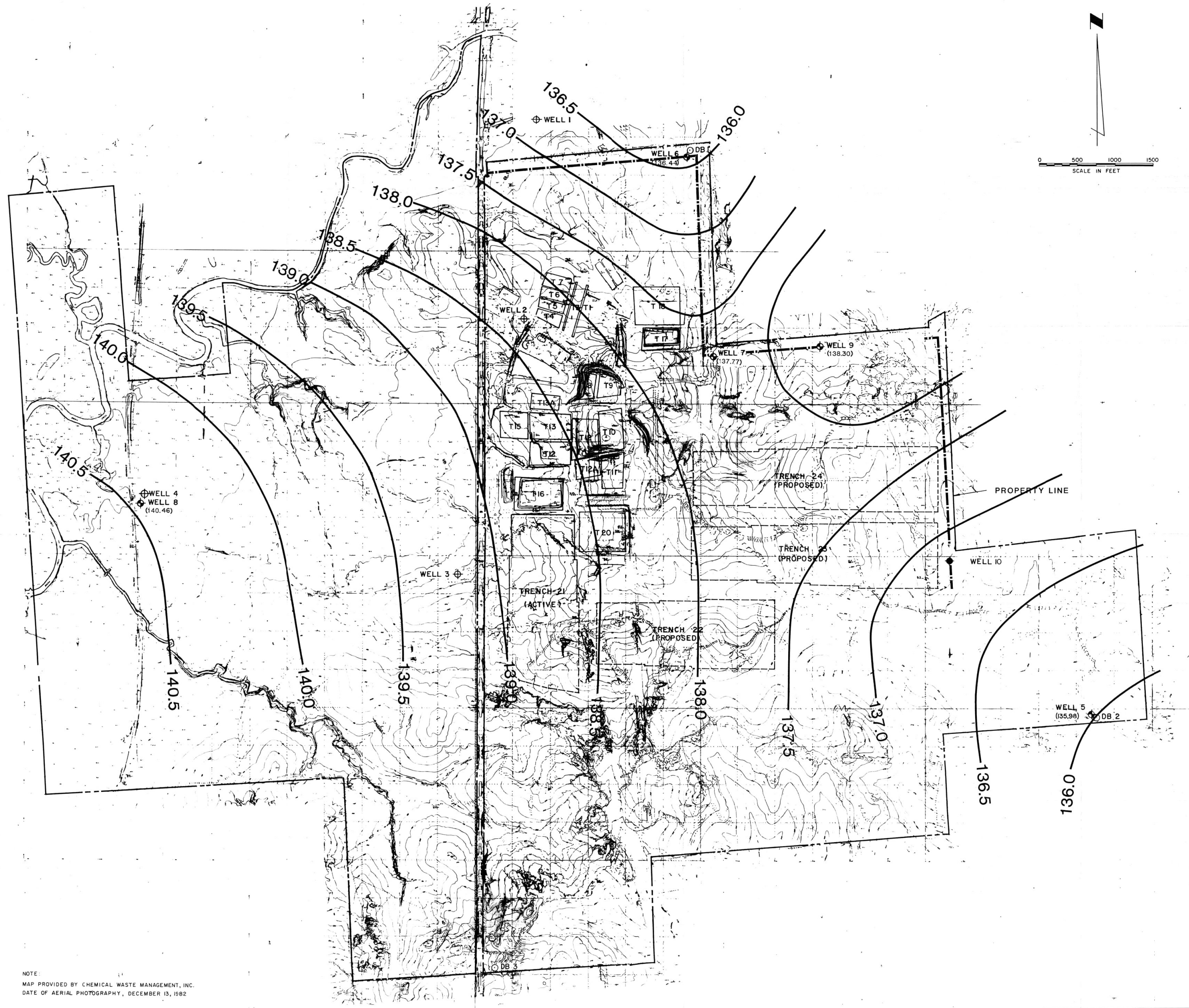


NOTE:
TAKEN FROM GEOLOGICAL SURVEY OF ALABAMA, BULLETIN 118 (REFERENCE 2)

JOB NO. 824-1308	SCALE AS SHOWN	POTENTIOMETRIC SURFACE IN THE EUTAW AQUIFER	
DRAWN SKB	DATE 8-13-82		
CHECKED JEB	DWG NO. 19		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 6

GAF DRAFTING MEDIA

PLATE 1



LEGEND

WELL 2	INACTIVE WELL LOCATIONS
WELL 7 (137.77)	WELL LOCATION POTENTIOMETRIC LEVEL, FEET MSL
WELL 10	PROPOSED LOCATION OF RCRA WELL 10
DB1	CHALK COREHOLE LOCATION
138 ———	POTENTIOMETRIC SURFACE, FEET-MSL
— · —	BOUNDARY OF WASTE. MANAGEMENT AREA

NOTES:

1. POTENTIOMETRIC LEVELS AVERAGE OF MEASUREMENTS TAKEN MARCH, 1987 AND NOVEMBER, 1987.
2. MARCH, 1987 POTENTIOMETRIC LEVEL AT WELL 5 NOT USED. VALUE SHOWN AT WELL 5 IS NOVEMBER, 1987 MEASUREMENT.
3. ALL WELLS COMPLETED IN TOMBIGEE SAND MEMBER OF EUTAW AQUIFER.
4. POINT OF COMPLIANCE IS FACILITY PROPERTY LINE.

NOTE:
MAP PROVIDED BY CHEMICAL WASTE MANAGEMENT, INC.
DATE OF AERIAL PHOTOGRAPHY, DECEMBER 13, 1982

REV.	DATE	DESCRIPTION	DR BY	APP BY
3	2/15/88	Updated Potentiometric Levels	JLW	MTF
2	1/7/87	Updated Potentiometric levels	SKB	MTF
1	2/2/86	Added Trenches and Wells	SKB	AES

SCALE: AS SHOWN
GAI JOB NO. 824-1308

DES BY	KTM	2/15/88
DR BY	JLW	2/15/88
CHK BY		
APP BY	MTF	2/15/88

PROJECT NO.
PROJECT: EMELLE FACILITY
SHEET TITLE: WELL LOCATION MAP AND EUTAW AQUIFER POTENTIOMETRIC SURFACE CONTOURS

Golder Associates
Atlanta, Georgia

Chemical Waste Management, Inc.
Oak Brook, Illinois 60521

SHEET ____ OF ____
DRAWING NO.
00-150-021

total discharge from the Eutaw Aquifer in the Bodka Creek area would produce northward gradients at the site of the same order of magnitude as those observed.

The Selma Group serves as a confining bed for the underlying Eutaw Aquifer. Laboratory permeability tests, borehole packer tests, and recovery tests of monitoring wells completed in the Selma Group indicate a permeability of 1.2×10^{-8} to 5.5×10^{-7} cm/sec. This very low permeability value together with the great thickness of the Selma Group make it a very effective confining bed and makes the Emelle site very attractive for the isolation of wastes.

Water levels in the Selma Group are about thirty feet below land surface in the upland areas, and somewhat less in valleys. Thus, flow in the upland areas is downward into the Eutaw Aquifer, while flow in the valleys is upward through the chalk. In addition, there is a small component of lateral flow in the Selma Group. Because of the very low permeability of the Selma Group, seepage velocities are low, on the order of 0.1 feet per year or less (ref. 7, pp. 20-25).

3.0 EUTAW AQUIFER MONITORING WELL NETWORK

3.1 Previous Well Network

Prior to September, 1985, the Emelle Facility Eutaw Aquifer monitoring well network consisted of eight wells, one of which was located off-site (RCRA Well 1). Wells 1, 2, 3, and 4 were originally drilled as domestic or stock water supply wells before or shortly after the facility was opened. There is no documentation of the construction of Wells 1, 2, 3, and 4 , however, indications are that these wells were completed with a short section of surface casing (typically about 20 feet) in the soil and weathered chalk, an open borehole through the Selma Group, and possibly a section of perforated pipe set in the Eutaw Aquifer.

Wells 5, 6, 7 and 8 were installed between December 1982 and May 1983 by Graves Well Drilling Co. under the supervision of Golder Associates. The installation procedures for these wells are outlined below:

1. The 4" diameter steel casing joints are washed with acetone to remove threading lubricant. All casing is then cleaned with high temperature and pressure steam.

2. Rotary drill a 6 in. diameter hole, with water as the circulation fluid, to the first sand stringer of the Eutaw Formation.

3. Backfill the drillhole with 3 ft. to 5 ft. of drill cuttings to prevent grout clogging of the Eutaw sands.

4. Install the 4 in. diameter steel casing.

5. Inject Portland cement grout under pressure through the 4 in. casing and up the well bore. A 1 ft. to 2 ft. grout plug is left in the bottom of the casing.

6. After the grout sets, drill through the grout plug with a 4 in. rotary tricone bit and thoroughly flush the drill cuttings.

7. Advance the 4 in. drillhole 40 ft. to 50 ft. beneath the end of the 4 in. casing or until the upper sand zones of the aquifer are encountered.

8. Install 40 linear ft. of 2 in. diameter continuous wrap stainless steel screen (0.008 in. slots). The well screen is joined to the 4 in. casing with a lead swedge seal.

9. Develop the well by air lifting until the water is clear (2 to 6 hrs.). Development collapses the Eutaw sands around the screen, producing a natural sand pack.

10. Cover the well head with a 6 in. diameter steel locking cover set in a 2 ft. by 4 ft. concrete pad.

Well locations are presented in Figure 8 and well construction details are presented in Figures 9 and 10. WMI Monitoring Well Information Forms are presented as Appendix C and appropriate data on each well is summarized in Table 2. Wells 6, 7, and 8 were screened in the uppermost (Tombigbee Sand Member) sand unit in the Eutaw Aquifer, while Well 5 was screened in an intermediate sand unit about 150 feet lower. Wells 5, 6, and 7 are downgradient of the Emelle site waste disposal areas while Well 8 is upgradient.

3.2 Modifications to Eutaw Aquifer Monitoring Well Network

In September, 1985, a program was undertaken to modify and update the Eutaw Aquifer monitoring well network. The effort was to include the following tasks:

- Seal and abandon inactive, uncased wells 2, 3, and 4.

TABLE 2

EUTAW AQUIFER MONITORING WELL INFORMATION, EMELLE FACILITY, ALABAMA

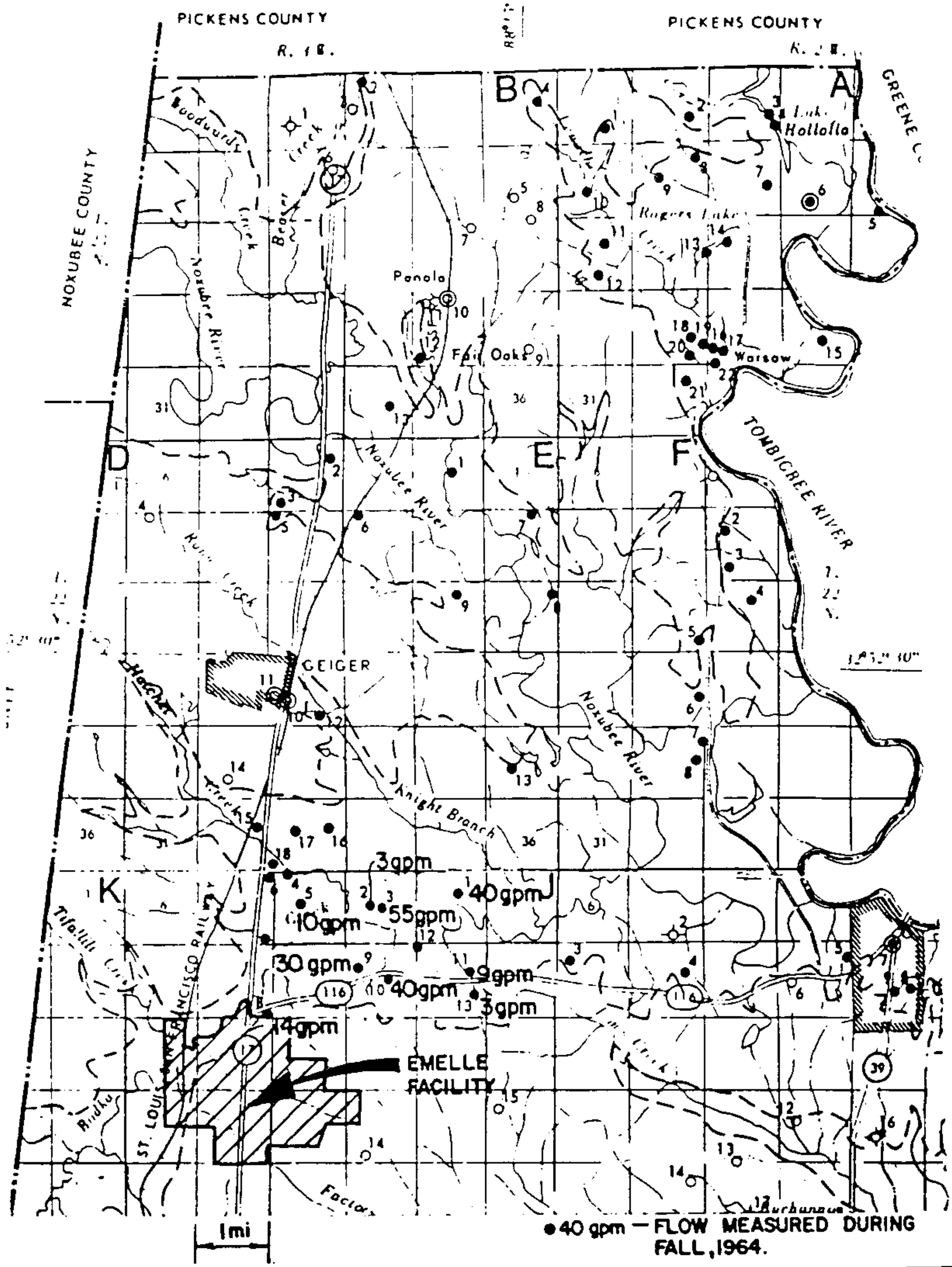
WELL #	WELL 5	WELL 6	WELL 7	WELL 8	WELL 9
NORTHING (FT)	8432.00	15729.30	13121.90	11158.40	10266.18
EASTING (FT)	10204.00	7821.60	8187.00	550.10	9045.02
UP/DOWN GRADIENT	DOWN	DOWN	DOWN	UP	DOWN
COLLAR ELEV.(1)	211.63	162.94	207.62	140.93	211.37
GROUND ELEV.(1)	211	164	206	131	209
TOP OF EUTAW(1)	-451	-446	-453	-514	-453
TOP OF SCREEN(1)	-480	-442	-476	-537	-483
BOTTOM OF SCREEN(1)	-520	-462	-516	-577	[illegible]
WELL DEPTH(2)	732	645	723	718	733
TOTAL DEPTH(2)	937	650	708	692	725

(1) ELEVATION IN FEET MSL

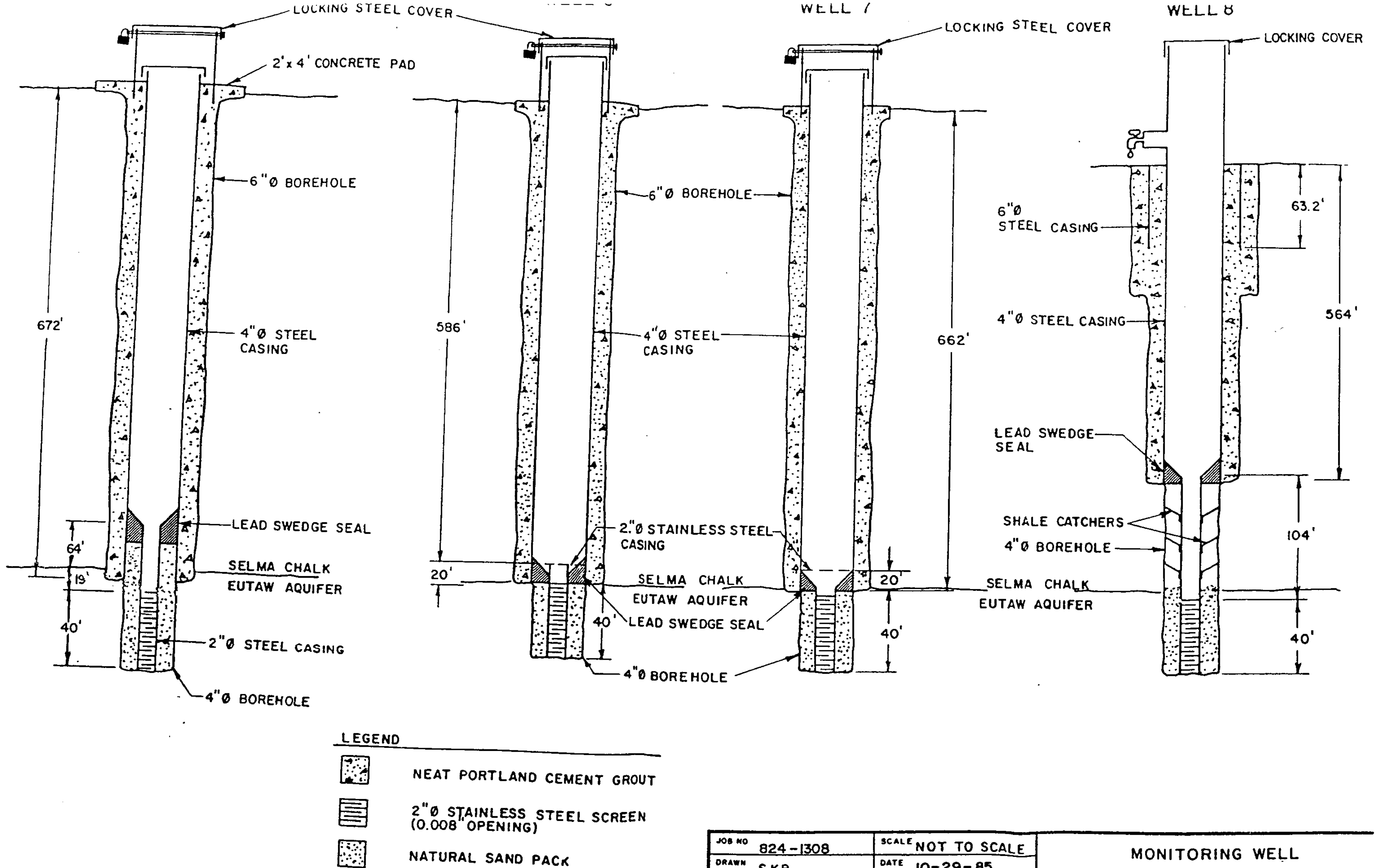
(2) TOP OF CASING TO BOTTOM OF SCREEN

(3) GROUND SURFACE TO BOTTOM OF BORING

AF 2044CA 8



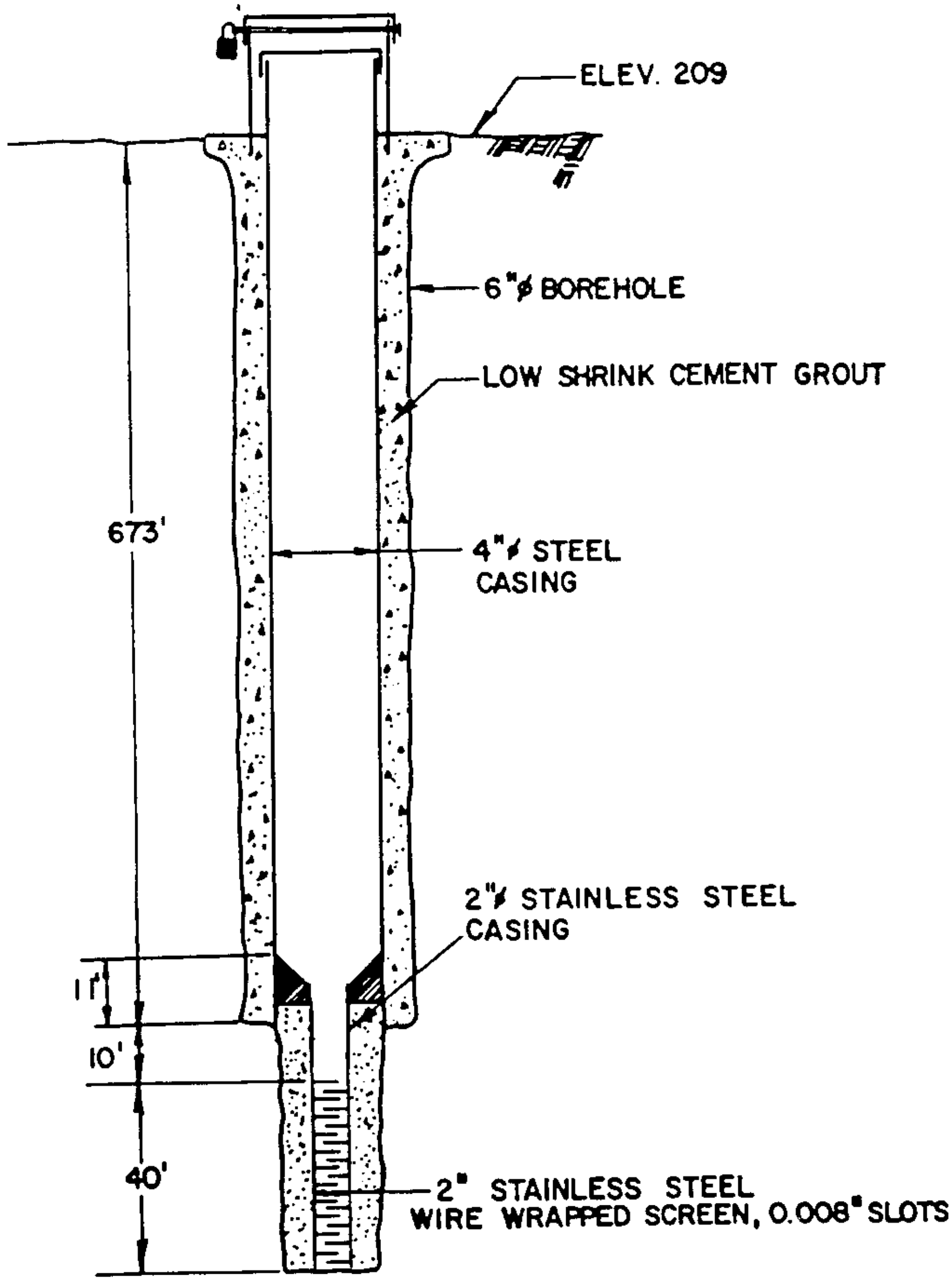
JOB NO. 824-1308	SCALE AS SHOWN	LOCATION OF FLOWING ARTESIAN WELLS NORTH OF THE EMELLE FACILITY
DRAWN T.S.R.	DATE 11/01/85	
CHECKED AES	DWG NO. 110	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 8



JOB NO 824-1308	SCALE NOT TO SCALE	MONITORING WELL CONSTRUCTION DETAILS
DRAWN SKB	DATE 10-29-85	
CHECKED AES	DWG. NO ·107	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 9

AF 20440A B

WELL 9



JOB NO. 824-1308	SCALE N.T.S.	MONITORING WELL CONSTRUCTION DETAILS
DRAWN T.S.R.	DATE 10/30/85	
CHECKED AES	DWG NO. 109	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 10

- Rework Well 5 to reset the screen in the uppermost sand unit of the Eutaw Formation, so that head levels in that well would correspond to head levels in the other Eutaw Aquifer monitoring wells.
- Install a fourth downgradient monitoring well, Well 9.
- Assemble geologic, hydrogeologic and well completion information in support of the certificate of compliance.

This report contains the information assembled for the final task. Of the other tasks, all are complete with the exception of sealing and abandoning wells 2 and 3, which is currently planned to take place in late February, 1986.

3.2.1 Sealing Well 4

Well 4 is a flowing artesian well which is adjacent to Well 8, an active monitoring well. Special precautions were therefore required for sealing this well. Prior to grouting, a 4" bit was run to the bottom of the hole to insure that the entire open interval could be grouted. Near the bottom of the Selma Group, the bit encountered what is probably the top of the perforated pipe which extends into the Eutaw Aquifer. A plug was set at the top of the pipe to insure that the cement did not invade the aquifer and the adjacent monitoring well. The hole was then grouted by the tremie method. Similar procedures will be used in sealing wells 2 and 3 except that the plug will not be used. Detailed well sealing procedures are presented below:

1. Mobilize workover rig to the well site.
2. Complete required information on the Well Sealing Form except depth which will be measured with the tremie pipe.
3. Photograph the well head.

4. Remove the steel protective cover and all other surface appurtenances.

5. Install the grout tremie pipe to the full depth of the well; record depth.

6. Pump the computed volume of low shrink cement grout into the well while maintaining submergence of the end of the tremie pipe at all times. Pump additional grout as required to show good return at the surface.

7. Allow grout to settle for about 12 hours and add grout to fill the hole to the surface.

8. Remove all surface fixtures, grade the area to drain away from the well and take a final photograph.

9. Complete remaining information of Well Sealing Form.

The well sealing form completed following the sealing of Well 4 is included as Appendix D. Similar forms will be completed for Wells 2 and 3, when sealed.

3.2.2 Reworking Well 5

In order to insure that head levels measured in Well 5 were comparable to head levels measured in other wells, the screen was removed and reset in the upper sand unit of the Eutaw Aquifer. The procedure was as follows:

1. Mobilize equipment to well site and run tubing into hole with left hand threaded nipple on bottom of tubing and screw into 4 in. X 2 in. lead seal.

2. Pull screen, riser pipe and lead seal out of hole.

3. Run tubing back into hole and inject 16 sacks of cement from 937 ft. to 740 ft..

4. Withdraw tubing to 747 ft. and wash with water to remove grout from interval to be screened.

5. Allow cement to cure overnight. Measure bottom depth the next morning.

6. Re-install screens and lap pipe with new lead seal.

7. Swedge lead seal and develop well by airlifting.

The procedures used to rework Well 5 required significant use of downhole tools which have a high potential for introducing oil and grease into the well. This well is therefore suitable for obtaining water level information only, and should not be used for water quality assessments.

3.2.3 Installing Well 9

After reworking Well 5, an additional downgradient monitoring well was installed. Well 9 was installed to provide additional water quality data and to define areas of eastward and northward gradients in the Eutaw Aquifer beneath the site. Figure 10 shows the completion details of RCRA Well 9. Well 9 was installed by the following procedure:

1. Wash the casing with high pressure water to remove dirt and rust. Swab the casing inside and out with reagent grade acetone to remove threading lubricant. Immediately follow with a potable water rinse. Finally, wash with high temperature and pressure steam.

2. Rotary drill a 6 in. diameter hole with water as the circulation fluid, to the top of the Eutaw Formation

3. Backfill the drillhole with 3 ft. to 5 ft. of drill cuttings to prevent grout clogging of the Eutaw sands.

4. Install the 4 in. diameter steel casing.

5. Inject low shrink grout (Halliburton 50/50 poz/mix) under pressure through the 4 in. casing and up the well bore.

6. After the grout sets, drill through the 4-in. steel pipe with a nominal 3 3/4 in. rotary tricone bit and thoroughly flush the drill cuttings.

7. Advance the drillhole to about 50 ft. beneath the end of the 4 in. casing.

8. Install 40 ft. of 2 in. diameter continuous wrap stainless steel screen (0.008 in. slots) and about 20 ft. of 2 in. stainless steel lap pipe. The well screen and lap pipe are joined to the 4 in. casing with a lead swedge seal.

9. Develop the well by air lifting using filtered compressed air until the water is clear (about 1.5 hrs.). Development collapses the Eutaw sands around the screen, producing a natural sand pack.

10. Cover the well head with a 6 in. diameter steel locking cover set in a 2 ft. by 4 ft. concrete pad.

11. Survey the plan location and MSL elevation of the well.

Following the installation of Well 9, water levels were measured in all 5 of the active monitoring wells in the Eutaw Aquifer. These water levels and the resulting potentiometric contours are shown on Figure 7.

3.2.4 Proposed Well 10

To provide a well on the downgradient side of proposed landfill trenches 23 and 24, Well 10 will be installed prior to disposal of waste in these trenches. This well will be located generally as shown on Figure 7 and will be installed and constructed in the same manner as Well 9. The borehole will be geophysically logged prior to placement of the steel casing and after drilling the final depth into the Eutaw Formation. These logs will include electric logs, gamma log and neutron log.

4.0 GROUNDWATER COMPLIANCE CERTIFICATION

As required by the Hazardous and Solid Waste Amendments of November 8, 1984, CWM must certify that the Emelle Facility is in compliance with 40 CFR 265, Subpart F. In support of this certification, Golder Associates has certified that, based on our knowledge of the site, it is our opinion that the Emelle Facility is in compliance with 40 CFR 265, Subpart F. A letter to this effect is included as Appendix E.

5.0 SUMMARY

Chemical Waste Management maintains a monitoring well network in the uppermost aquifer beneath their Emelle, Alabama Facility. The uppermost aquifer at the site is the Tombigbee Sand Member of the Eutaw Formation. The aquifer is overlain and confined by the Selma Group, comprised of at least 650 feet of low permeability chalk.

The current Eutaw Aquifer monitoring well network in the uppermost aquifer consists of one sealed well (Well 4), two inactive wells (Wells 2 & 3) which will be sealed in late February, 1986, one active upgradient monitoring well (Well 8) and four active downgradient wells (Wells 5, 6, 7, and 9). An additional monitoring well, Well 10, is proposed. Recently completed modifications to the well network include sealing Well 4, resetting the screened section of Well 5, and installation of Well 9. This report represents a compilation of information pertaining to the Eutaw Aquifer monitoring well network and includes a certification by Golder Associates that the network is in compliance with the standards set forth in 40 CFR 265, Subpart F.

GOLDER ASSOCIATES

A.E. Stone, Jr.
Hydrogeologist

J. Edmund Baker, P.E
Principal

Attachments

AES:JEB:mrs

References:

1. "Geology of the Alabama Coastal Plain", Charles W. Copeland, Ed., Geological Survey of Alabama, Circular 47, 1968.

2. Adams, George I. et al., Geology of Alabama, Geological Survey of Alabama, Special Report 14, 1926.

3. Self, Donald M. et al., "Structural Features of the Selma Group of Central Alabama", Chapter 4 of Studies on Recent Faulting Criteria in Alabama by T.L. Weathery et al., Publication of the Geological Survey of Alabama, 1975.

4. Monroe, Watson H., "Bluffport Marl Member of Demopolis Chalk, Alabama", Bulletin of the American Association of Petroleum Geologists, V. 40, No. 11, Nov. 1956.

5. Davis, Marvin E. et al., "Water Availability and Geology of Sumter County, Alabama", Geological Survey of Alabama Map 158, 1980.

6. Gardner, Richard A., "Model of the Ground-Water Flow System of the Gordo and Eutaw Aquifers in West Central Alabama", Geological Survey of Alabama Bulletin 118, 1981.

7. Golder Associates, Inc., "Hydrogeologic Characterization, Emelle Facility" revised June 1983.

APPENDIX A

Driller's Logs

WELL 5

Depth (ft.)	Description
0 - 7	Surface Clay
7 - 620	Chalk (Soapstone - SS)
620 - 662	Chalk with Pepper
662 - 680	Eutaw Sand No Cap Rock
680 - 690	Greenish Blue Sand and Some Soapstone
690 - 699	Soapstone all Way. Some Fine Sand in Sample
699 - 703	Sand Cut Even
703 - 705	Soapstone Snug Cut
705 - 708	Sand
708 - 709	Rock 12" Medium Hard
709 - 717	Streaked Sand and Soapstone More Sand in Last - Medium Fine Blue
717 - 719	Soapstone
719 - 720	Sand
720 - 731	Soapstone
731 - 733	Sand
733 - 738	Soapstone
738 - 743	Sand
743 - 747	Streaked Sand and Soapstone
747 - 749	Streaked Soapstone and Sand
749 - 757	Sand Cut Pretty Good in Mica in Sample
757 - 761	Streaked Sandstone and Sand
761 - 765	Streaked Sand and Some Soapstone
765 - 769	Soapstone
769 - 775	Soapstone with Small Sand Streaks
775 - 778	Sand with Soapstone Streaks
778 - 787	Sand Fair Cutting, Some 2" Soapstone Streaks
787 - 797	Sand - Flakey Soapstone in Wash
797 - 810	Soapstone Snug Cut. Some Fine Sand in Wash
810 - 811½	Rock 18" Soft
811½ - 815	Soapstone Snug
815 - 817	Sand
817 - 824½	Even Cutting Sand - Medium Fine
824½ - 827	Rock 2½" Hard
827 - 845	Blue Medium Sand Lots of Pepper
845 - 857	Soapstone and Sand Streaks
857 - 867	Soapstone Some Fine Sand
867 - 877	Soapstone
877 - 879	Soapstone
879	Rock 4" Medium Hard
879 - 889	Sand and Soapstone Streaks
889 - 897	Medium Sand
897 - 907	Rock at 903' 2" Soft Rest Sand
907 - 917	Good Cutting Medium Sand
917 - 921	Good Cutting Medium Sand
921	Rock 3" Medium Hard Chattery
921 - 927	Good Cutting Sand Medium
927 - 937	Good Cutting Sand Medium
937	Total Depth

WELL 6

Depth (ft.)	Description
0.00- 1.75	yellow clay
1.75- 64.65	white chalk sticky some brittle
64.65-317.00	chalk brittle some sticky
317.00-604.75	chalk sticky changed to fluid at 400'
604.75-606.75	chalk sandy with pepper specs
606.75-609.58	chalk sandy with pepper specs
609.58-612.08	sand medium loose
612.08-615.00	sand with chalk
615.00-619.58	chalk
619.58-621.83	sand with chalk seams
621.83-628.08	sand medium loose to loose
628.08-630.40	chalk with sand seams
630.40-634.00	sandy chalk
634.00-639.00	sand medium loose to loose with tight spots
639.00-649.58	yellow clay

WELL 7

Depth (ft.)	Description
0.00- 3.50	white chalk sticky
3.50-175.00	blue chalk brittle some sticky
175.00-230.50	blue chalk with greenish color brittle
230.50-463.00	chalk greenish gray sticky changed to fluid
463.00-576.00	chalk greenish gray sticky
576.00-626.00	white chalk some brittle
626.00-655.04	hard chalk
655.04-659.04	pepper in clay sandy
659.04-667.04	hard clay
667.04-669.62	sand with clay
669.62-671.00	sand with clay
671.00-676.00	chalk with clay
676.00-685.51	medium loose sand
681.51-687.50	clay
687.50-693.50	sand medium loose
693.50-697.00	tight sand
697.00-699.00	clay
699.00-708.25	tight hard sand

WELL 8

Depth (ft.)	Description
0.00- 4.00	clay with brown hard sand
4.00- 7.80	blue clay
7.80- 61.89	white chalk some brittle some sticky
61.89-360.00	white chalk some brittle some sticky
360.00-379.00	chalk sticky - changed to mud pump
379.00-500.00	chalk sticky
500.00-564.00	chalk some sticky some brittle
564.00-620.00	chalk some sticky some brittle-sand seam @ 595'
620.00-623.00	brittle - hard pyrite seam at 612.00'
623.00-623.25	rock seam
623.25-627.50	chalk sticky
627.50-628.50	sandy chalk with pyrite
628.50-638.00	chalk
638.00-651.50	chalk with black specs no sand
651.50-660.50	sand tight with medium loost spots with green black spots clay
660.50-664.00	small rock seams at 669.50' & 675.00'
664.00-679.41	sand green with clay looks more like blue marl
679.41-686.91	sandy chalk
686.91-688.00	tight chalk
688.00-688.25	rock seam
688.25-691.50	sandy chalk
691.50-692.41	tight sticky chalk

flowing 1/2 GPM

WELL 9

Depth (ft.)	Description
0.00- 2.50	white chalk
2.50- 207.00	blue chalk brittle
207.00- 246.00	blue white chalk
246.00- 307.00	blue white chalk
309.00- 390.00	chalk gummy
390.00- 412.00	chalk w/ some sea shale
394.00-	switched to fluid drilling
412.00- 489.00	gummy sticky chalk
489.00- 530.00	gummy sticky chalk
574.00- 614.50	brittle chalk or gummy chalk
614.50- 666.75	sticky chalk
666.75- 668.50	hard chalk
668.50- 670.75	brittle chalk
670.75- 672.75	green salt & pepper sand
672.75- 677.50	med. tight to tight green salt & pepper clayey sand
677.50- 682.00	med. tight to med loose green salt & pepper clayey sand
682.00- 690.20	rock seam
690.20- 704.95	salt & pepper sand med. tight to med. loose
704.95- 718.00	med. tight to tight green salt & pepper clayey sand. med. to fine sand
718.00- 722.00	salt & pepper sand clayey w/some shells. med. to fine sand
722.00- 725.30	med. to tight shaley chalk

APPENDIX B

Geophysical Logs

Pg 1 of 5

PELA P.E. LaMoreaux & Associates, Inc.
P.O. BOX 2310
TUSCALOOSA, AL 35403

GEOPHYSICAL WELL SURVEY

FEB 24 1986

Client: Graves Well Drilling Date: 10/9/85
Log by: Abner Patton Well No.: Monitoring Well 9
Observer: Ned Stone, Jr. Project No.: 469900
Location: State: Alabama County: Sumter
Sec. ___ T. ___ N/S R. ___ E/W

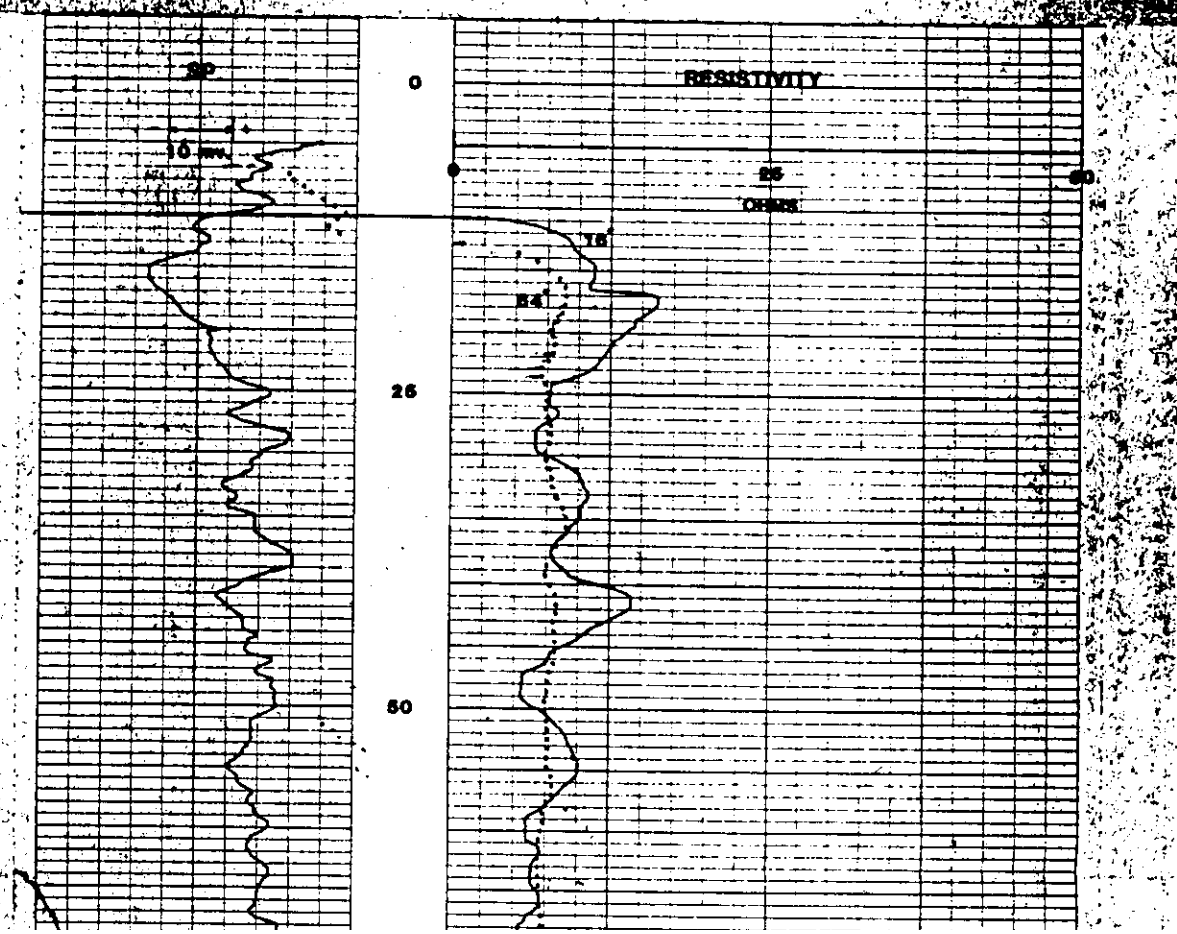
X Electric ___ Caliper
___ Gamma Ray ___ Fluid Resistivity
___ Temperature ___ Fluid Velocity

Owner: Chem Waste Management
Well Name: Monitoring Well 9
Driller: John Mitchell Date Drilled: 10/9/85
Surface Elevation: ___ ft. ___ Estimated ___ Measured ___ Above MSL
T.D. Logged: 669.8 T.D. Drilled: 672
Hole Dia. ___ From ___ To ___
Hole Dia. ___ From ___ To ___
Casing I.D. ___ From ___ To ___
Casing Dia. ___ From ___ To ___
Finish: X Open Hole ___ Screen ___ Gravel ___ Other
Water Level ___ ft. ___ Above / ___ Below MP ___ Above / ___ Below Land Surface
Yield: Flow ___ gpm Pump ___ gpm
Drawdown: ___ ft. after ___ hours pumping @ ___ gpm
Use: ___ Dom. ___ Stock ___ PS ___ Ind. ___ Irr.
___ Heating or cooling ___ Drainage ___ Disposal
___ Obs. ___ Test ___ None ___ Recharge
Water Quality:
Temp. ___ °F; Sp. Cond. ___ Iron ___ ppm;
Taste, odor, color ___; Chloride ___ ppm;
Sulfate ___ ppm; Hardness ___ ppm
Water Samples:
Depths sampled ___, ___, ___, ___, ___, ___

Log Scales

Electric Log	Fluid Resistivity
SP 20 millivolts/inch	___ ohm-meters/inch
Res. 10 ohms/inch	@ ___ °F
Gamma Ray Log	Fluid Velocity
___ Counts/sec./inch	___ Counts/min./inch
	___ FPM (continuous)
Logging speed ___ FPM	
Temperature ___ °F/inch	Caliper ___ divisions = ___ inches
Logging speed ___ FPM	

16
Rec. Output = ___ TC = ___ Zero = 2551
Suppression = ___ c/s = ___ Span = 2892
64
Rec. Output = ___ TC = ___ Zero = 2559
Suppression = ___ c/s = ___ Span = 2884
SP
Remarks ___
Zero = 505
Span = 946



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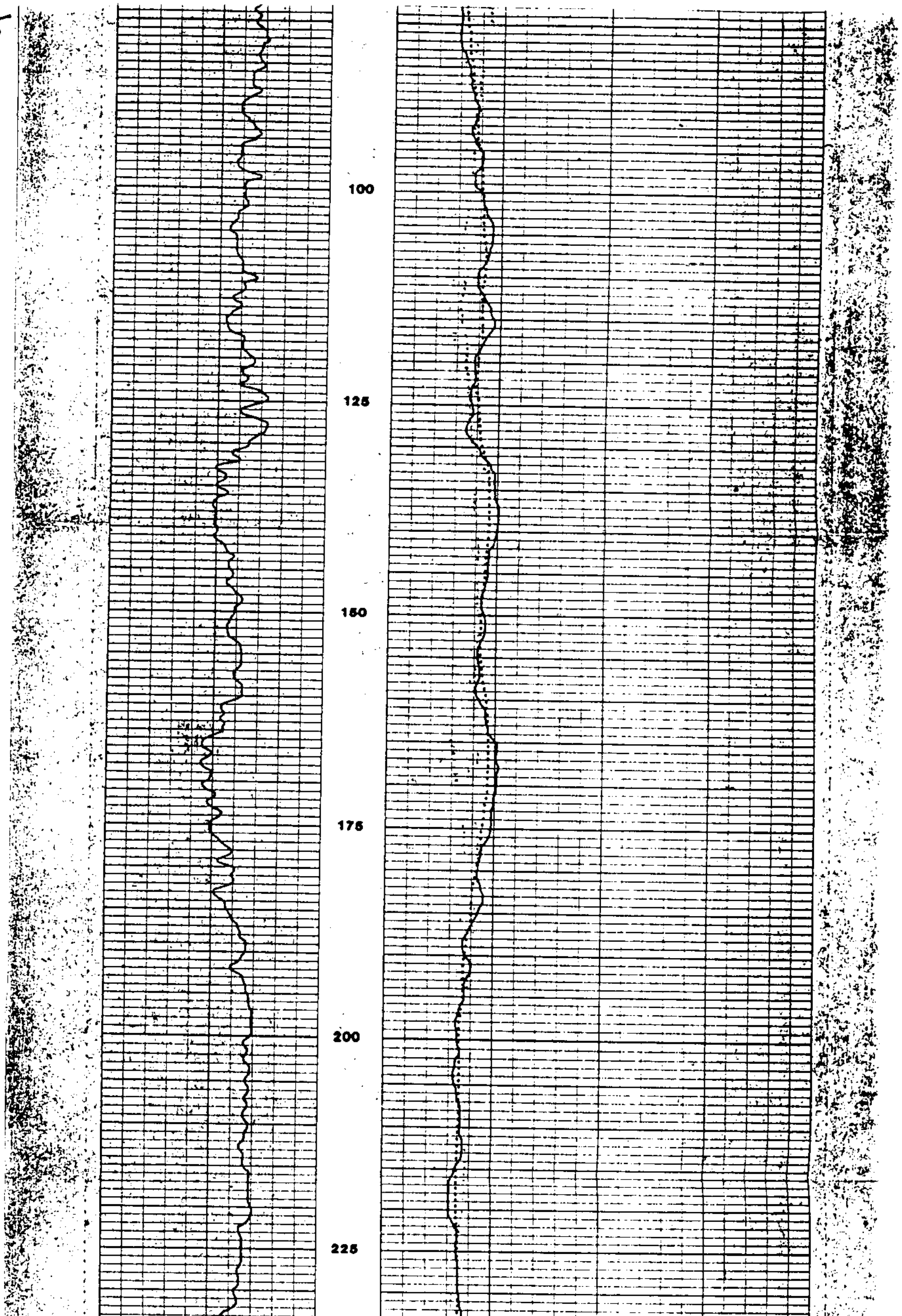
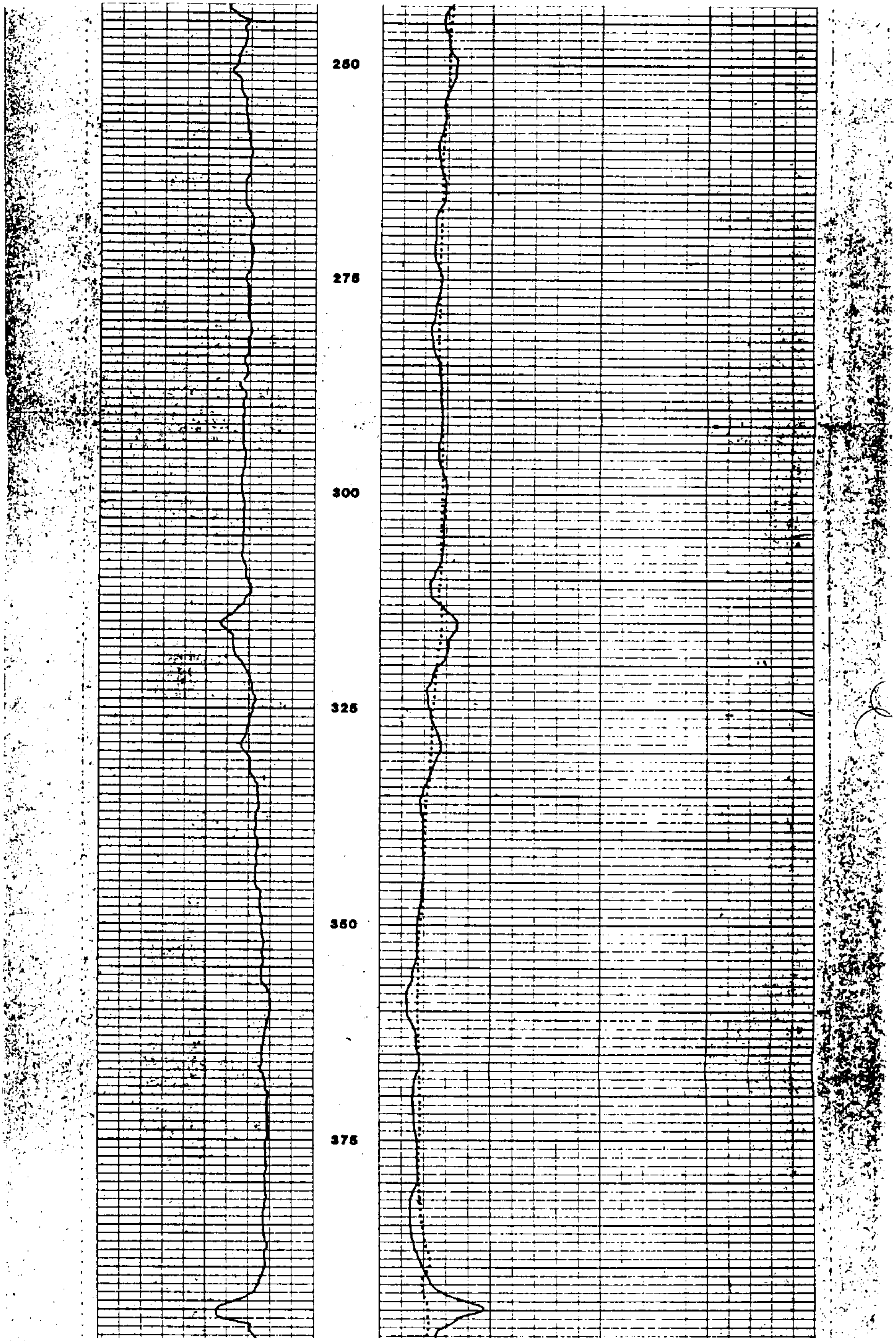


Pg 3 of 5



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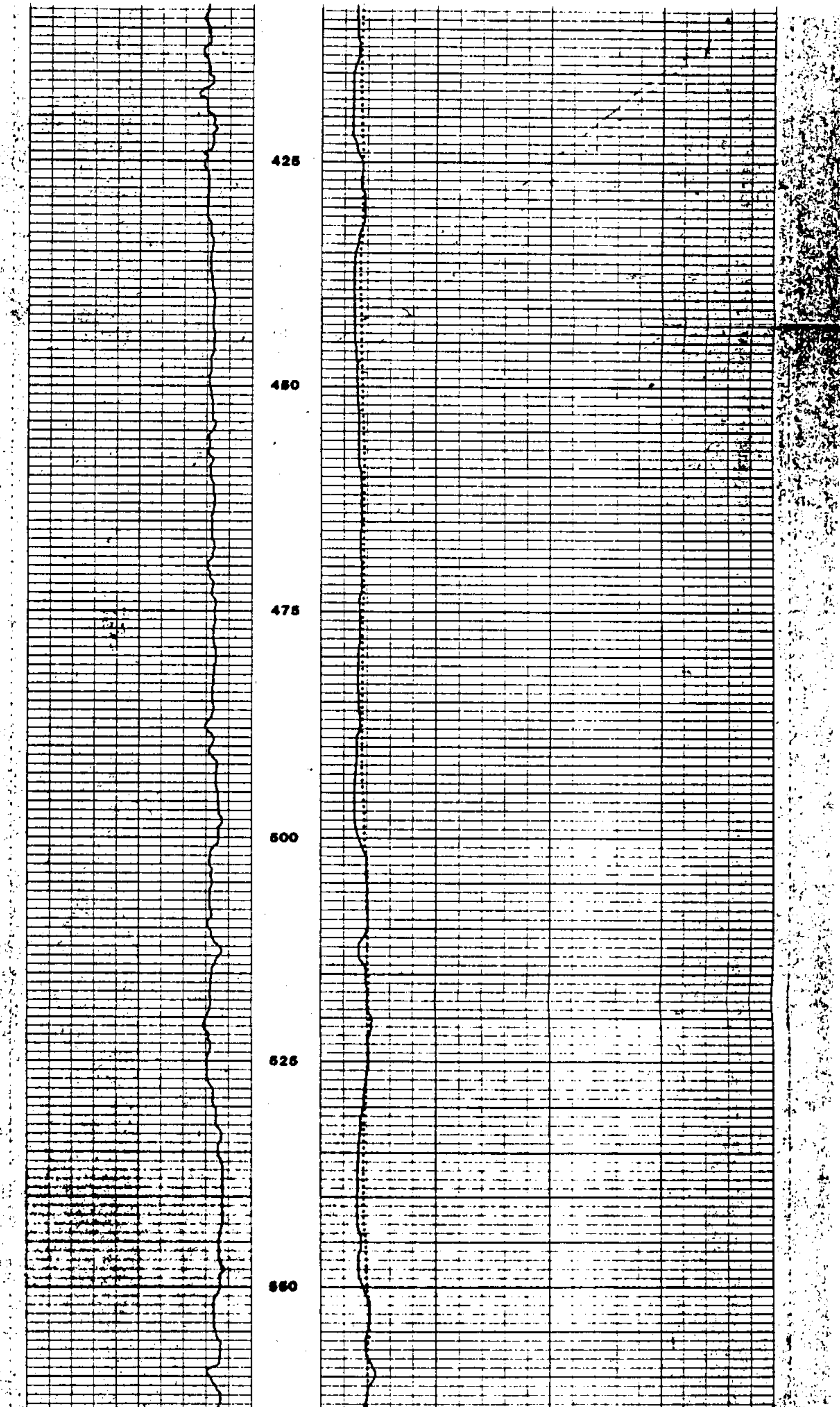

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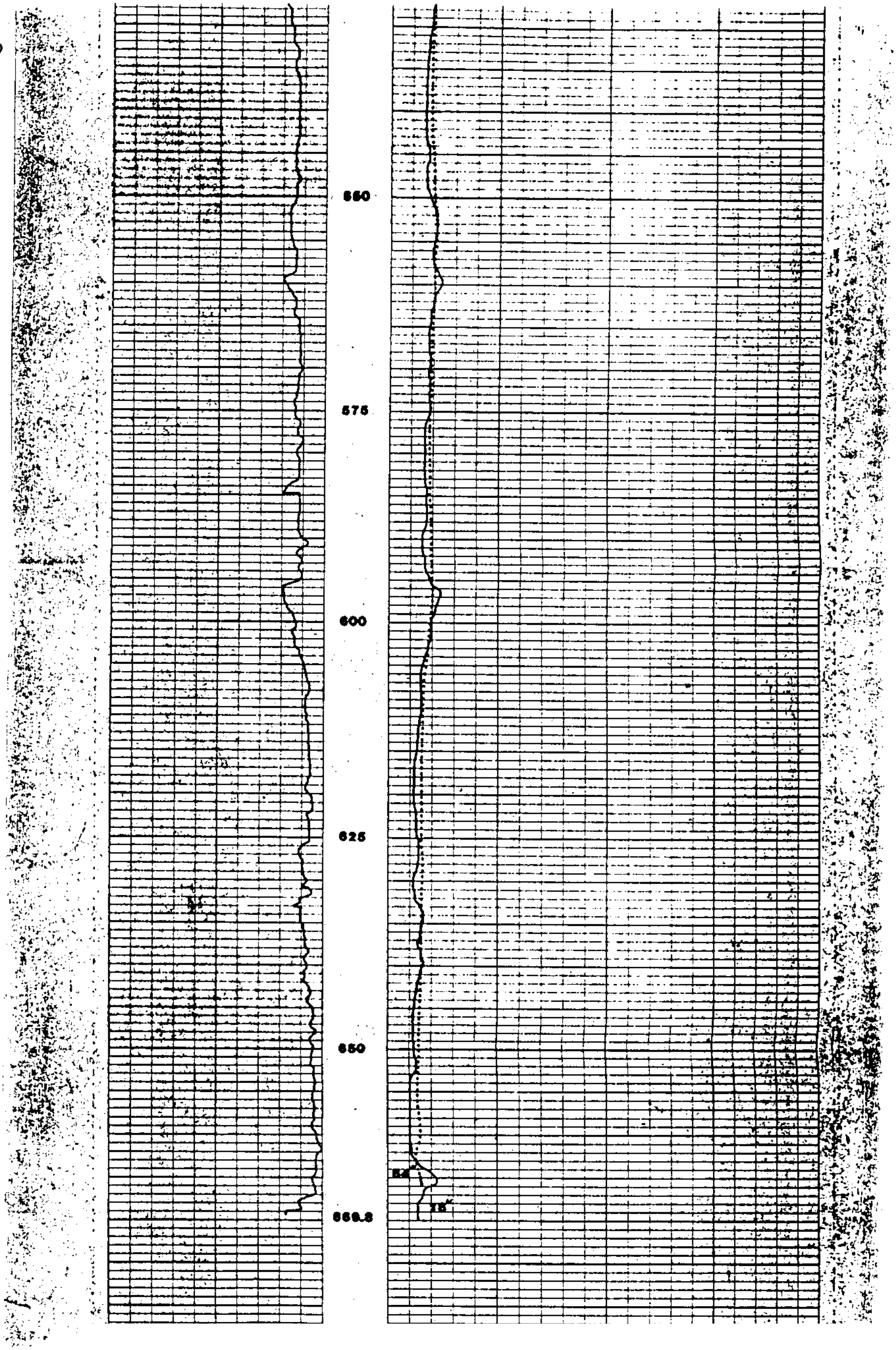


Page 1 of 5

P.E. LaMoreaux & Associates, Inc.
P.O. BOX 2310
TUSCALOOSA, AL 35403

GEOPHYSICAL WELL SURVEY

FEB 4 1986

Client: Graves Well Drilling Date: 10/9/85
Log by: Abner Patton Well No: Monitoring Well 9
Observer: Ned Stone, Jr. Project No: 469900
Location: State: Alabama County: Sumter
____ ____ ____ Sec. ____ T. ____ N/S R. ____ E/W

Owner: Chem Waste Management
Well Name: Monitoring Well 9
Driller: John Mitchell Date Drilled: 10/9/85
Surface Elevation ____ ft. __Estimated __Measured __ Above MSL
T.D. Logged: 670.5 T.D. Drilled: 672
Hole Dia. ____ From ____ To ____
Hole Dia. ____ From ____ To ____
Casing I.D. ____ From ____ To ____
Casing Dia. ____ From ____ To ____
Finish: X Open Hole __ Screen __ Gravel __ Other
Water Level ____ ft. __Above __Below MP ____ __Above __Below Land Surface
Yield: Flow ____ gpm Pump ____ gpm
Drawdown: ____ ft. after ____ hours pumping @ ____ gpm
Use: __ Dom. __ Stock __ PS __ Ind. __ Irr.
__ Heating or cooling __ Drainage __ Disposal
__ Obs. __ Test __ None __ Recharge
Water Quality:
Temp. ____ F; Sp. Cond. ____ Iron ____ ppm;
Taste, odor, color ____; Chloride ____ ppm;
Sulfate ____ ppm; Hardness ____ ppm
Water Samples:
Depths sampled ____, ____, ____, ____, ____, ____

__ Electric __ Caliper
X Gamma Ray __ Fluid Resistivity
__ Temperature __ Fluid Velocity
X Neutron

Log Scales

Electric Log
SP ____ millivolts/inch
Res. ____ ohms/inch

Fluid Resistivity
____ ohm-meters/inch
@ ____ °F

Gamma Ray Log
40 Counts/sec./inch
Logging speed 20 FPM

Fluid Velocity
____ Counts/min./inch (stationary)
____ FPM (continuous) Q = ____

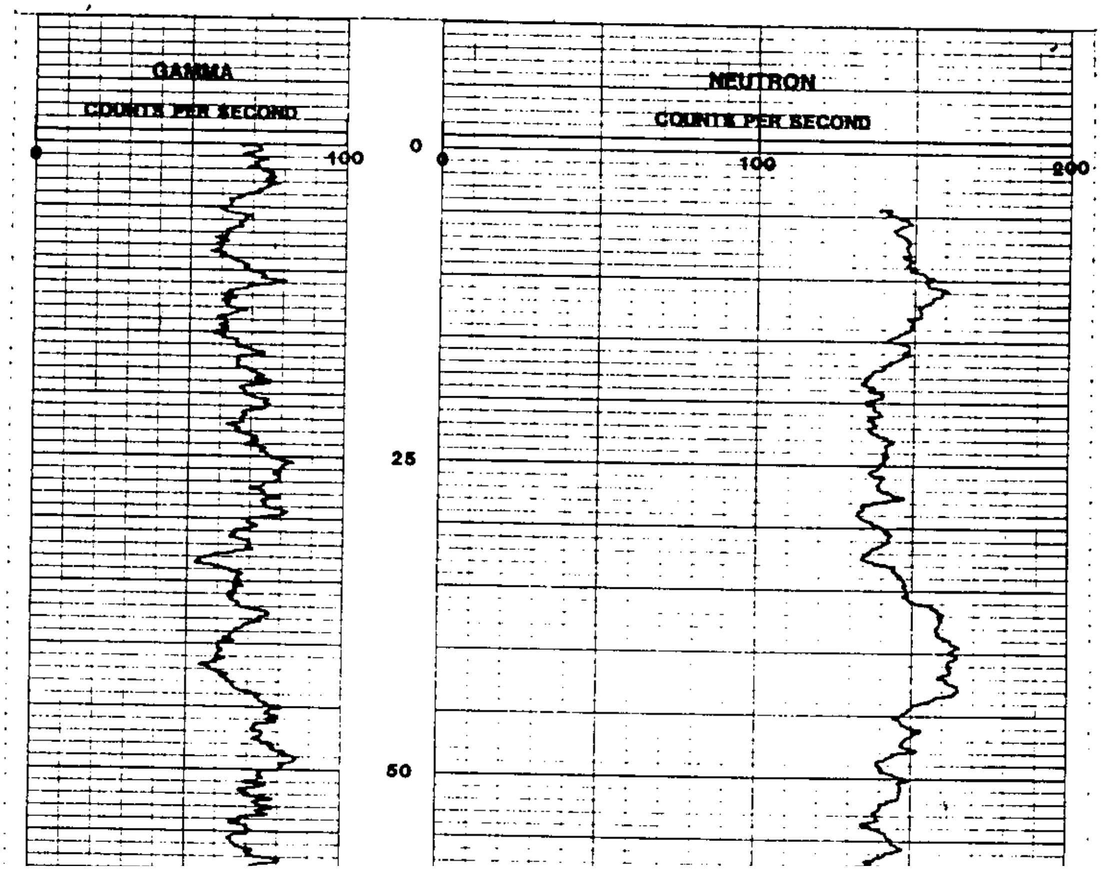
Temperature
____ °F/inch
Logging speed ____ FPM

Caliper
____ divisions = ____ inc

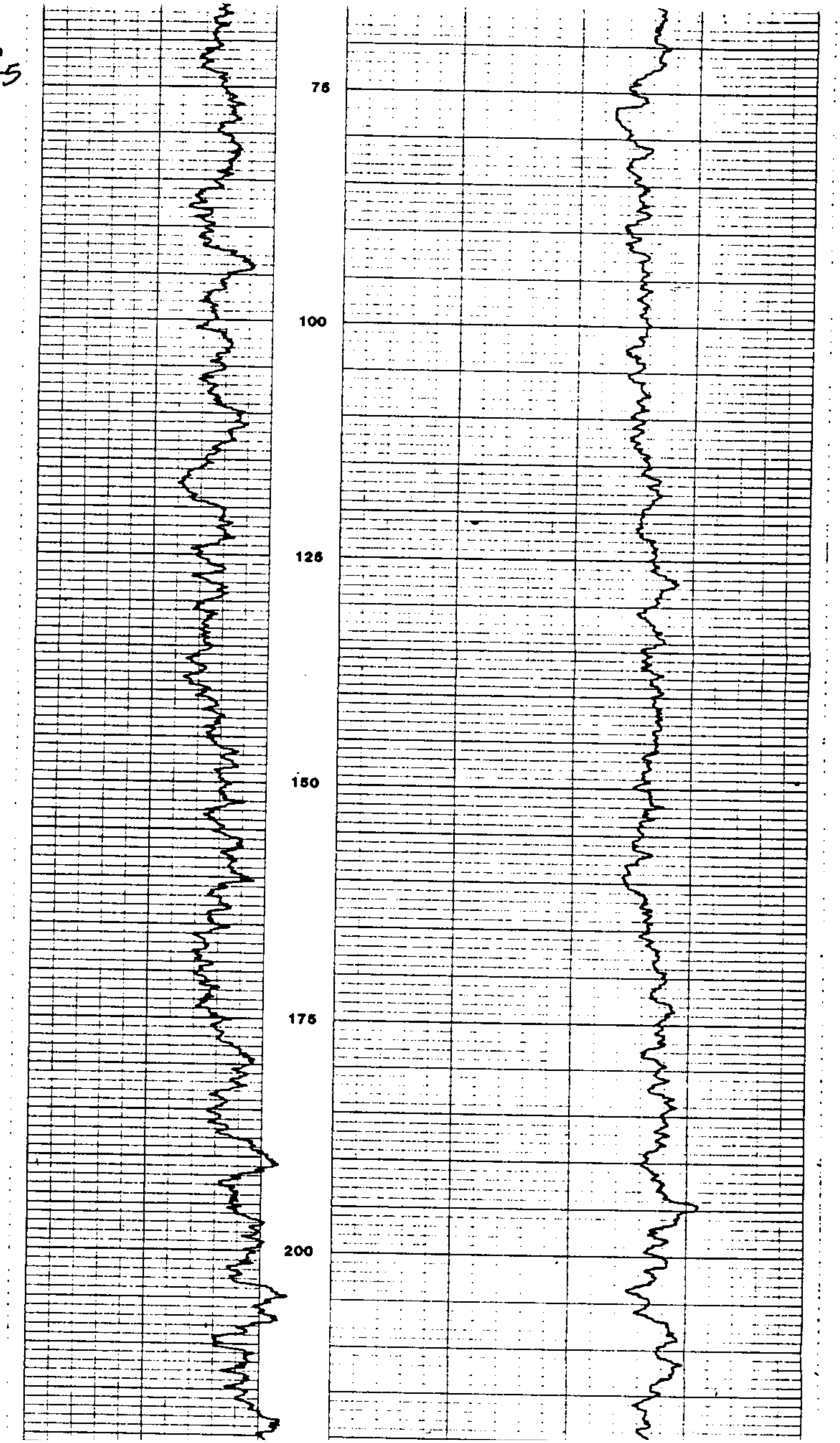
Gamma
Rec. Output = 250 TC = 2 Zero = 520
Suppression = 100 c/s = 100 Span = 640

Neutron
Rec. Output = 250 TC = 2 Zero = 550
Suppression = 100 c/s = 100 Span = 643

Remarks: Neutron log:
40 counts/sec/inch
logging speed 20 fpm



Page 2 of 5



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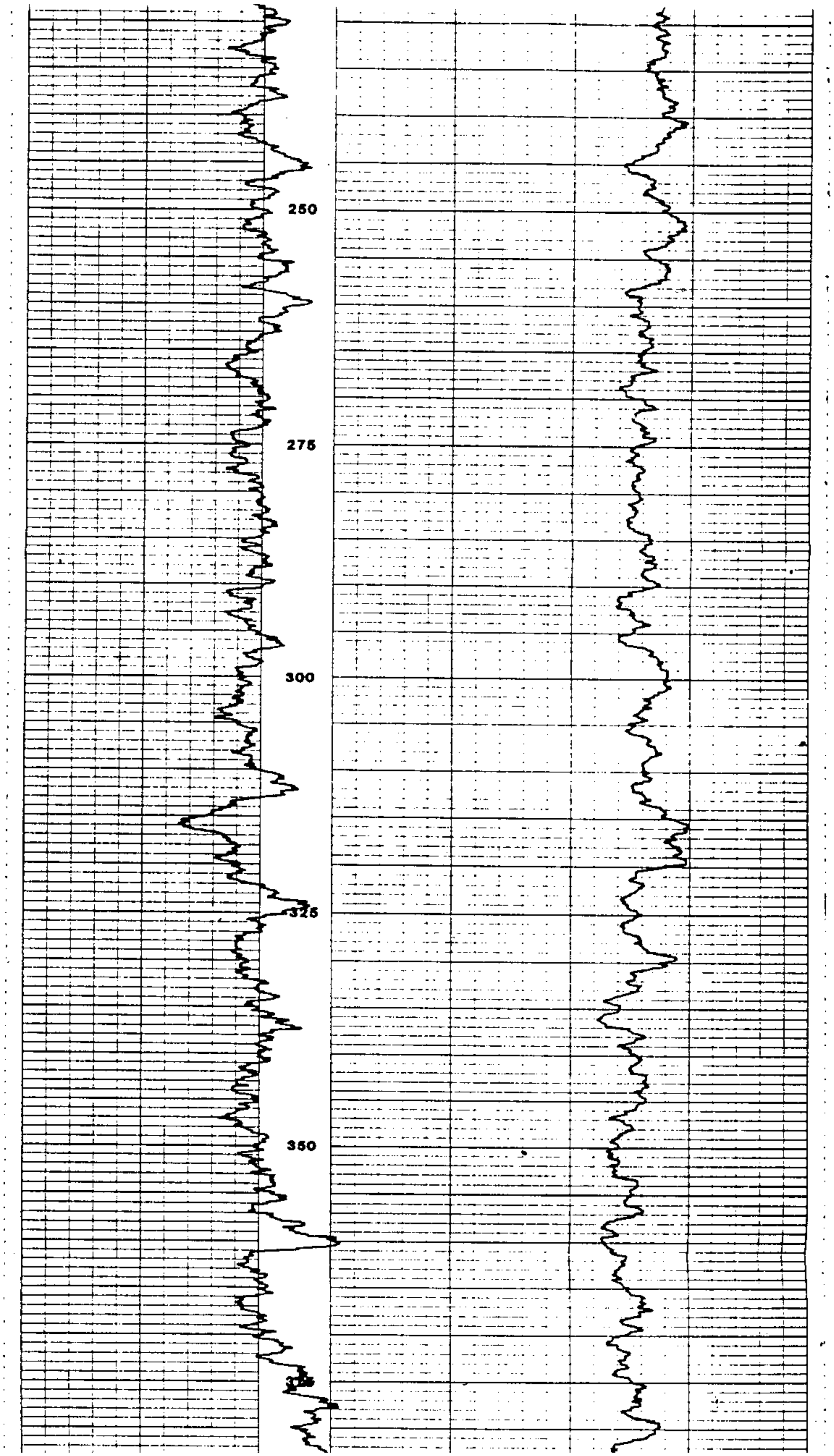
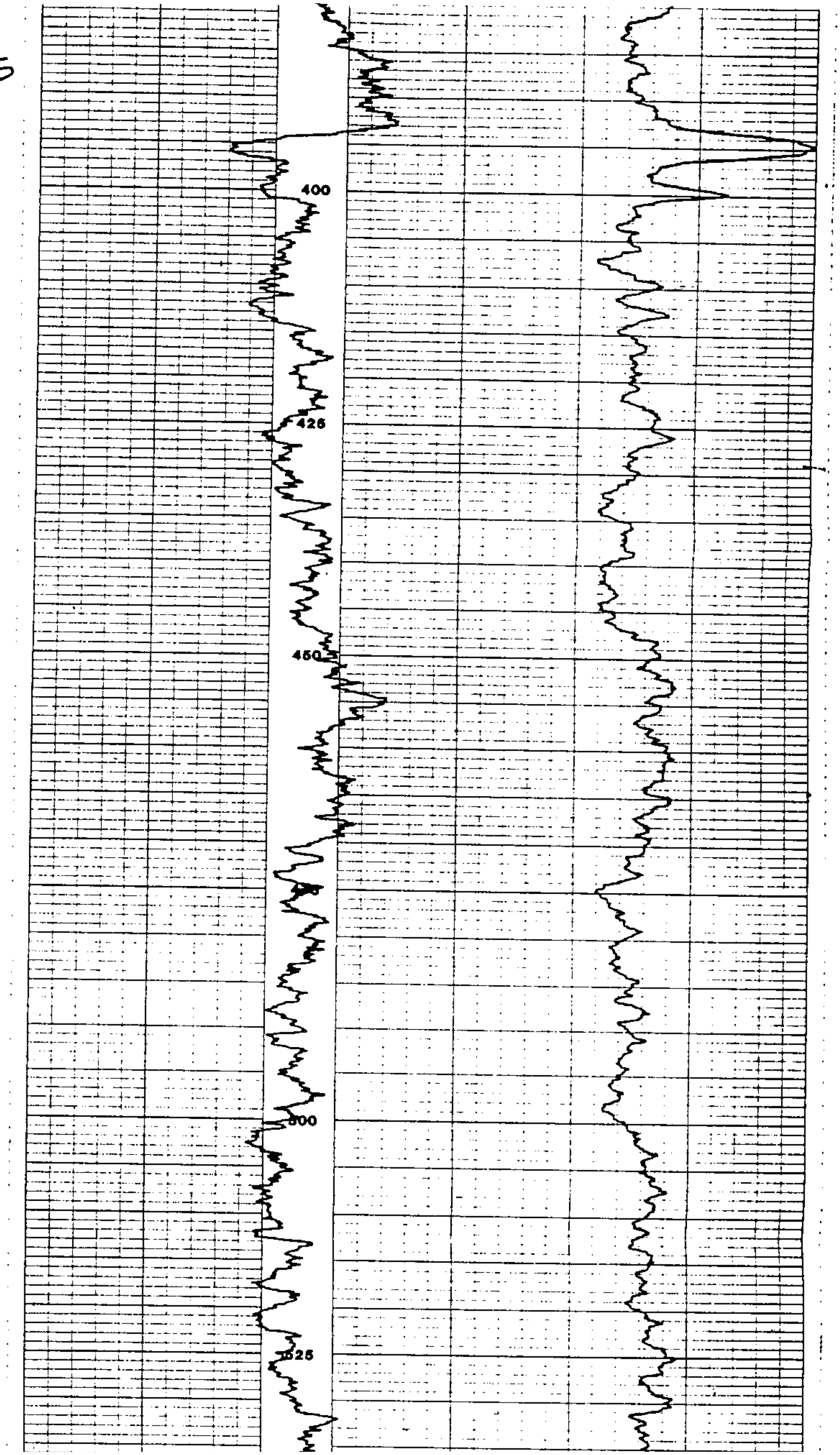


Page 4 of 5



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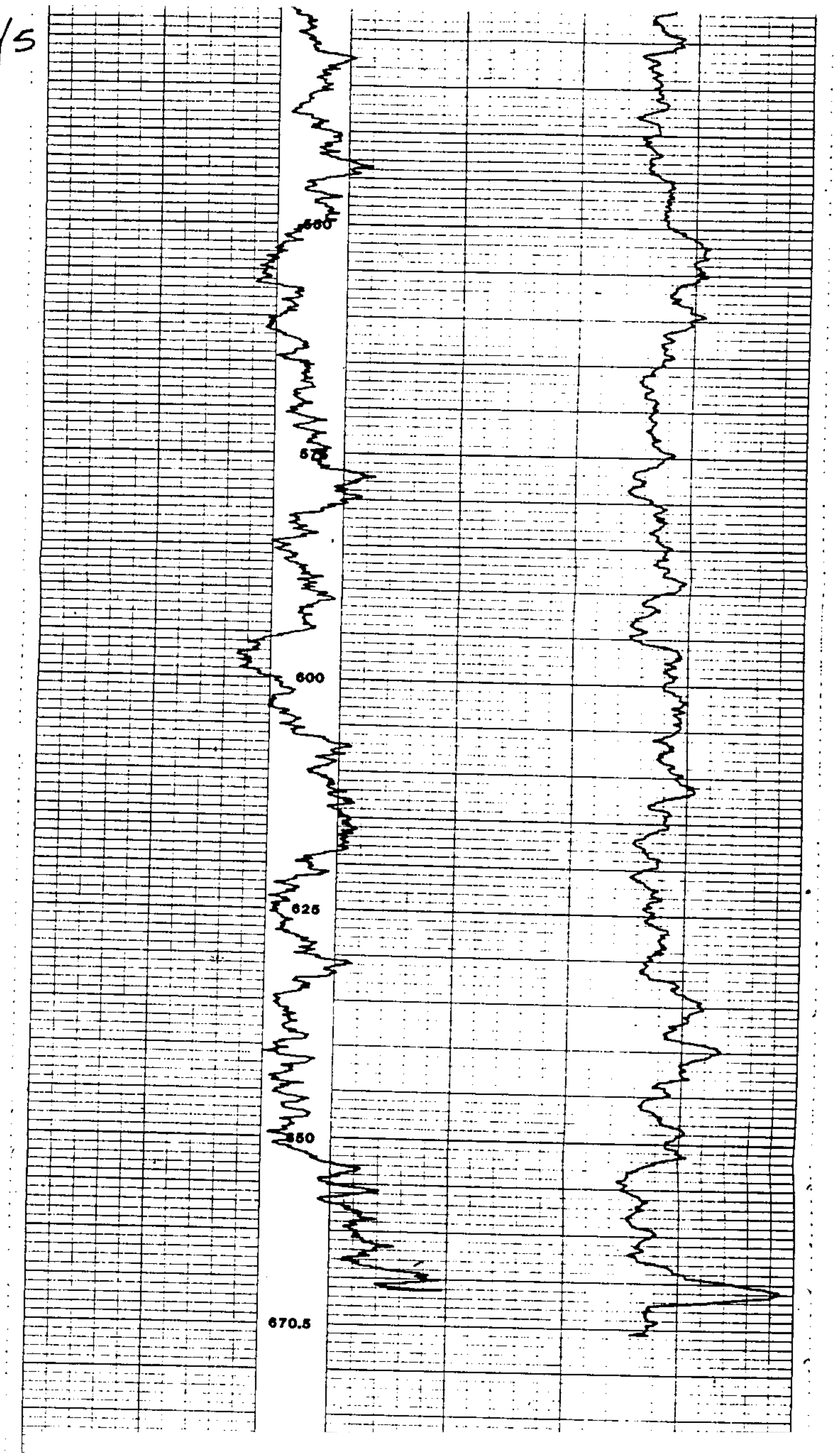


Page 1 of 2

PELA P.E. LaMoreaux & Associates, Inc.
P.O. BOX 2310
TUSCALOOSA, AL 35403

GEOPHYSICAL WELL SURVEY

FEB 24 1986

Client: Graves Well Drilling Date: 10/14/85
Log by: Abner Patton Well No: Monitoring Well 9
Observer: Jose Luis Urrutia Project No: 469900
Location: State: Alabama County: Sumter
____ ____ ____ Sec. ____ T. ____ N/S R. ____ E/W

___ Electric ___ Caliper
X Gamma Ray ___ Fluid Resistivity
___ Temperature ___ Fluid Velocity
X Neutron

Owner: Chem Waste Management Inc.
Well Name: Monitoring Well 9
Driller: John Mitchell Date Drilled: 10/14/85
Surface Elevation ____ ft. __Estimated __Measured ___ Above MSL
T.D. Logged: 718.7' T.D. Drilled: 725'
Hole Dia. ____ From ____ To ____
Hole Dia. ____ From ____ To ____
Casing I.D. 4" From 0 To 673'
Casing Dia. ____ From ____ To ____
Finish: X Open Hole ___ Screen ___ Gravel ___ Other
Water Level ____ ft. __Above __Below MP ____ __Above __Below Land Surface
Yield: Flow ____ gpm Pump ____ gpm
Drawdown: ____ ft. after ____ hours pumping @ ____ gpm
Use: ___ Dom. ___ Stock ___ PS ___ Ind. ___ Irr.
___ Heating or cooling ___ Drainage ___ Disposal
___ Obs. ___ Test ___ None ___ Recharge
Water Quality:
Temp. ____ °F; Sp. Cond. ____ Iron ____ ppm;
Taste, odor, color ____; Chloride ____ ppm;
Sulfate ____ ppm; Hardness ____ ppm
Water Samples:
Depths sampled ____, ____, ____, ____, ____, ____

Log Scales

Electric Log
SP ____ millivolts/inch
Res. ____ ohms/inch

Fluid Resistivity
____ ohm-meters/inch
@ ____ °F

Gamma Ray Log
40 Counts/sec./inch
Logging speed 20 FPM

Fluid Velocity
____ Counts/min./inch (stationary)
____ FPM (continuous) Q = ____ g

Temperature
____ °F/inch
Logging speed ____ FPM

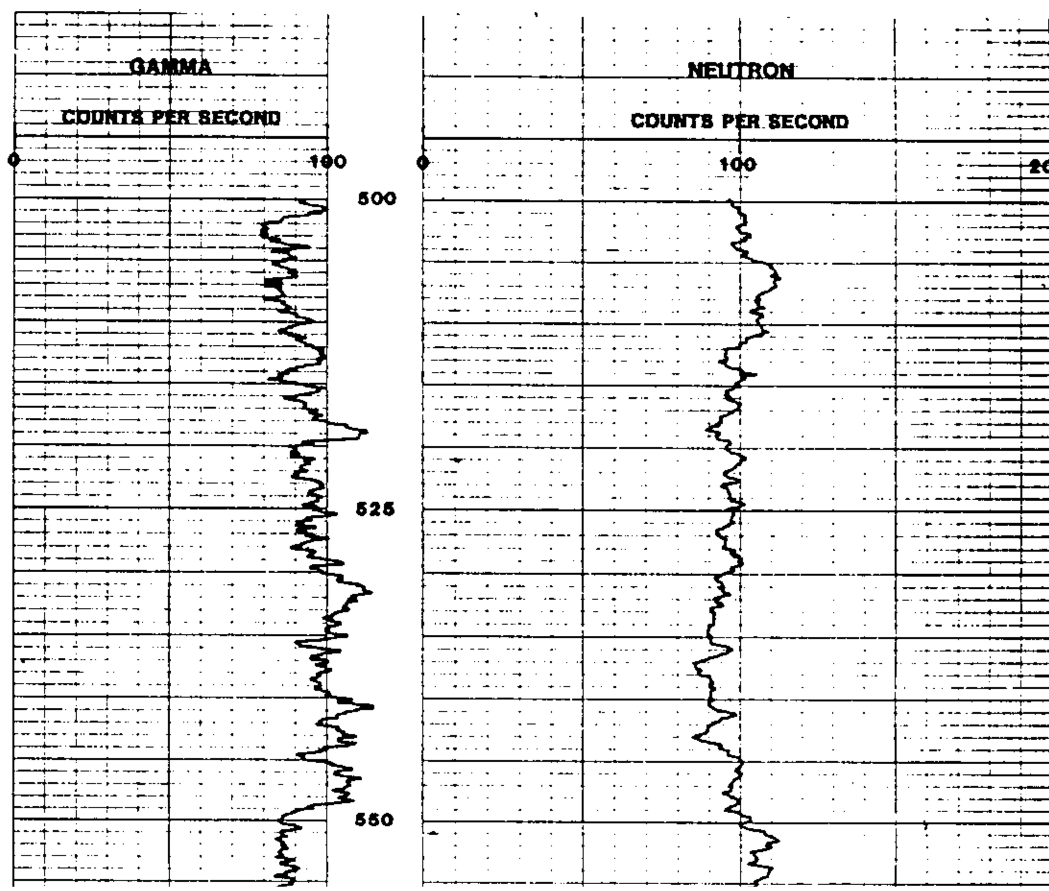
Caliper
____ divisions = ____ inches

Gamma
Rec. Output = 250 TC = 2 Zero = 520
Suppression = 100 c/s = 100 Span = 640

Neutron
Rec. Output = 250 TC = 2 Zero = 550
Suppression = 100 c/s = 100 Span = 645

Remarks: Neutron:
40 counts/sec/inch

Logged from TD to 500 feet below land surface.



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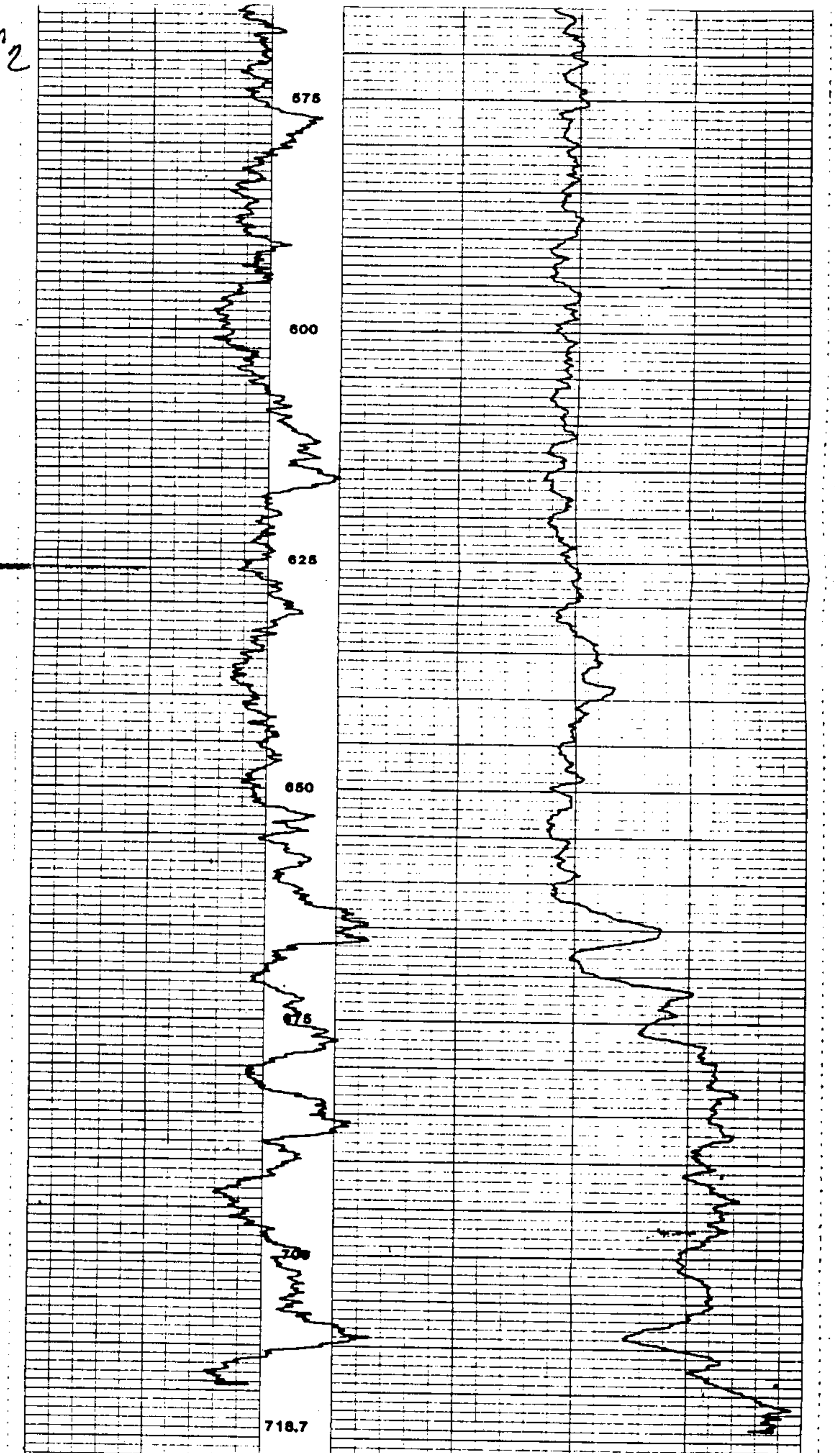


Page 1 of 1

PELA P.E. LaMoreaux & Associates, Inc.
P.O. BOX 2310
TUSCALOOSA, AL 35403

GEOPHYSICAL WELL SURVEY

FEB 24 1986

Client Graves Well Drilling Date 10/14/85
Log by Abner Patton Well No Monitoring Well 9
Observer Jose Luis Urrutia Project No 469900
Location: State Alabama County Sumter
Sec. T. N/S R. E/W

X Electric
Caliper
Gamma Ray
Fluid Resistivity
Temperature
Fluid Velocity

Owner Chem Waste Management Inc.
Well Name Monitoring Well 9
Driller John Mitchell Date Drilled 10/14/85
Surface Elevation ___ ft. Estimated / Measured ___ Above MSL
T.D. Logged 717.1' T.D. Drilled 725'
Hole Dia. ___ From ___ To ___
Hole Dia. ___ From ___ To ___
Casing I.D. 4" From 0 To 673'
Casing Dia. ___ From ___ To ___
Finish: X Open Hole ___ Screen ___ Gravel ___ Other
Water Level ___ ft. Above/Below MP ___ Above/Below Land Surface
Yield: Flow ___ gpm Pump ___ gpm
Drawdown: ___ ft. after ___ hours pumping @ ___ gpm
Use: ___ Dom. ___ Stock ___ PS ___ Ind. ___ Irr. ___ Heating or cooling ___ Drainage ___ Disposal ___ Obs. ___ Test X None ___ Recharge
Water Quality:
Temp. ___ F; Sp. Cond. ___ Iron ___ ppm; Taste, odor, color ___; Chloride ___ ppm; Sulfate ___ ppm; Hardness ___ ppm
Water Samples:
Depths sampled ___, ___, ___, ___, ___, ___

Log Scales

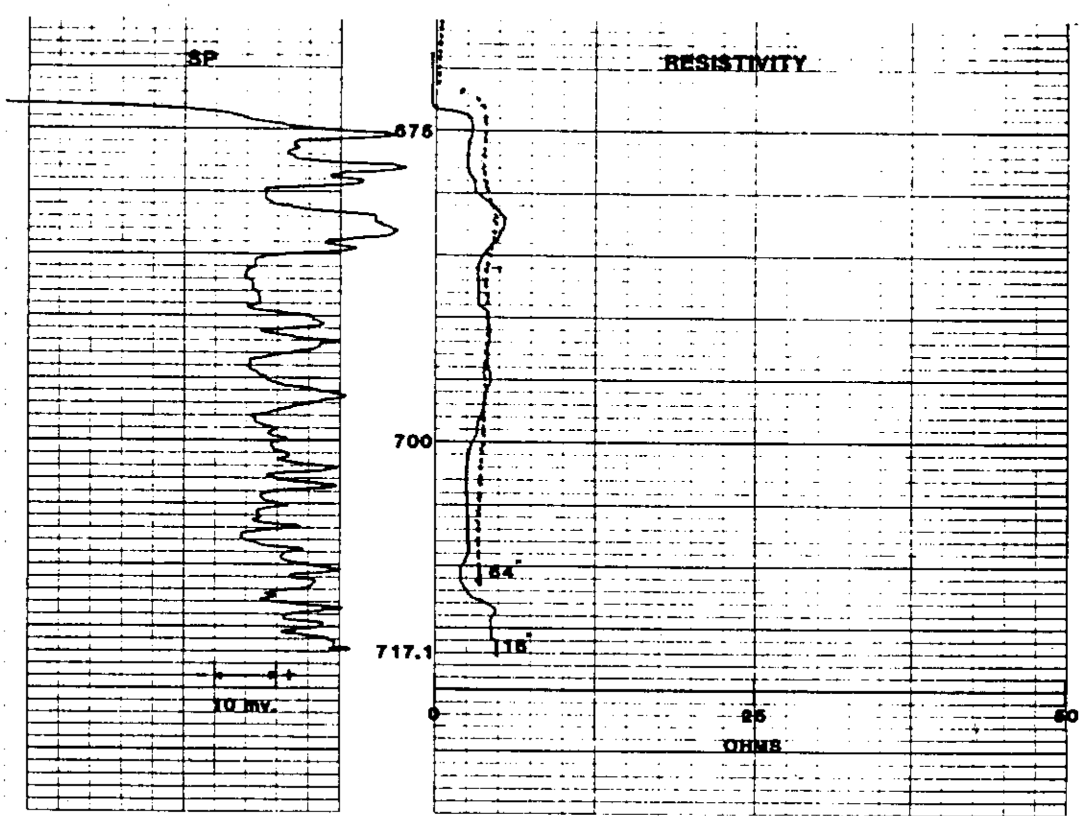
Electric Log	Fluid Resistivity
SP 20 millivolts/inch	___ ohm-meters/inch
Res. 10 ohms/inch	@ ___ °F
Gamma Ray Log ___ Counts/sec./inch	**Fluid Velocity** ___ Counts/min./inch (stationary) ___ FPM (continuous) Q = ___ gpm
Logging speed ___ FPM	
Temperature ___ °F/inch	**Caliper** ___ divisions = ___ inches
Logging speed ___ FPM	

Rec. Output = ___ TC = ___ 16" Zero = 550
Suppression = ___ c/s = ___ Span = 894

Rec. Output = ___ TC = ___ 64" Zero = 558
Suppression = ___ c/s = ___ Span = 884

Remarks SP
Zero = 567
Span = 939

Logged from total depth to bottom of casing.



ESPEY, HUSTON & ASSOCIATES, INC.
ENGINEERING & ENVIRONMENTAL CONSULTANTS

FEB 24 1986

LOG HEADING

HOLE NO. DB3

COMPANY Chem. Wst. Mgmt.	LOCATION	UNIT NO. OFFICE
CLAIM HOLE NO. DB-3	SECTION TWP. RNG.	OPERATOR(S) G. Berger
CLIENT REPRESENTATIVE J. Kensella	COUNTY Sumpter STATE Ala.	DATE Nov. 22, 1982
DRILLED DEPTH 500 FT. ELEVATION FT.	CASING DIAMETER IN. FACTOR	DRILLING MEDIUM Water
HOLE DIAMETER IN.	WALL THICKNESS IN.	TYPE OF MUD N. A.

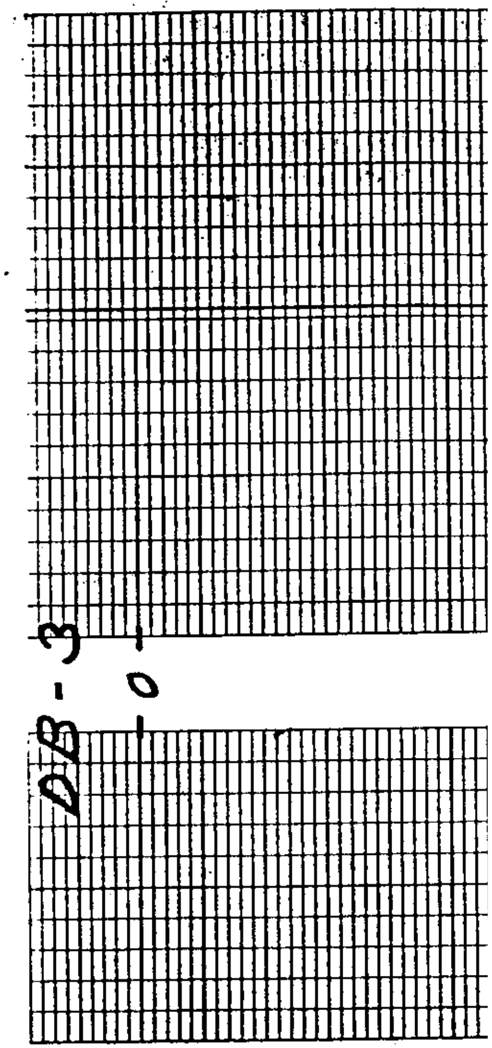
NUCLEAR RADIATION N.A.			
RUN NUMBER	1	2	3
DEPTH (INTERVAL) FT.			
RANGE C.P.S.			
TIME CONSTANT SEC.			
LOGGING SPEED Ft/Min			
VERTICAL SCALE Ft/In			
WATER LEVEL FT.			
DIGITAL RECORD			

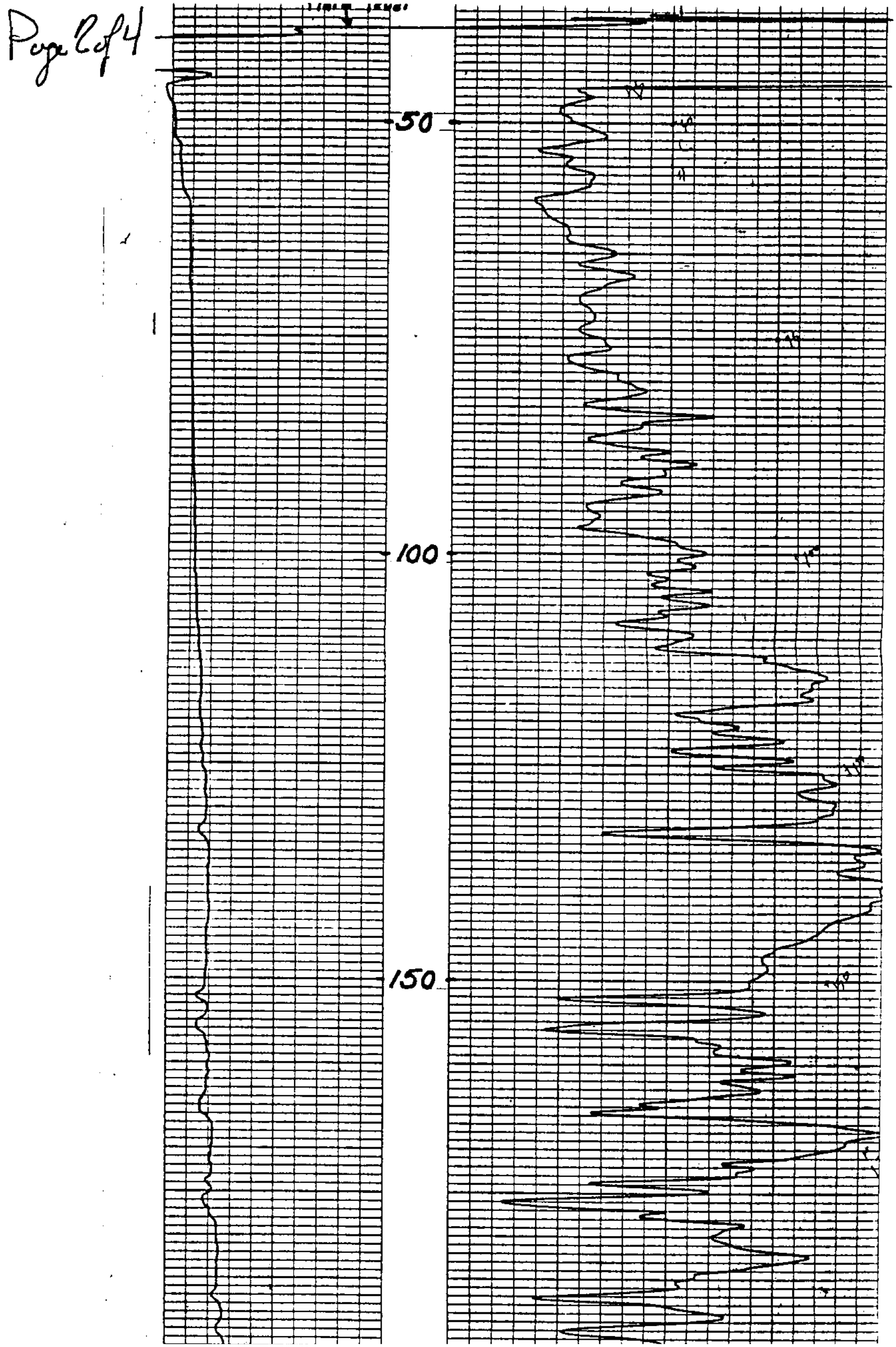
INSTRUMENTATION	
PROBE NUMBER	
TYPE	
k FACTOR	.0000
DEAD TIME	µ Sec.
WATER FACTOR	

Remarks: logging Speed 25'/min

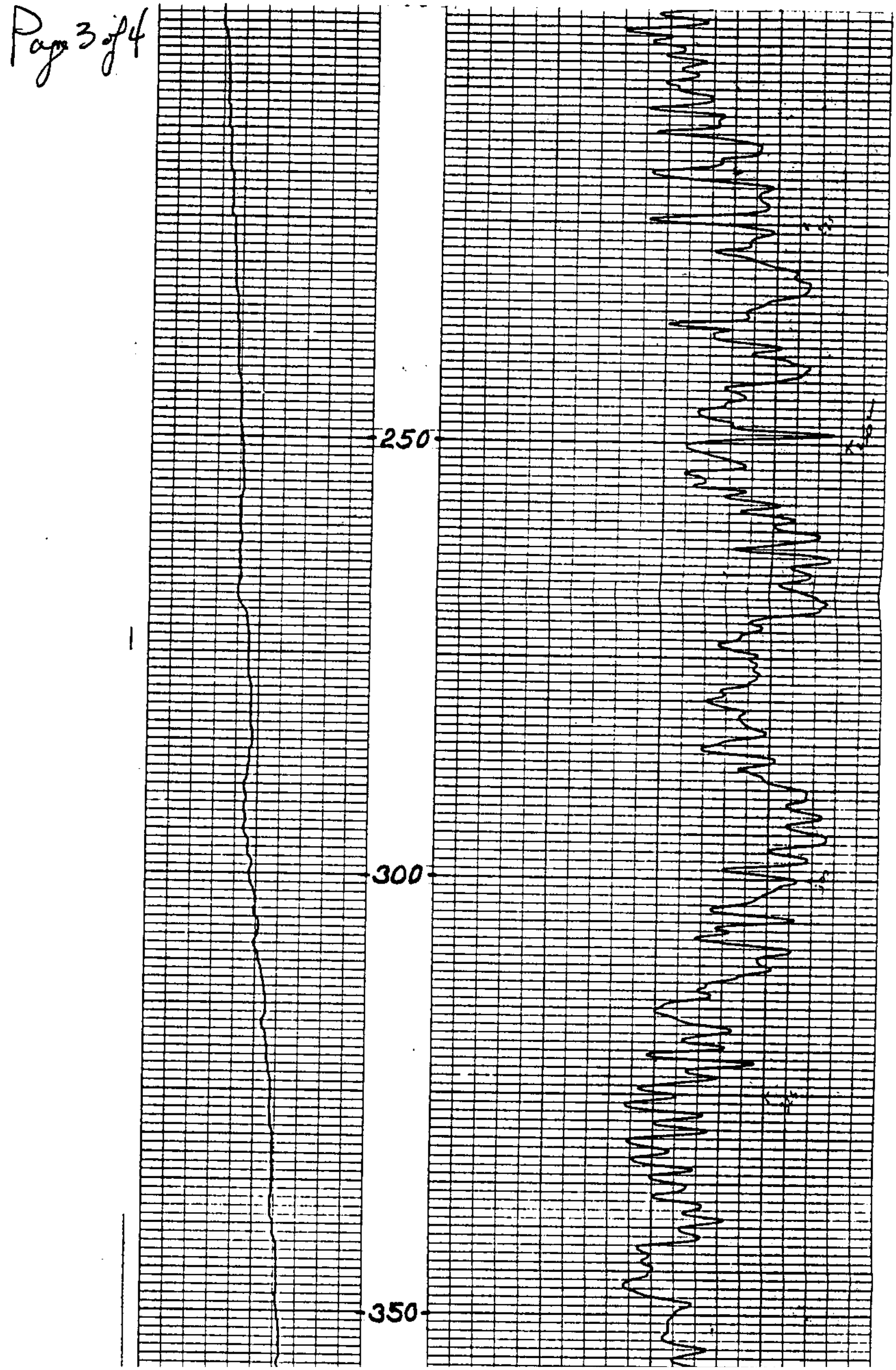
ELECTRIC LOG		
DEPTH	489	Ft.
RESISTIVITY	20	Ohms
S. P.	20	M V
VERTICAL SCALE	10	Ft/In
CALIPER NA		
VERTICAL SCALE		Ft/In
HORIZONTAL SCALE		In/In
OTHER N/A		
DEPTH		Ft.
RANGE		

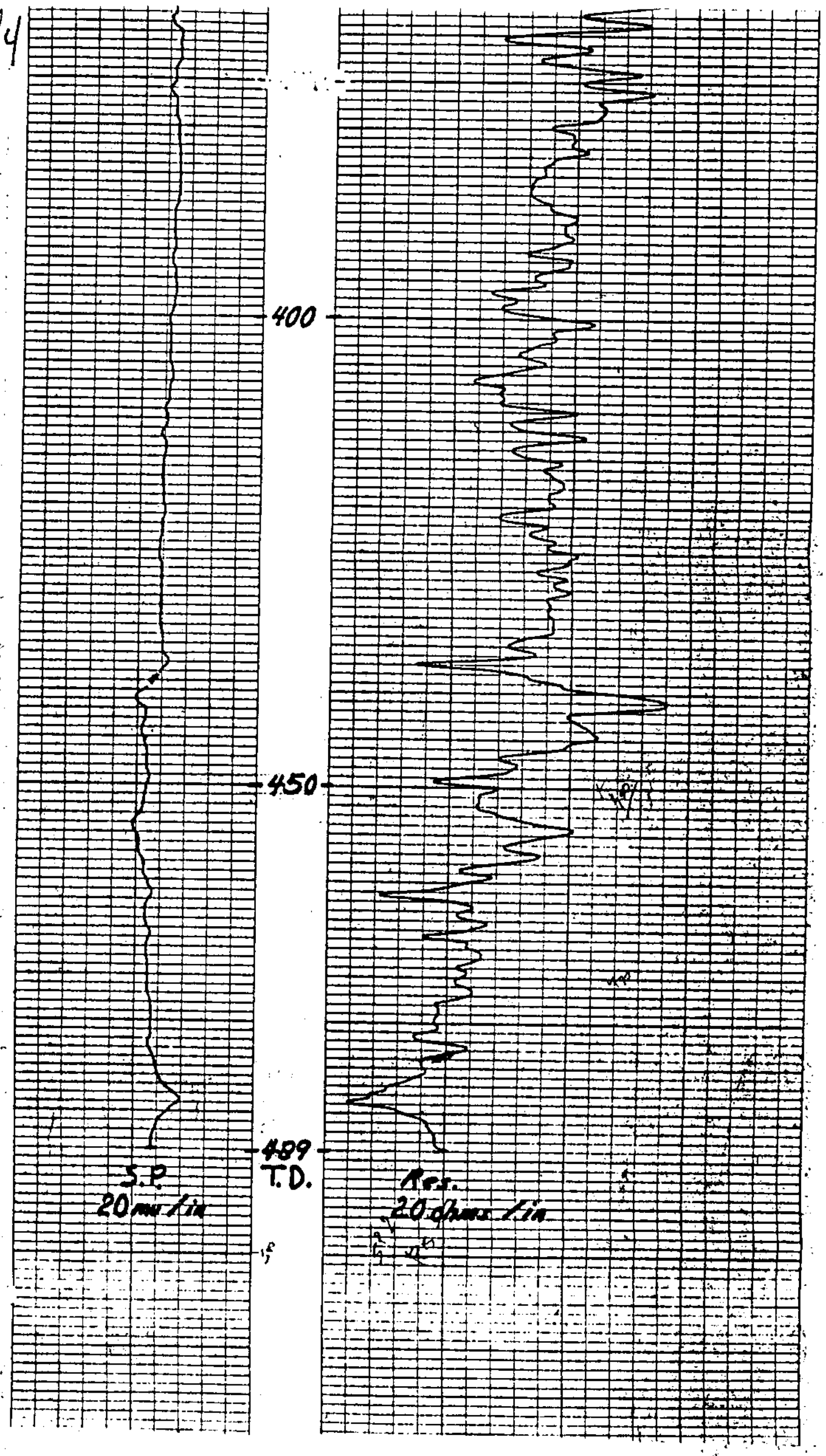
MLS-000 3-81





Page 2 of 4
50
100
150


Page 3 of 4
250
300
350


400
450
489
T.D.
S.P.
20 mv/in
Res.
20 ohms/in

Page 1 of 4

ESPEY, HUSTON & ASSOCIATES, INC.
ENGINEERING & ENVIRONMENTAL CONSULTANTS

LOG HEADING

FEB 24 1986

HOLE NO. DB-[illegible]

COMPANY Chem. Wst. Mgmt.	LOCATION	UNIT NO. OFFICE
CLAIM Emelec HOLE NO. DB 1	SECTION TWP. RNG.	OPERATOR(S) G. Berger
CLIENT REPRESENTATIVE J. Keneella	COUNTY Sumpter STATE Ala.	DATE Nov. 22, 19[illegible]
DRILLED DEPTH 500 FT. ELEVATION FT.	CASING DIAMETER IN. FACTOR	DRILLING MEDIUM Water
HOLE DIAMETER IN.	WALL THICKNESS IN.	TYPE OF MUD N.A.

NUCLEAR RADIATION NA			
RUN NUMBER	1	2	3
DEPTH (INTERVAL) FT.			
RANGE C.P.S.			
TIME CONSTANT SEC.			
LOGGING SPEED Ft/Min			
VERTICAL SCALE Ft/In			
WATER LEVEL FT.			
DIGITAL RECORD			

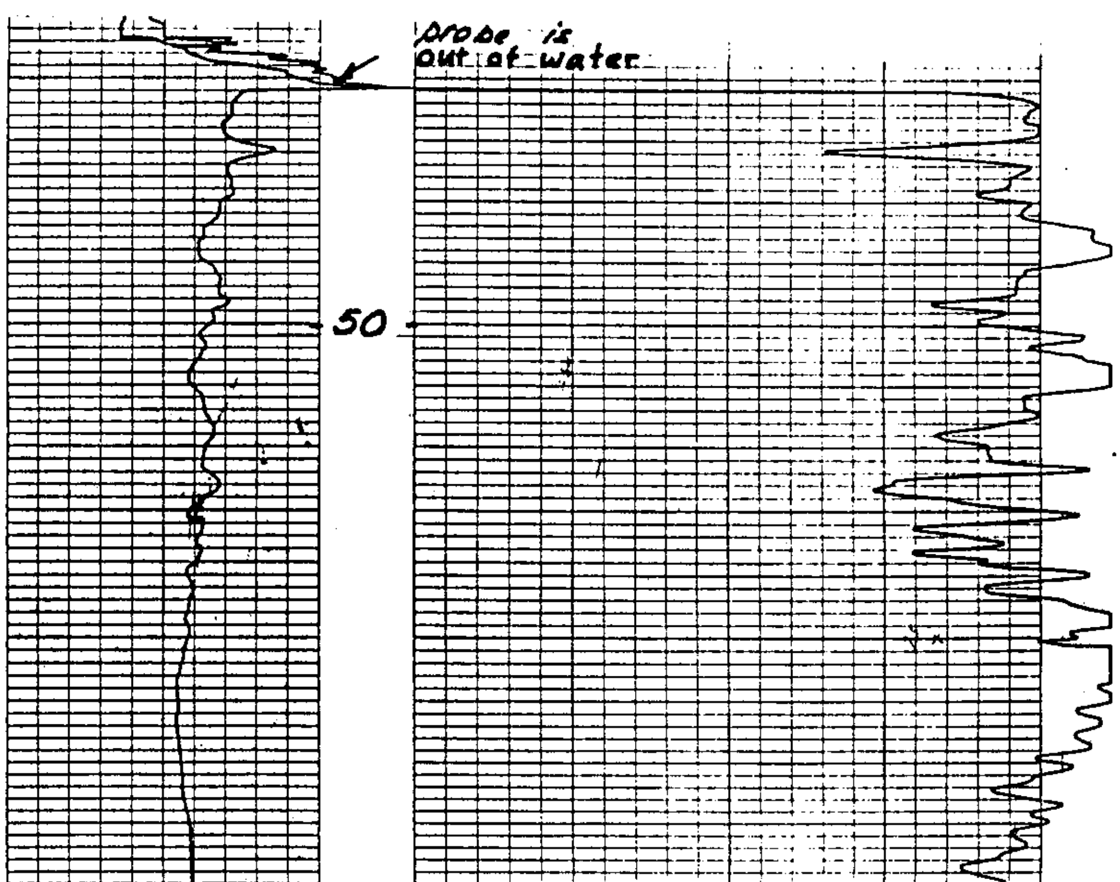
INSTRUMENTATION	
PROBE NUMBER	
TYPE	
k FACTOR	.0000
DEAD TIME	µ Sec.
WATER FACTOR	

Remarks: logging speed 25 ft/min

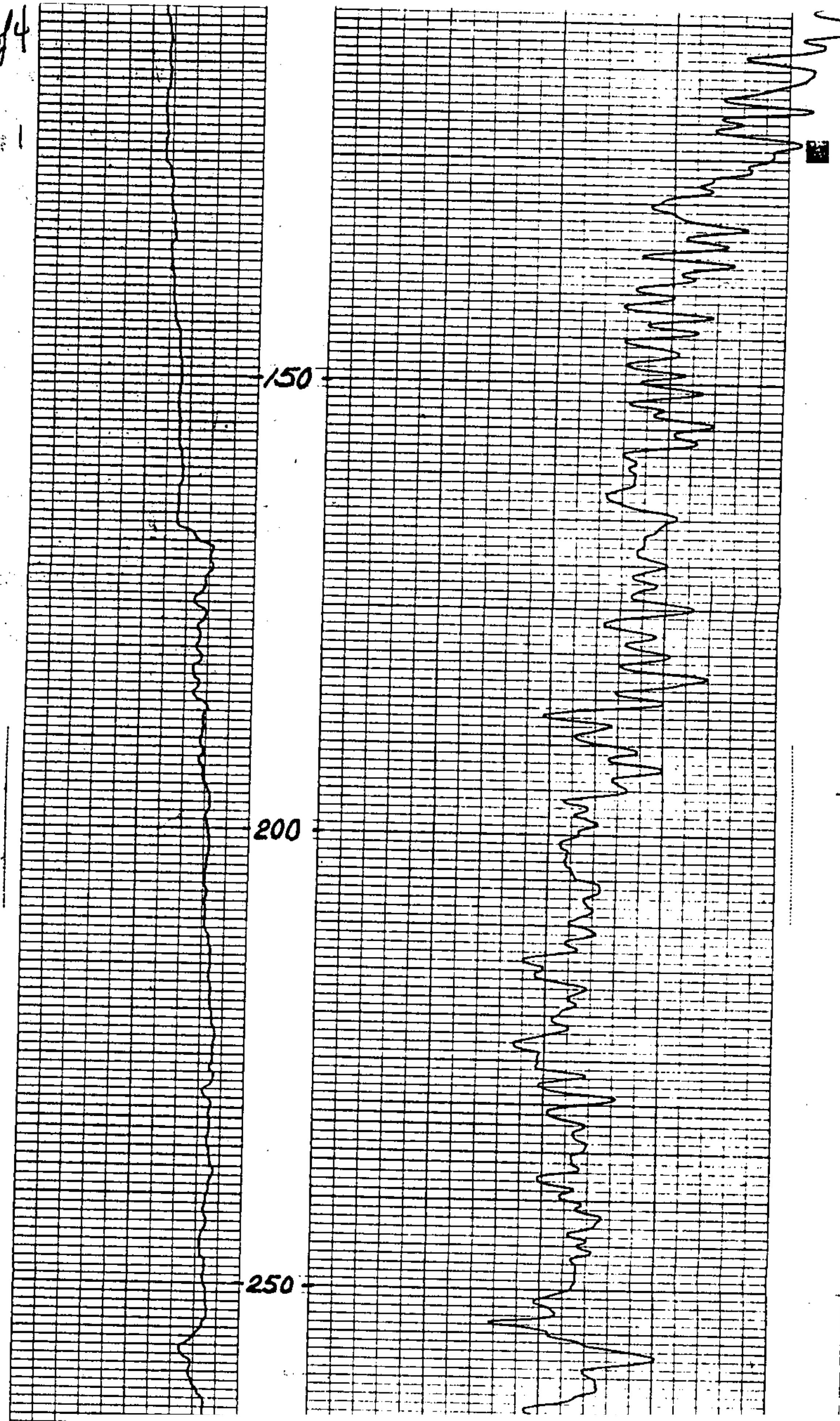
ELECTRIC LOG		
DEPTH	498.5	Ft.
RESISTIVITY	20	Ohms
S. P.	10	MV
VERTICAL SCALE	10	Ft/In

CALIPER NA		
VERTICAL SCALE	—	Ft/In
HORIZONTAL SCALE	—	In/In

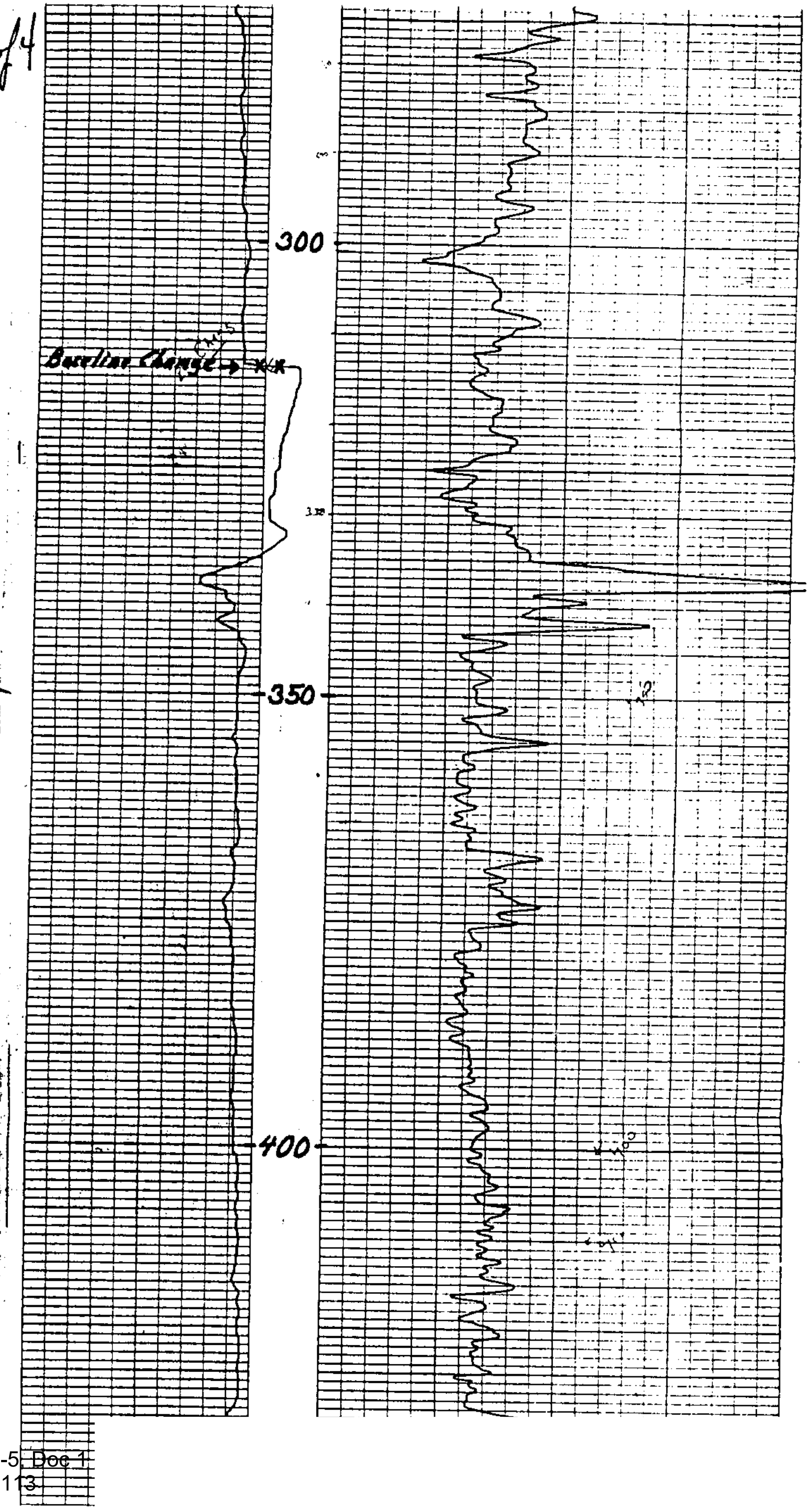
OTHER NA		
DEPTH	—	Ft.
RANGE	—	

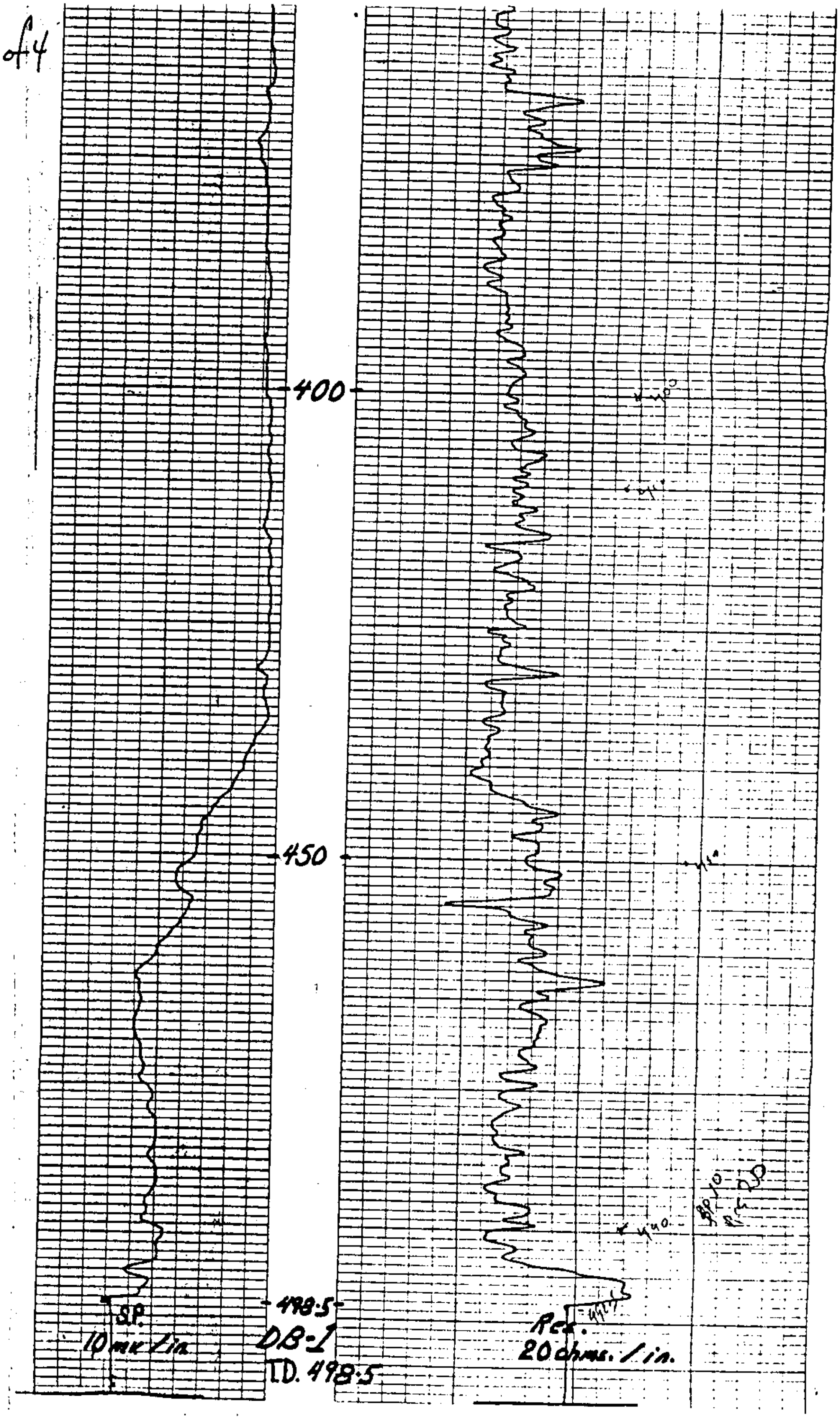


Page 2 of 4



Page 3 of 4





400
450
498.5
S.P.
10 mv/in
DB-1
T.D. 498.5
Res.
20 ohms./in.

APPENDIX C

WMI Well ID Forms

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 5 Date Installed: reworked 9-13-85

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/Water Rotary Total Depth: 937' Boring Dia: 6"/4"

Ground El.: 211 Standpipe El.: 211.63

Casing: Diameter: 4" Length: 672 Material: steel

Screen: Diameter: 2" Length: 41' Slot Size: 0.008"

Water Level: Initial: ---- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: This well has been reworked and the open interval below the screen grouted. The well is not suitable for water quality assessment.

Description of Screened Interval

From*	To*	Soil Description
691	732	Tombigbee Sand Member, Eutaw Formation. See drillers log for detailed description of strata.
		*See drawing 107 for well completion details

*Values are: x depth from ground surface or ____ elevation msl.

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 6 Date Installed: 5-24-83

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/Water Rotary Total Depth: 650 Boring Dia: 6"/4"

Ground El.: 164 Standpipe El.: 162.94

Casing: Diameter: 4" Length: 650 Material: steel

Screen: Diameter: 2" Length: 40' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Downgradient well

Description of Screened Interval

From*	To*	Soil Description
606	646	Tombigbee Sand Member, Eutaw Formation. See drillers log for detailed description of strata.
		*See Drawing 107 for well completion details

*Values are: x depth from ground surface or ____ elevation msl.

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 7 Date Installed: 5-30-83

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/Water Rotary Total Depth: 708 Boring Dia: 6"/4"

Ground El.: 206 Standpipe El.: 207.62

Casing: Diameter: 4" Length: ___ Material: steel

Screen: Diameter: 2" Length: 40' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Downgradient well

Description of Screened Interval

From*	To*	Soil Description
682	722	Tombigbee Sand Member, Eutaw Formation. See drillers log for detailed description of strata.
		*See drawing 107 for well completion details

*Values are: x depth from ground surface or ___ elevation msl.

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 8 Date Installed: 5-13-83

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/water Rotary Total Depth: 692 Boring Dia: 6"/4".

Ground El.: 131 Standpipe El.: 140.93

Casing: Diameter: 4" Length: ______ Material: ______

Screen: Diameter: 2" Length: 40' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Upgradient well

Description of Screened Interval

From*	To*	Soil Description
668	708	Tombigbee Sand Member, Eutaw Formation. See Driller's log for detailed description of strata.
		*See Drawing 107 for well completion details

*Values are: x depth from ground surface or ______ elevation msl.

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 9 Date Installed: 10-15-85

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/water Rotary Total Depth: 725' Boring Dia: 6"/4"

Ground El.: 209 Standpipe El.: 211.37

Casing: Diameter: 4" Length: 673' Material: steel

Screen: Diameter: 2" Length: 41' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Downgradient well

Description of Screened Interval

From*	To*	Soil Description
684	725	Tombigbee Sand Member, Etuaw Formation. See Driller's log for detailed description of strata.

*Values are: x depth from ground surface or ____ elevation msl.

APPENDIX D

Well Sealing Forms

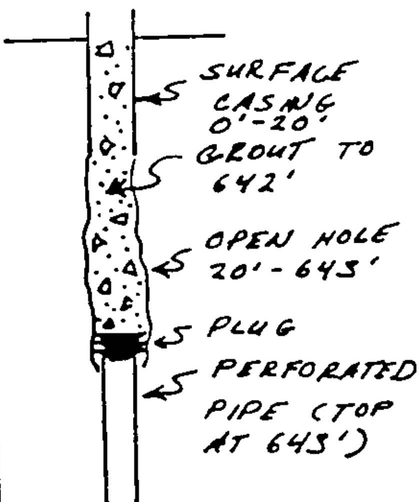
WELL SEALING FORM

PROJECT: CWM/RCRA WELLS/EMELLE WELL: RCRA 4
JOB NUMBER: 853-3107 DATE: 9-18-85
GOLDER INSPECTOR: AES GROUTER: GRAVES/HALLI-BURTON

WELL INFORMATION

DESIGNED WELL DEPTH: UNKNOWN ft. MEASURED DEPTH (H): SEE NOTES ft.
DEPTH TO WATER: FLOWING CASING STICKUP: 0 ft.
CASING TYPE: SEE NOTES INSIDE CASING DIA. (D): 4" in.

GROUT VOLUME



COMPUTED VOLUME

REQUIRED VOLUME = $\frac{D^2 \text{ (in.)} \times H \text{ (ft.)}}{183.4}$ = — ft.^{3}

ACTUAL VOLUME

BAGS OF CEMENT: 37.5
~~BAGS OF~~ BENTONITE: 150 #
GALLONS OF WATER: 430
GROUT VOLUME: 84 ft.^{3}
GROUT SETTLEMENT: 0 in.
ADDED GROUT VOLUME: — ft.^{3}
FLYASH: 37.5 ft^3
CALCIUM CHLORIDE: 150 #

COMMENTS

The well was constructed with 4" surface casing to about 20', open hole through the Selma Group, and perforated pipe in the Eutah Aquifer. The top of the perforated pipe was at 643'; the screened interval and total depth of the well are unknown. Set a top-hole plug at 642' before grouting.

Golder Associates

APPENDIX E

Letter of Compliance Certification

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

853-3103.3

September 27, 1985

Mr. Don R. McCombs, P.E.
Chemical Waste Management, Inc.
3003 Butterfield Road
Oakbrook, Illinois 60521

SUBJECT: HYDROGEOLOGIC CHARACTERIZATION
CHEMICAL WASTE MANAGEMENT
EMELLE, ALABAMA FACILITY
EPA ID # ALD 000 622 464

Dear Mr. McCombs:

As a qualified geohydrologist, I have reviewed the relevant geologic, hydrogeologic and geotechnical information describing the location of the Emelle Facility. I certify that the hydrogeology of the site has been adequately characterized. Based on this characterization and on my interpretation of the regulations, it is my opinion that the groundwater monitoring system meets the requirments of the 40 CFR 265 Subpart F.

Sincerely,

GOLDER ASSOCIATES

J E Baker

J. Edmund Baker, P.E.
Associate

ALABAMA REGISTERED No. 14971 PROFESSIONAL ENGINEER JAMES EDMUND BAKER

JEB:rac

Golder Associates Inc.

3730 Chamblee Tucker Road
Atlanta, GA USA 30341
Telephone (404) 496-1893
Fax (404) 934-9476

Golder Associates

REVISED LETTER REPORT ON

WELL DEVIATION STUDY

Submitted to:

Chemical Waste Management, Inc.
P.O. Box 55
Rt. 17 at Milepost 163
Emelle, Alabama 35459

DISTRIBUTION:

4 Copies - Chemical Waste Management, Inc.
1 Copy - Golder Associates Inc.

August 1993

933-3513

Golder Associates Inc.

3730 Chamblee Tucker Road
Atlanta, GA USA 30341
Telephone (404) 496-1893
Fax (404) 934-9476

Golder Associates

August 10, 1993

933-3513

Mr. Clyde Pendergrass
Chemical Waste Management, Inc.
P.O. Box 55
Rt. 17 at Milepost 163
Emelle, AL 35459

RE: REVISED LETTER REPORT ON WELL DEVIATION STUDY

Dear Mr. Pendergrass:

Golder Associates Inc. (Golder Associates) is pleased to present this report on the monitoring well deviation study conducted on two wells at the Chemical Waste Management, Inc. (CWMI) Emelle Facility. The purpose of the study was to provide monitoring well dip and azimuth data so future water level depth measurements can be corrected to water level elevations. In addition to the well deviation study, Golder Associates was asked to attempt to remove the existing groundwater sampling pumps from the wells and to establish the prospects of using a geophysical tool by running a dummy probe down the wells. The addition of these tasks to this project was based on communications between Mr. Clyde Pendergrass of CWMI and Mr. Randall Sullivan of Golder Associates on July 17, 1993. This report summarizes the findings of the study and the procedures utilized to obtain measurements from the monitoring wells.

BACKGROUND INFORMATION

CWMI owns and operates the Emelle treatment, storage and disposal (TSD) facility near Emelle, Alabama. During October of 1991, a slope failure (slide) occurred near disposal Trench 21. As a result of this slide, monitoring wells SM-10 and SM-10A were deflected near the slide failure surface. Subsequently earthen materials and PVC well pipe were removed to a depth of approximately five feet to six feet below the failure surface. Monitoring wells SM-10 and SM-10A were then both extended in stages during the backfilling process. The soil around the wells was compacted during the backfilling process, causing deflection in the wells. Based on survey data, the wells were extended approximately 33 feet in elevation, in addition to the six feet that were originally excavated. Therefore, these monitoring wells are likely to have primary deflection from near the failure surface extending up to the recently established ground surface. The wells are expected to be fairly straight and plumb below 38 feet or 39 feet in vertical depth.

To accurately establish the groundwater elevation in most monitoring wells, a fundamental assumption is that the wells are straight and plumb (vertical). With this assumption, the water level elevation is calculated by simply subtracting the measured depth to water in the wells (the water level depth) from the top of casing elevation of the well. However, monitoring wells SM-10 and SM-10A have been deflected and are neither straight nor plumb. Therefore, this deviation study was proposed to evaluate the extent of deflection and to allow for water level elevation corrections to estimate the vertical distance to the water surface in the well from the top of the well.

PROPOSED APPROACH

The planned approach to the study was to use a downhole geophysical tool to measure the orientation of the casing as the tool was run down the well. This would require first that the sampling pumps be removed since the geophysical tool might not fit inside the well with tubing in the well. Second, the change in orientation could not be severe or the tool would not pass any major deflection points in the wells. Accordingly, a tool was found that could provide the required measurements. The proposed and preferred tool used a digital slimhole magnetometer/tiltmeter probe for downhole measurements. This probe's overall dimensions were: 1.75 inches in diameter by 5.5 feet in length. Prior to mobilization to the site, the tool was rented and tested, and a dummy probe of these dimensions was acquired to check tool passage before inserting the tool in the wells.

CLEANING AND HANDLING

The proposed study required evaluation of groundwater monitoring installations. Golder Associates was concerned about compromising the use of the monitoring wells by potentially contaminating them during the study. Therefore, all materials were cleaned with alconox and rinsed with deionized water prior to insertion into the wells. Further, all material were handled with latex gloves and placed on plastic adjacent to the well (not on the ground).

PUMP REMOVAL

Prior to conducting the deviation study in the wells, the groundwater sampling pumps had to be removed from the wells. The sample pumps (QED Well Wizard bladder pumps) have dimensions of about 1.75 inches in diameter and about 2.5 feet in length and are connected to the surface with plastic tubing which serves to transmit compressed gas (N_2) and sample water.

An attempt was made to pull the pump out of monitoring well SM-10. However, the pump became stuck after pulling approximately 78 feet of tubing from the hole. Golder Associates personnel managed to force the pump back down the well by applying downward pressure on the plastic tubing connected to the pump. No further attempts were made to remove the sampling pump from well SM-10 because of the possibility of getting the pump stuck and thus rendering the well useless. This decision was also made, in part, because the downhole magnetometer/tiltmeter tool has larger dimensions than does the sampling pump and, therefore, was not likely to be of use in this well. The sample pump tubing inside the 2-inch diameter PVC well casing also prohibited the geophysical tools available from fitting down the well.

Golder Associates personnel then attempted to carefully pull the sampling pump from SM-10A. This pump became stuck after pulling only 18 feet of tubing. This correlates to a depth of about 125 feet to 130 feet below the top of casing (Ft.TOC). The pump could not be forced back down the hole, rather it was dislodged by twisting the tubing and pulling upward with more force. The pump again became stuck at approximately 38 Ft.TOC and could not be dislodged by twisting and pulling the tubing. One inch diameter PVC pipe was then used to force the pump back down the well, however, the air tubing was damaged in the process, rendering the pump unusable. Since the pump was not functioning, an attempt was made to pull hard on the tubing such that the tubing would break off and the pump could be pushed to the bottom of the well, and a smaller pump installed. However, with two people pulling very hard, the pump was removed from the well without breaking off the tubing.

PUMP REPLACEMENT

Golder Associates personnel investigated various small diameter pump options for use in well SM-10A based on the criteria of fitting down the well pipe and being able to pump water up 150 feet. Dummy probes of specific dimensions were placed down the well to help determine which pumps would fit. From this evaluation at least two, and possibly three, pumps will fit down the well and handle the necessary 150 feet of head. These pumps and their general dimensions are:

- Fultz Pump - 1.75 inches in diameter by 9.16 inches long;
- Solinst Pump - 5/8 inches in diameter by 12 inches long; and
- QED Well Wizard T1300 - 1 inch in diameter by 46.75 inches long.

A dummy probe was not run for the Well Wizard pump because pump dimensions were not obtained from QED prior to obtaining materials for constructing the dummy probes. A dummy probe with these dimensions should be run if this pump is considered. Descriptions and specifications for each of these pumps is included in Attachment 1. The QED pump is recommended (assuming it fits down the well) since CWMI already uses this system in the other monitoring wells at the site. The Fultz pump and the Solinst pump would cost approximately $2,000 to $2,500. The QED pump would be much less expensive (less than $1,000) because CWMI already owns a QED controller and well seals. Additional costs will also be incurred for shipping, installation, and documentation of the replacement pump.

ORIENTATION MEASUREMENTS

As previously stated, the program was initially proposed using a digital slimhole magnetometer/tiltmeter probe. The dummy probe, consisting of PVC pipe with the same dimensions as the slimhole probe, was first placed down the wells. The probe could not fit in well SM-10 because of the tubing attached to the pump. In well SM-10A the dummy probe became stuck at a fairly shallow depth (about 30 feet). Therefore the magnetometer/tiltmeter tool was not used on the well and an alternate approach was adopted.

The Pajari, a mechanical gyroscopic tool with smaller dimensions than the magnetometer/tiltmeter tool, was acquired for downhole measurements. The tool is designed to measure both angle of dip and azimuth. However, the compass measurement did not lock in properly and the resulting azimuth data was considered unreliable. The tool is encased in a cylindrical brass container with dimensions of about 1.75 inches in diameter by 16 inches long. The Pajari is equipped with a mechanical timer and is lowered into the hole to a specified depth and allowed to stabilize for 10 minutes to 15 minutes before the measurement is taken. The tool is then removed from the hole and the reading is recorded. The tool could not pass by the tubing in well SM-10, and was not used in the well. In well SM-10A, this procedure was repeated six times at depths of ten feet, 20 feet, 25 feet, 30 feet, 35 feet and 36 feet. The instrument would not go past 36 feet down the well. The measurements are summarized in Table 1.

As a rough check, well casing orientations for both wells were estimated using a Brunton compass. A measurement was taken at the surface of SM-10A using a Brunton compass and a PVC extension (placed inside the well casing and extended out away from the protective casing). This measurement is also included in Table 1. The aluminum protective casing for well SM-10 was also measured with the Brunton compass, resulting in dip and azimuth measurements similar to those of well SM-10A.

Survey data was also obtained for this evaluation. Each well had previously been surveyed by CWMI in 1986, prior to well movement, and in 1992 following the extension of each well. These survey readings are:

WELL NO.	NORTHING	EASTING	ELEVATION (Ft.MSL)
SM-10 (1986)	10748.80	5477.40	195.90
SM-10 (1992)	10751.84	5459.11	228.75
SM-10A (1986)	10759.10	5478.00	195.90
SM-10A (1992)	10760.31	5459.83	229.33

EVALUATIONS

The inclination measurements obtained from well SM-10A were plotted using a CAD system, as shown on Figure 1. As discussed above, the last measurement was taken at a depth of 36 feet. Since no dip measurements were obtained below this depth, the last dip angle (81 degrees) was continued to a depth of about 38 vertical feet, at which point the well was assumed to be vertical (90 degrees). The plotted dip angles resulted in a horizontal displacement of 18.2 feet from the top of the existing casing to the point where the well deviation is assumed to begin. This matches the horizontal displacement calculated from the survey coordinates (before and after the well extension) as discussed below. The well inclination plot does not take into account possible azimuth deviations (winding) in the well casing.

Horizontal coordinates of wells SM-10 and SM-10A were plotted from survey data obtained before and after deflection and extension of the wells occurred. Net horizontal displacement and the displacement direction were calculated and compared with the inclination plot results and dip direction measurements taken at the surface in SM-10A (see Attachment 2).

	SURVEY RESULTS	FIELD MEASUREMENT RESULTS
SM-10A Horizontal Displacement Dip Direction	18.21 ft. N94° E	18.2 ft. N97° E
SM-10 Horizontal Displacement Dip Direction	18.54 ft. N99° E	— N111° E

As shown in the above comparison, the displacement predicted in the inclination plot and the measured dip direction in well SM-10A were very similar to the calculated displacement distance and direction obtained from the survey data. This would indicate that there is very little azimuth deviation (winding) in the casing between the existing well location and the original well location. If significant azimuth deviations were present the inclination plot would extend far beyond the predicted 18.2 feet before returning to vertical. Based on the available data, the inclination plot is believed to be reasonably accurate and reliable.

Apparent measured depths (down-hole depths) were correlated to calculated vertical depths on the inclination plot (Figure 1). This was accomplished by enlarging the plot several times and measuring along the downhole well plot at various increments (ranging from 0.1 foot to 1.0 foot) with an engineering scale. This method of correlation was deemed appropriate considering the level of accuracy in the data used to construct the plot. The corresponding calculated vertical depths were recorded and a table was constructed relating measured depths, depth corrections, actual depths, and water level elevations for well SM-10A (see Table 2). Although the depth corrections were estimated to an accuracy of 0.1 feet, as shown in Table 2, it should be noted that these are only estimations and are based on limited available data. Depth correlations are reported at 1 foot intervals from the top of casing down to 30 feet, at 0.1 foot intervals from 30 feet down to 45 feet, and at again at 1 foot intervals from 45 feet to 100 feet below the top of casing. The water level in SM-10A is expected to remain below 30 Ft.BG, therefore, depth correlations were reported at 0.1 foot intervals below this depth.

The same depth corrections used in well SM-10A can be used for well SM-10, based on the similarities in inclination, displacement direction and calculated displacement distance. The estimated depth corrections for well SM-10, based on the TOC elevation for this well, are tabulated in Table 3. The resulting estimated water level elevations for well SM-10 would be considered less reliable than those for well SM-10A.

RESULTS

Based on the above evaluations, Tables 2 and 3 present the estimated depth correlations for wells SM-10A and SM-10, respectively. These tables can be used to estimate water level elevations in each well based on measured water levels below the top of PVC casing (TOC). As an example, during the latest sampling event in February 1993, water levels were measured at depths of 40.89 feet below the top of PVC casing (Ft.TOC) in monitoring well SM-10A and 57.45 Ft.TOC in monitoring well SM-10. Using the depth corrections presented in Tables 2 and 3, the actual depths would be 36.2 Ft.TOC and 52.7 Ft.TOC, which correspond to water level elevations of 193.1 Feet Mean Sea Level (Ft.MSL) and 176.0 Ft.MSL in wells SM-10A and SM-10, respectively. These correlations are estimated to be accurate to the nearest 0.1 feet in well SM-10A. The level of accuracy would be slightly lower for well SM-10.

Golder Associates appreciates the opportunity to work with CWMI on this project. If you have any questions or need further clarification of the contents of this report, please do not hesitate to call.

Very truly yours,

GOLDER ASSOCIATES INC.

Jonathan S. Radtke
Project Hydrogeologist

John F. Clerici, P.E.
Principal

JSR/JFC:maa

Attachments

FN: 3513-CWM.LTR\2\MAA

TABLE 1

INCLINATION MEASUREMENTS
MONITORING WELL SM-10A

MEASUREMENT DEPTH (FT.TOC)(1)	DIP ANGLE(2) (DEGREES)	DIP DIRECTION(3) (DEGREES)
0	54°	N97°E
10	58°	—
20	62°	—
25	65°	—
30	68°	—
35	78°	—
36	81°	—

Notes:
1. FT.TOC - Feet below top of PVC casing.
2. Dip angle measured in degrees from horizontal using a Pajari Inclinometer.
3. Dip direction measured at surface using a Brunton compass.

3513TAB1 WK1/JSR

TABLE 2

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10A
PAGE 1 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
0.0	0.0	0.0	229.3
1.0	-0.2	0.8	228.5
2.0	-0.3	1.7	227.6
3.0	-0.6	2.4	226.9
4.0	-0.8	3.2	226.1
5.0	-1.0	4.0	225.3
6.0	-1.2	4.8	224.5
7.0	-1.4	5.6	223.7
8.0	-1.5	6.5	222.8
9.0	-1.7	7.3	222.0
10.0	-1.8	8.2	221.1
11.0	-2.0	9.0	220.3
12.0	-2.2	9.8	219.5
13.0	-2.3	10.7	218.6
14.0	-2.5	11.5	217.8
15.0	-2.6	12.4	216.9
16.0	-2.8	13.2	216.1
17.0	-3.0	14.0	215.3
18.0	-3.1	14.9	214.4
19.0	-3.2	15.8	213.5
20.0	-3.3	16.7	212.6
21.0	-3.4	17.6	211.7
22.0	-3.5	18.5	210.8
23.0	-3.6	19.4	209.9
24.0	-3.7	20.3	209.0
25.0	-3.8	21.2	208.1
26.0	-3.9	22.1	207.2
27.0	-4.0	23.0	206.3
28.0	-4.1	23.9	205.4
29.0	-4.2	24.8	204.5
30.0	-4.3	25.7	203.6
30.1	-4.3	25.8	203.5
30.2	-4.3	25.9	203.4
30.3	-4.3	26.0	203.3
30.4	-4.3	26.1	203.2
30.5	-4.3	26.2	203.1
30.6	-4.3	26.3	203.0
30.7	-4.3	26.4	202.9
30.8	-4.3	26.5	202.8
30.9	-4.3	26.6	202.7
31.0	-4.3	26.7	202.6
31.1	-4.4	26.7	202.6
31.2	-4.4	26.8	202.5
31.3	-4.4	26.9	202.4
31.4	-4.4	27.0	202.3
31.5	-4.4	27.1	202.2
31.6	-4.4	27.2	202.1
31.7	-4.4	27.3	202.0
31.8	-4.4	27.4	201.9
31.9	-4.4	27.5	201.8
32.0	-4.4	27.6	201.7
32.1	-4.4	27.7	201.6
32.2	-4.4	27.8	201.5
32.3	-4.4	27.9	201.4
32.4	-4.5	27.9	201.4
32.5	-4.5	28.0	201.3
32.6	-4.5	28.1	201.2
32.7	-4.5	28.2	201.1
32.8	-4.5	28.3	201.0
32.9	-4.5	28.4	200.9
33.0	-4.5	28.5	200.8
33.1	-4.5	28.6	200.7
33.2	-4.5	28.7	200.6
33.3	-4.5	28.8	200.5
33.4	-4.5	28.9	200.4
33.5	-4.6	28.9	200.4
33.6	-4.6	29.0	200.3
33.7	-4.6	29.1	200.2
33.8	-4.6	29.2	200.1
33.9	-4.6	29.3	200.0
34.0	-4.6	29.4	199.9
34.1	-4.6	29.5	199.8
34.2	-4.6	29.6	199.7
34.3	-4.6	29.7	199.6
34.4	-4.6	29.8	199.5
34.5	-4.6	29.9	199.4
34.6	-4.6	30.0	199.3
34.7	-4.6	30.1	199.2
34.8	-4.6	30.2	199.1
34.9	-4.6	30.3	199.0

3513TAB2.WK1/JSR

TABLE 2

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10A
PAGE 2 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
35.0	-4.6	30.4	198.9
35.1	-4.6	30.5	198.8
35.2	-4.6	30.6	198.7
35.3	-4.6	30.7	198.6
35.4	-4.6	30.8	198.5
35.5	-4.6	30.9	198.4
35.6	-4.6	31.0	198.3
35.7	-4.6	31.1	198.2
35.8	-4.6	31.2	198.1
35.9	-4.6	31.3	198.0
36.0	-4.6	31.4	197.9
36.1	-4.6	31.5	197.8
36.2	-4.6	31.6	197.7
36.3	-4.6	31.7	197.6
36.4	-4.6	31.8	197.5
36.5	-4.6	31.9	197.4
36.6	-4.6	32.0	197.3
36.7	-4.6	32.1	197.2
36.8	-4.6	32.2	197.1
36.9	-4.6	32.3	197.0
37.0	-4.6	32.4	196.9
37.1	-4.6	32.5	196.8
37.2	-4.6	32.6	196.7
37.3	-4.6	32.7	196.6
37.4	-4.6	32.8	196.5
37.5	-4.6	32.9	196.4
37.6	-4.6	33.0	196.3
37.7	-4.6	33.1	196.2
37.8	-4.6	33.2	196.1
37.9	-4.6	33.3	196.0
38.0	-4.6	33.4	195.9
38.1	-4.6	33.5	195.8
38.2	-4.6	33.6	195.7
38.3	-4.6	33.7	195.6
38.4	-4.6	33.8	195.5
38.5	-4.6	33.9	195.4
38.6	-4.6	34.0	195.3
38.7	-4.6	34.1	195.2
38.8	-4.6	34.2	195.1
38.9	-4.6	34.3	195.0

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
39.0	-4.6	34.4	194.9
39.1	-4.6	34.5	194.8
39.2	-4.6	34.6	194.7
39.3	-4.6	34.7	194.6
39.4	-4.6	34.8	194.5
39.5	-4.7	34.8	194.5
39.6	-4.7	34.9	194.4
39.7	-4.7	35.0	194.3
39.8	-4.7	35.1	194.2
39.9	-4.7	35.2	194.1
40.0	-4.7	35.3	194.0
40.1	-4.7	35.4	193.9
40.2	-4.7	35.5	193.8
40.3	-4.7	35.6	193.7
40.4	-4.7	35.7	193.6
40.5	-4.7	35.8	193.5
40.6	-4.7	35.9	193.4
40.7	-4.7	36.0	193.3
40.8	-4.7	36.1	193.2
40.9	-4.7	36.2	193.1
41.0	-4.7	36.3	193.0
41.1	-4.7	36.4	192.9
41.2	-4.7	36.5	192.8
41.3	-4.7	36.6	192.7
41.4	-4.7	36.7	192.6
41.5	-4.7	36.8	192.5
41.6	-4.7	36.9	192.4
41.7	-4.7	37.0	192.3
41.8	-4.7	37.1	192.2
41.9	-4.7	37.2	192.1
42.0	-4.7	37.3	192.0
42.1	-4.7	37.4	191.9
42.2	-4.7	37.5	191.8
42.3	-4.7	37.6	191.7
42.4	-4.7	37.7	191.6
42.5	-4.7	37.8	191.5
42.6	-4.7	37.9	191.4
42.7	-4.7	38.0	191.3
42.8	-4.7	38.1	191.2
42.9	-4.7	38.2	191.1

3515TAB2 WK1/JSR

TABLE 2

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10A
PAGE 3 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
43.0	-4.7	38.3	191.0
43.1	-4.7	38.4	190.9
43.2	-4.7	38.5	190.8
43.3	-4.7	38.6	190.7
43.4	-4.7	38.7	190.6
43.5	-4.7	38.8	190.5
43.6	-4.7	38.9	190.4
43.7	-4.7	39.0	190.3
43.8	-4.7	39.1	190.2
43.9	-4.7	39.2	190.1
44.0	-4.7	39.3	190.0
44.1	-4.7	39.4	189.9
44.2	-4.7	39.5	189.8
44.3	-4.7	39.6	189.7
44.4	-4.7	39.7	189.6
44.5	-4.7	39.8	189.5
44.6	-4.7	39.9	189.4
44.7	-4.7	40.0	189.3
44.8	-4.7	40.1	189.2
44.9	-4.7	40.2	189.1
45.0	-4.7	40.3	189.0
46.0	-4.7	41.3	188.0
47.0	-4.7	42.3	187.0
48.0	-4.7	43.3	186.0
49.0	-4.7	44.3	185.0
50.0	-4.7	45.3	184.0
51.0	-4.7	46.3	183.0
52.0	-4.7	47.3	182.0
53.0	-4.7	48.3	181.0
54.0	-4.7	49.3	180.0
55.0	-4.7	50.3	179.0
56.0	-4.7	51.3	178.0
57.0	-4.7	52.3	177.0
58.0	-4.7	53.3	176.0
59.0	-4.7	54.3	175.0
60.0	-4.7	55.3	174.0
61.0	-4.7	56.3	173.0
62.0	-4.7	57.3	172.0

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
63.0	-4.7	58.3	171.0
64.0	-4.7	59.3	170.0
65.0	-4.7	60.3	169.0
66.0	-4.7	61.3	168.0
67.0	-4.7	62.3	167.0
68.0	-4.7	63.3	166.0
69.0	-4.7	64.3	165.0
70.0	-4.7	65.3	164.0
71.0	-4.7	66.3	163.0
72.0	-4.7	67.3	162.0
73.0	-4.7	68.3	161.0
74.0	-4.7	69.3	160.0
75.0	-4.7	70.3	159.0
76.0	-4.7	71.3	158.0
77.0	-4.7	72.3	157.0
78.0	-4.7	73.3	156.0
79.0	-4.7	74.3	155.0
80.0	-4.7	75.3	154.0
81.0	-4.7	76.3	153.0
82.0	-4.7	77.3	152.0
83.0	-4.7	78.3	151.0
84.0	-4.7	79.3	150.0
85.0	-4.7	80.3	149.0
86.0	-4.7	81.3	148.0
87.0	-4.7	82.3	147.0
88.0	-4.7	83.3	146.0
89.0	-4.7	84.3	145.0
90.0	-4.7	85.3	144.0
91.0	-4.7	86.3	143.0
92.0	-4.7	87.3	142.0
93.0	-4.7	88.3	141.0
94.0	-4.7	89.3	140.0
95.0	-4.7	90.3	139.0
96.0	-4.7	91.3	138.0
97.0	-4.7	92.3	137.0
98.0	-4.7	93.3	136.0
99.0	-4.7	94.3	135.0
100.0	-4.7	95.3	134.0

3513TAB2.WK1/JSR

TABLE 3

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10
PAGE 1 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
0.0	0.0	0.0	228.8
1.0	-0.2	0.8	228.0
2.0	-0.3	1.7	227.1
3.0	-0.6	2.4	226.4
4.0	-0.8	3.2	225.6
5.0	-1.0	4.0	224.8
6.0	-1.2	4.8	224.0
7.0	-1.4	5.6	223.2
8.0	-1.5	6.5	222.3
9.0	-1.7	7.3	221.5
10.0	-1.8	8.2	220.6
11.0	-2.0	9.0	219.8
12.0	-2.2	9.8	219.0
13.0	-2.3	10.7	218.1
14.0	-2.5	11.5	217.3
15.0	-2.6	12.4	216.4
16.0	-2.8	13.2	215.6
17.0	-3.0	14.0	214.8
18.0	-3.1	14.9	213.9
19.0	-3.2	15.8	213.0
20.0	-3.3	16.7	212.1
21.0	-3.4	17.6	211.2
22.0	-3.5	18.5	210.3
23.0	-3.6	19.4	209.4
24.0	-3.7	20.3	208.5
25.0	-3.8	21.2	207.6
26.0	-3.9	22.1	206.7
27.0	-4.0	23.0	205.8
28.0	-4.1	23.9	204.9
29.0	-4.2	24.8	204.0
30.0	-4.3	25.7	203.1
30.1	-4.3	25.8	203.0
30.2	-4.3	25.9	202.9
30.3	-4.3	26.0	202.8
30.4	-4.3	26.1	202.7
30.5	-4.3	26.2	202.6
30.6	-4.3	26.3	202.5
30.7	-4.3	26.4	202.4
30.8	-4.3	26.5	202.3
30.9	-4.3	26.6	202.2
31.0	-4.3	26.7	202.1
31.1	-4.4	26.7	202.1
31.2	-4.4	26.8	202.0
31.3	-4.4	26.9	201.9
31.4	-4.4	27.0	201.8
31.5	-4.4	27.1	201.7
31.6	-4.4	27.2	201.6
31.7	-4.4	27.3	201.5
31.8	-4.4	27.4	201.4
31.9	-4.4	27.5	201.3
32.0	-4.4	27.6	201.2
32.1	-4.4	27.7	201.1
32.2	-4.4	27.8	201.0
32.3	-4.4	27.9	200.9
32.4	-4.5	27.9	200.9
32.5	-4.5	28.0	200.8
32.6	-4.5	28.1	200.7
32.7	-4.5	28.2	200.6
32.8	-4.5	28.3	200.5
32.9	-4.5	28.4	200.4
33.0	-4.5	28.5	200.3
33.1	-4.5	28.6	200.2
33.2	-4.5	28.7	200.1
33.3	-4.5	28.8	200.0
33.4	-4.5	28.9	199.9
33.5	-4.6	28.9	199.9
33.6	-4.6	29.0	199.8
33.7	-4.6	29.1	199.7
33.8	-4.6	29.2	199.6
33.9	-4.6	29.3	199.5
34.0	-4.6	29.4	199.4
34.1	-4.6	29.5	199.3
34.2	-4.6	29.6	199.2
34.3	-4.6	29.7	199.1
34.4	-4.6	29.8	199.0
34.5	-4.6	29.9	198.9
34.6	-4.6	30.0	198.8
34.7	-4.6	30.1	198.7
34.8	-4.6	30.2	198.6
34.9	-4.6	30.3	198.5

3513TAB3.WK1/JSR

TABLE 3

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10
PAGE 2 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
35.0	-4.6	30.4	198.4
35.1	-4.6	30.5	198.3
35.2	-4.6	30.6	198.2
35.3	-4.6	30.7	198.1
35.4	-4.6	30.8	198.0
35.5	-4.6	30.9	197.9
35.6	-4.6	31.0	197.8
35.7	-4.6	31.1	197.7
35.8	-4.6	31.2	197.6
35.9	-4.6	31.3	197.5
36.0	-4.6	31.4	197.4
36.1	-4.6	31.5	197.3
36.2	-4.6	31.6	197.2
36.3	-4.6	31.7	197.1
36.4	-4.6	31.8	197.0
36.5	-4.6	31.9	196.9
36.6	-4.6	32.0	196.7
36.7	-4.6	32.1	196.7
36.8	-4.6	32.2	196.6
36.9	-4.6	32.3	196.5
37.0	-4.6	32.4	196.3
37.1	-4.6	32.5	196.2
37.2	-4.6	32.6	196.2
37.3	-4.6	32.7	196.1
37.4	-4.6	32.8	195.9
37.5	-4.6	32.9	195.8
37.6	-4.6	33.0	195.7
37.7	-4.6	33.1	195.7
37.8	-4.6	33.2	195.5
37.9	-4.6	33.3	195.4
38.0	-4.6	33.4	195.3
38.1	-4.6	33.5	195.2
38.2	-4.6	33.6	195.1
38.3	-4.6	33.7	195.0
38.4	-4.6	33.8	194.9
38.5	-4.6	33.9	194.8
38.6	-4.6	34.0	194.7
38.7	-4.6	34.1	194.6
38.8	-4.6	34.2	194.5
38.9	-4.6	34.3	194.4

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
39.0	-4.6	34.4	194.4
39.1	-4.6	34.5	194.3
39.2	-4.6	34.6	194.2
39.3	-4.6	34.7	194.1
39.4	-4.6	34.8	194.0
39.5	-4.7	34.8	194.0
39.6	-4.7	34.9	193.9
39.7	-4.7	35.0	193.8
39.8	-4.7	35.1	193.7
39.9	-4.7	35.2	193.6
40.0	-4.7	35.3	193.5
40.1	-4.7	35.4	193.4
40.2	-4.7	35.5	193.3
40.3	-4.7	35.6	193.2
40.4	-4.7	35.7	193.1
40.5	-4.7	35.8	193.0
40.6	-4.7	35.9	192.9
40.7	-4.7	36.0	192.8
40.8	-4.7	36.1	192.7
40.9	-4.7	36.2	192.6
41.0	-4.7	36.3	192.5
41.1	-4.7	36.4	192.4
41.2	-4.7	36.5	192.2
41.3	-4.7	36.6	192.2
41.4	-4.7	36.7	192.1
41.5	-4.7	36.8	192.0
41.6	-4.7	36.9	191.8
41.7	-4.7	37.0	191.7
41.8	-4.7	37.1	191.7
41.9	-4.7	37.2	191.6
42.0	-4.7	37.3	191.4
42.1	-4.7	37.4	191.3
42.2	-4.7	37.5	191.2
42.3	-4.7	37.6	191.2
42.4	-4.7	37.7	191.0
42.5	-4.7	37.8	190.9
42.6	-4.7	37.9	190.8
42.7	-4.7	38.0	190.7
42.8	-4.7	38.1	190.6
42.9	-4.7	38.2	190.5

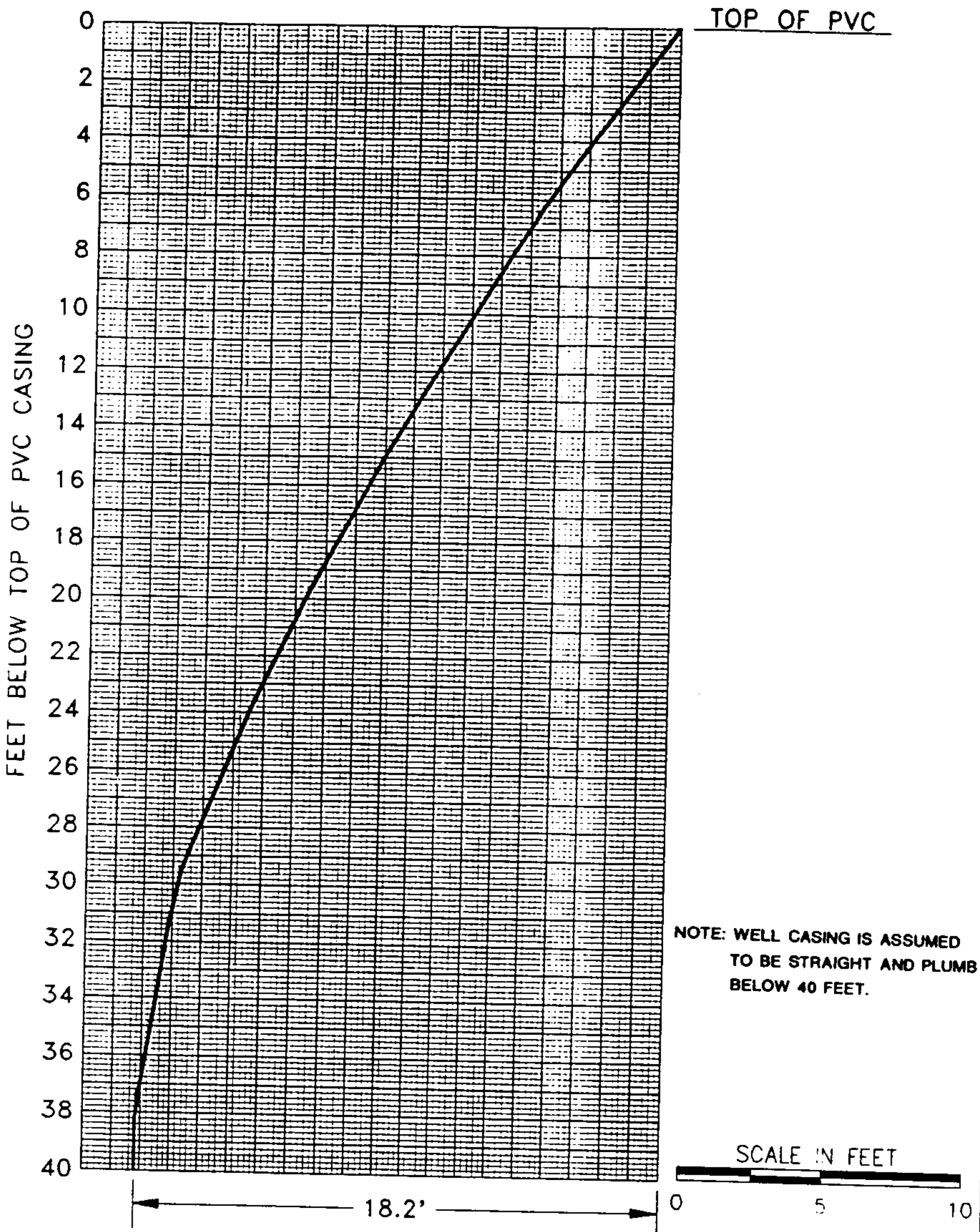
3513TAB3 WK1/JSR

TABLE 3

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10
PAGE 3 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
43.0	-4.7	38.3	190.5
43.1	-4.7	38.4	190.4
43.2	-4.7	38.5	190.3
43.3	-4.7	38.6	190.2
43.4	-4.7	38.7	190.1
43.5	-4.7	38.8	190.0
43.6	-4.7	38.9	189.9
43.7	-4.7	39.0	189.8
43.8	-4.7	39.1	189.7
43.9	-4.7	39.2	189.6
44.0	-4.7	39.3	189.5
44.1	-4.7	39.4	189.4
44.2	-4.7	39.5	189.3
44.3	-4.7	39.6	189.2
44.4	-4.7	39.7	189.1
44.5	-4.7	39.8	189.0
44.6	-4.7	39.9	188.9
44.7	-4.7	40.0	188.7
44.8	-4.7	40.1	188.7
44.9	-4.7	40.2	188.6
45.0	-4.7	40.3	188.5
46.0	-4.7	41.3	187.5
47.0	-4.7	42.3	186.5
48.0	-4.7	43.3	185.5
49.0	-4.7	44.3	184.5
50.0	-4.7	45.3	183.5
51.0	-4.7	46.3	182.5
52.0	-4.7	47.3	181.5
53.0	-4.7	48.3	180.5
54.0	-4.7	49.3	179.5
55.0	-4.7	50.3	178.5
56.0	-4.7	51.3	177.5
57.0	-4.7	52.3	176.5
58.0	-4.7	53.3	175.5
59.0	-4.7	54.3	174.5
60.0	-4.7	55.3	173.5
61.0	-4.7	56.3	172.5
62.0	-4.7	57.3	171.5
63.0	-4.7	58.3	170.5
64.0	-4.7	59.3	169.5
65.0	-4.7	60.3	168.5
66.0	-4.7	61.3	167.5
67.0	-4.7	62.3	166.5
68.0	-4.7	63.3	165.5
69.0	-4.7	64.3	164.5
70.0	-4.7	65.3	163.5
71.0	-4.7	66.3	162.5
72.0	-4.7	67.3	161.5
73.0	-4.7	68.3	160.5
74.0	-4.7	69.3	159.5
75.0	-4.7	70.3	158.5
76.0	-4.7	71.3	157.5
77.0	-4.7	72.3	156.5
78.0	-4.7	73.3	155.5
79.0	-4.7	74.3	154.5
80.0	-4.7	75.3	153.5
81.0	-4.7	76.3	152.5
82.0	-4.7	77.3	151.5
83.0	-4.7	78.3	150.5
84.0	-4.7	79.3	149.5
85.0	-4.7	80.3	148.5
86.0	-4.7	81.3	147.5
87.0	-4.7	82.3	146.5
88.0	-4.7	83.3	145.5
89.0	-4.7	84.3	144.5
90.0	-4.7	85.3	143.5
91.0	-4.7	86.3	142.5
92.0	-4.7	87.3	141.5
93.0	-4.7	88.3	140.5
94.0	-4.7	89.3	139.5
95.0	-4.7	90.3	138.5
96.0	-4.7	91.3	137.5
97.0	-4.7	92.3	136.5
98.0	-4.7	93.3	135.5
99.0	-4.7	94.3	134.5
100.0	-4.7	95.3	133.5

3513TAB3 WK1/JSR



Golder Associates Atlanta, Georgia

TITLE
WELL INCLINATION MEASUREMENTS
SM-10A

CLIENT/PROJECT
CHEMICAL WASTE MANAGEMENT, INC.
EMELLE FACILITY

DRAWN R.C.A.	DATE 7/23/93	JOB NO. 933-3513
CHECKED J.S.R.	SCALE AS SHOWN	DWG NO. / REV. NO.
REVIEWED JFC	FILE NO. 933-3513	SUBTITLE / FIGURE NO. 1

ATTACHMENT 1

PUMP SPECIFICATIONS

Where there's a well, there's a way.

The Fultz Pump Pak SP-300

[illegible]

SP 300 Model Standard Equipment and Specifications

PUMP: 1.75 inch diameter x [illegible] inch length 304 stainless [illegible] steel and virgin Teflon. Stainless [illegible] Teflon rotors (wear item, field replaceable), high efficiency motor.

CONTROL PANEL: Run/Off/charge switch. Forward/Reverse switch allows backwash of screen. Internal/external switch. External power supplies available.

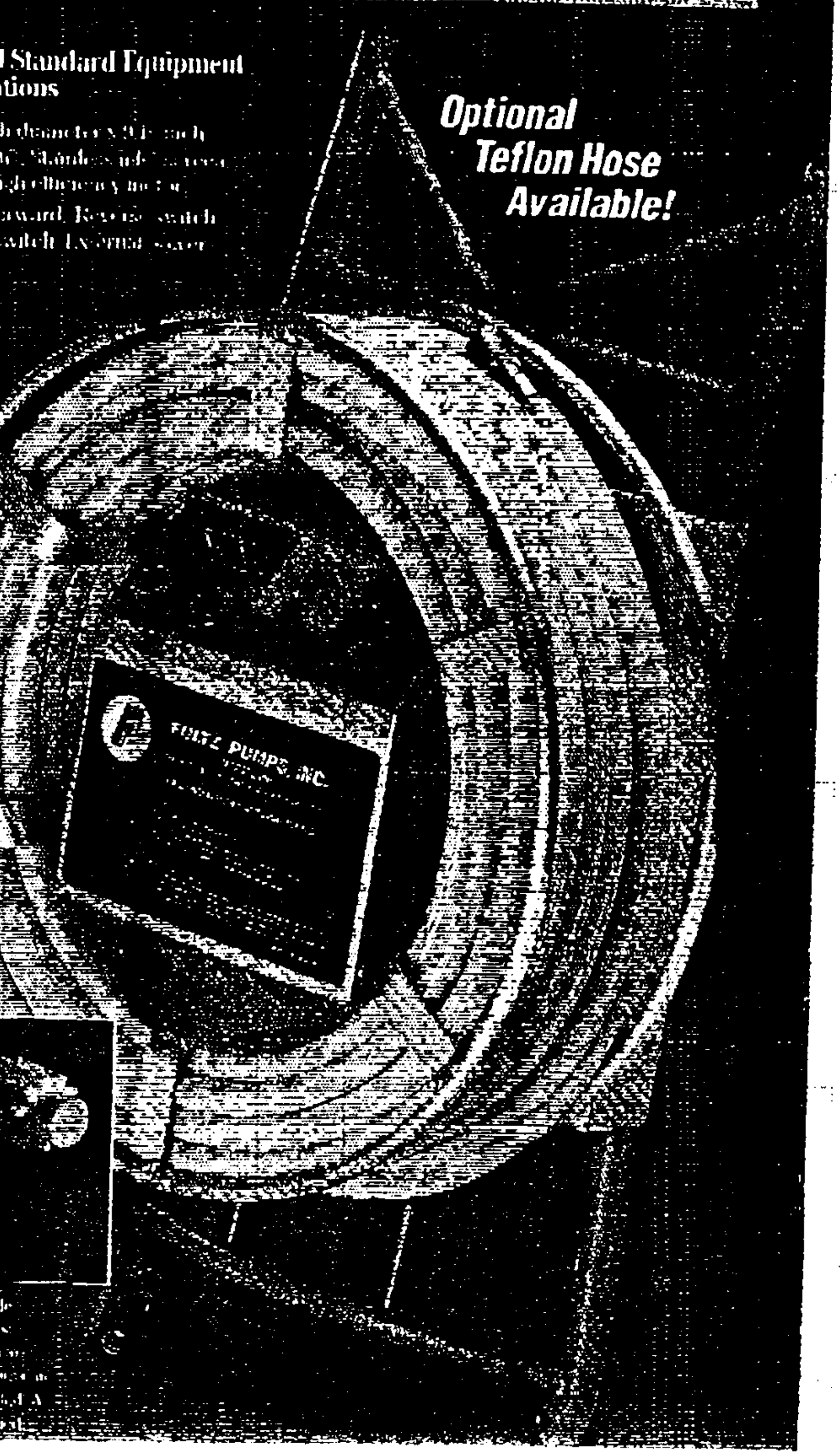
PACK FRAME: Welded aluminum frame with padded straps and belt.

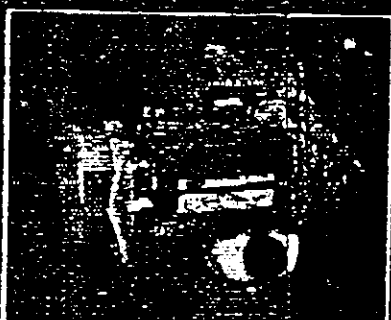
BATTERY PACK: [illegible] batteries supplied. Approximately four hours charge depending on pumping height.

HOSE: 100 feet of polyethylene hose with integrated power wire for extreme safety. Optional [illegible] Teflon hose is available.

BATTERY CHARGER: [illegible] Volt AC to [illegible] Volt DC

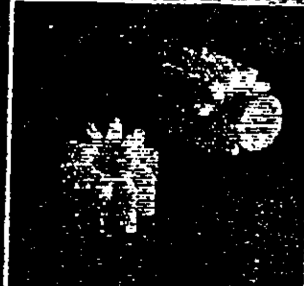
Optional Teflon Hose Available!



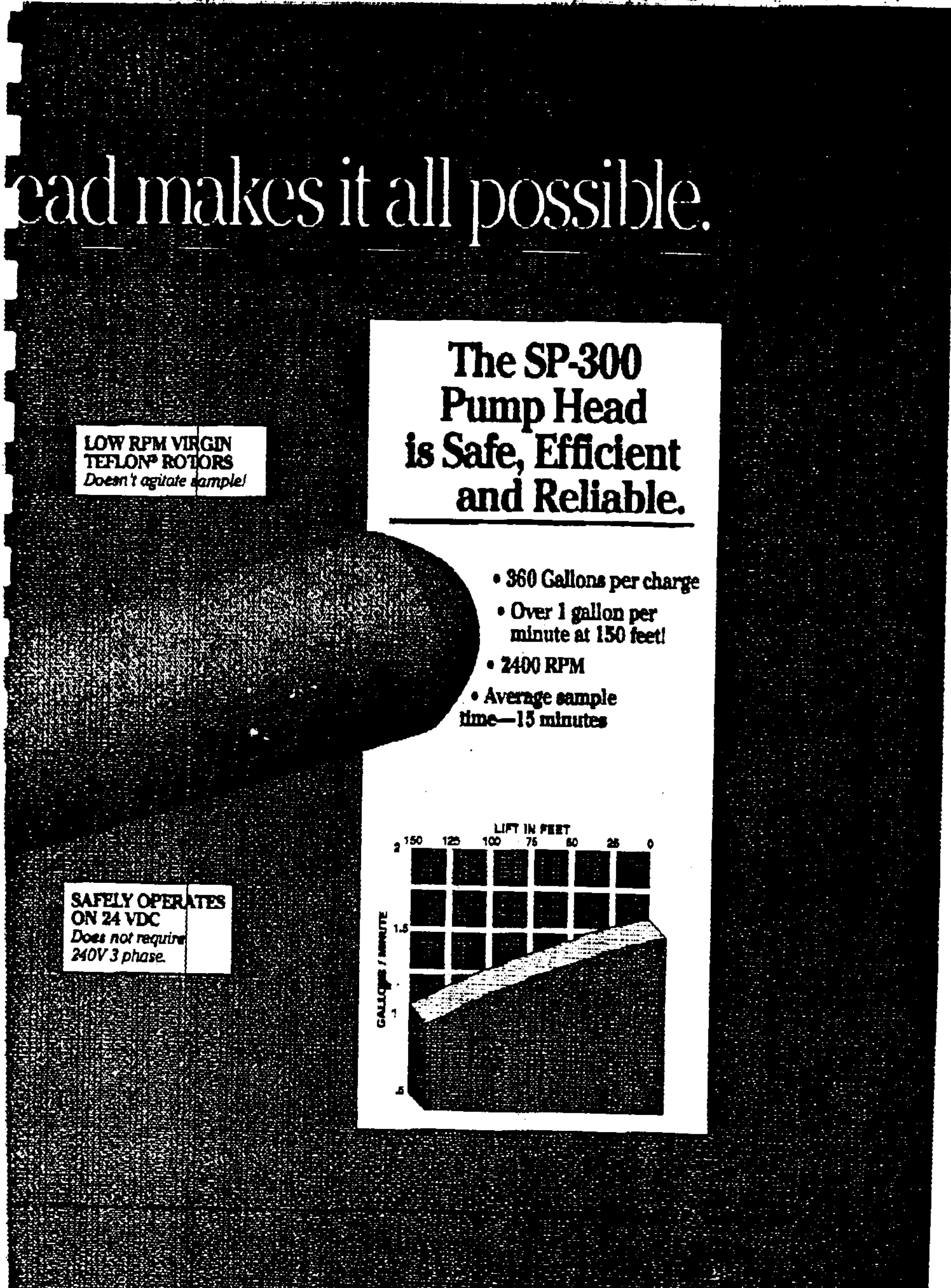


Optional Generator: Modified by Fultz Pumps [illegible] to the following specifications: [illegible] Output 300W, 110 V [illegible]

Standard Rechargeable Batteries: [illegible] rechargeable [illegible] batteries. These batteries [illegible] [illegible] if necessary.



Standard Replaceable Virgin Teflon Rotors: [illegible] replaceable [illegible] the Teflon rotors can be purchased as needed. A complete [illegible] supplied.


ead makes it all possible.
The SP-300 Pump Head is Safe, Efficient and Reliable.
• 360 Gallons per charge
• Over 1 gallon per minute at 150 feet!
• 2400 RPM
• Average sample time—15 minutes
LOW RPM VIRGIN TEFLON® ROTORS
Doesn't agitate sample!
SAFELY OPERATES ON 24 VDC
Does not require 240V 3 phase.
LIFT IN FEET
150 125 100 75 50 25 0
2
1.5
1
.5
GALLONS / MINUTE


The special Fultz pump h
WEAR RESISTENT HOSE
Integral power wire. Snag-free and SAFE.
POWERFUL
3 times the output of earlier models!
LONG RUNNING
6-8 wells per charge.
HIGH EFFICIENCY
4 hours per charge.

Groundwater Sampling and Leachate Removal

Solinst offers a choice of sampling pumps, including the pneumatic-drive Double Valve Pump, a drive-point version, and the Bladder Pump described here. Also available are the Model 404: WaTerra Pump, which is ideal for low cost dedication, and the Model 402: Triple Tube Sampler, for sampling from very small diameter tubes, as narrow as 3/8" (9.5 mm) I.D.

Discrete interval samplers, bailers, and pressurized bailers are described in the Model 420 Series data sheet.

Double Valve Pump: Model 403

For high quality samples, from any depth, the Double Valve Pump offers field serviceability, no bladder replacement, a variety of sizes, and higher flow rates. The pump has been field tested in hundreds of applications.

High Quality Samples: - gives excellent VOC results, comparable with bladder pump results. (See paper on VOC Retention by Baerg et al, presented at 1992 National Groundwater Sampling Symposium - available through Solinst.)

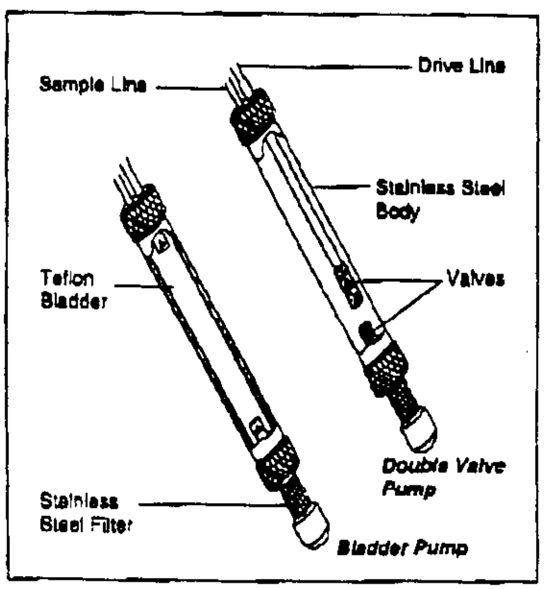
Deep Applications: - used to depths of 2000 ft. (600m).

Direct Burial: - can reduce costs in dedicated and multilevel applications. The bladder-free design allows reliable, maintenance-free operation, over time. Pump filters are available to suit your application.

Portable Models: - can be made for any size or depth of application. No tools required for field decontamination.

Non-Vertical Applications: - operates effectively at any angle and can be placed under landfills, tailings, storage tanks or plumes.

Miniature Model: - allows cost effective sampling from wells as small as 3/4" dia. (1.9 cm).



Bladder Pump: Model 405

Allows consistent high quality samples from all types of applications. The Solinst Bladder Pump utilizes most of the same parts as the Double Valve Pump. The standard size is 1.5" dia. by 2' (3.8 x 61 cm) Conversion from one to the other is efficient and easy (approx. 2 min.), requiring no tools. This is especially useful for portable pumps. It allows faster purging as a Double Valve Pump and sampling as a Bladder Pump when desired.

Low Level VOC Monitoring: - the Solinst Bladder Pump is designed to meet the most rigorous U.S. E.P.A. standards for groundwater monitoring. The pump body is stainless steel, with a Teflon® bladder. It can be used with Teflon® sample tubing for sampling of the highest integrity.

The bladder ensures that drive air or gas does not contact the sample. Bladders and filters only take a few minutes to replace. No tools are needed. Other sizes and materials available.

Features of Both Pumps

High-Flow Valves: - larger intake for increased purge rates.

Zero-Submergence Capability: - allows sampling from low-yield wells and complete emptying of well.

Easy Decontamination: - no tools required; everything easily accessible; replaceable and interchangeable parts; all stainless steel components. All components can be cleaned with LIQUI-NOX®, Hexane, etc.

Leachate/Product Pumping: - the stainless steel, pneumatic drive pumps are well suited for pumping contaminant liquids. Easily and economically pump high solids content, strong solvents and corrosive chemicals. Survive dry pumping, dirty air and sand.

Dedicated Pumps

For long term monitoring it is best to dedicate Bladder Pumps or Double Valve Pumps, to reduce sampling time and avoid cross-contamination. The Double Valve Pump offers maintenance-free installations. All dedicated installations are available with well head and protective well cover.

Portable Pumps

For less frequent sampling, portable systems allow access to multiple monitoring wells, even in remote locations. Reel mounted portable units have a convenient carrying handle where tubing length permits. All are available with a lowering guide and depth counter.

Automatic Control Unit

The fully pneumatic control unit requires no battery, is fully automatic, and has a quick exhaust valve for faster pumping. Fill and discharge cycles can be adjusted separately and give high flow rates for purging, and precise low flow to ensure representative samples. (100 ml/m for VOC sampling.)

Gas/air can be prevented from entering the Double Valve Pump sample line, as Solinst controllers allow careful control of the pressure and vent cycles. The convenient lightweight case is rugged and dependable in all environments.

Quick connect fittings allow instant attachment to dedicated well heads and portable reels.

Size & Material Options

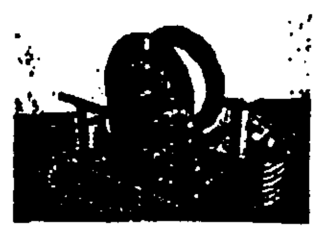
Model 405: Bladder Pump - The pump body of the standard model is a convenient 1.5" dia. x 2 ft long (3.8 cm x 61 cm). The construction is all 316 stainless steel, with Viton® o-rings, and a Teflon® bladder. Other sizes are available on request.

Model 403: Double Valve Pump - The two standard pump body sizes are: 5/8" dia. x 1 ft long (1.6 cm x 30 cm)
1.5" dia. x 2 ft long (3.8 cm x 61 cm)

Other sizes are available on request. Construction is all 316 stainless steel, with Viton® o-rings. The small 5/8" dia. model is adapted slightly for use in the Waterloo System.

Tubing - Teflon®, Teflon®-lined polyethylene, and nylon tubing is available in a variety of sizes. The standard is dual-line, bonded polyethylene:

1/4" for the 5/8" pump (6 mm for 1.6 cm pump)
1/2" for the 1.5" pump (12 mm for 3.8 cm pump)



Flow Rates

Flow rates very with depth of pump, depth below water level, size of drive and sample tube, drive and vent cycle times, gas pressure applied, aquifer recharge, and size of pump body.

The Solinst Bladder Pump compares favourably with published data for similar sized bladder pumps under similar conditions.

2'x1.5" Bladder Pump at 120 psi, with 1/2" drive and sample lines, at 150' (50 m) below water level gives 1.5 l/min.
2'x1.5" Double Valve Pump at 120 psi; with 1/2" drive and sample lines, at 150' (50 m) below water level gives 3.3 l/min.

Drive-Point Double Valve Pump: Model 406

Allows direct placement of a pump for sampling without drilling a borehole. The Drive-Point Double Valve Pump can be driven directly into soft sands and clays to 65 ft. (20m) and more.

The pump allows sampling at various depths during placement. A vacuum may be applied for low-flow conditions. A unique bladder seals the filter during driving to keep sediment out. It creates a surging action on the screen to help develop a sand pack around the pump and prevent the screen from clogging. The 1" dia. by 10" (2.54 x 25.4 cm) stainless steel pump achieves flow rates up to 1 l/min. Drive-in accessories are available, including extension rods, tubing, well head, pump control units.

Accessories

Controllers - automatic and manual models available.
Air Compressor: - to suit application.
Buggy: - for compact field transport of pump and accessories.
Packers: - minimize purge time by reducing the purge volume required and the cost of disposal and labour.
Filters: - 700 sq. cm filter area, disposable, with a barbed fitting to connect to a variety of tube sizes.
Sample Labeler™: - software offers better quality control of sampling schedules. Pre-print sample labels and a summary list from a data base. Avoids forgotten or illegible samples and expensive repeat samples.
Well Head, Protective Well Cover, Lowering Guide, Depth Counter.

Ordering Information

Double Valve and Bladder Pumps

Specify: Model 403, 405 or 406
- Dedicated or portable use
- Size required
- Depth to sampling point(s)
- Special materials
- Accessories

Printed in Canada
03/93

For further information contact: Solinst Canada Ltd.
The Williams Mill, 515 Main Street, Glen Williams, ON, L7G 3S9
Fax: (416) 873-1992 Tel: (416) 873-2255 or (800) 661-2023

Solinst

Pneumatic Bladder Sampling Pumps

Well Wizard pumps come in an unmatched range of sizes and materials—plus a 10-year warranty.

Top to bottom: P1101S, P1201, T1100, T1200, T1300 Pumps

THE BEST PUMPS FOR YOUR PROJECT-GUARANTEED!

No matter how demanding your application, we've got the pump. Need samples from over 600 feet? Testing in the ppb range? What about other tough sample collection problems—aggressive/corrosive environments, non-standard well casings, difficult site conditions? No matter what the challenge, QED makes a pump that will do the job better.

So much better, we guarantee it. Dedicated Well Wizard bladder pumps with protective intake screens are guaranteed for ten years against pump failure. They'll keep on working or QED will repair or replace them free. Nobody else in the business offers this level of protection.

PURGE AND SAMPLE WITH THE SAME PUMP

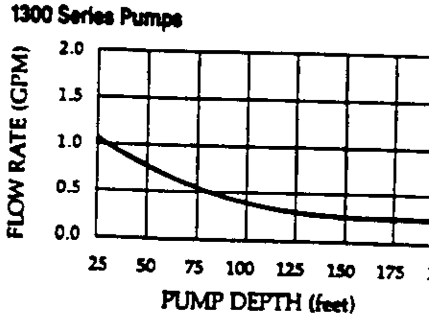
In many situations, a Well Wizard bladder pump can be used for both purging and sampling. For low purge volumes, a standard model (1100, 1200, or 1300-series) may be the choice. Model T1200 is most commonly used. For greater volumes, a high-rate 1500-series Power Pump will cut purging times (and labor costs) by approximately 50%.

The advantages are obvious. A single-pump system is simple to specify and install; extremely economical; and delivers unmatched bladder-pump sample quality. Large purge volumes may require the use of an accessory, such as a Purge Mizer™ inflatable packer or a purge pump; see pp. 18-19 for details.

SPECIFICATIONS:

MODEL NO.	PUMP MATERIAL	BLADDER MATERIAL	INTAKE SCREEN	FITTING MATERIAL	MAXIMUM LIFT (ft.)	LENGTH (Dimension in inches)	DIA	WEIGHT (lbs)
T1100	Teflon	Teflon	Opt	Teflon	250	40.33	1.66	4
P1101S	PVC	Teflon	Std	Polypro	300	52.00	1.66	3
ST1101P	316 S.S.	Teflon	Std	316 S.S.	1000	49.00	1.66	10
T1200	Teflon/316 S.S.	Teflon	Opt	316 S.S.	300	41.14	1.50	5
P1201	PVC/316 S.S.	Teflon	Opt	Polypro	300	41.23	1.50	4
P1201H	PVC/316 S.S.	Teflon	Opt	316 S.S.	600	41.37	1.50	4
T1300*	Teflon/316 S.S.	Teflon	Std	316 S.S.	200	46.75	1.00	3
Power Pumps								
P1500*	PVC/316 S.S.	Teflon	Opt	316 S.S.	200	93.00	1.50	9
T1500*	Teflon/316 S.S.	Teflon	Opt	316 S.S.	200	93.00	1.50	9

* T1300, P1500, and T1500 require Clamp Tool No. 35188 for field attachment of tubing. Clamps are provided w/ pump.



Note: Flow rates are based on pump submergence 25 feet and operating gas pressure of 100 psi from 3111HR Air Source/Controller. Call for flow rates under other conditions.

ATTACHMENT 2

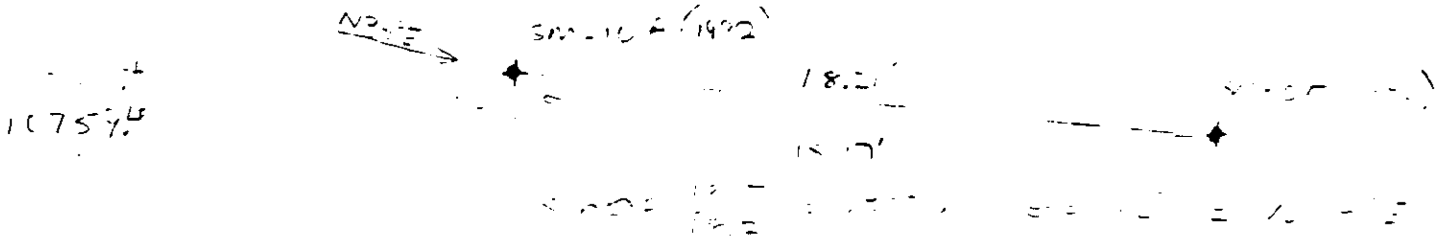
CALCULATIONS

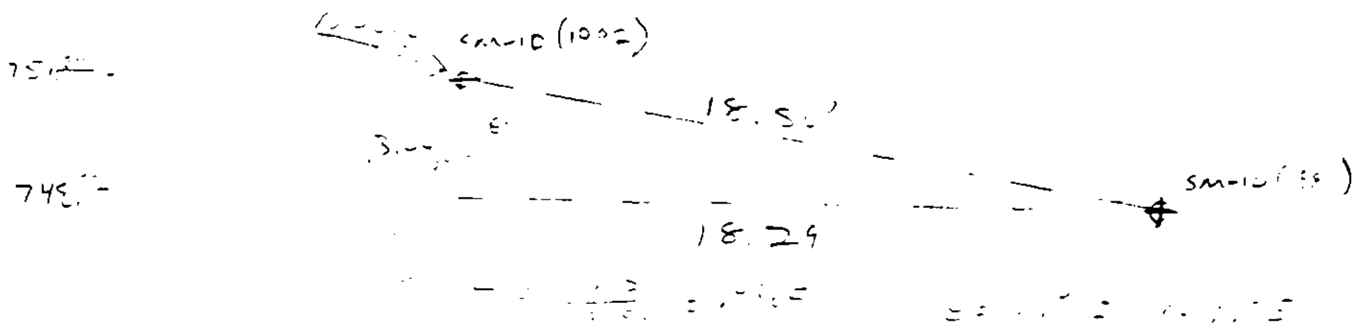
Golder Associates

SUBJECT Well Deviation / Emelle AL.		
Job No. 933-3513 Ref.	Made by JSE Checked Reviewed	Date 7/22/93 Sheet 2 of 2

5459.[83] 5478.[00]

Horizontal Displacement of SM-10 + SM-10A + Vertical





Horizontal Displacement

SM-10 = 18.54 ft. Dip Direction N 34°E.

SM-10A = 18.21 ft. Dip Direction N 34°E

Total Displacement

$SM\text{-}10 = \sqrt{(18.54\,ft)^2 + (33.56\,ft)^2} = 38.34\,ft$

$SM\text{-}10A = \sqrt{(18.21\,ft)^2 + (33.63')^2} = 38.07\,ft$

Attachment 2

Golder Associates

SUBJECT Well Deviation / EMELLE, AL
Job No. 933-3513 | Made by JSR | Date 7/22/93
Ref. | Checked | Sheet 1 of 2
Reviewed

RE: Determine well displacement from elevation + horizontal coordinates before and after well extensions.

1991 SM-10 ELEV. TOC = 195.19'
N 10,748.80' E 5477.40'
SM-10A ELEV. TOC = 195.90'
N 10756.[illegible] E 5478.[illegible]

1992 SM-10 ELEV. TOC = 228.75' FT MSL
N 10,751.[illegible] E 545[illegible]

SM-10A ELEV. TOC = 229.33 FT MSL
N 10,760.31 E 5459.[illegible]

Vertical Displacement

SM-10 228.75' - 195.19' = 33.56'
SM-10A 229.33' - 195.90' = 33.43'

WELL INSTALLATION LOG / Also PCO wells

JOB NO. ____ PROJECT Closure Trench 16 Well raised ____ WELL NO. PM 17 APR - 1 1986 SHEET ____ OF

GA ENGR. ____ DRILLING METHOD ____ GROUND ELEV. 247.3 WATER DEPTH ____

WEATHER ____ DRILLING COMPANY ____ COLLAR ELEV. 250.94 DATE/TIME ____

TEMP. ____ DRILL RIG ____ DRILLER ____ STARTED 5/16/86 (TIME / DATE) COMPLETED ____ (TIME / DATE)

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f.

CASING TYPE ____

JOINT TYPE ____

GROUT QUANTITY ____

GROUT TYPE ____

WELL SCREEN ____ in. dia. ____ l.f.

SCREEN TYPE ____

SLOT SIZE ____

CENTRALIZERS ____

DRILLING MUD TYPE ____

BENTONITE SEAL ____

INSTALLATION METHOD ____

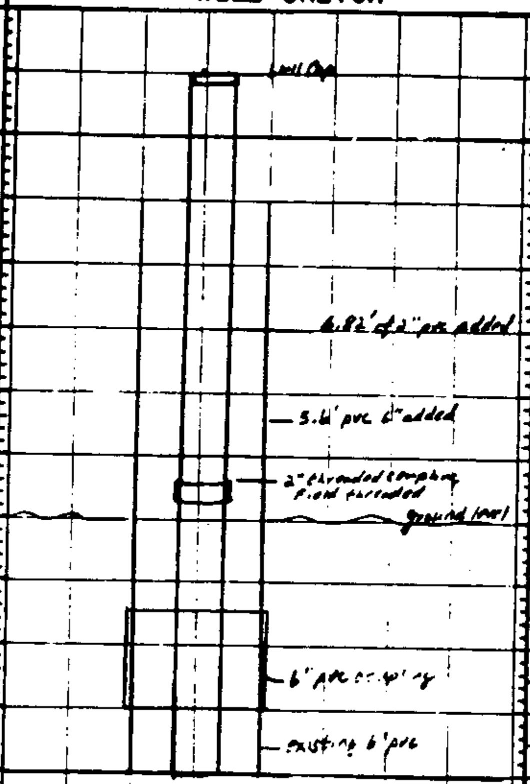
FILTER PACK QTY. ____

FILTER PACK TYPE ____

INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	

WELL SKETCH



INSTALLATION NOTES

Well raised in stages
Two 2'x4' ...
Shown. Well had previ...
been raised before ...

PVC + tools steam clean...
well field threaded. ...
added. Threads teflon ...
6" pvc added to ...
6" pvc from previous rai...
5 gal bentonite pellets ...
6" annulus
well housing 6" steel
with locking cap set
new elev. ... 250.9...

WELL DEVELOPMENT NOTES

taken from Closure report 8-18 + 20 1986 pages 1-9

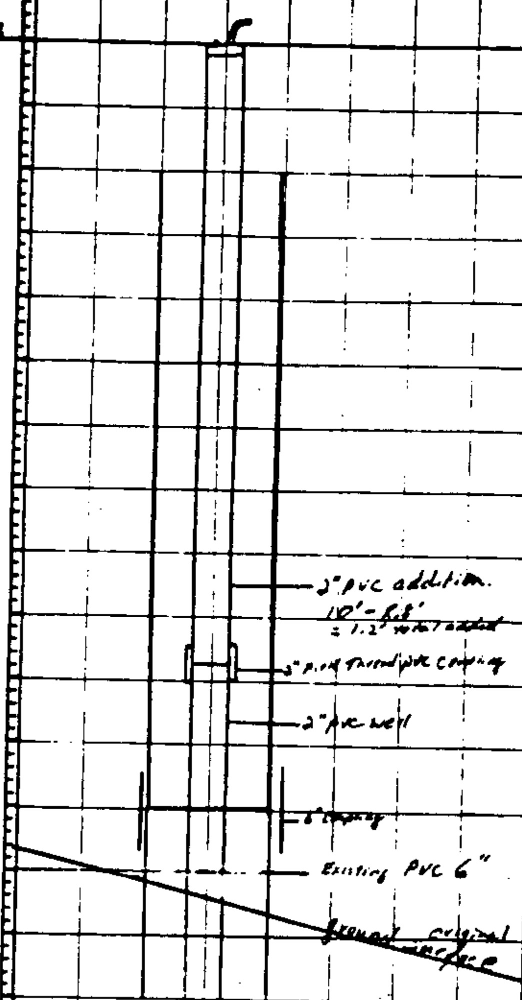
(1)

WELL INSTALLATION LOG

JOB NO.	PROJECT Trench 16 Closure Well raised	WELL NO. DM 18	SHEET 1
GA ENGR.		GROUND ELEV. 198.6	WATER DEPTH
WEATHER	DRILLING COMPANY	Top of Casing COLLAR ELEV. 201.02	DATE/TIME
TEMP.	DRILL RIG / DRILLER	STARTED 5/ / 5/16/86	COMPLETED

MATERIALS INVENTORY

WELL CASING ___ in. dia. ___ LF	WELL SCREEN ___ in. dia. ___ LF	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH
0.0	GROUND SURFACE	

INSTALLATION NOTES

5-16-86 Well raised.
10.0' section added to ...
6" pvc connected to exis...
pvc. Well cap replaced ...
placed over well.

Final Grade detem... changed. Addition to well cut off so that only a ... of 1.2' added to well.
2'x4' Concrete ...
Steel well locking Cap...
Bentonite pellets in ...
Steel annulus.
NBS msl elev. 201.0...
Well depth 198.6'

WELL DEVELOPMENT NOTES

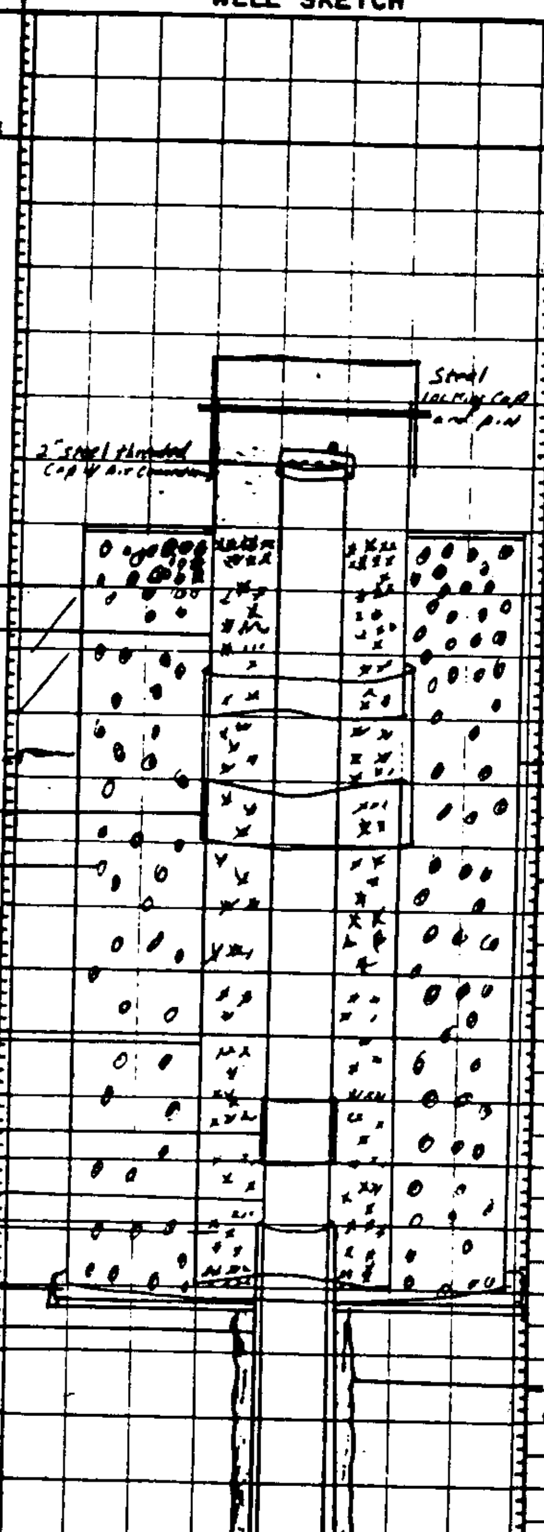
WELL INSTALLATION LOG

[redacted]	PROJECT: T&O Closure Well raising	WELL NO. MS4	SHEET 1 OF
G.E. [illegible]	DRILLING METHOD: [redacted]	GROUND ELEV. [illegible]	WATER DEPTH
[illegible]	DRILLING COMPANY: [redacted]	COLLAR ELEV. 246.13	DATE/TIME
TEMP.	[redacted]	STARTED (TIME / DATE)	COMPLETED (TIME / DATE)

MATERIALS INVENTORY

WELL CASING: 2 [redacted]	WELL SCREEN ___ in. dia. ___ ft	BENTONITE SEAL
CASING TYPE: 4" and 6"	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE: threaded	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
0.0			



INSTALLATION NOTES

2" pvc cut off with [illegible] hacksaw 3" below the gl[illegible] joint attached 6-29-94. 2" pvc rethreaded with field threader. Wrapped [illegible] teflon tape and joined w[illegible] a threaded 2" pvc coupling. All tools and new pvc steam cleaned and [illegible]. Well in plastic 2' x 4' concrete tile placed [illegible] raised well to protect [illegible] fill. 10' section [illegible] to well [illegible] Well [illegible] unlocked until final grade [illegible] Plastic bag over [illegible] interim. WR[illegible] 2.15' [illegible] off and well protection [illegible] 7.85' total added new [illegible] PSL elev. 246.13

Bentonite pellets poured in 6" [illegible] ground surface

[illegible]

WELL DEVELOPMENT NOTES

6" borehole w/ portland cement grout

MONITORING WELL INSTALLATION LOG

JOB NO: ______ PROJECT: Albeus Trenches 18+17 well raised WELL NO. M 57 SHEET 1

GA MGR ______ [illegible] GROUND ELEV. 203.6 WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ COLLAR ELEV. 207.40 DATE/TIME ______

TEMP ______ DRILL RIG ______ DRILLER ______ STARTED 5-19-86 (TIME / DATE) COMPLETED ______

MATERIALS INVENTORY

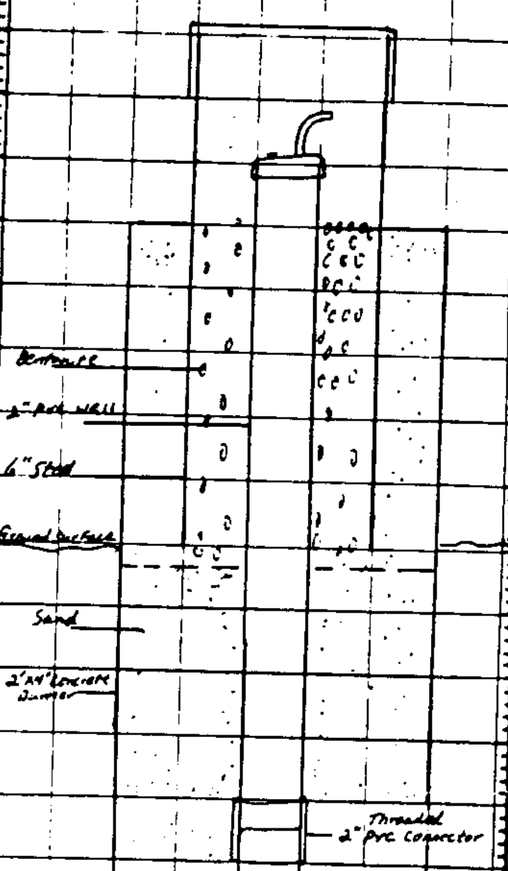
WELL CASING ______ in. dia. ______ LF WELL SCREEN ______ in. dia. ______ LF BENTONITE SEAL ______

CASING TYPE ______ SCREEN TYPE ______ INSTALLATION METHOD ______

JOINT TYPE ______ SLOT SIZE ______ FILTER PACK QTY. ______

GROUT QUANTITY ______ CENTRALIZERS ______ FILTER PACK TYPE ______

GROUT TYPE ______ DRILLING MUD TYPE ______ INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	GROUND SURFACE		
0.0			6" steel protective [illegible] and cap removed. Concrete pad broken to remove steel. 3" well field threaded, taped threads. 6.7' added. (Two) 2'x4' concrete [illegible] tiles placed around well, bentonite pellets poured [illegible] annulus.

WELL DEVELOPMENT NOTES

MONITORING WELL INSTALLATION LOG

JOB NO. ______ PROJECT ______ WELL NO. M62 SHEET 1 OF

GA ENGR. ______ ENGRAVED ______ GROUND ELEV. 252.6 WATER DEPTH ______

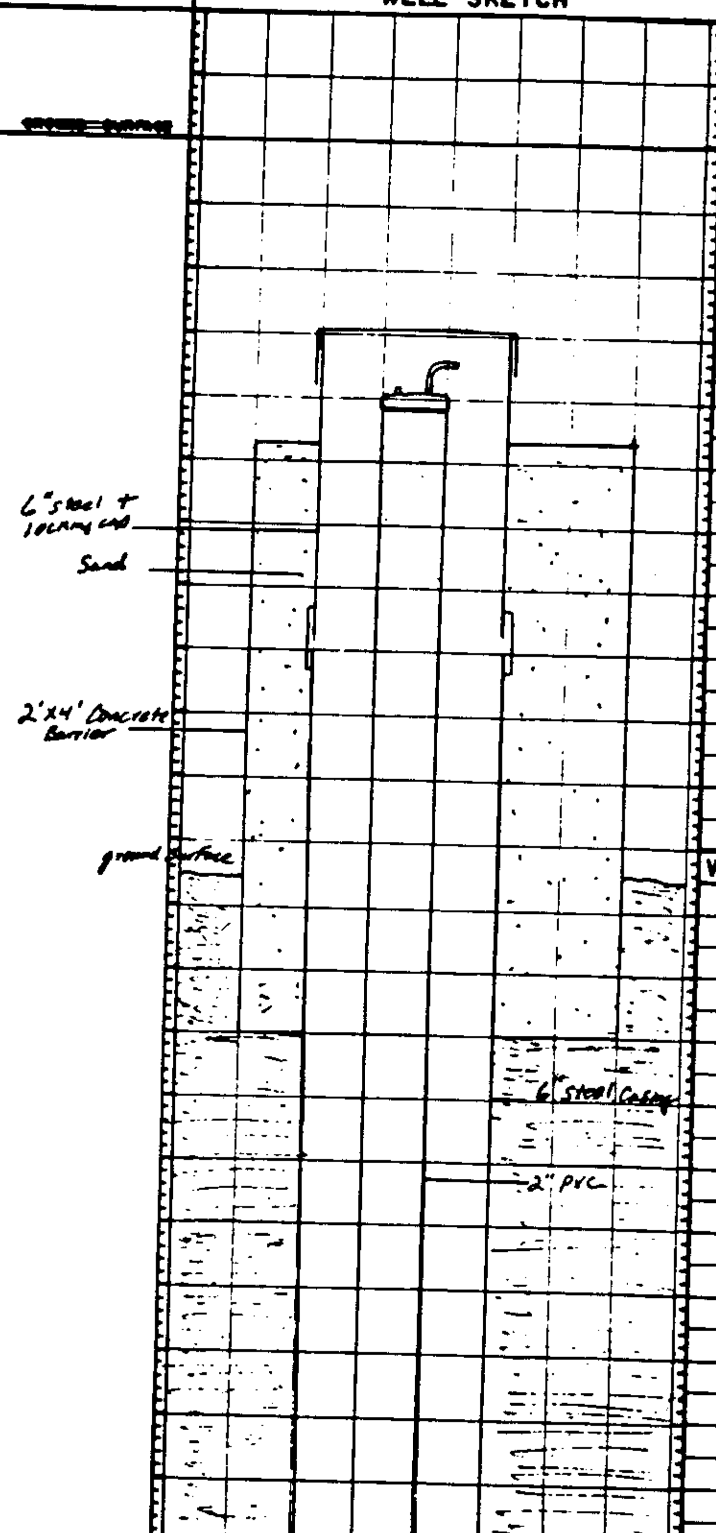
WEATHER ______ DRILLING COMPANY ______ TOC ELEV. 260.83 DATE/TIME ______

TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED 4-2-86 TIME 1 ______ COMPLETED ______

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ LF	WELL SCREEN ______ in. dia. ______ LF	BENTONITE SEAL ______
CASING TYPE ______	SCREEN TYPE ______	INSTALLATION METHOD ______
JOINT TYPE ______	SLOT SIZE ______	FILTER PACK QTY. ______
GROUT QUANTITY ______	CENTRALIZERS ______	FILTER PACK TYPE ______
GROUT TYPE ______	DRILLING MUD TYPE ______	INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH
	GROUND SURFACE	
0.0		



INSTALLATION NOTES

4-2-86 removed bumper ... well. Cut away approx. 6' of 6" steel casing from well. Some sand fell ... 6" annulus no grout ... at top. 2" PVC drill ... threaded for resetting ... cap tubing. Total 4.9' ... cut from well. ... New elev shot 260.83 New well depth 161.6' 2'x4' Concrete barrier ... 6" steel with locking cap ... set over well when final grade reached. B... (5 gal) poured in 6" steel ...

WELL DEVELOPMENT NOTES

MONITORING WELL INSTALLATION LOG

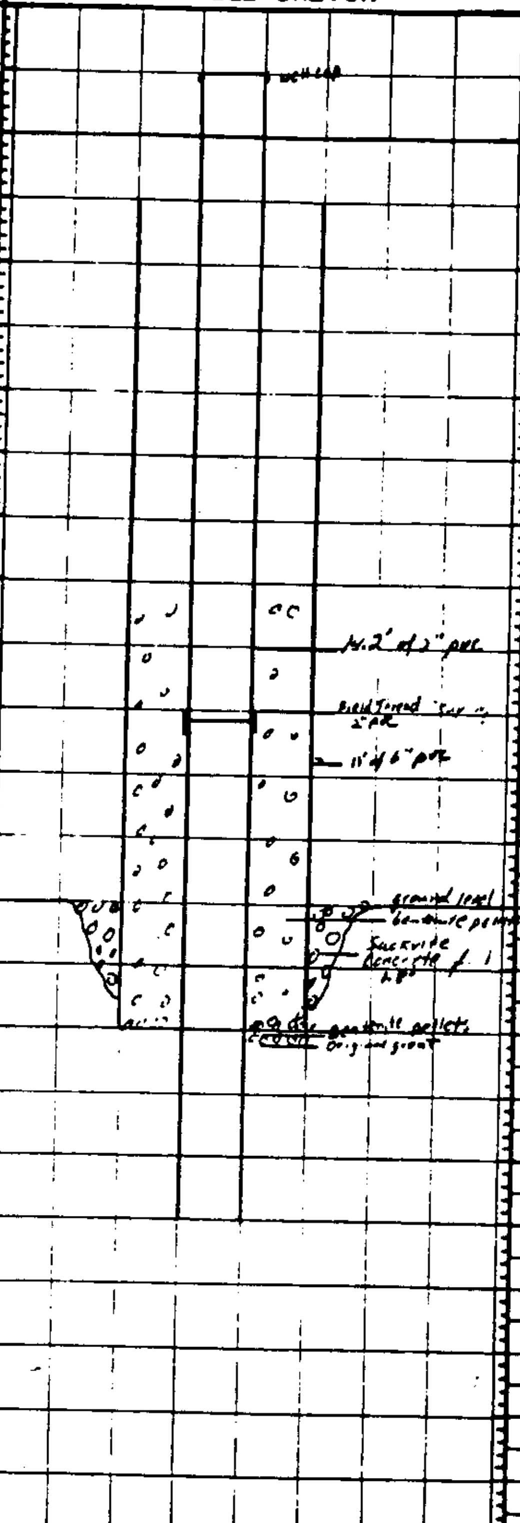
PROJECT: Travel Plaza Well [illegible]
WELL NO.: M64
SHEET: 1
GROUND ELEV.: 270.7
COLLAR ELEV.: 274.60
STARTED: 5/16/[illegible]
COMPLETED: 7-2[illegible]

JOB NO. ____ DRILLING METHOD ____ WEATHER ____ DRILLING COMPANY ____ TEAM ____ DRILL RIG ____ DRILLER ____ WATER DEPTH ____ DATE/TIME ____

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ LF
CASING TYPE ____
JOINT TYPE ____
GROUT QUANTITY ____
GROUT TYPE ____
WELL SCREEN ____ in. dia. ____ LF
SCREEN TYPE ____
SLOT SIZE ____
CENTRALIZERS ____
DRILLING MUD TYPE ____
BENTONITE SEAL ____
INSTALLATION METHOD ____
FILTER PACK QTY. ____
FILTER PACK TYPE ____
INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	GROUND SURFACE		
0.0			



INSTALLATION NOTES

pvc + tools steamed [illegible]
threaded joints teflon [illegible]
6" pvc added to protect
Well from fill. bento[illegible]
pellets [illegible] of 6"
in [illegible]. 14.2' added
well total.

Concrete pad 6" steel
and locking cap placed
around Well. [illegible]
New [illegible] elev 274.6[illegible]
depth of well 153.99'

WELL DEVELOPMENT NO[TES]

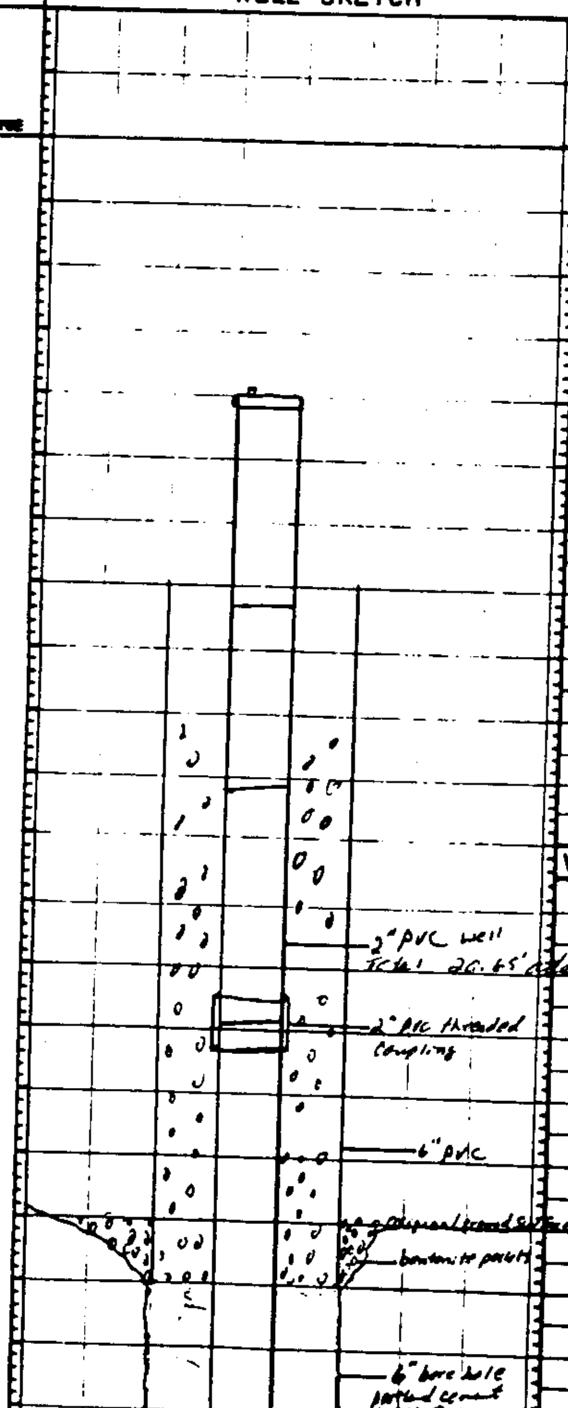
JOB NO.	PROJECT *Trench Closure Well raised*		WELL NO. *M66*	SHEET *1* OF	
GA INSP.	DRILLING METHOD		GROUND ELEV. *249.97*	WATER DEPTH	
WEATHER	DRILLING COMPANY		*Top of Casing* COLLAR ELEV. *251.99*	DATE/TIME	
TEMP.	DRILL RIG	DRILLER	STARTED (TIME / DATE)	COMPLETED (TIME /	

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f.	WELL SCREEN ____ in. dia. ____ l.f.	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
0.0	~~GROUND SURFACE~~		

WELL SKETCH



INSTALLATION NOTES

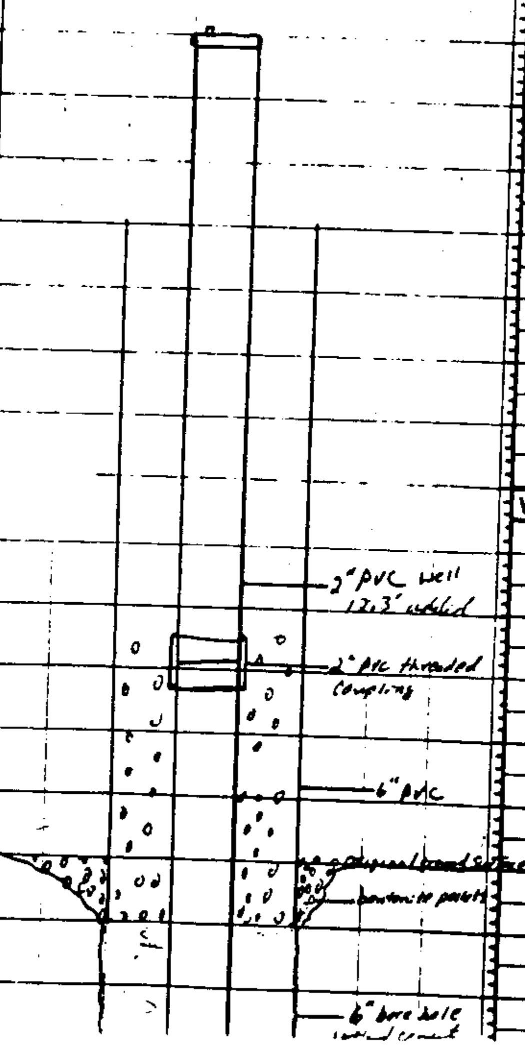
Well raised in Stages
as fill was placed.
PVC 2" 66" Steam Clea[illegible]
Carried to well and kep[illegible]
wrapped in plastic.
2" PVC field threaded joi[illegible]
wrapped w/ teflon tape
6" PVC placed on top o[illegible]
what looked like 6" bo[illegible]
grout. 6" PVC held w[illegible]
fill placed around well.
bag placed over well [illegible]
while closure [illegible]
Fill allowed to settle + [illegible]
2'x4' concrete barrier [illegible]
Steel with locking cap
placed around well. N+S[illegible]
New elev. 251.99 ms[illegible]
New depth 122.6' fr[illegible]
Top of Casing.
Bentonite pellets placed [illegible]
down 6" steel [illegible]

WELL DEVELOPMENT NOTE[S]

JOB NO.	PROJECT Trench Closure Well raised for road	WELL NO. M 68	SHEET 1 OF
GA INSP.	DRILLING METHOD	GROUND ELEV. 198.3	WATER DEPTH
WEATHER	DRILLING COMPANY	Top of Casing COLLAR ELEV. 202.08	DATE/TIME
TEMP.	DRILL RIG / DRILLER	STARTED (TIME / DATE)	COMPLETED (TIME)

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f.	WELL SCREEN ____ in. dia. ____ l.f.	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
0.0	~~GROUND SURFACE~~		Well protection removed. 2" PVC field threaded 12.3' added to well. Teflon taped threaded joints. 6" PVC placed over well with [illegible] bentonite pellets placed at bottom. 6" PVC held while fill placed. 2'x2' concrete [illegible] with 6" steel and locking cap placed 2 [illegible] [illegible]. Fill finished [illegible] final grade. Bentonite pellets in annulus. New elev. MSL 202.[illegible] Well depth 122.0'

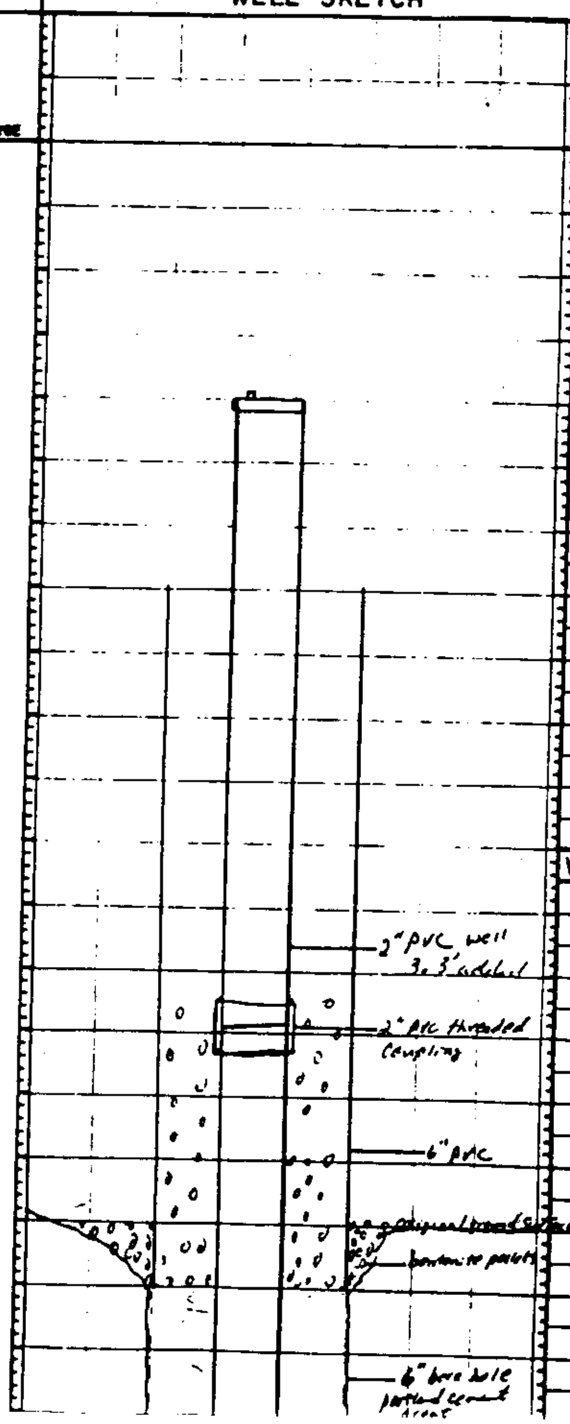
WELL DEVELOPMENT NOTES

JOB NO.	PROJECT Trench Closure Well raised	WELL NO. M69	SHEET 1 OF
GA INSP.	DRILLING METHOD	GROUND ELEV. 232.4	WATER DEPTH
WEATHER	DRILLING COMPANY	Top of Casing / COLLAR ELEV. 234.62	DATE/TIME
TEMP.	DRILL RIG / DRILLER	STARTED TIME / DATE	COMPLETED TIME

MATERIALS INVENTORY

WELL CASING ___ in. dia. ___ l.f.	WELL SCREEN ___ in. dia. ___ l.f.	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH
	~~GROUND SURFACE~~	
0.0		



INSTALLATION NOTES

Well barrier removed [illegible]
2" PVC full threaded [illegible]
6" and 2" PVC tools [illegible]
steam cleaned. 2" [illegible]
added first, threaded [illegible]
teflon threads. Well [illegible]
cap next. 6" PVC [illegible]
lowered over well. [illegible]
pellets placed at bottom [illegible]
2'x4' concrete barrier [illegible]
set. Fill placed [illegible]
well. Another 2'x4' [illegible]
barrier placed on top [illegible]
Annular filled w/ sand [illegible]
Bentonite in 6" ann[illegible]
6" lock and cap set.
Concrete top poured.
New elev. msl 234.[illegible]
new depth 147.5

WELL DEVELOPMENT NOTES

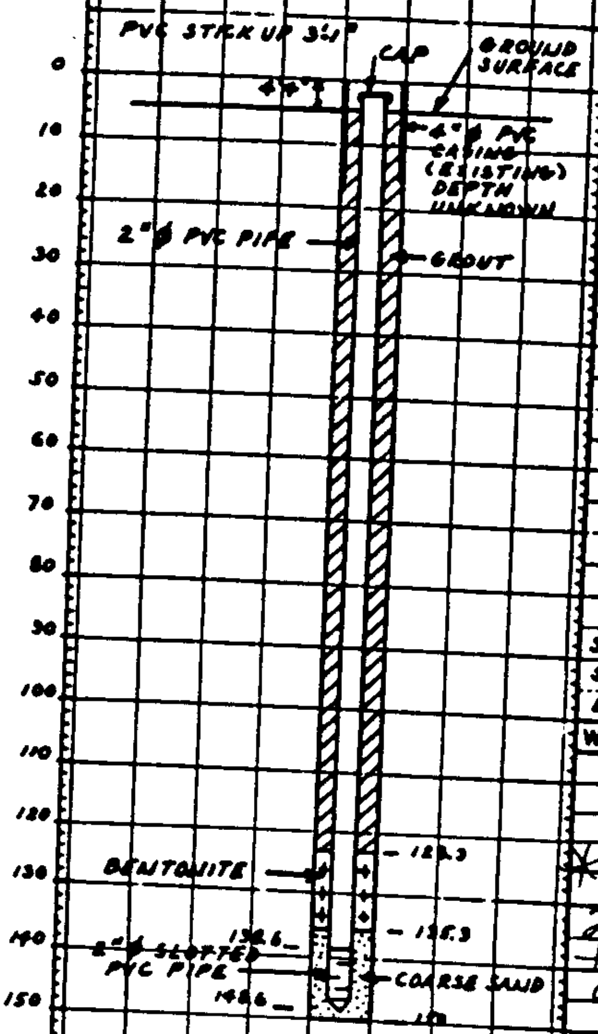
MONITORING WELL INSTALLATION LOG

JOB No. 884-1308	PROJECT SWM/EMELLE/ALA.	WELL NO. MSS	SHEET 1 OF 1
LOGGED BY CSH/JVK	DRILLING METHOD HAND COMPLETED	GROUND ELEV.	DEPTH
WEATHER SUNNY	DRILLING COMPANY —	(PVC TOP) ELEV. 222.45 *	DATE/TIME 10-17-89
TEMP WARM	DRILL RIG —	DRILLER —	STARTED — / COMPLETED —

MATERIALS INVENTORY

WELL CASING 2 IN. DIA. 140 FT	WELL SCREEN 2 IN. DIA. 10 FT	BENTONITE SEAL ✓
CASING TYPE BK TRILOCK SCH 40 PVC	SCREEN TYPE SLOTTED PVC TRILOCK	INSTALLATION METHOD HAND POURED
JOINT TYPE FLUSH THREADED	SLOT SIZE 0.010	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS NONE	FILTER PACK TYPE COARSE SAND
GROUT TYPE PORTLAND CEMENT		INSTALLATION METHOD HAND POURED

DEPTH/ELEV	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES



INSTALLATION NOTES

WELL WAS PREVIOUSLY DRILLED

INSERT PVC
ADD SAND
135.3' TOP OF SAND
ADD BENTONITE
123.3' TOP OF BENTONITE

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

* approximately 25' was added to the well after damage in 1991.

The elevation at the top of PVC is 248.95

REDRAWN BY SAR

Attachemnt 2
TSCA Well Summary
Well ID Chart
Average

Date : November 1997

Well Id. Number	Active or Inactive	Purpose	Gradient	Northing	Easting	Well Depth	Elev. Top of PVC Casing	Elev. Top of Casing (Original)
M-3	A	TSCA	Down	14,405	6198	161.2	178.68	182.35
PM-17	A	TSCA	Down	11,309	5511	151.9	204.84	191.34
PM-18	A	TSCA	Down	11,111	5859	150	225.64	202.59
M-54	A	TSCA	Down	11,091	6690	154.6	245.16	238.91
M-55	A	TSCA	Down	10,815	6372	171.0	248.95	222.16
M-56	A	TSCA	Down	14,112	5861	93.9	204.90	191.51
M-57	A	TSCA	Down	13,795	7112	157	207.34	207.40
M-58	A	TSCA	Down	12,689	7048	206.5	252.96	247.68
M-59	A	TSCA	Down	13,884	5675	105.7	196.30	196.30
M-61	A	TSCA	Down	12,995	9349	110.6	218.37	218.37
M-62	A	TSCA	Down	12,500	9679	166.8	260.84	265.84
M-64	A	TSCA	Down	12,287	6997	141.1	274.69	264.40
M-65	A	TSCA	Down	11,625	7154	130.24	278.66	278.66
M-66	A	TSCA	Down	11,425	6531	118.0	252.22	231.37
M-68	A	TSCA	Down	12,464	5268	117.2	201.95	189.77
M-69	A	TSCA	Down	13,171	7442	143.05	234.03	231.32

Chemical Waste Management, Inc.
Emelle Facility
P.O. Box 55
Emelle, Alabama 35459-0055
205/652-9721

December 17, 1997

Mr. John Poole, Jr.
Chief, Land Division
ALABAMA DEPARTMENT ENVIRONMENTAL MANAGEMENT
1751 Congressman W. L. Dickinson Drive
Montgomery, Alabama 36109-2608

RE: Chemical Waste Management - Emelle, AL
AHWMMA Hazardous Waste Permit No. ALD000622464
Part X - Groundwater Monitoring and Corrective Action

Pursuant to Section X, Part B.1.h., General Monitoring Program, Chemical Waste Management is herewith submitting revised well information as required by the above reference.

Eutaw Monitoring Wells

Review of the well information associated with these wells indicates that all data is correct and no updates are necessary.

Selma Chalk Surveillance Wells:

As a review of the well information, i.e. well depth, elevations, well schematics, etc., the following information is being updated. Well information that is available on file, was compared to recent survey information. The following observations were made:

- The Truck Wash Facility was built in 1989. As a result of the construction of the approach road to the Truck Wash, SM-04 had to be raised approximately (5) five feet. The well information was changed to reflect this extension. This information is included in Attachment 1.

- The shallow monitoring wells for Trench 21 Cells A and B (SM-10 and SM-10A) were damaged as a result of the slope failure in October 1991. These wells were repaired and returned to the surface level of the new slope, however the casings were at a slight angle. Golder and Associates of Atlanta, GA, completed an inclination study to accommodate water level measurement calculations based on the new elevations. Groundwater elevations are calculated for these wells based on this study. This information is included in Attachment 1.

All other information associated with these wells appears to be correct and up to date.

TSCA Wells

A review of the information associated with these wells indicate that extensive work was completed on several wells. The well information charts have been changed to reflect these elevation differences. The information that is available at the facility is included in Attachment 2.

- In 1986, during the closure of Trenches 8-16 and Trench 20, several wells were extended to accommodate the closure cover. These elevations were not recorded on the well information logs at that time. The 1986 updated well installation logs are attached to verify these additions.

- TSCA Well M-55 was damaged by a bulldozer during placement of fill material at the time of Trench 21, Cell A and B closure. Approximately 25 feet was added to the well at the time of repair. The well installation log has been revised to reflect this addition.

- All TSCA Well data has been thoroughly researched, however, there are several wells with significant discrepancies in top of casing elevations. The well installation records have been amended to reflect the new elevations (October 1997), however, no documentation is available to substantiate the procedures or the circumstances that would have caused an extension to the well.

A well information chart is included for TSCA wells. All other additions made to the TSCA Wells are included in Attachment 2.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to be the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Chemical Waste Management

Rodger Henson

Dr. Rodger Henson
Division President

cc: Repository
Stephen Pekera
Project File
Teresa Williams
Correspondence

Attachment 1

JOB NO 872 2283	PROJECT CWM / CONSENT WELLS / EMELLE	WELL NO A-4	SHEET ___ OF ___
GA INSP 22D	DRILLING METHOD ROTARY WASH	GROUND ELEV 225.0'	WATER DEPTH —
WEATHER SUNNY	DRILLING COMPANY TRI-STATE	PVC COLLAR ELEV 228.45'	DATE/TIME —
TEMP 30°F	DRILL RIG MOBILE B-61	DRILLER J./WG	STARTED 7:30AM / 1986 (TIME / DATE)	COMPLETED (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in dia 98.6 LF — WELL SCREEN 2 in dia 9.5 LF — BENTONITE SEAL

CASING TYPE PVC SCH 80 — SCREEN TYPE PVC SCH 80 — INSTALLATION METHOD BY HAND

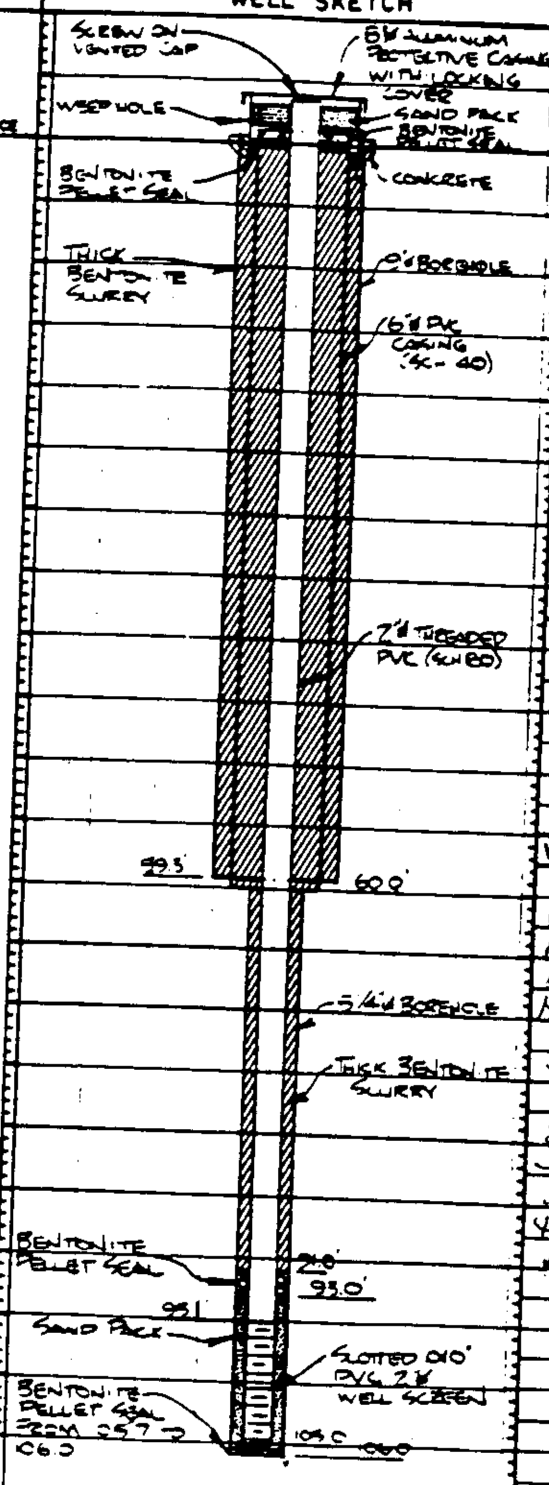
JOINT TYPE THREADED (TEFLON WRAPPED) — SLOT SIZE .010 INCH — FILTER PACK QTY 4 BAGS

GROUT QUANTITY APPROX. 70 CU FT ABOVE BENTONITE — CENTRALIZERS — — FILTER PACK TYPE

GROUT TYPE APPROX. 1:1 RATIO OF AQUAGEL GOLD SEAL BENTONITE POWDER W/WATER — DRILLING MUD TYPE — — INSTALLATION METHOD BY HAND

ELEV/DEPTH	SOIL/ROCK DESCRIPTION
225.0' / 0.0	GROUND SURFACE
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	IN SITU CHALK (NO FRACTURES ABOVE LEACHATE)
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

WELL ORIGINALLY SET ... HOLE ON 2/15/86 HOWEVER DUE TO THE FACT THAT THE PVC PIPE WAS CUT SHORT THIS WELL WAS ... THE HOLE THEREFORE THE 2" PVC WAS PULLED OUT, HOLE FLUSHED, AND THE WELL RESET TO THE CORRECT DEPTH. A BENTONITE PELLET SEAL WAS ADDED TO THE BOTTOM OF THE HOLE.

2" PVC STANDPIPE STICKUP FROM GROUND SURFACE: 3.45'

ALUMINUM CASING STICKUP FROM GROUND SURFACE = 3.5'

WELL DEVELOPMENT NOTES

On 9/28/[redacted] the well was extended 5' due to access road building for truck wash. The new elevation is 238.96 the well tubing was also extended to keep the pump @ the same elevation.

Golder Associates

APPENDIX E-5

DOCUMENT 2

December 4, 2015 1417910

Mr. Clay Messer
Alabama Department of Environmental Management
1400 Coliseum Boulevard, P.O. Box 301463
Montgomery, Alabama 36130-1463

**RE: EUTAW AQUIFER MONITORING WELL INSTALLATION AND ABANDONMENT REPORT
CHEMICAL WASTE MANAGEMENT FACILITY, EMELLE, ALABAMA
PERMIT NUMBER ALD 000 622 464**

Dear Mr. Messer:

Golder Associates Inc. (Golder) has prepared this report on behalf of Chemical Waste Management (CWM) to summarize monitoring well installation of RCRA-8R and RCRA-8 abandonment activities conducted at the CWM Hazardous Waste Landfill (Site) located in Emelle, Alabama. These activities were performed in accordance with the Eutaw Monitoring Well Abandonment and Installation Plan (the Plan; Golder 2015), approved by the Alabama Department of Environmental Management (ADEM) in a letter dated July 21, 2015.

BACKGROUND

Site Background

The CWM Emelle Facility (Facility; Site) is a Subtitle C landfill located in Emelle, Sumter County, Alabama. Hazardous waste is disposed of in disposal cell trenches dug directly into more than 600 feet of impermeable "Selma Chalk" limestone. In accordance with the facility permit, disposal cells, constructed under very strict U.S. Environmental Protection Agency (EPA) and ADEM guidelines, are constructed into the Selma Chalk with double layers of 60 mil High Density Poly Ethylene (HDPE). Additional security measures include a complex leak detection system and sophisticated leachate collection system containing 81 monitoring wells, 6 Resource Conservation Recovery Act (RCRA) compliance wells, and 8 sediment basins to prevent run off.

Site Geology

The surficial geology beneath the Facility is characterized by competent chalk of the Selma Group overlain by weathered chalk and relatively thin residual soils. The Selma Group varies in thickness between 600 and 750 feet in the Site vicinity and locally consists of two units:

- The Mooreville Chalk
- The Demopolis Chalk

With the exception of the Aracola Limestone Member (Aracola), few physical properties allow for easy differentiation of the two Selma Chalk units. The Aracola occurs at the top of the Mooresville Chalk, dividing these two formations at a depth of approximately 380 to 400 feet below ground surface. The Aracola consists of two or more dense limestone beds separated by beds of chalky clay. The thickness of the Aracola Limestone is generally less than 10 feet thick and is typically identified through drill rig response (i.e. chattering or hard drilling). Hydrogeologic studies conducted at the Site indicate that the Selma Group has low permeability (on the order of 10^{-7} centimeters per second, or cm/s) with total porosity of 38.4% and effective porosity of 33.4% (Golder 1983). Monitoring wells screened in the Selma Group constitute the Facility's surveillance monitoring system. The surveillance monitoring system presently consists of numerous wells which monitor the saturated portion of the Selma Chalk adjacent to disposal trenches to provide early warning of constituent migration to the underlying Eutaw Aquifer and nearby surface waters.

The Selma Group is underlain by interbedded clays, silts, and sands of the Eutaw Formation. The Eutaw Formation is approximately 400 feet thick in the Site vicinity, and can be subdivided into upper, middle, and lower portions. The upper portion, also known as the Tombigbee Sand Member, consists of fossiliferous sand with layers of chalk, claystone, and calcareous sandstone. The middle portion consists of clay, shale, and thin sand beds and is the screened zone for Eutaw Aquifer wells on-Site. Flow data for municipal wells in the area indicate an average specific capacity for the lower portion of the Eutaw Formation of 12.5 gallons per minute per foot (gpm/ft), which corresponds to an approximate hydraulic conductivity on the order of 10^{-3} cm/s (Golder, 1983). At the Facility the potentiometric surface of the Selma chalk ranges from 204 to 120 feet mean sea level (feet-msl). The potentiometric surface of the Eutaw Formation beneath the Facility ranges in elevation from approximately 125 to 129 feet–msl. There is a vertical gradient from the Eutaw through the Selma Chalk. Groundwater is inferred to flow to the northeast under a hydraulic gradient around one foot per mile.

The detection monitoring system presently consists of five (5) wells which monitor the uppermost drinking water aquifer beneath the Facility, the Eutaw Aquifer: RCRA-6, RCRA-7, RCRA-8R, RCRA-9, and RCRA-10A. A sixth well, RCRA-5 is used for water level monitoring, but is not sampled on a regular basis. Detailed geophysical logging and rock coring during the installation of RCRA-9, RCRA-10, RCRA-10R, and RCRA-10A was performed as part of the Arcola Limestone Evaluation Report (Jordan, Jones, & Goulding, Inc. 1998).

RCRA WELL MAINTENANCE

Appendix E-13 of the Facility Permit (CWM Manual for Groundwater Sampling & Laboratory Quality Manual) requires that total depths of Eutaw Aquifer monitoring wells are measured every 5 years. Golder, on behalf of CWM, measured the total depth of RCRA monitoring wells during the week of February 9, 2015. These activities identified clogged well screens at three locations (RCRA-7, RCRA-8, and RCRA-9). Golder began well development activities at the facility on March 30, 2015. While RCRA-7 and RCRA-9 were successfully redeveloped, an obstruction was identified in RCRA-8 at approximately 525 feet below top of casing. A damage notification, dated April 20, 2015, was submitted in accordance with Facility Permit Condition I.X.B.1.a.iii. ADEM responded in a letter dated May 26, 2015, requesting a well installation and abandonment plan. The plan was submitted on June 30, 2015, and later approved by ADEM in a letter dated July 21, 2015.

WELL INSTALLATION ACTIVITIES

Drilling activities were initiated on August 19, 2016 at the RCRA-8R location shown in Figure 1. Installation of RCRA-8R was accomplished by mud rotary drilling methods. Water for drilling was collected an on-site municipal source and transported to the drill location with a tanker truck. A surface casing was advanced to a total depth of 40-feet below ground surface (feet-bgs) by drilling a 19-inch diameter borehole into competent Selma Chalk and grouting a 14-inch diameter casing to stabilize the drilling surface. After allowing the casing to set for 24 hours, a 12¼-inch drag bit was utilized to drill to 710 feet below ground surface into the Eutaw Aquifer. Mud cuttings were maintained within a mud system and decanted into roll-off tanks to be discharged. Once the target depth was reached, the bit was removed and the well construction materials were inserted into the well.

Drilling fluid, modified with Baroid Industrial Drilling Products, was monitored throughout the drilling process to limit Selma Chalk swelling. The mass and viscosity of the drilling fluid were routinely monitored. Mud thickening was observed during drilling, a consequence of moisture being absorbed by the Selma Chalk. Thinning additives (e.g. Barofos®) were used when the drilling mud weight increased beyond 9.5 pounds per gallon and/or the viscosity, as measured with a Marsh funnel, exceeded 38 seconds.

Recovered soil cuttings from the return drilling mud were logged in the field to determine the lithologic change between the Selma Chalk and Eutaw Aquifer. Based on historical lithologic descriptions, the transition is characterized by a change from blue-gray, un-weathered chalk (the Selma Chalk) to gray-green sand (Tombigee Sand Member of the Eutaw Formation). This transition was observed at a depth of 653 feet-bgs.

WELL CONSTRUCTION SPECIFICATIONS

Following drilling, groundwater RCRA-8R was installed according to specifications:

- Approximately 40 feet of 14-inch diameter 304 stainless steel 0.010 inch, wire-wrap, screen between 690 and 650 feet below ground surface;
- Approximately 650 feet of 4-inch carbon steel riser to the ground surface;
- 3000 pounds of Standard Sand and Silica (20-40 sieve mesh size) installed using the tremie method around the screen to an elevation approximately 24 feet above the top of the screen;
- A bentonite plug, tremied as a bentonite slurry, was installed above the filter pack between 626 and 610 feet-bgs.;
- A thin layer of fine seal sand was added above the bentonite seal to prohibit grout infiltration;
- Neat cement was installed from the bentonite seal in two lifts. The first lift was installed from approximately 605 to approximately 552 feet-bgs and allowed to set overnight. The second lift was installed from approximately 552 to the ground surface;
- A locking protective case extending to approximately 3.75 feet-bgs.

As-built well construction data are included in **Attachment A**.

WELL DEVELOPMENT ACTIVITIES

RCRA-8R was developed on September 10, 2015, by periodic pumping and surging using air lift techniques. Approximately 1,550 gallons were removed. Turbidity, temperature, specific conductance, and pH were measured during development with a Horiba U-53 Multi-parameter Meter. With the exception of turbidity, measured field parameters stabilized during development. During surging the minimum turbidity reading was 218 NTUs. While this turbidity is in excess of well development standards, the flow rate during development (10 gallons per minute) and surging did not allow for a representative turbidity reading. Additional readings were collected during groundwater sampling, with a final turbidity reading of 11.7 NTU.

The development record is included in **Attachment B**.

WELL SURVEYING

A licensed surveyor with Neel Schaffer surveyed well RCRA-8R on October 27, 2015. The latitude and longitude were surveyed to the nearest 0.01 foot in the Alabama state plane coordinate system, and the top of casing and ground surface elevations were surveyed to the nearest 0.01 foot relative to mean sea level.

Survey data are included in **Attachment C**.

RCRA 8 ABANDONMENT

RCRA-8 was abandoned on September 14 and September 15, 2015 in general accordance with abandonment protocols outlined in *Guidelines for Well Abandonment* (ADEM Ground Water Brach). As specified in the approved Plan, RCRA-8 was abandoned in place by filling with neat cement, using the tremie method from the well occlusion (525 feet-bgs) to the ground surface. Approximately 556 gallons of grout were used to abandon RCRA-8. This volume is in excess of the theoretical well volume, suggesting that the well was sealed below the occlusion. The surface completion was removed and the site was brought as close to the original grade as possible.

Abandonment records are included in **Attachment D**.

SUMMARY AND CLOSURE

These field activities were conducted in August and September 2015 in accordance with the approved Plan and Facility Permit. A certification statement is included in Attachment E. Please contact Mike Smilley at (770) 496-1893 with any questions or concerns regarding this report.

Sincerely,

GOLDER ASSOCIATES INC.

Michael Jay Smilley, P.G.
Senior Project Geologist

Brent B. Waters, P.G.
Principal and Practice Leader

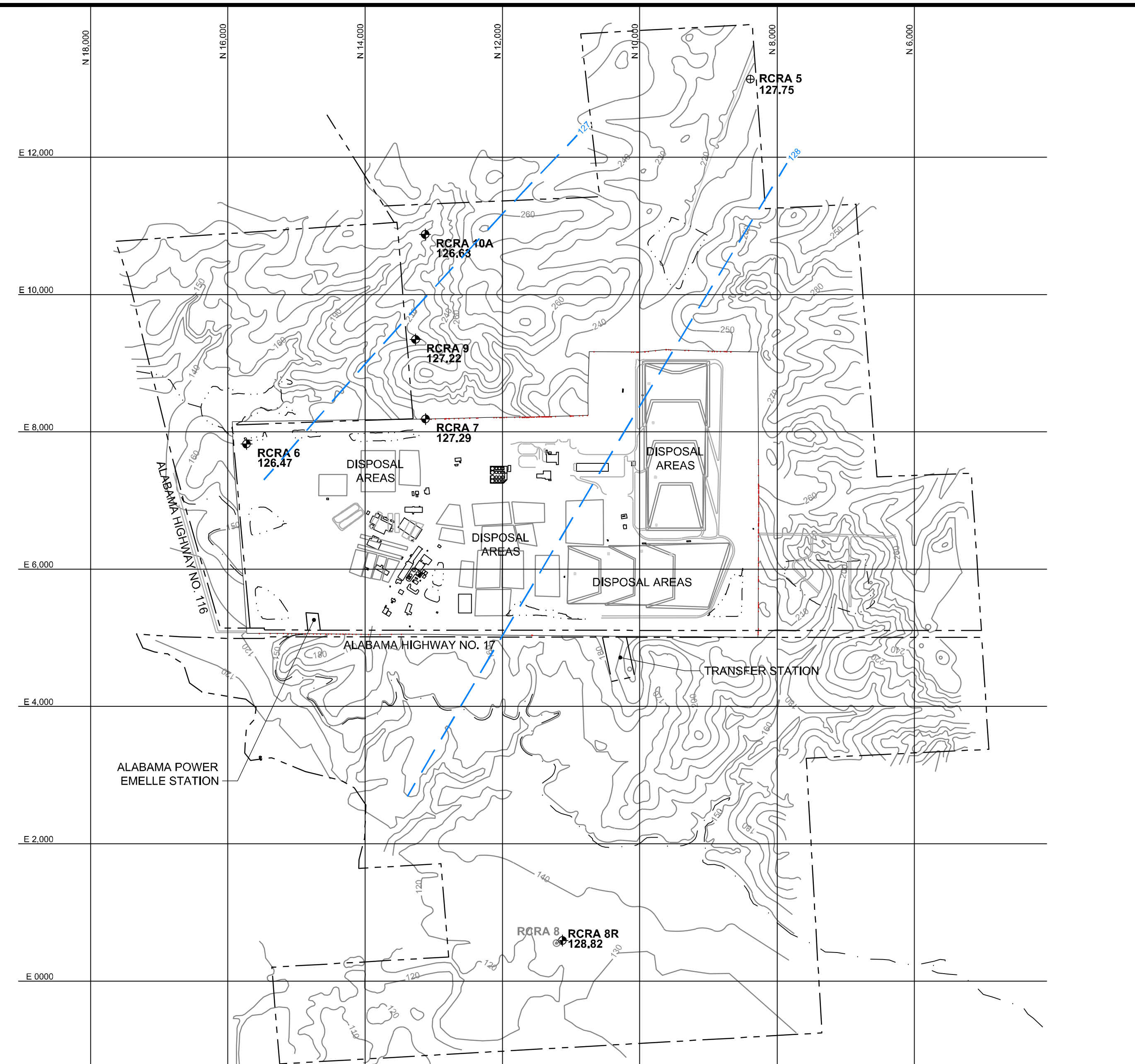
Attachments:

Figure 1 – Eutaw Aquifer October 2015 Potentiometric Surface
Attachment A – Well Diagram
Attachment B – Well Development Log
Attachment C – Survey Data
Attachment D – Well Abandonment Log

Cc: Robert W. Kronable, CWM

MJS/BBW/kds

FIGURE



LEGEND

— — - - — —	PROPERTY LINE
RCRA 9	RCRA MONITORING WELL (EUTAW AQUIFER)
RCRA 5	WATER LEVEL GAUGING WELL (EUTAW AQUIFER)
RCRA 8	ABANDONED WELL LOCATION OF RCRA 8
— — —	POTENTIOMETRIC CONTOUR (FT. MSL)

REFERENCES

1. BASE MAP (emellewrk.dwg) PROVIDED BY WASTE MANAGEMENT INC. VIA E-MAIL DATED MAY 31, 2011.

2. GRID IS BASED ON SITE COORDINATE SYSTEM.

0 750 1500 2250
SCALE FEET

PROJECT
WASTE MANAGEMENT
EMELLE FACILITY / ALABAMA

TITLE
EUTAW AQUIFER OCTOBER 2015 POTENTIOMETRIC SURFACE

Golder Associates

PROJECT No.		1417910.2	FILE No. 1417910-001 Eutaw Potentiometric Surface
DESIGN	-	-	SCALE AS SHOWN
CADD	SEP	2015/11/10	FIGURE
CHECK	MJS	2015/11/10	1
REVIEW	-	2015/11/10	

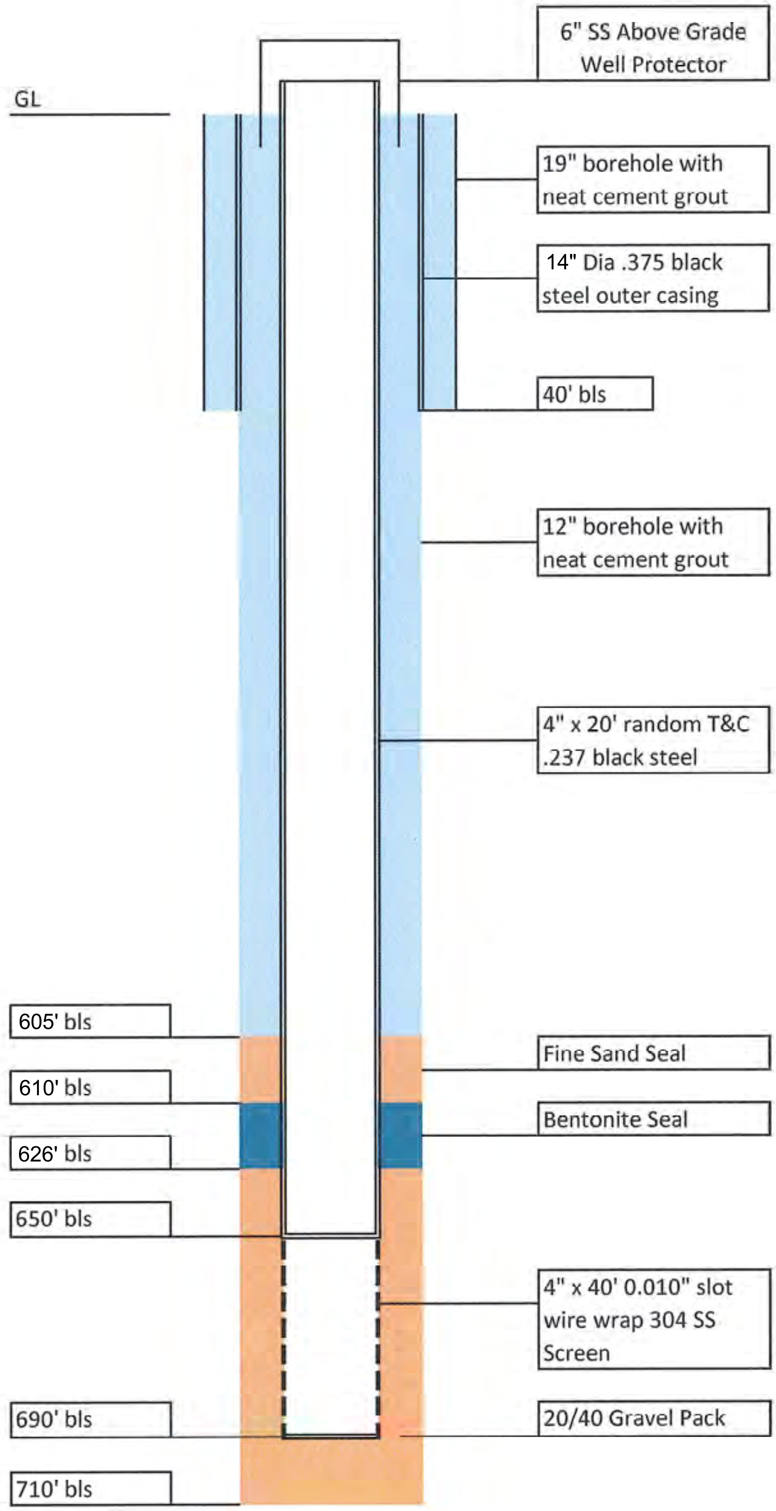
ATTACHMENT A

WELL DIAGRAM

Well Schematic

Project: Chem Wste Management
Well No: RCRA-8B
Layne Job: 36900
Date: 9/16/2015

Not to Scale



Layne - Central

3720 North Palafox St.
Pensacola, FL 32505

Phone 1-850- 432-5101 Toll Free 1-800-356- 3824 Fax 1-850-432-2999

FORMATION LOG

Contract: Golder Contract No. 36900 Date: 9/16/2015

City: Emelle County: Sumter State: AL

Location: West of Hwy 17 SW of Chem Waste Management

Test Hole No. NA Well No. RCRA-8B Elevation: 138'

Date Began: Date Completed: Electric Log: NA

Size Slush Pit: NA

Sample No.			Formation	Thickness Ea. Strata	Total Depth	Notes Wash Samples
			Brown clay/fine sand	6	6	
			Brown clay/white chalk	19	25	
			Hard chalk	13	38	
			Hard gray clay/chalk	2	40	
			Medium gray/blue clay/chalk	22	62	
			Soft clay/chalk	3	65	
			Hard chalk	3	68	
			Medium blue clay/chalk	9	77	
			Medium clay	17	94	
			Soft clay/chalk	11	105	
			Medium grey/blue chalk	75	180	
			Soft chalk	23	203	
			Hard chalk	20	223	
			Medium chalk	30	253	
			Medium clay chalk	81	334	
			Soft chalk	9	343	
			Hard clay/chalk	16	359	
			Medium clay/chalk	4	363	
			Soft chalk	2	365	
			Medium chalk	15	380	

FORMATION LOG

Contract No. 36900

Sample No.	Viscosity Mud	Wt. Mud	Formation	Thickness Ea. Strata	Total Depth	Notes Wash Samples
			Soft chalk	20	400	
			Hard clay	54	454	
			Medium clay	15	469	
			Hard clay	1	470	
			Soft clay	60	530	
			Hard clay	5	535	
			Soft clay	35	570	
			Hard clay	2	572	
			Medium clay	14	586	
			Soft clay	12	598	
			Medium clay	9	607	
			Medium caly with Pyrite	12	619	
			Medium clay	13	632	
			Hard clay	18	637	
			Medium clay	16	653	
			Fine Sand	23	676	
			Hard chalky sand	2	678	
			Coarse Sand	32	710	

NOTIFICATION OF INTENT TO DRILL A WATER WELL AND CERTIFICATION OF COMPLETION

9-22-2015

DRILLING CONTRACTOR	License Number	Address	Zip Code	Date
LAYNE CHRISTENSEN CO	659	3720 N. PALAFOX PENSACOLA FL	32505	

PROPERTY OWNER	Address (mailing)	Zip Code
WASTE MANAGEMENT CORP	400 14TH ST SE SUITE A DECATUR AL	

WELL LOCATION	County	Township	Range	Section	1/4 Section
	SUMTER	21N	3W	18	SE/NW

SUMTER OFF HWY 17 N ABOUT 4 1/2 MI NO OF EMELLE AL
Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☐ Test well ☒ Monitoring well ☐ Irrigation Other:

Latitude	Longitude	Diameter of well	Estimated depth
N 32° 47' 24.26	W 88° 14' 34.30	4"	710'

LOCATION OF WELL:

Estimated starting date: 8-5-15

Drilling Method: ☐ Cable tool ☒ Rotary ☐ Jetted ☐ Bored ☐ Other:

SIGNATURE of Drilling Contractor 659

Total Depth 710'

Completion Date 9-16-2015

Interval	Description of cuttings
	SEE ATTACHED

Completion date: report depths below ground level

Pump
Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl Other NO
Intake depth ____ H.P. ____ Yield ____ gpm

Capacity
Tested by: ☐ pumping ☒ air-lift ☐ bailer none
Measured Static Water Level 5 ft.
Measured pumping level NA ft. after ____ hrs. pumping NA gpm
Development time prior to testing NA hrs.

Finish
☐ Open hole ☒ Screened ☐ Slotted pipe ☐ Gravel pk.
Inerval(s) screened: 650 to 690 ft; ____ to ____; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. 4" ; Size openings .010"

Casing

Interval cased	Diam. (inches)	*Type pipe	*Type couplings	Interval grouted
0-650	4"	T&C	STL	0-650

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (TC&W)
Other: CASING BLK STL SCREEN 304 SS
*Pipe: Black; PCV; Galv.; Other:

Quality
Water analysis obtained? (check) ☒ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ Ala Health Dept. ☐ U.S. Geol. Surv. ☐ Private lab.

Signed Certification: 659

*For deeper well please attach continuation sheet.

Send WHITE copy to:
ALABAMA GEOLOGICAL SURVEY
P.O. BOX 869999
TUSCALOOSA, AL 35486

Send YELLOW and PINK copies to:
ADEM DRINKING WATER BRANCH
P.O. BOX 301463
MONTGOMERY, AL 36130-1463

Retain GOLD copy for your Records

ADEM FORM 60 5/02

ATTACHMENT B

WELL DEVELOPMENT LOG

WELL DEVELOPMENT FIELD RECORD

Job Name RCRA-8R Development Job No. 147910 Well No. RCRA-8R

Developed By WC Date Of Installation ______ Sheet 1 Of 2

Started Development 9/10/15 / 0725 (DATE / TIME) Completed Development 9/10/15 / 1000 (DATE / TIME)

W.L. Before Development 14.55 Ft / 0715 (~~DATE~~ WL / TIME) After Development 140.10 Ft 1005 (~~DATE~~ WL / TIME)

Well Depth:

Before Development ≃ 700 After Development ≃ 700 Well Diameter 4 in.

Standing Water Column (Ft.) ______ Standing Well Volume ______ gal.

Screen Length ______ Drilling Water Loss ______ gal.

DATE/TIME	VOLUME REMOVED (GALS)	FIELD PARAMETERS: mS/cm SPEC.COND. (unhos/cm)	TEMP (C)	pH (s.u.)	NTU OTHER	REMARKS
9/10/15 / 0728	≃30	1.93	23.90	8.97	170	Initial; Cloudy
0740	150	1.97	23.18	8.87	130	Color is Cloudy Grey
0750	250	1.94	22.91	8.81	NA	Grey Color
0800	350	1.98	23.64	8.66	NA	Grey Color
0810	450	1.94	23.03	8.78	1000	Grey Color
0820	550	1.90	23.40	8.79	630	Grey Color
0830	650	1.89	23.17	8.79	450	Grey, More Clear
0840	750	1.95	23.13	8.79	382	light Grey
0850	850	1.97	23.10	8.78	370	Cloudy
0900	950	1.97	23.12	8.79	370	Cloudy
0910	1050	1.96	23.40	8.80	295	Cloudy
0920	1150	1.97	23.47	8.82	264	Cloudy
0930	1250	1.96	23.60	8.84	242	Cloudy
0940	1350	1.96	23.70	8.85	242	Cloudy
		= TOTAL VOLUME REMOVED (gal.)				

DEVELOPMENT METHOD: air pumped into well @ a depth of 290' @ ≃ 140 psi. Flow Rate stable @ ≃ 10 gpm.

NOTES: Purge water for parameters is taken from crafted water shoot. The shoot is dirty with sediment. Air hose makes it too risky to sample purge water straight from well. Water from well apears to be clear & free of sediment @ ≃ 0910 am

WELL DEVELOPMENT FIELD RECORD

Job Name RCRA - 8R Development Job No. 1417910 Well No RCRA-8R

Developed By VC Date Of Installation ______ Sheet 2 Of 2

Started Development 0725 / 9/10/15 Completed Development 9/10/15T 1000
DATE TIME DATE TIME

W.L. Before Development ______ / ______ After Development ______ / ______
DATE TIME DATE TIME

Well Depth:

Before Development ______ After Development ______ Well Diameter ______ in.

Standing Water Column (Ft.) ______ Standing Well Volume ______ gal.

Screen Length ______ Drilling Water Loss ______ gal.

DATE/TIME	VOLUME REMOVED (GALS)	FIELD PARAMETERS SPEC.COND. (unhos/cm)	TEMP (C)	pH (s.u.)	Turb OTHER NTU	REMARKS
9/10/15 / 950	1450	1.95	23.85	8.55	218	Cloudy
/ 1000	1550	1.96	23.83	8.86	223	Cloudy
/						
/						
/						
/						
/						
/						
/						
/						
/						
/						
/						
/						
		= TOTAL VOLUME REMOVED (gal.)				

DEVELOPMENT METHOD: ______

NOTES:

ATTACHMENT C

SURVEY DATA

Well Elevations:
Chemical Waste Management, Inc
Emelle, Alabama

RCR-A5
N:8389.67'
E:13135.71'
TOP OF WELL=213.31' (MEASURING POINT)
TOP OF CASING=214.38'
TOP OF CONCRETE=212.94'

RCR-A6
N:15729.28'
E:7821.37'
TOP OF WELL=162.24' (MEASURING POINT)
TOP OF CASING=163.12'
TOP OF CONCRETE=162.12'

RCR-A7
N:13122.06'
E:8186.99'
TOP OF WELL=206.96' (MEASURING POINT)
TOP OF CASING=207.47'
TOP OF CONCRETE=205.68'

RCR-A9
N:13266.34'
E:9344.54'
TOP OF WELL=210.50' (MEASURING POINT)
TOP OF CASING=210.99'
TOP OF CONCRETE=209.36'

RCR-A10
N:13126.85'
E:10874.05'
TOP OF WELL=220.80' (MEASURING POINT)
TOP OF CASING=221.44'
TOP OF CONCRETE=219.14'

W-08R
N:11126.82
E:590.50
TOP OF WELL=136.40'(MEASURING POINT)
TOP OF CASING=136.83'
TOP OF CONCRETE=132.35'

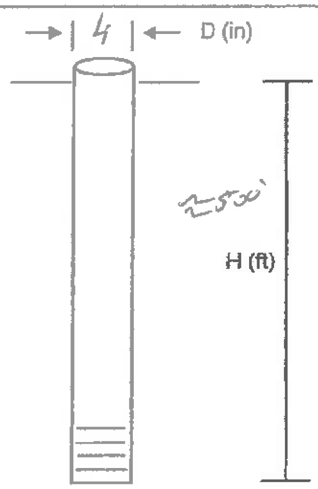
ATTACHMENT D

WELL ABANDONMENT LOG

WELL DECOMMISIONING FORM

Date/Time	4/14/15 / 0855	Page	1 of 1
Golder Insp.	Will Caruso	Well ID	RCRA - 8
Drill Rig	Garden Denver 15000 Friction Rig	Well Type	RCRA monitoring well
Bit Size		Grouter	Layne

Design Depth	(ft)	Actual Depth	(ft)
Water Level	5.00 (ft)	Casing Stickup	6.5 inches (ft)
Casing Type	Concrete	Inside Casing Diameter	4 (in)
Screen Length	(ft)		



COMPUTED VOLUME

$$\text{REQUIRED VOLUME} = \frac{D^2 \text{ (in)} \times H \text{ (ft)}}{183.4} \times 7.481 = \_\_\_\_ \text{ (gal)}$$

(4 × 5.00 written above formula)

ACTUAL VOLUME

Bentonite Volume	—	(ft3)
Grout Volume	≈1.5 yds, ≈ 277.38	(gal)
Bags of Cement	—	(#)
Grout Settlement	settled ~~8ft~~ ft below surface	(in)
Top-Off Volume	~~[illegible]~~ yds ≈ 48.95	(gal)
Total Seal Added	~1.25 yds	(gal)
Total Cement Bags	—	(#)

COMMENTS

Well decommisioned using the trime method. Trime Line set @ ≈500 ft. Cement truck onsite @ 0840 w/ 2 yds @ 15.4 lbs/gal. Cement settled @ 81' ft. Top 6 ft of well dug out & cut off 9/15/15. Last 75 ft filled 9/15/15

APPENDIX E-6

SECTION E

RESULTS OF PACKER PERMEABILITY TESTS

EMELLE, ALABAMA WASTE DISPOSAL SITE

Revision No.
5.0

APPENDIX E-6

SECTION E

LIST OF DOCUMENTS

Document 1: Results of Packer Permeability Tests, Emelle, Alabama Waste Disposal Site, prepared by Woodward-Clyde Consultants, dated May 1, 1979.

Document 2: Packer Testing of Borehole AB-1, Chemical Waste Management Facility, Emelle, Alabama, prepared by Golder Associates, Inc., dated July 1999.

APPENDIX E-6

DOCUMENT 1

RESULTS OF PACKER PERMEABILITY TESTS

EMELLE ALABAMA WASTE DISPOSAL SITE

RESOURCE INDUSTRIES OF ALABAMA, INC.
CHEMICAL WASTE MANAGEMENT, INC.

Woodward-Clyde Consultants

Consulting Engineers, Geologists and Environmental Scientists
1440 Canal Street, Suite 1913, New Orleans, LA 70112

1440 Canal Street, Suite 1913
New Orleans, Louisiana 70112
504-525-1154

Woodward-Clyde Consultants

1 May 1979
WCC File: Y9C00039

Chemical Waste Management, Inc.
2131 Kingston Court, S.E.
Suite 112
Marietta, GA 30067

Attention: Dr. Roger Henson

Re: Results of Packer Permeability Tests
Emelle AL Waste Disposal Site

Gentlemen:

This letter transmits our report, Results of Packer Permeability Tests, Emelle AL Waste Disposal site, made to evaluate the coefficient of permeability of rock at this site. The report also presents our conclusions and recommendations.

Our work has been authorized by your Waste Management of Alabama, Inc. Purchase Order No. 5451 dated 26 March 1979, authorized by Roger Henson and approved by Mark Gregory.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

Richard J. Woodward, III, P.E.

Enclosures

RJW/dn

CONTENTS

INTRODUCTION

During late February 1979 Roger Henson of Chemical Waste Management, Inc. (CWMI) called Richard Woodward of Woodward-Clyde Consultants (WCC) identifying a concern that CWMI had regarding the Emelle AL waste disposal site. Site staff members had observed linear stains in the upper portion of the chalk rock in the east wall of Trench 7 but not on the floor and they wanted to know the geologic significance of these stains. Dr. Henson asked that WCC made a brief literature review, make observations at the site, and provide conclusions and recommendations to CWMI.

On 5 and 7 March our Dr. James Smith, a geologist thoroughly familiar with the geology of the Southeast, reviewed current literature, maps, aerial photographs and Landsat images of the site available at the Geology Survey of Alabama and the U.S. Geological Survey offices in Tuscaloosa. On 6 March he and Dr. Woodward inspected Trench 7 in detail. We reported to you that day that one form of fracture in rocks, called faults which are a common occurrence in many parts of the United States, were present at Trench 7. All rock has a tendancy for naturally occurring fractures. One kind of fracture is a fault where the rock has moved in a direction parallel to the plane of the fracture. Another kind of fracture is a joint where there has been no macroscopic movement parallel to the fracture. The existance of the faults in itself is not a major concern to us - what was of concern was the potential that these fractures could be a conduit for leakage which may or may not occur from the trenches. To evaluate this potential we proposed a test program which you accepted. This report describes the test program, the test program results, our conclusions and recommendations.

With the east, south and portions of the north wall exposed and cleared of loose rock we were able to determine that there are two clearly identifiable and traceable faults in the east wall of Trench 7, one clearly identifiable and traceable fault in the north wall, and several identifiable but not easily traceable faults in the north wall, north end of the west wall, and north and central portions of the floor of the trench. No faults were observed on the south wall of Trench 7.

We reported to you that the northerly fault in the east wall of Trench 7 strikes N85°W and dips 65° north and that the southerly fault strikes N80°W and dips 70° north. Strike is the compass direction of a horizontal line in the plane of the fault and dip is the angle between the plane of the fault and the horizontal, measured perpendicular to strike.

The attitude (that is, the orientation) of the faults in the east wall of Trench 7 is such that they project towards Trenches 1 and 3 which have been filled and covered with a clay cap to close them. The locations of trenches at the site are illustrated in Figure 1. (Note: Trench 2 was planned to be located between Trenches 1 and 3. It was never excavated and this trench designation number was abandoned). Mr. Mark Gregory, General Manager of the Emelle Site, indicated that stains similar to those observed in Trench 7 have been observed only in the upper parts of the walls of Trenches 1 and 3. The coupling of the observations of Mr. Gregory and the projections of faults we observed in the east wall of Trench 7 led us to believe that there may be one or more faults projecting through Trenches 1, 3 and 7.

BACKGROUND

The site is located adjacent and southeast of the intersection of State Routes 17 and 116 in Sumter County AL. The site contains 908 acres and approximately 100 acres in the northwest portion are under development which began during 1977. The excavation for Trench 1 was approximately 50 ft wide, 700 ft long, and the depth ranged from 15 to 25 averaging approximately 20 ft in the burial portion. Chemical wastes, packaged usually in 55 gallon drums, were laid in the trench. At regular intervals soil cover and sorbancy materials were placed to cover the drums. When the trench was filled an approximately 6-ft-thick soil cover was placed on the trench to close and seal it. As Trench 1 was being filled, excavation of Trench 3 began. Following the filling and closing of Trench 3 development of Trenches 4, 5, 6 and 7 has progressed on a similar fashion. As can be seen on Fig. 1 the shapes of Trenches 4 through 7 are not as long and narrow as Trenches 1 and 3.

In the waste burial portion of the site ground surface slopes downward from south to north. Ground surface elevations range from Elev 220 ft above Mean Sea Level (MSL) to Elev 176 ft MSL.

During observation on Trench 7 it was determined that there is a soil cover overlying intact chalk. The soil cover is a mixture of naturally occurring soil which was removed, mixed with pulverized chalk, and the mixture placed back. The thickness of the soil cover is 6 ft as we estimated it at Trench 7 and there was no soil present between Trenches 1 and 3. The chalk at the site is called Demopolis Chalk by geologists. Demopolis Chalk is a sedimentary formation composed of white to grey beds which range from relatively pure to very impure chalk and they contain much clay, silt and fine to medium grained sand and abundant fossils. The site is in impure chalk. The Demopolis Chalk is a few hundred feet thick.

Below the Demopolis Chalk is a few thousand feet of formations of chalk, sand and clay. The sand beds are aquifers and the first aquifer below the site is several hundred feet below ground surface. The water in these aquifers is brackish.

Chalk is a variety of limestone. Chalk has developed from the compression of beds of marine micro-organisms and calcareous ooze.

There are four manifestations of the fault form of fractures at Trench 7. The first is the presence of previously mentioned stains. They begin at the soil-chalk interface and extend an estimated maximum of 5 ft below the top of the chalk on the east wall of Trench 7. We observed stains 30 ft below the top of chalk in the northwest corner of Trench 7 on 29 March 1979, the day of our second site visit. The stains are iron-oxide discolorations of the otherwise blue-gray chalk and are up to 3 to 4 in. wide. The iron oxide is carried by water flowing along the fracture but because of the tightness of the fracture the water and, hence, the staining generally extended only a few feet down into the chalk. The second manifestation of faulting is the presence of striations in the fractures. Striations are parallel scratches in the chalk that occurred when movement parallel to the fracture occurred. A third manifestation is the presence of calcite in the fractures. Calcite is a mineral precipitated from water that was in the fractures. At some locations the surface of the calcite has striations reflecting the striations of the fault in which the mineral precipitated or they represent renewed movement along the fracture after deposition of the calcite. The fourth manifestation is the presence of offset beds. There are two, nearly horizontal, beds of light colored chalk that can be seen in Trench 7. On the east wall each of these beds are vertically offset by approximately 2 ft at the northerly fault and 4 ft at the southerly fault.

TESTING PROGRAM

The testing program consisted of two parts. The first part consisted of coring the rock using diamond drilling techniques and examining the recovered rock core for the presence of fractures with striated surfaces. The second part was packer permeability testing and it consisted of isolating 10-ft-long sections of the core hole in the ground using pneumatic packers, trying to force water into the rock under hydraulic pressure, and measuring any flow rates. By isolating fractured and suspect zones of chalk with packers and comparing the results to zones without fractures a determination was made that the fractures or suspect zones are not conduits for potential flow of fluid from the trenches.

ROCK CORING

Description of Rock Coring Method

Three holes were drilled for the rock coring. We determined that three core holes located in different parts of the site and oriented so that the core holes would most likely intercept faults would be, in our professional opinion, an adequate number of core holes. One was a vertical hole drilled from the bottom of Trench 7. Its location was selected so that both faults observed in the trench when projected as plane surfaces could be intercepted at reasonable drilling depths. Two diagonal holes were drilled on 45° angles below the horizontal. Their locations were chosen so that faults would be intercepted in each hole, so that neither hole would pass through the trenches, and so that one hole would terminate under Trench 1 and the other under Trench 3. After packer permeability testing was completed the diagonal holes were reamed to a larger size and sampling wells were installed for future sampling. The ground surface locations of the core holes as well as the projections of the diagonal holes under the trenches are shown on Figure 1. A description of the sampling well installation techniques is given in Appendix A. The vertical hole was grouted using a 20:1 cement/bentonite grout. The group was placed using tremie methods as described in Appendix A.

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All rock coring, packer permeability testing, hole reaming, and grouting was supervised by our Mr. Richard Ashley and was done by Raymond International, Inc. We selected Mr. Ashley, a Senior Engineer Technician to supervise the work because of his considerable experience in rock coring and packer permeability testing. Raymond assigned a crew of two drillers to the work, each of whom is very experienced in rock coring and packer permeability testing, as opposed to a normal crew of a driller and a roustabout. The vertical coring from the bottom of Trench 7, designated CWM V-1, was made using a truck-mounted CME 55 drilling machine. The diagonal corings were made with a truck-mounted Mobil B40L drilling machine. The diagonal coring made under Trench 1 is designated CWM D-1 and the diagonal coring made under Trench 3 is designated CWM D-2. Field work began on 29 March 1979 and was completed 11 April. Coring was done with a Longyear NQ wire-line, double core barrel. This core barrel makes a hole in the rock that is 2-63/64 in. dia (nom) and recovers core that is 1-7/8 in. dia (nom) up to 10 ft long.

With the drilling technique used, an outer barrel with diamonds embedded at the end is rotated and forced into the rock, cutting an annular hole. The cylindrical piece of rock inside the annual hole, called core,

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slides into the inner barrel (which does not rotate) as the core barrel advances. The wire line method allows the inner barrel with its core to be retrieved without removing the outer barrel and drill rods from the core hole.

Field logs of rock coring are given in Appendix B and schematic drawings illustrating the results of coring are given on Figures 2, 3 and 4. The distance the core barrel advances before retrieving the inner barrel and its core is called the length of the run. Recovery is length of core retrieved divided by the length of the run, expressed as a percent. An indicator of the quality of rock as it exists in the ground, commonly accepted by the profession, is Rock Quality Designation (RQD). It is calculated by determining the cummulative length of pieces of core in a run that are 4 in. long or more, dividing this cummulative length by the length of the run and expressing the result as a percent. If drilling or core handling methods caused lost core or breaks in the core, these losses and breaks are disregarded in calculating RQD. Experienced geologists and engineering technicians can usually determine which losses and breaks in core are due to drilling and handling and which are naturally occurring by careful observation of the drilling process and broken surfaces of core. High values of both recovery and RQD are strong indicators of high quality rock in its natural condition.

Coring locations were chosen so that faults could be intercepted and in addition, in the case of the diagonal cores, so that sampling wells could be installed in the core holes. In calculating where the core holes will intercept faults two important assumptions are made: (1) faults are plane surfaces and not curved; and (2) faults do not terminate or die out. Using these assumptions we calculated that the vertical coring would intercept the faults between 40 and 80 ft depth, the diagonal coring under Trench 1 would intercept faults between 79 and 93 ft along the axis of the core, and the diagonal coring under Trench 3 would intercept faults between 101 and 115 ft.

Results of Rock Coring

Results of rock coring are described in detail on the field logs given in Appendix B and are summarized on Figures 2, 3 and 4.

The vertical coring from the botom of Trench 7, CWM V-1 (Figure 2) has a recovery of 100% for all runs except the first which was just below the excavated surface where the recovery was 89%. RQD is 96% or greater for all runs. Combined values of recovery and RQD of approximately 90% or greater are commonly accepted in the profession as indicators of high quality intact rock. Striations on fractured surface of core were found at depths of 60.0 and 60.4 ft below the bottom of the excavation in Trench 7. The trench was approximately 50 ft deep and the bottom was at Elev 138 ft MSL when the coring was done.

The diagonal coring under Trench 1, CWM D-1, (Figure 3) has a recovery and RQD of 90% or greater for all runs except for Run Nos. 1, 3 and 7. It is not uncommon for competent intact rock to have lower recovery and RQD values at shallower depths than at greater depths, as occurred in this core hole, because of stress relief and weathering. Striations on the fractured surface of core were found only in Run No. 3 and at distances of 27.0 and 27.4 ft along the core axis (approximately 19 ft below ground surface).

The diagonal coring under Trench 3, CWM D-2, (Figure 4) has a recovery of 100% for all runs except Run Nos. 1, 2 and 3. RQD is 100% except for Run Nos. 1 and 2. Striations on fractured surfaces were found at distances of 12.0 ft (Run No. 1), 12.5 to 15.5 ft (Run No. 2), 97.6 ft (Run No. 12), and at 106.0, 108.8 and 111.5 ft (Run No. 13) along the axis of the core. The depths below ground surface at which these striations were encountered range from 8 to 79 ft.

PACKER PERMEABILITY TESTS

Description of Packer Permeability Test Method

The method commonly accepted by the profession for determining in-place permeability (that is, resistance to fluid flow) of rock is the packer permeability test. In this test it is necessary to isolate a length of the core hole, apply water pressure to the isolated length and to measure the flow rate into the isolated section. The configuration of equipment is schematically illustrated in Figure 5 and consists of a fresh water supply water pump, surge chamber and water filter at ground surface, calibrated flow meter and pressure gauge at ground surface, bottled gas at ground surface to inflate the packers, pipe in the core hole to conduct water to the test section, gas lines in the core hole to inflate the packers from the bottled gas, and packer equipment at the test section. The packer equipment used consists of a 16 ft long pipe, the central 10 ft of which is perforated. Three foot long heavy rubber membranes, called packers, are wrapped and sealed around both ends of this pipe. The bottled gas is used to inflate the packers against the core hole wall to prevent seepage between the core hole wall and the packers. A Moyno water pump was used because it minimizes surges in pressure and therefore makes it relatively easy to regulate flow at constant pressure. The flow meter and pressure gauge were calibrated on 6 and 12 October 1978, respectively. The flow meter was 99% accurate at a flow rate of 1 gal/min. The pressure gauge read 51 psi where the test gauge read 50 psi.

Prior to making the test the core hole was thoroughly flushed by pumping clear water into the hole to remove any cuttings or clay from the walls of the core hole which might clog potential conduits for flow during the test.

The core hole is completely filled with water prior to making the test. If there is a leak past the upper packer the leak is easily detected because water will be observed flowing out of the core hole at ground surface. If there is a leak past the lower packer the leak can not be detected. The effect is that the test length may become the distance between the bottom of the core hole and the upper packer and as a result the rock appears less resistant to flow than it actually is.

Because the core holes are filled with water there is a full hydraulic head applied from the top of the core hole to the test location. Because the tops of the diagonal core holes were ground surface that head of water is the maximum that would naturally occur and the effect of applying added pressure from the pump is to apply a hydraulic head in excess of what could occur in nature. Because the top of the vertical core was the bottom of a 50 ft deep trench the maximum pressure used produced a hydraulic head in excess of what could occur in nature.

Packer Permeability Test Locations

Packer permeability tests were made at three locations in each core hole. In the vertical coring below Trench 7, tests were made at 35 to 45 ft, 55 to 65 ft and 85 to 95 ft below the drilling surface which was at the bottom of the trench. The test section from 35 to 45 ft was chosen because one 10 ft long piece of core was recovered there and we believed that this section would represent rock with the most resistance to flow. The test section from 55 to 65 ft was chosen because of the presence of striated fractures of core found at 60.0 and 60.4 ft. The test section from 85 to 95 ft was chosen because examination of the core caused us to suspect that there may be joints in the rock in that depth range.

In the diagonal core hole below Trench 1 tests were made at 25 to 35 ft, 55 to 65 ft, and 80 to 90 ft along the axis of the core hole. The midpoints of these test sections are approximately 21 ft, 42 ft and 60 ft below ground surface. The shallowest depth was chosen because striated fractures of core and several pieces of core were found in this test length, and because both the recovery and RQD were less than 80%. The middle depth was chosen because the recovered core at that test length was in several pieces. The deepest depth was chosen because examination of the core indicated massive sound rock with the most resistance to flow.

In the diagonal core hole below Trench 3 tests were made at 25 to 35 ft, 95 to 105 ft and 105 to 115 ft along the axis of the core. The midpoints of these test lengths are approximately 21 ft, 71 ft and 78 ft below ground surface. The shallowest depth was chosen because examination of the core indicated good quality rock in place. The other depths were chosen because striated fracture surfaces were found in these test lengths.

Results of Packer Permeability Tests

The results of the packer permeability tests are summarized on Table 1. The tests were made holding the pressure constant for usually 20 minutes and measuring any flow. Hydraulic pressure increments of 5 pounds per square inch (psi) were used, up to a maximum of 25 psi in the vertical core hole and to a maximum of 20 psi in the diagonal core holes. A pneumatic pressure of 40 psi was used to inflate the packers.

The flow rates into the rock were either zero or very low. These very low flow rates caused difficulty on occasion in regulating flow and on occasion small negative flows were measured. We interpret these negative flows as measure equivalent to no take.

Where positive flow was measured the coefficient of permeability, k, was calculated as shown on Table 1. This coefficient is a numeric measure of the resistance to flow, the larger the number the less the resistance, and the lower the number the more resistance. The values of the coefficient are expressed in scientific notation where 1×10^{-7} is ten times greater than 1×10^{-8}. Head losses between the pressure gauge and the packer section have been neglected on Table 1 because the flow rates were so low.

For most of the test locations and pressures no flow occurred indicating very low values of coefficient of permeability. At the vertical core hole in Trench 7, very low flow rates occurred at all pressure increments for the test sections from 55 to 65 ft and from 85 to 95 ft and only at the 25 psi pressure level for the test section from 35 to 45 ft. At the 55 to 65 ft section the calculated values of coefficient of permeability are slightly less level than that at the 85 to 95 ft level as shown on Table 1.

DISCUSSION OF RESULTS OF TEST PROGRAM

The results of the coring indicate that high quality rock coring was done by the drillers. As a result we believe that the probability is very high that all faults which could have been intercepted by the core holes have been identified.

The fact that only one fault was encountered in Trench 7 most likely means that one of the two faults terminated at a shallow depth or the two faults coallesced into one.

Packer permeability tests were made at all fault locations except those encountered from 12.5 to 22.5 ft along the axis of coring CWM D-2. We chose not to make the test there because the water pressures required to make the test might exceed the pressure due to weight of rock at that depth. Any results of tests made at so shallow a depth would be suspect of indicating less resistance to flow than actually exists.

The results of the packer permeability tests indicate that faults encountered under Trenches 1 and 3 have very low permeability and are not conduits for potential flow of fluid from the trenches. The tests made below Trench 7 indicated that the fractures are not more permeable than the rock below them.

The values of coefficient of permeability calculated at Trench 7 are approximately equal to the maximum values permitted by EPA draft regulations for hazardous waste disposal sites. Because the rock at the site is well above the water table it is very probably not saturated. As a result, the calculated values of coefficient of permeability are therefore higher than the true value.

There is a water well at the site and it connects with aquifers far below ground surface. The static water level, measured when no pumping is being done, is at Elev 120 to 125 ft MSL. The core holes encountered faults far below this level at Elev 78 ft MSL in core hole CWM V-1 and at Elev 104 ft MSL in core hole CWM D-2. No flow from the faults was detected indicating no connections of faults with aquifers. The sampling wells below Trenches 1 and 3 can be used to check for any very slow flow from the aquifers in years to come.

CONCLUSIONS AND RECOMMENDATIONS

We conclude that the faults in the vicinity of Trenches 1, 3 and 7 have a very high resistance to flow and are no less resistant than the non-faulted chalk except within a few feet ground surface. However, we understand that a very low permeability clay cap is constructed in the top several feet of the trenches to prevent leakage and, as a result, no wastes are buried there. In addition, your leachate control system prevents a fluid pressure head rise so that there can be no flow.

We recommend that future trenches be located in areas where there are fewer or no faults. After trenches are excavated and their walls cleaned of loose rock they should be examined by an experienced geologist. Because there were several faults observed in Trench 7 we recommend that Trench 7 be lined with a low permeability clay lining meeting state or EPA guidelines for disposal sites such as this.

Table 1
Results of Packer
Permeability Tests
Sheet 1 of 2

Core Hole	Packer(1) Location Along Axis of Hole, ft	Pump Pressure psi	Pressure Head ft	Total(2) Head ft	Flow gal	Time min	Flow Rate gal/min	Flow Rate ft^3/min	$F^{(3)}$ ft	Coefficient of Permeability, k ft/min	Coefficient of Permeability, k cm/sec
CWM V-1	40	5	11.6	59.1	0	0	0	0			
		10	23.1	70.1	0	0	0	0			
		15	34.6	82.1	0	0	0	0			
		20	46.2	93.7	0	0	0	0			
		25	57.8	105.3	0.05	20	0.0025	$3.34x10^{-4}$	47.8	$0.7x10^{-7}$	$0.4x10^{-7}$
	60	10	23.1	90.6	0.05	20	0.0025	$3.34x10^{-4}$	28.1	$1.3x10^{-7}$	$0.7x10^{-7}$
		15	34.6	102.1	0.10	20	0.0050	$6.68x10^{-4}$	33.8	$1.9x10^{-7}$	$1.0x10^{-7}$
		20	46.2	113.7	0.45	20	0.0225	$3.01x10^{-3}$	37.5	$7.1x10^{-7}$	$3.6x10^{-7}$
		25	57.8	125.3	0.75	20	0.0375	$5.01x10^{-3}$	41.2	$9.7x10^{-7}$	$4.8x10^{-7}$
	90	5	11.6	109.1	0	5	0	0			
		10	23.1	120.6	0.55	20	0.0275	$3.68x10^{-3}$	27.5	$11.1x10^{-7}$	$5.5x10^{-7}$
		15	34.6	132.1	0.45	20	0.0225	$3.01x10^{-3}$	31.2	$7.5x10^{-7}$	$3.8x10^{-7}$
		20	46.2	143.7	0.70	20	0.0350	$4.68x10^{-3}$	32.5	$10.6x10^{-7}$	$5.0x10^{-7}$
		25	57.8	155.3	0.25	10	0.0250	$3.34x10^{-3}$	35.0	$6.1x10^{-7}$	$3.1x10^{-7}$
CWM D-1	30	5	11.6	39.3	0	20	0	0			
		10	23.1	50.8	0	20	0	0			
		15	34.6	62.3	0.15*		20	0			
		20	57.8	85.5	0.10*		20	0			
	60	5	11.6	60.6	**	20	0	0			
		10	23.1	72.1	**	20	0	0			
		15	34.6	83.6	0	20	0	0			
		20	57.8	106.8	0	20	0	0			
	85	5	11.6	78.2	0	20	0	0			
		10	23.1	89.7	**	20	0	0			
		15	34.6	101.2	0	20	0	0			
		20	57.8	124.4	0	20	0	0			

Table 1
Results of Packer Permeability Tests
Sheet 2 of 2

Core Hole	Packer (1) Location Along Axis of Hole, ft	Pump Pressure psi	Pressure Head ft	Total (2) Head ft	Flow gal	Time min	Flow Rate gal/min	Flow Rate ft^3/min	F (3) ft	Coefficient of Permeability, k ft/min	Coefficient of Permeability, k cm/sec
CWM D-2	30	5	11.6	39.3	0	20	0	0			
		10	23.1	50.8	0	20	0	0			
		15	34.6	62.3	0	20	0	0			
		20	57.8	85.5	0	20	0	0			
	100	5	11.6	88.5	0	20	0	0			
		10	23.1	100.3	0	20	0	0			
		15	34.6	111.8	0	20	0	0			
		20	57.8	135.0	0	20	0	0			
	110	5	11.6	95.9	0	20	0	0			
		10	23.1	107.4	0	20	0	0			
		15	34.6	118.9	0	20	0	0			
		20	57.8	142.1	0	20	0	0			

Notes:

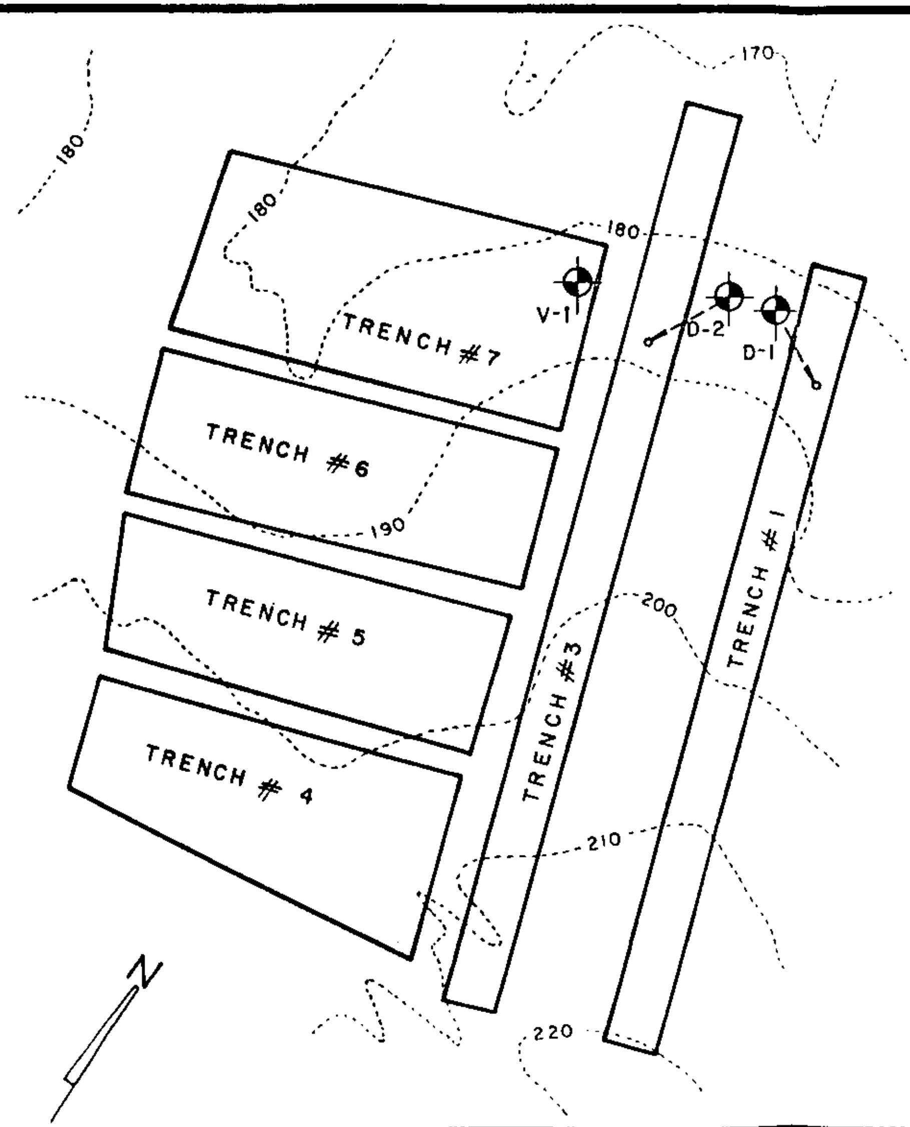
(1) Distance from top of core hole to midpoint of test section.

(2) Total head at bottom packer.

(3) Shape factor for test for calculating coefficient of permeability according to United States Bureau of Reclamation analysis method for constant head test above the water table, and unsaturated for an unlined test section with two packers. Reference is USBR, 1951, "Permeability Tests Using Drill Holes and Wells", Geology Report G-97.

* indicates measured flow occurred during the first 10 seconds only of 20 minute test. Considered as no flow.

** indicates measured flow was slightly negative. Considered as no flow.



NOTES

1. GENERAL SITE LAYOUT FROM GREGORY-GRACE AND ASSOCIATES, INC. DRAWING G-1, "MASTER PLAN, HAZARDOUS WASTE MANAGEMENT SYSTEM, SUMTER COUNTY, ALABAMA", DATED 6 FEBRUARY 1978 WITH 1 AND 26 MARCH 1979 REVISIONS.
2. LOCATION OF BORINGS FOR THIS PROJECT SELECTED BY WOODWARD-CLYDE CONSULTANTS. BORING LOCATIONS WERE STAKED IN FIELD BY SURVEYORS UNDER CONTRACT TO CHEMICAL WASTE MANAGEMENT, INC.

LEGEND

V-1 — INDICATES CORE HOLE NUMBER AND LOCATION OF CORING

D-2 — INDICATES THAT CORING WAS DRILLED ON AN ANGLE OF 45 DEGREES WITH RESPECT TO THE HORIZONTAL. DASH LINE INDICATES PROJECTION OF CORE HOLE

200 — INDICATES GROUND SURFACE CONTOUR & ELEVATION IN FEET (MEAN SEA LEVEL)

SCALE - FEET

100 0 50 100 200

WASTE DISPOSAL SITE
EMELLE, ALABAMA

CHEMICAL WASTE
MANAGEMENT, INC.

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS
HOUSTON BATON ROUGE NEW ORLEANS

SCALE NOTED | MADE BY CS | DATE 23APR79 | FILE NO. Y9C00032

SITE PLAN AND
BORING LOCATIONS

FIGURE 1

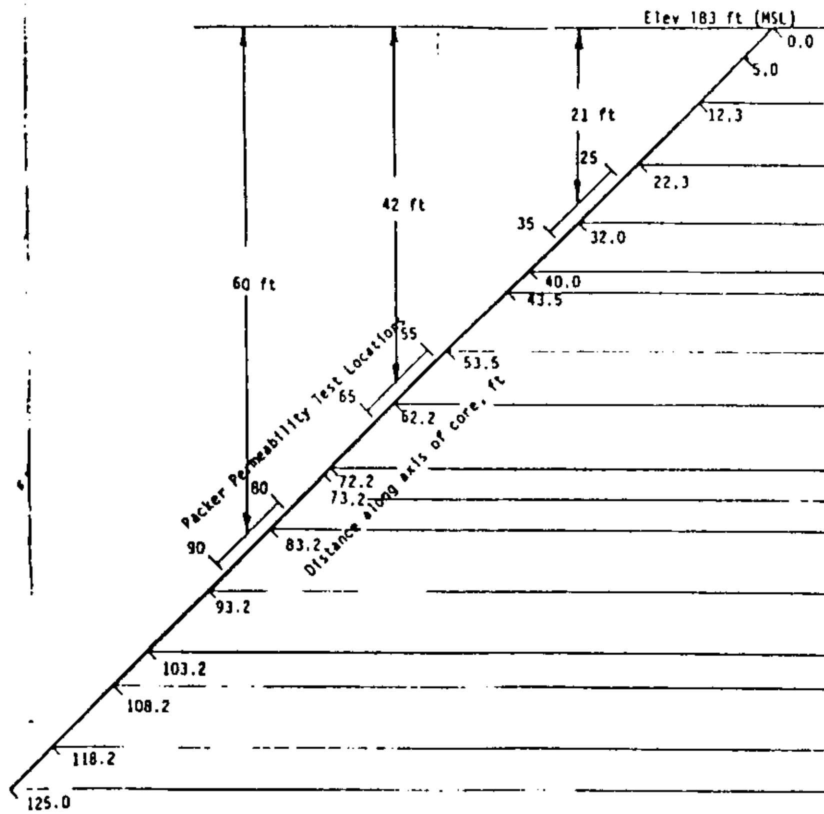
Depth ft	Run No	Length of Run ft	Recovery %	RQD %	Description and Remarks
0					
3.7					Augered and set surface pipe. Trench at Elev 138 ft M
9.3	1	5.6	89	100	Grey soft to med Ls (Chalk). Three pieces of core, 0.9 to 2.1 ft.
14.3	2	5.0	100	97	Grey soft to med Ls (Chalk). Three pieces of core 0.9 to 2.1 ft. Tight jointed seam at 10.8 ft.
24.3	3	10.0	100	100	Grey soft to med Ls (Chalk). Three pieces of core, 2.5 to 5.0 ft long.
35 34.3	4	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 2.5 and 7.5 ft
45 44.3	5	10.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 10 ft.
55 54.3	6	10.0	100	97	Grey m. hard Ls (Chalk). Three pieces of core, 0.1 to 9.3 ft.
65 64.3	7	10.0	100	96	Grey m. hard Ls (Chalk). Five pieces of core 0.1 to 4.6 ft. Straited core surface at 60.0 and 60.4 ft.
74.3	8	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 4.2. and 5.8 ft.
85 84.3	9	10.0	100	99	Grey m. hard Ls (Chalk). Three pieces of core, 0.1 to 7.9 ft.
95 94.3	10	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core 4.2 and 5.8 ft.
100.6	11	6.3	100	99	Grey m. hard Ls (Chalk). Three pieces of core 0.1 to 5.5 ft long.

Note: (1) m. indicates medium and Ls indicates limestone.

(2) I indicates packer permeability test location.

Summary Log of Core Hole CWM V-1 (Under Trench 7)

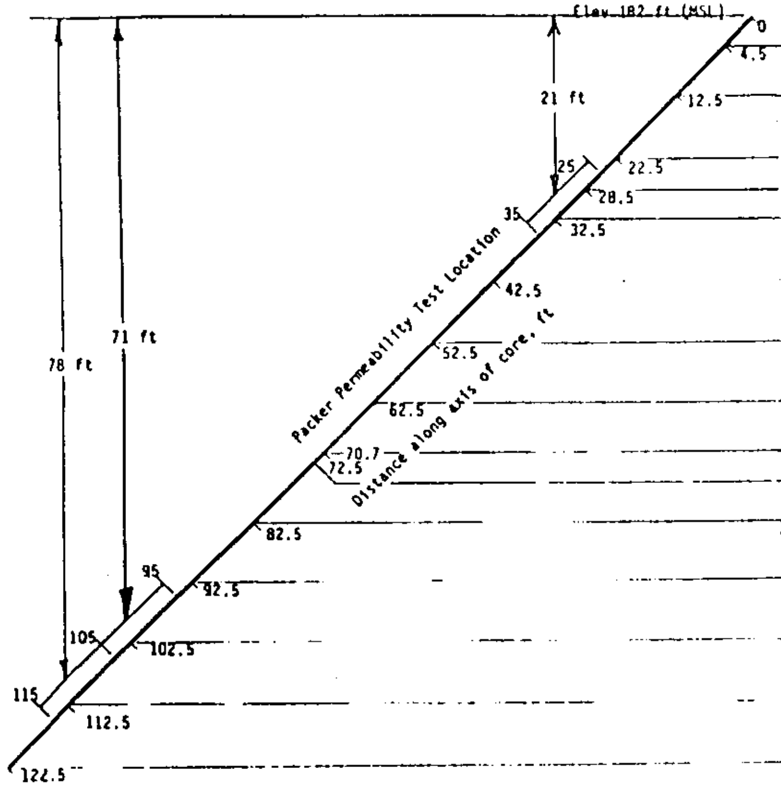
Figure 2



Run No	Length of run ft	Recovery %	RQD %	Description and Remarks
				Grey soft Ls (Chalk). Set surface pipe.
1	7.3	58	43	Grey soft Ls (Chalk). Note core barrel dropped from 6.0 to 8.7 ft. Two pieces of core, 0.7 and 2.7 ft.
2	10.0	90	99	Grey, med to soft Ls (Chalk). Three pieces of core, 0.1 to 7.6 ft.
3	9.7	74	70	Grey m. hard Ls (Chalk), becomes softer at 27.0 ft. Four pieces of core 0.4 to 4.8 ft. Straitions at 27.0 and 27.4 ft.
4	8.0	100	93	Grey m. hard Ls (Chalk) with softer zone from 37.7 to 38.3 ft. Eight pieces of core 0.3 to 3.2 ft.
5	3.5	100	100	Grey m. hard Ls (Chalk). Three pieces of core 0.3 to 1.3 ft.
6	10.0	100	100	Grey m. hard Ls (Chalk). Seven pieces of core, 0.4 to 4.3 ft.
7	8.7	89	80	Grey m. hard Ls (Chalk). Seven pieces of core, 0.3 to 4.0 ft.
8	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 1.8 and 8.2 ft.
9	1.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 1.0 ft.
10	10.0	100	100	Grey m. hard Ls (Chalk). Four pieces of core, 0.5 to 5.5 ft.
11	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 0.4 and 9.6 ft.
12	10.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 10 ft.
13	5.0	100	100	Grey m. hard Ls (Chalk). One piece of core, 5 ft.
14	10.0	100	100	Grey m. hard Ls (Chalk). Two pieces of core, 0.1 and 9.9 ft.
15	6.8	100	100	Grey m. hard Ls (Chalk). One piece of core 6.8 ft.

Summary Log of Core
Hole CWM D-1 (Under
Trench 1)

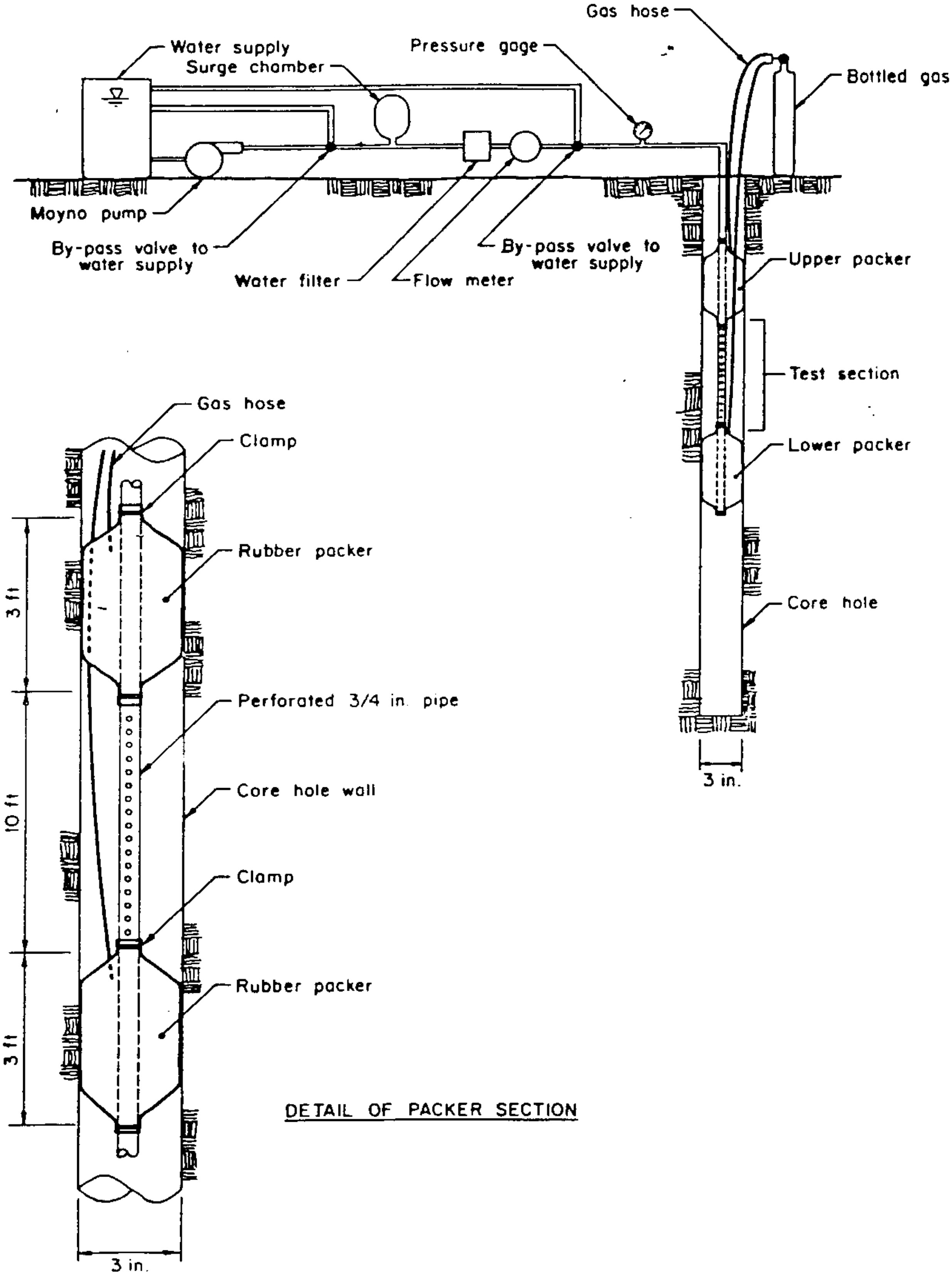
Figure 3



Run No	Length of run ft	Recovery %	RQD %	Description and Remarks
				Tan weathered soft Ls (Chalk); Set Surface pipe
1	8.0	75	52	Grey m Hard Ls (Chalk) with soft brown clay from 6.8 to 9.5 ft, Striations at 12.0 ft.
2	10.0	92	85	Tan highly weathered Ls to 14.0 ft, becomes grey m hard Ls (Chalk) after 14.0 ft. Many striations from 12.5 to 14.0 ft and one at 15.5 ft.
3	6.0	83	100	Grey m hard Ls (Chalk). Two pieces of core, 1.0 and 4.0 ft.
4	4.0	100	100	Grey m hard Ls (Chalk). One piece of core, 4.0 ft.
5	10.0	100	100	Grey m hard Ls (Chalk). Three pieces of core, 2.6 to 6.0 ft
6	10.0	100	100	Grey m hard Ls (Chalk). Three pieces of core, 1.2 to 5.4 ft.
7	10.0	100	100	Grey m hard Ls (Chalk). Two pieces of core, 2.7 and 7.3 ft.
8	8.2	100	100	Grey m hard Ls (Chalk). One piece of core, 8.2 ft.
9	1.8	100	100	Grey m hard Ls (Chalk). One piece of core, 1.8 ft.
10	10.0	100	100	Grey m hard Ls (Chalk). One piece of core, 10.0 ft.
11	10.0	100	100	Grey m hard Ls (Chalk). One piece of core, 10.0 ft.
12	10.0	100	100	Grey m hard Ls (Chalk). Two pieces of core, 4.6 and 5.4 ft. Striations at 97.6 ft.
13	10.0	100	100	Grey m hard Ls (Chalk). Six pieces of core, 0.5 to 3.5 ft. Striations at 106.0, 108.8 and 111.5 ft.
14	10.0	100	100	Grey m hard Ls (Chalk). One piece of core, 10.0 ft.

Summary Log of Core Hole CWM D-2 (Under Trench 3)

Figure 4



PACKER PERMEABILITY TEST EQUIPMENT

Figure 5

APPENDIX A

SAMPLING WELL

INSTALLATION PROCEDURE

CONTENTS

FIGURE LIST

APPENDIX A

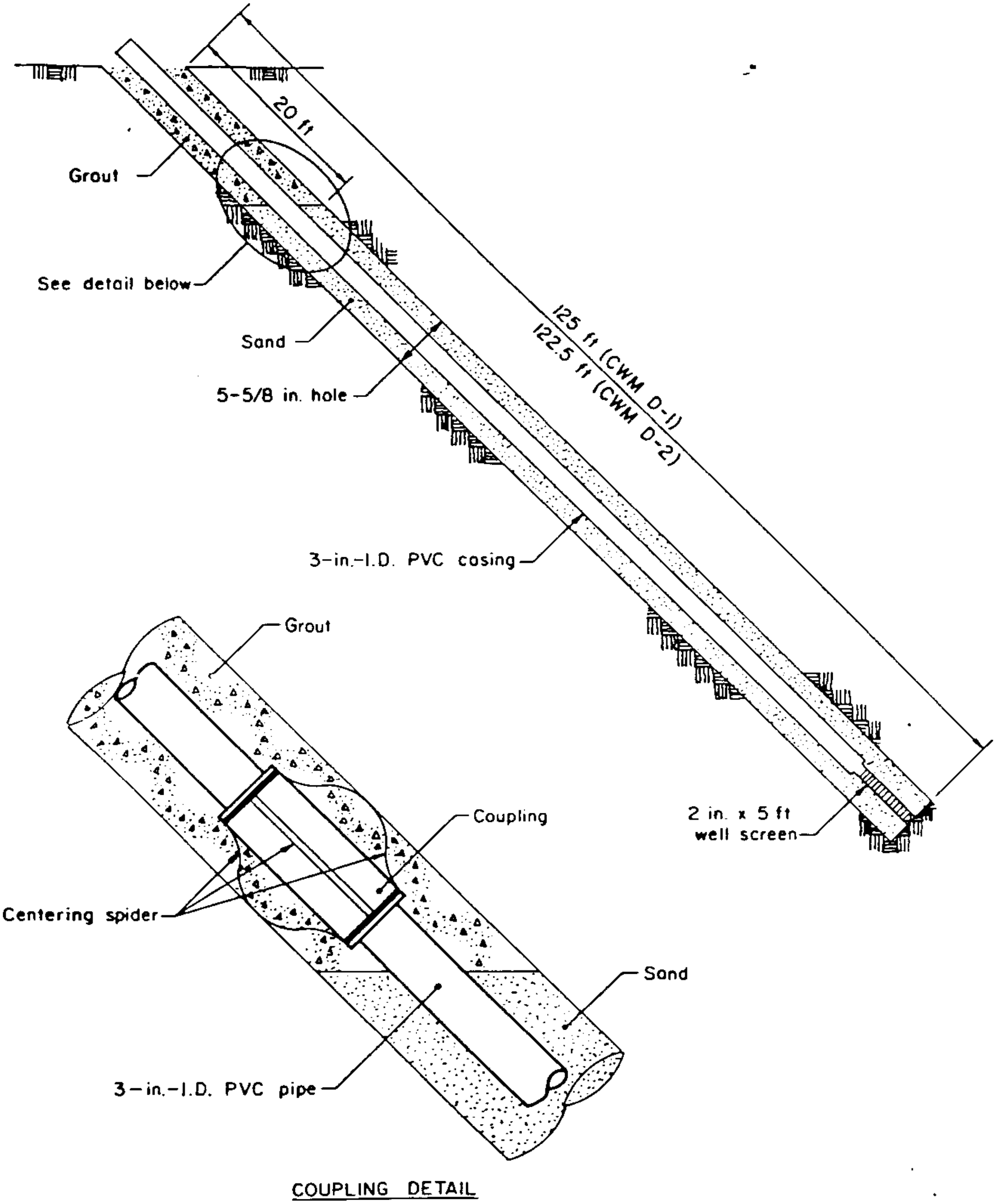
DESCRIPTION OF SAMPLING WELL INSTALLATION PROCEDURE

In order to install the sampling wells in the diagonal core holes, the approximately 3-in-dia holes were enlarged by reaming the holes with a 5-5/8 in. tricone bit the full length of the core holes. The holes were then thoroughly flushed with clear water to remove all cuttings.

The well consists of a 2 in. ID by 5 ft long Johnson well point screen attached to the end of 3 in. ID P.V.C. casing. The couplings joining the casing lengths were cemented using P.V.C. cement. The casings extend approximately 5 ft out of the ground. See Fig. A1 for details.

To keep the casing centered in the diagonal holes spiders were fabricated and attached to each coupling. After the wells were installed, a clean, medium to fine sand was placed from the well screen to 20 ft from the start of coring (along the core axis, 14 ft vertically below ground surface). Sand was placed to this level so that any fluid from below the grout seal can flow through the sand to the well screen for sampling.

To seal the annular space between the reamed hole and the casing, grout was placed. The grout mix consisted of 10:1 cement/bentonite and water. To assure a good seal the grout was placed using the tremie method. A 21-ft-long 0.5-in-ID grout pipe was inserted in the annular space between the casing and the core hole, until the end of the grout pipe was touching the sand. The grout pipe was then retracted approximately 2 in. and the grout was pumped in. When the grout began to spill out at ground surface the grout pipe was slowly removed. The maintaining of the end of the grout pipe below the surface of the grout at all times while pumping is the tremie method.



SAMPLING WELL INSTALLATION DETAILS

Figure A1

APPENDIX B

LOGS OF CORE HOLES

CONTENTS

BORING LOG

SHEET 1 OF 4

PROJECT NAME: CHEM-WASTE

PROJECT NO: X9C 0033

TRENCH-7
WM V-1

DATE: 29 MAR 79

PROJECT LOCATION: SUMTER CO. ALA.

RIG: CME 55

GEOLOGIST: R. ASHLEY DRILLER: HERSHEL BOYD

WATER ENTERS: N/A

SURFACE ELEVATION: 138.2 ft ELEVATION DATUM: MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0	A.O.	N/A	N/A	AUGERED THROUGH LIGHT GREY SOFT LIMESTONE (CHALK) 3.7 ft. & SET SURFACE PIPE. BEGAN CORING 3.7 ft.		CORE BARREL & SUB = 12.7 FT; CORE BARREL = 12.2 FT; CASING STICK-UP 2.6 ft. BEGAN CORING 10:00A
5 – 9.3	N.Q. CORE SPLIT BARREL	5.6 ...	5.6/... 94%	SOFT TO MED GRAY LIMESTONE (MARL) 3 PIECES .9 ft to 2.1 ft. long (BOTTOM 1 ft. BROKEN BY DRILLING PROCEDURES.) (OVER CORED 0.6 ft & GROUND UP LAST 0.6 ft.) R.Q.D = 100% → BROKEN PORTION NOT INDICATIVE OF INSITU CONDITION		NQ CORE BARREL. TIME (2.44 min/ft. / 2.63 min/ft. 1ST RUN 3.7 ft to 9.3 ft
9.3 – 14.3	NQ CORE	5 ft RUN 100% REC	RQD 97%	SOFT TO MED GRAY LIMESTONE (MARL) w/ SOME SHELL FOSSILS. 3 PIECES .2 ft. to 3.5 ft long, TIGHT JOINTED SEAM @ 10.8 ft.		2ND RUN 9.3 ft. to 14.3 ft
14.3 – 25 (15, 20)	N.Q. CORE	10 ft. RUN 100% REC	RQD = 100%	SOFT TO MED GREY LIMESTONE (MARL) w/ OCCASIONAL FOSSILS. 3 PIECES 2.5 ft. to 5.0 ft long		3RD RUN 14.3 to 24.3; 4TH RUN 24.3 to 34.3

FIGURE NO. B1

BORING LOG

TRENCH 7
CWM V-1

PROJECT NAME: CHEM-WASTE

SHEET 2 OF 4

PROJECT NO. Y9C00039

DATE 29 MAR 79

PROJECT LOCATION: SUMTER CO ALA.

RIG CME 55

GEOLOGIST R. ASHLEY   DRILLER H. BOYD

WATER ENTERS N/A

SURFACE ELEVATION 138.2 ft   ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	REC	RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	NO CORE, 10 ft. RUN 100% REC, RQD = 100% (RUN #4)			MED HARD GREY LIMESTONE, (MARL) MASSIVE, 2 PIECES 2.5 & 7.5 ft. LONG		
30						END RUN #4 34.3 ft.
35	NO CORE 10 ft RUN - 100% REC, RQD 100% (RUN #5)			MED HARD GREY LIMESTONE (MARL) - MASSIVE - 1 PIECE 10 ft LONG		BEGIN RUN #5
40						
45						END RUN #5 44.3, BEGIN RUN #6
50						

FIGURE NO. B2

BORING LOG

SHEET 3 OF 4

PROJECT NAME CHEM-WASTE

PROJECT NO Y9C00039

TRENCH 7
CMW V-1

DATE 29 & 30 MAR. 79

PROJECT LOCATION SUMTER CO. ALA

RIG CME 55

GEOLOGIST R. ASHLEY DRILLER H. BOYD

WATER ENTERS N/A

SURFACE ELEVATION 138.2 ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	REC	RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
50 (RUN #6)	10 ft RUN, 100% REC., RQD=97%	100%		MED HARD GRAY LIMESTONE (MARL) MASSIVE, 3 PIECES 0.1 ft to 9.3 ft. LONG		END RUN #6 54.3 ft
55–60 (RUN #7)	10 FT RUN, 100% REC., RQD=96%	100%		MED HARD GRAY LIMESTONE (MARL) MASSIVE, 6 PIECES 0.1 ft. to 4.6 ft. LONG. TIGHTLY JOINTED DIAGONAL FRACTURE @ 60.0 AND 60.4 ft. ANGLE OF FRACTURE APPROX 80° from AXIS OF CORE. STRIATIONS NOTED ON FACE OF JOINT AS WELL AS TRACE OF MARCASITE STAININGS.		BEGIN RUN #7. END RUN #7 64.3 ft.
65–70 (RUN #8)	10 FT. RUN, 100% REC., RQD=100%			MED HARD GRAY LIMESTONE (MARL) MASSIVE, 2 PIECES 4.2 & 5.8 ft LONG		BEGIN RUN #8. END OF SHIFT 5:30 P.M 29 MAR. 79. BEGAN DRILLING 8:00 AM 30 MAR. END RUN #8 74.3 ft
75						BEGIN RUN #9

FIGURE NO B3

BORING LOG

SHEET 4 OF 4

PROJECT NAME CHEM-WASTE

PROJECT NO. Y9C00039

TRENCH 7
MW V-1

DATE 20 MAR 79

PROJECT LOCATION SUMTER CO. ALA

RIG CME 55

GEOLOGIST R ASHLEY DRILLER H BOYD

WATER ENTERS N/A

SURFACE ELEVATION 138.2 ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
75–84.3	N.Q. CORE 10 ft. RUN	100% REC RQD = 99%		MED HARD GRAY LIMESTONE (MARL) MASSIVE, 3 PIECES 0.1 ft to 7.9 ft. LONG		END RUN #9 84.3 ft
80						
84.3–94.3	N.Q. CORE 10 ft. RUN	100% REC. RQD = 100%		MED HARD GRAY LIMESTONE (MARL) MASSIVE 2 PIECES 4.2 ft & 5.8 ft. long		BEGIN RUN # 10 EXHAUSED SUPPLY OF WIRE LINE DRILL STEEL. ADDED 0.7 ft OF SUBS TO WIRE LINE RODS & ADAPTED TO "BX" DRILL STRING IN ORDER TO ADVANCE THE BORING
90						
94.3–100.6	N.Q. CORE 6.3 ft RUN	100% REC RQD: 99%		MED HARD GRAY LIMESTONE (MARL) MASSIVE, 3 PIECES 0.1 ft to 5.5 ft LONG.		BEGIN RUN #11 COMPLETED BORING. 3:00 P.M 30 MAR. 79
95						
100				BOTTOM OF BORING 100.6 ft		

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. B4

BORING LOG

SHEET 1 OF 5

PROJECT NAME CHEM-WASTE MGT

PROJECT NO Y9C0039

TRENCH #1
CWM - D - 1

DATE 3 APR 79

PROJECT LOCATION SUMTER CO. ALA.

RIG MOBIL B40L

GEOLOGIST P. ASHLEY DRILLER J KODITEK

WATER ENTERS N/A

SURFACE ELEVATION 183.3 ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0–5	AUGER & WASHED OUT	N/A	N/A	GREY - SOFT LIMESTONE (MARL)		BEGAN CORING @ 5 ft. ON 45° ANGLE. BEGAN CORING 2:10 PM 3APR 79 SET 5 FT OF 4" SURFACE PIPE - LOST CIRCULATION AT 6.0 FT.
5–12.3 (RUN #1)	NQ CORE 7.3 FT RUN	REC. = 58%	RQD = 45%	LIGHT GRAY SOFT LIMESTONE, BROKEN CORE BARREL DROPPED 2.7 FT THROUGH VERY SOFT WEATHERED LIMESTONE 7.7 ft. LIGHT TO MED GREY, SOFT LIMESTONE, (MARL) 2 PIECE 0.7 & 2.7 FT. LONG		END RUN #1 12.3 FT
12.3–22.3 (RUN #2)	N.Q CORE 10.0 FT. RUN	REC. = 90%	RQD = 99%	MED. GRAY, MED. TO SOFT. LIMESTONE (MARL), MASSIVE, 3 PIECES 0.1 FT to 7.6 FT LONG. NOTE, BROKE CORE WHILE REMOVING FROM BARREL. INSITU CONDITION REFLECTS AT LEAST A ROD OF 99%.		BEGIN RUN #2 2.7 ft OF VERY SLICK CORE DROPPED OUT OF BARREL INTO HOLE, WENT BACK IN TO RETRIEVE. RETRIEVED 1.7 FT. END RUN #2 22.3 FT
22.3–25				ON 3rd RUN, PICKED UP 0.8 FT OF CORE THAT FELL IN THE HOLE		BEGIN RUN #3

FIGURE NO B5

BORING LOG

SHEET 2 OF 5

PROJECT NO. Y9C 0029

DATE 3&4 APR 79

RIG MOBIL B-40L

WATER ENTERS N/A

PROJECT NAME CHEM-WASTE MGT

TRENCH 1
CWM-D-1

PROJECT LOCATION SUMTER CO. ALA.

GEOLOGIST R ASHLEY DRILLER J. KODITEK

SURFACE ELEVATION 183.3 ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	REC	RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25–32 (RUN #3)	N.Q. CORE 9.7 ft. RUN	REC = 74%	RQD = 70%	GREY - MED HARD LIMESTONE (MARL) MASSIVE - BECOMING SOFTER AT 27.0 ft. - 4 PIECES 0.4 ft. TO 4.8 FT LONG. 27.0 TO 27.4 FT - TIGHTLY JOINTED SEAM WITH STRAITIONS AND DARKER COLOR. - SEAM APPROX. 90° ANGLE TO AXIS OR CORE. - LOST 2.1 ft OF CORE IN HOLE - GROUND IT UP ON NEXT RUN.		MADE A 9.7 FT. RUN AS CORE FROM RUN #2 FILLED THE INNER BARREL. 4.0 ft OF CORE FELL OUT OF BARREL - RETRIE 1.9 ft. 32.0 FT
			* RQD - NOT INDICATIVE OF INSITU CONDITION - BROKE CORE WHILE RETRIEVING			
32–40 (RUN *)	NQ CORE 8.0 FT RUN	REC = 100%	RQD = 93%	GREY, MED. HARD LIMESTONE (MARL) MASSIVE - SOFTER ZONE 37.7 ft to 38.3 FT - 8 PIECES 0.3 FT TO 3.2 ft. LONG. CORE VERY HARD TO REMOVE FROM INNER BARREL. BROKE CORE TRYING TO EXTRUDE FROM BARREL		BEGIN RUN #4 END RUN #4 40.0 FT
40–43.5 (RUN #5)	NQ CORE 3.5 ft RUN	REC 100%	RQD 100%	GREY, MED. ~~HARD~~ LIMESTONE (MARL) MASSIVE - 3 PIECES 0.3 TO 1.3 FT LONG.		BEGIN RUN #5 END OF SHIFT 5:30 3 APR 79 BEGIN CORING 10:00 4 APR 79 END RUN #5 43.5 FT
43.5–50 (RUN #6)	NQ CORE 10 ft RUN	REC 100%	RQD = 100%	GREY, MED ~~HARD~~ LIMESTONE (MARL) MASSIVE. 7 PIECES 0.4 ft to 4.3 FT. LONG		BEGIN RUN #6

FIGURE NO. B6

WOODWARD-CLYDE CONSULTANTS

BORING LOG

SHEET 3 OF 5

PROJECT NAME: CHEM WASTE MGT

PROJECT NO: Y9C0039

TRENCH NO 1 / CORE D-1

DATE: 4 APR 79

PROJECT LOCATION: SUMTER CO ALA

RIG: MARIL B-40

GEOLOGIST: K. ASHLEY — DRILLER: J. RODITEC

WATER ENTERS: N/A

SURFACE ELEVATION: 183.3 ft — ELEVATION DATUM: MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
50 (RUN #6)				* NOTE – CONTINUING TO HAVE PROBLEMS WITH CORE SLIPPING OUT OF BARREL – INSTALLED NEW CATCHER.		END RUN #6 53.5
55–60 (RUN #7)	NQ CORE 8.7 FT RUN	REC 7.7 REC = 89% * RQD 80% ?	* RQD VERY DIFFICULT TO DETERMINE DUE TO PROBLEMS OF CORE REMOVAL FROM BARREL	GREY, MED. HARD LIMESTONE (MARL) – MASSIVE – BECOMING SOFTER AT 57.7 FT. – 7 PIECES 0.3 FT TO 4.0 FT LONG. → 57.7 TO 58.7 – GROUND UP CORE TRYING TO RETRIEVE AFTER LOSING IN HOLE.		BEGIN RUN #7 / END RUN #7 62.2 ft
65–70 (RUN #8)	NQ CORE 10 FT RUN	REC: 100% RQD: 100%		GREY – MED HARD LIMESTONE (MARL) – MASSIVE, 2 PIECES 1.8 & 8.2 FT LONG		BEGIN RUN #8 / LOST 8.0 FT OF CORE OUT OF BARREL – WENT BACK IN TO RETRIEVE. OVER CORED 1.0 FT AND GOT FULL RECOVERY / END RUN 8 72.2 FT
				OVER CORE RUN TO RETRIEVE ROCK		BEGIN RUN #9 / END RUN #9 73.2
75						BEGIN RUN #10

FIGURE NO B7

BORING LOG

SHEET 4 OF 5

PROJECT NAME CHEM·WASTE MGT

PROJECT NO V9C0039

TRENCH NO1 CMW-D-1

DATE 4 APR. 79

PROJECT LOCATION SUMTER CO ALA.

RIG MOBIL B-40L

GEOLOGIST R. ASHLEY DRILLER J KODITECK

WATER ENTERS N/A

SURFACE ELEVATION 183.3 ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
75–83.2 (RUN #10)	N.Q CORE 10 FT RUN	REC: 100% ROD: 100%		GREY, MED HARD LIMESTONE (MARL) MASSIVE - 4 PIECES 0.5 ft TO 6.5 ft. LONG		6.5 FT OF CORE FELL OUT OF BARREL - MADE RUN TO RETRIEVE - RECOVERED ALL OF THE 6.5 FT END RUN #10 83.2
83.2–93.2 (RUN #11)	N.Q CORE 10 FT RUN	REC: 100% ROD: 100%		GREY, MED HARD LIMESTONE (MARL) MASSIVE - 2 PIECES - 0.4 FT TO ~~8~~ 9.6 FT LONG		BEGIN RUN #11 END RUN #11 93.2 FT
93.2–100 (RUN #12)	N.Q CORE	REC 100% ROD 100%		GREY, MED HARD LIMESTONE (MARL) MASSIVE. 1 PIECE 10 ft. long		BEGIN RUN #12 CORE BARREL EMPTY CORE SLIPPED OUT WENT BACK IN TO TRY AND RETRIEVE - RETRIEVED 10.0 FT

FIGURE NO 88

BORING LOG

SHEET 5 OF 5

PROJECT NAME CHEM-WASTE MGT.

PROJECT NO Y9C 0039

DATE 4 APR. 79

TRENCH NO. 1
CWM-D-1

PROJECT LOCATION SUMTER CO. ALA.

RIG MOBIL B 40L

GEOLOGIST R ASHLEY DRILLER J. KODITEC

WATER ENTERS N/A

SURFACE ELEVATION 183.3 ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	REC	RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
100	NO CORE					END RUN 12 103.2 FT
105 (RUN #13)	N.Q CORE 5.0 FT RUN	REC. 100% RQD: 100		GREY, MED ~~HARD~~ LIMESTONE (MARL) MASSIVE, 1 PIECE 5 ft LONG		BEGIN RUN #13; END RUN #13 108.2 FT
110–115 (RUN - 14)	N.Q CORE 10 FT RUN	REC 100% RQD 100%		GREY, MED HARD LIMESTONE (MARL) MASSIVE; 2 PIECES 0.1 ft & 9.9 ft LONG		BEGIN RUN #14; END RUN #14 118.2 FT
120–125 (RUN)	N.Q CORE 6.8 ft RUN	REC. 100% RQD 100%		GREY MED ~~HARD~~ LIMESTONE (MARL) - MASSIVE 1 PIECE ~~6~~ 6.8 ft LONG		4 APR. 79 FINISHED BORING 4:15 PM

FIGURE NO. B9

BORING LOG

SHEET 1 OF 5

PROJECT NAME CHEM-WASTE MGT

PROJECT NO Y9C0039

TRENCH #3
CWM D-2

DATE 9 APR. 79

PROJECT LOCATION SUMTER Co. ALA.

RIG MOBIL R40L

GEOLOGIST R. ASHLEY DRILLER J. KODITEK

WATER ENTERS N/A

SURFACE ELEVATION 181.8± ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0	AUGER ONLY	N/A	N/A	TAN WEATHERED SOFT LIMESTONE (MARL)		BEGAN AUGERING TO SET SURFACE PIPE 1:00 PM
5 (RUN #1 8 FT RUN)	N.Q. CORE	REC = 75%	RQD = 52	GREY MED HARD LIMESTONE (MARL) 4 PIECES 0.2 to 1.3 FT LONG		BEGAN CORING 4.5 ft. 2:00 PM 9 APR 79
6.8 FT				BROWN SOFT CLAY 1 PIECE 0.6 FT LONG - WASHED AWAY 2.0 FT		LOST CIRCULATION AT 6.5 FT.
9.5 FT – 10				GREY MED HARD LIMESTONE MARL w/WEATHERING SEAMS 7 PIECES 0.1 FT TO 0.7 FT LONG AT 12.0 FT. DIAGONAL CRACK WITH INDICATION OF STRIATIONS		REGAINED SOME CIRCULATION @ 8.0 FT - TAN COLOR. END RUN #1 12.5 ft.
12.5 – 15 (RUN #2)	N.Q. CORE 10 ft. RUN	REC = 92%	RQD = .85	TAN, HIGHLY WEATHERED, FRACTURED LIMESTONE (MARL) - SOME AREAS WEATHERED TO CLAY. STRIATIONS APPEAR THROUGHOUT - SHADING TO GREY AT 14.0		BEGIN RUN #2 ← WASHED AWAY 0.8 ft OF SOFT WEATHERED LIMESTONE 13.2 TO 14.0 ft.
15.5				DIAGONAL FRACTURE w/STRIATIONS AND MUCH DARKER GREY COLORING		
16.0 – 20				FROM 16.0 FT - GREY MED. HARD LIMESTONE (MARL) MASSIVE, FULL RECOVERY FROM 14.0 FT TO 22.5 7 PIECES 0.3 ft. to 2.7 ft. long. RQD from 14.0 = 100		END RUN #2 22.5
22.5 – 25						BEGIN RUN #3

FIGURE NO B10

BORING LOG

PROJECT NAME: CHEM-WASTE MGT

SHEET 2 OF 5

PROJECT NO: Y9C 003

TRENCH #3
CWM D-2

DATE: 9 APR. 79

PROJECT LOCATION: SUMTER CO. ALA

RIG: MOBIL B-40

GEOLOGIST: R ASHLEY

DRILLER: J. KOBITEK

WATER ENTERS: N/A

SURFACE ELEVATION: 181.8 ± ft

ELEVATION DATUM: MSL

Run	DEPTH	SAMPLE TYPE	REC	RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
RUN #3	25	N.O CORE 6 ft RUN	REC 83.3% RQD 100		GREY MED HARD LIMESTONE (MARL), MASSIVE - 2 PIECES, 4.0 & 1.0 ft LONG - GROUND UP CORE FROM 27.5 to 28.5 WHEN BIT PLUGGED INSITU RQD = 100		END RUN #3 28.5
RUN #4	30	N.O CORE 4 FT RUN	REC = 100% RQD = 100		GREY MED. HARD LIMESTONE, (MARL) • 1 PIECE 4.0 FT long. MASSIVE		BEGIN RUN #4 / END RUN #4 32.5
RUN #5	35, 40	N.O CORE 10 FT RUN	REC = 100% RQD = 100		(SAME) 3 PIECES 2.6 ft to 6.0 ft. LONG.		BEGIN RUN #5 / END RUN #5 42.5
RUN #6	45, 50	N.O CORE 10 FT RUN	REC = 100% RQD = 100		SAME 3 PIECES 1.2 TO 5.4 ft LONG		BEGIN RUN #6

BORING LOG

PROJECT NAME	CHEM-WASTE MGT.
TRENCH #3 CWM D-2	
PROJECT LOCATION	SUMTER CO. ALA.
GEOLOGIST	R. ASHLEY
DRILLER	J. KOBITEK
SURFACE ELEVATION	181.8 ± ft
ELEVATION DATUM	MSL
SHEET	3 OF 5
PROJECT NO	Y9C003[illegible]
DATE	9 APR. 79
RIG	MOBIL B40L
WATER ENTERS	N/A

RUN	DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C	SPECIAL NOTES AND FIELD OBSERVATIONS
	50						END RUN #6 52.5
RUN #7	55 – 60	N.Q. CORE 10 ft RUN	REC = 100 %	RQD = 100	(SAME) (MASSIVE MARL) 2 PIECES 2.7 & 7.3 ft. LONG		BEGIN RUN #7 … END RUN #7 62.5
RUN #8	65 – 70	N.Q. CORE 8.2 ft RUN	REC = 100 %	RQD = 100.	SAME - SHADING SLIGHTLY DARKER - (MASSIVE MARL) 1 PIECE, 8.2 ft LONG. * NOTE · DRILLER FELT HE MAY BE GRINDING UP THE CORE, AND DECIDED TO CUT SHORT THE RUN. — NOT THE CASE - FULL RECOVERY		BEGIN RUN #8 (INNER BARREL MAY BE PLUGGED) … END RUN #8 70.7
RUN 9		NQ CORE 1.8 FT RUN	REC 100 %	RQD 100	SAME - 1 PIECE 1.8 ft. LONG (SHORT RUN COMPLETED PREVIOUS 10 ft. INCREMENT.)		BEGIN RUN #9 END RUN #9 72.5 BEGIN RUN #10
	75						

FIGURE NO. B12

BORING LOG

SHEET 4 OF 5

PROJECT NAME CHEM-WASTE MGT.

PROJECT NO Y9C003?

TRENCH #3
CWM D-2

DATE 9 & 10 APR '79

PROJECT LOCATION SUMTER CO. ALA.

RIG MOBIL R-40L

GEOLOGIST R. ASHLEY DRILLER J. KODITEK

WATER ENTERS N/A

SURFACE ELEVATION 181.8 ± ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
75–82.5 (RUN #10)	N.Q. CORE 10 ft RUN	REC: 100% RQD: 100		(SAME) (MASSIVE MARL) 1 PIECE 10 ft. long		END OF SHIFT 5:30 P.M. END RUN #10 82.5
82.5–92.5 (RUN #11)	N.Q. CORE 10 FT RUN	REC: 100% RQD: 100		(SAME) (MASSIVE MARL) 1 PIECE 10 ft long		BEGIN Run #11 BEGAN CORING 7:30 AM 10 APR. 79
						END RUN #11 92.5
92.5–100 (RUN #12)	N.Q. CORE 10 FT RUN	REC: 100% RQD: 100		(SAME) MASSIVE MARL		BEGIN RUN #12
97.6				TIGHTLY JOINT DIAGONAL SEAM w/ STRIATIONS - DARKER GREY COLORING AT FACE ON JOINT		
100						

Ø 13

BORING LOG

SHEET 5 OF 5

PROJECT NAME CHEM-WASTE MGT.

PROJECT NO Y9C0035

TRENCH # 3
CWM - D-2

DATE 10 APR. 79

PROJECT LOCATION SUMTER CO. ALA.

RIG MOBIL B-40 L

GEOLOGIST R ASHLEY DRILLER J. CODITEK

WATER ENTERS N/A

SURFACE ELEVATION 181.8 ± ft ELEVATION DATUM MSL

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
100						END RUN #12 102.5
102.5–112.5 (RUN #13)	N.Q. CORE 10 ft. RUN	REC: 100% RQD = 100		SAME -(MASSIVE MARL) 6 PIECES 0.5 TO 3.5 FT LONG ALL BREAKS SHOWING STRIATIONS AND DARKER GREY COLORING 106.0 TIGHTLY JOINTED DIAGINAL FRACTURE W/STRIATIONS 108.8 TIGHTLY JOINTED DIAGINAL FRACTURE W/STRIATIONS 111.5 TIGHTLY JOINTED DIAGINOL FRACTURE W/STRIATIONS.		BEGIN RUN #13 END RUN #13 112.5
112.5–122.5 (RUN #14)	N.Q CORE 10 FT RUN	REC. 100% RQD = 100.		(SAME) MASSIVE MARL 1 PIECE 10 ft. long		BEGIN RUN #14
122.5				END OF BORING 122.5 ft. BEGAN PREPARATIONS TO RUN PACKER TESTS at 110 ft, 100 ft & 30 ft.		9:15 AM 10 APR. 79
125						

B 12

APPENDIX E-6

DOCUMENT 2

PACKER TESTING OF BOREHOLE AB-1
CHEMICAL WASTE MANAGEMENT
FACILITY
EMELLE, ALABAMA

Prepared for:

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Distribution:

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July 1999 993-9611

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) was contracted by Jordan Jones & Goulding, Inc. (JJG) for performance of packer testing at the Chemical Waste Management (CWM) Facility in Emelle, Alabama. The field work was performed between June 1st and 9th, 1999. This report documents the testing program and presents the results of the data interpretation.

Testing was performed in angle-drilled Borehole AB-1, completed entirely within the Demoplois Chalk. The location and orientation of the borehole was designed to maximize the possibility of encountering fractures that were mapped on a nearby excavation wall. Both fractured and non-fractured zones were selected for testing. The test zones were chosen by JJG and based on inspection of the rock core. Test objectives were to determine the hydraulic conductivity and static hydraulic head for each isolated zone.

This report has the following structure:

- Chapter 2 summarizes the relevant borehole information;
- Chapter 3 presents the pertinent test interval dimensions;
- Chapter 4 discusses the test equipment;
- Chapter 5 is the main part of the report and describes the interpretation of the test data;
- Chapter 6 summarizes the results; and
- Chapter 7 provides a list of references.

Immediately following the text is a glossary of abbreviations. The figures are provided following the text. A detailed summary of each test is provided in Appendix A. Appendix B contains a calibration certificates for the pressure transducers.

2.0 BOREHOLE SUMMARY

Borehole AB-1 was cored at a 45° inclination on May 25th and 26th, 1999 to a total depth of 150 ft ABH (feet along borehole). The borehole diameter is 3.8 in (inch). Surface casing was installed to 9.2 ft ABH. The rock core drilling was performed with water. No significant fluid losses were encountered during coring activities. A summary of the pertinent borehole data is summarized in Table 2.1.

Table 2.1 Borehole Parameters

Borehole Name		AB-1	
Location		CWM Facility – Emelle, Alabama	
Reference Point		Ground Surface (GS)	
Easting		7183.54	
Northing		9817.55	
Ground Surface Elevation		238.60	[ft msl]
Borehole Inclination	Nominal	45	[°]
Borehole Direction		N 25 E	[°]
Borehole Depth	Measured	150.00	[ft ABH]
Borehole Depth	Vertical	106.07	[ft BGS]
Borehole Diameter	Nominal	3.8	[in]
Casing Diameter	ID	4.5	[in]
Casing Depth		9.2	[ft ABH]
Test String Diameter	ID	2.375	[in]
Slim Tubing Diameter	ID	1.00	[in]
Start Drilling of Borehole		25 May 1999	
End Drilling		26 May 1999	
Drilling Contractor		Boart Longyear - Virginia	

3.0 TEST INTERVAL INFORMATION

The packer straddle length for all tests was 7.2 ft to encompass the longest fractured zone (5.1 ft) in the borehole between 119.0 and 124.1 ft ABH. A summary of the dimensions for the test interval and key geologic features within each zone is summarized below in Table 3.1.

Table 3.1: Interval Parameters

Interval Dimensions		
Interval Length	7.2	[ft]
Test Interval Volume	0.56 (0.016)	[ft^3; m^3]
Volume of pipe inside interval	0.06 (0.0017)	[ft^3; m^3]
Volume of fluid in interval (shut-in)	0.050 (0.014)	[ft^3; m^3]
Test 1		
Top of Interval	41.5, 29.3	[ft ABH, ft BGS]
Bottom of Interval	48.7, 34.3	[ft ABH, ft BGS]
Key Geologic Feature	Fractures logged in core	
Depth of Feature	44.3 to 45.0	[ft ABH]
Test 2		
Top of Interval	96.40, 68.2	[ft ABH, ft BGS]
Bottom of Interval	103.6, 73.3	[ft ABH, ft BGS]
Key Geologic Feature	No fractures observed in core	
Test 3		
Top of Interval	118.0, 83.4	[ft ABH, ft BGS]
Bottom of Interval	125.2, 88.8	[ft ABH, ft BGS]
Key Geologic Feature	Fractures logged in core	
Depth of Feature	119.0 to 124.1	[ft ABH]

4.0 DESCRIPTION OF THE TESTING EQUIPMENT

The purpose of this section is to provide a description of the equipment used to perform the testing. Subsections 4.1 and 4.2 contain test relevant technical information on the downhole and surface equipment. A schematic for the downhole tools is shown in Figure 1.

4.1 Description of the Downhole Equipment

The hydraulic testing was performed with a double packer configuration with a shut-in tool (SIT) located in the test interval. The shut-in tool isolates the test interval from the test tubing and provides an ideal mechanism to initiate pulse phases, the preferred test type in low permeability environments. The packers were inflated with nitrogen and the packer pressure was monitored throughout the test for possible leaks. No leaks were detected. A brief summary of the test tool is provided below in Table 4.1.

Table 4.1: Description of the Packer Assembly Equipment

Tool Description	3.25" BASKI double packer tool
Packer Configuration	Double Packers
Description of Control Lines	Line 1 – Interval Pressure Line 2 – Adjacent Zone Pressure Line 3 – Inflation Line for Both Packers Line 4 – Open SIT Line 5 – Close SIT
Inflation Method	Inflation with Nitrogen at Surface
Nominal Inflate Pressure	100 - 125 [psi]
Packer Seal Length	3.00 [ft]

The bottom zone was vented to the annulus. The annulus pressure was monitored to confirm the integrity of both packers. A lack of response in the bottom zone and the annulus to the activities in the test zone (see Figures 2, 7 and 12) confirmed there was no problems with the packers.

Downhole pressures and temperatures were monitored with 2 GEOKON vibrating wire sensors. Calibration certificates are provided in Appendix B. The sensors were located in a gauge carrier above the upper packer. The test zone gauge (P2) was attached to a 0.25-inch hydraulic line and ported to the interval, while the second gauge (P1) measured conditions in both the annulus and the bottom zone. Table 4.2 presents the technical data of the downhole sensors.

Table 4.2: Description of the Downhole Pressure/Temperature Sensors

Gauge Information		
Type		GEOKON vibrating wire
Model No.		4500H
Calibration Date		26 May 1998 (Manufacture; see Appendix D)
Pressure Measurement Specifications		
Measuring Range (FS)		0 to 250 [psi]
Resolution		0.06 [psi]
Accuracy		1.25 [psi]
Temperature Measurement Specifications		
Calibrated Range		-20 to 80 [° C]
Transducer Details		
Annulus and Bottom Zone	P1 Serial No.	42095
Test Interval	P2 Serial No.	42096

The technical data relating to the hydraulically operated zero displacement shut-in tool, located in the test interval, is summarized in Table 4.3 below.

Table 4.3: Description of the Hydraulic Shut-In Tool

Type	3.5-inch OD zero displacement shut-in tool
Method of Operation	Pressurization of ¼" hydraulic line from the surface to open and close
Comments: - No malfunctions in the shut-in tool operation during the test.	

A slim tubing packer was used for the slug test events to reduce the wellbore storage and enhance the recovery to well above the gauge resolution. The slim tubing packer is manufactured by TAM and was installed with 0.25-inch diameter nylon tubing inflation line. A one-inch diameter PVC pipe was used to restrict the flow through area. The procedure is to install the slim tube packer to below the water level in the test tubing and inflate the system to approximately 100 psi. Upon opening the shut-in tool, the water level rises or decreases inside the one-inch PVC pipe. After the shut-in tool is closed, the packer is retrieved to the surface.

4.2 Description of the Surface Equipment

The data acquisition and control was performed by GEOKON datalogger and software, version 2.3. The minimum sampling rate is one second and the rate may be changed to optimize the test data for analysis. Data is periodically downloaded from the logger and backed-up on the hard drive of the field computer.

5.0 TEST DESCRIPTION AND ANALYSIS

Hydraulic tests were performed in Borehole AB-1 to determine whether the fractured zones contained significantly higher permeability then the surrounding non-fractured zones within the Demopolis Chalk. A total of three intervals were tested; two zones encompassed fracture/fracture zones while one zone contained no discontinuities. The specific aims for each test were to derive reliable estimates for the hydraulic conductivity and static hydraulic head using an appropriate flow model.

5.1 Test Design

The tests were designed based on existing information and then modified during the tests using real time data to optimize parameter reliability. The previous investigations showed a relatively low hydraulic conductivity and head conditions were expected to be below ground surface based on water level measurements in nearby monitoring wells.

After packer inflation, the shut-in tool was to be closed to allow the test interval pressure to recovery proximal to static conditions (equilibration period). As the water level in the open borehole was maintained proximal to ground surface due to rain events, above static conditions, the pressure was expected to decrease during the equilibration period.

The main tests phases were to include pulse, slug and slug shut-in events. These phases are controlled by different inner boundary conditions and therefore reliability of parameters can be shown by consistent results. For the slug and pulse events, the controlling inner boundary condition is the wellbore storage. In contrast, the parameters derived in the slug shut-in are dependent on the flowrate measured in the previous flow period and the wellbore storage.

5.2 Analysis Background and Approach

INTERPRETATION TOOLS

Two software packages were used to interpret the data set. The pulse and slug data was analyzed using an in-house Golder program FLOWDIM. This program incorporates deconvolution (CHAKBRABARTY and ENACHESCU, 1997; PEREZ et all, 1989) that provides enchanced recognition of the flow model to improve parameter reliability. In addition, the analysis is complimented by the more traditional Cooper method. For shut-in data following slug events, the analysis was performed with INTERPRET/2 (INT/2) of Scientific Software Intercomp. This program uses a constant rate solution to provide optimized hydraulic parameters for a wide range of potential reservoir models. Some of the features of INT/2 include non-linear regression and full superposition to account for all events including the period between end of drilling and start of testing.

Analysis Methodology

The general analysis approach was to first determine the best estimate for the input parameters. Once this was achieved, the relevant phases would be interpreted and the results would be compared for consistency. Phases, which showed anomalous response, were excluded from the analysis. The analysis was terminated after a consistent set of parameters was derived to show reliability in the results. The specific analysis methodology for each phase is summarized below:

- Input parameters are entered into the appropriate software;
- For full superposition analysis with INT/2, the next step is to discretise the test sequence into a series of equivalent constant rate events;
- Determine the most appropriate flow model based on examination of the pressure and pressure derivative data in log-log co-ordinates; and
- Type curve matching to derive the relevant hydraulic parameters.

The slug and pulse data was analyzed with deconvloution and complimented by the more traditional COOPER method. For the slug phase in Test 2, the RAMEY C type curves were utilized which emphasizes the early time data. The slug phases in tests 1 and 3 were not analyzed as the pressure change was within the resolution of the gauges due to the relatively low interval transmissivity.

Input Parameters

Geometric input parameters are provided in Tables 2.1 and 3.1. The sensitive input parameter for slug and pulse phases is the wellbore storage. For slug phases, the wellbore storage is computed from the following definition:

$$C_f = \frac{\pi r_t^2}{\rho g}$$

where C_f = changing level wellbore storage, r_t = radius of the test tubing, ρ = density of fluid (1000 kg/m^3) and g = gravitational acceleration (9.81 m^2/s). The test tubing radius was 0.50 in. For the analysis, the radius used in the calculation of wellbore storage was larger, 0.59 in., to account for a borehole inclination of 45°, as the volume change for a given pressure change is larger in comparison to a vertical configuration.

For pulse phases, the wellbore storage is computed from the definition below:

$$C_s = V_w ct$$

where C_s = shut-in wellbore storage, V_w = volume of the interval, and c_t = compressibility of the test interval. The interval volume is the wellbore volume minus the 1.5 inch tubing inside the interval (0.014 m^3). There are several components to the test interval compressibility:

$c_t = c_w + c_b + c_p$ where,

c_w = compressibility of water
c_b = borehole wall compressibility
c_p = tool compressibility.

A minimum wellbore storage may be derived by assuming a test zone compressibility equivalent to the compressibility of water (5E-10 1/Pa). This results in a wellbore storage of 7.0E-12 m^3/Pa. However, due to the elasticity of the packers, the borehole wall and the pipe inside the interval, the actual value is expected to be larger.

In this investigation, the wellbore storage used in the analysis of pulse data was derived by directly measuring the change in volume to an instantaneous change in pressure. This was performed by measuring the fluid level inside the slim tubing packer prior to and after the initiation of pulse phases in tests 1 and 3 (see logbooks in Appendix B). The measured values show good consistency with a range between 5.8E-11 and 1.2E-10 m^3/Pa and a mean of 8.45E-11 m^3/Pa. The mean value was used in all analyses.

5.3 Test Summary and Analysis Results

The test specific details for each test is provided in Appendix B including logbooks.

Test 1 – Fractured Zone (41.5 to 48.7 ft ABH)

Test interval 1 encompasses a fracture/fracture zone between 44.3 and 45.0 ft ABH. The pressure and temperature sequence measured by the downhole gauges is provided in Figures 2 and 3, respectively. No anomalies or equipment problems were detected during the test (Figure 2). The total test duration was 23.4 h and performed between June 8th and 9th, 1999.

The analyses were performed on Pulse Withdrawal 1 (Figure 4), Slug Injection Shut-In (Figures 5a-5c) and Pulse Injection 1 (Figures 6a and 6b). A homogenous model was diagnosed based on inspection of the pressure derivative data (Figures 5a and 6a). The results for transmissivity show good consistency with a range between 3.6E-11 and 4.3E-11 m^2/s with a mean value of 3.9E-11 m^2/s. Hydraulic conductivity is derived by dividing by the interval length of 2.19 m, resulting in a range between 1.6E-11 m/s (1.6E-09 cm/s) and 2.0E-11 m/s (2.0E-09 cm/s) and a mean value of 1.8E-11 m/s (1.8E-09 cm/s).

Prior to the start of packer inflation, the borehole was filled with water to ground surface and the interval gauge showed a pressure of 11.1 psi. The decreasing pressure trend during the equilibration period and in the subsequent slug injection shut-in shows that the static head conditions are below ground surface. The pressure at the end of the slug injection shut-in, 4.8 psi, provides an upper limit for the static head conditions as the pressure was on a decreasing trend. In reference to ground surface, the upper limit for static head is 14.6 ft BGS (11.1 - 4.8 psi). A static head of 1.4 psi was extrapolated in the Horner analysis of the slug injection shut-in data (Figure 5b). In reference to ground surface, the static head derived in the analysis is 22.4 ft BGS (11.1 - 1.4 psi; 216.2 ft msl).

Test 2 – Non-fractured Zone (96.4 to 103.6 ft ABH)

Test interval 2 was selected in a zone with no fractures. The pressure and temperature sequences measured by the downhole gauges are provided in Figures 7 and 8, respectively. No anomalies or equipment problems were detected during the test (Figure 7). The total test duration was 47.5 h and performed between June 4th and 6th, 1999.

The analyses were performed on Pulse Withdrawal 1 (Figures 9a and 9b), Slug Withdrawal 1 (Figure 10) and Pulse Withdrawal 2 (Figures 11a and 11b). A homogenous model was diagnosed based on inspection of the pressure derivative data (Figures 9a and 11a). The results for transmissivity show good consistency with a range between 4.2E-10 and 4.4E-10 m^2/s with a mean value of 4.3E-10 m^2/s. Hydraulic conductivity is derived by dividing by the interval length of 2.19 m, resulting in a range between 1.9E-10 m/s (1.9E-08 cm/s) and 2.0E-10 m/s (2.0E-08 cm/s) and a mean value of 2.0E-10 m/s (2.0E-08 cm/s).

Prior to the start of packer inflation, the borehole was filled with water to ground surface and the interval gauge showed a pressure of 28.1 psi. The pressure change in the latter part of the slug withdrawal shut-in was relatively small and the final pressure was proximal to the end pressures measured in the other test phases. Therefore, the end pressure from the slug withdrawal shut-in of 16.1 psi provides an estimate for the static head conditions. In reference to ground surface, the static head derived from test 2 is 27.7 ft BGS (28.1 - 16.1 psi; 210.9 ft msl).

Test 3 – Fractured Zone (118.0 to 125.2 ft ABH)

Test interval 3 encompasses a fracture/fracture zone between 118.0 and 125.2 ft ABH. The pressure and temperature sequences measured by the downhole gauges are provided in Figures 12 and 13, respectively. No equipment problems were detected during the test (Figure 12). In the Slug Injection 1 phase, the recovery showed anomalous undulations and therefore the analysis focused on the pulse phases. The total test duration was 29.7 h and performed between June 6th and 8th, 1999.

The analyses were performed on Pulse Withdrawal 1 (Figures 14a and 14b) and Pulse Withdrawal 2 (Figure 15). A homogenous model was diagnosed based on inspection of the pressure derivative data (Figure 14a). The results for transmissivity show good consistency, 9.1E-10 and 1.7E-09 m^2/s, with a mean value of 1.3E-09 m^2/s. Hydraulic conductivity is derived by dividing by the interval length of 2.19 m, resulting values of 4.2E-10 m/s (4.2E-08 cm/s) and 7.8E-10 m/s (7.8E-08 cm/s) and a mean of 6.0E-10 m/s (6.0E-08 cm/s).

Prior to the start of packer inflation, the borehole was filled with water to ground surface and the interval gauge showed a pressure of 35.0 psi. The pressure at the end of pulse phases was relatively stable and the similar values of approximately 22.5 psi provide an estimation for the static head conditions. In reference to ground surface, the static head derived from test 3 is 28.9 ft BGS (35.0 - 22.5 psi; 209.7 ft msl).

6.0 SUMMARY AND CONCLUSIONS

Three packer tests were performed in angle-drilled borehole AB-1 between June 1st and 9th, 1999 at the Emelle Facility in Emelle, Alabama. The primary aim was to determine a reliable estimate for the interval hydraulic conductivity. Both fractured and non-fractured zones were selected for testing. The test zones were chosen by JJG and based on inspection of the rock core. No equipment problems were detected and the objectives were successfully achieved.

The tests were designed to optimize parameter reliability for a relatively low hydraulic conductivity environment. Analysis was performed with deconvolution to improve diagnostics of the formation response. Within each test, different phase types were analyzed to allow for a cross check; the consistent internal results confirm the reliability of the derived parameters. The results are summarized in Table 6.1 below and shown graphically in Figures 16 and 17.

Table 6.1: Summary of Results

	Test Interval					Results
Test	**TOP [ft ABH]**	**TOP [ft BGS]**	**Bottom [ft ABH]**	**Bottom [ft ABH]**	**Geologic Feature**	**Hydraulic Conductivity [cm/s]**
1	41.5	29.3	48.7	34.3	Fracture/ fracture zone	1.8E-09
2	96.4	68.2	103.6	73.3	No fractures	2.0E-08
3	118.0	83.4	125.2	88.8	Fracture/ fracture zone	6.0E-08

Note:
Borehole AB-1 was cored at a nominal 45 ° inclination. The ground surface elevation is 238.60 ft msl.

The analysis results show a relatively low hydraulic conductivity for both fractured and non-fractured zones that were tested in the Demopolis Chalk. In comparison to previous studies at the site, the geometric mean hydraulic conductivity of 6.0E-09 cm/s derived in this investigation is lower then the range of 7.9E-08 - 1.2E-06 cm/s reported for slug test results conducted in the SM-18 cluster (JJG, 1997).

A secondary aim of the tests was to derive reliable estimate for the static head conditions. The vertical hydraulic gradient between the zones is expected to be relatively small, based on the relatively small topographic relief in the area, and within the resolution of the measurements. Results for static head conditions from the three intervals show a range between 22 and 29 ft BGS (210 to 216 ft msl).

7.0 REFERENCES

CHAKRABARTY, C., & ENACHESCU C. (1997): Using deconvolution approach for slug test analysis: theory and application. – Groundwater Vol. 35 No. 5, September-October.

JJG. (1997): Evaluation Report for the SM-18 Well Cluster – prepared for Chemical Waste Management, Inc., Emelle, Alabama, Project Number 1186.007.

PERES, A.M.M., ONUR, M., & REYNOLDS, A.C. (1989): A new analysis procedure for determining aquifer properties from slug test data. – Water Resources Research Vol.25, No. 7, pp. 1591-1602.

Glossary

ft	feet
ft ABH	feet along borehole, referenced to ground surface
ft BGS	feet below ground surface
ft msl	ft above mean sea level
in	inches
psi	pounds per square inch
SIT	shut-in tool
PI	Pulse Injection
PW	Pulse Withdrawal
SI	Slug Injection
SIS	Pressure Recovery after Slug Injection (shut-in)
SW	Slug Withdrawal
SWS	Pressure Recovery after Slug Withdrawal (shut-in)

FIGURES

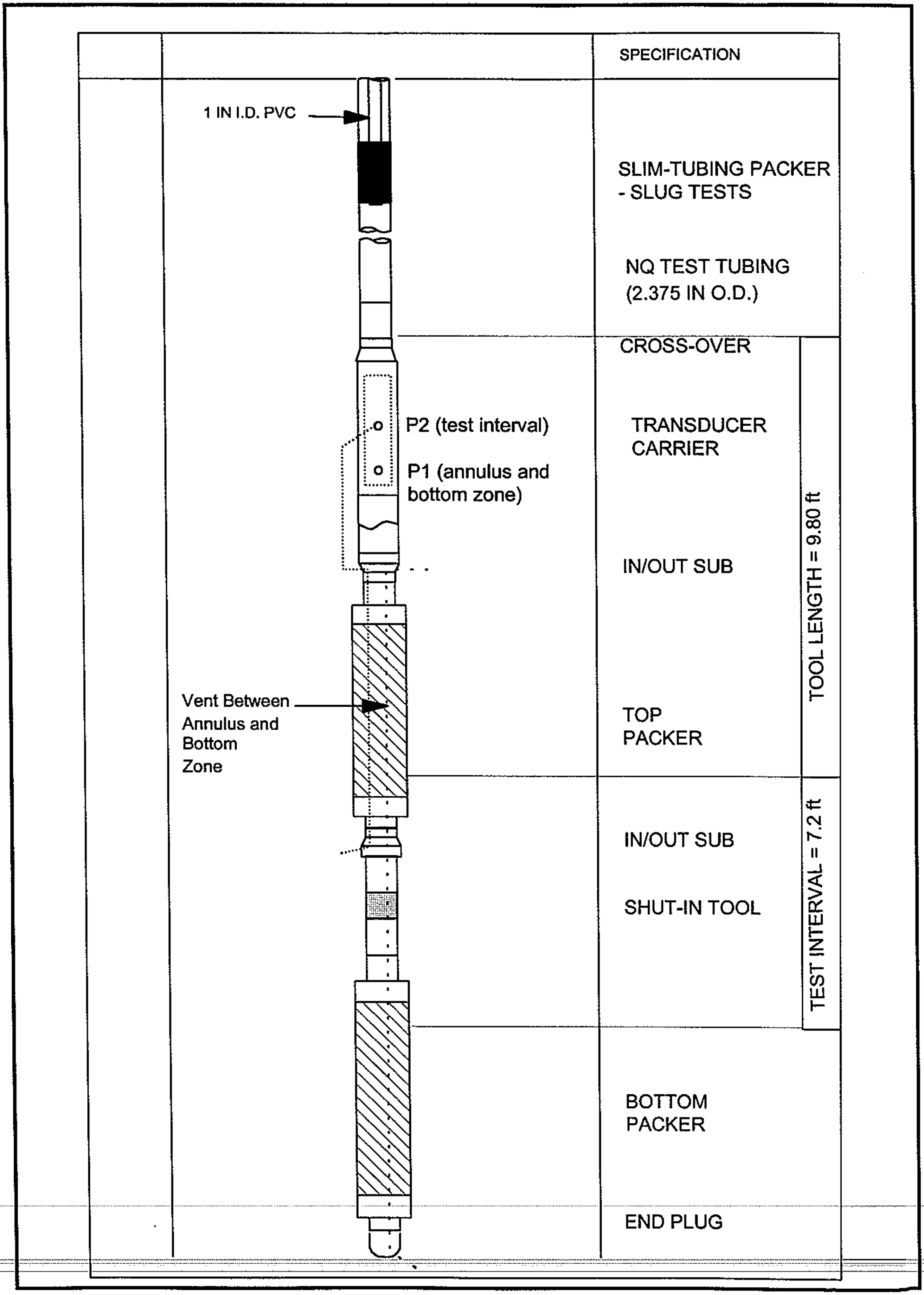

FIG. 1: EMELLE FACILITY; SCHEMATIC FOR DOUBLE PACKER TOOL

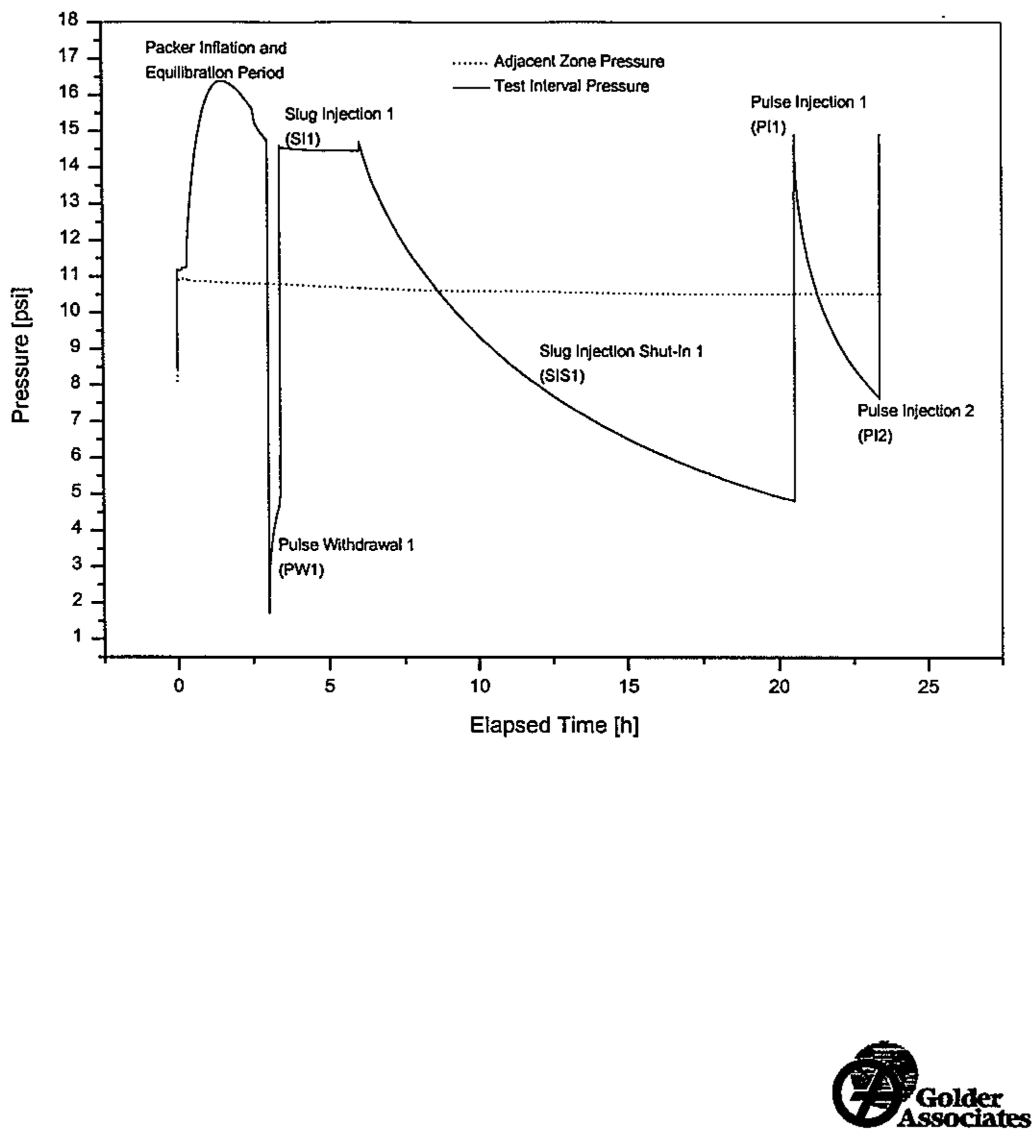

FIG. 2: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; PRESSURE RESPONSE

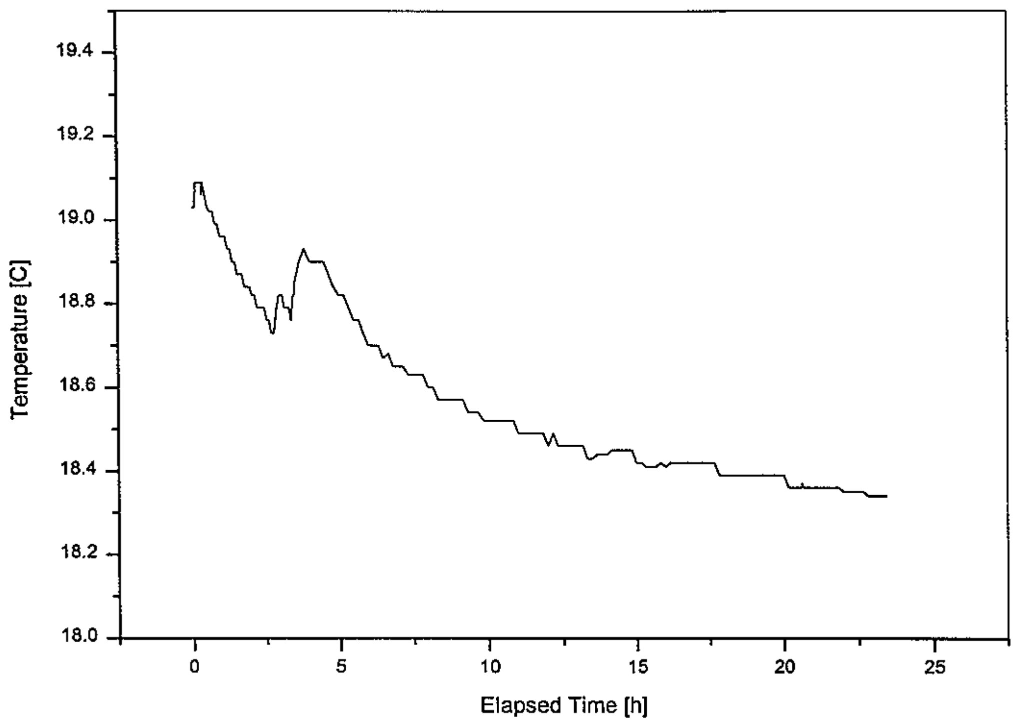

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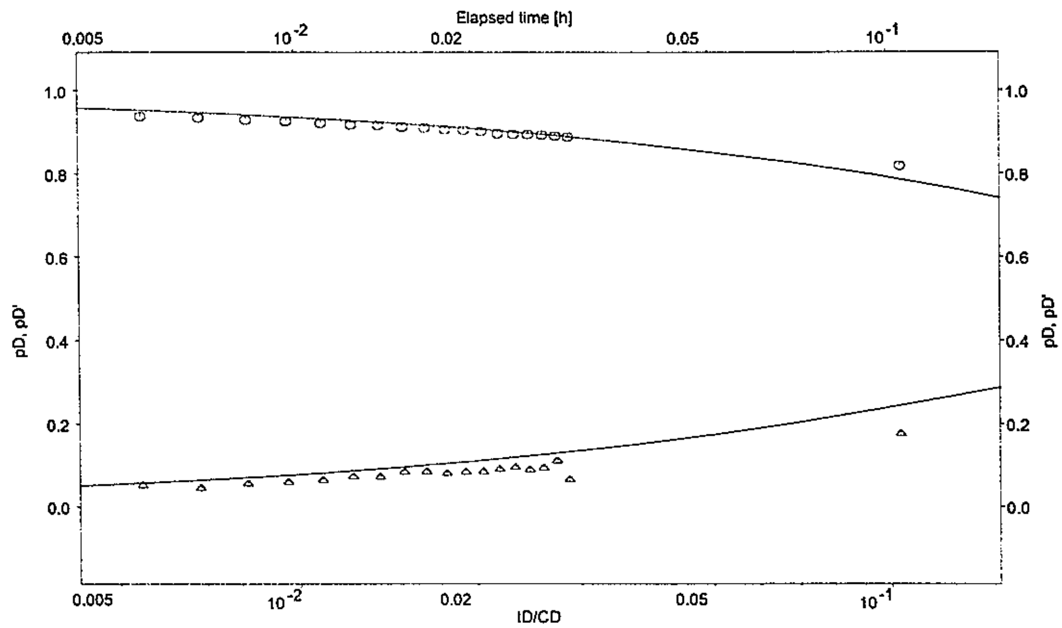
FIG. 3: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; TEMPERATURE RESPONSE



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Ramey A

C=	8.45E-11	m3/Pa
T=	3.60E-11	m2/s
S=	7.04E-05	-
s=	0.00E+00	-
n=	2.00E+00	-

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FIG. 4: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; PULSE WITHDRAWAL 1 PHASE (PW1); RAMEY A MATCH (EQUIVALENT TO COOPER METHOD)

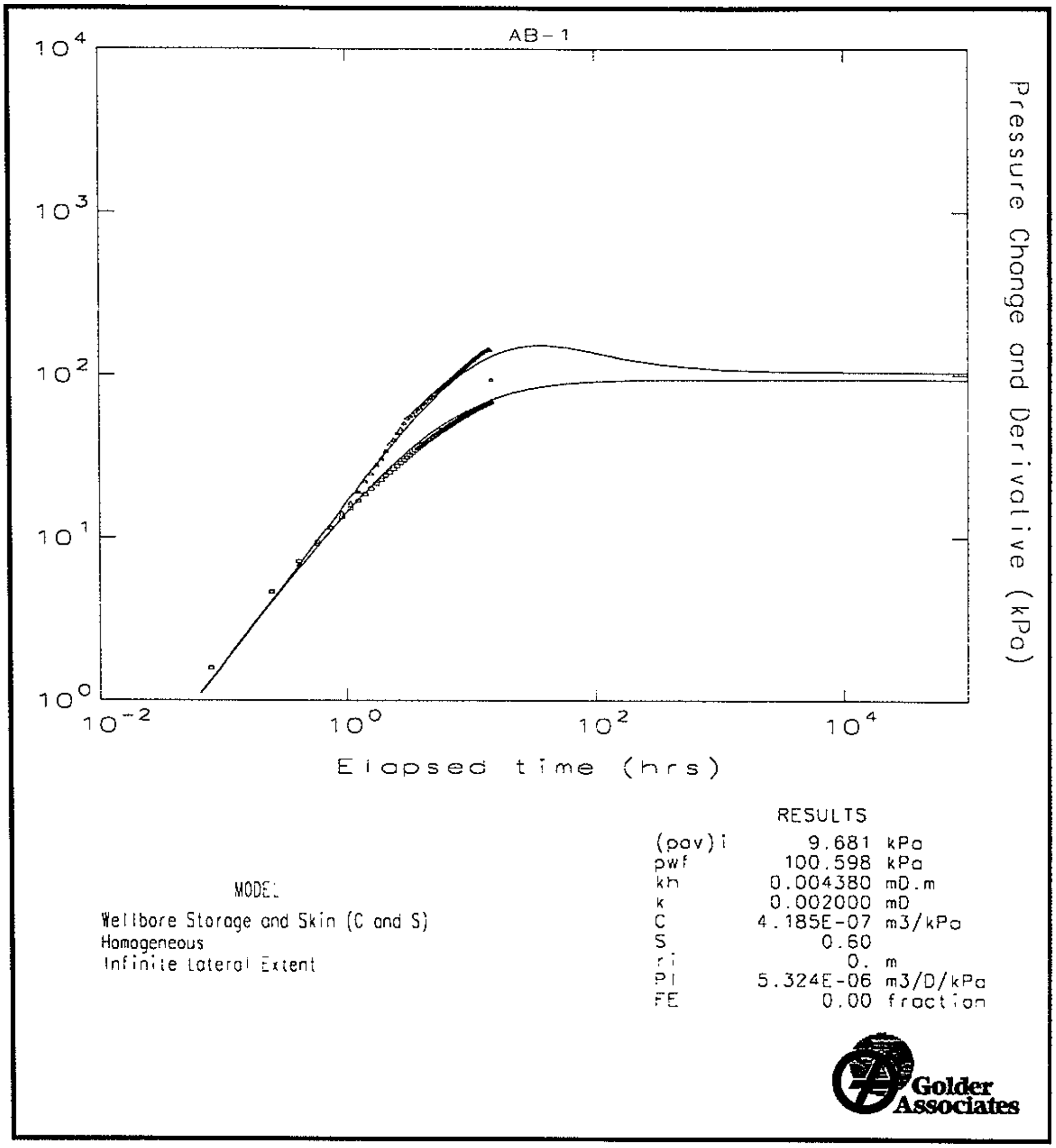


FIG. 5a: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; SLUG INJECTION SHUT-IN 1 (SIS1); LOG LOG MATCH

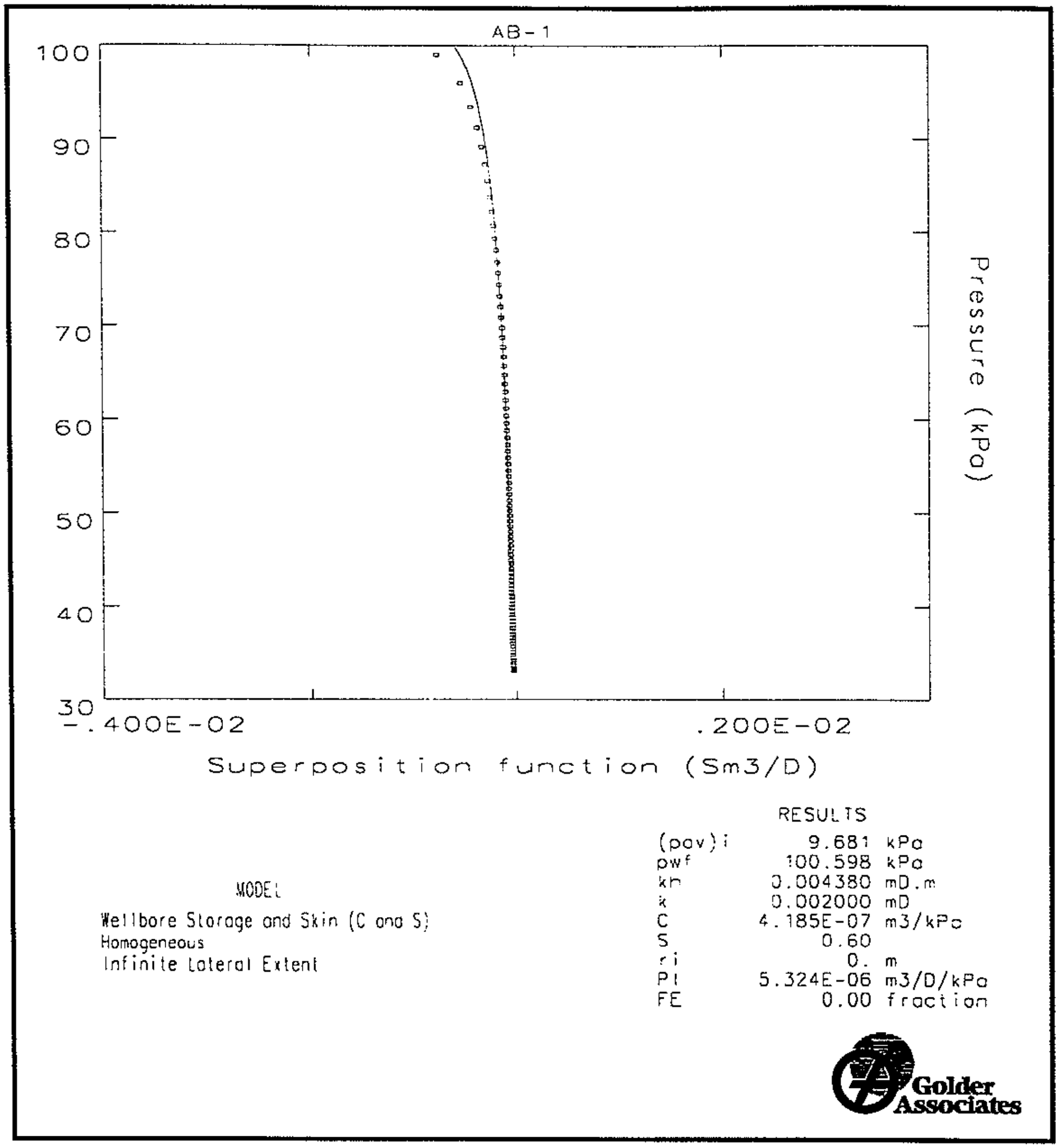
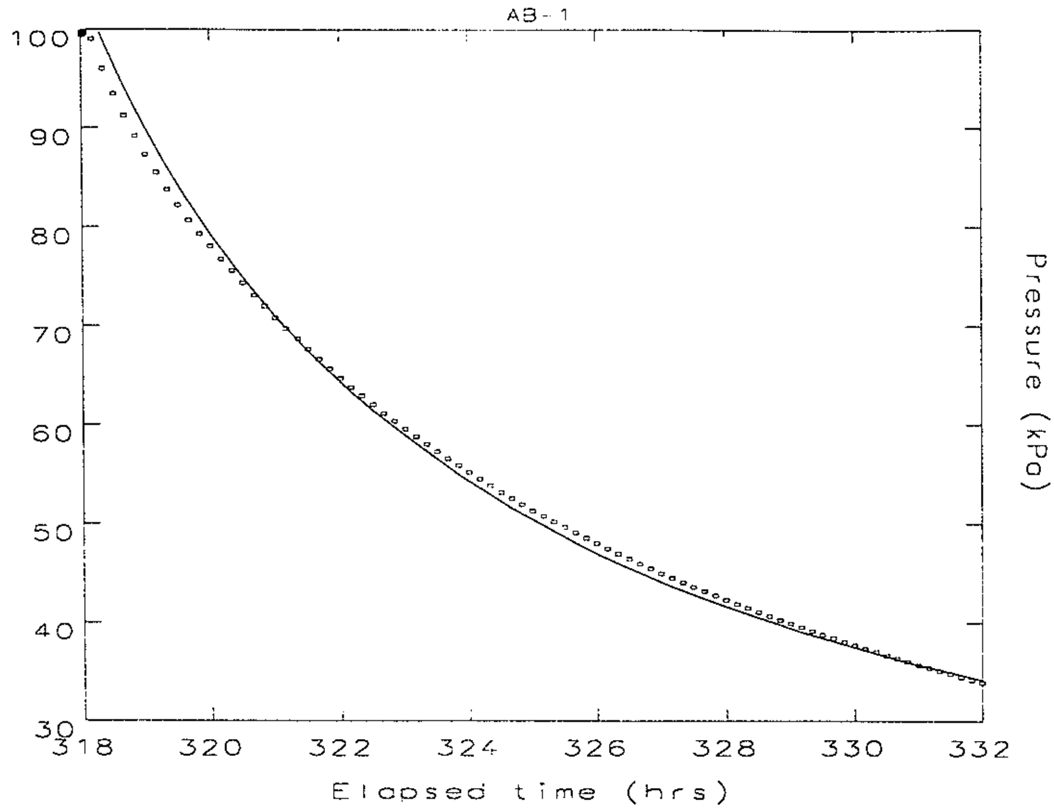


FIG. 5b: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; SLUG WITHDRAWAL SHUT-IN 1 (SIS1); HORNER MATCH



MODEL

Wellbore Storage and Skin (C and S)
Homogeneous
Infinite Lateral Extent

RESULTS

(pav)i	9.681	kPa
pwf	100.598	kPa
kh	0.004380	mD.m
k	0.002000	mD
C	4.185E-07	m3/kPa
S	0.60	
ri	0.	m
PI	5.324E-06	m3/D/kPa
FE	0.00	fraction

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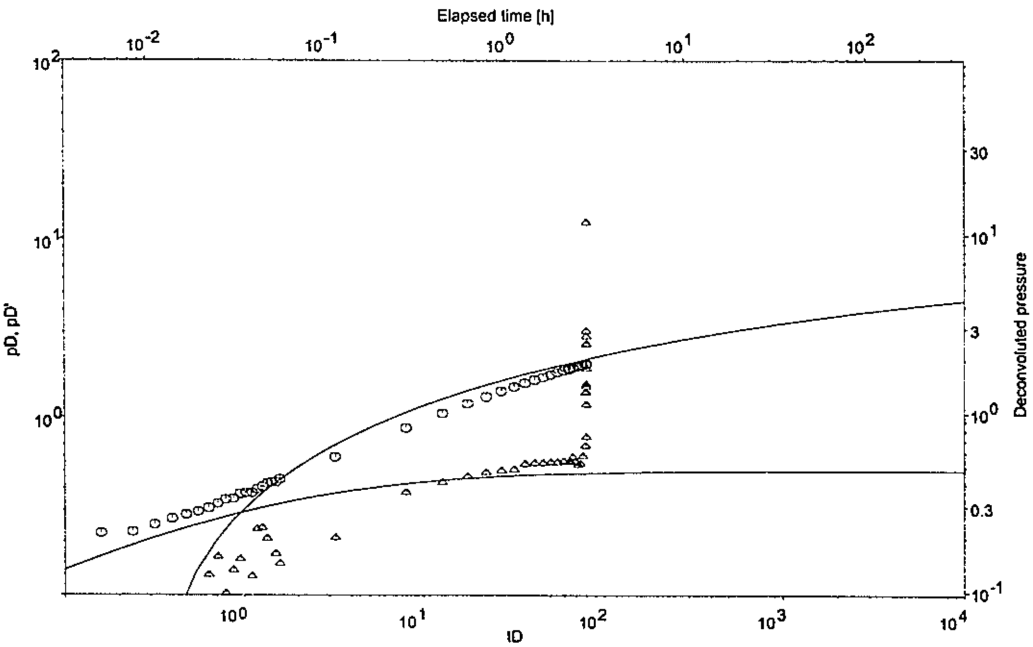
FIG. 5c: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; SLUG INJECTION SHUT-IN 1 (SIS1); SIMULATION MATCH



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Peres, Reynolds

C=	8.45E-11	m3/Pa
T=	3.84E-11	m2/s
S=	7.77E-06	-
s=	-5.00E-01	-
n=	2.00E+00	-

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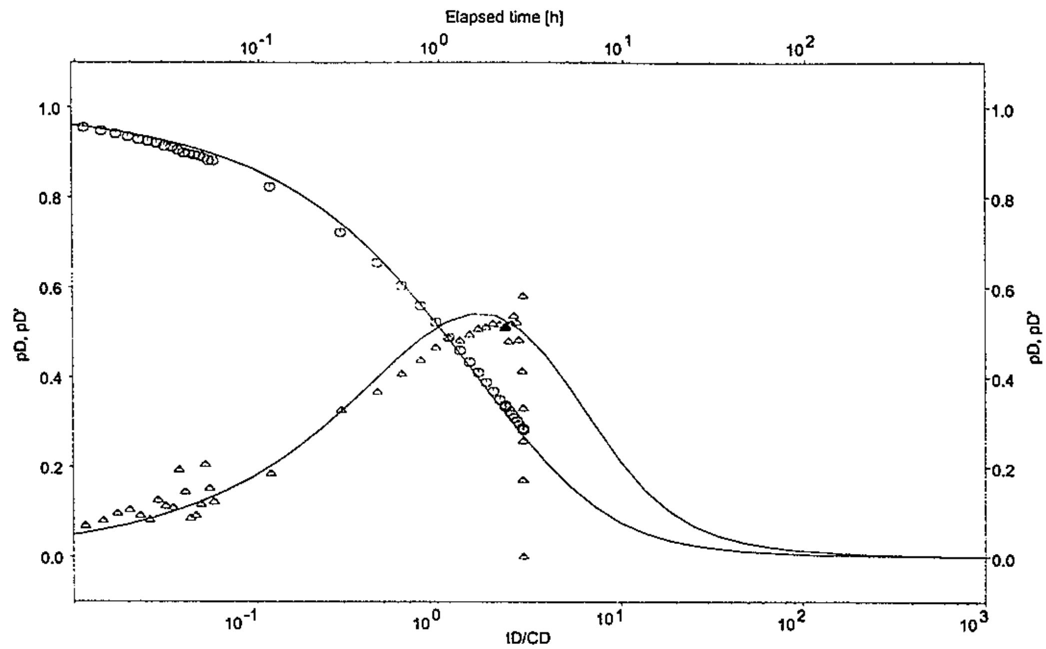
FIG. 6a: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; PULSE INJECTION 1 (PI1); DECONVOLUTION LOG LOG MATCH



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Ramey A

C=	8.45E-11	m3/Pa
T=	3.84E-11	m2/s
S=	7.77E-06	-
s=	-5.00E-01	-
n=	2.00E+00	-

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FIG. 6b: EMELLE FACILITY; BOREHOLE AB-1; TEST 1; PULSE INJECTION 1 (PI1); RAMEY A MATCH (EQUIVALENT TO COOPER METHOD)

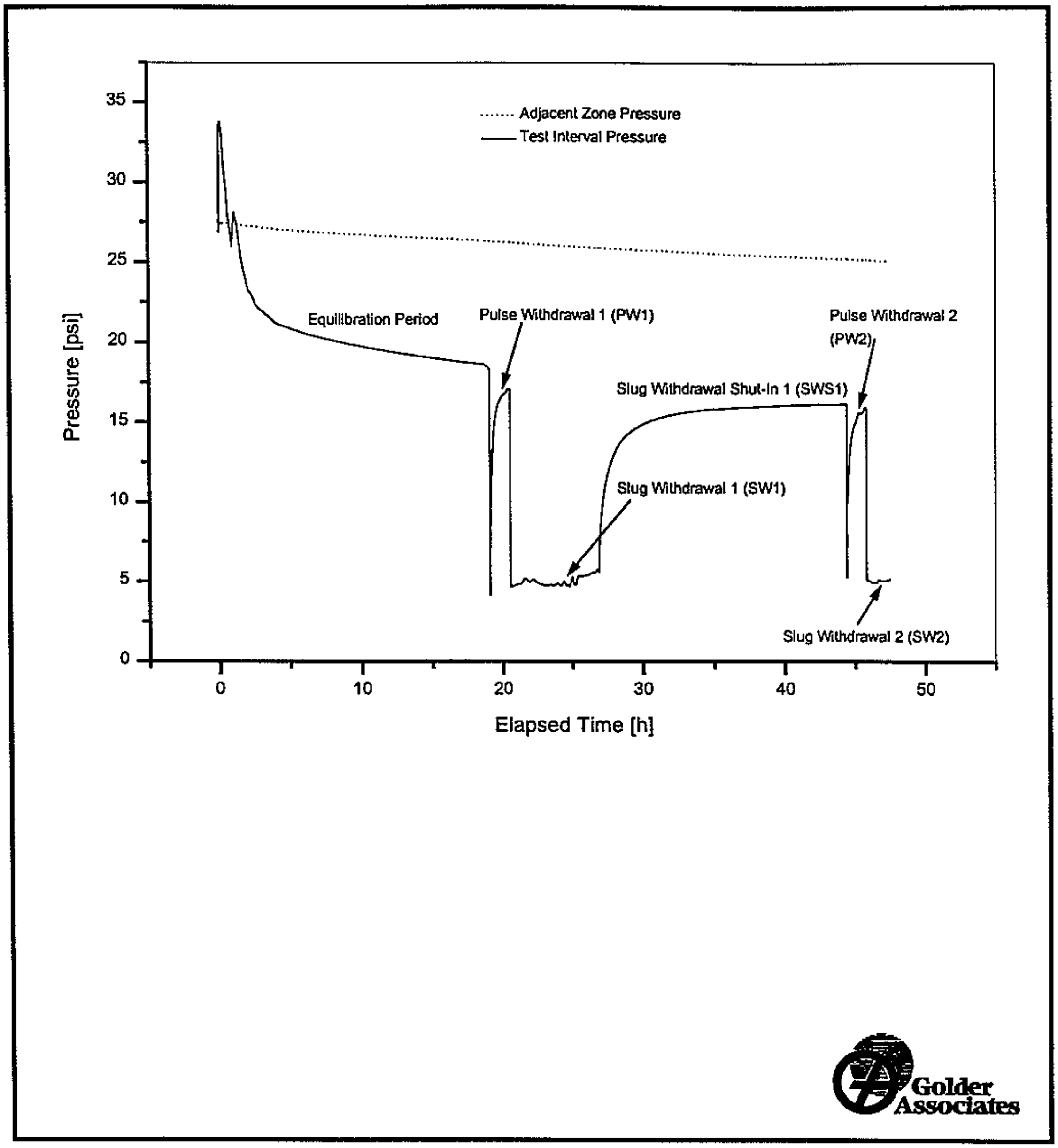


FIG. 7: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; PRESSURE RESPONSE

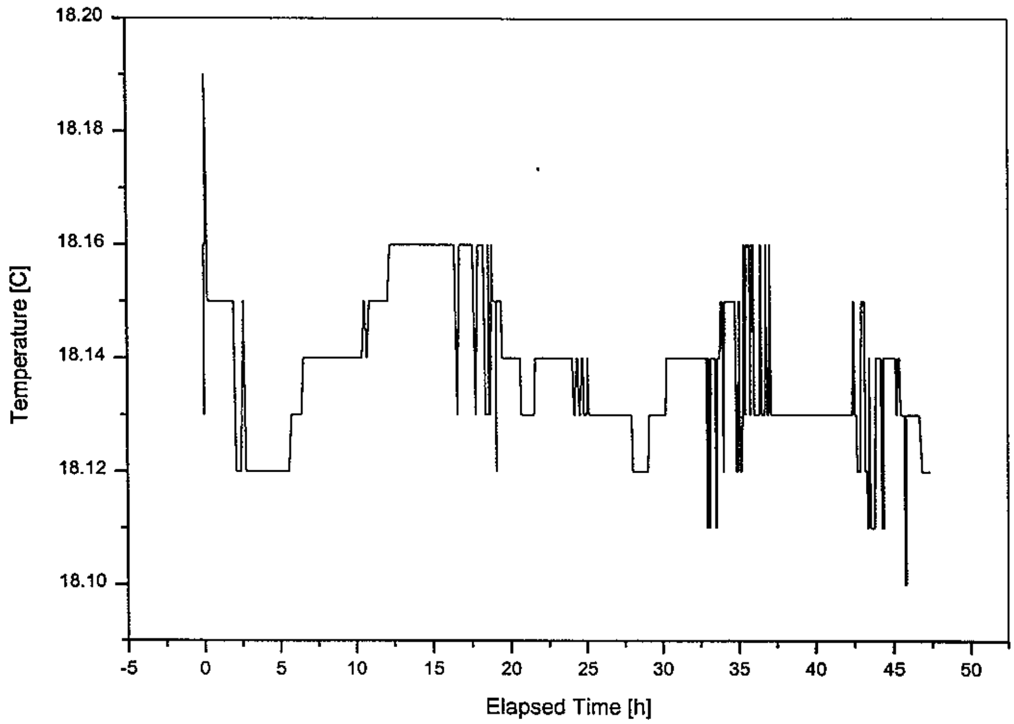
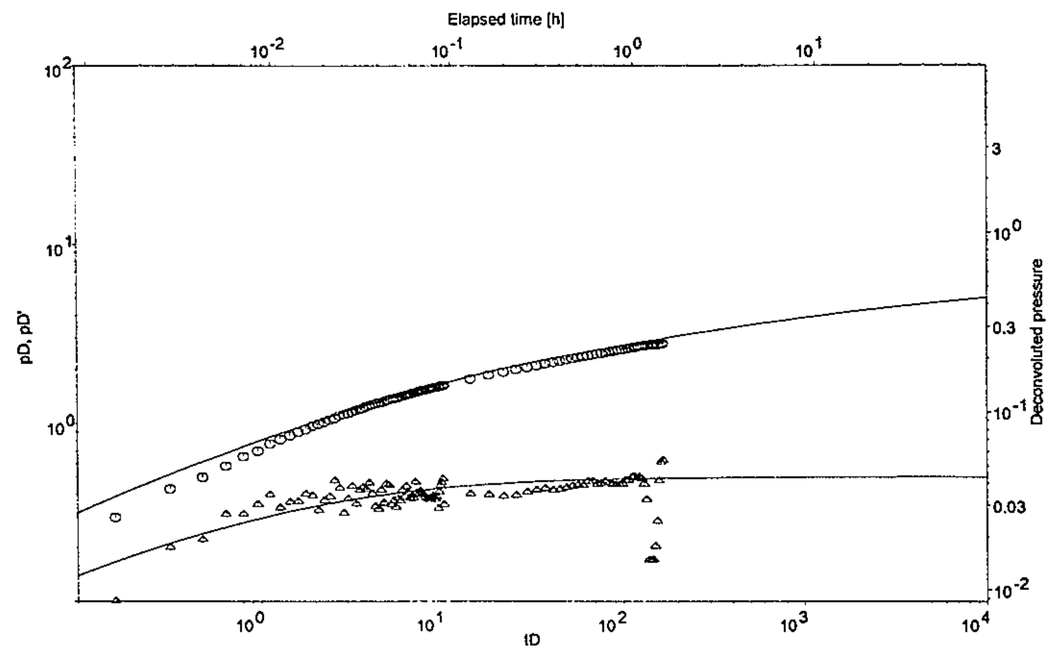


FIG. 8: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; TEMPERATURE RESPONSE



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Peres, Reynolds

C=	8.45E-11	m3/Pa
T=	4.25E-10	m2/s
S=	2.11E-05	-
s=	0.00E+00	-
n=	2.00E+00	-

FIG. 9a: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; PULSE WITHDRAWAL 1 (PW1); DECONVOLUTION LOG LOG MATCH

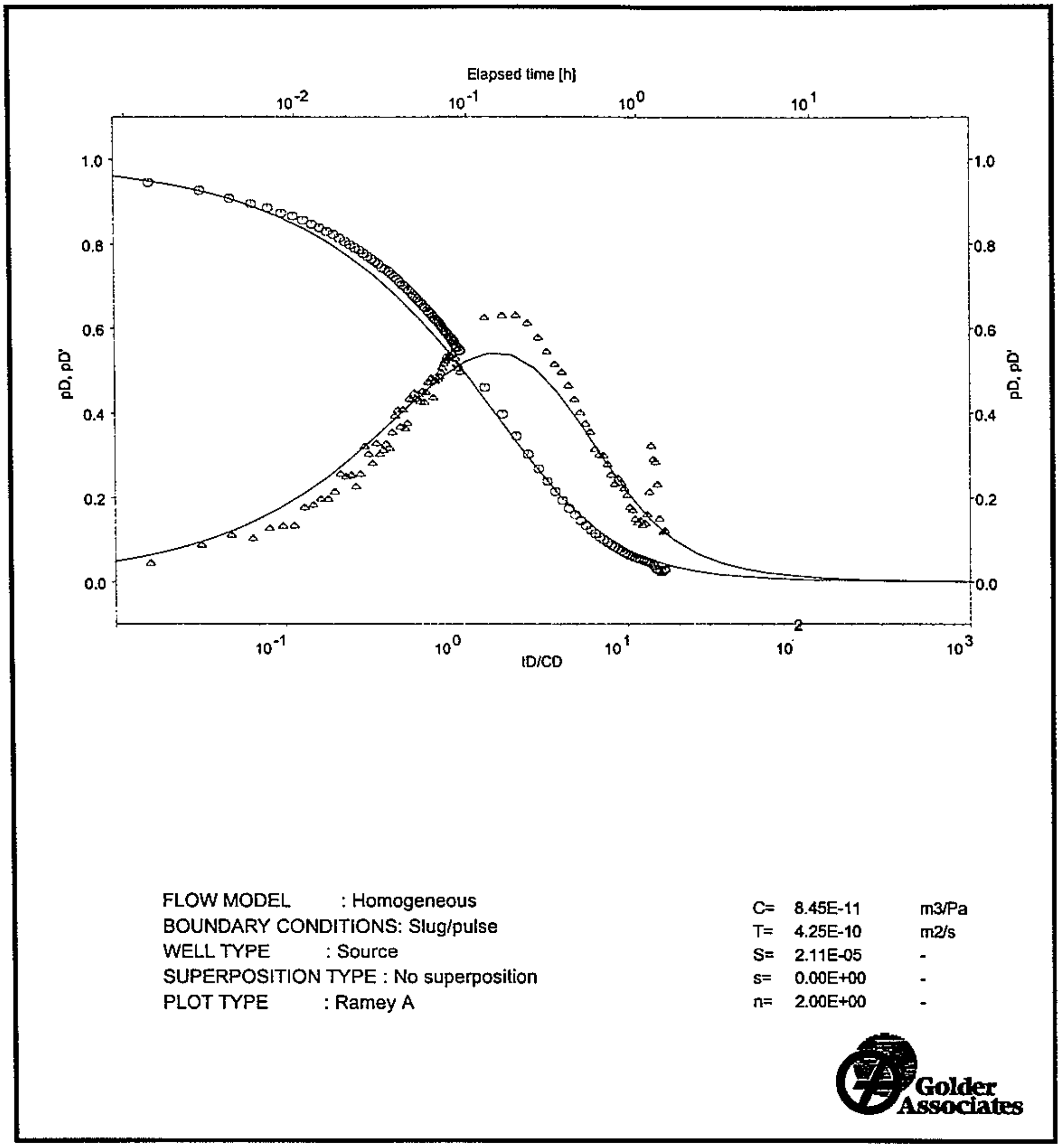
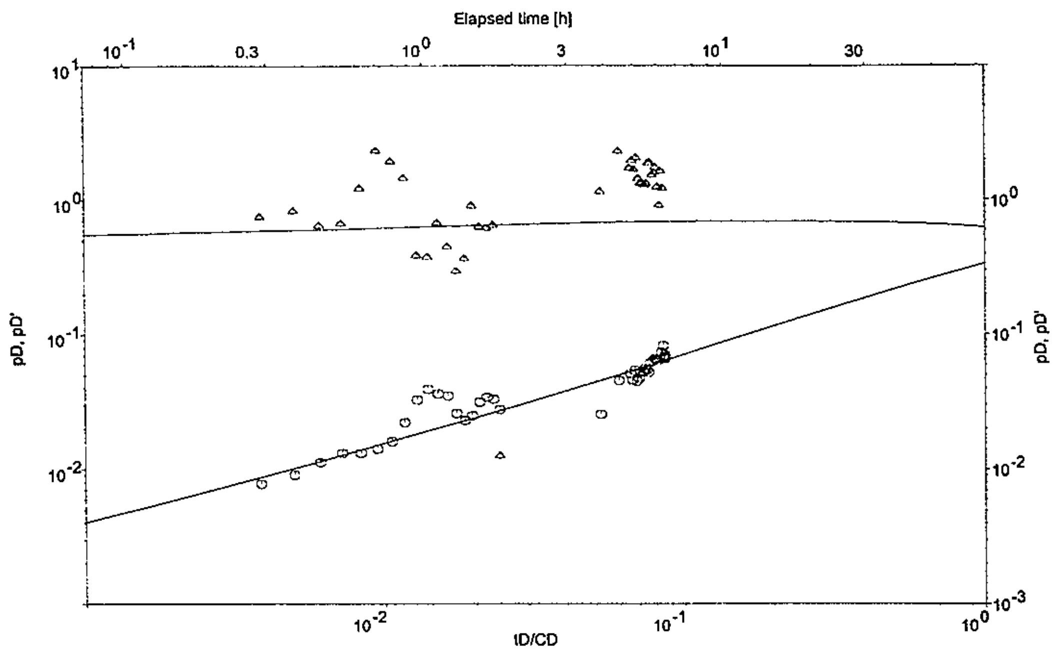


FIG. 9b: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; PULSE WITHDRAWAL 1 (PW1); RAMEY A MATCH (EQUIVALENT TO COOPER METHOD)



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Ramey C

C=	7.20E-08	m3/Pa
T=	4.22E-10	m2/s
S=	1.80E-03	-
s=	0.00E+00	-
n=	2.00E+00	-

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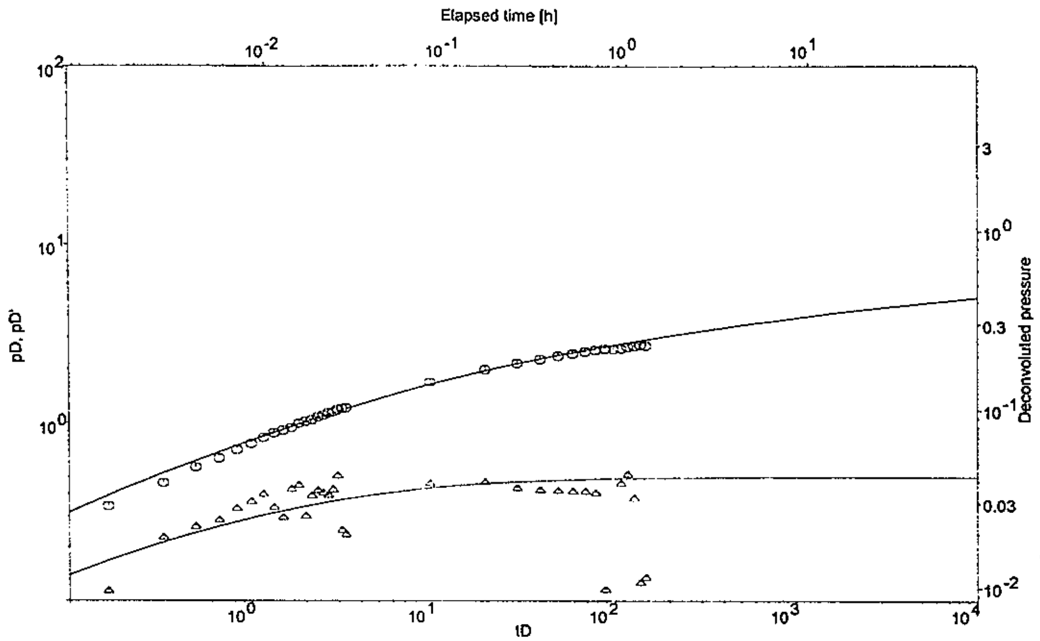
FIG. 10: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; SLUG WITHDRAWAL 1 (SW1); RAMEY C MATCH

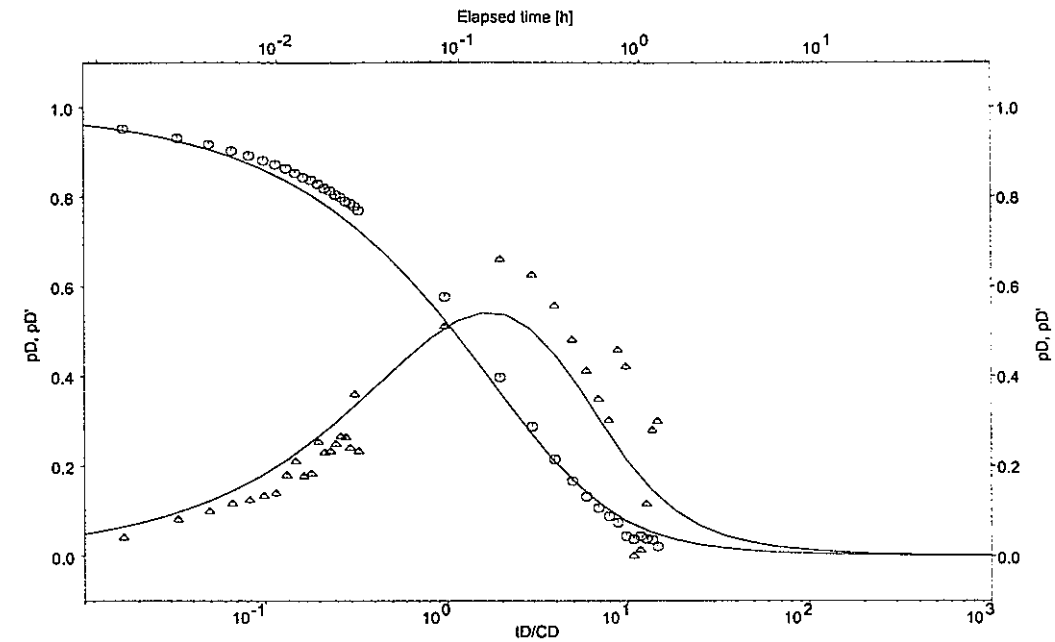


FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Peres, Reynolds

C=	8.45E-11	m3/Pa
T=	4.35E-10	m2/s
S=	2.11E-05	-
s=	0.00E+00	-
n=	2.00E+00	-

Golder Associates

FIG. 11a: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; PULSE WITHDRAWAL 2 (PW2); DECONVOLUTION LOG LOG MATCH



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Ramey A

C=	8.45E-11	m3/Pa
T=	4.35E-10	m2/s
S=	2.11E-05	-
s=	0.00E+00	-
n=	2.00E+00	-

Golder Associates

FIG. 11b: EMELLE FACILITY; BOREHOLE AB-1; TEST 2; PULSE WITHDRAWAL 2 (PW2); RAMEY A MATCH (EQUIVALENT TO COOPER METHOD)

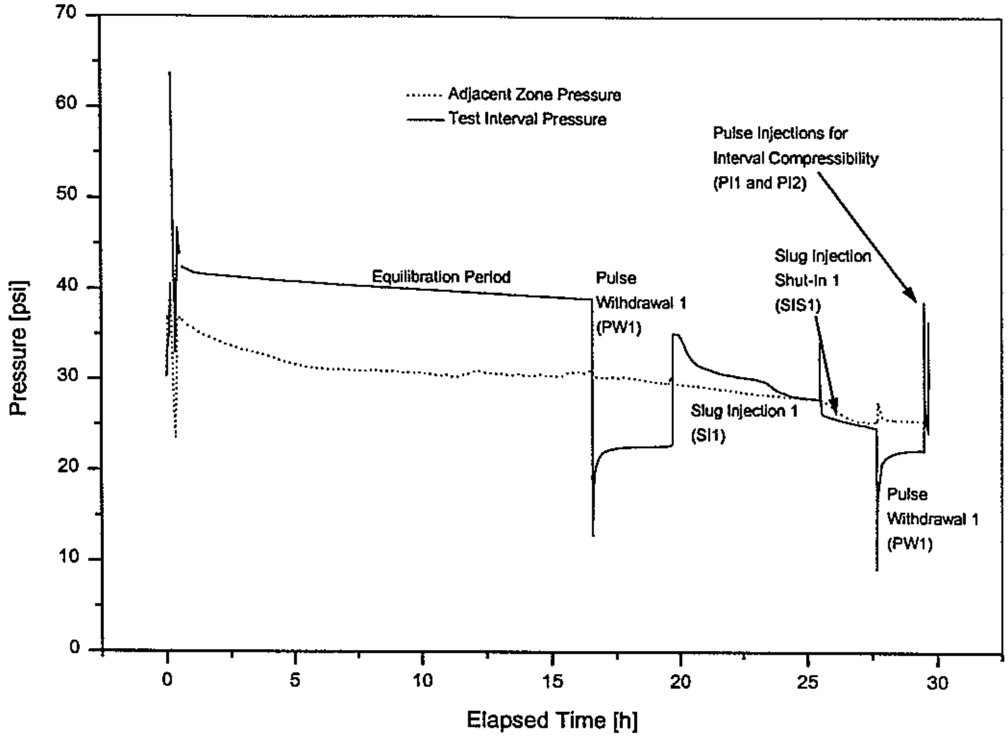


FIG. 12: EMELLE FACILITY; BOREHOLE AB-1; TEST 3; PRESSURE RESPONSE

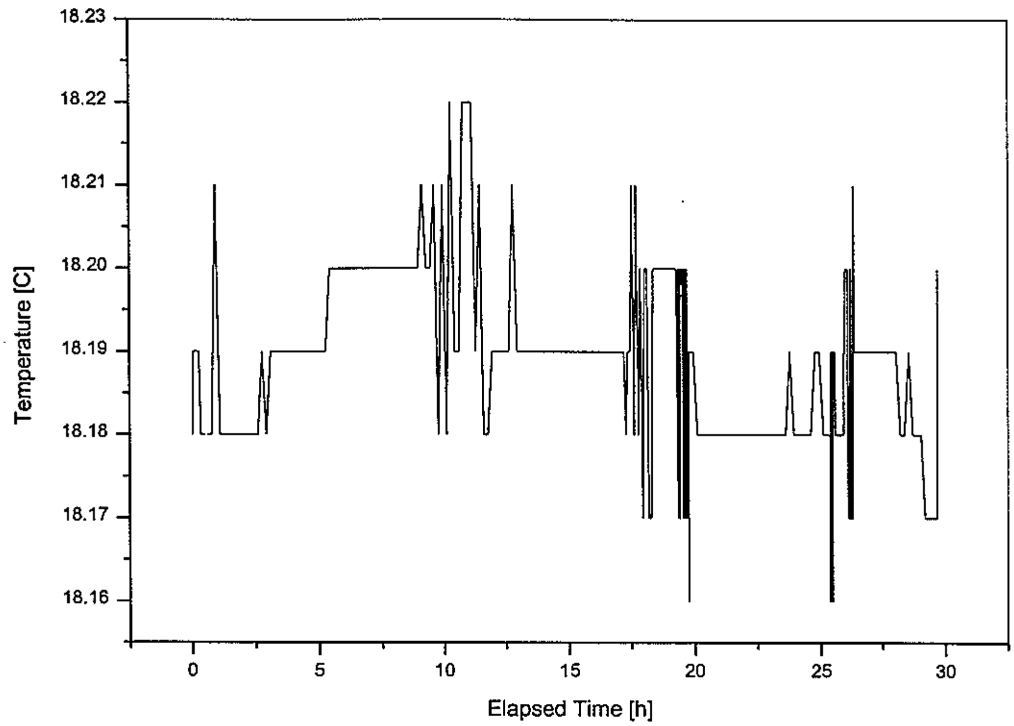
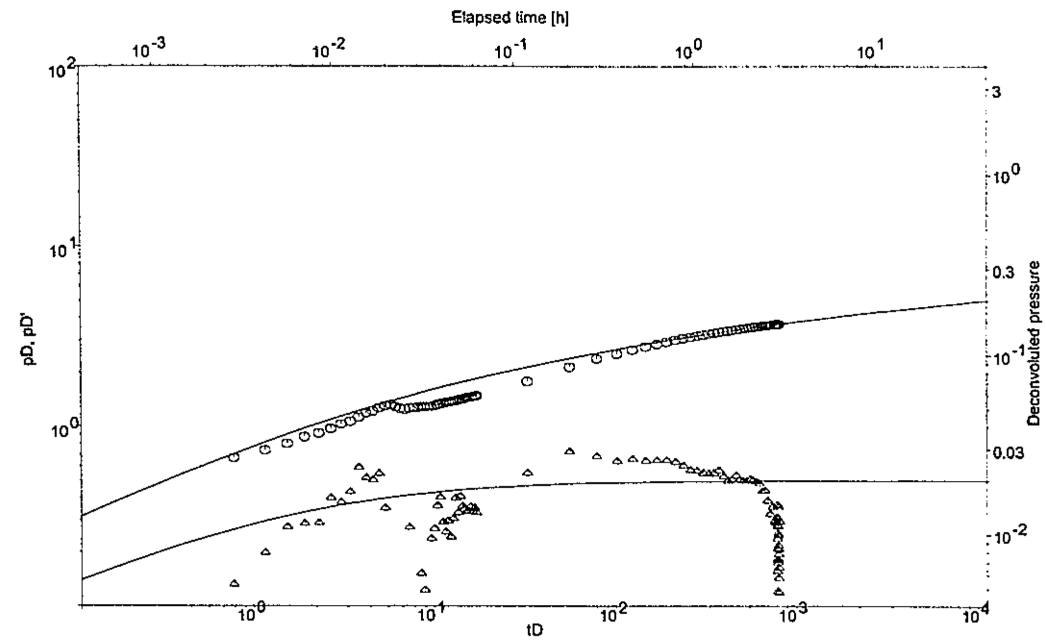


FIG. 13: EMELLE FACILITY; BOREHOLE AB-1; TEST 3; TEMPERATURE RESPONSE



FLOW MODEL	: Homogeneous
BOUNDARY CONDITIONS:	Slug/pulse
WELL TYPE	: Source
SUPERPOSITION TYPE	: No superposition
PLOT TYPE	: Peres, Reynolds

C=	8.45E-11	m3/Pa
T=	9.13E-10	m2/s
S=	2.11E-05	-
s=	0.00E+00	-
n=	2.00E+00	-

Golder Associates

FIG. 14a: EMELLE FACILITY; BOREHOLE AB-1; TEST 3; PULSE WITHDRAWAL 1 (PW1); DECONVOLUTION LOG LOG MATCH

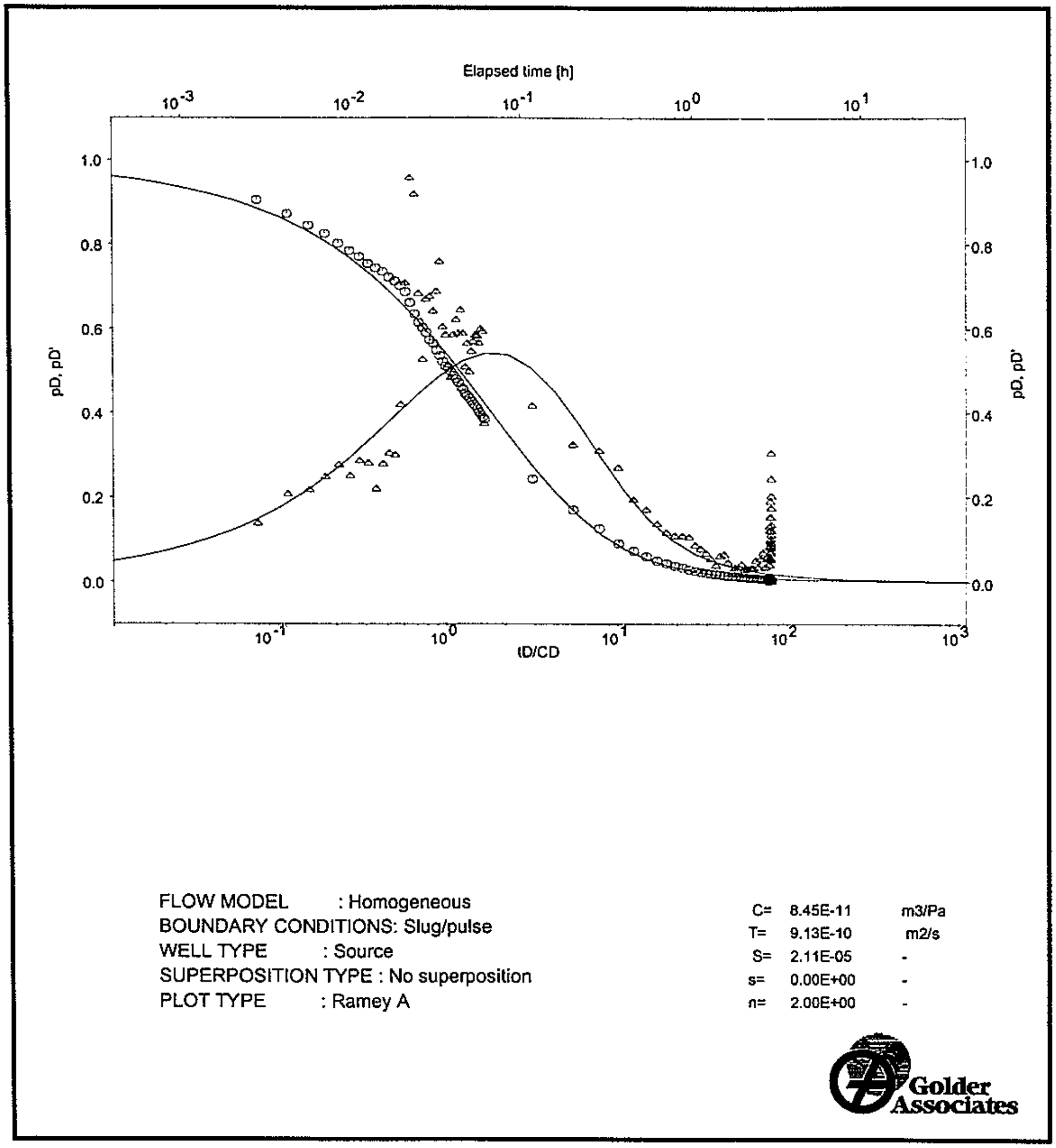
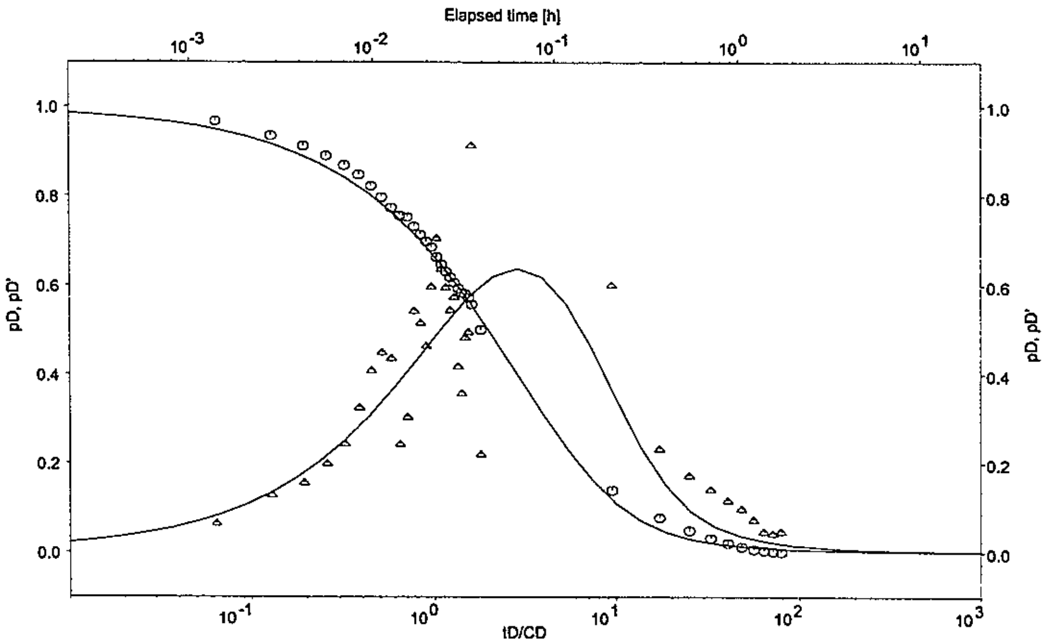


FIG. 14b: EMELLE FACILITY; BOREHOLE AB-1; TEST 3; PULSE WITHDRAWAL 1 (PW1); RAMEY A ANALYSIS (EQUIVALENT TO COOPER METHOD)



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Slug/pulse
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Ramey A

C=	8.45E-11	m3/Pa
T=	1.70E-09	m2/s
S=	5.74E-06	-
s=	5.00E-01	-
n=	2.00E+00	-

Golder Associates

FIG. 15: EMELLE FACILITY; BOREHOLE AB-1; TEST 3; PULSE WITHDRAWAL 2 (PW2); RAMEY A ANALYSIS (EQUIVALENT TO COOPER METHOD)

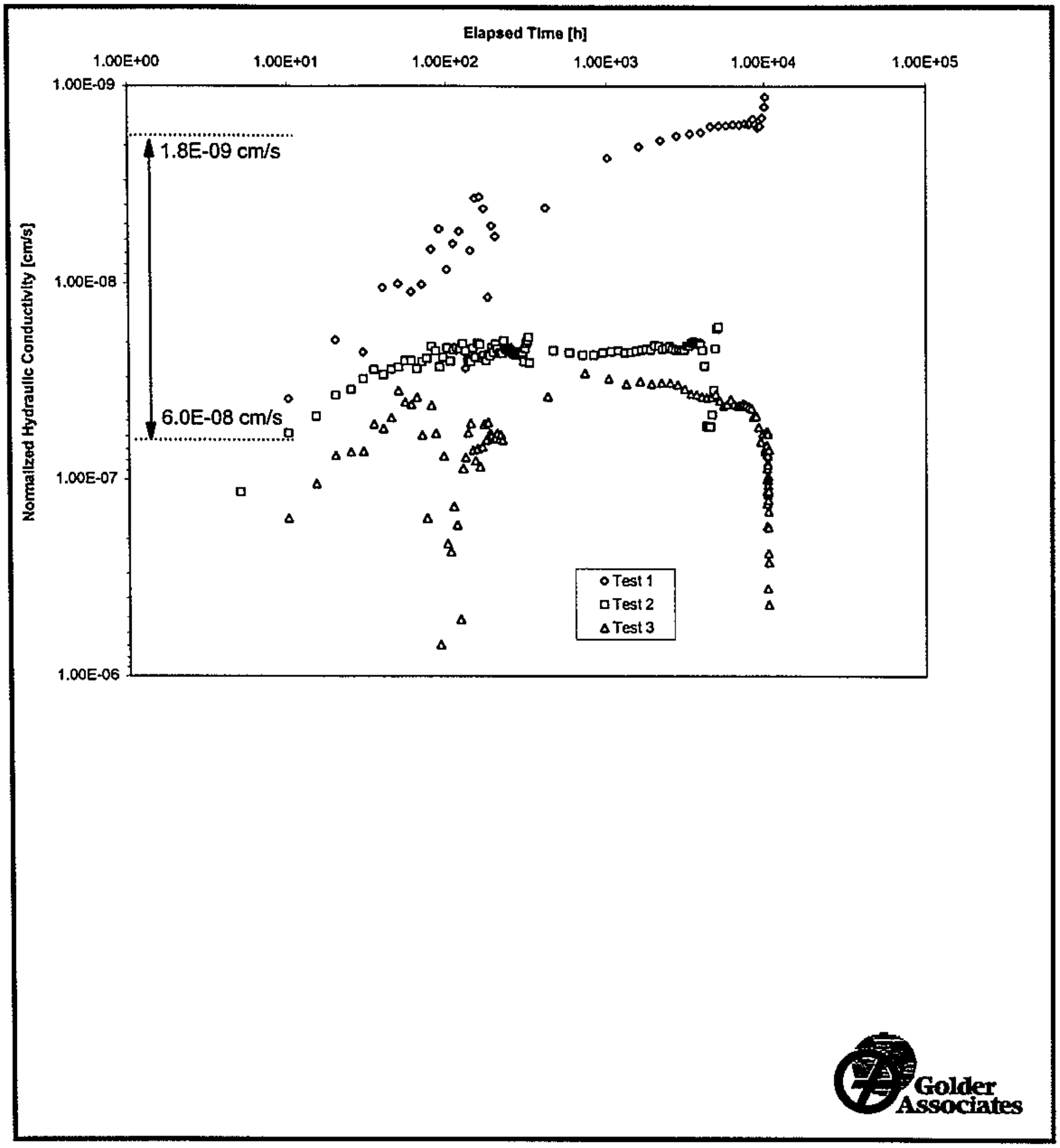


FIG. 16: EMELLE FACILITY; COMPARION OF ALL TESTS ON A HYDRAULIC CONDUCTIVITY NORMALIZED PLOT

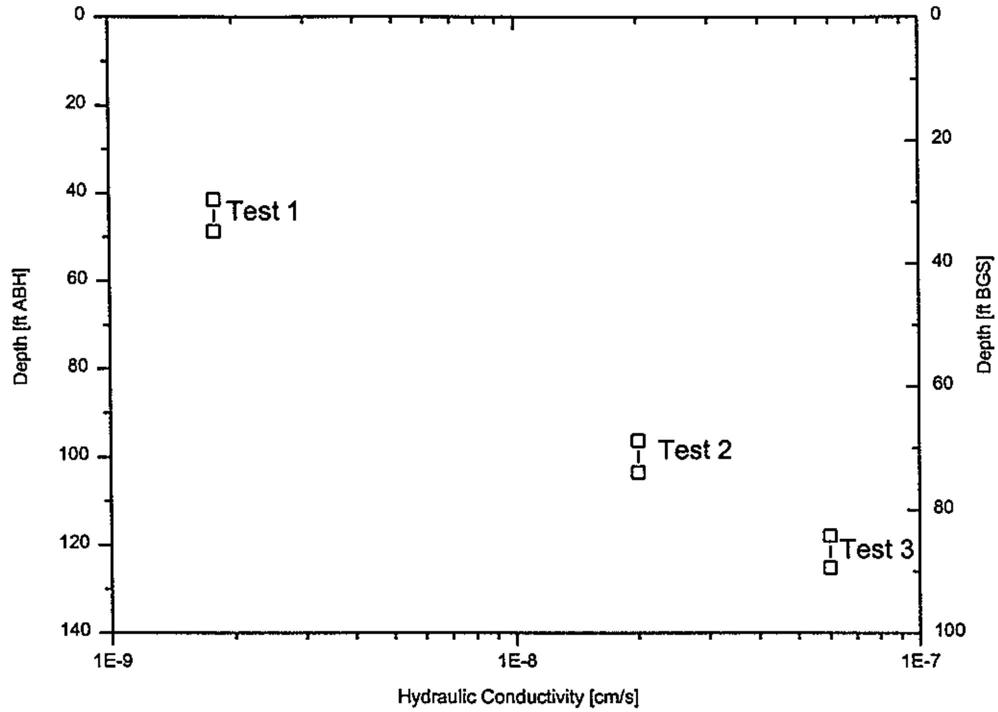


FIG. 17: EMELLE FACILITY; HYDRAULIC CONDUCTIVITY PROFILE

APPENDIX A

Summary of Tests

Quality Assurance Forms

Golder Associates

Borehole AB-1

Test 1

QA Forms

Golder Associates

TEST DATA SHEET 1

PACKER TEST DETAILS

Borehole No	AB-1
Test No.	1
Start Date	8 June 1999
End Date	9 June 1999
Test Type	Pulse and Slug
Test Objectives	Hydraulic Head and Transmissivity

BOREHOLE DATA

Depth of casing (ft ABH)	9.2
Casing Stick-up (ft ABH)	-0.8
Total Borehole Depth (ft ABH)	150
Nominal Inclination (degrees)	45
Borehole Direction (degrees)	N 25 E
Elevation (ground surface, ft msl)	238.60

TEST INTERVAL DATA

Depth of Top of Interval (ft ABH)	41.5
Depth of Bottom of Interval (ft ABH)	48.7
Length of Interval (ft)	7.2
Nominal Borehole Diameter (in)	3.8
Interval Volume (ft^3; minus tubing)	0.49 (0.014 m^3)

PRESSURE TRANSDUCER DATA

	[ft ABH]	[ft BGS]	Serial #
Transducer P1 – adjacant zones	35.73	25.26	42095
Transducer P2 - test interval	34.90	24.67	42096

Note: ft ABH – feet along borehole below ground surface; ft BGS – vertical distance below ground surface; ft msl – feet above mean sea level.

Golder Associates

TEST DATA SHEET 1

RELEVANT ANALYSIS DATA

Test Tubing Radius – Slim Tubing Packer (in)	0.50 (0.013 m)
Equivalent Tubung Radius (in) 1)	0.59 (0.015 m)

1) larger tubing radius used for slug tests to account for inclined borehole

Golder Associates

TEST DATA SHEET 2

PACKER TEST ASSEMBLY DETAILS

BOREHOLE NO.	AB-1
TEST NO	1

DESCRIPTION OF TOOL	O.D. (in)	I.D. (in)	LENGTH (ft)	DEPTH TO BASE (ft ABH)
Stick-up			-8.3	
Test Tubing (4 NQ rods)	2.75	2.375	40.00	
inline adapter, gauge carrier, adapter	3.25	1.25	4.55	Tool: 9.80
upper packer stick-up and mandrel	3.25	1.25	2.25	
Upper packer element (upper seal)	3.25	1.25	3.00	**41.5**
upper packer stick down	3.25	1.25	1.15	Interval: 7.20
mandrel and inline adapter	1.30	1.25	0.87	
nipple	1.30	1.25	2.31	
shut-in valve	3.25	1.25	0.80	
nipple	1.30	1.25	0.85	
lower packer stickup and mandrel	3.25	1.25	1.25	
Lower packer element (lower seal)	3.25	1.25	3.00	**48.7**
lower packer stick down and through tube fitting	1.30	1.25	1.74	

Testing Logbook

Date	Time	Event	Comment
Borehole DH98_2 drilled at a nominal 45° inclination, borehole diameter is 3.8 in, casing is set to 9.2 ft ABH, total depth is 150 ft ABH. The borehole was drilled on 25 and 26 May 1999 with freshwater. No significant fluid losses were recorded during coring.			
06/08/99	10:00	Tools on test depth, fill borehole with water	P1: 10.9 psi P2: 11.1 psi
	10:15	Inflate packers to 125 psi and close shut-in tool (SIT)	
	13:00	Bail water from NQ rods down to approx. 30 ft ABH	
	13:30	Open and close SIT	**Start PW1**
	13:45	Fill tubing with water, install slim tubing packer and fill 1 inch PVC with water, 1 inch PVC extends above NQ rods	
	14:00	Open SIT, water level falls 0.35 ft rapidly and then relatively stable	**Start SW1**
	16:40	Measure fluid level inside tubing at 0.57 ft, close SIT	**Start SWS1**
06/09/99	07:15	Open and close SIT **PI1** Instantaneous change in level: 0.055 ft Change in volume: 8.5E-06 m^3 Change in pressure: 69757 Pa Measured wellbore storage: 1.2E-10 m3/Pa	**Start PI1**
	10:00	Open and close SIT for borehole compressibility measurement **PI2** Instantaneous change in level: 0.03 ft Change in volume: 4.66E-06 m^3 Change in pressure: 50471 Pa Measured wellbore storage: 9.2E-11 m3/Pa	**Start PI2**
	10:15	Deflate packers and end test	

Golder Associates

Borehole AB-1

Test 2

QA Forms

Golder Associates

TEST DATA SHEET 1

PACKER TEST DETAILS

Borehole No	AB-1
Test No.	2
Start Date & Time	4 June 1999 at 14:27
End Date & Time	6 June 1999 at 14:15
Test Type	Pulse and Slug
Test Objectives	Hydraulic Head and Transmissivity

BOREHOLE DATA

Depth of casing (ft ABH)	9.2
Casing Stick-up (ft ABH)	-0.8
Total Borehole Depth (ft ABH)	150
Nominal Inclination (degrees)	45
Borehole Direction (degrees)	N 25 E
Elevation (ground surface, ft msl)	238.60

TEST INTERVAL DATA

Depth of Top of Interval (ft ABH)	96.4
Depth of Bottom of Interval (ft ABH)	103.6
Length of Interval (ft)	7.2
Nominal Borehole Diameter (in)	3.8
Interval Volume (ft^3; minus tubing)	0.49 (0.014 m^3)

PRESSURE TRANSDUCER DATA

	[ft ABH]	[ft BGS]	Serial #
Transducer P1 – adjacant zones	90.63	64.09	42095
Transducer P2 - test interval	89.80	63.50	42096

Note: ft ABH - feet along borehole below ground surface; ft BGS - vertical distance below ground surface from datum; ft msl – feet above mean sea level.

Golder Associates

RELEVANT ANALYSIS DATA

Test Tubing Radius – Slim Tubing Packer (in)	0.5 (0.013 m)
Equivalent Tubung Radius (in)	0.59 (0.015 m)

Golder Associates

TEST DATA SHEET 2

PACKER TEST ASSEMBLY DETAILS

BOREHOLE NO.	AB-2
TEST NO	2

DESCRIPTION OF TOOL	O.D. (in)	I.D. (in)	LENGTH (ft)	DEPTH TO BASE (ft ABH)
Stick-up			-3.4	
Test Tubing (9 NQ rods)	2.75	2.375	90.00	
inline adapter, gauge carrier, adapter	3.25	1.25	4.55	Tool:
upper packer stick-up and mandrel	3.25	1.25	2.25	9.80
Upper packer element (upper seal)	3.25	1.25	3.00	**96.4**
upper packer stick down	3.25	1.25	1.15	
mandrel and inline adapter	1.30	1.25	0.87	Interval:
nipple	1.30	1.25	2.31	7.20
shut-in valve	3.25	1.25	0.80	
nipple	1.30	1.25	0.85	
lower packer stickup and mandrel	3.25	1.25	1.25	
Lower packer element (lower seal)	3.25	1.25	3.00	**103.6**
lower packer stick down and through tube fitting	1.30	1.25	1.74	

Testing Logbook

Date	Time	Event	Comment
Borehole DH98_2 drilled at a nominal 45° inclination, borehole diameter is 3.8 in, casing is set to 9.2 ft ABH, total depth is 150 ft ABH. The borehole was drilled on 25 and 26 May 1999 with freshwater. No significant fluid losses were recorded during coring.			
06/04/99	14:26	Tools on test depth, fill borehole with water to top of casing	P1: 27.6 psi P2: 28.1 psi
	14:35	Inflate packers to 100 psi	
	14:40	Packers set to 100 psi, close shut-in tool (SIT) to allow pressure to equilibrate	
	14:45	Bail water from NQ rods to approx. 50 ft	
06/05/99	09:44	Open and close SIT	**Start PW1**
	10:30	Place slim tubing packer in the hole	
	11:07	Open SIT	**Start SW1**
	17:00	Close SIT	**Start SWS1**
06/06/99	11:05	Open and close SIT	**Start PW2**
	12:00	Place slim tubing packer into test string	
	12:20	Open SIT	**Start SW2**
	14:15	Deflate packers and move tools down to the next interval	

Golder Associates

Borehole AB-1

Test 3

QA Forms

Golder Associates

TEST DATA SHEET 1

PACKER TEST DETAILS

Borehole No	AB-1
Test No.	3
Start Date & Time	6 June 1999
End Date & Time	8 June 1999
Test Type	Pulse and Slug
Test Objectives	Hydraulic Head and Transmissivity

BOREHOLE DATA

Depth of casing (ft ABH)	9.2
Casing Stick-up (ft ABH)	-0.8
Total Borehole Depth (ft ABH)	150
Nominal Inclination (degrees)	45
Borehole Direction (degrees)	N 25 E
Elevation (ground surface, ft msl)	238.60

TEST INTERVAL DATA

Depth of Top of Interval (ft ABH)	118.00
Depth of Bottom of Interval (ft ABH)	125.20
Length of Interval (ft)	7.2
Nominal Borehole Diameter (in)	3.8
Interval Volume (ft^3; minus tubing)	0.49 (0.014 m^3)

PRESSURE TRANSDUCER DATA

	[ft ABH]	[ft BGS]	Serial #
Transducer P1 – adjacant zones	112.23	79.36	42095
Transducer P2 - test interval	111.40	78.77	42096

Note: ft ABH - feet along borehole below ground surface; ft BGS - vertical distance below ground surface from datum; ft msl – feet above mean sea level.

Golder Associates

RELEVANT ANALYSIS DATA

Test Tubing Radius (in)	0.5 (0.013 m)
Equivalent Tubung Radius (in)	0.59 (0.015 m)

Golder Associates

TEST DATA SHEET 2

PACKER TEST ASSEMBLY DETAILS

BOREHOLE NO.	AB-2
TEST NO	3

DESCRIPTION OF TOOL	O.D. (in)	I.D. (in)	LENGTH (ft)	DEPTH TO BASE (ft ABH)
Stick-up			-1.80	
Test Tubing (11 NQ rods)	2.75	2.375	110.00	
inline adapter, gauge carrier, adapter	3.25	1.25	4.55	Tool:
upper packer stick-up and mandrel	3.25	1.25	2.25	9.80
Upper packer element (upper seal)	3.25	1.25	3.00	**118.0**
upper packer stick down	3.25	1.25	1.15	
mandrel and inline adapter	1.30	1.25	0.87	Interval:
nipple	1.30	1.25	2.31	7.20
shut-in valve	3.25	1.25	0.80	
nipple	1.30	1.25	0.85	
lower packer stickup and mandrel	3.25	1.25	1.25	
Lower packer element (lower seal)	3.25	1.25	3.00	**125.2**
lower packer stick down and through tube fitting	1.30	1.25	1.74	

Testing Logbook

Date	Time	Event	Comment
Borehole DH98_2 drilled at a nominal 45° inclination, borehole diameter is 3.8 in, casing is set to 9.2 ft ABH, total depth is 150 ft ABH. The borehole was drilled on 25 and 26 May 1999 with freshwater. No significant fluid losses were recorded during coring.			
06/06/99	14:43	Tools on test depth, fill casing with water	P1: 37.0 psi P2: 35.0 psi
	14:50	Inflate packers to 125 psi	
	15:07	Close shut-in tool (SIT) to allow test interval pressure to equilibrate, bail water to approx. 85 ft ABH	
06/07/99	07:20	Open and close SIT	**Start PW1**
	09:00	Install slim tubing packer	
	10:30	Open SIT	**Start SW1**
06/08/99	07:30	Remove slim tubing packer and bail fluid from the test tubing to approx. 85 ft ABH	
	07:47	Open and close SIT	**Start PW2**
	07:50	Fill test tubing with water and install slim tubing	
	09:35	Open and close SIT **PI1** Instanataneous change in level: 0.05 ft Change in volume: 7.8E-06 m^3 Change in pressure: 114250 Pa Measured wellbore storage: 6.8E-11 m^3/Pa	**Start PI1**

Testing Logbook

Date	Time	Event	Comment
	09:45	Open and close SIT **PI2** Instanataneous change in level: 0.03 ft Change in volume: 4.7E-06 m^3 Change in pressure: 81292 Pa Measured wellbore storage: 5.8E-11 m3/Pa	Start PI2
	09:50	Deflate packers and end test	

APPENDIX B

Calibration Certification

For Pressure Transducers

GEOKON

Vibrating Wire Pressure Transducer Calibration

Model Number: 4500H-250 | Pressure Range: 250 psi

Serial Number: 42095 | Mfg. Number: 7-3002

Customer: Golder Assoc. | Temperature: 23.1 °C

Cust. I.D. #: n/a | Barometric Pressure: 988.7 mbar

Job Number: 10986R | Date: May 26, 1998

Cal. Std. Control #(s): 176, 399 | Technician: [signature]

Pressure (psi)	Reading 1st Cycle	Pressure (psi)	Reading 2nd Cycle	Average Pressure	Average Reading	Change	Linearity (%FS)	Polynomial Fit (%FS)
0	8805	0	8804	0	8805			-0.08
50	8059	50	8058	50	8059	746	0.07	0.11
100	7318	100	7315	100	7317	742	0.12	0.06
150	6577	150	6571	150	6574	743	0.29	-0.11
200	5816	200	5820	200	5818	756	0.10	-0.05
250	5056	250	5054	250	5055	763	0.28	0.05

Linear Gage Factor (G): 0.06676 **(psi/digit)**

Polynomial Gage Factors: A: -2.99E-07 **B:** -0.06261 **C:*** 574.3

Thermal Factor (K): 0.05652 **(psi/°C)**

Calculated Pressures: **Linear,** $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)$**

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)$**

***Barometric compensation is not required with vented transducers.*

Factory Zero Reading:

GK-401 Pos. B or F(R_0): 8797 Temp(T_0): 22.9 °C Baro(S_0): 988.7 mbar Date: May 26, 1998

**The user is advised to establish zero conditions in the field by recording the reading at a known temperature and barometric pressure.*

Wiring Code: Red and Black: Gage White and Green: Thermistor Bare: Shield

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

8791

GEOKON

Vibrating Wire Pressure Transducer Calibration

Model Number: 4500H-250   Pressure Range: 250 psi

Serial Number: 42096   Mfg. Number: 7-2997

Customer: Golder Assoc.   Temperature: 23.2 °C

Cust. I.D. #: n/a   Barometric Pressure: 988.6 mbar

Job Number: 10986R   Date: May 26, 1998

Cal. Std. Control #(s): 176, 399   Technician: [signature]

Pressure (psi)	Reading 1st Cycle	Pressure (psi)	Reading 2nd Cycle	Average Pressure	Average Reading	Change	Linearity (%FS)	Polynomial Fit (%FS)
0	9135	0	9133	0	9134			-0.03
50	8490	50	8488	50	8489	645	0.02	0.04
100	7848	100	7843	100	7846	644	0.11	-0.01
150	7197	150	7195	150	7196	650	0.05	0.05
200	6553	200	6550	200	6552	645	0.14	-0.12
250	5887	250	5900	250	5894	658	0.18	0.05

Linear Gage Factor (G): 0.07721 (psi/digit)

Polynomial Gage Factors: A: -2.27E-07 B: -0.07380 C:* 692.9

Thermal Factor (K): 0.01297 (psi/°C)

Calculated Pressures: **Linear, $P = G(R_0 - R_1)+K(T_1 - T_0)-(S_1 - S_0)$****

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0)-(S_1 - S_0)$**

***Barometric compensation is not required with vented transducers.*

Factory Zero Reading:

GK-401 Pos. B or F(R_0): 9120 Temp(T_0): 22.8 °C Baro(S_0): 988.7 mbar Date: May 26, 1998

**The user is advised to establish zero conditions in the field by recording the reading at a known temperature and barometric pressure.*

Wiring Code: Red and Black: Gage White and Green: Thermistor Bare: Shield

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

Gill

TOTAL P.04

APPENDIX E-7

SECTION E

LINEAMENT STUDY

EMELLE, ALABAMA WASTE DISPOSAL SITE

Revision No.

5.0

APPENDIX E-7

SECTION E

LIST OF DOCUMENTS

Document 1: Lineament Study, Emelle, Alabama Waste Disposal Site, prepared by Woodward-Clyde Consultants, dated December 12, 1980.

11 East Adams Street
Suite 1500
Chicago, Illinois 60603
312-939-1000
Telex 253875 (WOODWARD CGO)

Woodward-Clyde Consultants

LINEAMENT STUDY
EMELLE ALABAMA WASTE DISPOSAL SITE

Prepared for

WASTE MANAGEMENT, INC
900 Jorie Boulevard
Oak Brook, Illinois 60521

Prepared by

WOODWARD-CLYDE CONSULTANTS
11 East Adams Street
Suite 1500
Chicago, Illinois 60603

Richard J. Woodward, III, PE

12 December 1980
WCC File: Y9C00084

Consulting Engineers, Geologists
and Environmental Scientists

Offices in Other Principal Cities

CONTENTS

ILLUSTRATIONS

INTRODUCTION

Resource Industries of Alabama, Inc (RIA), a subsidiary of Waste Management, Inc., operates a treatment and disposal facility for hazardous waste at a 908 acre site located approximately 5 miles north of Emelle, Alabama. The site is situated adjacent and southeast of the intersection of State Routes 17 and 116 in Sumter County, Alabama. In 1979 approximately 100 acres in the northwest portion of the site were under development which began during 1977.

During 1979 RIA requested that Woodward-Clyde Consultants (WCC) examine and explain the implications of stains observed by site staff near ground surface on the face of an excavation for a burial trench in which it planned to dispose hazardous waste. On 6 March we observed the site and orally reported that the stains were one of several manifestations of faults which crossed the excavation. We recommended that an evaluation be made of the potential for these faults to be conduits for any leachate that might develop. WCC was retained by RIA to make the evaluation which was done using rock coring and logging, and packer permeability testing of faults encountered in the core holes. Our 1 May 1979 report concluded that faults in the burial trench vicinity had a very high resistance to flow and that future trenches be located in areas with fewer faults, if possible. Most people consider the site area to have low potential for seismic activity.

WCC proposed in an 11 May 1979 letter to collect literature, maps, photographs and imagery of the site area, analyze this information for linear features, make field observations of significant linear features to determine if they are associated with faults, and prepare a report summarizing information and recommending areas where few faults are likely to be located. Waste Management, Inc. authorized the proposed work by Purchase Order 18550 dated 16 July 1979. This report presents the results of the study. This work was done by Dr. James Smith, geologist, and Dr. Richard J. Woodward, III, project manager.

DESCRIPTION OF THE SITE

The site is situated southeast of the intersection of Alabama State Routes 17 and 116 in Sumter County, as shown in Figure 1, approximately 38 miles northeast of

Meridian, MS. Relief on site ranges from elevation 300 ft Mean Sea Level, in the central portion of the site, to elevation 130 ft Mean Sea Level at the north west corner. The ground surface consists of gently rolling hills and is tree covered except where it has been cleared.

The geologic units that crop out at the site are Upper Cretaceous sediments belonging to the Selma Group. Demopolis Chalk is encountered in the disposal trenches and it is a sedimentary formation composed of white to gray beds which range from relatively pure chalk to very impure chalk and the beds contain much clay, silt and fine to medium-grained sand, and abundant fossils. The Demopolis Chalk is a few hundred feet thick.

Below the Dempolis is a few thousand feet of formatons of chalk, sand, and clay of Cretaceous age. The sand beds are aquifers and the first aquifer below the site is several hundred feet below ground surface. The water is brackish.

Below the Cretaceous rocks there is a thin group of sedimentary rock of possible Jurassic age. Palezoic rocks a few thousand feet thick are next below, and Precambrian rocks are below the Paleozoic rocks.

The sedimentary rocks at ground surface dip gently southwestward into the Gulf geosynoline. A fault zone trending northwest across most of Sumter County, called the Livingston Fault Zone, has been mapped within a few miles southeast of the site.

The Paleozoic sedimentary rocks unconformably below the Cretaceous rocks have been highly folded and thrust faulted, and the major structural trends are northwestward. There are also a few northwest striking transverse faults which are likely to dip very steeply.

DESCRIPTION OF TECHNICAL APPROACH

The technical approach consisted of a literature review, mapping of linear features identified on satellite images, aerial photographs and topographic maps, and making field observations of significant linear features to determine if they are associated with faults.

Literature was reviewed to provide background information on general and structural geology of the area. Most of the literature was obtained at the Alabama Geological Survey office in Tuscaloosa. The satellite images chosen for review were LANDSAT images obtained from the USGS EROS Data Center, Souix Falls, S.D. Upon reviewing the listing of available images of the area four images were selected meeting the following criteria: less the 10% cloud cover; quality "5" or better; and imagery bands which enhance geologic features. High Altitude photographs were also selected from EROS Data Center listings; a false color IR printed on paper and a black/white sterographic pair printed on paper and film positives were chose. Sets of low altitude photography of the site has been obtained at three different times by the US Department of Agriculture. The set with the highest quality has been enlarged to a scale 1:4800 by RIA and this set was chosen for review. The topographic maps used were USGS 1:250,000 and 1:24,000 scale maps, and a commercial 1:1200 scale map of the Western third of the property. All literature, imagery, photographs and maps used in the study are listed in References.

Linear features or linear groups of features, called lineaments, identified from each of these sources were traced on overlays of the imagery, photographs and maps. The major lineaments which pass the site were then examined in the field to determine if they were associated with faults.

Lineaments arise from a number of sources, many of which are unrelated to geology such as a fence, and a field cleared to the property line. Some manmade features are geology related in some cases; for example, a road may tend to be aligned with a valley. Some geology related lineaments are due to local anomolies, such as a straight segment of a creek may be associated with a local weakness in the rock. Faults tend to be long linear features which often are difficult to detect at ground surface. By reviewing lineaments from a variety of remotely sensed sources, and by examining these features at ground surface it is sometimes possible to identify faults.

DISCUSSION OF LINEAMENTS

LANDSAT lineaments in the site vicinity are shown on Figure 2. No LANDSAT lineaments pass through the site. LANDSAT lineaments nearest the site trend northwestward. There is a prominent northeast trending lineaments around the site, but they are further away and less frequently than the northwest trending lineaments.

High altitude photography lineaments in the site vicinity are shown on Figure 3. Lineaments on high altigude photographs of the site vicinity principally trend northwest, and are concentrated on the northeast side of the site and a short distance southwest of the site. The second most numerous lineaments (which are also shorter than the northwest trending lineaments) are those which trend northeast. These are fairly numerous at the site.

Low altitude photography lineaments in the site vicinity are shown on Figure 4. On low altitude photographs north, northwest, and northeast trending lineaments are prominent. There are some east-west trending lineaments, two of which are prominent. There are two prominent northeast trending lineaments and two prominent north trending lineaments. The great detail on low altitude photographs at a scale of 1:4800 enhances manmade features. Several of these lineaments are roads, trails, etc.

The 1:250,000 scale topographic map lineaments in the site vicinity are shown on Figure 5. Most of the lineaments are long straight segments of streams. The lineaments show a pronounced northwest trend. One northeast trending lineament about 4 miles southwest of the site trends towards the northwest corner of the site.

The 1:24,000 scale topographic map lineaments in the site vicinity are shown on Figure 6. Most of the lineaments are long, straight stretches of valleys or streams. The longest lineaments trend northwest to west-northwest. The one most prominent west-northwest trending lineament on the site extends through the southeast corner of the site and then trends westward. A northwest trending lineament cuts across the northeast side. Several short north trending lineaments are present.

The 1:1200 scale topographic map lineaments on the western portion of the site are shown on Figure 7. Most of the linear features on the map are man-made. Linear features mainly trend northwest, but there are many other trends. Many of the features are due to roads, trails, etc. and probably do not reflect fracture patterns of the rocks. Many lineaments probably follow some fractures, but many follow property lines.

OBSERVATIONS IN BACKHOE TRENCHES

Field observations were made of prominent lineaments on the site to determine if there were ground surface manifestations of faults at the locations of these lineaments. There were no ground surface manifestations of faults observed.

Trenches were excavated with a backhoe across two lineaments at locations shown on Figure 7. Trench 1 was approximately 30 feet long and 8 feet deep and Trench 2 was approximately 50 feet long and 6 feet deep. The overburden soils were removed and the chalk surface was exposed; approximately 4 inches of weathered chalk could be excavated with the backhoe. The exposed chalk surface was examined in detail for manifestations of faults such as the oxidation discoloration which was observed in the upper few feet of chalk at locations of faults in disposal Trench 7.

The backhoe excavated trenches exposed no fractures, either joints or faults. The lineaments crossed by these trenches are associated with an east-west trending trail and a segment of an intermittent stream.

FAULTING IN SITE AREA

The Livingston Fault Zone has been mapped in the area surrounding the site; it is northwest trending and maps show it to be located southeast of the site but does not pass through the site (Schneeflock, 1972). The only published account of a fault at the site prior to disposal trench excavation is a suspected one passing along the northeast side of the company property, detected a few thousand feet below ground surface by seismic reflection profiling several miles from the site (Schneeflock, 1972).

Two faults detected by visual observation and rock coring at disposal Trenches 1, 3 and 7 strike west-northwest. In disposal Trenches 8 and 9 several faults were observed. The most prominent are five that strike west-northwest. A few north south strikiing faults were observed in disposal Trench 7 and one was observed immediately south of a road near the southern end of disposal Trench 3. The only remotely sensed sources from which the known faults could be detected are the low altitude photographs for the faults at disposal Trenches 1, 3 and 7 and to a partial extent the 1:1200 scale topographic maps for faults at disposal Trenches 8 and 9.

CONCLUSIONS AND RECOMMENDATIONS

Major lineaments at the site trend northwest to west-northwest. Minor lineaments trend northeast, east-west, and north-south. Most mapped lineaments are probably associated with geologic structure, but many are clearly manmade.

The only proven faults at the site are those in the vicinity of the disposal trenches discussed in the previous section of this report. The west-northwest faults at disposal Trenches 1, 3 and 7 are detected on only one of the remotely sensed images, the low altitude photographs. West-northwest faults at disposal Trenches 8 and 9 are detected on only one remotely sensed source, the detailed topographic map, and then only partially.

The proven faults southeast of the site, the Livingston Fault zone, strike northwest to west-northwest; the suggested fault in the Paleozoic rocks beneath the site strikes northwest.

The backhoe excavated trenches which cross two, large scale map lineaments revealed no fractures in the top surface of the chalk.

It is concluded that most lineaments mapped are not associated with faults, including those from large scale remote sensing sources.

It is recommended that in making decisions on where to locate disposal facilities on the site, a consideration be to locate in areas with few lineaments. Because there could be faults at locations where there are no lineaments, backhoe trenches should be excavated at proposed disposal trench locations to expose the top surface of the chalk for examination by a geologist for manifestations of faults.

REFERENCES

Literature

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Moser, Paul H. and Michael J. Keener (1975), "Environmental Geology of an Area in West-Central Alabama", Alabama Geological Survey Atlas Series 7, 56 p.

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Imagery

NASA LANDSAT E5 667-14491-6, 14 February 1977 (Reviewed at Alabama Geological Survey office); scale 1:250,000

NASA LANDSAT E-30052-15491-D, 26 April 1978; scale 1:250,000

NASA LANDSAT E-30231-15451-C, 22 October 1978; scale 1:250,000

NASA LANDSAT E-30250-15505-D, 10 November 1978; scale 1:250,000

High Altitude Photography

NASA - Aircraft - Standard 5 73 1453 4050, 16 September 1973, False color IR 9 in. print; scale 1:136,000

NASA - Aircraft - Standard 6 192 35-0002, 31 January 1972, B/W 9 in. print and film positive; scale 1:51,700

NASA - Aircraft - Standard 6 192 35-0003, 31 January 1972, B/W 9 in. print and film positive; scale 1:50,100

Low Altitude Photography

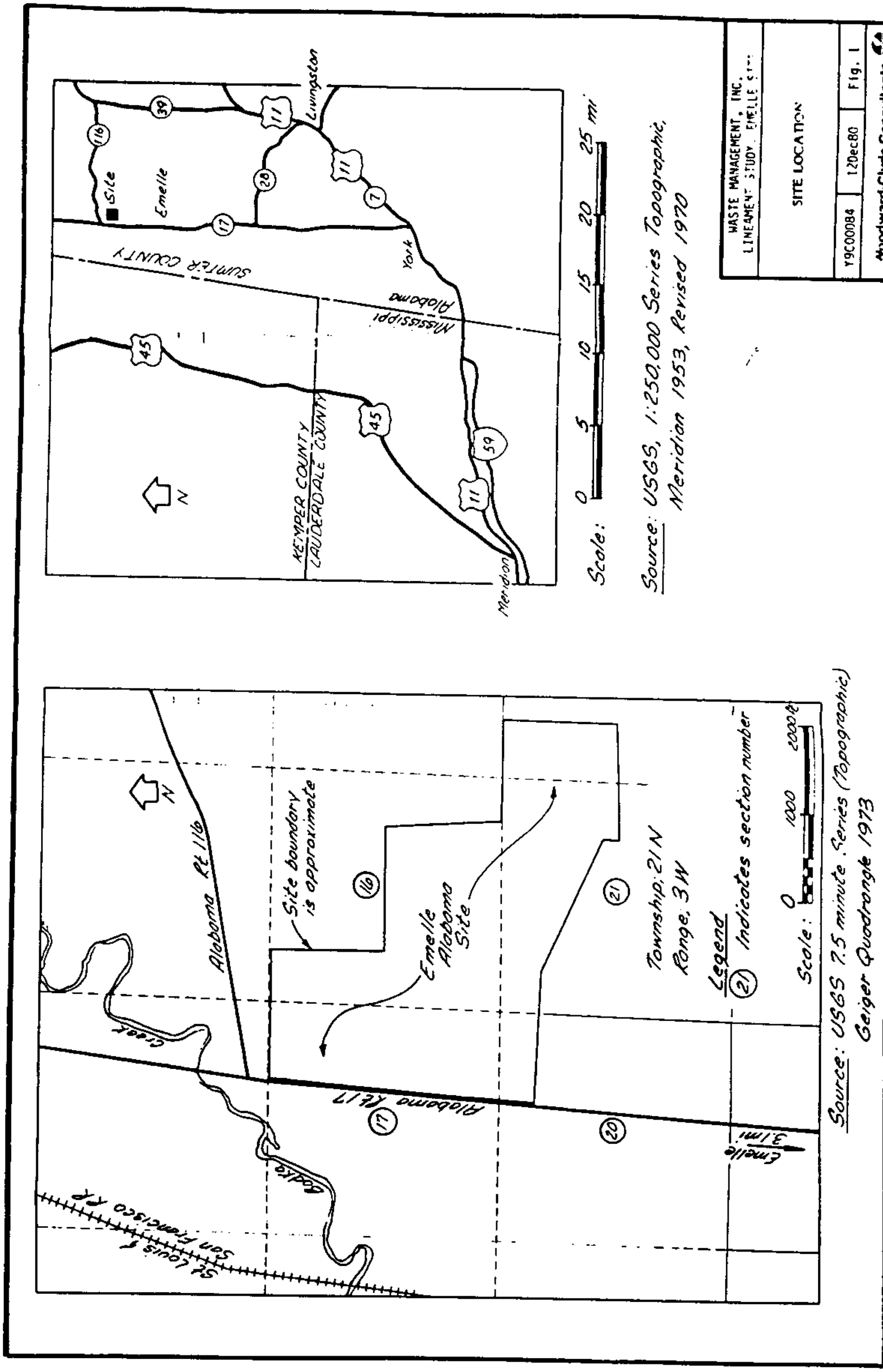
United States Department of Agriculture; scale 1:4,800

Maps

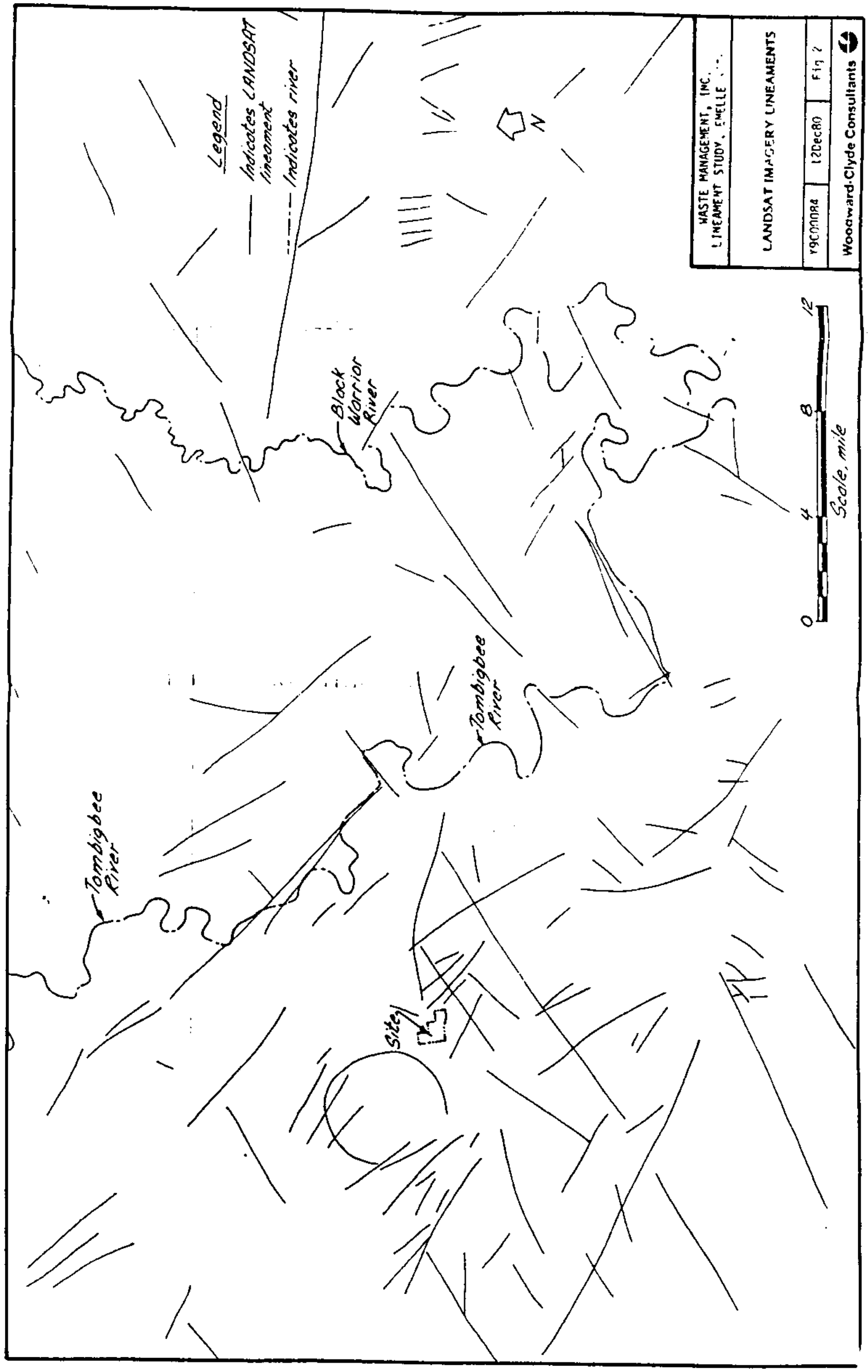
United States Geological Survey, Scale 1:250,000 series, Meridian, Miss., Ala., NI 16-10 series V501 Edition 3, 1953 Rev 1970.

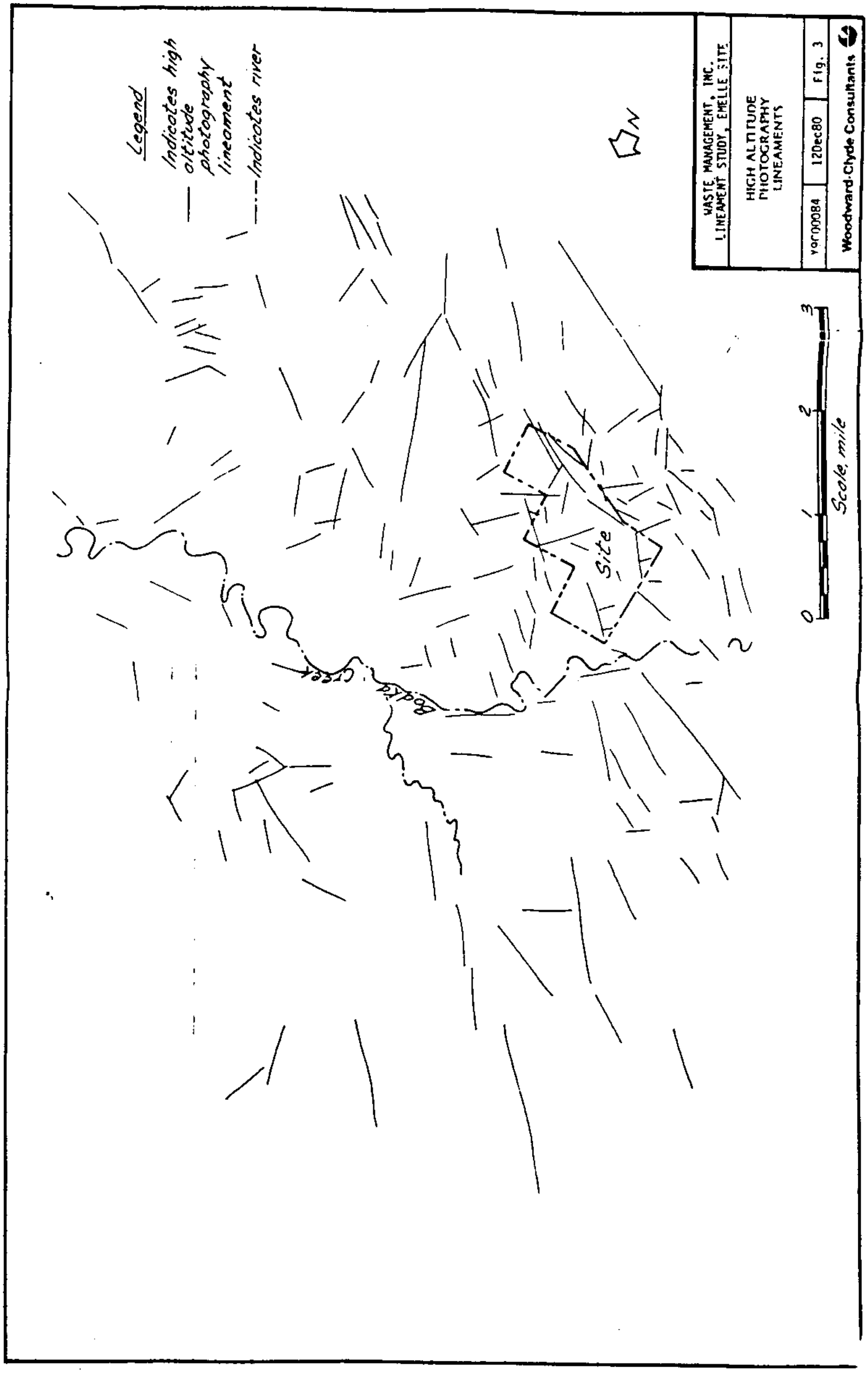
United States Geological Series, 7.5 Minute Series (Topographic) Geiger Quadrangle, Alabama-Mississippi, 1973, Sale 1:24,000

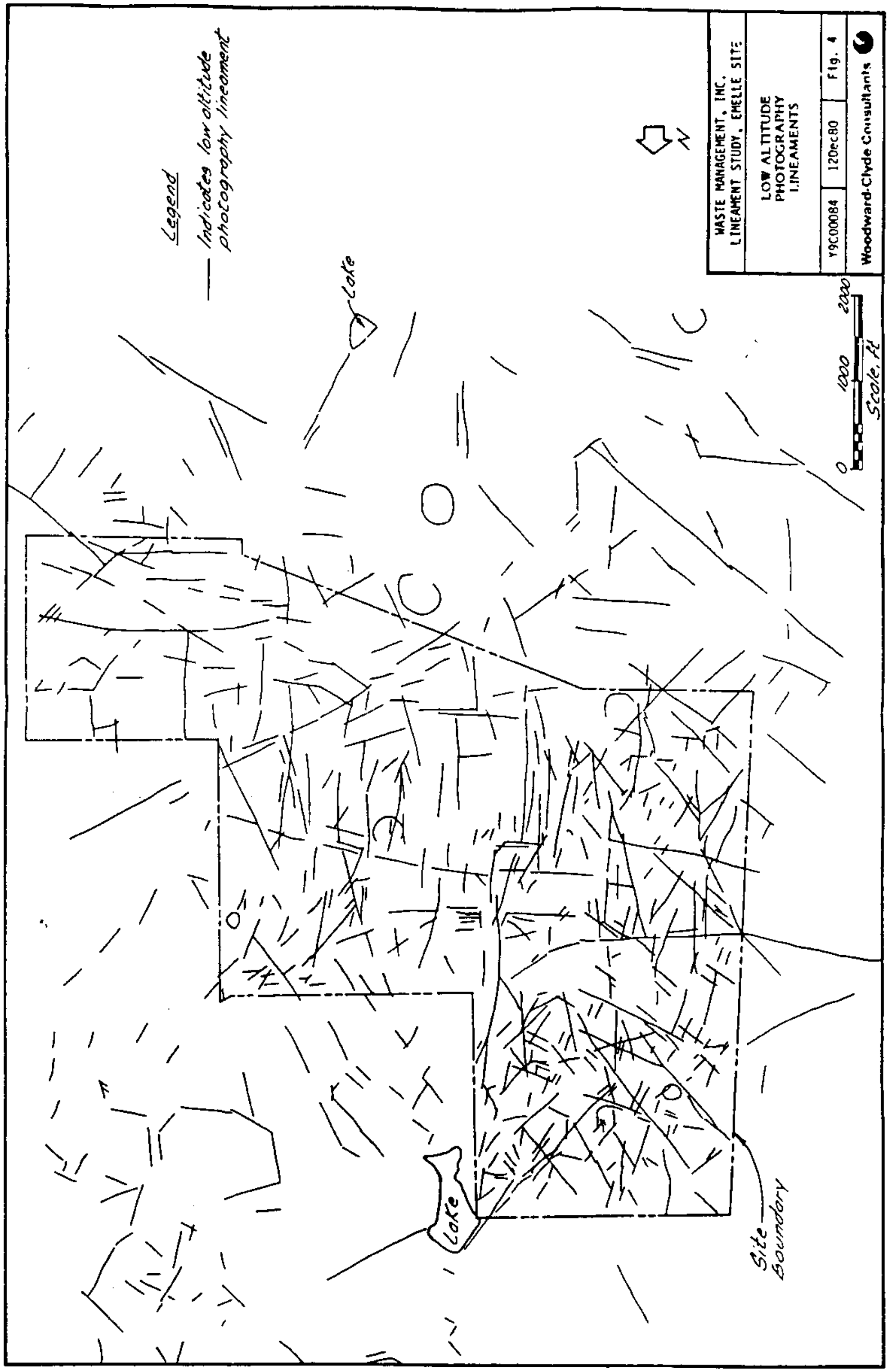
"Master Plan, Hazardous Waste Management System, Sumter County, Alabama", prepared by Gregory-Grace and Associates Incorporated, dated Feb. 6, 1978, rev. March 26, 1979; scale 1:1200

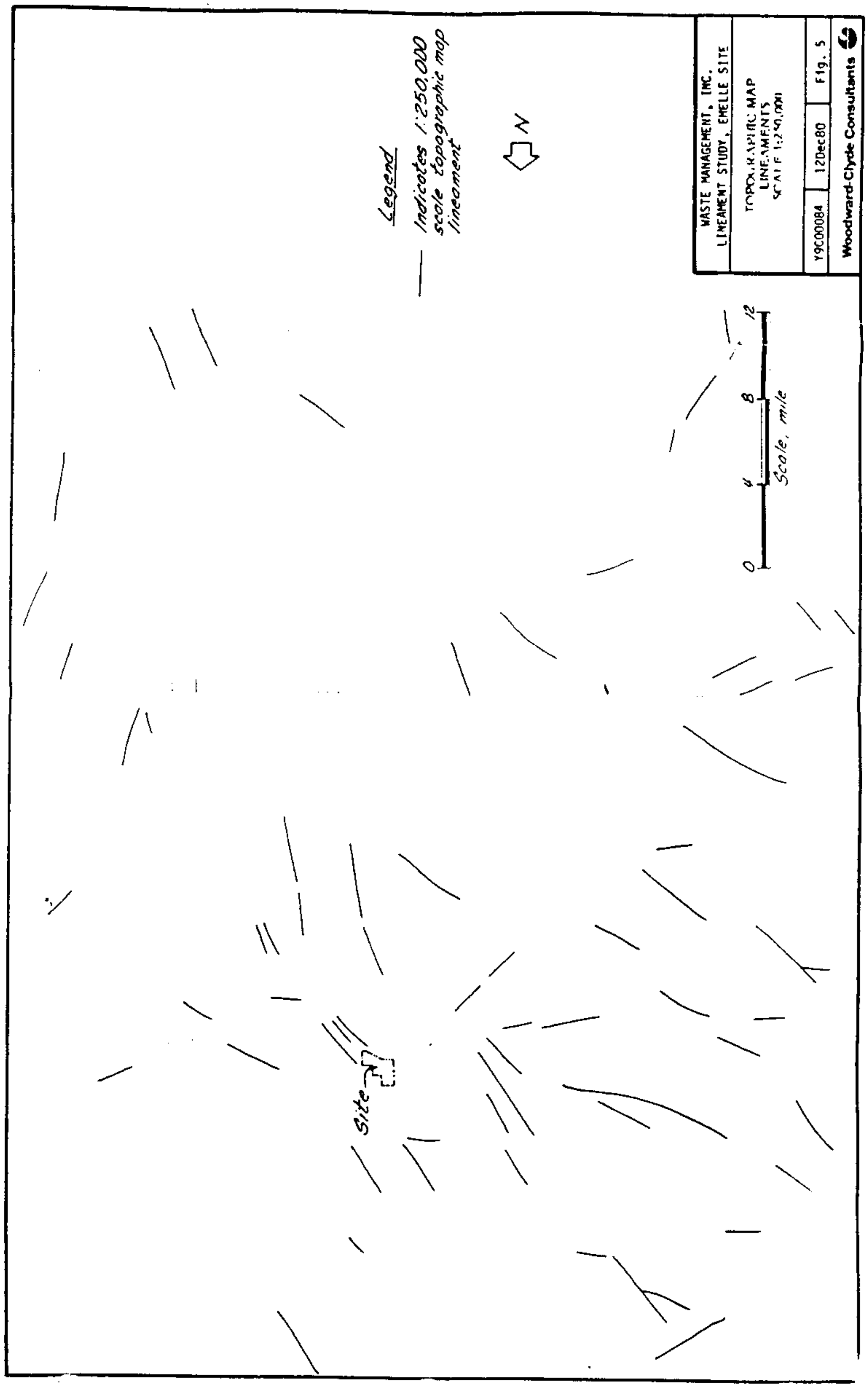


WASTE MANAGEMENT, INC.
SITE LOCATION
Y9C00084
12Dec80
Fig. 1
Woodward-Clyde Consultants
Livingston
Site
Emelle
SUMTER COUNTY
York
Mississippi
Alabama
KEMPER COUNTY
LAUDERDALE COUNTY
Meridian
Scale: 0 5 10 15 20 25 mi
Source: USGS, 1:250,000 Series Topographic, Meridian 1953, Revised 1970
Alabama Rt 116
Site boundary is approximate
Emelle Alabama Site
Alabama Rt 17
Creek
St Louis & San Francisco RR
Emelle 3.1mi
Township: 21 N
Range: 3W
Legend
(21) Indicates section number
Scale: 0 1000 2000ft
Source: USGS 7.5 minute Series (Topographic) Geiger Quadrangle 1973

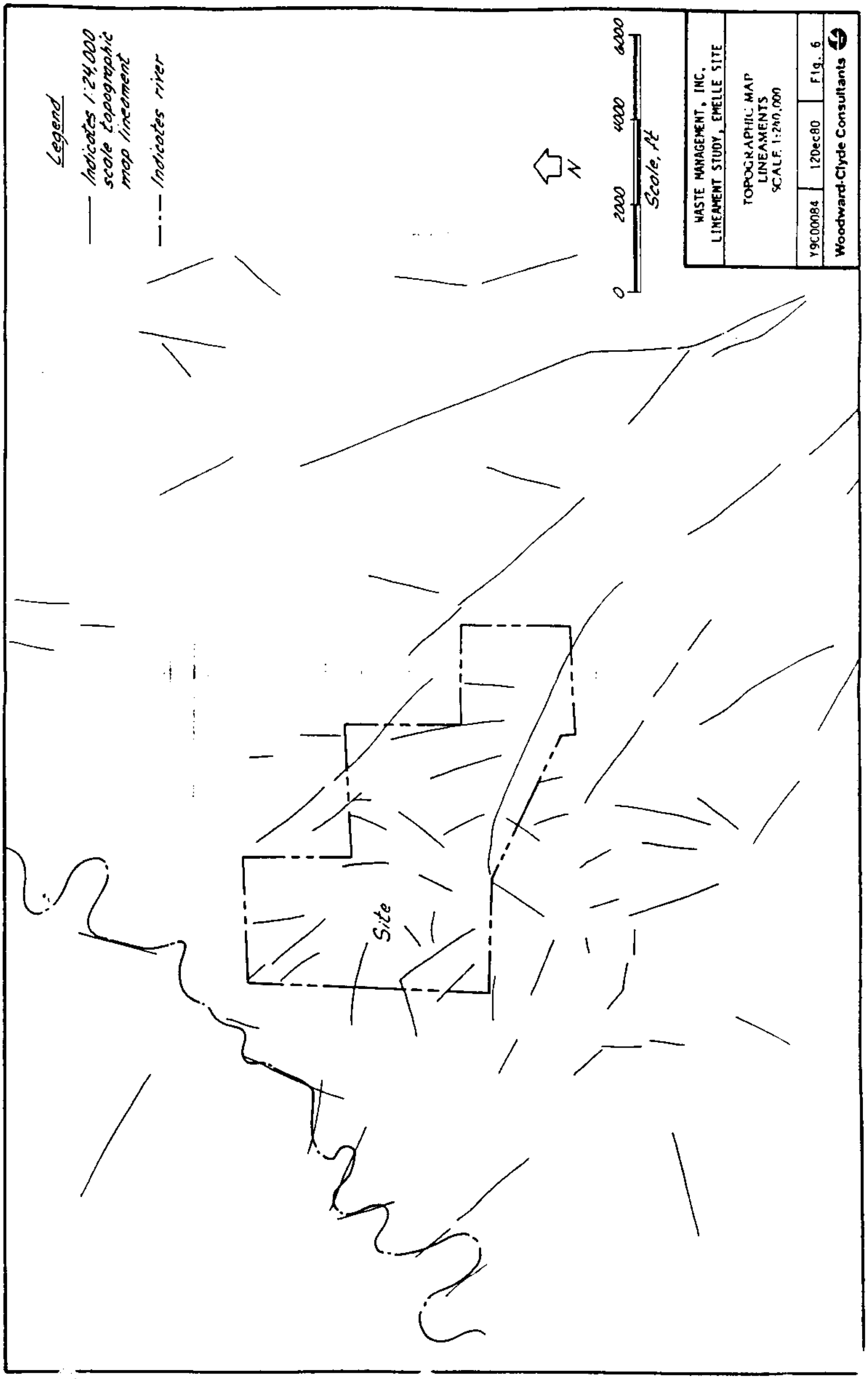

WASTE MANAGEMENT, INC.
LINEAMENT STUDY, EMELLE
LANDSAT IMAGERY LINEAMENTS
Y9C00084
12Dec80
Fig 2
Woodward-Clyde Consultants
Legend
Indicates LANDSAT lineament
Indicates river
N
Black Warrior River
Tombigbee River
Tombigbee River
Site
0
4
8
12
Scale, mile

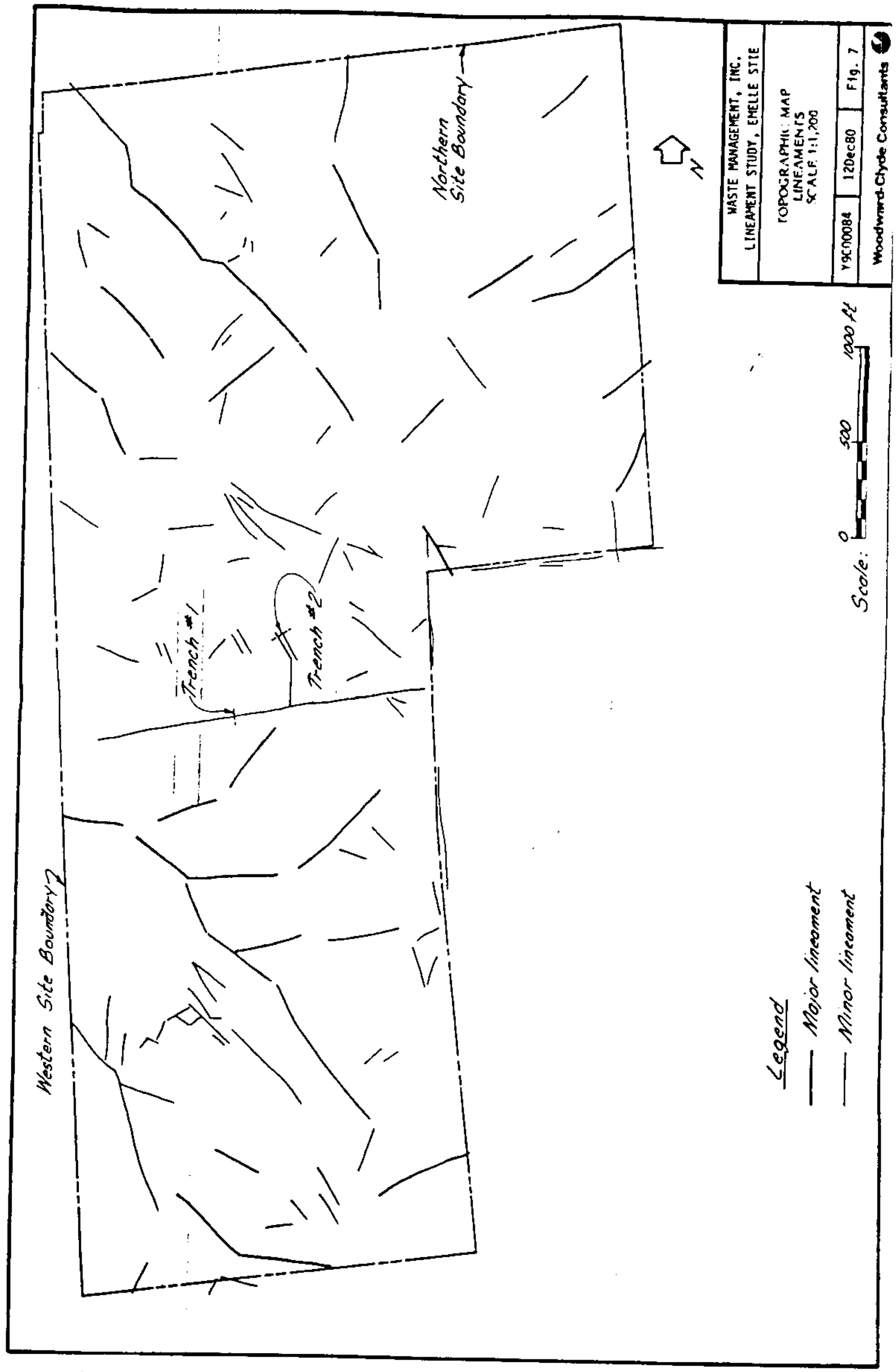

Legend
Indicates high altitude photography lineament
Indicates river
N
Site
Bodka Creek
0
1
2
3
Scale, mile
WASTE MANAGEMENT, INC.
LINEAMENT STUDY, EMELLE SITE
HIGH ALTITUDE PHOTOGRAPHY LINEAMENTS
12Dec80
Fig. 3
Woodward-Clyde Consultants


Legend
Indicates low altitude photography lineament
Lake
Lake
Site Boundary
0
1000
2000
Scale, ft
N
WASTE MANAGEMENT, INC.
LINEAMENT STUDY, EMELLE SITE
LOW ALTITUDE PHOTOGRAPHY LINEAMENTS
Y9C00084
12Dec80
Fig. 4
Woodward-Clyde Consultants



Legend
Indicates 1:250,000 scale topographic map lineament
N
0
4
8
12
Scale, mile
Site
WASTE MANAGEMENT, INC.
LINEAMENT STUDY, EMELLE SITE
TOPOGRAPHIC MAP
LINEAMENTS
SCALE 1:250,000
Y9C00084
12Dec80
Fig. 5
Woodward-Clyde Consultants


Legend
Indicates 1:24,000 scale topographic map lineament
Indicates river
N
0
2000
4000
6000
Scale, ft
Site
WASTE MANAGEMENT, INC.
LINEAMENT STUDY, EMELLE SITE
TOPOGRAPHIC MAP
LINEAMENTS
SCALE 1:240,000
Y9C00084
12Dec80
Fig. 6
Woodward-Clyde Consultants


WASTE MANAGEMENT, INC.
LINEAMENT STUDY, EMELLE STIE
TOPOGRAPHIC MAP
LINEAMENTS
SCALE 1:1,200
Y9C00084
12Dec80
Fig. 7
Woodward-Clyde Consultants
N
Northern Site Boundary
Western Site Boundary
Trench #1
Trench #2
Scale: 0 500 1000 ft
Legend
Major lineament
Minor lineament

APPENDIX E-8

SECTION E

SHALLOW MONITORING SYSTEM

EMELLE FACILITY

<u>Revision No.</u>

5.0

APPENDIX E-8

SECTION E

LIST OF DOCUMENTS

Document 1: Shallow Monitoring System, Emelle Facility, prepared by Golder Associates, revised August 22, 1985.

Document 2: 40 CFR 264 Groundwater Monitoring Waiver Demonstration, Emelle Facility, prepared by Golder Associates, dated September 1985.

Document 3: Shallow Well Recharge Information for the following wells SM-01, SM-01A, SM-02, SM-03, SM-04, SM-05, SM-05A, SM-06, SM-06A, SM-07, SM-07A, SM-08, SM-08A, SM-09, SM-09A, SM-10, SM-10A, SM-11, SM-12, SM-12A, SM-13, SM-14, SM-14A, SM-15, SM-16, SM-16A, SM-17, SM-18, SM-19, SM-20, SM-21, SM-22, SM-23, SM-23A, SM-24, SM-27, SM-28, SM-29, SMBG-01, SMBG-02, SM-30, SM-31, SM-32, and SM-33

Document 4: Revised Letter Report on Well Deviation Study, prepared by Golder Associates, dated August 1993.

Document 5: Monitoring Well Installation Information for Groundwater Monitoring Wells SM-05B, SM-05C, SM-05D, SM-05E, SM-17, SM-18, SM-18A, SM-18B, SM-18C, SM-18D, SM-19, SM-20, SM-21, SM-22, SM-23, SM-23A, SM-24, SM-27, SM-28, SM-29, SM-30, SM-31, SM-32, SM-33, SM-34, SM-35, SM-35B, SM-36, SM-37, CMI-1, CMI-2, and CMI-3.

APPENDIX E-8

DOCUMENT 1

Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

Report on

SHALLOW MONITORING SYSTEM

EMELLE FACILITY

Submitted to:

Chemical Waste Management, Inc.
2600 Delk Road, Suite 200
Marietta, Georgia 30067

DISTRIBUTION:

5 Copies - CWM, Don McCombs
1 Copy - CWM, John Baker
1 Copy - CWM, Wayne Sartin
2 Copies - Golder Associates

August 1985
Revised August 22, 1985

853-3098.2

GOLDER ASSOCIATES INC • 3772 PLEASANTDALE ROAD SUITE 185 ATLANTA GEORGIA 30340 U.S.A. • TELEPHONE (404) 496-1893 • TELEX 700573 New Page

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

February 21, 1986 853-3098

Chemical Waste Management, Inc.
2600 Delk Road, Suite 200
Marietta, Georgia 30067

Attn: Mr. Don R. McCombs, P.E.

RE: SHALLOW MONITORING SYSTEM
EMELLE FACILITY

Gentlemen:

Please find attached the Shallow Monitoring System report for the Emelle Facility. This report is the same document submitted under the title "Consent Agreement Coring Program - Emelle Facility" and outlines the details of the shallow chalk monitoring well system currently being installed. About 16 of the wells have been installed to date. Following completion of these wells "as-built" documentation will be prepared.

Golder Associates appreciates the opportunity to work on this project and should there be any questions, please contact us.

Very truly yours,

GOLDER ASSOCIATES

J. Edmund Baker, P.E.
Principal

JEB:jvw

[illegible] ROAD SUITE [illegible] ATLANTA GEORGIA [illegible] U S A • TELEPHONE (404) [illegible]

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List of Tables and Figures

1.0 INTRODUCTION

On December 19, 1984, Chemical Waste Management, Inc. signed the Emelle Consent Agreement with the United States Environmental Protection Agency. Pursuant to the Consent Agreement, Section IX RCRA COMPLIANCE REQUIREMENTS, Paragraph C(6), Chemical Waste Management was to provide a Proposed Plan and Protocol, the purpose of which was to verify the minimum travel time of 1,000 years for hazardous waste or hazardous waste constituents from the facility to migrate via the uppermost aquifer to water supply wells or surface water as outlined in the Partial Groundwater Monitoring Waiver Demonstration.

This program involves two phases, Phase I (coring), and Phase II (well construction). For a review of the Proposed Plan and Protocol, refer to Golder Associates report "Proposed Final Plan and Protocol For Consent Agreement Groundwater Monitoring Program Emelle Facility". Phase I coring commenced on May 20, 1985 and was completed on July 12, 1985. Sixteen holes around the perimeter of the existing trench system and two holes for background wells were cored. This Interim report summarizes all cleaning, coring, logging, and sampling procedures used during Phase I coring.

Also included is a discussion of discontinuities observed in the core, recommendations for Phase II well construction details based on the Phase I core holes, and recommendations for placement and number of Phase II monitoring wells. All Phase I boring logs are enclosed in Appendix A.

2.0 CLEANING AND CORING PROCEDURES

Phase I coring consisted of the coring of sixteen holes to a depth nominally twenty-five feet below the bottom of the adjacent trenches, and the coring of two background holes to a depth of approximately 100 feet each (See Table 2.1). Surveyed stakes were placed twenty feet away from active trenches and fifty feet away from closed trenches. Drilling locations were determined by choosing a point in line between the two surveyed stakes. If no point along the line fell within a couple feet of the final closure elevation, the existing ground surface was graded near the final closure elevation. Surveyed elevations and coordinates for the Phase I core holes are shown on Table 2.2. These are based on elevations and coordinates from the surrounding surveyed stakes.

The following procedures were used in the cleaning and drilling of all eighteen core holes. See Figure 2.1 for core hole location and construction.

1. All downhole equipment, the backside of the drill rig including wireline cable, wrenches, shovels, etc., were degreased prior to the drilling of each core hole using a procedure of steam cleaning, spraying with acetone, and rinsing with distilled water. This was repeated as many times as necessary to ensure properly cleaned equipment.

2. All drilling water was supplied by a fire hydrant located on Chemical Waste Management's Emelle, Alabama facility. The hydrant is fed by the city of Livingston Water System.

3. A 9 inch rotary bit was used to drill through the recompacted and/or weathered insitu chalk and into the unweathered insitu chalk. The hole was then flushed to remove cuttings from the hole.

4. The rotary bit was removed and the 6 inch diameter PVC casing was cleaned using the procedure outlined in (1). All downhole sections of casing were coupled with a PVC coupling and secured with three pop rivets to each piece of casing. No PVC glue was used. Casing stickups were nominally one foot above ground surface.

5. Bentonite pellets (1/4 inch) were then poured around the casing and allowed to set a minimum of 45 minutes before coring began.

6. A PVC T-joint and a 4 inch diameter PVC extension tube were placed on the casing to ensure proper run off of drill water. Both pieces were cleaned following the procedure in (1) before being placed on the casing.

7. Drill water was not recirculated as the core hole was advanced.

8. "Crisco" brand shortening was used as a lubricant on all downhole drilling equipment.

9. Samples of bentonite pellets, drilling water, "Crisco" shortening, acetone, PVC, and rivets were archived with Chemical Waste Management, Inc. at the Emelle facility.

10. All core not taken as samples were placed in wood core boxes, marked with job number, job name, core hole number, and interval length. All boxes were stored on site.

11. All core holes were flushed with potable water at completion to remove cuttings from the coring operation.

12. A nominal five foot length of 6 inch diameter PVC casing (with bell shaped end or PVC coupling) was pushed over each casing and capped with a PVC push-on cap. Both casing and cap were cleaned following the procedure outlined in (1). These will be removed when Phase II well construction begins.

TABLE 2.1
PHASE I CORING DEPTHS

Core Hole No.	Surface Elevation(ft-msl)	Insitu Chalk[1] Depth(ft)	Insitu Chalk[1] Elevation(ft-msl)	Casing Depth(ft)	Casing Elevation(ft-msl)	Bottom of Core Hole Depth(ft)	Bottom of Core Hole Elevation(ft-msl)	Depth Below Bottom of Adjacent Trench (ft)	Adjacent Trench
BG-1	285	0	285	20.1	265	100.1	185	----	---
BG-2	260	0	260	9.6	250	100.0	160	----	---
CA-1	174.0	5	169	10.0	164.0	75.1	98.9	31.1	19
CA-2	195.2	5	190	9.0	186.2	145.0	50.2	24.8	18
CA-3	204.3	7	197	13.5	190.8	85.4	118.9	26.1	17
CA-4	225.0	0	225	10.0	215.0	105.0	120.0	25.0	17
CA-5	251.3	10	241	13.6	237.7	100.0	151.3	23.7	9
CA-6	262.8	14	249	19.0	243.8	135.3	127.5	32.5	10
CA-7	267.0	4	263	9.0	258.0	115.0	152.0	27.0	11
CA-8	251.8	5	247	8.9	242.9	175.0	76.8	28.2	20
CA-9	242.6	0	243	9.0	233.6	150.0	92.6	27.4	20
CA-10	191.3	25	166	26.0	165.3	110.0	81.3	25.7	21
CA-11	197.7	55	143	59.0	138.7	100.0	97.7	27.3	16
CA-12	191.4	30	161	31.0	160.4	130.0	61.4	28.6	15
CA-13	208.2	16	192	23.4	184.8	140.5	67.7	22.3	15
CA-13a	209	25	184	*	*	28.2	180.8	----	15
CA-14	212.4	6	206	9.9	202.5	80.6	131.8	33.2	13a
CA-15	217.6	7	211	12.3	205.3	85.4	132.2	32.8	13a
CA-16	243.5	37	207	40.0	203.5	95.0	148.5	26.5	8

[1] Estimated to nearest foot

New Page
February 24, 1986

TABLE 2.2

SURVEYED LOCATIONS AND ELEVATIONS FOR
PHASE I CORE HOLES

Core Hole No.	Northing[1]	Easting[1]	Elevation (ft-msl)
BG-1	*	*	285.0
BG-2	*	*	260.0
CA-1	14584	7049	174.01
CA-2	13809	7772	195.23
CA-3	13405	7774	204.34
CA-4	13144	7265	224.98
CA-5	12678	6984	251.27
CA-6	12191	7005	262.80
CA-7	11758	7018	267.02
CA-8	10775	7015	251.81
CA-9	10533	6753	242.58
CA-10	10750	5478	191.26
CA-11	11433	5465	197.69
CA-12	12160	5267	191.40
CA-13	12442	5463	208.22
CA-14	12515	5685	212.42
CA-15	12664	5934	217.56
CA-16	12691	6335	243.53

1 Estimated from surveyed stakes.
* Not presently surveyed, elevation estimated from topographic map.

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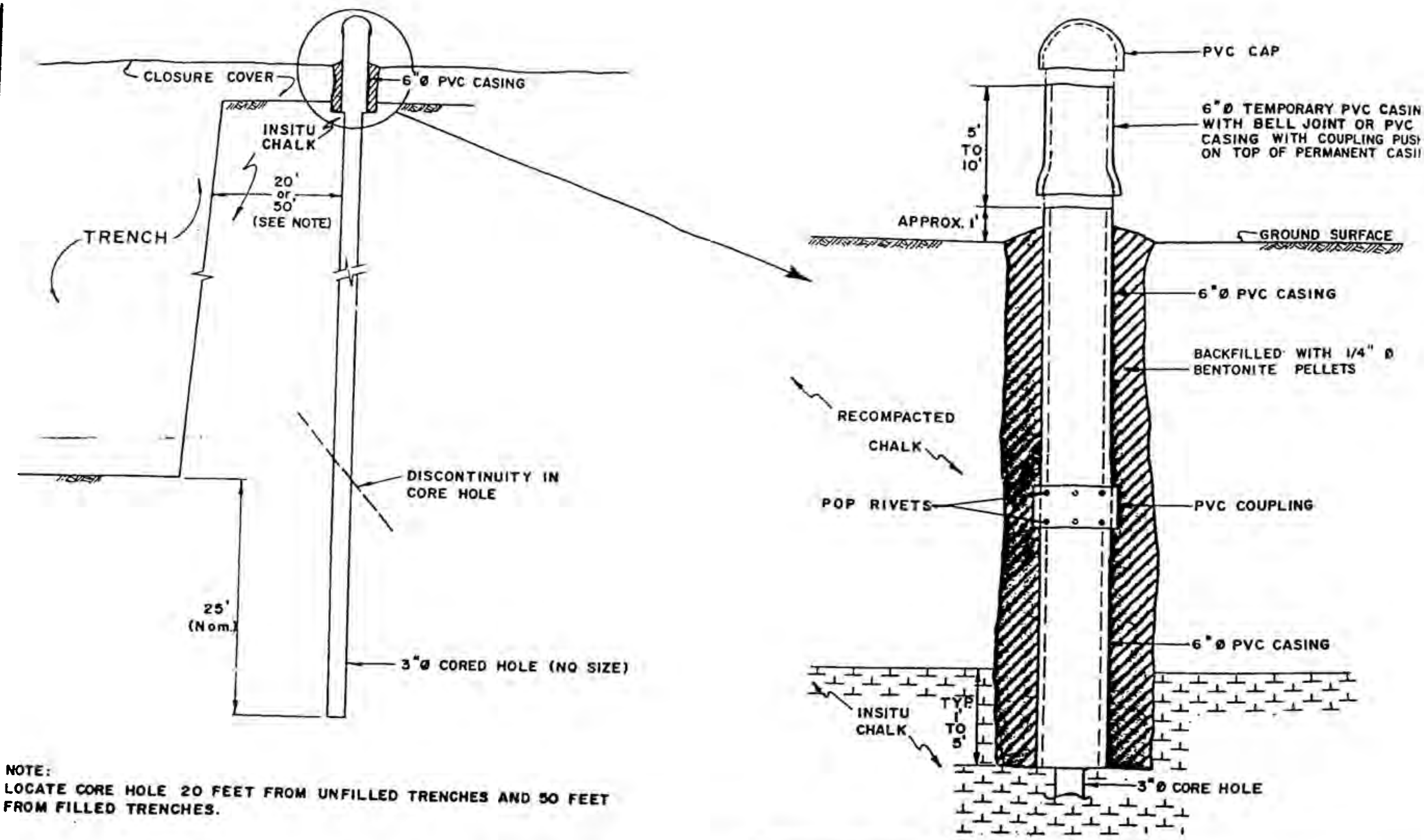
February 24 [illegible]



NOTE:
LOCATE CORE HOLE 20 FEET FROM UNFILLED TRENCHES AND 50 FEET FROM FILLED TRENCHES.

JOB NO. 853-3098	SCALE NOT TO SCALE	TYPICAL CORE HOLE LOCATION AND CONSTRUCTION		
DRAWN SKB	DATE 7-17-85			
CHECKED FHW	DWG. NO. 99			
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE	2.1

3.0 SAMPLING AND LOGGING PROCEDURES

To provide as few mechanical breaks in the chalk core as possible, an NQ size triple-tube barrel (NQTT) was used for all coring with the exception of run number 3 in RC-1. With exception to the few cases of overcoring (when more than 10.2 feet of core is pushed into the core barrel of 10.2 feet in length), core recovery and the core Rock Quality Designation (RQD) were generally very good, allowing all non-mechanical breaks to be easily observed and logged.

The following procedures were used to sample, store, and preserve all core samples taken by Golder Associates.

1. Each core run was removed from the NQTT barrel and placed in a trough especially made for core logging.
2. The core was logged using the log sheet format seen in Appendix A. The core logging key is also shown in Appendix A.
3. Fractured core to be sampled was removed from the trough and wrapped twice in plastic wrap, twice in aluminum foil, and once in duct tape. This procedure preserved the moisture of the sample.
4. The sample was then labeled with core hole number and sample interval. See Table 3.1 for a list of samples taken.
5. Where a sample was removed from the core run, a wooden block marked with the sample interval was placed in the core box.
6. All unsampled core were then placed in appropriately labeled wood core boxes marked with job number, job name, core hole number, and interval length. All boxes were photographed by Golder Associates and stored on site at Chemical Waste Management's Emelle, Alabama facility.
7. All fracture core samples were taken to Golder Associates and further preserved with a coating of paraffin wax.

8. All core samples are stored at Golder Associate's Atlanta office.

TABLE 3.1

LIST OF DISCONTINUITIES SAMPLED

Core hole No.	Depth (ft)	Elevation (ft-msl)
BG-1	69.4-69.9	---
BG-2	No Samples	
CA-1	48.8-50.5	125.2-123.5
	68.3-69.4	105.7-104.6
CA-2	No Samples	
CA-3	No Samples	
CA-4	39.6-40.6	185.4-184.4
CA-5	53.5-54.6	197.8-196.7
CA-6	50.9-52.0	211.9-210.8
	73.6-74.4	189.2-188.4
	83.5-84.2	179.3-178.6
CA-7	19.6-20.9	247.4-246.1
	52.0-52.8	215.0-214.2
	60.9-61.6	206.1-205.4
	93.9-94.9	173.1-172.1
	106.8-107.7	160.2-159.3
CA-8	85.0-85.9	166.8-165.9
	89.7-90.7	162.1-161.1
	109.6-110.7	142.2-141.1
	112.9-115.0	138.9-136.8
	116.8-118.3	135.0-133.5
CA-9	55.0-55.9	187.6-186.7
	75.9-77.0	166.7-165.6
	143.0-144.5	99.6-98.1
CA-10	48.2-48.9	143.1-142.4
	79.3-79.5	112.0-111.8
CA-11	84.0-84.8	113.7-112.9
CA-12	60.2-61.7	131.2-129.7
CA-13	139.5-140.4	68.7-67.8
CA-14	33.2-34.7	179.2-177.7
	50.3-51.4	162.1-161.0
	57.4-59.4	155.0-153.0
CA-15	No Samples	
CA-16	78.8-80.9	164.7-162.6

New Page

4.0 FRACTURES

The coring of holes BG-1 through CA-16 produced a fairly low total number of discontinuities. The majority of breaks in the core were mechanical and broken perpendicular to near perpendicular to the core axis. The core holes averaged approximately three natural fractures each, with CA-8 containing the most with sixteen. Five core holes contained no discernible natural fractures. These were CA-2, CA-3, CA-11, CA-13, and CA-15.

Zones containing slickensides were the most common natural discontinuities present in the chalk core. Natural joints were much less frequently encountered. Healed joints were seen in BG-1 at 69.8 feet and 70.3 feet, CA-1 at 30.0 feet, CA-6 at 51.4 feet, CA-7 at 20.3 feet, and CA-12 at 49.5 feet. Open joints were rare. Only four were encountered during Phase I coring. The few open joints that were found were located in CA-7 at 61.4 feet, CA-8 at 85.2 feet and 85.6 feet, and CA-9 at 55.6 feet. All joints were very tight with no discernible space between discontinuity sides.

Slickensides contained within the core were generally very clean and exhibited no signs of staining. One zone, however, did show signs of water movement. In CA-8, disseminated pyrite was found in the fracture at 110.0 feet below ground surface. This fracture was one of thirteen in a zone of about eight feet in length.

Nine core holes contained zones of multiple shear fractures. These were CA-1 from 49.4 to 50.2 feet, CA-5 from 53.9 to 54.1 feet, CA-7 from 52.3 to 55.4 feet, CA-8 from 109.9 to 117.3 feet, CA-9 from 76.5 to79.3 feet, CA-12 from 57.1 to 61.3 feet, CA-14 from 50.5 to 51.0 feet and

57.8 to 59.9 feet, and CA-16 from 79.4 to 80.5 feet. CA-4 contained one fracture at 40.0 feet and CA-10 contained single fractures at 48.9 feet and 79.5 feet.

A color correlation was seen between some of these zones and the chalk. As a number of zones were approached, the chalk became a slightly lighter gray, and the darker gray banding normally very prevalent was not as pronounced. Below the zone, the chalk returned to the earlier gray and dark gray pattern.

5.0 RECOMMENDED FRACTURE MONITORING DEPTHS

Based on the core logs obtained from CA-1 through CA-16, it was found that eleven of the sixteen holes contained fractures. Two of these contained only individual fractures, while the remaining nine showed zones of multiple discontinuities.

Five core holes, CA-2, CA-3, CA-11, CA-13, and CA-15, contained no natural fractures and one core hole, CA-4, had no fractures below the leachate in the adjacent landfill trench. It is recommended that these six be reamed out to a depth of twenty-five feet below the bottom of the adjacent trench, screened with ten foot sections of slotted PVC, and monitored at this elevation. No second Phase II well should be installed at these six locations.

Golder Associates recommends the remaining core holes be monitored across a particular fracture or set of fractures found within each hole. Core holes CA-1, CA-5, CA-6, CA-7, CA-9, CA-12, CA-14, and CA-16 have particular zones that contain the majority of fractures found within each core hole. With the exception of CA-8, these zones are relatively small (0.2 ft. to 4.2 ft.) and can be monitored with a five foot screen. Core hole CA-8 contains a shear zone approximately eight feet long, and should be monitored with a ten foot PVC screen. This screen interval is longer than the five feet specified in the Final Plan and Protocol document but is considered appropriate in this case. Core holes CA-9, CA-14 and CA-16 contain fracture zones that lie approximately ten feet below the bottom of the adjacent trenches. It is recommended that these core holes be completed as wells with a ten foot screen at or near the base of the core hole. This will allow these wells to screen fracture zones, as well as monitor approximately twenty-five feet below the bottom of the adjacent trenches. This is a condition which was not anticipated in the Final Plan and Protocol document but this approach is considered appropriate.

Core hole CA-10 contains two fractures spaced 30.6 feet apart. It is recommended that the uppermost fracture, at 48.9 feet, be monitored. This will provide a screened interval about halfway down Trench 21 in CA-10, and below the bottom of Trench 21 in the adjacent Phase II well.

All recommended fracture zones and screened intervals are shown on Table 5.1. Measured leachate levels are shown on Table 5.2.

TABLE 5.1
RECOMMENDED INTERVALS TO BE MONITORED

Core hole	Fracture Zone		Screen Interval		Casing	
No.	Depth (ft)	Elevation (ft-msl)	Depth (ft)	Elevation (ft-msl)	Depth (ft)	Elevation (ft-msl)
BG-1	---	---	89.0-99.0	196.0-186.0	20.1	265.0
BG-2	---	---	89.0-99.0	171.0-161.0	9.6	250.0
CA-1	49.4-50.2	124.6-123.8	47.0-52.0	127.0-122.0	10.0	164.0
CA-2	no fractures	---	135.0-145.0	60.2-50.2	9.0	186.2
CA-3	no fractures	---	75.4-85.4	128.9-118.9	13.5	190.8
CA-4	no fracture above leachate	---	75.0-85.0	150.0-140.0	60.0*	165.0
CA-5	53.9-54.1	197.4-197.2	51.0-56.0	200.3-195.3	13.6	237.7
CA-6	83.6-84.0	179.2-178.8	82.0-87.0	180.8-175.8	77.0*	185.8
CA-7	93.9-94.9	173.1-172.1	92.0-97.0	175.0-170.0	88.0*	179.0
CA-8	109.9-117.3	141.9-134.5	109.0-119.0	142.8-132.8	104.0*	147.8
CA-9	143.0-144.5	99.6-98.1	140.0-150.0	102.6-92.6	135.0*	107.6
CA-10	48.9	142.4	46.0-51.0	145.3-140.3	26.0	165.3
CA-11	no fractures	---	90.0-100.0	107.7-97.7	59.0	138.7
CA-12	57.1-61.3	134.3-130.1	57.0-62.0	134.4-129.4	31.0	160.4
CA-13	no fractures	---	130.5-140.5	77.7-67.7	23.4	184.8
CA-14	57.8-59.9	154.6-152.5	56.0-66.0	156.4-146.4	53.0*	159.4
CA-15	no fractures	---	75.4-85.4	142.4-132.2	12.3	205.3
CA-16	79.4-80.5	164.1-163.0	77.0-87.0	166.5-156.5	40.0	203.5

*Original casing removed and reset between monitored fracture and fracture above.

New Page
February 24, 1986

TABLE 5.2
LEACHATE ELEVATIONS

Trench No.	Leachate Elevation(1) (ft-msl)
8	223
9	235
10	279
11	190
13a	189
15	149
16	181
17	167
18	See note 2
19	See note 3
20	161
21	See note 3

Notes: 1) Leachate levels measured on February 13, 1985 except for Trenches 20 and 17 which were measured on August 13, 1985.

2) Trench 18 is an operational trench.

3) Trenches 19 and 21 are lined trenches with leachate collection and removal systems.

New Page
February 2-

6.0 PHASE II DRILLING AND WELL INSTALLATION

Upon agreement by the United States Environmental Protection Agency (USEPA), Alabama Department of Environmental Management (ADEM), and Chemical Waste Management, Inc. as to which fractures found in Phase I coring will be monitored, the Phase II drilling and well installation will commence. Figure 6.1 shows the proposed well construction details for coreholes with no fractures and Figure 6.2 shows the well completions for coreholes with fractures. Table 6.1 shows the depths of the second adjacent wells for coreholes with fractures. The installation procedure for these wells is outlined below.

1. All downhole equipment, the backside of the drill rig, wrenches, shovels, etc., will be degreased prior to the drilling of each well using a procedure of steam cleaning, spraying with reagent grade acetone, and rinsing with potable water followed by distilled water. This will be repeated as many times as necessary to ensure properly cleaned equipment. The final step will be steam cleaning in order to vaporize any acetone left on the equipment.

2. If setting a well at a known fracture zone, seal the bottom portion of the core hole (beneath the fracture zone) with a thick bentonite slurry. Place 2 feet of bentonite pellets above the slurry. If more than one fracture zone is present, remove the existing PVC casing and reinstall to near the top of the fracture zone. See Table 5.1 for casing depths.

3. Ream the core hole to 5-1/2 inch diameter using potable water as the circulation fluid. Depth of the reamed hole will be about 3 feet below the fracture interval to be screened.

4. After reaming, flush the hole with potable water to remove cuttings.

5. Install a 2 inch threaded PVC pipe to the depth of the fracture with the bottom pre-determined interval slotted (0.010 inch slots). The slotted section will be placed such that the fracture zone

is in the center of the 5 foot section of slotted pipe. The bottom will be sealed with a threaded plug and all threaded joints will be wrapped with Teflon tape to prevent leakage.

6. Install a washed sand pack around the slotted section and 2 feet above.

7. Place a bentonite pellet seal (minimum thickness of 2 feet) above the sand.

8. After hydration of the bentonite pellet seal, place a thick bentonite slurry to within 3 feet of the surface.

9. Remove approximately 1 ft. of subsoil and hydrated bentonite from around the outside of the 6 inch diameter PVC casing. Push an 8 inch diameter aluminum protective casing into the bentonite, and fill inside to the top of the 6 inch diameter PVC casing with cement grout. Pour cement grout around the outside of the casing. A 6 inch thick layer of sand should then be placed inside the aluminum protective casing and a weep hole cut through the 8 inch diameter casing into the sand pack. The casing should be sealed with a locking aluminum cap. See Figure 6.3 for Well Head Design.

10. Pump the well dry of drilling water after completion.

The second monitoring well, if required, will be installed to full depth as follows. The second well will be located within 10 feet of the first well (see Figure 6.2).

1. All downhole equipment, the backside of the drill rig, wrenches, shovels, etc., will be degreased prior to the drilling of each well using a procedure of steam cleaning, spraying with reagent grade acetone, and rinsing with potable water followed by distilled water. This will be repeated as many times as necessary to ensure properly cleaned equipment. The final step will be steam cleaning in order to vaporize any acetone remaining on the equipment.

2. Drill a nominal 8 inch borehole to a depth of about 10 feet below the base of the adjacent trench.

3. Set a 6 inch PVC surface casing to full depth and backfill with a thick bentonite slurry.

4. Rotary drill a 5-1/2 inch diameter hole to about 25 feet below the bottom of the adjacent landfill trench (15 feet below the base of the casing).

5. After drilling, flush the hole with potable water to remove cuttings.

6. Set a 2 inch threaded PVC pipe to the bottom of the hole with the bottom 10 feet slotted (0.010 inch slots).

7. Install a washed sand pack around the slotted section and 2 feet above.

8. Place a bentonite pellet seal (minimum thickness of 2 feet) above the sand.

9. After hydration of the bentonite pellet seal place a bentonite slurry to within 3 feet of the surface.

10. Remove approximately 1 ft. of subsoil and hydrated bentonite from around the outside of the 6 inch diameter PVC casing. Push an 8 inch diameter aluminum protective casing into the bentonite, and fill inside to the top of the 6" diameter PVC casing with cement grout. Pour cement grout around the outside of the casing. A 6 inch thick layer of sand should then be placed inside the aluminum protective casing and a weep hole cut through the 8 inch diameter casing into the sand pack. The casing should be sealed with a locking aluminum cap. See Figure 6.3 for Well Head Design.

11. Pump the well dry of drilling water after completion.

All wells will be installed in a manner to minimize cross contamination or contamination due to foreign materials. Extreme caution will be observed to avoid contamination of all well casing and downhole tools. All materials used during the construction of the groundwater monitoring wells will be sampled and archived for future testing if necessary. In addition to the core logs, detailed well construction logs will be maintained on each well as shown in Figure 6.3 and the elevation and horizontal coordinates for each well will be surveyed.

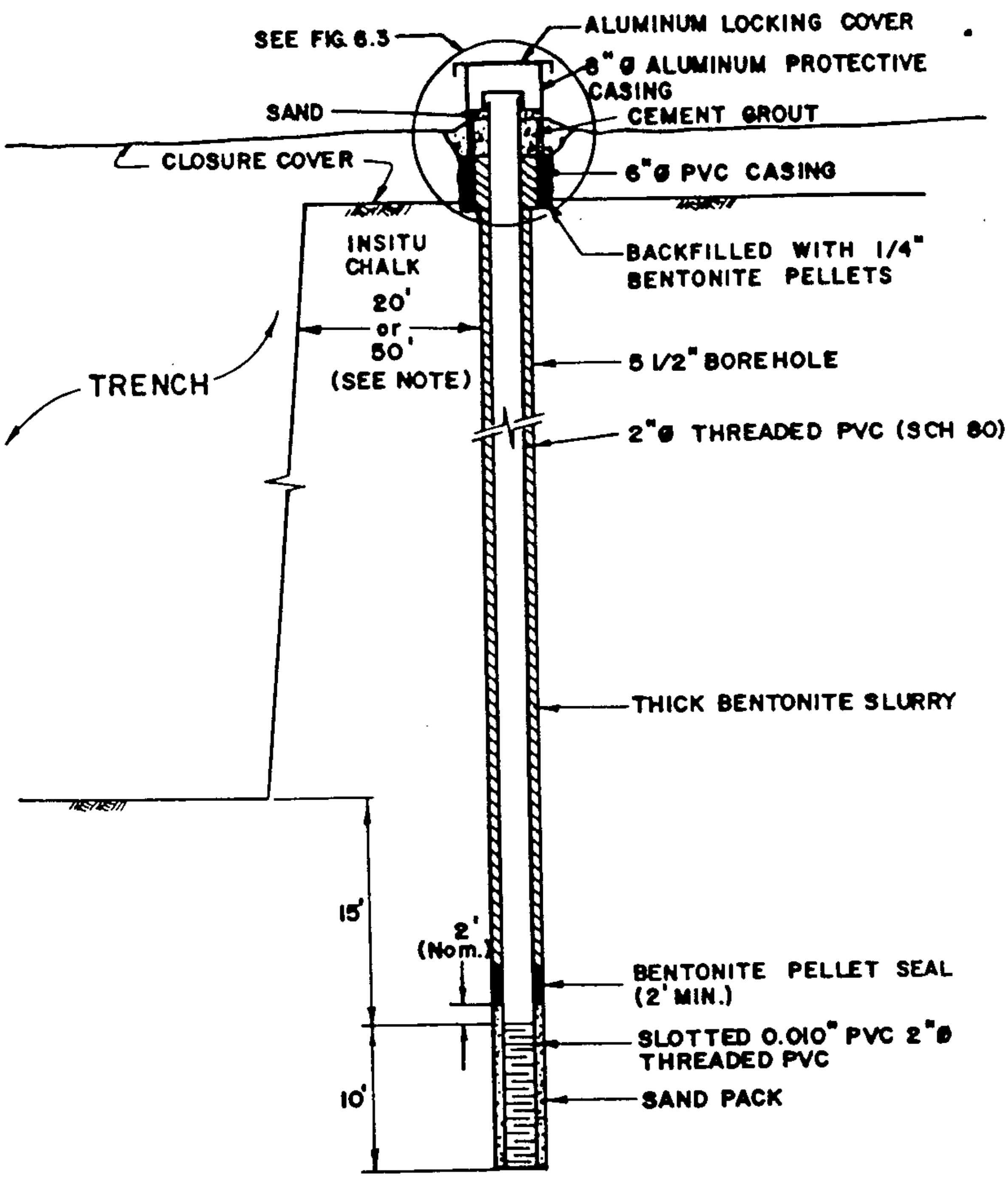
TABLE 6.1

RECOMMENDED PHASE II MONITORING WELL DRILLING AND INSTALLATION

Phase I	Phase II	Phase II 6 Inch Casing		Phase II Bottom of Well		Phase II Screened Interval	
Core hole No.	Well No.	Depth (ft)[1]	Elevation (ft-msl)	Depth(ft)[1]	Elevation (ft-msl)[2]	Depth (ft)[1]	Elevation (ft-msl)
BG-1	No second well	---	---	---	---	---	---
BG-2	No second well	---	---	---	---	---	---
CA-1	CA-1 (II)	54	120	69	105	59-69	115-105
CA-2	No second well	---	---	---	---	---	---
CA-3	No second well	---	---	---	---	---	---
CA-4	No second well	---	---	---	---	---	---
CA-5	CA-5 (II)	86	165	101	150	91-101	160-150
CA-6	CA-6 (II)	113	150	128	135	118-128	145-135
CA-7	CA-7 (II)	98	169	113	154	103-113	164-154
CA-8	CA-8 (II)	157	95	172	80	162-172	90-80
CA-9	No second well	---	---	---	---	---	---
CA-10	CA-10 (II)	94	97	109	82	99-109	92-82
CA-11	No second well	---	---	---	---	---	---
CA-12	CA-12 (II)	111	80	126	65	116-126	75-65
CA-13	No second well	---	---	---	---	---	---
CA-14	No second well	---	---	---	---	---	---
CA-15	No second well	---	---	---	---	---	---
CA-16	No second well	---	---	---	---	---	---

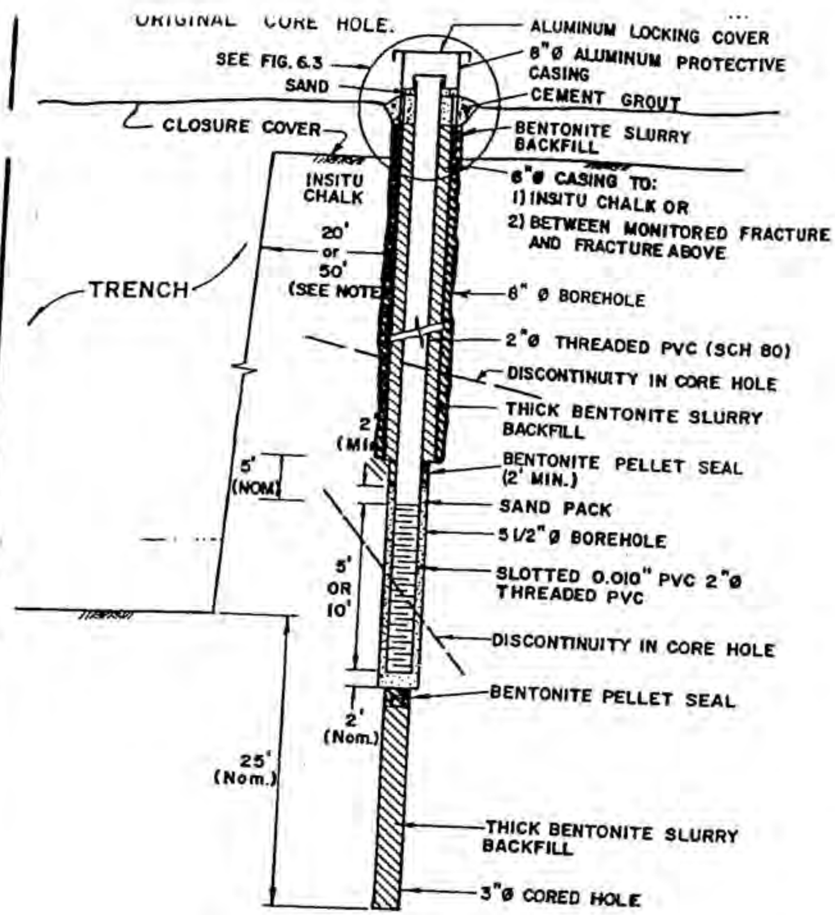
1) Based on Adjacent Phase I Corehole groundsurface elevation.
See Table 2.1.
[illegible] adjacent trench.

New Page
February 21, 1996

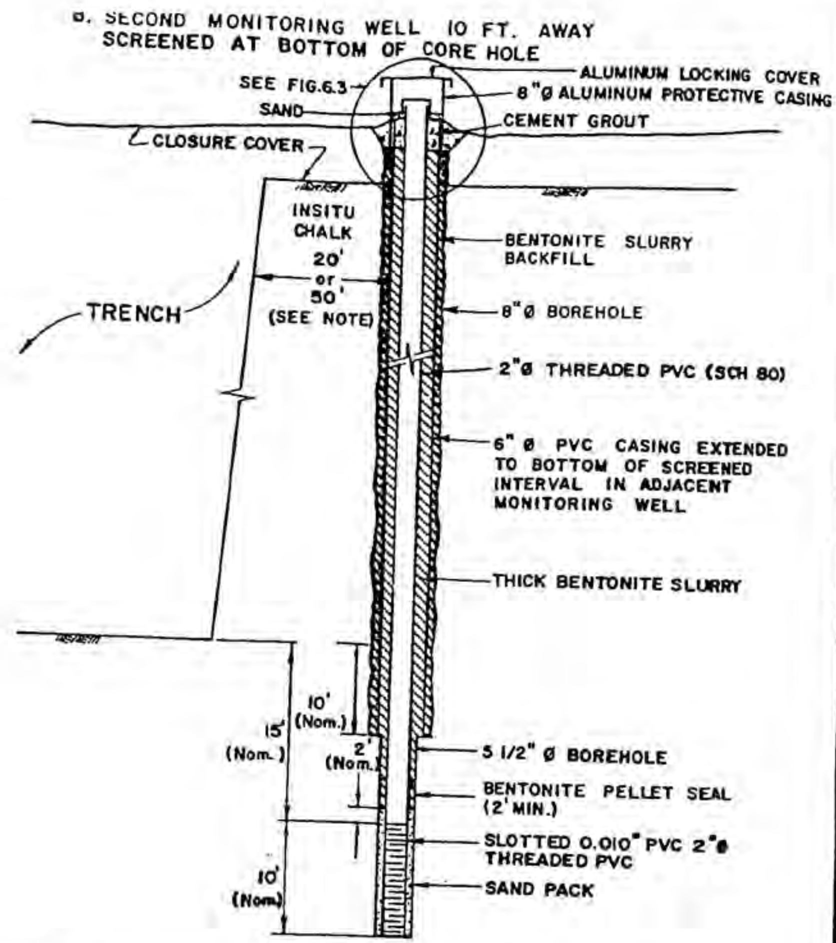


NOTE:
LOCATE WELL 20 FEET FROM UNFILLED TRENCHES AND 50 FEET FROM FILLED TRENCHES.

JOB NO 853-3098	SCALE NOT TO SCALE	TYPICAL SINGLE MONITORING WELL
DRAWN LJW	DATE 7/16/85	
CHECKED FAW	DWG NO 101	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 6.1



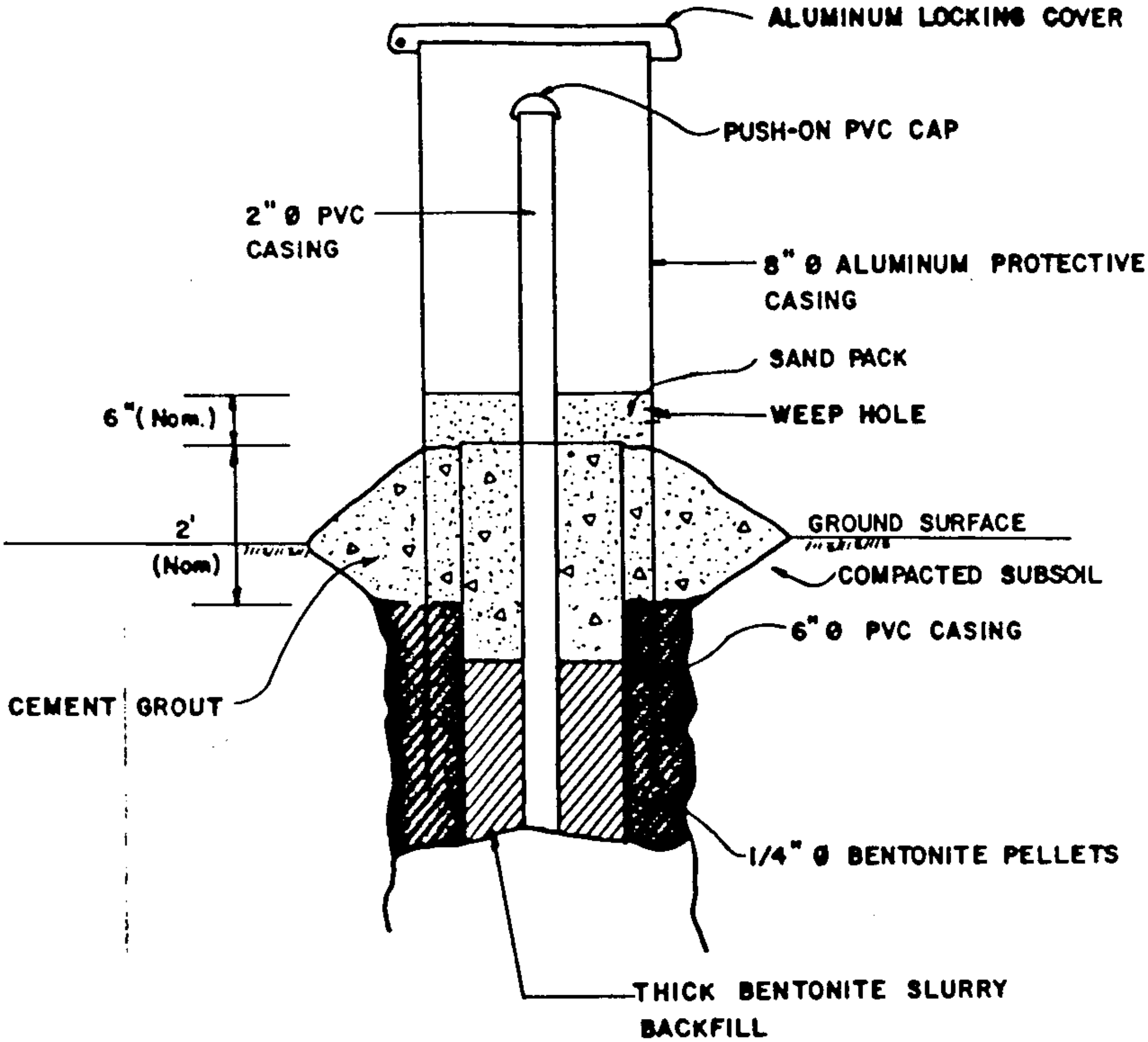
NOTE:
LOCATE WELL 20 FEET FROM UNFILLED TRENCHES AND 50 FEET FROM FILLED TRENCHES.



NOTE:
LOCATE WELL 20 FEET FROM UNFILLED TRENCHES AND 50 FEET FROM FILLED TRENCHES.

JOB NO. 853-3098	SCALE NOT TO SCALE	TYPICAL DOUBLE MONITORING WELL SYSTEM
DRAWN LJW	DATE 7/19/85	
CHECKED FH(?)	DWG. NO. 100	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 6.2

A= 20440A-B



JOB NO. 853-3098	SCALE NOT TO SCALE	WELL HEAD DESIGN
DRAWN S.B.C.	DATE 7/29/85	
CHECKED FKW	DWG. NO. 102	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 6.3

MONITORING WELL INSTALLATION LOG

JOB NO ______	PROJECT ______	WELL NO ______	SHEET ____ OF ____
QA INSP ______	DRILLING METHOD ______	GROUND ELEV ______	WATER DEPTH ______
WEATHER ______	DRILLING COMPANY ______	COLLAR ELEV ______	DATE/TIME ______
TEMP ______	DRILL RIG ______ DRILLER ______	STARTED ______ TIME / DATE	COMPLETED ______ TIME / DATE

MATERIALS INVENTORY

WELL CASING ______ in dia ______ ft	WELL SCREEN ______ in dia ______ ft	BENTONITE SEAL ______
CASING TYPE ______	SCREEN TYPE ______	INSTALLATION METHOD ______
JOINT TYPE ______	SLOT SIZE ______	FILTER PACK QTY ______
GROUT QUANTITY ______	CENTRALIZERS ______	FILTER PACK TYPE ______
GROUT TYPE ______	DRILLING MUD TYPE ______	INSTALLATION METHOD ______

ELEV/DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	GROUND SURFACE		
0.0		Sample Monitoring Well Log Figure 6.4	
			WELL DEVELOPMENT NOTES

7.0 SUMMARY

This document summarizes cleaning, coring, sampling, and logging procedures used during the Emelle Consent Agreement Phase I coring operation from May 20, 1985 to July 12, 1985. In addition, discontinuities found within the core are discussed and recommendations for well monitor screening are presented.

Golder Associates recommends screening core holes CA-1, CA-5, CA-6, CA-7, CA-10, and CA-12 across their largest fracture zones with five foot screens, CA-8 across its largest fracture zone with a ten foot screen, and CA-9, CA-14 and CA-16 with a ten foot screen in order to monitor the fracture zones as well as twenty-five feet below the bottom of the adjacent trenches. Core holes CA-2, CA-3, CA-11, CA-13, and CA-15 contained no discontinuities and CA-4 contained no discontinuities below the leachate level in the adjacent landfill trench. These core holes should be monitored twenty-five feet below the bottom of the adjacent trenches.

Upon agreement by the United States Environmental Protection Agency (USEPA), Alabama Department of Environmental Management (ADEM), and Chemical Waste Management, Inc. concerning fracture intervals to monitored, Phase II drilling and well installation will begin. Phase II drilling and well installation procedures are included in the last section of this report.

GOLDER ASSOCIATES

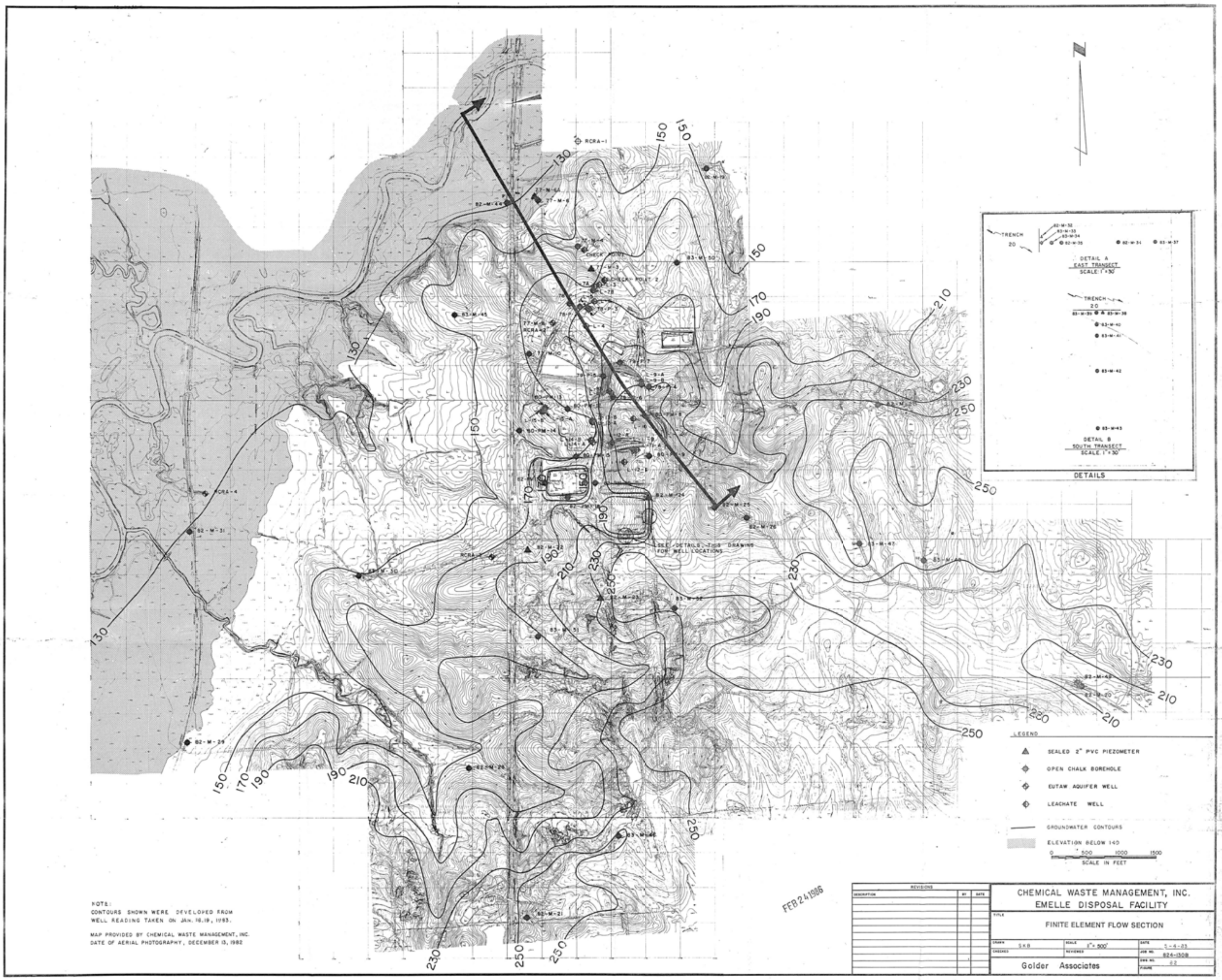
Frank H. Willmann/JEB

Frank H. Willmann
Geological Engineer

JEBaker

J. Edmund Baker, P.E.
Associate

FHW:JEB:mrs


DETAILS
DETAIL A
EAST TRANSECT
SCALE: 1"=30'
DETAIL B
SOUTH TRANSECT
SCALE: 1"=30'
TRENCH 20
LEGEND
SEALED 2" PVC PIEZOMETER
OPEN CHALK BOREHOLE
EUTAW AQUIFER WELL
LEACHATE WELL
GROUNDWATER CONTOURS
ELEVATION BELOW 140
0 500 1000 1500
SCALE IN FEET
NOTE:
CONTOURS SHOWN WERE DEVELOPED FROM WELL READING TAKEN ON JAN. 18,19, 1983.
MAP PROVIDED BY CHEMICAL WASTE MANAGEMENT, INC.
DATE OF AERIAL PHOTOGRAPHY, DECEMBER 13, 1982
SEE DETAILS, THIS DRAWING FOR WELL LOCATIONS
RCRA-1
RCRA-4
FEB 24 1986
130
150
170
190
210
230
250
CHEMICAL WASTE MANAGEMENT, INC.
EMELLE DISPOSAL FACILITY
FINITE ELEMENT FLOW SECTION
Golder Associates
REVISIONS

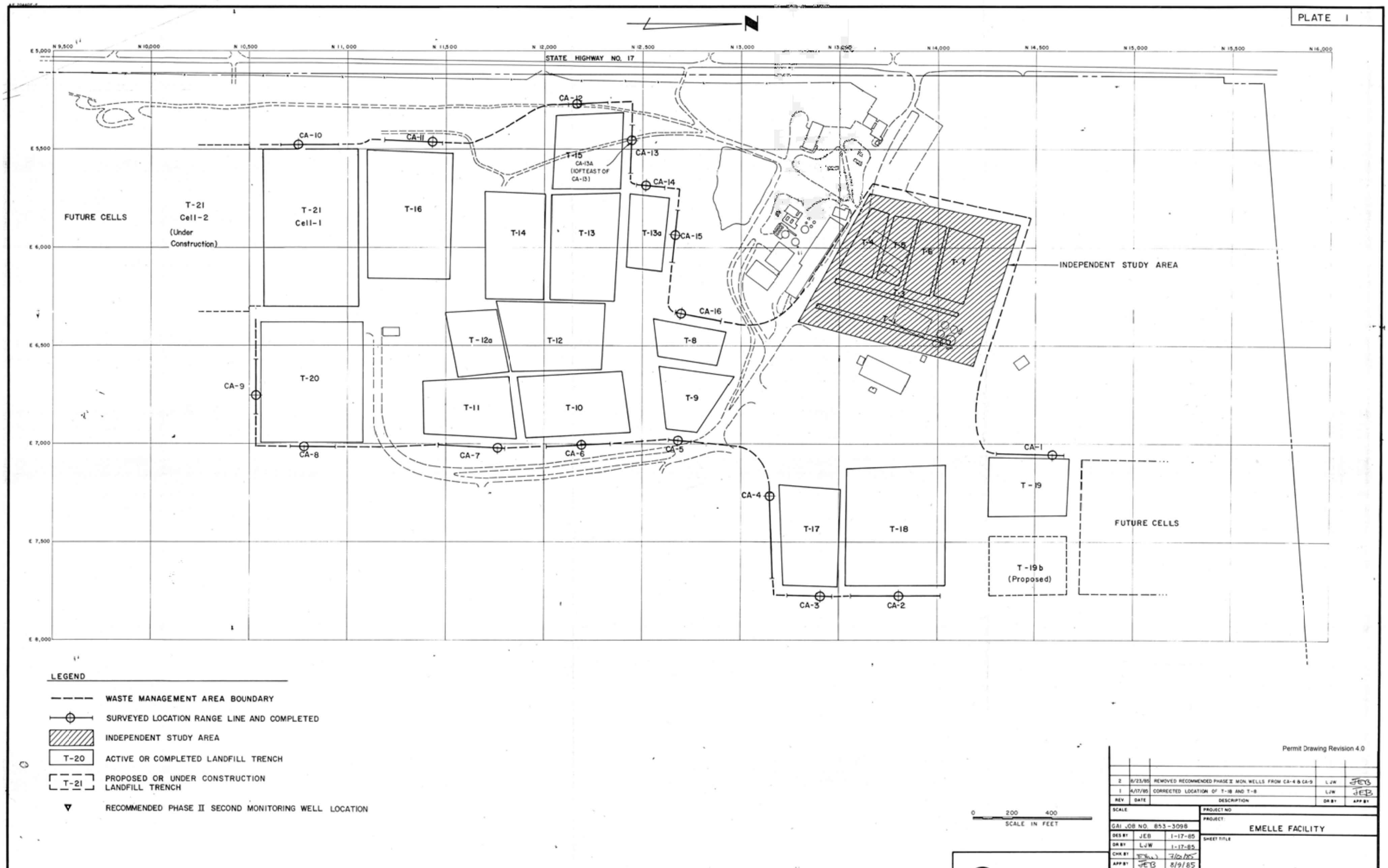
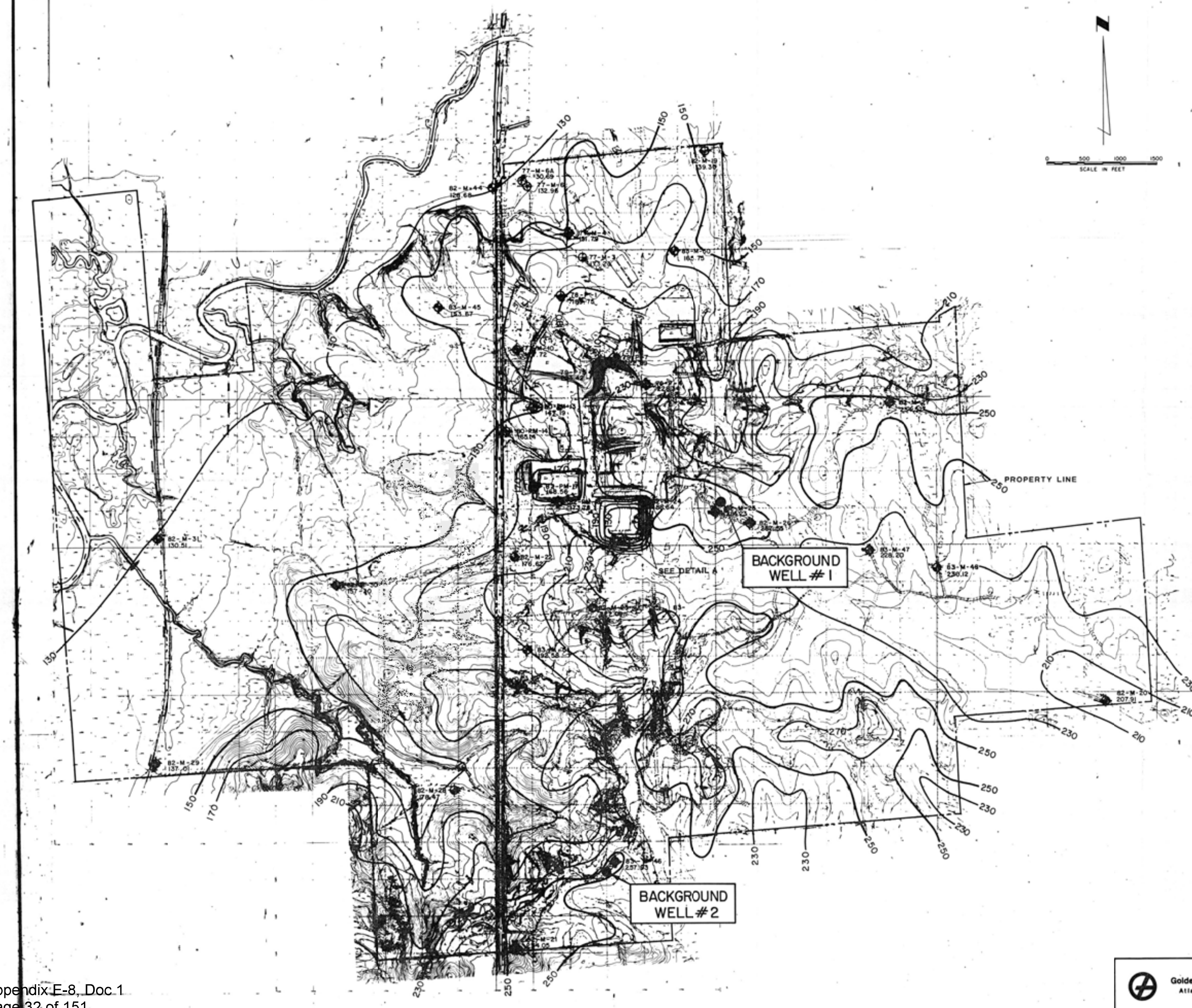
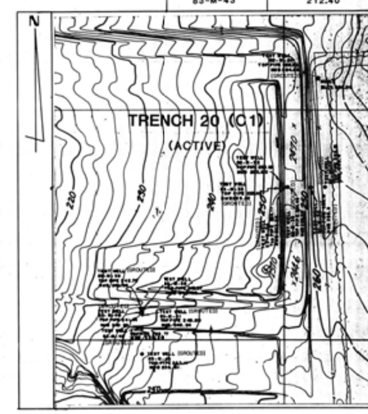


PLATE I
STATE HIGHWAY NO. 17
N 9,500
N 10,000
N 10,500
N 11,000
N 11,500
N 12,000
N 12,500
N 13,000
N 14,000
N 14,500
N 15,000
N 15,500
N 16,000
E 5,000
E 5,500
E 6,000
E 6,500
E 7,000
E 7,500
E 8,000
FUTURE CELLS
T-21 Cell-2 (Under Construction)
T-21 Cell-1
T-16
T-15
CA-13A (10FT EAST OF CA-13)
T-14
T-13
T-13a
T-12a
T-12
T-20
T-11
T-10
T-8
T-9
T-4
T-5
T-6
T-7
T-3
T-1
T-17
T-18
T-19
T-19b (Proposed)
FUTURE CELLS
INDEPENDENT STUDY AREA
CA-1
CA-2
CA-3
CA-4
CA-5
CA-6
CA-7
CA-8
CA-9
CA-10
CA-11
CA-12
CA-13
CA-14
CA-15
CA-16
LEGEND
WASTE MANAGEMENT AREA BOUNDARY
SURVEYED LOCATION RANGE LINE AND COMPLETED
INDEPENDENT STUDY AREA
T-20 ACTIVE OR COMPLETED LANDFILL TRENCH
T-21 PROPOSED OR UNDER CONSTRUCTION LANDFILL TRENCH
RECOMMENDED PHASE II SECOND MONITORING WELL LOCATION
0 200 400
SCALE IN FEET
Permit Drawing Revision 4.0
2 8/23/85 REMOVED RECOMMENDED PHASE II MON. WELLS FROM CA-4 & CA-9 LJW JEB
1 4/17/85 CORRECTED LOCATION OF T-18 AND T-8 LJW JEB
REV DATE DESCRIPTION DR BY APP BY
SCALE
PROJECT NO
PROJECT
EMELLE FACILITY
SHEET TITLE
GAI JOB NO. 853-3098
DES BY JEB 1-17-85
DR BY LJW 1-17-85
CHK BY 7/2/85
APP BY JEB 8/9/85
Golder Associates
Atlanta, Georgia
Chemical Waste Management, Inc.
Oak Brook, Illinois 60521
SHEET OF
DRAWING NO
00-130-002

PLATE 2

WELL NO.	WATER LEVEL ELEVATION (FT-MSL)
82-M-24	188.64
82-M-34	dry to 144.56
82-M-35	dry to 144.55
82-M-36	190.53
83-M-37	259.22
83-M-38	150.52
83-M-39	caved
83-M-40	163.32
83-M-41	168.19
83-M-43	212.40





DETAIL A
WELL LOCATIONS
SCALE 1" = 100'

LEGEND

—210— ESTIMATED CHALK WATER TABLE SURFACE CONTOURS (FT.-MSL)

83-M-50 230.05 MONITORING WELL DESIGNATION CHALK WATER TABLE SURFACE ELEVATIONS (FT.-MSL)

83-M-48 GROUTED BETWEEN 5/13/85 AND 7/15/85

NOTE

1. CHALK WATER LEVEL DATA ACQUIRED MAY 30, 1983 TO JUNE 9, 1983.
2. BASE MAP PROVIDED BY CHEMICAL WASTE MANAGEMENT, INC. DATE OF AERIAL PHOTOGRAPHY, DECEMBER 13, 1982.

REV.	DATE	DESCRIPTION	DR BY	APP BY
1	7/25/85	GROUTED WELLS AND BACKGROUND WELL LOCATIONS	S.B.C.	

SCALE: 1" = 500'
GAI JOB NO. 853 3096
DES BY JEB 1-21-85
DR BY SKB 1-22-85
CHK BY 2/20/85
APP BY 8/9/85
PROJECT: EMELLE FACILITY
SHEET TITLE: APPROXIMATE BACKGROUND WELL LOCATIONS
DRAWING NO. 00-150-OH

Golder Associates
Atlanta, Georgia

Chemical Waste Management, Inc.
Oak Brook, Illinois 60521

APPENDIX A

Coring Logs

PROJECT [illegible] | JOB NO. [illegible] | BORING NO. [illegible] DATE 5/20/85 SHEET 1 OF 4
CORE HOLE LOCATION —

BORING BEGAN 5/20/85 | BORING COMPLETED 5/20/85

METHOD OF CORING NQ?? | DRILLING FLUID Potable Water | GRADE [illegible] | WEATHER P/C LOY [illegible]

CASING USED PVC SIZE 6" | INSPECT FNW | OPERAT [illegible] | WATER LEVEL TIME DATE —

Column headings: DEPTH (FT) | BOX/RUN NUMBER | RECOVERY | RQD | DISCONTINUITIES: DEPTH (FT), TYPE, INFILLING, ANGLE W/AXIS, FRACTURES/FT | LITHOLOGY | COLOR | TEXTURE | WEATHERING | DESCRIPTION | POINT LOAD TEST | HARDNESS | SAMPLES LABORATORY TESTS | DRILLING RATE MIN/FT

0.0

ROTARY DRILLED TO 20.1 FT

WEATHERED, GRAY, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.

Color: N8

WATER COLOR CHANGE FROM LIGHT GRAY TO DARKER GRAY @ ~13 FT

Color: N6

SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES

20.1

CASING SET @ 20.1 FT.

Box 1, Run 1 — Recovery 4.9/5.0 — RQD 53/60 [illegible] — Discontinuity 21.3 [illegible] 6 90 — Fractures 5/4.9 — Color N6 — Texture VF — Weathering 1

UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.

Hardness: S — Drilling rate: 20/5.0

25.0 — Discontinuity 24.9 [illegible] 6 75

NOTES

SCALE: 1 DIVISION=0.5 FEET

New Page
February 24, 1986

DATE 5/20/85 LOGGED BY FNW

PROJECT [illegible] JOB NO [illegible] BORING NO [illegible] DATE [illegible] SHEET 2 OF 4

BORING BEGAN 5/20/85 BORING COMPLETED 5/21/85 CORE HOLE LOCATION —

METHOD OF CORING NQ [illegible] / SOLID TUBE DRILLING FLUID POTABLE WATER DRILLER [illegible] WEATHER CLDY

CASING USED PVC SIZE 6" INSPECT FHW OPERAT [illegible] WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
25.0 – 30.1	#2	2.5/5.0	2.3/6.0	29.7 29.9	I3PR I3PR	C C	90 90	2/2.5		N6	VF	1	USE NQ[illegible] BARREL UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		5		22/5.0
30.1 – 35.1	#3	5.2/6.0	5.1/6.0	30.2 30.4 31.9 32.1	I3IV I3IV I3IR I3PS	C C C C	85 — 10 90	5/5.2		N6	VF	1	USE NQ SOLID TUBE BARREL HIGHLY BROKEN @ 30.2 & 30.4		5		18/5.0
35.1 – 40.1	#4	4.8/5.0	5.6/6.0	34.9 35.3 35.4 38.5	I3PR I3IR I3PR I3PS	C C C C	85 90 90 90	4/4.8		N6	VF	1	USE NQ[illegible] BARREL		5		20/5.0
40.1 – 45.1 (41.0 Box 2)	#5	5.0/6.0	5.6/6.0	39.9 40.2 42.2	I3IR I3PR I3PS	C C C	80 65 80	3/6.0		N6	VF	1	42.2 BROKEN AFTER CORE REMOVED		5		18/5.0
45.1 – 50.0	#6	10.0/10.0	11.7/12.0	44.9	I3PR	C	90	2/10.0		N6	VF	1			5		40/10.0

NOTES RUN #2: CHALK FORCED UP OUTSIDE BOTTOM OF T-TUBE AND BENT T-TUBE INWARD. BIT CLOGGED AND RECOVERY VERY POOR.
RUN #3: USE NQ SOLID TUBE

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CNM/CONSENT DECREE/AL	JOB NO. 855 3698.1	BORING NO. B4-1 DATE 5/14/85 SHEET 3 OF 4	
BORING BEGAN 5/14/85	BORING COMPLETED 5/20/85	CORE HOLE LOCATION —	
METHOD OF CORING NQ TT	DRILLING FLUID POTABLE WATER	DRILLER – EBERT WEATHER CLDY	
CASING USED PVC SIZE 6"		INSPECT FMW OPERAT DIR —	WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#6	10.0/10.0	117/120	50.0	ISPR	C	80						50.6 - BROKEN AFTER REMOVED FROM NQTT				46/10.0
				52.5	ISPR	C	85	2/10.0		N6	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		S		
				54.9	ISIR	C	80										
55.1	#7	10.0/10.0	115/120	55.3 / 55.5	ISPS / ISPR	C / C	90 / 85	7/10.0		N6	VF	1			S		50/10.0
				60.2	ISPR	C	90										
60.1	Box 5			60.7	ISIR	C	85										
				63.2	ISIR	C	90										
				63.8	ISPR	C	80										
				64.9	ISIR	C	90										
65.1	#8	10.0/10.0	120/120	68.2	ISPR	C	90	5/10.0		N6	F-VF	1	CORE BECOMES A LITTLE MORE SANDY.		S	68.6	45/10.0
				69.8 / 69.9	ISPS / ISIS	C / C	50 / 90						69.8 - SMALL FRACTURE IN CORE.			69.4	
				70.3	ISPR	W	90						70.3 - SMALL CALCITE HEALED FRACTURE.				
				74.3	ISPS	C	90										
75.0 / 75.1				74.7	ISIS	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT [illegible] | JOB NO. [illegible] | [illegible]
BORING BEGAN 5/20/85 | BORING COMPLETED 5/21/85 | CORE HOLE LOCATION —
METHOD OF CORING NQ?? | DRILLING FLUID POTABLE WATER | DRILLER [illegible] WEATHERLY
CASING USED PVC SIZE 6" | INSPECTOR [illegible] | OPERATOR [illegible] | WATER LEVEL TIME DATE —

DEPTH (FT)	BOTTOM NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
75.1	9	9.5/10.0	102/120	75.0	IJPR	C	90	10/9.5		N6	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		S		33/10.0
				78.6	IJIS	C	70										
79.2	DH 4			79.2	IJPS	C	90										
				79.4	IJIR	C	90										
				79.7	IJPR	C	85										
				80.1	IJPR	C	85										
				82.0	IJPR	C	80										
				83.8	IJPS	C	45						83.7 - 83.8 SHELL FRAGMENT				
				83.9	IJIV	C	70						83.8 BREAK ALONG SHELL				
				84.0	IJIV	C	90										
85.1	10	10.2/10.0	102/120	86.0	IJIR	C	90	11/10.2		N6 TO N8	VF	1			S		31/10.0
				86.4	IJIV	C	40										
				89.9	IJPR	C	85						90.0 - 91.0: OVER CORED RUN (DRILLING INDUCED)				
				90.3	IJPS	C	50										
				90.9	IJIV	C	85										
				91.5	IJIR	C	50						92.0 : DRILLING INDUCED				
				92.3	IJIR	C	85										
				92.9	IJPS	C	10						92.9 : BREAK ALONG SHELL				
				93.5	IJPR	C	60						93.2 - 95.1: OVER CORED RUN (DRILLING INDUCED)				
				94.5	IJIV	C	40										
				95.0	IJIR	C	90										
95.1	11	5.0/5.0	53/60	95.4	IJIR	C	90	7/5.0		N6 TO N8	VF	1			S		7/5.0
				96.0	IJIR	C	90										
				97.5	IJIR	C	70										
97.9	DH 5			[illegible]	[illegible]	C	[illegible]										
100.0													END OF CORING @ 100.1 FT.				

NOTES
FLUSHED WITH POTABLE WATER THROUGH CASING AFTER DRILLING (5 MINUTES)

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CHEM CONSERV [illegible] JOB NO [illegible] BORING NO [illegible]
BORING BEGAN 8/22/85 BORING COMPLETED 8/22/85 CORE HOLE LOCATION —
METHOD OF CORING NQ?? DRILLING FLUID POTABLE WATER GR. ELEV. [illegible] WEATHER C&R
CASING USED PVC SIZE 6" INSPECT FHW OPERAT DIR [illegible] WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
0													ROTARY DRILLED TO 9.6 FT				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—		—	—	—		—	—	—	—
9.6	BOX 1 RUN #1												CASING SET @ 9.6 FT.				
				10.8	ISFS	≤	90					1					13/5.9
								4/5.9		N6	VF	2	11.5 - 12.8 WEATHERED ZONE		S		
		5.2/5.9	57/71							[illegible]			WEATHERED, BROWN, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK.				
				13.2 13.5	ISFS ISFS	≤ ≤	90 40			N6		1					
				13.8	ISIR	≤	90						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES				
15.5	#2																19/10.0
										N6	VF	1			S		
		10.0/10.0	118/120	20.4	ISIR	≤	80	2/10.0									
25.0				25.3	ISIR	≤	90										

NOTES

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

PROJECT: CWM/CONSENT [illegible]	JOB NO: 855 [illegible]	BORING NO: [illegible] SHEET 2 OF 4
BORING BEGAN: 5/22/85	BORING COMPLETED: 5/23/85	CORE HOLE LOCATION: —
METHOD OF CORING: NQ??	DRILLING FLUID: Potable water	DRILLER: [illegible] WEATHER: CLR
CASING USED: PVC SIZE: 6"	INSPECTOR: FHW OPERATOR: [illegible]	WATER LEVEL TIME DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES, LABORATORY TESTS	DRILLING RATE MIN/FT
25.0–25.5	#2	10.0/10.0	12/120					4/10.0		N6	VF	1			S		21/10.0
25.5–29.8	#3												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
29.8	BOX 2	9.9/10.0	119/120	30.5	I3PS	C	90	5/10.0		N6	VF	1			S		28/10.0
				32.9	I3PR	C	90										
				35.1	I3PS	C	90										
35.5	#4			36.5	I3PR	C	90										
				37.9	I3PR	C	90										
				39.7	I3PR	C	85										
		10.0/10.0	117/120	40.4	I3PR	C	80			N6	VF	1			S		21/10.0
				40.9	I3PS	C	85	9/10.0									
				41.6	I3PS	C	80										
				42.8	I3PS	C	85										
				43.9	I3PR	C	80										
				45.2	I3IR	C	90										
45.5	#5			45.6	I3PS	C	90										23/10.0
								4/10.0		N6	VF	1			S		
48.0	BOX 3	10.0/10.0	116/120														
50.0																	

NOTES

SCALE: 1 DIVISION=0.5 FEET

New Page
February 24, 1986

PROJECT [illegible] JOB NO. 855 [illegible] BORING NO. B6 DATE 5/23/85 SHEET 3 OF 4

BORING BEGAN 5/22/85 BORING COMPLETED 5/23/85 CORE HOLE LOCATION —

METHOD OF CORING NQ DRILLING FLUID Potable Water DRILLER [illegible] WEATHER CLOUDY

CASING USED PVC SIZE 6" INSPECTOR FHW OPERATOR [illegible] WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES, LABORATORY TESTS	DRILLING RATE MIN/FT
50.0 – 55.5	R 5	10.0/10.0	116/120	50.5 53.4 55.3	IJPR IJPR IJIR	C C C	90 90 90	4/10.0		N6	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES. 53.4 BREAK ALONG SHELL FRAGMENT		5		23/10.0
55.5 – 65.5	R 6	10.0/10.0	120/120	59.3 64.8 65.1	IJPS IJPR IJPR	C C C	80 90 90	3/10.0		N6	VF	1			5		20/10.0
65.5 – 75.0 (BOX 4 at 67.0)	R 7	10.0/10.0	116/120	69.0 70.7 73.7 74.8	IJIR IJPR IJIR IJIR	C C C C	85 90 85 90	4/10.0		N6	VF	1			6		25/10.0

SCALE: 1 DIVISION = 0.2 FEET

NOTES

New Page
February 24, 198[illegible]

PROJECT CWM/CONSENT [illegible]/AL — JOB NO. #55 [illegible] — BORING NO. BG-[illegible] DATE 5/23/85 SHEET 4 OF 4

BORING BEGAN 5/22/85 — BORING COMPLETED 5/23/85 — CORE NO. & LOCATION —

METHOD OF CORING NQ?? — DRILLING FLUID POTABLE WATER — DRILLER [illegible] WEATHER CLOUDY

CASING USED PVC SIZE 6" — INSPECTOR FNW OPERATOR [illegible] — WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
75.0–75.5	#7	10/10.0	11/12.0					9/10.0		N6	VF	1			5		25/??
75.5–85.5	#8	10.0/10.0	118/120					4/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				80.5	ISIR	C	90										
				81.1	ISIS	C	50						81.1 BREAK ALONG SHELL		6		24/10.0
				82.7	ISPR	C	80						82.7 BREAK ALONG SHELL				
				85.3	ISPR	C	90										
85.5–95.5	BOX 6, #9	7.5/10.0	86/120					5/7.5		N6 TO N8	VF	1					
				87.1	ISIR	C	85										
				90.4	ISPR	C	90										
				90.5	ISIR	C	90										
				90.7	ISIR	C	85						90.7 BREAK ALONG SHELL		5		25/10.0
				91.4	ISIS	C	80						91.4 BREAK ALONG SHELL				
				94.8	ISIR	C	90										
				95.0	ISIR	C	90										
				95.2	ISIR	C	90						95.2 BREAK ALONG SHELL				
				95.3	ISIR	C	90						95.3 - 95.5 ISSR C 10°				
95.5–100.0	#10	6.1/4.5	61/54	95.5	ISIR	C	90	8/6.1		N6 TO N8	VF	1	* 94.8 - 95.5 CORE LOST FROM PREVIOUS RUN. PICKED UP IN RUN #10		5		6/4.5
				95.7	ISIR	C	90										
				96.4	ISPS	C	80										
				99.3	ISPR	C	85										
100.0													END OF CORING @ 100.0 FT				

NOTES: RUN #9: LOST 2.5 FT. OF CORE IN HOLE
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT LWM/CONSENT DECREE/AL — JOB NO. 855 BCNF 1 — BORING NO. CA-1 DATE 6/10/85 SHEET 1 OF 3

BORING BEGAN 6/7/85 — BORING COMPLETED 6/10/85 — CORE HOLE LOCATION: 285.0 FT FROM SOUTH STAKE

METHOD OF CORING NQTT — DRILLING FLUID: POTABLE WATER — DRILLER 174 — WEATHER CLDY

CASING USED PVC SIZE 6" — INSPECT FMW — OPERAT DIE — WATER LEVEL/TIME/DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0												RATARY DRILLED TO 10.0 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
	—	—	—	—	—	—	—	—	—	—	—	INSITU CHALK @ ~5.0 FT.	—	—	—	—
												SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
10.0	BOX 1 RUN 1	5.4/5.5	45/66	10.8	I3PR	C	85					CASING SET @ 10.0 FT. UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
									N8	VF	1			5		6/5.5
				13.9	I3PS	C	90	3/5.4								
				14.4	I3PR	C	90									
15.5	RUN 2			15.7	I3IR	C	80									
				16.1	I2PR	C	70					16.1 BREAK ALONG SHELL				
				16.7	I3PR	C	90									
				17.3	I3IR	C	90									
				18.2	I2PR	C	75					18.2 BREAK ALONG SHELL				
		10.0/10.0	114/120					11/10.0	N8	VF	1			5		18/10.0
				20.4	I2IR	C	80									
				20.6	I2PS	C	90									
				21.5	I2PS	C	85					21.5 BREAK ALONG SHELL				
				23.7	I3PR	C	80									
				24.3	I2IR	C	75					24.3 BREAK ALONG SHELL				
25.0				24.7	I2IR	C	70					24.7 BREAK ALONG SHELL				

NOTES:
5-GAL. BUCKETS OF BENTONITE USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT: LWM/CONSENT DECREE/AL — JOB NO. 859 PHASE 1 — BORING NO. CA — DATE 6/11/85 — SHEET 2 OF 3

BORING BEGAN: 6/7/85 — BORING COMPLETED: 6/11/85 — CORE HOLE LOCATION: 280 FT FROM SOUTH STAKE

METHOD OF CORING: NQ?? — DRILLING FLUID: POTABLE WATER — DRILLER: FAIRWEATHER — ELEV. /85

CASING USED: PVC — SIZE: 6" — INSPECT: FHW — OPERAT. DIR. — WATER LEVEL/TIME/DATE: —

Depth (ft)	Box/Run Number	Recovery	RQD	Discontinuities: Depth (ft)	Type	Infilling	Angle w/ Axis	Fracture/ft	Lithology	Color	Texture	Weathering	Description	Point Load Test	Hardness	Samples-Laboratory Tests	Drilling Rate min/ft
25.0	#2	11.5/11.0	11.?/11.0					11/11.0		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		?/10.0
	#3			26.7	I3CR	C	90										
				27.8	I2PS	C	75						27.8 BREAK ALONG SHELL				
29.0	Box 2	10.0/10.0	12.0/12.0	30.3	I3PR	C	85	5/10.0		N6 TO N8	VF	1			5		10/10.0
				31.1	I3PS	C	86										
				34.1	I3PR	C	90										
35.5	#4	10.0/10.0	11.8/12.0	35.6	I3PS	C	80	5/10.0		N6 TO N8	VF	1			5		22/10.0
				36.4	I3PS	C	90										
				38.0	I3PR	C	90										
				40.4	I3PS	C	85										
				44.4	I3PS	C	85										
45.5	#5	10.0/10.0	11.4/12.0	47.5	I3PR	C	80	1/10.0		N6 TO N8	VF	1			5	49.8	15/10.0
49.1	Box 3			49.9	FIPK	C	35										
50.0				49.9	FIPK	C	35										

NOTES:

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/11/85 — LOGGED BY FHW

PROJECT: CWM/CONSENT DECREE, AL — JOB NO. 859 3CMP1 — BORING NO. C4-1 — DATE 6/10/85 — SHEET 3 OF 3

BORING BEGAN: 6/7/85 — BORING COMPLETED: 6/10/85 — CORE HOLE LOCATION: 283 FT FROM SOUTH STAKE

METHOD OF CORING: NQ?? — DRILLING FLUID: POTABLE WATER — DRILLER: [illegible] — WEATHER: [illegible] 65

CASING USED: PVC — SIZE: 6" — INSPECTOR: FHW — OPERATOR: [illegible] — WATER LEVEL TIME DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#5	5.0/5.0	114/120	50.2 50.3 50.5	FIFR FIFR ISPR	C C C	10 90 90	7/5.0	Chalk	N4 TO N6	VF	1	48.1 - 50.5 SHEAR ZONE UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	50.5	15/10.0
				55.1	ISPR	C	85										
55.5	#6	9.8/10.0	120/120	56.8	ISPS	C	85	4/9.8	Chalk	N4 TO N6	VF	1			S		14/10.0
				60.6	ISPS	C	90										
				62.6	ISPS	C	90										
				63.5	ISPS	C	85										
65.5	#7			65.6	ISPR	C	90		Chalk								
68.0	BOX 4	9.5/9.6	110/115	68.0	ISPS	C	75	5/9.6		N4 TO N6	VF	1			S	68.3 69.4	15/9.6
				68.8	FIFR	C	20										
				70.5	ISPS	C	90										
				73.5	ISPR	C	90										
75.0 75.1													END OF CORING @ 75.1 FT.				

SCALE: 1 DIVISION=0.2 FEET

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

New Page
February 24, 1986

PROJECT ENM 'CONSENT DECREE/AL — JOB NO. 855 3CHP 2 — BORING NO. & DATE — SHEET 1 OF 6
CORE HOLE LOCATION: 2417 FT FROM SOUTH STAKE

BORING BEGAN 6/11/85	BORING COMPLETED 6/11/85
METHOD OF CORING NQ TT	DRILLING FLUID: POTABLE WATER
CASING USED PVC SIZE 6"	GRND ELEV / EST. WEATHER CLDY '85
INSPECT EMN	DRILLER DIR JMB — WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES/LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 9.0 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
													INSITU CHALK @ ≈ 5.0 FT. WEATHERED, GRAY, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
9.0	BOX 1 RUN # 1	1.5/6.0	.5/12	* SEE SIDE NOTE				10+		MG	VF	2-1	CASING SET @ 9.0 FT. SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES. * ALL 1.5 FT. OF RECOVERY HIGHLY BROKEN DRILLING INDUCED. POOR RECOVERY IN RUNS 1, 2, 3 AND 4 DUE TO USE OF CARBIDE BIT		VS		1/6.0
15.0	#2	1.5/5.0	.4/6.0	19.5 / 19.8 / 19.9	ISIR / ISPR / ISIR	C / C / C	90 / 80 / 80	10+		MG	VF	2-1			VS TO S		5/5.0
20.0	#3	2.0/6.0	.5/6.0	23.9 / 24.7 / 24.9	ISIR / ISIR / ISIR	C / C / C	90 / 90 / 90	10+		MG	VF	2-1	23.0 - 23.9 HIGHLY BROKEN		VS TO S		2/5.0
25.0																	

SCALE: 1 DIVISION = 0.2 FEET

NOTES: 3 - 5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING

New Page
February 24, 1986

PROJECT [illegible]	JOB NO. [illegible]
BORING NO. [illegible] DATE 6/11/85 SHEET 2 OF 6	
BORING BEGAN 6/11/85	BORING COMPLETED 6/11/85
METHOD OF CORING NQ [illegible]	DRILLING FLUID: POTABLE WATER
DRILLER [illegible]	WEATHER [illegible]/85
CASING USED PVC SIZE 6"	INSPECT. FMW OPERATOR [illegible]
CORE HOLE LOCATION: 24 7 FT FROM SOUTH STAKE	WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES, LABORATORY TESTS	DRILLING RATE MIN/FT
25.0	R 4	0/5.0	0/6.0					10+		N8	VF	2-1	100% CORE LOSS FROM T-TUBE PULLED RODS - NO CORE RETAINED. SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES		VS		5/6.0
31.0	R 5	4.9/5.0	53/60	31.0	J3 PR	C	80	2/4.9		N8	VF	2-1 / 1			S		3/5.0
				33.4	J3 PS	C	60						33.4 BREAK ALONG SHELL				
35.0	R 6	10.1/9.7	116/116	35.5	J3 PS	C	90	7/10.1		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		19/9.7
				37.0	J3 IR	C	80										
				38.0	J3 PR	C	90										
				39.3	J3 PR	C	80										
				40.7	J3 PS	C	80										
				41.1	J3 PR	C	85										
43.1	BOX 2			43.3	J3 PR	C	85										
44.7	R 7	3.0/2.9	[illegible]/34	44.9	J3 PS	C	90	3/3.0		N6 TO N8	VF	1			S		11/2.9
				45.3	J3 PS	C	90										
				45.4	J3 PS	C	90										
47.6	R 8	7.3/7.4	88/89					3/7.3		N6 TO N8	VF	1			S		15/7.4
50.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CWM CHEMICAL SERVICES, AL — JOB NO. 895 BC4P1 — BORING NO. GA-2 DATE 6/11/85 SHEET 3 OF 6

BORING BEGUN 6/11/85 — BORING COMPLETED 6/18/85

METHOD OF CORING NQ — DRILLING FLUID POTABLE WATER — DRILLER 195 — WEATHER CLOUDY 90

CASING USED PVC SIZE 6" — INSPECT. FHW — OPERATOR — WATER LEVEL TIME DATE —

248 FT FROM SOUTH STAKE

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#8	7.3/7.4	88/89	52.2	IEPS	C	75	2/3		NG TO NB	VF	1	52.2 BREAK ALONG SHELL		S		15/7.4
				52.9	IEPS	C	75						52.9 BREAK ALONG SHELL				
													UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES				
55.0	#9	10.0/10.0	118/120	56.1	I3IR	C	90	4/10.0		NG TO NB	VF	1			S		18/10.0
				56.9	I2PS	C	80						56.9 BREAK ALONG SHELL				
				57.1	I2PS	C	30						57.1 BREAK ALONG SHELL				
				57.6	I3PS	C	85										
60.0	BOX 3																
65.0	#10	10.0/10.0	120/120	66.3	I3PR	C	80	4/10.0		NG TO NB	VF	1			S		26/10.0
				68.5	I3PR	C	90										
				70.2	I3PR	C	90										
				71.9	I3PR	C	80										
75.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CWM 'CONSENT DECREE,' AL | JOB NO. 855 3CMP 1 | BORING NO. CA-8 DATE 6/11/85 SHEET 4 OF 6

BORING BEGAN 6/11/85 | BORING COMPLETED 6/12/85 | CORE HOLE LOCATION

METHOD OF CORING NQ ?? | DRILLING FLUID POTABLE WATER | GEOLOGIST MS ? WEATHER ? | 6?? FT FROM SOUTH STAKE

CASING USED PVC SIZE 6" | INSPECT FHW OPERAT DIR ? | WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#11	9.8/10.0	114/120	76.2	ISPS	C	90	4/9.8		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		20/10.0
				77.8	ISPS	C	90										
82.9	BOX 4			82.9	ISPR	C	90										
				84.5	ISPR	C	90										
85.0	#12	10.0/10.0	117/120	85.5	ISPS	C	90	6/10.0		N6 TO N8	VF	1			S		17/10.0
				87.8	ISPR	C	85										
				90.7	ISPR	C	80										
				90.8	ISPR	C	90										
				91.0	ISPS	C	90										
				93.6	ISPS	C	75						93.6 BREAK ALONG SHELL				
95.0	#13	10.1/10.0	118/120	95.3	ISPS	C	90	6/10.1		N6 TO N8	VF	1			S		14/10.0
				97.3	ISPR	C	90										
98.7	BOX 5																
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/12/85 LOGGED BY FHW

PROJECT CNM CONSENT DECREE, AL | JOB NO 839 [illegible] | BORING NO CA-E [illegible] DATE 6/12/85 SHEET 5 OF 6

BORING BEGAN 6/11/85 | BORING COMPLETED 6/11/85 | CORE HOLE LOCATION 260 FT FROM SOUTH STAKE

METHOD OF CORING NQ [illegible] | DRILLING FLUID POTABLE WATER | DRILLER [illegible] WEATHER CLDY/80

CASING USED PVC SIZE 6" | INSPECTOR FHW [illegible] | WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#13	10.1/10.0	118/120	101.2	I3PR	<	85	5/10.1		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		5		19/10.0
				102.6	I3IR	<	80										
				103.9	I3PR	<	85										
105.0	#14	10.0/10.0	120/120	107.1	I3PR	<	90	4/10.0		N6 TO N8	VF	1			5		16/10.0
				108.9	I3IR	<	80										
				110.9	I3IR	<	85										
				114.0	I2PR	<	80						114.0 BREAK ALONG SHELL				
115.0	#15	9.9/10.0	117/120	115.2	I3PR	<	90	4/9.9		N6 TO N8	VF	1			5		18/10.0
117.4	BOX 6			117.4	I3PR	<	90										
				119.0	I3PR	<	90										
				123.2	I3PR	<	85										
125.0																	

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24 1986

PROJECT: [illegible] JOB NO.: [illegible]
BORING NO. & LOCATION: [illegible]
BORING BEGUN: 6/11/85 BORING COMPLETED: 6/16/85
CORE HOLE LOCATION: [illegible] FT. FROM SOUTH STAKE
METHOD OF CORING: NQ?? DRILLING FLUID: POTABLE WATER DRILLER: MC [illegible]
CASING USED: PVC SIZE: 6" INSPECT: [illegible] OPERAT: [illegible] WATER LEVEL TIME DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES - LABORATORY TESTS	DRILLING RATE MIN/FT
125.0	16	10.1/10.0	117/120	125.?	ISPS	<	90	8/10.1		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES. 128.3 BREAK ALONG SHELL		5		15/10.0
				125.5	ISIR	<	90										
				127.2	ISPR	<	90										
				128.3	ISPS	<	85										
				129.0	ISPR	<	80										
				129.7	ISPR	<	80										
				132.2	ISPS	<	90										
				134.6	ISPR	<	90										
135.0 / 135.5	17	9.9/9.9	116/120	136.5	ISPS	<	85	6/9.9		N6 TO N8	VF	1			5		15/10.0
				138.8	ISPR	<	90										
				140.3	ISPR	<	90										
				141.2	ISPR	<	85										
				143.4	ISPR	<	90										
				144.7	ISPR	<	90										
145.0													END OF CORING @ 145.0 FT.				
150.0																	

SCALE: 1 DIVISION=0.2 FEET

NOTES
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

New Page
February 24, 1986

PROJECT CHM/CONSENT DECREE/AL	JOB NO. 855 DCAP 2	BORING NO. CA-3 DATE 7/11/85 SHEET 1 OF 4
BORING BEGAN 7/10/85	BORING COMPLETED 7/11/85	CORE HOLE LOCATION: 69.5 FT FROM NORTH STAKE
METHOD OF CORING NQ??	DRILLING FLUID: POTABLE WATER / DRILLER ??? WEATHER CLR/95°	
CASING USED PVC SIZE 6"	INSPECTOR FHN / OPERATOR DIR ???	WATER LEVEL/TIME DATE —

DEPTH (FT)	CORE RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 13.5 FT				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
													INSITU CHALK @ ≈ 10 FT				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
13.5	BOX 1 RUN 1	1.9/1.9	1.5/2.3	13.7	I3PR	C	90	4/1.9		N8	VF	1	CASING SET @ 13.5 FT		S		2/1.9
				13.9	I3PR	C	90										
				14.2	I3PR	C	90										
				15.1	I3IR	C	90										
15.4	2	9.2/10.0	4.8/1.9	15.6	I3IR	C	80	114		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		S		19/10.0
				16.5	I3PR	C	90						BREAKS CAUSED BY OVERCORING 17.5 - 17.7 VERY FRACTURED				
				17.6	I3IR	C	90										
				19.2	I3IR	C	90										
				20.2	I3PR	C	90						20.2 - 20.8 VERY FRACTURED				
				20.8	I3IR	C	80										
				21.2	I3PR	C	80						21.7 - 24.6 VERY FRACTURED				
				21.8	I3IR	C	70										
				22.2	I3IR	C	85										
				22.7	I3IR	C	75										
				23.4	I3IR	C	80										
				24.2	I3IR	C	55										
25.0																	

NOTES: 7 - 5 GAL. BUCKETS OF BENTONITE USED TO SET CASING

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24. 1986

PROJECT	ENW 'CONSENT DECREE,' AL
JOB NO.	855 TCMP
BORING NO.	#4
DATE	7/10/85
SHEET	2 OF 4
BORING BEGAN	7/10/85
BORING COMPLETED	7/10/85
CORE HOLE LOCATION	67.5 FT FROM NORTH STAKE
METHOD OF CORING	NQ??
DRILLING FLUID	POTABLE WATER
CASING USED	PVC
SIZE	4"
DRILLER	[illegible]
WEATHER	[illegible] 85
INSPECT	FHW
OPERAT DIR	[illegible]
WATER LEVEL/TIME DATE	—

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE F/T	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
25.4																	
	#3	10.0/10.0	120/120	26.0	I3PR	<	85						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				30.4	I3IR	<	75	5/10.0		N4 TO N6	VF	I			S		21/10.0
				31.1	I3PR	<	85										
32.9	BOX 2																
				34.5	I3PR	<	80										
				34.9	I3PR	<	85										
35.4				35.0	I3PS	<	90										
				[illegible]	I3PR	<	85										
				[illegible]	I3PR	<	85										
				[illegible]	I3PR	<	80										
				36.6	I3PR	<	80										
				37.0	I3PR	<	80										
	#4	11.2/11.4	119/120	38.3	I3PR	<	85	15/10.2		N4 TO N6	VF	I			S		19/10.0
				39.0	I3PR	<	80										
				40.6	I3PR	<	85										
				41.3	I2PS	<	80						41.3 BREAK ALONG SHELL				
				43.0	I3PR	<	75										
				44.1	I2PR	<	80						44.1 BREAK ALONG SHELL				
				44.6	I3PR	<	85										
				[illegible]	I3PR	<	85										
				[illegible]	I3PR	<	85										
46.4				[illegible]	I3PR	<	70										
				[illegible]	I3PR	<	80										
				[illegible]	I3PR	<	80										
				[illegible]	I2PS	<	70										
	#5	10.0/10.0	108/120					11/10.0		N4 TO N6	VF	I			S		20/10.0
				48.6	I3PR	<	75										
50.0				49.6	I2PR	<	70						49.6 BREAK ALONG SHELL				

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CNM 'CONSENT DECREE/AL	JOB NO. 855 Bore 1	BORING NO. CA-3	DATE 7/10/85 SHEET 3 OF 4
BORING BEGAN 7/10/85	BORING COMPLETED 7/11/85	CORE HOLE LOCATION	
METHOD OF CORING NQ??	DRILLING FLUID Pothole water	GRILLER ?? SHIFT WEATHER ??	69 EFT FROM NORTH STAKE
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR ??	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
50.0				50.4	I3PR	C	80										
51.1	Box 3												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES				
	R 5	4.0/4.0	4.8/4.8	53.4	I3PR	C	75	11/4.0		N6 TO N8	VF	1			5		10/10.0
				54.0	I3IR	P	80						54.0 MARCASITE NODULE				
				54.6	I2PR	C	80						54.6 BREAK ALONG SHELL				
				55.2	I2PR	C	85										
55.4	R 6	10.0/10.0	12.0/12.0	56.1	I3PR	C	80	9/10.0		N6 TO N8	VF	1			5		15/10.0
				57.6	I3PR	C	85										
				58.4	I3PR	C	80										
				59.8	I3PR	C	90										
				60.5	I3PR	C	85										
				62.8	I3PR	C	85										
				64.6	I3PR	C	85										
65.4	R 7																
69.4	Box 4	10.0/10.0	12.0/12.0	70.4	I3PR	C	90	5/10.0		N6 TO N8	VF	1			5		20/10.0
				71.2	I3PR	C	90										
				73.5	I3PR	C	75										
				74.2	I3PR	C	85										
75.0				74.6	I3PR	C	80										

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CWM CONSENT DECREE/AL — JOB NO 855 [illegible] — BORING NO CA-3 — DATE 7/10/85 — SHEET 4 OF 4

BORING BEGAN 7/10/85 — BORING COMPLETED 7/10/85 — CORE HOLE LOCATION: 59 FEET FROM NORTH STAKE

METHOD OF CORING NQ?? — DRILLING FLUID: POTABLE WATER — GR ELEV [illegible] — WEATHER CLR/95°

CASING USED PVC — SIZE 6" — INSPECT FMW — OPERAT DYR [illegible] — WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0		[illegible]	[illegible]					[illegible]		[illegible]	VF	1			5		[illegible]
75.4																	
	8R			77.5	ISPR	C	85						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
		10.0/10.0	118/120	80.1	ISPR	C	90	5/10.0		N6 TO N8	VF	1			5		16/10.0
				82.2	ISPR	C	85										
				84.9	ISPR	C	85										
				85.2	ISPR	C	90										
85.4													END CORING @ 85.4 FT.				

SCALE: 1 DIVISION=0.2 FEET

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

New Page
February 24, 1986

PROJECT CHM CONSENT TOCAL? AL | JOB NO 855 3C9P1 | BORING NO CA-4 | DATE 7/11/85 | SHEET 1 OF 5

BORING BEGAN 7/11/85 | BORING COMPLETED 7/12/85 | CORE HOLE LOCATION 16 EFT. FROM WEST STAKE

METHOD OF CORING NQ | DRILLING FLUID POTABLE WATER | DRILLER 221 | WEATHER CLR 95

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR JNB | WATER LEVEL TIME DATE —

DEPTH (FT)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES, LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 10.0 FT				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—		N8	—	—		—	—	—	—
										N6			DARK GRAY WATER RETURN @ ≈ 5.0 FT.				
													UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
10.0	RUN 1												CASING SET @ 10.0 FT.				
		4.9/5.0	5.7/6.0					1/4.9		N6	VF	1			3		1/5.0
				14.7	IJPR	C	90										
15.0				15.3	IJPR	C	90										
				16.6	IJPR	C	80										
	RUN 2																
		10.0/10.0	117/120	20.1	IJIR	C	90	5/10.0		N6 TO N8	VF	1			3		16/10.0
				22.5	IJPR	C	85										
25.0				24.8	IJPR	C	90										

NOTES
4-5 GAL. BUCKETS OF BENTONITE USED TO SET CASING.

SCALE: 1 DIVISION = 0.5 FEET

New Page
February 24, 1986

PROJECT CWM/CONSENT DECREE/AL | JOB NO. 855 [illegible] | BORING NO. CA-4 DATE 7/[illegible]/85 SHEET 2 OF 5

BORING BEGAN 7/11/85 | BORING COMPLETED 7/18/85 | CORE HOLE LOCATION: [illegible] FEET FROM WEST STAKE

METHOD OF CORING NQ TT | DRILLING FLUID POTABLE WATER | DRILLER [illegible] WEATHER CLR/95

CASING USED PVC SIZE 6" | INSPECTOR FMW OPERATOR [illegible] | WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0																	
	B 3			26.5	I3IR	C	90						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				27.4	I3PR	C	85										
[illegible]	R 2	10.0/10.0	116/120	29.1	I2IR	C	75	8/10.0		N6 TO N8	VF	1	29.1 BREAK ACROSS SHELL		S		12/10.0
				30.0	3SPR	C	35						30.0 HEALED JOINT				
				31.1	I3IR	C	90										
				33.1	I3IR	C	90										
				34.6	I3PR	C	90										
				34.8	I3PR	C	90										
35.0	B 4																
		10.0/10.0	118/120	40.0	F1PR	C	45	4/10.0		N8	VF	1			S	39.6 / 40.6	9/10.0
				41.8	I3PR	C	90										
				43.6	I3PR	C	90										
				44.9	I3PR	C	90										
45.0				45.7	I2PS	C	90						45.7 BREAK ALONG SHELL				
[illegible]	B 5 / R 3	10.0/10.0	120/120					5/10.0		N6 TO N8	VF	1			S		11/10.0
[illegible]				[illegible]	I2PR	C	90										

NOTES: | SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1996

PROJECT CNM/CONSENT SITE CBRS/AL JOB NO 859 3... BORING NO ... DATE 7/11/85 SHEET 3 OF ...

BORING BEGAN 7/11/85 BORING COMPLETED 7/12/85 CORE HOLE LOCATION 19 FEET FROM WEST STAKE

METHOD OF CORING NQ?? DRILLING FLUID POTABLE WATER GR ELEV ... WEATHER ...

CASING USED PVC SIZE 6" INSPECT FNW OPERAT ... WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	5/5	10.0/10.0	120/120	52.1 54.0 54.6	I3PR I3PR I3PR	C C C	90 85 80	5/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		11/10.0
55.0	6/6	10.0/10.0	118/120	56.0 58.3 60.2 64.9	I3PR I3PR I2PR I3PR	C C C C	85 80 85 80	4/10.0		N6 TO N8	VF	1	60.2 BREAK ACROSS SHELL		5		16/10.0
65.0 66.7	7/7 BOX 4	10.0/10.0	119/120	67.3 68.9 70.1 72.5 73.5 74.7	I2PS I2PS I3PS I3PR I3PR I3PR	C C C C C C	70 85 90 90 90 85	6/10.0		N6 TO N8	VF	1	67.3 BREAK ALONG SHELL 68.9 BREAK ALONG SHELL		5		15/10.0
75.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CNM 'CONSENT DECREE'/AL — JOB NO. 855 8042 A — BORING NO. CA-4 — DATE 7/12/85 — SHEET 4 OF 5

BORING BEGAN 7/11/85 — BORING COMPLETED 7/12/85 — CORE HOLE LOCATION: 14 FT FROM WEST STAKE

METHOD OF CORING NQ?? — DRILLING FLUID: POTABLE WATER — DRILLER ??? — WEATHER SUN/95°

CASING USED PVC — SIZE 6" — INSPECTOR FMW — OPERATOR ??? — WATER LEVEL/TIME/DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	R 8	10.0/10.0	118/120	76.0	I2IR	<	65	4/10.0		N6 TO N8	VF	1	76.0 BREAK ACROSS SHELL		5		10/10.0
				77.9	I3PR	<	90						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES				
				80.1	I3PR	<	90										
				83.1	I2PR	<	70						83.1 BREAK ACROSS SHELL				
				84.2	I3PR	<	80										
				84.9	I3PR	<	90										
85.0	R 9	10.0/9.4?	119/120	85.1	I3PE	<	90	6/10.0		N6 TO N8	VF	1			5		11/10.0
85.7	BX 5			86.5	I3IR	<	75										
				88.2	I2PR	<	85										
				90.0	I3PR	<	90										
				93.4	I3PR	<	65										
				93.9	I3IR	<	85										
95.0	R 10	9.8/9.4?	117/120	97.6	I3PR	<	90	4/9.8		N6 TO N8	VF	1			5		15/10.0
100.0				100.0	I3PS	<	90										

SCALE: 1 DIVISION=0.2 FEET

NOTES:

New Page
February 24, 1986

PROJECT CWM/CHEMSERV DECARO/AL	JOB NO. 859 3CAPE	BORING NO. CA 4 DATE 7/12/85 SHEET 5 OF 5	
BORING BEGAN 7/11/85	BORING COMPLETED 7/12/85	CORE HOLE LOCATION	
METHOD OF CORING NQ2T	DRILLING FLUID POTABLE WATER	DRILLER ESE WEATHER CLOUDS	16 FT FROM WEST STAKE
CASING USED PVC SIZE 6"		INSPECT EHW OPERAT DIR [illegible]	WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0																	
	5/10	98/100	117/120	101.6	ISPR	C	90	4/98		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		15/10.0
				103.8	ISPR	C	80										
105.0													END OF CORING @ 105.0 FT				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1936

PROJECT: CAM CONSENT [illegible], AL | JOB NO: 833 [illegible] | BORING NO. CA-4 | DATE 6/9/85 | SHEET 1 OF 4

BORING BEGUN: 6/9/85 | BORING COMPLETED: 6/15/85 | CORE HOLE LOCATION: 45.0 FT FROM SOUTH STAKE

METHOD OF CORING: NQ?? | DRILLING FLUID: POTABLE WATER | GROUND ELEV | WEATHER: CLR, 90

CASING USED PVC/STEEL SIZE: 6" & 4" | INSPECT: PMJ | OPERAT: DER [illegible] | WATER LEVEL TIME DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 15.0 FT.				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
													INSITU CHALK @ ~10.0 FT. SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
13.6													6" P.V.C. CASING SET @ 13.6 FT.				
14.5													4" STEEL CASING TO 14.5 FT.				
15.0													BEGIN CORING NQ??				
				16.5	ISPS	C	90								VS		
															S		27 / 10.0
										NG TO NB	VF	2-1					
				20.0	ISPS	C	90										
				22.9	ISPS	C	90										
				23.5	ISPS	C	90										
				24.5	ISPS	C	90										
25.0																	

NOTES

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

PROJECT CWM/CONSENT [illegible]/AL — JOB NO 855 [illegible] — BORING NO [illegible] DATE 6/4/85 SHEET 2 OF 4

BORING BEGAN 6/4/85 — BORING COMPLETED 6/5/85 — CORE HOLE LOCATION: 45.0 FT FROM SOUTH STAKE

METHOD OF CORING NQ [illegible] — DRILLING FLUID: POTABLE WATER — DRILLER [illegible] — WEATHER [illegible]

CASING USED PVC/STEEL SCI 6 5/4" STEEL — INSPECTOR PMI — OPERATOR [illegible] — WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
25.0	B2									N8	VF	1-2	SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES		VS-S		77/10.0
		9.9/10.0	19/120	30.1	ISPS	C	90	5/9.9									
				31.5	ISPS	C	90										
33.8	BOX 6																
35.0										N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		23/10.0
				36.1	ISPR	C	90										
				38.8	ISPR	C	90										
	R5	9.9/10.0	19/120	40.8	ISPR	C	90	6/9.9									
				41.6	ISPR	C	90										
				42.5	ISPR	C	90										
				43.6	ISPR	C	90										
45.0				45.1	ISPS	C	90						45.1 BREAK ALONG SHELL				
				46.6	ISPS	C	90						46.6 BREAK ALONG SHELL		S		19/10.0
		10.2/10.0	120/120					10/10.2		N8	VF	1					
	R6			48.0	ISPS	C	90						48.0 BREAK ALONG SHELL				
				48.6	ISPR	C	90										
50.0																	

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

PROJECT CNM CONSENT DECREE/AL | JOB NO. #55 3C4P... | BORING NO. CA-5 | DATE 6/5/85 | SHEET 3 OF 4

BORING BEGUN 6/4/85 | BORING COMPLETED 6/5/85 | CORE HOLE LOCATION 45.0 FT FROM SOUTH STAKE

METHOD OF CORING NQ?? | DRILLING FLUID Potable water | GREELEY ... | WATER LEVEL, TIME, DATE —

CASING USED ... 6"/4" STEEL | INSPECT. ... | OPERAT. ...

DEPTH (FT)	CORE RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#4			50.7	I3PR	C	90										
				51.4	I3PR	C	90						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
52.5	BOX 3	10.2/10.0	12.0/12.0	52.4	I3PR	C	90	10/10.0		N8	VF	1			S		19/10.0
				53.0	I3PS	C	90						53.0 BREAK ALONG SHELL			53.5	
				53.9 / 54.1	F3PR / F3PR	C / C	40 / 40									54.2	
55.0	#5	① 9.1/10.0	9.0/12.0										55.2 MARCASITE BAND		S		21/10.0
				58.0	I3PR①	C	90										
				60.2	I3PR①	C	90			N8	VF	1					
				60.6	I3PR①	C	90										
				60.9	I3PR①	C	90										
				61.3 / 61.5 / 61.7	I3PR① / I3PR① / I3PR①	C / C / C	90 / 90 / 90	12/9.1									
				61.8	I3PR①	C	90						62.0 CORE GROUND UP DUE TO RETRIEVAL OF LOST CORE				
				63.5 / 63.7	I3PR① / I3PR①	C / C	90 / 90										
				63.9 / 64.1	I3PR① / I3PR①	C / C	90 / 90						LOST CORE GROUND UP				
65.0	#6	5.0/6.0	6.0/6.0	66.1	I3PR	C	90	3/5.0		N8	VF	1			S		11/6.0
				66.9	I3PR	C	90										
				68.7	I3PR	C	90										
70.0	#7	5.0/6.0	6.0/6.0					0/5		N8	VF	1			S		10/6.0
72.5	BOX 4																
75.0																	

NOTES: ① CORE RECOVERY AND RQD LOW DUE TO HAVING TO PUSH CORE BARREL OVER LOST CORE.

SCALE: 1 DIVISION = 0.5 FEET

New Page

PROJECT LWM/CONSENT DECREE/AL | JOB NO. 859 5... | BORING NO. CA 5 DATE 6/5/85 SHEET 4 OF 4

BORING BEGAN 6/4/85 | BORING COMPLETED 6/5/85 | CORE HOLE LOCATION: 45.0 FT. FROM SOUTH STAKE

METHOD OF CORING NQ?? | DRILLING FLUID: POTABLE WATER | GRILEY ...

CASING USED PVC/STEEL SET 6"/4" SIZE | INSPECT. PMI | OPERAT. DIR ... | WATER LEVEL TIME DATE —

DEPTH (FT)	CORE RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES, LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8	10.0/10.0	115/120	75.3	I3PR	C	90	8/10.0		N8 TO N6	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		S		20/10.0
				75.5	I3PR	C	90										
				75.9	I3PR	C	90										
				76.0	I3PR	C	90										
				77.6	I3PR	C	90										
				78.2	I3PR	C	90										
				80.7	I3PR	C	90										
				82.7	I3PR	C	90										
85.0	#9	(1) 9.95/10.0	112/120	85.9	I3PR	C	90	6/9.95		N8 TO N6	VF	1			S		15/10.0
				88.1	I3PR	C	90										
				90.2	I3PR	C	90										
				92.8	I3PR	C	90										
				94.1	I3PR	C	90										
				94.2	I3PR	C	90										
95.0	#10	5.05/5.0	60/60	96.0	I3PR	C	90	1/5.05		N8	VF	1			S		7/5.0
100.0													END OF CORING @ 100.0 FT.				

NOTES (1) .05 CORE LEFT IN HOLE.
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page

PROJECT [illegible] JOB NO. 895 [illegible] BORING NO. CA-6 DATE 6/[illegible] SHEET 1 OF 6

BORING BEGAN 6/6/85 BORING COMPLETED 6/7/85 CORE HOLE LOCATION

METHOD OF CORING NQ [illegible] DRILLING FLUID POTABLE WATER DRILLER [illegible] 1470 FT FROM NORTH STAKE

CASING USED PVC SIZE 6" INSPECTOR P/T/ OPERATOR [illegible] WATER LEVEL TIME DATE ——

DEPTH (FT)	BOTTOM NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 19.0 FT WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
19.0	BOX 1 RUN 1	61/63	71/76	20.0	IJPS	C	90	5/6.1		NG	VF	I-E			VS-S		15/63
				20.7	IJPS	C	90										
				22.7	IJPS	C	90										
				24.8	IJPS	C	90										
25.0				24.9	IJPS	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page

PROJECT CWM 'CONSENT DECREE' AL | JOB NO. 859 3C4P1 | BORING NO. CA 6 DATE 6/6/85 SHEET 2 OF 6

BORING BEGUN 6/6/85 | BORING COMPLETED 6/7/85 | CORE HOLE LOCATION 1418 FT. FROM NORTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR. ELEV. 262 ft | WEATHER CLR/98

CASING USED PVC | SCT 6" | INSPECT. PMI | OPERAT. DIR | WATER LEVEL TIME DATE ——

DEPTH (FT)	BOTTOM NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE WIDTH	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
250 / 25.3	8 / 2	9.8 / 10.0	116 / 120	25.9 / 25.2	I3PS / I3PS	C / C	90 / 90	8 / 4.8		N6	VF	I	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		VS-S		26 / 100
28.0	BV / 2																
35.3	5	10.0 / 10.0	118 / 120	35.4	I3PS	C	90	2 / 10.0		N6	VF	I		I	VS-S		23 / 100
				45.2	I3PS	C	90			N8			BECOMING LIGHTER @ 44.1				
45.3	4	10.1 / 10.0	115 / 120	46.5	I3PS	C	90	2 / 10.1		N8	VF	I			VS-S		20 / 100
50.0																	

NOTES

SCALE: 1 DIVISION=0.5 FEET

New Page
February 24, 1986

PROJECT CWM/CONSENT DECREE/AL — JOB NO 855-2092 A — BORING NO CA-6 — DATE 6/6/85 — SHEET 3 OF 6

CORE HOLE LOCATION 147.8 FT FROM NORTH STAKE

BORING BEGAN 6/6/85 — BORING COMPLETED 6/7/85

METHOD OF CORING NQTT — DRILLING FLUID POTABLE WATER — GR. ELEV 202.8 FT — WEATHER CALM 98

CASING USED PVC — SIZE 6" — INSPECT PMI — OPERAT DER — WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#4	10.1/10.0	115/120	51.4	(3/F)SPS	C?	45	5/10.1		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S	50.4 – 52.0	20/10.0
				55.0	ISPS	C	90										
55.3	BOX 3 (at 57.9)	10.0/10.0	119/120	56.7	ISPR	C	90	4/10.0		N8	VF	1			VS-S		21/10.0
				58.2	ISPR	C	90										
	#5			60.1	ISPR	C	90										
				62.9	ISPR	C	90										
65.8	#6	10.0/10.0	—/120	67.2	ISPR	C	90	7/10		N8	VF	1			S		17/10
				69.9	ISPR	C	90										
				70.3	ISPR	C	90										
				72.5	ISPR	C	90										
				74.1	F1PK	C?	80									73.6 – 74.4	
				74.4	ISPR	C	90										
75.0				75.1	ISPR	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/6/85 LOGGED BY PMI

Golder Associates

PROJECT CWM/CONSENT DECREE/AL

BORING BEGAN 6/6/85	BORING COMPLETED 6/7/85		CORE HOLE LOCATION 147.0 FT. FROM NORTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR. ELEV. 262.80 FT. WEATHER CLR/98	
CASING USED PVC SIZE 6"		INSPECT PMI OPERAT. D&R	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0 / 75.3				75.6	I3PR	C	90			N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		18/100
76.9	BOX 4			77.2	I3PR	C	90	7/10.1									
	#7	10.1/10.0	120/120	79.0	I3PR	C	90										
				82.4	I3PR	C	90									83.5	
				83.6	(3)(?)PS	CT	45										
				84.0	FIPK	C	80									84.?	
				85.1	I3PU	C	70										
85.3		9.8/10.0	119/120	86.5	I3PR	C	90								VS-S		15/100
	#8			87.8	I3PR	C	90										
				88.1	I3PR	C	75	6/9.8		N6 TO N8	VF	1					
				92.8	I3PR	C	90										
				93.5	I3PR	C	90						93.5 - 93.8: BROKEN ALONG SHELL IN CORE				
				93.8	I3PR	C	90										
95.3																	
95.9	BOX 5	-/10.0	-/120	96.1	I3PR	C	90	2/10.0		N8	VF	1			VS-S		12/10
	#9																
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/7/85 LOGGED BY PMI

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 853-3092.2 | BORING NO CA-6 | DATE 6/7/85 | SHEET 5 OF 6

BORING BEGAN 6/6/85 | BORING COMPLETED 6/7/85 | CORE HOLE LOCATION 147.8 FT. FROM NORTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 262.86FT | WEATHER CLR/98

CASING USED PVC | SIZE 6" | INSPECT PMI | OPERAT DTR-JWB | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#9	—/10.0	—/12.0	100.7	I3PS	c	90			NB	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		12/10.0
105.3	#10	10.0/10.0	118/120	106.6	I3PR	c	90			NB	VF	1			VS-S		17/10.0
				107.2	I3PR	c	80	3/10									
				112.2	I3PR	c	85										
115.0 / 115.3	BOX 6, #11	10.1/10.0	120/120	116.6	I3SR	c	70			NB	VF	1			VS-S		16/10.0
				117.9	I3PR	c	85	5/10.1									
				119.5	I3PR	c	70										
				123.5	I3PR	c	90										
				124.6	I3PR	c	90										
125.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/7/85 LOGGED BY PMI

Golder Associates

PROJECT LWM 'CONSENT DECREE,' AL | JOB NO 855-3C9P 1 | BORING NO CA-6 | DATE 6/7/85 | SHEET 6 OF 6

BORING BEGAN 6/6/85 | BORING COMPLETED 6/7/85 | CORE HOLE LOCATION 147.8 FT. FROM NORTH STAKE

METHOD OF CORING NGTT | DRILLING FLUID POTABLE WATER | GR. ELEV 262 BOFT | WEATHER CLR/98

CASING USED PVC | SIZE 6" | INSPECT PM1 | OPERAT DIR JONES | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0 – 125.8	11 12	8.9/10.0	100/120					2/8.9		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		15/100
				130.4	I3 PR	C	90										
				133.5	I3 PS	C	85										
135.3													END OF CORING @ 135.3 FT.				

NOTES
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/7/85 LOGGED BY PM1

Golder Associates

PROJECT [illegible]

BORING BEGAN 6/14/85	BORING COMPLETED 6/15/85		CORE HOLE LOCATION 40 FT FROM NORTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID Potable Water	GR ELEV 267.0 FT WEATHER CLDY	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR [illegible]	WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 9.0 FT WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
9.0	BOX 1 RUN # 1	5.7/6.0	68/72	12.2	13PR	C	90	1/5.7		N6 To N8	VF	1	CASING SET @ 9.0 FT UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		11/6.0
15.0	# 2	10.0/10.0	120/120	19.6 20.3	13PS 32PR	C C	90 45	2/10.0		N6 To N8	VF	1			S	19.6 20.9	17/10.0
25.0																	

NOTES: CASING DROPPED TO 9.0 FT. PULLED UP 2.0 FT. AND POURED 2½-3 GAL. BUCKETS OF BENTONITE PELLETS INSIDE CASING. PUSHED CASING BACK TO 9.0 FT. POURED ADDITIONAL 1½ BUCKETS OF BENTONITE PELLETS OUTSIDE CASING TO COMPLETE SEAL.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 855-3048 2 | BORING NO CA-7 DATE 6/15/85 SHEET 2 OF 5

BORING BEGAN 6/14/85 | BORING COMPLETED 6/15/85 | CORE HOLE LOCATION 40.1 FT. FROM NORTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR.ELEV 867.0 | WEATHER RAIN/80

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DIR JONES | WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0	#3												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
28.8	BOX 2	10.0/10.0	120/120	29.9	I3PS	C	90	1/10.0		N6 To N8	VF	1			5		19/10.0
35.0	#4	10.0/10.0	120/120	40.0	I3PR	C	90	1/10.0		N6 To N8	VF	1			5		—/10.0
45.0	#5	10.0/10.0	116/120	45.2	I3IR	C	90	7/10.0		N6 To N8	VF	1			5		19/10.0
				45.4	I3IR	C	90										
				46.2	I2PR	C	30						46.2 BREAK ALONG SHELL				
				46.7	I3PS	C	90										
				46.9	I3PS	C	90										
47.7	BOX 3																
				49.6	I3IR	C	90										
50.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT: CWM/CONSENT DECREE/AL	JOB NO: B55 3C9P1	BORING NO: CA-7	DATE: 6/15/85
BORING BEGAN: 6/14/85	BORING COMPLETED: 6/15/85	CORE HOLE LOCATION: 40.1 FT. FROM NORTH STAKE	
METHOD OF CORING: NQTT	DRILLING FLUID: POTABLE WATER	GR ELEV: 267.02	WEATHER: CLDY/85
CASING USED: PVC	SIZE: 6"	INSPECT: FHW	OPERAT: DIR. JMB
WATER LEVEL, TIME, DATE: —			

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#6	10.0/10.0	116/120	52.3	FIPK	C	30	7/10.0	Chalk	N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	52.0 / 52.6	19/10.0
55.0	#6	10.0/10.0	120/120	55.4	FIPK	C	40	3/10.0	Chalk	N6 TO N8	VF	1			S	60.9 / 61.6	20/10.0
				58.3	I3PR	C	90										
				61.4	JIPS	C	50										
65.0	#7	10.1/10.0	120/120	65.1	I3IR	C	90	5/10.1	Chalk	N6 TO N8	VF	1			S		18/10.0
				66.2	I3CS	C	65										
67.2	BOX 4			68.7	I3CS	C	75										
				72.4	I3PR	C	85										
75.0				74.0	I3PR	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

DATE 6/15/85 LOGGED BY FHW

PROJECT [illegible]

BORING BEGAN 6/14/85	BORING COMPLETED 6/15/85	CORE HOLE LOCATION 40.1 FT. FROM NORTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR.ELEV. [illegible] WEATHER CLDY/85
CASING USED PVC SIZE 4"	INSPECT FHW OPERAT. DTR [illegible]	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8	9.9/10.0	119/120	79.9	I3PS	C	90	3/9.9		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		11/10.0
				81.3	I3IR	C	86										
				82.9	I3IR	C	80										
85.0																	
86.0	BOX 5			86.3	F1PR	C	45										
	#9	10.0/10.0	119/120	91.3	I3IR	C	85	7/10.0		N6 TO N8	VF	1			5		20/10.0
				92.2	I3PS	C	90										
				93.2	I3IR	C	90									93.9	
				93.9	I3IR	C	90										
				94.5	F1PR	C	60									94.9	
				94.9	I3IS	C	90										
95.0	#10	10.0/10.0	119/120	96.1	I3IR	C	90	6/10.0		N8	VF	1			5		16/10.0
				98.7	I3IR	C	85										
100.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 855-3049.2 | BORING NO CA-7 DATE 6/15/85 SHEET 5 OF 5

CORE HOLE LOCATION 40.1 FT FROM NORTH STAKE

BORING BEGAN 6/14/85 | BORING COMPLETED 6/15/85

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 267.02 | DEPTH | WEATHER CLDY/85

CASING USED PV | SIZE 6" | INSPECT FHW | OPERAT DIR JOHNS | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#10	10.0/10.0	119/120	102.2	I3PS	C	90	6/10.0		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		16/10.0
				103.5	I3PR	C	85										
				104.4	I3PR	C	85										
				104.9	I3PS	C	90										
105.0																	
105.6	BOX 6 #11	10.0/10.0	119/120	106.1	I3PS	C	90	4/10.0		N8	VF	1			S	106.8 – 107.7	13/10.0
				107.3	FIPK	C	40										
				111.4	I3IR	C	90										
				112.5	I3PR	C	85										
115.0													END OF CORING @ 115.0 FT.				
125.0																	

NOTES:
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | 67.7 FT. FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID Potable? water? | GR. ELEV 851.81 FT | WEATHER RAIN/60

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERATOR [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 8.9 FT.				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—			—	—	INSITU CHALK @ ~5.0 FT.	—	—	—	—
										N6			SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
8.9	BOX 1 RUN # 1	6.0/6.1	65/73	[illegible]	[illegible]	<	[illegible]	6/6.0		N6	VF	1	CASING SET @ 8.9 FT. UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		13/6.1
				14.8	I3PR	<	80										
15.0	# 2																
				17.4	I3PR	<	85										
				20.0	I3PS	<	90			N6	VF	1			5		17/10.0
		10.0/10.0	117/120					9/10.0									
25.0				24.8	I3PR	<	90										

NOTES: 5 - 5 GAL. BUCKETS OF BENTONITE USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSEAN DE CREEK/AL | JOB NO. 855-3098.2 | BORING NO CA-8 DATE 6/18/85 SHEET 2 OF 7

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 251.81 FT | WEATHER RAIN/80 | 67.7 FT. FROM SOUTH STAKE

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DYE Jones | WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
25.0	#3			26.2	I3IR	C	80						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
27.4	BOX 2	10.0/10.0	118/120	29.4	I2PR	C	85	4/10.0		N6	VF	1	29.4 BREAK ACROSS SHELL		S		21/10.0
				30.0	I3PR	C	90										
				34.8	I3PR	C	85										
35.0	#4	10.0/10.0	119/120	39.9	I3PR	C	80	9/10.0		N6 TO N8	VF	1			S		21/10.0
				40.0	I3PS	C	90										
				43.3	I3PR	C	90										
45.0		10.0/10.0	120/120	45.4	I3PS	C	90	4/10.0		N6 TO N8	VF	1			S		22/10.0
46.1	BOX 3			47.5	I3PS	C	90										
50.0	#5																

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT ... CREEK/AL | JOB NO. ... | BORING NO. CA-8 ... SHEET ... OF ...

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR.ELEV. 267.8 FT | WEATHER RAIN/80 | 67.7 FT. FROM SOUTH STAKE

CASING USED PVC SIZE 6" | INSPECT. FHW | OPERAT. DIS ... | WATER LEVEL, TIME, DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#5	10.0/10.0	120/120					4/ND		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		22/10.0
				53.7	I3PR	C	75										
				54.4	I3PR	C	90										
55.0	#6	10.0/10.0	120/120	55.4	I3PR	C	80	7/10.0		N6 TO N8	VF	1			5		16/10.0
				57.2	I3PR	C	75										
				58.3	I3PR	C	80										
				59.3	I3PR	C	80										
				61.3	I3PR	C	90										
				62.6	I3PR	C	70										
				64.1	I2PS	C	70						64.1 BREAK ALONG SHELL				
65.0	BOX 4 #7	10.1/10.0	117/120					6/10.1		N6 TO N8	VF	1			5		15/10.0
				66.8	I3PR	C	90										
				68.3	I3PR	C	85										
				69.8	I3PR	C	85										
				70.0	I3PS	C	90										
				74.1	I2IR	C	80						74.1 BREAK ALONG SHELL				
				74.5	I2PS	C	70						74.5 BREAK ALONG SHELL				
75.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT 1-6 CRKK/AL JOB NO 853 3047.1 BORING NO CW-D DATE 6/18/85 SHEET 4 OF 7

BORING BEGAN 6/17/85 BORING COMPLETED 6/19/85

CORE HOLE LOCATION 67.7 FT. FROM SOUTH STAKE

METHOD OF CORING NQ-TT DRILLING FLUID POTABLE WATER GR. ELEV 251.8 WEATHER RAIN/80°

CASING USED PVC SIZE 6" INSPECT FHW OPERAT DIR JAMES WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8	10.0/10.0	120/120					1/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		—/10.0
83.6	BOX 5			83.8	I3IR	C	90										
85.0	#9	10.0/10.0	118/120	85.1	I3PS	C	90	6/10.0		N8	VF	1			85.0 BEX; S	89.1–90.7	8/10.0
				85.2	3IPR?	C	60										
				85.6	3IPR?	C	65										
				86.8	I3IR	C	85										
				90.2	FIPK	C	60										
				93.6	I3PR	C	90										
95.0	#10	10.0/10.0	120/120	96.0	I3PR	C	90	1/10.0		N8	VF	1			S		9/10.0
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986
DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL	JOB NO. 855 3042 Z	BORING NO. CA-8 DATE 6/18/85	SHEET 5 OF 7
BORING BEGAN 6/17/85	BORING COMPLETED 6/19/85	CORE HOLE LOCATION	61.7 FT. FROM SOUTH STAKE
METHOD OF CORING NQ??	DRILLING FLUID Potable Water	GR. ELEV. 257.81 FT.	WEATHER RAIN/80
CASING USED PVC SIZE 6"	INSPECT FHW	OPERAT. DTR Jones	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#10												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				102.8	I3PR	C	85										
103.4		10.0/10.0	120/120					9/10.0		N8	VF	1			S		9/10.0
				103.9	I3IR	C	80										
	BOX 6																
105.0	#11			105.5	I3PR	C	90										
				105.6	I3PR	C	90										
				106.3	I3IR	C	90										
				109.7	I3PR	C	90						109.9 - 117.8 SLICKENSIDE ZONE			109.6	16/10.0
				109.9	FIPK	C	50						110.0 SLICKENSIDE WITH PYRITE INFILLING.		S		
		9.9/10.0	106/120	110.0	FIPK	P	30	12/9.9		N6 TO N8	VF	1				110.7	
				110.1	I3IR	C	85										
																112.9	
				113.3	FIPK	C	50										
				113.4	FIPK	C	60										
				114.3	FIPK	C	25										
				114.6	FIPK	C	50										
				114.7	FIPK	C	40										
115.0																115.0	
				115.4	I3PR	C	80										
				115.8	FIPK	C	65										
	#12			115.9	FIPK	C	85										
				116.1	FIPK	C	60										
				116.4	FIPK	C	85										
				116.8	FIPK	C	65										
				117.3	FIPK	C	60									116.8	
				118.3	I3PR	C	80								S	118.5	
		10.0/10.0	113/120					12/10.0		N6 TO N8	VF	1					16/10.0
				119.1	I3PS	C	75										
				120.5	I3PS	C	80										
				121.5	I3PR	C	80										
				123.4	I3PR	C	80										
125.0																	

NOTES:

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

PROJECT CWM/CONSENT DECREE/AL | JOB NO 855 3098 2 | BORING NO LA-8 | DATE 6/19/85 | SHEET 6 OF 7

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION 67.7 FT. FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR. ELEV 85.81 FT | WEATHER RAIN/60

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT D/R | WATER LEVEL, TIME, DATE

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0				125.8	I3PR	C	75										
126.1	Box 7			126.4	I3PR	C	85										
	#13	10.0/10.0	120/120	128.7	I3PR	C	80	3/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		19/10.0
135.0	#14	9.6/10.0	114/120	135.7	I3PR	C	90	4/9.6		N6 TO N8	VF	1			5		19/10.0
				140.3	I3PR	C	90										
				141.3	I3PR	C	85										
				143.6	I3PR	C	90										
145.0	Box 8 #15	6.5/5.0	60/60	145.8	I3PR	C	90	1/5.5		N6 TO N8	VF	1			5		5/5.0
150.0																	

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

Golder Associates

PROJECT CNM/CONSENT DECREE/AL | JOB NO. 859 3C9P 1 | BORING NO. CA-8 | DATE 6/19/85 | SHEET 7 OF 7

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION 67.9 FT. FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | DRILLER ZST [illegible] | WEATHER RAIN/80

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
150.0	#16	5.0/5.0	57/60	152.1 154.8	I3PR I3PR	C C	90 90	2/5.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		6/5.0
155.0	#17	10.0/10.0	120/120	161.4	I3PS	C	85	1/10.0		N6 TO N8	VF	1			S		12/10.0
163.4	Box 9																
165.0	#18	10.0/10.0	120/120	168.8 170.2	I3PR I3PR	C C	80 85	2/10.0		N6 TO N8	VF	1			S		12/10.0
175.0													END OF CORING @ 175.0 FT.				

NOTES:

FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

BORING BEGAN 6/16/85	BORING COMPLETED 6/17/85		CORE HOLE LOCATION
METHOD OF CORING NQTT	DRILLING FLUID Potable Water	GR. ELEV 242 SEFF WEATHER CLDY/85	97.2 FT. FROM EAST STAKE
CASING USED PVC SIZE 6"		INSPECT FHW OPERATOR JOHN	WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 9.0 FT.				
												2	WEATHERED, GRAY, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—		—	—			—	—	—	—
												2-1	SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
9.0	BOX 1 RUN #1			9.1 9.4	I3PS I3PS	C C	90 90						CASING SET @ 9.0 FT.				
		2.7/6.0	28/72	11.4 11.6	I3PR I3PR	C C	90 90	4/2.7		NG	VF	1			S		15/6.0
15.0	#2			15.3	I3PS	C	90										
				15.9 16.3	I3PS I3PS	C C	90 90										
		4.9/5.0	57/60	17.0	I3PS	C	90										
				17.8	I3PS	C	90	6/4.9		NG	VF	1			S		9/5.0
				19.5	I3PR	C	75										
20.0	#3	5.0/5.0	57/60														
				23.3	I2PS	C	90	3/5.0		NG	VF	1	23.3 BREAK ALONG SHELL		S		4/5.0
25.0				24.7	I3PR	C	90										

NOTES 4½ - 5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 853 3069 I | BORING NO CA-4 | DATE 6/11/85

CORE HOLE LOCATION: 97.2 FT. FROM EAST STAKE

BORING BEGAN 6/10/85 | BORING COMPLETED 6/11/85

METHOD OF CORING NQTT | DRILLING FLUID: POTABLE WATER | GR. ELEV 248.68 FT | WEATHER PCLDY/100

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR-JING | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0–35.0	#4; BOX 2 (at 30.8)	9.9/10.0	119/120	30.0 30.5	I3PR I3PS	C C	80 90	2/9.9		N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		19/10.0
35.0–45.0	#5	10.2/10.0	118/120	35.2 35.5 40.2 44.4 44.8	I3PS I3PS I3PR I3PR I3PR	C C C C C	90 90 90 90 90	4/10.2		N6 To N8	VF	1			S		12/10.0
45.0–50.0	#6; BOX 3 (at 49.2)	9.8/10.0	113/120	45.6 47.2 48.2 49.2 49.3 49.5 [illegible] [illegible]	I3IR I3PR I3PR I3IR I3IR I3IR I3IR I3PS	C C C C C C C C	80 85 90 90 90 90 90 90	10/9.8		N4 To N8	VF	1			S		17/10.0

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/11/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 855-3C4P1 | BORING NO 6A-9 DATE 6/17/85 SHEET 3 OF 6

BORING BEGAN 6/10/85 | BORING COMPLETED 6/17/85 | CORE HOLE LOCATION 97.2 FT. FROM EAST STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | DRILLER EASTERN WEATHER SUNNY/90

CASING USED PVC SIZE 6" | INSPECT FHW OPERAT DIR JHO | WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#6	9.8/10.0	112/120	50.4	I3PS	C	90	10/9.8		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	55.0	17/10.0
				53.5	I3PR	C	75										
55.0	#7	10.2/10.0	120/120	55.0	J1PR	C	60	10/10.2		N6 TO N8	VF	1			S	55.9	17/10.0
				56.5	I3PR	C	85										
				58.3	I2PR	C	85						58.3 BREAK ACROSS SHELL				
				60.5	I3PR	C	90										
				61.4	I3PR	C	90										
				62.2	I3IR	C	70										
				62.5	I3PR	C	80										
				63.6	I3PR	C	85										
				64.0	I3PR	C	90										
				64.8	I3PR	C	90										
65.0	#8	10.0/10.0	120/120	65.6	I3IR	C	90	9/10.0		N6 TO N8	VF	1			S		13/10.0
				66.7	I3PR	C	85										
68.7	BOX 4			70.1	I3PR	C	90										
				71.6	I3PR	C	85										
				73.5	I2PS	C	60						73.5 BREAK ALONG SHELL				
75.0				74.7	I3PR	C	90										

SCALE: 1 DIVISION=0.2 FEET

NOTES

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

PROJECT CWM CONSENT DECREE/AL | JOB NO 855 3049 2 | BORING NO CA-9 | DATE 6/17/85 | SHEET 4 OF 6

BORING BEGAN 6/16/85 | BORING COMPLETED 6/17/85 | CORE HOLE LOCATION 91.2 FT. FROM EAST STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GRZLEY 24E 68 FT | WEATHER PCLDY, 90

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR JONES | WATER LEVEL, TIME, DATE ———

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#9	10.0/10.0	114/120	76.6	F/PK	C	30	7/10.0		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES		S	75.0 – 77.0	12/10.0
				77.5	I3IR	C	80										
				79.3	F/PK	C	45										
				81.7	I3PR	C	90										
				83.9	I3PR	C	85										
				84.6	I3PS	C	90										
				84.9	I3PR	C	90										
85.0	#10	10.0/10.0	116/120	85.4	I3IR	C	90	7/10.0		N8	VF	1			S		9/10.0
				85.9	I3PR	C	90										
88.3	Box 5																
				91.7	I3PR	C	90										
				92.7	I3PR	C	85										
				93.5	I3PR	C	90										
				94.2	I3PR	C	85										
				94.6	I3PR	C	90										
95.0	#11	9.9/10.0	116/120	96.1	I3PR	C	90	6/9.9		N6 TO N8	VF	1			S		13/10.0
				97.2	I3PR	C	90										
				97.5	I3PR	C	90										
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

PROJECT: CWM CONSENT DECREE, AL — JOB NO. 853 3C4F-1 — BORING NO. CA-8 — DATE 6/17/85 — SHEET 5 OF 6

BORING BEGAN: 6/10/85 — BORING COMPLETED: 6/17/85 — CORE HOLE LOCATION: 97.2 FT. FROM EAST STAKE

METHOD OF CORING: NQ TT — DRILLING FLUID: POTABLE WATER — GREELEY 246 SOFT — WEATHER: PCLDY/90

CASING USED: PVC — SIZE: 6" — INSPECT: FHW — OPERAT: DYR JONES — WATER LEVEL, TIME, DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0–105.0	#11	9.7/10.0	116/120	100.1 101.4 103.7	I3PS I3PR I3PR	c c c	90 80 85	4/9.9	N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		15/10.0
105.0–115.0	#12 (107.1) Box 6	10.1/10.0	117/120	106.3 107.8 109.2 109.3 110.5 114.5 114.6 114.9	I3PR I3PS I3PR I3PR I2PS I3PR I3PR I3PR	c c c c c c c c	85 90 90 90 90 90 80 90	8/10.1	N6 To N8	VF	1	110.5 BREAK ALONG SHELL		S		15/10.0
115.0–125.0	#13	10.0/10.0	118/120	116.5 119.0 119.3 119.8 124.8	I3PR I2PR I2PR I3PR I3IR	c c c c c	90 80 75 85 85	5/10.0	N6 To N8	VF	1	119.0 BREAK ALONG SHELL		S		15/10.0

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

PROJECT [illegible]

BORING BEGAN 6/10/85	BORING COMPLETED 6/17/85
METHOD OF CORING NQ??	DRILLING FLUID Potable Water
CASING USED PVC SIZE 6"	GR. ELEV [illegible] WEATHER P. Cldy/Hu
INSPECT FHW	OPERAT DIR [illegible]
CORE HOLE LOCATION 97.2 FT FROM EAST STAKE	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0	Box 7 / #14	10.0/10.0	118/120	126.0	I3PS	C	80	1/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		15/10.0
				127.7	I3PR	C	85										
				129.5	I3PR	C	90										
				129.8	I3PR	C	80										
				131.4	I3PR	C	80										
				133.6	I3PS	C	90										
				134.8	I3PR	C	85										
135.0	#15	10.2/10.0	119/120	141.0	I3PR	C	90	4/10.2		N6 TO N8	VF	1			S	143.6–144.5	16/10.0
				143.6	F1PR	C	25										
				144.5	I3PR	C	75										
				144.7	I3PR	C	85										
145.0	Box 8 / #16	5.0/5.0	55/60	147.3	I3PS	C	90	3/5.0		N6 TO N8	VF	1			S		7/5.0
				149.6	I3PR	C	90										
				149.8	I3PR	C	90										
150.0													END OF CORING @ 150.0 FT.				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/24/85	BORING COMPLETED 5/28/85	CORE HOLE LOCATION: 89.5 FT FROM SOUTH STAKE
METHOD OF CORING: NQTT	DRILLING FLUID: POTABLE WATER	GR. ELEV. / DRILL RIG: MIDGET; WEATHER: CLR
CASING USED: PVC SIZE: 6"	INSPECTOR: FHW; OPERATOR: [illegible]	WATER LEVEL, TIME, DATE: —

DEPTH (FT)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	DISCONTINUITIES: TYPE	DISCONTINUITIES: INFILLING	DISCONTINUITIES: ANGLE W/AXIS	DISCONTINUITIES: FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED @ 8.9 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES. 5.2 - CELL 1 LINER MATERIAL.				
8.9	RUN #1	1.3 / 6.5	11 / 70	15.0 15.2 15.3	ISIR ISIR ISIR	C C C	90 90 90	10+		N8	VF	1-2	CASING INITIALLY SET @ 8.9 FT. FOUND TO BE SET IN RECOMPACTED CHALK. REMOVED AND RESET TO 26.0 FT.		VS		12 / 6.5
16.4	#2	2.9 / 10.0	15 / 120	23.4 24.7	ISIR ISIR	C C	90 90	10+		N8	VF	1-2	INSITU CHALK @ ≈ 24.7 FT.		VS 3		15 / 10.0
25.0																	

NOTES: 2-5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING @ 26.0 FT.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/24/85 LOGGED BY FHW

Golder Associates

PROJECT [illegible] | BORING BEGAN 5/24/85 | BORING COMPLETED 5/24/85 | CORE HOLE LOCATION: 89.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR.ELEV [illegible] WEATHER CLR

CASING USED PVC SIZE 6" | INSPECT FHW OPERAT D. [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISC. DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
25.0		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10+		N8	VF	1-2			S		[illegible]
25.4	#2			25.9	J3PR	C	90						CASING RESET TO 26.0 FT.				
				26.4	J3PR	C	85										
	#3	10.0/10.0	100/120	29.0	J2PR	C	45	1/10.0		N8	VF	1-2	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		14/10.0
				30.5	J3PR	C	90										
				34.2	J3IR	C	45										
				34.6	J3IR	C	60										
				35.0	J3IR	C	45										
35.4	#4	5.9/10.0	34/120	35.6	J3IR	C	40	15+/5.9		N8	VF	1-2	CORE CATCHER FOR NQTT LOST AFTER RUN #3. D. JONES RIGGED DOUBLE TUBE CORE CATCHER WITH A SPACER AND SPRING TO USE ON RUN #4 WITH SPLIT TUBE.		VS		20/10.0
				36.0	J3IR	C	85										
				36.3	J3IR	C	40										
				37.5	J3PR	C	70										
				37.7	J3IR	C	90										
				38.0	J3IR	C	70										
				38.7	J3PR	C	80										
				38.8	J3IR	C	60										
				39.1	J3IR	C	70										
				39.2	J3PR	C	90										
				39.4	J3PV	C	65										
				39.5	J3IR	C	85										
				39.8	J3IR	C	75										
44.1	BOX 2			44.1	J3IR	C	90						44.4-45.4 HIGHLY BROKEN CORE VERY FRAGMENTED. MACHINE BREAKS.				
				44.2	J3IR	C	85										
45.4	#5	4.8/5.0	44/60	45.7	J3IR	C	80	8/4.8		N8	VF	1			S	48.2	8/5.0
				46.0	J3PS	C	90										
				46.2	J3IR	C	70										
				47.7	J3IR	C	60										
				47.9	J3IR	C	30										
				48.9	F1PR	C	20						48.9 SHEARED. 1/2 OF FRACTURE CONTAINED IN SAMPLE TAKEN, OTHER HALF REMAINS IN CORE BOX.			48.9	
50.0																	

SCALE: 1 DIVISION = 0.2 FEET

NOTES:

New Page
February 24, 1986

DATE 5/27/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/24/85 | BORING COMPLETED [illegible] | 81.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID Potable Water | GR ELEV 19/26 FT | WEATHER CLR

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0																	
	#8			76.2	ISIR	C	85										
75.4	#9			75.6	ISPR	C	90										
				76.1	ISIR	C	85										
				76.6	ISPR	C	80						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				77.5	ISPR	C	85										17/10.0
				78.0	ISPS	C	85			N6 TO N8	VF	1			S		
		7.6/10.0	68/120	78.8	ISPR	C	90										
				79.4	ISIR	C	65	17/7.6								79.3/79.5	
				79.5	FIPK	C	60						79.5 SHEARED				
				79.9	ISIR	C	80										
				80.0	ISIR	C	90										
				80.2	ISIR	C	90										
				83.1	ISPR	C	75						*TRIPLE TUBE RUN BACKDOWN CORE BARREL AND ADDITIONAL 2.6 FT. OF RUN #9 RECOVERED				
				83.5	ISPR	C	90										
			*	84.1	ISPR	C	—										
				84.5	ISPR	C	85										
84.8	BOX 4			84.8	ISIR	C	90										
85.4				85.2	ISIR	C	85										
	#10			85.5	ISIR	C	90										
		5.1/5.0	57/60	86.9	ISIR	C	85	4/5.1		N6 TO N8	VF	1			S		9/5.0
				90.2	ISPS	C	90										
				90.3	ISIR	C	90										
90.4	#11			91.2	ISPR	C	85										
				91.7	ISPR	C	90										
				92.2	ISPR	C	85										
		5.0/5.0	58/60	93.0	ISPR	C	85	8/5.0		N6 TO N8	VF	1			6		13/5.0
				93.8	ISPR	C	85										
				94.2	ISPR	C	80										
				94.7	ISIR	C	85										
				95.3	ISPS	C	85										
95.4				95.5	ISPS	C	90										
	#12			96.8	ISPS	C	90								6		17/10.0
		10.0/10.0	116/120					6/10.0		N6 TO N8	VF	1					
100.0																	

NOTES

RECIRCULATION OF WATER CAUSING CORE TO CATCH IN T-TUBE.
NO RECIRCULATION STARTING WITH RUN #10.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/28/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT T.E.CBES/AL | JOB NO 855 3C9P 2 | BORING NO [illegible] DATE 5/[illegible] SHEET [illegible]

BORING BEGAN 5/24/85 | BORING COMPLETED 5/28/85 | CORE HOLE LOCATION 89.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 191.26 FT, WEATHER CLR

CASING USED PVC SIZE 6" | INSPECT FHW OPERAT D[illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0		4/5.0	4/6.0	[illegible]	I3PS	C	85	2/4.0		N8	VF	1	50.2 BREAK ALONG SHELL FRAGMENT		S		8/5.0
				[illegible]	I3PR	C	85										
				50.0	I3PS	C	90										
50.4	#6	4.9/5.0	5.4/6.0	52.1	I3PS	C	85	5/4.9		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		18/6.0
				53.0	I3PR	C	90										
				54.4	I3PS	C	80										
				55.2	I3PS	C	90										
55.4	#7	10.2/10.0	11/12.0	55.7	I3PR	C	80	16/10.2		N8	VF	1			S		14/10.0
				55.9	I3IR	C	90										
				56.5	I3IR	C	70										
				56.6	I3IR	C	85										
				58.0	I3IR	C	85										
				58.1	I3IR	C	80										
				59.2	I3IR	C	90										
				60.1	I3IR	C	90										
				60.4	I3PR	C	80										
				62.1	I3PR	C	80										
				62.8	I3IR	C	80										
63.5	Box 3			63.4	I3IR	C	85										
				63.9	I3PR	C	75										
				64.8	I3PR	C	80										
				[illegible]	I3PR	C	85										
				65.3	I3IR	C	90										
65.4	#8	9.8/10.0	11.0/12.0	66.1	I3PR	C	85	12/9.8		N8	VF	1	68.2 BREAK ALONG SHELL FRAGMENT.		S		9/10.0
				66.8	I3IR	C	80										
				67.0	I3IR	C	90										
				68.2	I3PR	C	80										
				68.6	I3IR	C	90										
				70.4	I3PS	C	90										
				71.0	I3PR	C	90										
				71.4	I3IR	C	85										
				73.8	I3PR	C	90										
				74.2	I3PR	C	70										
75.0				75.0	I3PR	C	70										

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/27/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL		JOB NO. 853 3092	BORING NO. CA-10 DATE 5/28/85 SHEET 3 OF 3
BORING BEGAN 5/29/85	BORING COMPLETED 5/28/85		CORE HOLE LOCATION 89.5 FT FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR.ELEV. 1912.4 FT WEATHER CLR	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR JONES	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#12			100.5	I3PR	C	90										
103.3	BOX 5	10.0/10.0	118/120	103.3	I3PR	C	80	6/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		17/10.0
				104.4	I3PR	C	85										
				105.3	I3PR	C	90										
105.4	#13	4.6/4.6	53/55	105.6	I3IR	C	80	2/4.6		N6 TO N8	VF	1			5		7/4.6
110.0				109.9	I3PR	C	90						END OF CORING @ 110.0 FT.				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/28/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL		JOB NO 855 3C4P 2	BORING NO CA-5 DATE 6/5/85 SHEET 4 OF 4
BORING BEGAN 6/4/85	BORING COMPLETED 6/5/85		CORE HOLE LOCATION 43.0 FT. FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GRELEV ZELTTTT WEATHER CLR/98°	
CASING USED PVC/STEEL SIZE 6"/4" STEEL		INSPECT PMI OPERAT DIR JWB	WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8	10.0/10.0	115/120	75.2	I3PR	C	90	8/10.0		N8 TO N6	VF	I	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		20/10.0
				75.5	I3PR	C	90										
				75.9	I3PR	C	90										
				76.6	I3PR	C	90										
				77.6	I3PR	C	90										
				78.2	I3PR	C	90										
				80.7	I3PR	C	90										
				82.7	I3PR	C	90										
85.0	#9	(3) 9.35/10.0	112/120	85.9	I3PR	C	90	6/9.35		N8 TO N6	VF	I			S		15/10.0
				88.1	I3PR	C	90										
				90.2	I3PR	C	90										
				91.3	I3PR	C	90										
				94.1	I3PR	C	90										
				94.2	I3PR	C	90										
95.0	#10	5.65/5.0	60/60	96.0	I3PR	C	90	1/5.65		N8	VF	I			S		7/5.0
100.0													END OF CORING @ 100.0 FT.				

NOTES (3) .65 CORE LEFT IN HOLE.
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/5/85 LOGGED BY PMI

PROJECT CNM 'CONSENT DECREE' 2 | BORING NO. ___ DATE ___ SHEET ___ OF ___

CORE HOLE LOCATION: 147.8 FT FROM NORTH STAKE

BORING BEGAN 6/6/85 | BORING COMPLETED 6/7/85

METHOD OF CORING NQWT | DRILLING FLUID Potable Water | GR. ELEV ELE BOT WEATHER Clear 98

CASING USED PVC SIZE 6" | INSPECT PMI | OPERAT DIR | WATER LEVEL, TIME, DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 19.0 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
19.0	BOX 1 RUN #1	6.1/6.3	7.1/7.5	20.0	ISPS	C	90	5/6.1		N6	VF	1-2			VS-S		15/63
				20.7	ISPS	C	90										
				22.7	ISPS	C	90										
				24.8	ISPS	C	90										
25.0				24.9	ISPS	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24. 1986

DATE 6/6/85 LOGGED BY PMI

Golder Associates

PROJECT CWM/CONSENT DECREE, AL — JOB NO 855 3092 — BORING NO [illegible]

BORING BEGAN 6/6/85 — BORING COMPLETED 6/7/85

CORE HOLE LOCATION 147.8 FT. FROM NORTH STAKE

METHOD OF CORING NQTT — DRILLING FLUID POTABLE WATER — GR.EL.EV 262.80 FT — WEATHER CLR/98

CASING USED PVC — SIZE 6" — INSPECT PMI — OPERAT DIR — WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0																	
25.3	#2	9.8/10.0	116/120	25.4 25.6	I3PS I3PS	C C	90 90	2/9.8		N6	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		26/10.0
28.4	BOX 2																
35.3	#3	10.0/10.0	118/120	35.4	I3PS	C	90	2/10.0		N6	VF	1		1	VS-S		23/10.0
										N8			BECOMING LIGHTER @ 44.1				
45.3	#4	10.1/10.0	115/120	45.2 46.5	I3PS I3PS	C C	90 90	2/10.1		N8	VF	1			VS-S		20/10.0
50.0																	

NOTES:

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/6/85 LOGGED BY PMI

Golder Associates

PROJECT CWM/CONSENT DECREE/AL — JOB NO 853-[illegible] — BORING NO [illegible] — DATE [illegible] — SHEET 3 OF 6

BORING BEGAN 6/6/85	BORING COMPLETED 6/7/85
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER
CASING USED PVC SIZE 6"	GR ELEV 202.8 FT WEATHER CLR 92
INSPECT PMI	OPERAT DIR [illegible]
CORE HOLE LOCATION 147.8 FT FROM NORTH STAKE	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#4	10.1/10.0	115/120	51.4	(3)(F)SPS	C?	45	3/10.1		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S	50.4–52.0	20/10.0
				55.0	I3PS	C	90										
55.3				56.7	I3PR	C	90			N8	VF	1			VS-S		21/10.0
57.9	BOX 3	10.4/10.0	119/120	58.2	I3PR	C	90	4/10.0									
	#5			60.1	I3PR	C	90										
				62.9	I3PR	C	90										
65.3		10.0/10.0	–/120	67.2	I3PR	C	90	7/10		N8	VF	1			S		17/10
	#6			69.9	I3PR	C	90										
				70.3	I3PR	C	90										
				72.3	I3PR	C	90										
				74.1	FIFK	C?	60									73.6–74.4	
				74.4	I3PR	C	90										
75.0				75.1	I3PR	C	90										

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/6/85 LOGGED BY PMI

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PROJECT CWM/CONSENT DECREE/AL

BORING BEGAN 6/6/85	BORING COMPLETED 6/7/85		CORE HOLE LOCATION 147.8 FT. FROM NORTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR.ELEV 262.8 FT WEATHER CLR/98	
CASING USED PVC SIZE 6"		INSPECT PMI OPERAT DIR [illegible]	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	DISCONTINUITIES: TYPE	DISCONTINUITIES: INFILLING	DISCONTINUITIES: ANGLE W/AXIS	DISCONTINUITIES: FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0																	
75.3				75.6	I3PR	C	90			N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		18/100
76.9	BOX 4			77.2	I3PR	C	90	7/10.1									
	#7	10.1/10.0	120/120	79.0	I3PR	C	90										
				82.4	I3PR	C	90										
				83.6	(J/F)FPS	C?	45									83.5	
				84.0	FIPR	C	80									84.2	
				85.1	I3PU	C	70										
85.3		9.8/10.0	119/120	86.5	I3PR	C	90								VS-S		15/100
	#8			87.8	I3PR	C	90										
				88.1	I3PR	C	75	6/9.8		N6 TO N8	VF	1					
				92.8	I3PR	C	90										
				93.5	I3PR	C	90						93.5 - 93.8: BROKEN ALONG SHELL IN CORE				
				93.8	I3PR	C	90										
95.3																	
95.9	BOX 5	-/10.0	-/120	96.1	I3PR	C	90	6/10.0		N8	VF	1			VS-S		12/10
	#9																
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/7/85 LOGGED BY PMI

Golder Associates

PROJECT CWM/CONSENT DECREE/AL — JOB NO. [illegible] — BORING NO./LOC. [illegible]

BORING BEGAN 6/6/85	BORING COMPLETED 6/7/85
METHOD OF CORING NQ??	DRILLING FLUID Potable Water
CASING USED PVC SIZE 6"	GR. ELEV 262.8 ft; WEATHER CLR/98
INSPECT PMI	OPERAT DIR [illegible]
CORE HOLE LOCATION 141.8 FT. FROM NORTH STAKE	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0–105.3	#9	-/10.0	-/120	100.7	I3PS	C	90			N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		13/10.0
105.3–115.3	#10	10.0/10.0	118/120	106.6	I3PR	C	90	9/10		N8	VF	1			VS-S		17/10.0
				107.2	I3PR	C	60										
				112.2	I3PR	C	85										
115.3–125.0	BOX 6 #11	10.1/10.0	120/120	116.6	I3SR	C	70	5/10.1		N8	VF	1			VS-S		16/10.0
				117.9	I3PR	C	85										
				119.5	I3PR	C	70										
				123.5	I3PR	C	90										
				124.8	I3PR	C	90										

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/7/85 LOGGED BY PMI

Golder Associates

PROJECT LWM 'CONSENT DECREE,' A	JOB NO 855-3C9P2	BORING NO CA-6 DATE 6/7/85 SHEET 6 OF 6	
BORING BEGAN 6/6/85	BORING COMPLETED 6/7/85	CORE HOLE LOCATION 147.8 FT. FROM NORTH STAKE	
METHOD OF CORING NGTT	DRILLING FLUID POTABLE WATER	GREELEY 262 BOFT WEATHER CLR/98	
CASING USED PVC SIZE 6"		INSPECT PMI OPERAT DIR JONES	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0																	
125.8	#12	8.9/10.0	100/120					2/8.9		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		15/100
				130.4	IBPR	C	90										
				133.5	IBPR	C	85										
135.8													END OF CORING @ 135.8 FT.				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/7/85 LOGGED BY PMI

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 853-3C9P.1 | BORING NO CA-7 | DATE 6/14/85 | SHEET 1 OF 5

BORING BEGAN 6/14/85 | BORING COMPLETED 6/15/85 | CORE HOLE LOCATION: 40 FT FROM NORTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID: POTABLE WATER | GR ELEV [illegible] | WEATHER CLDY

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DIR [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0 – 9.0													ROTARY DRILLED TO 9.0 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES. / SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
9.0 – 15.0	BOX 1 RUN #1	5.7/6.0	68/72	12.2	I3PR	C	90	1/5.7		N4 TO N8	VF	1	CASING SET @ 9.0 FT. UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		11/6.0
15.0 – 25.0	#2	10.0/10.0	120/120	19.6 20.3	I3PS 3ZPR	C C	90 45	2/10.0		N4 TO N8	VF	1			S	19.6 – 20.3	17/10.0

NOTES: CASING DRIPPED TO 9.0 FT. PULLED UP 2.0 FT. AND POURED 2½ - 5 GAL. BUCKETS OF BENTONITE PELLETS INSIDE CASING. PUSHED CASING BACK TO 9.0 FT. POURED ADDITIONAL 1½ BUCKETS OF BENTONITE PELLETS OUTSIDE CASING TO COMPLETE SEAL.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT LWM/CONSENT DECREE/AL | JOB NO 853-3CYP 2 | BORING NO CA-7 DATE 6/15/85 SHEET 2 OF 5

CORE HOLE LOCATION 40.1 FT. FROM NORTH STAKE

BORING BEGAN 6/14/85 | BORING COMPLETED 6/15/85

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 267.0 | WEATHER RAIN/80

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DIR

WATER LEVEL, TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0	#3												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
28.0	Box 2	11.0/10.0	120/120	29.9	I3PS	C	90	1/10.0		N6 To N8	VF	1			5		19/10.0
35.0	#4	10.0/10.0	120/120	40.0	I3PR	C	90	1/10.0		N6 To N8	VF	1			5		—/10.0
45.0	#5	10.0/10.0	116/120	45.2	I3IR	C	90	7/10.0		N6 To N8	VF	1			5		19/10.0
				45.4	I3IR	C	90										
				46.2	I2PR	C	30						46.2 BREAK ALONG SHELL				
				46.7	I3PS	C	90										
				46.9	I3PS	C	90										
47.7	Box 3																
				49.6	I3IR	C	90										
50.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT: CNM/CONSENT DECREE/AL	JOB NO: 853-3C4P2	BORING NO: CA-7 DATE 6/5/[illegible]	
BORING BEGAN: 6/14/85	BORING COMPLETED: 6/15/85	CORE HOLE LOCATION: 40.1 FT. FROM NORTH STAKE	
METHOD OF CORING: NQ??	DRILLING FLUID: POTABLE WATER	GR. EL. 267.0 FT	WEATHER: CLDY/85
CASING USED: PVC SIZE 6"		INSPECT: FHW	OPERAT: DIR [illegible]
WATER LEVEL, TIME, DATE: —			

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0–55.0	#6	10.0/10.0	116/120	52.3	FIPK	C	30	7/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	52.? / 52.?	19/10.0

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
55.0–65.0	#6	10.0/10.0	120/120	55.4	FIPK	C	40	1/10.0		N6 TO N8	VF	1			S	60.9 / 61.6	20/10.0
				58.3	IJPR	C	90										
				61.4	JIPS	C	50										

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
65.0–75.0	#7 (to 67.2); BOX 9 (from 67.2)	10.1/10.0	120/120	65.1	IJIR	C	90	5/10.1		N6 TO N8	VF	1			S		18/10.0
				66.2	IJCS	C	65										
				68.7	IJCS	C	75										
				72.4	IJPR	C	85										
				74.0	IJPR	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT: CWM/CONSENT DECREE/AL

BORING BEGAN: 6/14/85 | BORING COMPLETED: 6/15/85 | CORE HOLE LOCATION: 40.1 FT. FROM NORTH STAKE

METHOD OF CORING: NQTT | DRILLING FLUID: POTABLE WATER | GR. ELEV. [illegible] | WEATHER: CLAY/85

CASING USED: PVC | SIZE: 6" | INSPECT: FHW | OPERAT: DFR JWB | WATER LEVEL, TIME, DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8	9.9/10.0	119/120	79.9	IBPS	C	90	2/9.9		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		11/10.0
				82.3	IBIR	C	85										
				83.9	IBIR	C	80										
85.0																	
86.0	BOX 5			86.5	FIPR	C	45										
	#9	10.0/10.0	119/120	91.5	IBIR	C	85	7/10.0		N6 TO N8	VF	1			5		20/10.0
				92.2	IBPS	C	90										
				93.2	IBIR	C	90									93.9	
				93.9	IBIR	C	90										
				94.5	FIPR	C	50									94.9	
				94.9	IBIS	C	90										
95.0	#10	10.0/10.0	119/120	96.1	IBIR	C	90	6/10.0		N8	VF	1			5		16/10.0
				98.7	IBIR	C	85										
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL		JOB NO B55-309P 2	BORING NO LA-7 DATE 6/15/85 SHEET 5 OF 5
BORING BEGAN 6/14/85	BORING COMPLETED 6/15/85		CORE HOLE LOCATION 40.1 FT. FROM NORTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR ELEV 567.02 WEATHER CLDY/85	
CASING USED PV SIZE 6"		INSPECT FHW OPERAT D/R JINS	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#10	10.0/10.0	119/120	102.2	I3PS	C	90	6/10.0		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		16/10.0
				103.6	I3PR	C	85										
				104.9	I3PR	C	85										
				104.9	I3PS	C	90										
105.0																	
105.6	BOX 6 #11	10.0/10.0	119/120	106.1	I3PS	C	90	4/10.0		N8	VF	1			S	106.8–107.1	13/10.0
				107.3	F1PK	C	40										
				111.4	I3IR	C	90										
				112.5	I3PR	C	85										
115.0													END OF CORING @ 115.0 FT.				
125.0																	

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/15/85 LOGGED BY FHW

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | 67.7 FT. FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID: POTABLE WATER | GR ELEV 851.81 FT | WEATHER RAIN/60

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DYR | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
0.0													ROTARY DRILLED TO 8.9 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
										N6			INSITU CHALK @ ~5.0 FT. SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
8.9	BOX 1 RUN #1	6.0/6.1	65/73	9.2 9.3 9.4 9.6 9.7	I3PS I3PS I3PS I3PS I3PS	C C C C C	[illegible] [illegible] [illegible] [illegible] 90	6/6.0		N6	VF	1	CASING SET @ 8.9 FT. UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		12/6.1
				14.8	I3PR	C	80										
15.0	#2	10.0/10.0	117/120	17.4	I3PR	C	85										
				20.0	I3PS	C	90	9/10.0		N6	VF	1			5		17/10.0
25.0				24.8	I3PR	C	90										

NOTES: 5 - 5 GAL. BUCKETS OF BENTONITE USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL		JOB NO. 855-5095.2	BORING NO. CA-8 DATE 6/18/85 SHEET 2 OF 1
BORING BEGAN 6/17/85	BORING COMPLETED 6/19/85		CORE HOLE LOCATION
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR. ELEV 251.81 FT. WEATHER RAIN/80	67.7 FT. FROM SOUTH STAKE
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR Jones	WATER LEVEL TIME DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0	#3			26.2	I3IR	C	80						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
27.4	BOX 2	10.0/10.0	118/120	29.4	I2PR	C	85	4/10.0		N6	VF	1	29.4 BREAK ACROSS SHELL		5		21/10.0
				30.0	I3PR	C	90										
				34.8	I3PR	C	85										
35.0	#4	10.0/10.0	119/120	39.9	I3PR	C	80	3/10.0		N6 TO N8	VF	1			5		21/10.0
				40.0	I3PS	C	90										
				43.3	I3PR	C	90										
45.0		10.0/10.0	120/120	45.4	I3PS	C	90	4/10.0		N6 TO N8	VF	1			5		22/10.0
46.1	BOX 3			47.5	I3PS	C	90										
55.0	#5																

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT ? ECMAN, AL

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION 67.7 FT. FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID Potable Water | GR.ELEV 257.8 FT | WEATHER RAIN/80

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DYE-Jones | WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#5	10.0/10.0	120/120					4/10.0		N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		22/10.0
				53.7	I3PR	C	75										
				54.4	I3PR	C	90										
55.0	#6	10.0/10.0	120/120	55.4	I3PR	C	80	7/10.0		N6 To N8	VF	1			S		16/10.0
				57.2	I3PR	C	75										
				58.3	I3PR	C	80										
				59.3	I3PR	C	80										
				61.3	I3PR	C	90										
				62.6	I3PR	C	70										
				64.1	I2PS	C	70						64.1 BREAK ALONG SHELL				
65.0	Box 4 #7	10.1/10.0	117/120	66.8	I3PR	C	90	6/10.1		N6 To N8	VF	1			S		15/10.0
				68.3	I3PR	C	85										
				69.8	I3PR	C	85										
				70.0	I3PS	C	90										
				74.1	I2IR	C	80						74.1 BREAK ALONG SHELL				
75.0				74.5	I2PS	C	70						74.5 BREAK ALONG SHELL				

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT ... AL | JOB NO. ...

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION 67.9 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 261.8 FT | WEATHER RAIN/80°

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DTR | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8	10.0/10.0	120/120					1/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		-/10.0
83.6	BOX 5			83.8	I3IR	C	90										
85.0	#9	10.0/10.0	118/120	85.1	I3PS	C	90	6/10.0		N8	VF	1			85.0 S	89.1–90.7	8/10.0
				85.2	3IPR?	C	60										
				85.6	3IPR?	C	65										
				86.0	I3IR	C	85										
				90.2	F1PK	C	50										
				93.6	I3PR	C	90										
95.0	#10	10.0/10.0	120/120	96.0	I3PR	C	90	2/10.0		N8	VF	1			S		9/10.0
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL	JOB NO 853 3048 I	BORING NO CA-8 DATE 6/18/85 SHEET 5 OF 7
BORING BEGAN 6/17/85	BORING COMPLETED 6/19/85	CORE HOLE LOCATION
METHOD OF CORING NQTT	DRILLING FLUID Potable Water	GR ELEV 257.8 FT WEATHER RAIN/80 — 67.7 FT. FROM SOUTH STAKE
CASING USED PVC SIZE 6"	INSPECT FHW OPERAT DIR Jones	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#10																
				102.8	I3PR	C	85						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
103.9		10.0/10.0	120/120					9/10.0		N8	VF	1			S		9/10.0
	BOX 6			103.9	I3IR	C	80										
105.0	#11			105.5	I3PR	C	90										
				105.6	I3PR	C	90										
				106.8	I3IR	C	90										
				109.7	I3PR	C	90						109.9 - 117.3 SLICKENSIDE ZONE			109.6	16/10.0
				109.9	FIPK	C	60						110.0 SLICKENSIDE WITH PYRITE INFILLING.		S		
				110.0	FIPK	P	30			N6 TO N8	VF	1					
		9.9/10.0	100/120	110.1	I3IR	C	85	12/9.9								110.7	
																112.9	
				113.3	FIPK	C	50?										
				113.4	FIPK	C	60										
				114.5	FIPK	C	25										
				114.6	FIPK	C	60										
				114.7	FIPK	C	40									115.0	
115.0				115.4	I3PR	C	80										
				115.8	FIPK	C	65										
				115.9	FIPK	C	85										
	#12			116.1	FIPK	C	60										
				116.4	FIPK	C	85										
				116.8	FIPK	C	65									116.8	
				117.3	FIPK	C	60										
				118.3	I3PR	C	80	12/10.0		N6 TO N8	VF	1			S	118.5	16/10.0
		10.0/10.0	113/120	119.1	I3PS	C	75										
				120.5	I3PS	C	80										
				121.5	I3PR	C	80										
				123.4	I3PR	C	80										
125.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 855-3C9P2 | BORING NO CA-8 DATE 6/19/85 SHEET 6 OF 7

BORING BEGAN 6/17/85 | BORING COMPLETED 6/19/85 | CORE HOLE LOCATION

METHOD OF CORING NQTT | DRILLING FLUID Potable Water | GR ELEV 251.8 FT WEATHER Rain/60 | 67.7 FT. FROM SOUTH STAKE

CASING USED PVC SIZE 6" | INSPECT FHW OPERAT DIR | WATER LEVEL, TIME, DATE

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0–126.1				125.8	I3PR	C	75										
126.1	Box 7			126.4	I3PR	C	85										
	#13	10.0/10.0	120/120	128.7	I3PR	C	80	3/10.0		N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		19/10.0
135.0	#14	9.6/10.0	114/120	135.7	[illegible]	C	90	4/9.6		N6 To N8	VF	1			5		19/10.0
				140.3	I3PR	C	90										
				141.3	I3PR	C	85										
				143.6	I3PR	C	90										
145.0	Box 8 #15	5.5/5.0	60/60	146.2	I3PR	C	90	1/5.5		N6 To N8	VF	1			5		5/5.0
150.0																	

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

Golder Associates

PROJECT: CNM/CONSENT DECREE/AL | JOB NO: 855 3CMP 2 | BORING NO: CA-8 | DATE: 6/19/85 | SHEET 7 OF 7

BORING BEGAN: 6/17/85 | BORING COMPLETED: 6/19/85 | CORE HOLE LOCATION: 67.7 FT. FROM SOUTH STAKE

METHOD OF CORING: NQTT | DRILLING FLUID: POTABLE WATER | GR. ELEV: EST 6.8 FT | WEATHER: RAIN/80

CASING USED: PVC | SIZE: 6" | INSPECT: FHW | OPERAT: DIR JONES | WATER LEVEL, TIME, DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
150.0 – 155.0	#16	5.0/5.0	57/60	152.1 154.8	I3PR I3PR	C C	90 90	2/5.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		6/5.0
155.0 – 165.0	#17 (163.4: BOX 9)	10.0/10.0	120/120	161.4	I3PS	C	85	1/10.0		N6 TO N8	VF	1			S		12/10.0
165.0 – 175.0	#18	10.0/10.0	120/120	168.8 170.2	I3PR I3PR	C C	80 85	2/10.0		N6 TO N8	VF	1	END OF CORING @ 175.0 FT.		S		12/10.0

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

BORING BEGAN 6/16/85 | BORING COMPLETED 6/17/85 | CORE HOLE LOCATION 91.2 FT. FROM EAST STAKE

METHOD OF CORING NQ?? | DRILLING FLUID POTABLE WATER | GR. ELEV. 242.5 FT | WEATHER CLDY/85

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT. D/R JONES | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 9.0 FT.				
												2	WEATHERED, GRAY, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
												Z-1	SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
9.0	BOX 1 RUN # 1	2.7/6.0	28/72	9.1 9.4	I3PS I3PS	C C	90 90	4/2.7		NG	VF	1	CASING SET @ 9.0 FT.		S		15/6.0
				11.4 11.6	I3PR I3PR	C C	90 90										
15.0	#2	4.9/5.0	57/60	15.3	I3PS	C	90	6/4.9		NG	VF	1			S		9/5.0
				15.9 16.3	I3PS I3PS	C C	90 90										
				17.0	I3PS	C	90										
				17.8	I3PS	C	90										
				19.5	I3PR	C	75										
20.0	#3	5.0/5.0	57/60	23.3	I2PS	C	90	2/5.0		NG	VF	1	23.3 BREAK ALONG SHELL		S		4/5.0
25.0				24.7	I3PR	C	90										

NOTES: 4½ - 5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/18/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE, AL

BORING BEGAN 6/10/85 | BORING COMPLETED 6/11/85 | CORE HOLE LOCATION 97.2 FT. FROM EAST STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR. ELEV 242 [illegible] WEATHER PCLDY/[illegible]

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DYR [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0–35.0	#4 (Box 2 at 30.0)	9.9/10.0	119/120	30.0 30.5	I3PR I3PS	C C	80 90	2/9.9		N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		19/10.0
35.0–45.0	#5	10.2/10.0	118/120	35.2 35.5 40.2 44.4 44.8	I3PS I3PS I3PR I3PR I3PR	C C C C C	90 90 90 90 90	4/10.2		N6 To N8	VF	1			S		12/10.0
45.0–50.0	#6 (Box 3 at 49.2)	9.8/10.0	113/120	45.6 47.2 48.2 49.2 49.3 49.5 49.7	I3IR I3PR I3PR I3IR I3IR I3IR I3IR	C C C C C C C	80 85 90 90 90 90 90	10/9.8		N6 To N8	VF	1			S		17/10.0

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/11/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL — JOB NO 855-3C9P 2 — BORING NO CA-9 DATE 6/17/85 SHEET 3 OF 4

CORE HOLE LOCATION: 97.2 FT FROM EAST STAKE

BORING BEGAN 6/10/85 — BORING COMPLETED 6/17/85

METHOD OF CORING NQTT — DRILLING FLUID POTABLE WATER — GR.ELEV 247.58 — WEATHER SUNNY/90

CASING USED PVC SIZE 6" — INSPECT FHW — OPERAT DIR — WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0	#6	9.8/10.0	112/120	50.4	I3PS	C	90	10/9.8		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	55.0	17/10.0
				53.5	I3PR	C	75										
55.0	#7	10.2/10.0	120/120	55.0	J1PR	C	60	10/10.2		N6 TO N8	VF	1			S	55.9	17/10.0
				56.5	I3PR	C	85										
				58.3	I2PR	C	85						58.3 BREAK ACROSS SHELL				
				60.5	I3PR	C	90										
				61.4	I3PR	C	90										
				62.2	I3IR	C	70										
				62.5	I3PR	C	80										
				63.6	I3PR	C	85										
				64.0	I3PR	C	90										
				64.8	I3PR	C	90										
65.0	#8	10.0/10.0	120/120	65.6	I3IR	C	90	4/10.4		N6 TO N8	VF	1			S		13/10.0
				66.7	I3PR	C	85										
68.7	BOX 4			70.1	I3PR	C	90										
				71.6	I3PR	C	85										
				73.5	I2PS	C	60						73.5 BREAK ALONG SHELL				
75.0				74.7	I3PR	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

PROJECT GWM CONSENT DECREE/AL | JOB NO 855-3049A.1 | BORING NO LA-9 | DATE 6/17/85 | SHEET 4 OF 6

BORING BEGAN 6/16/85 | BORING COMPLETED 6/17/85 | CORE HOLE LOCATION 97.2 FT. FROM EAST STAKE

METHOD OF CORING NQTT | DRILLING FLUID ROTARY WATER | GR ELEV | WEATHER PCLDY 90

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISC. DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#9	10.0/10.0	114/120	76.5	F/PR	C	30	7/10.0		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	75.9–77.0	12/10.0
				77.5	I3IR	C	80										
				79.3	F/PR	C	45										
				81.7	I3PR	C	90										
				83.9	I3PR	C	85										
				84.5	I3PS	C	90										
				84.9	I3PR	C	90										
85.0	#10	10.0/10.0	120/120	85.4	I3IR	C	90	7/10.0		N8	VF	1			S		9/10.0
				85.9	I3PR	C	90										
88.3	Box 5																
				91.7	I3PR	C	90										
				92.7	I3PR	C	85										
				93.5	I3PR	C	90										
				94.2	I3PR	C	85										
				94.6	I3PR	C	90										
95.0	#11	9.9/10.0	116/120	96.1	I3PR	C	90	6/9.9		N6 To N8	VF	1			S		13/10.0
				97.2	I3PR	C	90										
				97.5	I3PR	C	90										
100.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

PROJECT: CNM 'CONSENT DECREE' A	JOB NO: 855-3C4P 2	BORING NO: CA-9	DATE: 6/17/85 SHEET 5 OF 6
BORING BEGAN: 6/16/85	BORING COMPLETED: 6/17/85	CORE HOLE LOCATION: 97.2 FT. FROM EAST STAKE	
METHOD OF CORING: NQ???	DRILLING FLUID: POTABLE WATER	GREELEY 24C SOFT; WEATHER: PCLDY 90	
CASING USED: PVC SIZE 6"	INSPECT: FHW	OPERAT: DIR [illegible]	WATER LEVEL, TIME, DATE: —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0–105.0	#11	9.9/10.0	116/120	100.1 101.4 103.7	I3PS I3PR I3PR	c c c	90 80 85	6/9.9		N6 To N8	VF	I	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		13/10.0
105.0–115.0	#12 (Box 6 from 107.1)	10.1/10.0	117/120	106.3 107.8 109.2 109.3 110.5 114.5 114.6 114.9	I3PR I3PS I3PR I3PR I2PS I3PR I3PR I3PR	c c c c c c c c	85 90 90 90 90 90 80 90	8/10.1		N6 To N8	VF	I	110.5 BREAK ALONG SHELL		S		15/10.0
115.0–125.0	#13	10.0/10.0	118/120	116.5 119.0 119.3 119.8 124.8	I3PR I2PR I2PR I3PR I3IR	c c c c c	90 80 75 85 85	5/10.0		N6 To N8	VF	I	119.0 BREAK ALONG SHELL		S		15/10.0

SCALE: 1 DIVISION=0.2 FEET

NOTES:

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

BORING BEGAN 6/16/85	BORING COMPLETED 6/17/85		CORE HOLE LOCATION
METHOD OF CORING NQTT	DRILLING FLUID Potable water	GR ELEV [illegible] WEATHER Pcldy/Hu	97.2 FT FROM EAST STAKE
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR Jones	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0	Box 7 #14	10.0/10.0	118/120	126.0	I3PS	C	80	7/10.0		N6 to N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		15/10.0
				127.7	I3PR	C	85										
				129.5	I3PR	C	90										
				129.8	I3PR	C	80										
				131.4	I3PR	C	80										
				133.6	I3PS	C	90										
				134.8	I3PR	C	85										
135.0	#15	10.2/10.0	113/120	141.0	I3PR	C	90	4/10.2		N6 to N8	VF	1			5	143.0–144.5	16/10.0
				143.6	F1PR	C	25										
				144.5	I3PR	C	75										
				144.7	I3PR	C	85										
145.0	Box 8 #16	5.0/5.0	55/60	147.3	I3PS	C	90	3/5.0		N6 to N8	VF	1			5		7/5.0
				149.6	I3PR	C	90										
150.0				149.8	I3PR	C	90						END OF CORING @ 150.0 FT.				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/17/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/24/85 | BORING COMPLETED 5/28/85 | 89.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID Potable Water | GR ELEV 412.6 FT | WEATHER CLR

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR | WATER LEVEL, TIME, DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0 – 8.9	—	—	—	—	—	—	—	—		—	—	—	ROTARY DRILLED @ 8.9 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES. 3.2 - CELL 1 LINER MATERIAL.	—	—	—	—
8.9 – 16.4	BOX 1 RUN #1	1.3 / 6.5	11 / 70	15.0 15.2 15.3	I3IR I3IR I3IR	C C C	90 90 90	10+		N8	VF	1-2	CASING INITIALLY SET @ 8.9 FT. FOUND TO BE SET IN RECOMPACTED CHALK. REMOVED AND RESET TO 26.0 FT.		VS		12 / 6.5
16.4 – 25.0	#2	2.4 / 10.0	15 / 120	23.4 24.7	I3IR I3IR	C C	90 90	10+		N8	VF	1-2	INSITU CHALK @ ≈ 24.7 FT		VS 3		15 / 10.0

NOTES: 2-5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING @ 26.0 FT.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 5/24/85 LOGGED BY FHW

Golder Associates

PROJECT [illegible]

BORING BEGAN 5/24/85 | BORING COMPLETED 5/28/85 | 89.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR. ELEV 19.26 FT | WEATHER CLR

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT D.F.R. [illegible] | WATER LEVEL, TIME, DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
25.0		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10+		N8	VF	1-2			S		[illegible]
25.4	#2			25.9	I3FR	C	90										
				26.4	I3FR	C	85						CASING RESET TO 26.0 FT.				
	#3												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				14/10.0
				29.0	I2FR	C	45								S		
		10.0/10.0	100/120	30.5	I3FR	C	90	1/10.0		N8	VF	1-2					
				34.2	I3IR	C	45										
				34.6	I3IR	C	60										
				35.0	I3IR	C	45										
35.4	#4			35.6	I3IR	C	90						CORE CATCHER FOR NQTT LOST AFTER RUN #3. D. JONES RIGGED DOUBLE TUBE CORE CATCHER WITH A SPACER AND SPRING TO USE ON RUN #4 WITH SPLIT TUBE.				20/10.0
				36.0	I3IR	C	85										
				36.3	I3IR	C	90										
				37.5	I3CR	C	70										
				37.9	I3IR	C	90										
				38.0	I3IR	C	70								VS		
				38.7	I3PR	C	80										
				38.8	I3IR	C	60										
		5.9/10.0	59/120	39.1	I3IR	C	70	15+/5.9		N8	VF	1-2					
				39.2	I3PR	C	40										
				39.4	I3PV	C	65										
				39.5	I3IR	C	85										
				39.8	I3IR	C	75										
44.1	BOX 2			44.1	I3IR	C	90						44.4-45.4 HIGHLY BROKEN CORE VERY FRAGMENTED. MACHINE BREAKS.				
				44.2	I3IR	C	85										
45.4	#5			45.7	I3IR	C	80								S		8/5.0
				46.0	I3PS	C	90										
				46.2	I3IR	C	70										
		4.8/5.0	44/60														
				47.7	I3IR	C	60	8/4.8		N8	VF	1				48.2	
				47.9	I3IR	C	80										
				48.9	F1PK	C	20						48.9 SHEARED. 1/2 OF FRACTURE CONTAINED IN SAMPLE TAKEN, OTHER HALF REMAINS IN CORE BOX.			48.9	
50.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/27/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/24/85 | BORING COMPLETED 5/28/85 | 89.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR. ELEV 1916.0 FT | WEATHER CLR

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT. DIR | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#8			75.2	ISIR	C	85										
75.4	#9	7.6/10.0	68/120	75.6	ISPR	C	90	17/7.6		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S	79.3 / 79.5	17/10.0
				76.1	ISIR	C	85										
				76.6	ISPR	C	80										
				77.5	ISPR	C	85										
				78.0	ISPS	C	85										
				78.8	ISPR	C	90										
				79.4	ISIR	C	65										
				79.5	FIPK	C	50						79.5 SHEARED				
				79.9	ISIR	C	80										
				80.0	ISIR	C	90										
				80.2	ISIR	C	90										
				83.1	ISPR	C	75						*TRIPLE TUBE RUN BACKDOWN CORE BARREL AND ADDITIONAL 2.6 FT. OF RUN #9 RECOVERED				
				83.5	ISPR	C	90										
			*	84.1	ISPR	C	—										
				84.5	ISPR	C	85										
84.8	BOX 4			84.8	ISIR	C	90										
				85.2	ISIR	C	85										
85.4	#10	5.1/5.0	57/60	85.5	ISIR	C	90	4/5.1		N6 TO N8	VF	1			S		9/5.0
				86.9	ISIR	C	85										
				90.2	ISPS	C	90										
				90.3	ISIR	C	90										
90.4	#11	5.0/5.0	58/60	91.2	ISPR	C	85	8/5.0		N6 TO N8	VF	1			S		13/5.0
				91.7	ISPR	C	90										
				92.2	ISPR	C	85										
				93.0	ISPR	C	85										
				93.8	ISPR	C	85										
				94.2	ISPR	C	80										
				94.7	ISIR	C	85										
				95.3	ISPS	C	85										
95.4	#12	10.0/10.0	118/120	95.5	ISPS	C	90	6/10.0		N6 TO N8	VF	1			S		17/10.0
				96.8	ISPS	C	90										
100.0																	

NOTES

RECIRCULATION OF WATER CAUSING CORE TO CATCH IN T-TUBE.

NO RECIRCULATION STARTING WITH RUN #10.

SCALE: 1 DIVISION=0.2 FEET

New Page

February 24, 1986

DATE 5/28/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT TIE CREE/AL — JOB NO 855 ACMF I — BORING NO [illegible]

CORE HOLE LOCATION: 89.5 FT FROM SOUTH STAKE

BORING BEGAN 5/24/85 — BORING COMPLETED 5/28/85

METHOD OF CORING NQTT — DRILLING FLUID: POTABLE WATER — GR.ELEV 191.26FT, WEATHER CLR

CASING USED PVC — SIZE 6" — INSPECT FHW — OPERAT DIR — WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0		4/5.0	4/6.0	50.2 50.3	I3PS I3PR	C C	85 85	3/4.1		N8	VF	1	50.2 BREAK ALONG SHELL FRAGMENT		S		8/5.0
50.4	#6			50.6	I3PS	C	90										
				52.1	I3PS	C	85										
		4.9/5.0	5.4/6.0	53.0	I3PR	C	90	5/4.9		N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		18/6.0
				54.4	I3PS	C	80										
				55.2	I3PS	C	90										
55.4	#7			55.7 55.9	I3PR I3IR	C C	80 90										
				56.5 56.9	I3IR I3IR	C C	70 85										
				58.0 58.1	I3IR I3IR	C C	85 80										
				59.2	I3IR	C	90										
		10.2/10.0	11.1/12.0	60.1 60.4	I3IR I3PR	C C	90 80	16/10.2		N8	VF	1			S		14/10.0
				62.1	I3PR	C	80										
				62.8	I3IR	C	80										
63.5	Box 3			63.4	I3IR	C	85										
				63.9	I3PR	C	75										
				64.8 65.2 65.3	I3PR I3PR I3IR	C C C	80 85 90										
65.4	#8			66.1	I3PR	C	85										
				66.8 67.0	I3IR I3IR	C C	80 90										
				68.2 68.6	I3PR I3IR	C C	80 90			N8	VF	1	68.2 BREAK ALONG SHELL FRAGMENT.		S		9/10.0
				70.4	I3PS	C	90										
		9.8/10.0	11.0/12.0	71.0 71.4	I3PR I3IR	C C	90 85	12/9.8									
				73.8 74.2	I3PR I3PR	C C	90 70										
75.0				75.0	I3PR	C	70										

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/27/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO. B55 309P 2 | BORING NO CA-10 | DATE 5/24/85 | SHEET 5 OF 5

BORING BEGAN 5/24/85 | BORING COMPLETED 5/28/85 | CORE HOLE LOCATION 89.5 FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 191.2 FT | WEATHER CLR

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR | WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#12			100.3	I3PR	C	90										
103.3	BOX 5	10.0/10.0	118/120	103.3	I3PR	C	80	6/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		17/10.0
				104.4	I3PR	C	85										
				105.3	I3PR	C	90										
105.4	#13	4.6/4.6	53/55	105.6	I3IR	C	80	2/4.6		N6 TO N8	VF	1			S		7/4.6
				109.9	I3PR	C	90										
110.0													END OF CORING @ 110.0 FT.				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/28/85 LOGGED BY FHW

Golder Associates

PROJECT CNM CONSENT DECREE AL | JOB NO 855 3C94 2 | BORING NO CA-11

BORING BEGAN 6/12/85 | BORING COMPLETED 6/14/85

METHOD OF CORING NQTT | DRILLING FLUID Potable Water | GR ELEV 197.69 FT | WEATHER CLOUDY/80

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR

CORE HOLE LOCATION: 47.1 FT. FROM NORTH STAKE

WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
0.0													ROTARY DRILLED TO 59.0 FT.				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
										N8							
													BROWN WATER RETURN BEGINNING @ 24.0 FT.				
25.0																	

NOTES.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/12/85 LOGGED BY FHW

Golder Associates

PROJECT CWM CONSENT [illegible], AL

BORING BEGAN 6/12/85	BORING COMPLETED 6/14/85	CORE HOLE LOCATION 47.1 FT FROM NORTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR. ELEV 197.69 FT WEATHER PCLDY / 80
CASING USED PVC SIZE 6"	INSPECT FHW OPERAT. DYR [illegible]	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0									(hatched)				WEATHERED, BROWN, FOSSILIFEROUS, RECOMPACTED CHALK				
	—	—	—	—	—	—	—	—		[illegible]	—	—		—	—	—	—
57.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/12/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL JOB NO. 855 [illegible] BORING NO. [illegible] DATE 6/19/85 SHEET [illegible]

BORING BEGAN 6/18/85 BORING COMPLETED 6/19/85

CORE HOLE LOCATION 471 FT FROM NORTH STAKE

METHOD OF CORING NQTT DRILLING FLUID POTABLE WATER GR. ELEV [illegible] WEATHER CLR/80

CASING USED PVC SIZE 6" INSPECT FHW OPERAT DYR-JONES WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
50.0										10YR7/4			WEATHERED, BROWN, FOSSILIFEROUS, RECOMPACTED CHALK				
	—	—	—	—	—	—	—	—			—	—		—	—	—	—
										N8			DRILL WATER BECOMING GRAY @ ~55.0 FT.				
													UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
59.0													CASING SET @ 59.0 FT				
59.4	BOX 1 RUN # 1	5.3/5.6	49/67	59.8	I3PS	C	90						REAMED OUT INSIDE CASING TO 59.4 FT.				8/5.6
				61.6	I3PR	C	85	3/5.8		N6 TO N8	VF	1			S		
				63.8	I3PR	C	85										
65.0	#2	10.1/10.0	114/120	65.1	I3PS	C	90	4/10.1		N6 TO N8	VF	1					
				65.7	I3IR	C	80										
				66.8	I3PR	C	85										
				67.5	I2PS	C	80						67.5 BREAK ALONG SHELL		S		15/10.0
				73.6	I3IR	C	85										
75.0				74.8	I3IR	C	90										

NOTES: CASING DROPPED TO 59.0 FT. PULLED UP 4.0 FT. AND 1½ - 5 GAL. BUCKETS OF BENTONITE POURED INSIDE CASING. ALLOWED TO SET ½ HOUR. CASING THEN PUSHED TO 59.0 FT. CHALK CAVED AROUND CASING. ADDITIONAL 1½ BUCKETS OF BENTONITE USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/19/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL | JOB NO 855 3C9P 2 | BORING NO CA-11 | DATE 6/14/85 | SHEET 4 OF 4

BORING BEGAN 6/12/85 | BORING COMPLETED 6/14/85 | CORE HOLE LOCATION 47.1 FT FROM NORTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR ELEV 1?? FT | WEATHER CLR, 85

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT D?R | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
75.0	#3												UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				77.0	I3PR	C	80										
				77.6	I2PS	C	80										
				77.8	I2PS	C	75										17/10.0
78.4	BOX 2	99/10.0	112/120							N4 TO N8	VF	1			5		
				79.1	I3PS	C	90										
				79.3	I3IR	C	80										
				80.7	I3PR	C	90										
				83.0	I3PR	C	90										
				84.4	3?PS	C	80									84.0	
				84.8	I3PS	C	90									84.5	
85.0				85.7	I3PR	C	90										
	#4																
				88.2	I3PR	C	80										16/10.0
		99/10.0	117/120	89.6	I3PS	C	85	4/9.9		N4 TO N8	VF	1			5		
				92.4	I2PS	C	85						92.4 BREAK ALONG SHELL				
95.0	#5																
		51/5.0	60/60	96.8	I3IR	C	80	2/5.1		N6 TO N8	VF	1			5		9/5.0
				97.6	I3PR	C	90										
100.0													END OF CORING @ 100.0 FT.				

NOTES: FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/14/85 LOGGED BY FHW

PROJECT CWM/CONSENT DECREE, AL

BORING BEGAN 5/28/85 | BORING COMPLETED 5/30/85

CORE HOLE LOCATION 40 B FT FROM SOUTH STAKE

METHOD OF CORING NQTT | DRILLING FLUID RUMBLE WATER | GR. ELEV 191.6 FT | WEATHER CLR

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT. D/R

WATER LEVEL, TIME, DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
0.0													ROTARY DRILLED TO 31.0 FT				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
25.0																	

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/28/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL

BORING BEGAN 5/28/85	BORING COMPLETED 5/30/85
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER
CASING USED PVC SIZE 6"	GR. ELEV MISOFT WEATHER CLR/90°
	INSPECT FHW OPERAT. DIR JONES
CORE HOLE LOCATION 40.8 FT. FROM SOUTH STAKE	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
25.0													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES. IN SITU CHALK @ ~29.5 FT. CASING SET @ 31.0 FT.				
31.0	BOX 1 RUN #1	1.5/4.3	6/51	31.2 31.3 31.8 31.9 32.1 32.3	I3PR I3PR I3PR I3IR I3IR I3IR	C C C C C C	90 90 90 60 85 85	4/1.5		N8	VF	2	SPRING IN CORECATCHER TWISTED SIDEWAYS SLIGHTLY REASON FOR POOR CORE RECOVERY SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.		S		6/4.3
35.3	#2	4.7/5.0	51/60	35.4 35.5 38.7 39.5	I3PS I3PR I2IR I3IR	C C C C	90 90 90 85	4/4.7		N8	VF	2	RUN #2 USE NEW CORECATCHER AND SPRING 38.7 WEAK ZONE IN CORE, POSSIBLY NATURAL FRACTURE, OR MECHANICAL BREAK.		S		6/5.0
40.3	#3	4.8/5.0	52/60	40.4 40.8 41.2 41.4 41.8 43.0 44.0 44.4	I3PR I3IR I3PR I3IR I3PS I3IR I3PR I3PR	C C C C C C C C	90 90 90 80 90 90 85 85	8/4.8		N6 TO N8	VF	1-2	40.7 - 40.9 VERY WEATHERED ZONE, VERY CLAYEY IN NATURE.		VS S		9/5.0
45.3	#4	10.1/10.0	120/120	45.4 46.7 47.8 49.0 49.5	I3PS I3IR I3PR I3PR I3PR	C C C C C	90 85 85 90 45	8/10.1		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		17/10.0
50.0																	

NOTES:

7½ - 5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/29/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/28/85	BORING COMPLETED 5/30/85	CORE HOLE LOCATION 40.8 FT FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID Potable Water	GR.ELEV 1914.0FT. WEATHER CLDY/40
CASING USED PVC SIZE 6"	INSPECT	OPERAT DTE WATER LEVEL,TIME,DATE ——

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
50.0	#4	10.1/10.0	120/120	51.0	I3IR	C	80	8/10.1		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		17/10.0
				51.6	I3PR	C	90										
53.5	BOX 2			54.2	I3PR	C	85										
55.3	#5	10.0/10.0	115/120	57.1	FIPK	C	65	10/10.0		N6 TO N8	VF	1	57.1 – 61.3 SHEARED ZONE		S	60.2	14/10.0
				59.6	FIPK	C	45										
				60.2	I3PS	C	90										
				60.7	FIPK	C	20										
				60.8	I3IR	C	90										
				61.3	FIPK	C	20										
				61.7	I3PR	C	85									61.7	
				63.2	I3PR	C	90										
				64.9	I3CR	C	85										
				65.1	I3IR	C	80										
65.3	#6	10.0/10.0	117/120	68.0	I3PR	C	90	8/10.0		N6 TO N8	VF	1			S		18/10.0
				68.5	I3PS	C	90										
				69.0	I3IR	C	75										
				69.4	I3PR	C	90										
				69.8	I3PS	C	90										
				70.7	I3PR	C	90										
				73.0	I3IR	C	90										
73.3	BOX 3			74.4	I3PR	C	85										
75.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/29/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL			CORE HOLE LOCATION 40.8 FT FROM SOUTH STAKE
BORING BEGAN 5/28/85	BORING COMPLETED 5/30/85		
METHOD OF CORING NQTT	DRILLING FLUID Potable Water	GR.ELEV 191.40 FT WEATHER PCLDY/80	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DTR	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
75.0 – 75.3	#7	10.0/10.0	119/120	75.4	I3PS	C	90	4/10.0		N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		18/10.0
				79.9	I3PS	C	90										
				82.6	I2PR	C	90										
				83.8	I3PR	C	90										
86.3	#8	10.0/10.0	117/120	85.8	I3PS	C	90	6/10.0		N6	VF	1			S		22/10.0
				86.0	I3PS	C	90										
				88.2	I2PR	C	75										
				90.1	I3PR	C	90										
				91.6	I3PR	C	86										
92.4	BOX 4																
				95.0	I3PR	C	90										
95.3	#9	10.0/10.0	120/120	98.1	I3PS	C	90	5/10.0		N6	VF	1			S		18/10.0
100.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/29/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/20/85	BORING COMPLETED [illegible]		40.8 FT FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR.ELEV 914.0 FT WEATHER P/CLDY/90	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR [illegible]	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
100.0	#9	10.0/10.0	120/120	100.3	ISPR	C	85	5/10.0		N6	VF	I	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		18/10.0
				102.2	ISPR	C	90										
				103.5	ISPR	C	90										
				104.7	ISPR	C	90										
105.3	#10	10.0/10.0	113/120	110.2	ISPR	C	85	4/10.0		N6 TO N8	VF	I			5		16/10.0
				110.5	ISPS	C	90										
111.4	BOX 5			114.7	ISPR	C	85										
				115.1	ISIR	C	90										
115.3	# [illegible]	10.0/10.0	113/120	115.5	ISPR	C	90	13/10.0		N6 TO N8	VF	I			5		13/10.0
				116.0	ISPR	C	85										
				117.1	ISPR	C	85										
				118.5	ISPR	C	90										
				119.2	ISPR	C	85										
				120.0	ISPR	C	90										
				120.4	ISPR	C	80										
				121.0	ISPR	C	85										
				122.5	ISPR	C	85										
				123.0	ISPR	C	85										
				123.9	ISPR	C	90										
				124.9	ISPR	C	85										
125.0				125.1	ISPR	C	90										

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/30/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL

BORING BEGAN 5/28/85	BORING COMPLETED 5/30/85	CORE HOLE LOCATION 40.8 FT FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER; GR.ELEV 191.40 FT WEATHER CLR/85	
CASING USED PVC SIZE 6"	INSPECT FHW OPERAT DIR	WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR*	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
125.0				125.5	J3IR	C	90										
	#12	4.7/4.7	5.0/5.6	127.2	J3PS	C	90	3/4.7		N6 To N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		5/4.7
130.0				129.6	J3PS	C	80						END OF CORING @ 130.0 FT.				

SCALE: 1 DIVISION=0.2 FEET

NOTES:

FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

New Page
February 24, 1986

DATE 5/30/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL   JOB NO. [illegible]   BORING NO. CA-4 [illegible]   SHEET [illegible]

BORING BEGAN 5/30/85   BORING COMPLETED 5/31/85   CORE HOLE LOCATION 10.0 FT EAST OF CA-18

METHOD OF CORING NQTT   DRILLING FLUID POTABLE WATER   GR.ELEV. ~209 FT   WEATHER CLR/85°

CASING USED PVC   SIZE 6"   INSPECT FHW   OPERAT. DTR [illegible]   WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
0.0													ROTARY DRILLED TO 28.2 FT. WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
25.0													INSITU CHALK @ ≈ 24.7 FT.				

NOTES:

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 5/31/85   LOGGED BY FHW

Golder Associates

PROJECT [illegible]	CORE HOLE LOCATION
BORING BEGAN 5/30/85 — BORING COMPLETED 5/31/85	10.0 FT EAST OF CA-13
METHOD OF CORING NQTT — DRILLING FLUID POTABLE WATER — GR.ELEV ~209 FT. WEATHER CLR/85°	
CASING USED PVC SIZE 6" — INSPECT FHW OPERAT D&R JONES	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
25.0	—	—	—	—	—	—	—	—		—	—	—	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.	—	—	—	—
28.2													WRENCH LOST DOWN BORING (9 IN. DIA.) UNABLE TO RETRIEVE. BORING BACKFILLED WITH 2.5-5 GAL. BUCKETS OF BENTONITE PELLETS AND CHALK. END OF BORING @ 28.2 FT.				

NOTES:

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 5/31/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/31/85	BORING COMPLETED 6/4/85		160.2 FT. FROM EAST STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR ELEV 201.22 FT WEATHER CLR/90	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT D(R JONES	WATER LEVEL, TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
0.0													ROTARY DRILLED TO 23.4 FT.				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—		—	—	—		—	—	—	—
													IN SITU CHALK @ ≈ 16.0 FT.				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
23.4													CASING SET @ 23.4 FT.				
25.0	BOX 1 RUN 1	0/21	0/25							—	VF	—			5		—/26

NOTES
7½ – 5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SEAL CASING.
BEGINING RUN #1 USE NEW CARBIDE BIT RATHER THAN DIAMOND BIT.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 5/31/85 LOGGED BY FHW

Golder Associates

PROJECT CWM CONSENT DECREE, AL — JOB NO 833-2472 — BORING NO CA-3(SVAT 6/3/85) — SHEET 2 OF 6

BORING BEGAN 5/31/85	BORING COMPLETED 6/4/85	CORE HOLE LOCATION: 160.2 FT FROM EAST STAKE
METHOD OF CORING NQTT	DRILLING FLUID Potable water	DRILLER Bob Zeefweather, GRD. EL. 90
CASING USED PVC, SIZE 6"		INSPECT FHW — OPERAT DYE — WATER LEVEL TIME DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	DISCONTINUITIES: TYPE	DISCONTINUITIES: INFILLING	DISCONTINUITIES: ANGLE W/AXIS	DISCONTINUITIES: FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0		0/1.5	0/15							—	VF	—			5		1/2.4
26.5	#2	1.7/5.0	4/60	SEE SIDE NOTE →				10+		N8	VF	1	TOP 1.1 FT. OF RECOVERY FALL IN FROM CASING INSTALLATION. VERY HARD ROCK FRAGMENT FELL INTO BORING DURING CASING INSTALLATION AND BLOCKED CORE FROM ENTERING BARREL. REMAINING 0.6 FT. HIGHLY BROKEN, DRILLING INDUCED, IN SITU CHALK.		5		10/5.0
30.5	#3	4.9/5.0	53/60	30.7 30.8 33.0 35.1	I3PR I3PR I2PS I3PR	C C C C	90 90 90 90	4/4.9		N8	VF	1	REPLACED CARBIDE BIT WITH DIAMOND BIT FOR RUN # 3 33.0 BREAK ALONG SHELL UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		7/5.0
35.5	#4	4.0/4.6	43/55	35.8 36.6 36.7 37.7 38.3 38.8 39.? 39.4	I2PR I3PS I3PS I3PR I3PR I3IR I3IR I3PR	C C C C C C C C	90 90 90 85 90 80 60 80	8/9.0		N8	VF	1		•	5		18/4.6
40.1	#5	5.9/5.4	61/66	40.2 40.6 41.9 42.4 44.5 44.7 45.4	I3PR I3PS I3IR I3IR I3IR I3IR I3IR	C C C C C C C	90 90 85 75 60 75 90	7/6.9		N8	VF	1			5		8/5.4
45.5	#6			46.7	I3PR	C	75										
47.6	BOX 2	10.0/10.0	117/120	48.5	I3PR	C	80	7/10.0		N8	VF	1			5		14/10.0
50.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/3/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 5/31/85	BORING COMPLETED 6/4/85
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER
CASING USED PVC SIZE 6"	
GR ELEV 208.22 FT	WEATHER CLR, 95
INSPECT FHW	OPERAT DIR
CORE HOLE LOCATION: 160.2 FT FROM EAST STAKE	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	DISCONTINUITIES TYPE	DISCONTINUITIES INFILLING	DISCONTINUITIES ANGLE W/AXIS	FRACTURES/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
60.0	#6	10.0/10.0	117/120	60.1	I3PR	C	80	7/10.0		N6 TO N8	VF	I			S		14/10.0
				60.6	I3PS	C	90										
				62.2	I3PR	C	85										
				64.1	I3IR	C	85										
				65.0	I3IR	C	80										
55.5	#7	10.0/10.0	120/120	56.4	I3PR	C	75	5/10.0		N6 TO N8	VF	I	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		11/10.0
				56.8	I3IR	C	80										
				68.1	I3IR	C	90										
				80.6	I3PR	C	90										
				63.5	I3PR	C	85										
65.5	#8	9.8/10.0	117/120	65.6	I3PS	C	90	4/9.8		N6 TO N8	VF	I			S		17/10.0
66.4	BOX 3			68.8	I3PR	C	85										
				72.8	I3PR	C	90										
75.0				74.5	I3PR	C	85										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/3/85 LOGGED BY FHW

Golder Associates

PROJECT CWM 'CONSENT DECREE,' AL | JOB NO

BORING BEGAN 5/31/85 | BORING COMPLETED 6/4/85 | CORE HOLE LOCATION 160 2 FT FROM EAST STAKE

METHOD OF CORING NQTT | DRILLING FLUID POTABLE WATER | GR.ELEV 246.22 FT | WEATHER CLR/98

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DIR JWB | WATER LEVEL.TIME.DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
75.0	#8	9.8/10.0	117/120					4/9.8		N6 N8	VF	I			5		17/10.0
75.5	#9	9.9/10.0	108/120	75.9	I3PS	C	85	12/9.9		N6 TO N8	VF	I	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		17/10.0
				76.8	I3PR	C	90										
				78.9	I3PR	C	90										
				81.5	I2PR	C	70						81.5 BREAK ALONG SHELL				
				82.3	I3PS	C	90										
				83.1	I3PR	C	85										
				83.4	I3PR	C	90										
				83.4	I3PR	C	90										
				83.9	I3IR	C	90										
				84.0	I3PR	C	90										
				84.5	I3PR	C	90										
				84.9	I3PR	C	90										
85.5	BOX 4 #10	9.9/10.0	118/120	85.9	I3IR	C	80	8/9.9		N6 TO N8	VF	I			5		21/10.0
				86.0	I3IR	C	90										
				86.8	I3PR	C	85										
				87.4	I3PR	C	85										
				88.7	I2PR	C	75						88.7 BREAK ALONG SHELL				
				91.6	I3PR	C	90										
				92.6	I3PS	C	80										
				94.4	I3PR	C	85										
95.5	#11	9.6/10.0	112/120	96.8	I3PS	C	90	5/9.6		N6 TO N8	VF	I			5		19/10.0
				98.2	I2PR	C	80						98.2 BREAK ALONG SHELL				
100.0				99.7	I2PR	C	75						99.7 BREAK ALONG SHELL				

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/3/85 LOGGED BY FHW

Golder Associates

PROJECT CNM/CONSENT ...

BORING BEGAN 5/31/85	BORING COMPLETED 6/4/85		CORE HOLE LOCATION 160.2 FT. FROM EAST STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR.ELEV 208.22 FT. WEATHER CLR/90	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT. DIR ...	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
100.0	#11	9.6/10.0	112/120	100.8	I3IR	C	80	5/9.6		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		17/10.0
104.7	BOX 5			104.7	I3PR	C	90										
105.5	#12	5.7/5.0	60/60	105.6	I3PS	C	90	2/5.7		N6	VF	1			5		13/5.0
				110.3	I3PR	C	90										
110.5	#13	6.0/5.0	60/60	113.8	I2PS	C	85	3/5.0		N6	VF	1	113.0 BREAK ALONG SHELL		5		11/5.0
				114.3	I2PS	C	80						114.3 BREAK ALONG SHELL				
				114.9	I3PR	C	90										
115.5	#14	10.0/10.0	115/120	115.7	I3PS	C	90	6/10.0		N6	VF	1	CORE CATCHER LEFT OFF RUN #14 ACCIDENTALLY. NO RECOVERY INITIALLY. 5.3 FT RECOVERED AFTER DROPPING T-TUBE BACK DOWN 1ST TIME, 2ND TIME ADDITIONAL 4.7 FT. RECOVERED.		5		17/10.0
				120.0	I3PR	C	85										
				120.1	I3PR	C	90										
				120.4	I3IR	C	90										
				121.0	I3IR	C	85										
123.4	BOX 6			123.4	I3PR	C	90										
125.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/3/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL		JOB NO. 855-3098.2	BORING NO. CA-13 DATE 6/13/85 SHEET 6 OF 6
BORING BEGAN 5/31/85	BORING COMPLETED 6/4/85		CORE HOLE LOCATION 160.2 FT FROM EAST STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER	GR.ELEV 208.22FT. WEATHER CLR/95°	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR JONES	WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
125.0–125.5	#14	10.0/10.0	115/120					4/10.0		N6	VF	1			S		17/10.0
125.5–135.5	#15	9.3/10.0	118/120	126.9	I3PS	C	90	1/9.8		N6	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		18/10.0
135.5–140.5	#16	4.1/4.5	4.5/4.5	137.8	I3PS	C	90	2/5.0		N6	VF	1			S	139.5–140.4	7/4.5
				139.9	I2PS	C	76										
140.5													END OF CORING @ 140.5 FT.				

NOTES:
FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/4/85 LOGGED BY FHW/PMI

Golder Associates

PROJECT [illegible]

BORING BEGAN 7/9/85	BORING COMPLETED 7/9/85	CORE HOLE LOCATION 43.8 FT. FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID Potable Water	GR.ELEV. [illegible] FT. WEATHER CLR/90
CASING USED PVC SIZE 6"	INSPECT. FHW OPERAT. D/E [illegible]	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
0.0													ROTARY DRILLED TO 9.9 FT				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—		—	—	—		—	—	—	—
													INSITU CHALK @ ≈ 6.0 FT.				
													SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
9.9	BOX 1 RUN #1	5.1/5.1	61/69	10.0 10.1 10.3 10.4 10.6 11.8	I3PR I3IR I3PR I3PR I3PS I3PS	C C C C C C	90 80 80 [illegible] [illegible] 90	7/6.7		N6 TO N8	VF	1	CASING SET @ 9.9 FT. UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		11/6.7
				14.9	F2PK	C	40						14.9 SLICKENSIDE CORE WAS NOT BROKEN WHEN REMOVED FROM T-TUBE, SEPERATED AFTER CORE DRIED IN TROUGH.				
15.6	#2	5.0/6.0	11/60	17.7 18.5 [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]	I3IR I3PS I3PR I3PR I3PR I3PS I3PS [illegible] [illegible] [illegible]	C C C C C C C C C C	90 90 85 85 85 85 90 90 [illegible] [illegible]	11/30		N6 TO N8	VF	1	T-TUBE BLOCKED - PULLED AFTER 6.0 FT. RUN.		5		19/5.0
20.6	#3	6.3/6.0	53/60	20.7 21.0 23.3	I3PS I3PR I3PR	C C C	90 80 85	5/5.3		N6 TO N8	VF	1			5		9/5.0
25.0				[illegible]	[illegible]	C C	[illegible]						25.1 BREAK ALONG SHELL				

NOTES:
6-5 GAL. BUCKETS OF BENTONITE PELLETS USED TO SET CASING.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 7/9/85 LOGGED BY FHW

Golder Associates

PROJECT [illegible]

BORING BEGAN 7/9/85 | BORING COMPLETED 7/9/85 | CORE HOLE LOCATION 43.8 FT FROM SOUTH STAKE

METHOD OF CORING NQ?? | DRILLING FLUID PORTABLE WATER | GR. ELEV. 2/2 42 FT | WEATHER CLR 95

CASING USED PVC | SIZE 6" | INSPECT FHW | OPERAT DYE [illegible] | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT
25.0	#3	5.3/5.0	53/60					6/5.3		N6 TO N8	VF	1			5		[illegible]/5.0
25.6	#4			25.8	I3PR	C	90						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
				25.9	I3PR	C	90										
				26.1	I3PR	C	90										
				26.3	I3PR	C	90										
				26.6	I3PR	C	90										
				27.0	I3PR	C	90										
				27.2	I3PR	C	90										
29.9	BOX 2	10.0/10.0	105/120	30.6	I3PR	C	90	12/10.0		N6 TO N8	VF	1			5		19/10.0
				33.7	FIPK	C	90									33.2	
				33.8	I3PR	C	90										
				34.7	I3PR	C	85									34.7	
				36.4	I3PR	C	90										
35.6	#5	10.1/10.0	118/120	37.3	I2PS	C	85	4/10.1		N6 TO N8	VF	1	37.3 BREAK ALONG SHELL		5		17/10.0
				40.6	I3PR	C	90										
				41.7	I3PR	C	90										
				46.4	I3IR	C	90										
45.6	#6	10.0/10.0	110/120	46.7	I3PR	C	90	9/10.0		N8	VF	1			5		11/10.0
				46.8	I3PR	C	90										
				47.8	I3PR	C	85										
49.0	BOX 3																
50.0																	

NOTES.

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 7/9/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 7/9/85	BORING COMPLETED 7/9/85		CORE HOLE LOCATION: 43.8 FT. FROM SOUTH STAKE
METHOD OF CORING NQTT	DRILLING FLUID: POTABLE WATER	GR ELEV 212.42 FT WEATHER CLR/95	
CASING USED PVC SIZE 6"		INSPECT FHW OPERAT DIR	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
50.0	#6	10.0/10.0	110/120	50.5	F2PK	C	50	9/10.0		N8	VF	1	50.5 BREAK AFTER CORE REMOVED FROM BARREL		S	50.3	11/10.0
				51.0	F1PK	C	50									51.4	
				51.8	I3IR	C	90						UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		VS		
				54.0	I3PS	C	90								S		
				54.6	I3PS	C	90								VS		
				55.2	I3PR	C	55								S		
55.6	#7	10.0/10.0	109/120	55.7	I3PS	C	90	15/10.0		N8	VF	1			S		9/10.0
				56.7	I3PS	C	90										
				57.4	I3PS	C	85						57.8 - 59.9 SLICKENSIDE ZONE			57.9	
				57.7	I3IR	C	85										
				57.8	F1PK	C	30										
				58.0	F1PK	C	45										
				58.2	F1PK	C	30										
				58.6	F1PR	C	35										
				59.0	F1PK	C	50									57.9	
				59.2	F1PK	C	45										
				59.9	F5PK	C	10						59.9 NOT CONTINOUS ACROSS CORE.				
				60.7	I3PR	C	90										
				63.1	I3PR	C	85										
				64.5	I3PR	C	80										
				64.9	I3PS	C	90										
65.6	#8	10.1/10.0	117/120	65.9	I3PR	C	85	5/10.1		N6 TO N8	VF	1					18/10.0
				69.8	I2PS	C	80						69.8 BREAK ALONG SHELL				
70.1	BOX 4																
				72.1	I2PR	C	70						72.1 BREAK ALONG SHELL		S		
				74.2	I2PR	C	90						74.2 BREAK ALONG SHELL				
75.0				75.3	I3PS	C	90										

NOTES:

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 7/9/85 LOGGED BY FHW

Golder Associates

BORING BEGAN 7/9/85 | BORING COMPLETED 7/9/85 | CORE HOLE LOCATION 43.8 FT. FROM SOUTH STAKE

METHOD OF CORING NQ TT | DRILLING FLUID POTABLE WATER | GR. ELEV 212.42 FT. | WEATHER CR/95

CASING USED PVC SIZE 6" | INSPECT FHW | OPERAT DIR ... | WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
75.0–75.6	#8	10.1/10.0	117/120					5/10.1		N6 TO N8	VF	1			S		14/140
75.6–80.6	#9	5.0/5.0	60/60	76.3	I3PR	C	80	9/5.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		6/5.0
				78.2	I2PR	C	75						78.2 BREAK ALONG SHELL				
				79.2	I3PR	C	90										
80.6													END OF CORING @ 80.6 FT.				

NOTES:

FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1985

DATE 7/9/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL — JOB NO. 855-8040 — BORING NO. CA-15 DATE 7/8/85

BORING BEGAN 7/8/85 — BORING COMPLETED 7/8/85 — CORE HOLE LOCATION 140.8 FT. FROM EAST STAKE

METHOD OF CORING NQTT — DRILLING FLUID POTABLE WATER — GR.ELEV. 217.5 FT — WEATHER P.CLDY/90

CASING USED PVC SIZE 6" — INSPECT FHW — OPERAT. D1R — WATER LEVEL,TIME,DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
0.0													ROTARY DRILLED TO 12.5 FT.				
													WEATHERED TO UNWEATHERED, GRAY TO BROWN FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
	—	—	—	—	—	—	—	—		—	—	—	INSITU CHALK @ ≈ 7.0 FT.	—	—	—	—
													UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.				
12.3													CASING SET @ 12.3 FT.				
13.1													REAMED TO 13.1 FT.				
	RUN #1 BOX 1	2.2/2.3	2.1/2.3	15.0	J3PR	C	85	1/2.2		N6	VF	1			5		5/2.3
15.4				16.2	J3IR	C	80										
	#2			17.1	J3PS	C	90										
		9.8/10.0	117/120					2/9.8		N6	VF	1			5		25/10.0
25.0																	

NOTES:
4-5 GAL. BUCKETS OF BENTONITE USED TO SET CASING

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 7/8/85 LOGGED BY FHW

Golder Associates

PROJECT CWM/CONSENT DECREE/AL	JOB NO. 855-8090.2	BORING NO. ZA-15 DATE 7/8/85 SHEET 2 OF 4
BORING BEGAN 7/8/85	BORING COMPLETED 7/8/85	CORE HOLE LOCATION 140.0 FT. FROM EAST STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER / GR. ELEV. 217.5 FT / WEATHER P. CLDY/95	
CASING USED PVC SIZE 6"	INSPECT. FHW OPERAT. DIR	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
25.0																	
25.4 – 35.4	#3	10.0/10.0	118/120	27.6	I2IR	C	80	4/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES. 27.6 BREAK ALONG SHELL		5		21/10.0
				29.7	I3PR	C	90										
31.9	BOX 2																
				34.9	I3PR	C	85										
				35.1	I2IR	C	75						35.1 BREAK ALONG SHELL				
35.4 – 45.4	#4	10.1/10.0	116/120	36.6	I2PR	C	90	7/10.1		N6 TO N8	VF	1	36.6 BREAK ALONG SHELL		5		11/10.0
				36.8	I3PR	C	90										
				37.7	I2PS	C	90						37.7 BREAK ALONG SHELL				
				37.8	I2PR	C	90						37.8 BREAK ALONG SHELL				
				39.7	I2PR	C	75						39.7 BREAK ALONG SHELL				
				40.4	I3PR	C	70										
				45.1	I3PR	C	90										
45.4 – 50.0	#5	10.0/10.0	120/120	47.6	I2PS	C	75	3/10.0		N6 TO N8	VF	1	47.6 BREAK ALONG SHELL		5		8/10.0
50.0																	

NOTES:

SCALE: 1 DIVISION = 0.5 FEET

New Page
February 24, 1986

DATE 7/8/85 LOGGED BY FHW

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BORING BEGAN 7/8/85	BORING COMPLETED 7/8/85	CORE HOLE LOCATION 140.0 FT. FROM EAST STAKE
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER; GR. ELEV. 217.56 FT; WEATHER R CLDY/95	
CASING USED PVC SIZE 6"	INSPECT FHW; OPERAT. DIR	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURE/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
50.0–50.2	BOX 3 #5	10.0/10.0	120/120	50.5	I3PR	C	90	3/10.0		N6 TO N8	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		8/10.0
				54.2	I3PR	C	90										
55.4	#6	10.0/10.0	113/120	56.1	I3PR	C	90	12/10.0		N6 TO N8	VF	1	INTERMITTENT ZONES OF SOFT TO VERY SOFT		56.1–57.0		9/10.0
				56.3	I3PR	C	90										
				56.5	I3PR	C	85										
				56.6	I3PR	C	90										
				56.9	I3PS	C	90										
				60.4	I3PR	C	85								5		
				60.7	I3PR	C	85										
				61.0	I2PR	C	55						61.0 BREAK ACROSS SHELL				
				61.7	I3IR	C	85										
				62.9	I3IR	C	80										
				64.2	I3PR	C	90										
				64.6	I3PR	C	90										
65.4	#7	9.9/10.0	118/120	65.0	I3PR	C	90	5/9.9		N6 TO N8	VF	1			5		13/10.0
68.2	BOX 4			68.2	I2PS	C	75						68.2 BREAK ALONG SHELL				
				70.4	I2PS	C	90										
				71.6	I3PR	C	80										
				72.2	I3PR	C	85										
75.0																	

NOTES:

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 7/8/85 LOGGED BY FHW

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PROJECT CWM/CONSENT DECREE/AL — JOB NO. 855-8070 — BORING NO. CA-15 — DATE 7/8/85 — SHEET 4 OF 4

BORING BEGAN 7/8/85	BORING COMPLETED 7/8/85
METHOD OF CORING NQTT	DRILLING FLUID POTABLE WATER
CASING USED PVC SIZE 6"	GR. ELEV. [illegible] FT WEATHER [illegible]
INSPECT. FHW	OPERAT. [illegible]
CORE HOLE LOCATION 160.8 FT. FROM EAST STAKE	WATER LEVEL, TIME, DATE —

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES/FT.	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
75.0																	
75.4	#8	10.0/10.0	18/120	76.4	I3FR	C	90	4/10.0		N4 TO N5	4F	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		5		19/10.0
				77.9	I3FR	C	90										
				79.0	I3FR	C	85										
				80.4	I3FR	C	80										
				83.8	I3FR	C	80										
				85.2	I2FS	C	60						85.2 BREAK ALONG SHELL				
85.4													END OF CORING @ 85.4 FT				

NOTES:

FLUSHED WITH POTABLE WATER @ COMPLETION OF CORING.

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 7/8/85 LOGGED BY FHW

Golder Associates

PROJECT [illegible] JOB NO. [illegible] BORING NO. [illegible] SHEET [illegible]

BORING BEGAN 6/24/85 BORING COMPLETED 6/25/85

CORE HOLE LOCATION: 26 FT FROM SOUTH STAKE

METHOD OF CORING [illegible]

DRILLING FLUID: POTABLE WATER

[illegible] 24353 WEATHER CLR/90

CASING USED PVC [illegible] 6"

INSPECT. [illegible] OPERAT. [illegible]

WATER LEVEL AND DATE ——

DEPTH (FT)	SAMPLE NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	DISCONTINUITIES: TYPE	DISCONTINUITIES: INFILLING	DISCONTINUITIES: ANGLE W/AXIS	DISCONTINUITIES: FRACTURE/FT	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES, LABORATORY TESTS	DRILLING RATE MIN/FT
													ROTARY DRILLED TO [illegible] FT				
													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.				
150																	

NOTES 28 - 5 GAL. BUCKETS OF BENTONITE USED TO SET CASING

SCALE: 1 DIVISION = 0.2 FEET

New Page
February 24, 1986

DATE 6/24/85 LOGGED BY FHW

PROJECT: ENM/CAMSEAP DECELL/AL | JOB NO: 855 ТСНР 2 | BORING NO: CA-UDATE 6/71 | SHEET 2 OF 4

BORING BEGAN: 6/24/85 | BORING COMPLETED: 6/25/85 | CORE HOLE LOCATION: 86 FT FROM SOUTH STAKE

METHOD OF CORING: NQ?? | DRILLING FLUID: POTABLE WATER | DRILLER: DEI | WEATHER:

CASING USED: PVC | SIZE: 4" | INSPECT: FHW | OPERAT: DIR | WATER LEVEL TIME DATE: ———

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES LABORATORY TESTS	DRILLING RATE MIN/FT
25.0													WEATHERED TO UNWEATHERED, GRAY TO DARK GRAY, FOSSILIFEROUS, RECOMPACTED CHALK, WITH OCCASIONAL IRON SULFIDE NODULES				
													IN SITU CHALK @ - 37.0 FT.				
													WEATHERED, BROWN, VERY FINE GRAINED, SOFT, FOSSILIFEROUS, CHALK.				
40.0				40.1	I3IR	ST	40						CASING SET @ 40.0 FT				
	BOX 1 RUN #1	5.1/5.0	5.3/6.0	42.2 42.7 42.8 43.4	I3PR I3IR I3IR I3IR	ST ST ST ST	90 85 90 85	5/5.1		BROWN TO N6	VF	2-1	SLIGHTLY WEATHERED TO UNWEATHERED, GRAY TO BROWN VERY FINE GRAINED, SOFT TO V. SOFT FOSSILIFEROUS, CHALK, WITH OCCASIONAL IRON SULFIDE NODULES.		VS-S		4/50
										N6		1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES.		S		
45.0				45.2	I3PS	C	90										
	#2	10.0/10.0	11.3/12.0	46.5 47.1	I2CR I2PS	C C	80 60	7/10.0		N6 TO N8	VF	1	46.5 - BREAK ALONG SHELL 47.1 - BREAK ALONG SHELL		S		15/100
50.0																	

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/25/85 LOGGED BY FHW

PROJECT [illegible] / CONSENT [illegible] — JOB NO. [illegible]

BORING BEGAN 6/24/85 — BORING COMPLETED 6/25/85 — CORE HOLE LOCATION 20 FT FROM SOUTH STAKE

METHOD OF CORING NQ?? — DRILLING FLUID POTABLE WATER — GROUND ELEVATION [illegible]

CASING USED PVC SIZE 6" — INSPECTOR FHW — WATER LEVEL [illegible]

DEPTH (FT)	BOX/RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES DEPTH (FT)	TYPE	INFILLING	ANGLE W/AXIS	FRACTURES	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES: LABORATORY TESTS	DRILLING RATE MIN/FT
56.0	#2	10.0/10.0	11.3/12.0	61.5	ISPR	C	80	7/100		NG TO NB	VF	1	UNWEATHERED, GRAY TO DARK GRAY, VERY FINE GRAINED, SOFT TO VERY SOFT, FOSSILIFEROUS, CHALK WITH OCCASIONAL IRON SULFIDE NODULES	-	S		15/100
				59.2	ISPS	C	90										
				59.6	ISPR	C	85										
55.5				59.9	ISPR	C	90										
	#3			57.9	ISIR	C	90										13/100
58.5	Box 2	10.0/10.0	11.9/12.0	57.7	ISIR	C	75	7/100		NG TO NB	VF	1			S		
				60.1	ISPS	C	90										
				62.1	ISPR	C	80										
				63.3	ISIR	C	90										
				64.4	ISPR	C	75										
				64.9	ISPR	C	80										
65.0	#4	10.0/10.0	10.3/12.0	65.5	ISPR	C	90	13/100		NG TO NB	VF	1			S		11/100
				65.8	ISIR	C	90										
				66.0	ISPR	C	90										
				66.2	ISPR	C	90										
				66.7	ISPR	C	85										
				68.6	ISIR	C	80										
				70.1	ISPR	C	90										
				70.2	ISPR	C	90										
				73.1	ISPR	C	90										
				73.4	ISPR	C	90										
				73.5	ISPR	C	90										
				73.7	ISPR	C	90										
75.0				74.8	ISPR	C	90										

NOTES

SCALE: 1 DIVISION=0.2 FEET

New Page
February 24, 1986

DATE 6/25/85 LOGGED BY FHW

APPENDIX E-8

DOCUMENT 2

The 40 CFR 264 Groundwater Monitoring Waiver Demonstration, Emelle, Alabama is included in this application only for historical purposes and will not be updated routinely as a dynamic document.

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

40 CFR 264 GROUNDWATER MONITORING WAIVER DEMONSTRATION EMELLE FACILITY

Submitted To:

Chemical Waste Management, Inc.
P.O. Box 3065
Marietta, Georgia 30061

DISTRIBUTION:

8 Copies - Chemical Waste Management, Inc.
2 Copies - Golder Associates

September 1985

853-3103.3
1308 FN

GOLDER ASSOCIATES, INC. • 3772 PLEASANTDALE ROAD, SUITE 165, ATLANTA, GEORGIA 30340, U.S.A. • TELEPHONE (404) 496-1893 • TELEX 700523

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Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

September 5, 1985

853-3103.3
F/N 1308

Chemical Waste Management, Inc.
P.O. Box 3065
Marietta, Georgia 30061

Attn: Mr. Don R. McCombs, P.E.

RE: 40 CFR 264 GROUNDWATER MONITORING WAIVER DEMONSTRATION
EMELLE FACILITY

Gentlemen:

Please find attached the demonstration document in support of the Groundwater Monitoring waiver for the Emelle Facility. The document follows the requirements set forth in 40 CFR 264.90 (b) and is stamped by a Professional Engineer registered in the State of Alabama.

We appreciate the opportunity to work with CWM on this effort and should you have any questions, please contact us.

Very truly yours,

GOLDER ASSOCIATES

J. Edmund Baker, P.E.
Associate

JEB:mrs

GOLDER ASSOCIATES, INC. • 3772 PLEASANTDALE ROAD, SUITE 165, ATLANTA, GEORGIA 30340, U.S.A. • TELEPHONE (404) 496-1893 • TELEX 700523

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1.0 INTRODUCTION

Chemical Waste Management (CWM) owns and operates a hazardous waste treatment and disposal facility near Emelle, Alabama. One method of hazardous waste disposal at this facility is landfilling of bulk waste, containerized solid waste and solidified liquid waste in deep land disposal cells. A Part B Permit Application as required by the Resource Conservation Recovery Act (RCRA) was submitted to Region IV EPA on September 9, 1983 and resubmitted on September 9, 1985. In additional to other information required by the RCRA Regulations the Emelle Part B Permit Application includes comprehensive reports on the hydrogeology of the area and a geochemical assessment of the site which discusses its ability to contain hazardous waste constituents. The purpose of this report is to demonstrate that conditions exist at the Emelle Facility to support a waiver of the groundwater monitoring requirements outlined under 40 CFR 264 Subpart F. The provision for and requirements of this Groundwater Monitoring Waiver Demonstration is set forth in 40 CFR 264.90(b)(4).

This waiver demonstration was made at the request of EPA in order to allow CWM to install and operate an alternate groundwater monitoring system. The alternate groundwater monitoring system will consist of groundwater monitoring wells installed in the shallow saturated zone around the hazardous waste management areas. CWM will continue to operate the existing Eutaw aquifer groundwater monitoring system.

This document "stands alone" with respect to technical content. However, the laboratory tests and analyses which support this document are included in detail in three reports of the Emelle Facility Part B Permit Application; "Geologic and Geotechnical Evaluation - Emelle Facility," "Hydrogeologic Characterization - Emelle Facility" and "Geo-chemical Studies - Emelle Facility."

2.0 EXISTING GROUNDWATER MONITORING SYSTEM

The existing groundwater monitoring system at the Emelle Facility consists of a deep groundwater monitoring system which allows groundwater sampling from the uppermost aquifer, the Eutaw Formation, and a shallow saturated zone system which provides for sampling of groundwater in the Selma chalk into which the landfill cells are excavated. Each of these groundwater monitoring systems are presented in the following paragraphs.

The RCRA groundwater monitoring system currently consists of eight groundwater monitoring wells ranging in depths from about 700 feet to greater than 1000 feet. The location of the RCRA wells are shown on Figure 1. As can be seen from this figure, RCRA Well 1 is located off-site, RCRA Wells 2 and 3 are located in the interior portion of the site and Wells 4 through 8 are located near the site perimeter. Due to concerns regarding the lack of well completion and construction records, CWM has recently initiated a program to seal and abandon RCRA Wells 2, 3, and 4. In addition, RCRA Well 5 will be reworked to provide a screened interval consistent with RCRA Wells 6, 7, and 8 which are screened in the upper 50 feet of the Eutaw aquifer. Lastly, a third downgradient Eutaw Aquifer monitoring well, RCRA Well 9, will be installed following recompletion of RCRA Well 5. The revised RCRA monitoring well network will consist of Wells 5 through 9 and will provide for monitoring of the uppermost aquifer at the boundaries of the Emelle Facility.

It is important to realize that the location of the RCRA groundwater monitoring wells at the facility boundaries is to avoid penetration of the extremely low permeability

Selma chalk in the area that the landfill cells are excavated. It is the opinion of CWM and the Alabama Department of Environmental Management (ADEM) that Eutaw aquifer monitoring wells located very near existing landfills and surface impoundments at the Emelle Facility would greatly increase the potential for vertical migration of hazardous waste constituents through the Selma chalk and into the Eutaw aquifer.

In addition to the RCRA groundwater monitoring system, CWM is in the process of installing a shallow saturated zone monitoring system which will allow groundwater samples to be obtained from the low permeability Selma chalk immediately adjacent to the active and closed landfill cells. These wells are numbered CA-1 through CA-16 and their locations are shown on Figure 2. These wells will be completed to a depth of approximately 25 feet below the base of the adjacent landfill trench. In addition, thirteen of the shallow saturated zone monitoring well locations will have an additional groundwater monitoring well screened across a discontinuity located in the Selma chalk. There will be a total of 29 shallow monitoring wells. The shallow saturated-zone groundwater monitoring wells will provide a check of the calculated transit times in the saturated chalk formation. (See Section 4.2). It is important to note that this system is not part of the RCRA groundwater monitoring network and is not subjected to the same interpretative and evaluation criteria as the RCRA detection monitoring system.

3.0 GENERAL HYDROGEOLOGY

3.1 Physiography, Geology and Meteorology

The Emelle Site is located in the Black Prairie of the East Gulf Coastal Plain section of the coastal physiographic province. The rocks of west central Alabama consist of Upper Cretaceous sediments with bedding plains which dip approximately 45 feet per mile towards the southwest. The surficial geologic formations are members of the Selma Group which consist of dense, low permeability, homogeneous chalk and marls. The uppermost aquifer in the area lies immediately beneath the chalks and marls of the Selma Group and consists of the sand units of the Eutaw Formation. At depth the Gordo and Coker Formations underlie the Eutaw Formation and also serve as the water supply aquifers. The Selma Group and the Eutaw Formation are discussed in detail in the following sections.

The average precipitation in the Sumter County area is approximately 50 inches per year. Monthly average precipitation ranges between about 6.2 inches in the winter and spring months and about 2.2 inches in the late summer to early fall. Watersheds in the area are characterized by high amounts of evapotranspiration and widely varying amounts of runoff depending on the surficial geology. A detailed water balance is presented in Section 3.5. Temperatures in the area are moderate with below freezing temperatures occurring only during short periods. Therefore, accumulations of snow and ice are not a consideration in runoff or water balance calculations.

3.2 Selma Group

The Selma Group sediments consist of chalky limestone with a minerologic makeup of about 50% calcium carbonate, 44% clay minerals and about 6% sand. The Selma Group sediments range from a relatively pure chalk with clay contents as low as 10% to dark gray marls with clay contents as high as 55%. The sediments range in thickness from about 600 feet to 750 feet across the Emelle Site.

The unnamed lower member of the Selma Group is estimated to be about 250 feet thick and consists mainly of relatively uniform thinly bedded chalky marl except for the bottom few feet which consist of compact calcarious sandstone. This dense sandstone is referred to as "caprock" by local water well drillers and indicates the interface between the Selma Group and the underlying Eutaw Aquifer. In ascending order are the Arcola Limestone member which consists of an almost pure limestone interbedded with soft marl which is seldom more than 2 feet thick in western Alabama, and the Demopolis Formation which ranges in thickness from 350 feet to 500 feet in thickness at the site and consists of marly chalk base and relatively pure calcium carbonate materials in its upper portion.

Three deep continuous core holes each taken to a total depth of 500 feet were drilled on the south, north and eastern edges of the Emelle Facility to confirm the homogeneity and structural integrity of the Selma Chalk. These cores showed that while there are various stratigraphic distinctions which can be made throughout the Selma Group, it is essentially homogeneous with respect to hydrogeology. The low permeability and high homogeneity make this an excellent formation for the management of hazardous waste. The permeability and porosity characteristics of the Selma chalk and marl are presented in detail in Section 3.7.

3.3 Eutaw Formation

The Eutaw Formation underlies the Selma Group with a base elevation in the vicinity of the Emelle Site at about EL -950 feet MSL. This formation is about 400 feet thick and generally consists of thin clay and sand beds with thicker and coarser sand and gravel beds at its base. The Eutaw Formation is divided into the Tombigbee Sand Member which comprises the upper 100 feet of the formation and the McShan Member which comprises of the lower 300 feet. For monitoring purposes the uppermost aquifer is considered to be the Tombigbee Sand Member which exists immediately beneath the base of the Selma Group; however, water supply wells in the area are typically completed in the McShan Member which provides higher flow rate wells. Therefore, based on the objective of monitoring the "uppermost aquifer", the groundwater monitoring wells which are completed in the Eutaw Formation at the Emelle Facility are screened within the top 50 feet of the formation. The material at this depth can be described as a fine, slightly silty sand which is several orders of magnitude more permeable than the overlying Selma chalk and is considered to be the uppermost aquifer.

3.4 Relative Groundwater Levels

The groundwater levels within the Selma chalk and the underlying Eutaw Formation are not coincident over the Emelle Facility. The water level in the Selma chalk essentially follows the topography of the land surface. In the upland portions of the site this phreatic surface is observed to be as high as EL 240 feet MSL. In the lower areas of the facility along the floodplain of Bodka Creek the phreatic surface in the chalk is at approximately EL 120 feet MSL. This sloping gradient in the phreatic surface within the Selma chalk indicates that horizontal movement of groundwater would be expected at a very slow rate due to the low permeability of the chalk. However, the movement of groundwater within the Selma chalk must also be viewed in context with the pressure or potentiometric head within the underlying Eutaw Aquifer. Assessment of the literature, water level measurements from Eutaw Aquifer wells in the vicinity and the RCRA Eutaw Aquifer monitoring well network on the Emelle site show that the potentiometric head within the Eutaw Aquifer ranges form approximately EL 137 feet MSL to EL 140 feet MSL.

As can be seen from comparison of the phreatic surface in the Selma chalk and the potentiometric surface in the underlying Eutaw Aquifer, the difference in pressures between the two units causes a downward gradient to exist on high portions of the Emelle Facility and an upward gradient to exist in the lower portions. This condition produces some flow from the chalk downward into the Eutaw Aquifer in the upland areas of the site and the reverse condition of the groundwater flow upward from the Eutaw Aquifer through the chalk in the low lying area along the Bodka Creek floodplain. However, it is important to note that while gradients do exist and groundwater movement results, the actual quantity and rate of movement are miniscule.

The head differences between the two water levels within the chalk and the Eutaw Aquifer are a maximum of about 80 feet in the upland portions of the site and a maximum of about 20 feet in the low lying portions. The thickness of the Selma chalk is approximately 700 feet in the high areas and approximately 600 feet in the low areas producing groundwater gradients of a maximum of 11%. The low hydraulic conductivity or permeability of the chalk significantly retards the actual quantity and velocity of groundwater movement. This concept is discussed in detail in Section 4.

3.5 Water Balance

Based on the preceding discussion of the hydrogeologic setting, a detailed water balance was performed at the Emelle Facility and the surrounding region to confirm via a hydrologic mass balance that the general characterization is accurate. This was done by careful comparison between surface runoff, evapotranspiration, and infiltration. The precipitation and stream flow data required for this type of analyses were available at nearby U.S. Geological Survey gauging station on Jones Creek at Highway 39 approximately 10 miles southeast of the Emelle site. This watershed is in surficial geology virtually identical to the Emelle Facility. Coincident rainfall and stream flow records were maintained at this site from 1959 to 1965. By comparison of these data, an average annual precipitation amount of 54.3 inches and an effective streamflow of 20.8 inches were computed. Subtraction of these two amounts yields a difference of 33.5 inches per year which is lost through evapotranspiration and infiltration to deep groundwater sources. Site specific evapotranspiration data is not available so a county wide average value of 33.4 inches per year was used as reported in the "Water Availability and Geology of Sumter County, Alabama" in 1980 by the Geological Survey of Alabama. Subtraction of the evapotranspiration losses from the difference between rainfall and streamflow yields an estimated 0.1 inches per year deep infiltration.

In order to provide a subsequent check on the deep loss infiltration value, a detailed literature review was performed. The literature review revealed a groundwater modeling study which was performed by the U.S. Geological Survey and the Geological Survey of Alabama with results published in "Model of the Ground-Water Flow System of the Gordo and Eutaw Aquifers in West-Central Alabama". This modeling effort indicated that a deep loss infiltration or Eutaw Aquifer recharge amount of 0.02 inches per year occurs. This amount varies from the 0.1 inches per year arrived at by the water balance calculations discussed above, but confirms the extremely low magnitude of deep loss infiltration into the Eutaw Aquifer from the overlying Selma chalk.

3.6 Unsaturated Zone Characteristics

The unsaturated depth of the Selma chalk is shallow due to the very low permeability of the Selma chalk which retards the downward movement of rainfall infiltration and therefore exhibits a relatively high phreatic surface or water table. The phreatic surface in the chalk is typically 10 feet to 30 feet below the ground surface. However, the walls and floors of landfill cells excavated to depths of 100 feet or more remain dry due to the fact that the rate of evaporation from the chalk surfaces greatly exceeds the rate of inflow.

Waste at the Emelle Facility is typically disposed of in cells excavated below the phreatic surface in the chalk. However, it is important to note that while there is no unsaturated zone between the landfill cells and the phreatic surface in the chalk, the chalk itself is the protective barrier between the landfill and the Eutaw Aquifer. The characteristics of the unsaturated chalk do not differ from the saturated chalk.

3.7 Saturated Zone Characteristics

At the Emelle Facility, the Selma chalk serves as a geologic barrier to prevent the migration of hazardous waste or hazardous waste constituents to the uppermost aquifer for thousands of years. This assessment is based on several laboratory studies and field measurements which define the characteristics of the Selma chalk, as listed below:

Laboratory Tests (Performed on chalk cores)

1. Hydraulic conductivity (permeability)
2. Specific gravity
3. Total and effective transport porosity
4. Minerologic content
5. Cation Exchange Capacity

Field Measurement (Performed in situ)

1. Borehole permeability tests
2. Constant head drawdown test (trench wall monitoring)

The laboratory tests were performed on chalk cores obtained during the drilling of three continuous coreholes at the site. Each of these holes went a total depth of 500 feet. The procedures for each lab test is outlined below and the results are given in Table 1.

TABLE 1

LABORATORY AND FIELD TEST RESULTS

Permeability:	
Laboratory	6.9×10^{-9} cm/sec
Borehole Tests	2.0×10^{-8} to 5.7×10^{-8} cm/sec
Trench Monitoring Test	1×10^{-7} cm/sec
Specific Gravity	2.76
Total Porosity	38.4%
Effective Transport Porosity	33.4%
Minerologic Content	44% Clay 50% Calcium Carbonate 6% Quartz Sand
Cation Exchange Capacity	10.4 meq/100g

Permeability Test - The permeability test was performed on an intact chalk core 3.2 inches long by 1.8 inches in diameter in a triaxial load cell under backpressure saturation. The core reached saturation at a backpressure of 55 psi. The test was run with a pressure differential of 20 psi imposed across the length of the core which resulted in a gradient of 174 feet/feet. An additional lateral confining pressure of 5 psi was applied. The test was run with $CaCO_3$ saturated water as a permeant. The above procedure is a modification of ASTM D2434-68.

Specific Gravity Test - The specific gravity of the chalk was measured by ASTM D854-58 procedures. This procedure calls for grinding the chalk and immersing the powder in water.

Total Porosity Test - Total porosity is computed based upon measurements of moisture content at saturation and specific gravity. Moisture content is measured by ASTM D2216-80 (oven drying) procedures using a saturated core sample. By knowing the volume of water in a known volume of chalk and the specific gravity of the solid chalk, the void space or total porosity is computed.

Effective Transport Porosity Test - The effective transport porosity is measured by performing a tracer breakthrough test. This test was performed as a continuation of the constant head permeability test described above. Once steady-state inflow/outflow conditions were achieved using $CaCO_3$ saturated water permeant, a CaCl solution was introduced as the permeant. All confining pressures and gradients remained unchanged. The chloride content of the effluent was monitored and plotted as a percent of the initial concentration of 575 mg/l. The average breakthrough point was reached in 25.7 days which indicates an average porewater velocity of 0.010 feet/day. This value and the measured permeability are used to compute the effective transport porosity.

Minerologic Content - Minerologic content was measured by X-ray diffraction methods.

Cation Exchange Capacity - The CEC of the chalk was determined by analysis of the day minerology and assessment of the exchange capacity of the various clay types present.

The field measurements were based on two methods for estimating in situ permeability. The first series of estimates were based on borehole permeability tests in which the water in a chalk well was removed and the rate of rise in water level recorded. The geometry of the well and the rate of rise are used to compute permeability.

The second field estimate of in situ permeability was based on two transects of wells perpendicular to the wall of Trench 20 in which the water levels were read at regular intervals during the excavation and filling of the trench. A total of 10 wells were installed. The drop in the phreatic surface with time was analyzed using a finite difference groundwater computer model to determine the permeability of the chalk.

As can be seen in the results of the laboratory and field permeability tests listed in Table 1 the permeability results from the field tests showed higher values than those obtained in the laboratory. This trend is common for undisturbed material. The field permeability results were used for the upper chalk in migration studies as discussed in the next section.

4.0 POTENTIAL FOR CONTAMINANT MIGRATION

4.1 Regulatory Requirements

As outlined in 40 CFR 264.90(b)(4) a Groundwater Monitoring Waiver can be granted if "the Regional Administrator finds that there is no potential for migration of liquid from a regulated unit to the uppermost aquifer through the active life of the regulated unit (including the closure period) and the post-closure care period . . .". The Emelle Facility has ample disposal capacity to allow operations to continue in excess of 50 years and it is anticipated that following complete development of the site the closure period will take about 1 year. As defined in 40 CFR 264.117 the post-closure care period is 30 years following the complete closure of the facility. Therefore, the period of time for which no potential for migration of liquid from a regulated unit must be demonstrated at the Emelle Facility is about 81 years. Due to the extremely low permeability of the Selma chalk and the thick, massive nature of this formation, it is calculated that migration through the Selma chalk into the Eutaw Aquifer will take thousands of years. The following subsections outline the calculations performed to compute the estimated migration time through the uppermost aquifer, nearby water supply wells, and surface waters.

4.2 Migration to Uppermost Aquifer

As presented in Section 3.0, the Eutaw Formation is the uppermost aquifer at the Emelle Facility. The top of this formation is at EL -450 feet MSL; the deepest land disposal trench floor is at about EL 100 feet MSL. Therefore, the proximity of the uppermost aquifer to land disposed hazardous wastes is 550 feet. This thick zone of low permeability chalk and marl material provide an excellent barrier between disposed hazardous waste and the uppermost aquifer. Therefore, an analysis was undertaken to characterize the potential for migration and the expected transit times to the uppermost aquifer.

The Selma chalk consists primarily of calcium carbonate with approximately 44% clay content and analyses indicate a very low total organic carbon (TOC) content (less than 100 ppm). Therefore, retardation of charged inorganic compounds could be expected due to the cation exchange capacity of the chalk but retardation of non-polar organic compounds is expected to be minimal based on the low TOC content. Therefore, this analysis was performed with no retardation considered in order to properly reflect the relatively mobile nature of uncharged inorganic compounds and most organic compounds. The vertical gradients used in this analysis were based upon a groundwater modeling study. The contaminant migration analysis was performed using a one-dimensional closed form equation which describes the distribution of concentration at various points within the chalk at different times.

The groundwater model utilized to determine the vertical gradients at the Emelle Facility is a steady-state, two-dimensional, vertical section finite element groundwater flow model. This model was calibrated for conditions at the Emelle site so that observed groundwater levels in the Selma chalk were accurately reflected in the model output. Initial estimates of permeability and infiltration rates were modified slightly to achieve calibration. The final permeability values used in this calibrated model were 1.2×10^{-7} cm/sec. for the upper portion of the Selma chalk (above EL 100 feet MSL) and 5.8×10^{-8} cm/sec. for the lower Selma chalk. The decrease in permeability with depth in the

Selma Formation reflects the slightly higher clay content observed in the deep cores and the absence of any weathering at this depth. The net infiltration rates used in the calibrated groundwater model varied from 0.14 inches per year to 0.04 inches per year with the higher values reflected in the upland portions of the site.

The results of the steady-state groundwater flow model pertinent to this migration analysis is the flow velocity of groundwater moving downward through the chalk. The maximum downward flow velocity computed by the model is a Darcy velocity of 0.010 $ft.^2/yr$. The average transport velocity which must be used in migration analyses is the Darcy velocity divided by the effective transport porosity of 33.4%. Therefore, the average transport velocity at the point of the greatest downward gradient is 0.031 feet per year.

The method used to compute the rate of movement of dissolved constituents through the chalk is analytical solution of the one-dimensional advection-dispersion equation developed by Ogata. The inputs to this equation include the initial concentration of the seepage fluid, the average transport velocity and the hydrodynamic dispersion in the longitudinal direction of movement. The equation will predict the reduction in concentration at various points in time along the flow path at various distances from the source. The results of this analysis and listing of the short computer program used to solve the equation are included in the Appendix.

The results of the migration analysis were based upon a coefficient of dispersivity of 3 feet and an apparent molecular diffusion of 0.10 feet squared per year. This analysis indicates that the time required for a threshold concentration of 10 ppb of unretarded contaminants to reach the base of the Selma chalk and in the Eutaw Aquifer would be 10,200 years. As previously stated, the analysis did not consider the attenuation or retardation of polar organics and charged inorganics. The migration time for these compounds is estimated to range from 30,000 years to 1,000,000 years to reach the uppermost aquifer.

4.3 Migration to Water Supply Wells

The nearest water supply well and the only well within a 1/2 mile radius of the facility is a stock watering well located approximately 500 feet from the north property line along Highway 116. The minimum buffer distance between land disposal cells and the property line is 200 feet for a total distance between future land disposal cells and the nearest water supply well of 700 feet.

Based on drawdown records and pumping rates from municipal wells, the permeability of the Eutaw Formation is approximately 4×10^{-3} cm/sec. Multiplying this value by the horizontal gradient in the Eutaw Aquifer of about 4×10^{-4} feet/feet and dividing by an effective transport porosity of 10%, a rate of migration within the Eutaw Aquifer of about 0.05 feet/day is computed. Therefore, it is estimated that if hazardous waste constituents reached the Eutaw Aquifer, the transit time to the nearest water supply well would be about 43 years for a total computed transit time of 10,243 years. In addition, seepage through the chalk would be diluted to about 5% of its initial concentration by the much higher flow rate within the aquifer itself. This would reduce the threshold concentration discussed above of 10 ppb to a concentration of approximately 0.5 ppb at the water supply well.

4.4 Migration to Surface Water

As discussed in Section 3.0, General Hydrogeology, the difference in head levels between the Eutaw Aquifer and the Selma chalk produces both upward and downward gradients. On the west side of the Emelle Facility along Bodka Creek, the surface elevation is approximately 120 feet MSL. In this area, the potentiometric surface in the Eutaw Aquifer is at about EL 140 feet MSL. Therefore, an upward gradient is induced by this 20 feet head difference. However, the thickness of the Selma chalk at this point is approximately 570 feet and the 20 feet head difference provides an upward gradient in this area of 0.03 feet/feet. This very low gradient and the extremely low permeability of the Selma chalk virtually excludes the discharge of hazardous constituents into Bodka Creek from the Eutaw Aquifer.

The nearest surface water body which receives direct discharge from the Eutaw Aquifer is the Tombigbee River located about 10 miles east of the Emelle site. Based on the flow velocities estimated in the preceding section, the migration time to the Tombigbee River from the Emelle Facility within the Eutaw Aquifer would be about 2,900 years for a total computed transit of 13,100 years. In addition, the massive dilution which would take place over this 10 mile distance would reduce the concentration of hazardous constituents to an undetectable amount.

5.0 CONCLUSION AND SUMMARY

In conclusion, it is estimated that there is virtually no potential for migration of hazardous wastes or hazardous waste constituents to the uppermost aquifer within the 81 year active life, closure and post-closure period and the estimated transit time through the Selma chalk is on the order of 10,000 years. Therefore, the Emelle Facility meets the criteria for a waiver of the groundwater monitoring requirements of 40 CFR 264 Subpart F.

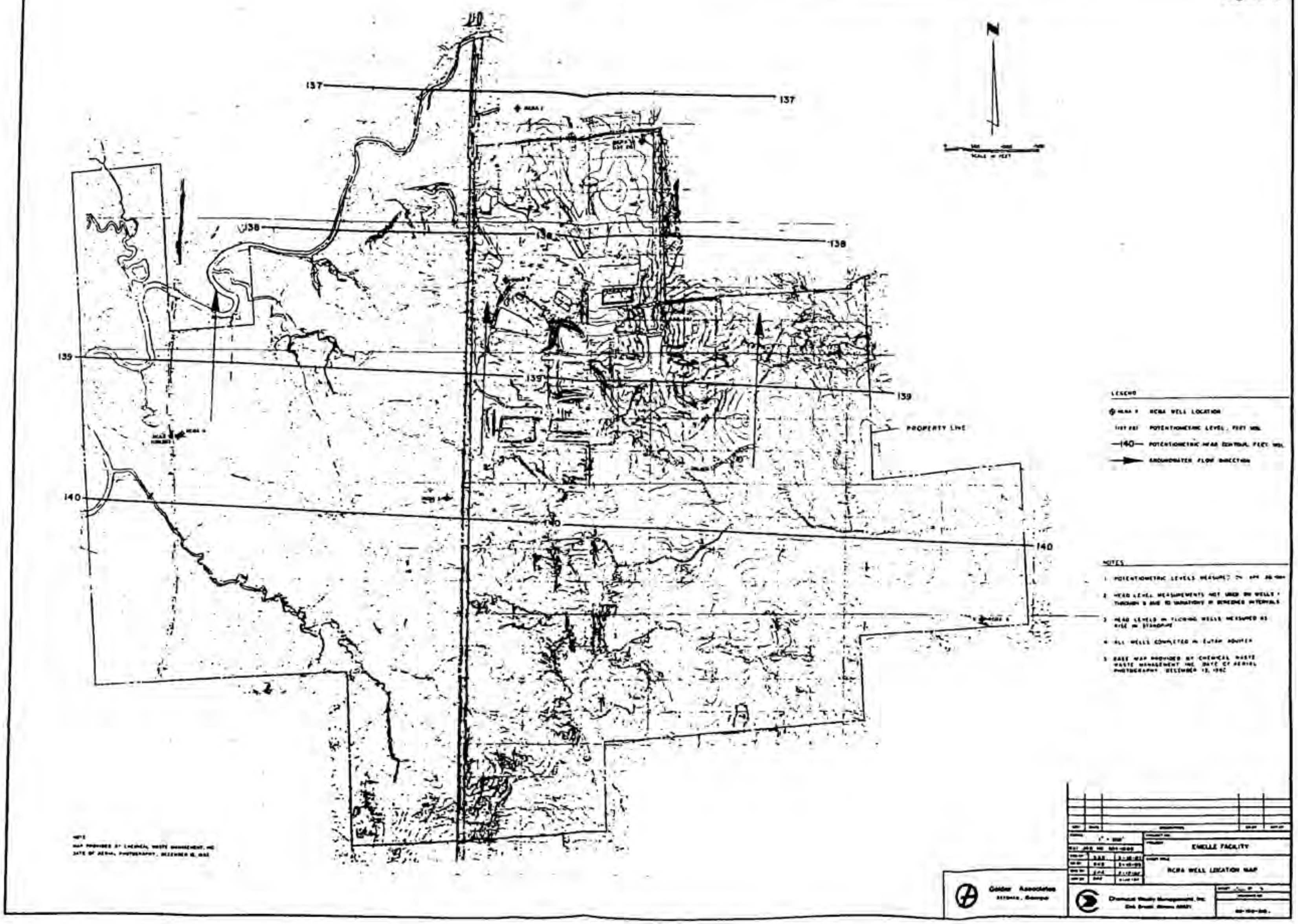
In the event that hazardous waste constituents were to reach the Eutaw Aquifer, it is estimated that it would take approximately 50 years for these compounds to reach the nearest existing water supply well and that the rate of dilution of this seepage would be approximately 95%. The discharge of water in the Eutaw Aquifer to Bodka Creek on the west side of the facility is eliminated by the very low upward hydraulic gradient between the Eutaw Aquifer and the water level in the Selma chalk and the low permeability of the chalk. In addition, the long transit time (about 2,900 years) to the Tombigbee River which is the nearest direct discharge from the Eutaw Aquifer and the massive dilution which would occur in transit, precludes any detectable concentration of hazardous waste constituents from being discharged into the Tombigbee River of the Eutaw Aquifer.

GOLDER ASSOCIATES

J. Edmund Baker, P.E.
Associate

JEB:kjb

Figure 1



N
137
138
139
140
PROPERTY LINE
LEGEND
RCRA WELL LOCATION
POTENTIOMETRIC LEVEL, FEET MSL
POTENTIOMETRIC HEAD CONTOUR, FEET MSL
GROUNDWATER FLOW DIRECTION
NOTES
EMELLE FACILITY
RCRA WELL LOCATION MAP
Golder Associates
Chemical Waste Management, Inc.

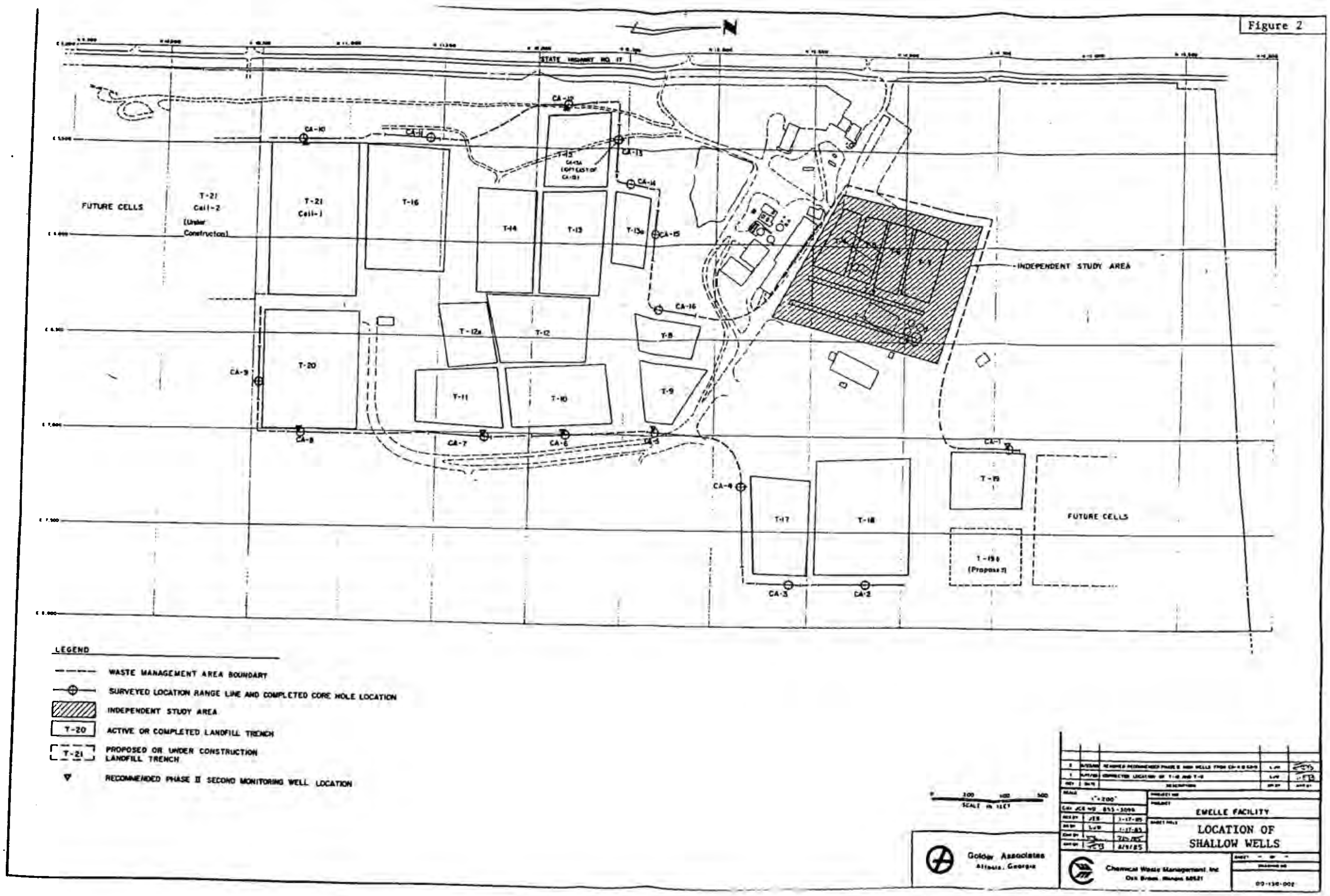


Figure 2
N
STATE HIGHWAY NO. 17
FUTURE CELLS
T-21
Cell-2
(Under Construction)
T-21
Cell-1
T-16
T-15
T-14
T-13
T-13a
T-12a
T-12
T-11
T-10
T-9
T-8
T-20
T-17
T-18
T-19
T-19a
(Proposed)
CA-1
CA-2
CA-3
CA-4
CA-5
CA-6
CA-7
CA-8
CA-9
CA-10
CA-11
CA-12
CA-13
CA-14
CA-15
CA-16
INDEPENDENT STUDY AREA
FUTURE CELLS
LEGEND
WASTE MANAGEMENT AREA BOUNDARY
SURVEYED LOCATION RANGE LINE AND COMPLETED CORE HOLE LOCATION
INDEPENDENT STUDY AREA
T-20
ACTIVE OR COMPLETED LANDFILL TRENCH
T-21
PROPOSED OR UNDER CONSTRUCTION LANDFILL TRENCH
RECOMMENDED PHASE II SECOND MONITORING WELL LOCATION
SCALE IN FEET
Golder Associates
Atlanta, Georgia
EMELLE FACILITY
LOCATION OF
SHALLOW WELLS
Chemical Waste Management, Inc.

APPENDIX

CONTAMINANT MIGRATION

ANALYSIS

```
*** ONE DIMENSION SOLUTE TRANSPORT MODEL ***
***   BASED ON OGATA'S EQUATION         ***


ANALYSIS TITLE : EMELLE SOLUTE TRANSPORT
ANALYSIS DATE : 2/17/85


DARCY VELOCITY - FT/YR = .0105
TRANSPORT VELOCITY - FT/YR = .0314371257
EFFECTIVE POROSITY - % = 33.4
DISPERSIVITY - FT = 3
DIFFUSSION - FT2/YR = .1
DISPERSION - FT2/YR = .194311377
INITIAL CONCENTRATION     - PPB = 50000


BETA>4.64
EXPONENT TERM = 1E37
CONCENTRATION AT 550 FEET AND 10000 YEARS = 3.92577731 PPB
BETA>4.64
EXPONENT TERM = 1E37
CONCENTRATION AT 550 FEET AND 11000 YEARS = 44.7518268 PPB
BETA>4.64
EXPONENT TERM = 1E37
CONCENTRATION AT 550 FEET AND 10200 YEARS = 6.74770563 PPB
BETA>4.64
EXPONENT TERM = 1E37
CONCENTRATION AT 550 FEET AND 10300 YEARS = 8.74959191 PPB
BETA>4.64
EXPONENT TERM = 1E37
CONCENTRATION AT 550 FEET AND 10350 YEARS = 9.9363567 PPB
BETA>4.64
EXPONENT TERM = 1E37
CONCENTRATION AT 550 FEET AND 17500 YEARS = 25036.2095 PPB


]LIST

10  REM  COMPUTE SOLUTE TRANSPORT (C/CO) IN ONE DIMENSION
20  REM      USING OGATA'S EQUATION - CHERRY P 391
30  REM
35  REM          ED BAKER 2/9/83  MODIFIED BY MIKE FEENEY 4-20-83
36  REM          MODIFIED ERFC FUNCTION, M. STEWART, 5/24/83
40  REM
90  ONERR  GOTO 3000
110 D$ = "": REM   CTRL-D  FOR PRINTER CONTROL
195  REM  INPUT PARAMETER VALUES
200  INPUT "INPUT RUN TITLE ";TI$
205  INPUT "INPUT RUN DATE ";DT$
210  INPUT "INPUT DARCY VELOCITY (FT/YR) ";VD
215  INPUT "INPUT EFFECTIVE POROSITY (%) ";EP
220  INPUT "INPUT DISPERSIVITY (FT) ";DS
225  INPUT "INPUT DIFFUSSION (FT2/YR) ";DF
230  INPUT "INPUT INITIAL CONCENTRATION & UNITS (SEP. BY COMMA) ";CO,UN$
350  REM  PRINT HEADER AND ECHO INPUT
400  INPUT "DO YOU WANT TO PRINT RESULTS       (Y/N) ?";YN$
410  IF ( LEFT$ (YN$,1) = "Y") THEN  INPUT "TURN ON PRINTER AND SET SELECT SWITCH TO APPLE AND HIT RETURN";X$: PRINT D$;"PR#
"
440  PRINT "*** ONE DIMENSION SOLUTE TRANSPORT MODEL ***"
450  PRINT "***   BASED ON OGATA'S EQUATION           ***"
```

```
460  PRINT "ANALYSIS DATE : ";DT$: PRINT : PRINT
465  PRINT "DARCY VELOCITY - FT/YR = ";VD
469 VL = VD / (EP / 100)
470  PRINT "TRANSPORT VELOCITY - FT/YR = ";VL
471  PRINT "EFFECTIVE POROSITY - % = ";EP
472  PRINT "DISPERSIVITY - FT = ";DS
474  PRINT "DIFFUSSION - FT2/YR = ";DF
476 DL = (VL * DS) + DF
480  PRINT "DISPERSION - FT2/YR = ";DL
490  PRINT "INITIAL CONCENTRATION     - ";UN$;" = ";CO
491  PRINT : PRINT
495  REM   *****  START COMPUTATION LOOP  ******
500  IF ( LEFT$ (YN$,1) = "Y") THEN  PRINT D$;"PR#0"
505  PRINT
510  INPUT "INPUT DISTANCE FROM SOURCE (FT) AND TIME (YRS) AT WHICH TO COMPUTE CONCENTRATION (SEPERATE BY COMMA)";L,T
515  IF L = 0 THEN  GOTO 999
520  IF ( LEFT$ (YN$,1) = "Y") THEN  PRINT D$;"PR#1"
600  REM  START SOLUTION LOOP
610 X1 = 2 *  SQR (DL * T)
615 B = (L - (VL * T)) / X1
620  GOSUB 2000: REM       INTERPOLATE ERFC, VALUE RETURNS IN E
630 C = E
640 B = (L + (VL * T)) / X1
650  GOSUB 2000: REM  LOOK UP ERFC
656 X2 =  EXP ((VL * L) / DL)
660 C = C + X2 * E
670 C = .5 * C * CO
680  PRINT "CONCENTRATION AT ";L;" FEET AND ";T;" YEARS = ";C;" ";UN$
690  GOTO 500
999  PRINT "END OF PROGRAM": END
2000  REM
2001  REM  INTERPOLATE ERFC FROM BETA
2002  REM     ENTER WITH B,EXIT WITH E
2010 NG = 0
2020  IF B < 0 THEN B = B * ( - 1.):NG = 1
2025  IF B > 4.64 THEN  PRINT "BETA>4.64":E = 0: GOTO 2150
2030  REM  POLYNOMIAL APPROXIMATION OF THE COMPLEMENTARY ERROR FUNCTION.
2035  REM   USES VARIABLES Q1 & Q2
2040 Q1 = 1 / (1 + .3275911 * B)
2045 Q2 =  EXP ( - (B * B))
2050 E = (Q1 * .254829592 + Q1 ^ 2 *  - .284496736 + Q1 ^ 3 * 1.421413741 + Q1 ^ 4 *  - 1.453152027 + Q1 ^ 5 * 1.061405429
     Q2
2150  IF NG = 1 THEN E = 2.0 - E
2901  REM  PRINT "BETA & ERFC =";B,E
2990  RETURN
3000  REM
3001  REM  ROUTINE TO HANDLE OVERFLOW ERROR IN THE EXPONENTIAL TERM
3002  REM
3010 Y =  PEEK (222)
3020  IF Y = 69 THEN  GOTO 3050
3025 Z =  PEEK (218) +  PEEK (219) * 256
3030  PRINT "ERROR NUMBER ";Y;" EXECUTION STOPPED AT LINE NUMBER ";Z
3040  END
3050 X2 = 1E37
3060  PRINT "EXPONENT TERM = 1E37"
3070  GOTO 660
3071  REM  END ERROR HANDLING ROUTINE

]
```

APPENDIX E-8

DOCUMENT 3

Shallow Well Recharge Information
Well Number SM-01

Well Depth 56.29

Date	Well Elev.	DTW'	Gallons	
11-11-97	179.34	12.33	7.1	purged
11-12-97	179.34	47.70	1.4	
11-13-97	179.34	47.70	1.4	
11-17-97	179.34	42.70	2.2	
11-19-97	179.34	40.61	2.6	
11-21-97	"	38.84	2.8	
11-24-97	"	36.60	3.2	
11-26-97	"	35.0	3.5	
12-03-97	"	34.48	3.6	
12-24-97	"	21.56	5.6	
12-29-97	"	10.25	7.5	purged
4-7-98		9.3	7.7	purged
4-10-98		45.32	1.8	
4-14-98		40.22	2.6	
4-16-98		39.33	2.8	
4-20-98		35.80	3.3	
5-1-98		28.72	4.5	
5-13-98		22.73	5.5	
7-9-98		11.2	7.4	purged
9-24-98		13.63	7.0	purged
Volatile sample in 1 day				
Complete samples in				

1 day VOA
14 days

Shallow Well Recharge Information
Well Number SM-01A

Well Depth 74.71

Date	Well Elev.	DTW	Gallons
11-11-97	179.77	10.35	10.4 p
11-12-97	"	Dry	—
11-14-97	"	Dry	—
11-17-97	"	48.83	4.2
11-19-97	"	43.62	5.1
11-21-97	"	39.10	5.8
11-24-97	"	33.62	6.7
11-26-97	"	30.56	7.2
12-03-97	"	22.77	8.5
12-24-97	"	11.81	10.3 p
~~12~~ 1-8-98	"	11.77	10.3
4-7-98		8.5	16.8 p
4-10-98		43.88	5.0
4-14-98		39.57	5.7
4-16-98		39.60	5.8
4-20-98		31.91	~~6~~ 7.0
5-1-98		20.03	9.0
5-13-98		14.65	10.0
7-17-98		10.0	10.5
10-2-98		11.0	10.2

VOA = 3 days
Comp. = 10 days

Shallow Well Recharge Information

Well Number SM-02

Well Depth 153.46

Date	Well Elev.	DTW	Gallons
11-11-97	**202.09**	30.82	19.9 P
11-12-97	"	Dry	—
11-14-97	"	Dry	—
11-17-97	"	66.64	14.18
11-19-97	"	56.67	15.8
11-21-97	"	49.83	16.9
11-24-97	"	43.0	18
11-26-97	"	39.97	18.5
12-03-97	"	39.00	19.6
12-24-97	"	34.00	~~22.07~~ 19.5 RS P
1-8-98	"	30.65	20.0 P
4-7-98		30.25	20.0
4-8-98		Dry	—
4-14-98		66.60	14.2
4-20-98		45.97	17.5 P
5-1-98		33.78	20
5-13-98		30.25	20
7-17-98		30.20	20.0
10-7-98		30.0	20.0
			VOA 1
			Cmp. 1

Shallow Well Recharge Information
Well Number SM-03

Well Depth 88.81

Date	Well Elev.	DTW	Gallons
11-11-97	207.50	26.30	10.1
11-12-97	|	Dry	—
11-14-97	"	Dry	—
11-17-97	"	80.0	1.4
11-19-97	"	77.58	1.8
11-21-97	"	73.43	2.5
11-24-97	"	67.97	3.4
11-26-97	"	64.62	3.9
12-03-97	"	54.00	5.7
12-24-97	"	33.0	9.09
1-8-98	"	17.5	11.6
4-7-98		8.8	13.0
4-10-98		83.55	0.8
4-14-98		80.77	1.3
4-16-98		72.31	2.7
4-20-98		69.01	3.2
5-1-98		52.83	5.7
5-13-98		41.82	7.7
7-17-98		25.68	10.3
10-7-98		27.83	10.0
			VOA. 7
			Cnp. Sdaup

Shallow Well Recharge Information

Well Number SM-04

Well Depth 119.50

Date	Well Elev.	DTW	Gallons
	238.96		
11-26-97	"	26.30	~~10.1~~ 15.2
12-29-97	"	24.55	~~15.5~~ 15.7
12-30-97	"	26.90	15.1
4-7-98	"	15.37	17.0
4-10-98	"	54.25	10.6
4-14-98		52.98	10.8
4-20-98		50.37	11.3
5-1-98		30.90	14.4
5-13-98		24.80	15.4
7-20-98		30.33	14.5
9-29-98		25.78	15.3

1 day all

Shallow Well Recharge Information

Well Number SM-05

Well Depth 61.84

Date	Well Elev.	DTW	Gallons
	255.19		
11-25-97	"	19.85	6.8
11-26-97	"	58.6	0.53
12-03-97	"	24.20	6.1
12-18-97	"	18.92	7.0
12-24-97	"	55.55	1.0
4-7-98		13.63	7.0
4-10-98		~~20.0~~ 49.42	2.0
4-14-98		42.22	3.2
4-16-98		37.55	4.0
5-1-98		26.0	6.8
7-28-98		16.74	7.4
10-8-98		18.95	7.0

2 day well

Shallow Well Recharge Information

Well Number SM-05A

Well Depth 107.21

Date	Well Elev.	DTW	Gallons
	255.90		
11-25-97	"	21.93	14
11-26-97	"	Dry	—
12-03-97	"	57.93	8.03
12-18-97	"	27.22	13
12-24-97	"	Dry	—
4-7-98		17.47	14.6
4-10-98		56.15	8.3
4-14-98		52.66	8.0
7-28-98		17.56	14.6
10-8-98		18.90	14.2

1 day all

Shallow Well Recharge Information
Well Number SM-06

Well Depth 100.10

Date	Well Elev.	DTW	Gallons
Oct. 97	275.92		
11-12-97	"	24.55	12.3
11-13-97	"	Dry	—
11-14-97	"	Dry	—
11-17-97	"	Dry	—
11-19-97	"	DRY	—
11-21-97	"	67.53	5.3
11-24-97	"	64.50	5.8
11-26-97	"	62.35	6.2
12-03-97	"	42.86	9.3
12-24-97		31.93	11.1
1-8-98	"	29.65	11.5
4-8-98		23.88	12.4
~~4-10-98~~		~~40.00~~ Dry	—
4-14-98		Dry	—
4-16-98		Dry	—
~~5-1-98~~		~~40.00~~	~~9.8~~ RS
~~5-13-98~~		~~22.73~~	~~12.6~~ RS
5-1-98		40.00	9.8
5-13-98		22.73	12.6
7-21-98		24.88	
10-6-98		25.84	12.1

at least 10 days for any

Shallow Well Recharge Information

Well Number SM-06A

Well Depth 141.43

Date	Well Elev.	DTW	Gallons
Oct. 97	276.25		
11-12-97	"	28.58	18.4
11-13-97	"	Dry	—
11-14-97	"	Dry	—
11-17-97	"	49.00	15.0
11-19-97	"	46.80	15.4
11-21-97	"	45.00	15.7
11-24-97	"	43.66	16
11-26-97	"	42.00	16.2
12-03-97	"	37.00	17.0
12-24-97	"	36.55	18.0
1-8-98	"	29.43	18.3
4-8-98		28.10	18.5
4-10-98		Dry ~~35.55~~	—
4-14-98		Dry	—
4-16-98		Dry	—
~~5-1-98~~		~~35.55~~	
~~4-20-98~~		~~31.91~~	
~~5-1-98~~		~~20.03~~	
5-1-98		35.55	17.3
7-21-98		28.85	
10-6-98		30.18	18.1

3day all

Shallow Well Recharge Information
Well Number SM-07

Well Depth 108.16

Date	Well Elev.	DTW	Gallons
Oct. 97	**278.14**		
11-12-97	"	47.25	9.9
11-13-97	"	Dry	—
11-14-97	"	Dry	—
11-17-97	"	Dry	—
11-19-97	"	Dry	—
11-21-97	"	62.87	7.4
11-24-97	"	60.0	7.9
11-26-97	"	59.35	8.0
12-03-97	"	51.85	9.3
12-24-97	"	51.55	~~11.7~~ 9.2
1-8-98		51.40	9.3
4-9-98		47.0	10
4-10-98		98.95	1.5
4-14-98		95.56	2.1
4-16-98		92.45	2.6
5-1-98		50.55	9.4
7-22-98		51.23	9.3
10-2-98		47.71	9.9

at least 10 for any

Shallow Well Recharge Information
Well Number SM-07A

well Depth 123.30

Date	Well Elev.	DTW	Gallons
Oct. 97	277.16		
11-12-97	"	51.30	11.7
11-13-97	"	Dry	—
11-14-97	"	Dry	—
11-17-97	"	Dry	—
11-19-97	"	Dry	—
11-21-97	"	61.00	10.2
11-24-97	"	59.0	10.5
11-26-97	"	57.62	10.7
12-03-97	"	54.33	11.2
12-24-97	"	50.00	9.5
1-8-98	"	47.33	12.4
4-9-98		51.04	11.8
4-10-98		Dry	-
4-14-98		Dry	-
4-16-98		Dry	-
5-1-98		53.63	11.4
7-22-98		47.50	12.4
10-2-98		51.55	11.7

at least 10 days for avg

Shallow Well Recharge Information

Well Number SM-08

Well Depth 132.90

Date	Well Elev.	DTW	Gallons
Oct. 97	265.55		
11-17-97	"	72.35	9.9
11-18-97	"	Dry	—
11-19-97	"	Dry	—
11-21-97	"	Dry	—
11-24-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	98.77	5.6
12-24-97	"	80.25	8.5
1-8-98	"	75.70	9.3
4-8-98		72.13	9.9
4-10-98		Dry	—
4-14-98		Dry	—
4-16-98		Dry	—
5-11-98		80.18	8.6
7-22-98		71.46	10
10-6-98		72.13	10

at least 13 days for any

Shallow Well Recharge Information
Well Number SM-08A

Well Depth 186.31

Date	Well Elev.	DTW	Gallons
Oct. 97	265.99		
11-17-97	"	61.62	20.3
11-18-97	"	Dry	—
11-19-97	"	Dry	—
11-21-97	"	Dry	—
11-24-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	75.53	18.1
12-24-97	"	64.25	20.3
1-8-98	"	62.20	20.3
4-8-98		61.50	20.3
4-10-98		Dry	—
4-14-98		Dry	—
4-16-98		Dry	—
5-11-98		64.24	19.9
7-22-98		61.53	20.3
10-6-98		81.55	17.1

At least 13 days for avg

Shallow Well Recharge Information
Well Number SM-09

Well depth 155.40'

Date	Well Elev.	DTW	Gallons
Oct. 97	252.13		
11-17-97	"	55.60	16.3
11-18-97	"	Dry	—
11-19-97	"	Dry	—
11-21-97	"	94.70	9.9
11-24-97	"	95.0	9.8
11-26-97	"	94.66	10
12-03-97	"	82.68	11.9
12-24-97	"	~~49~~ 79.28	12.4
1-8-98	"	62.13	15.2
4-10-98		52.13	16.8
4.14.98		91.68	10.4
4-16-98		95.61	9.7
5-11-98		88.30	10.9
7.21-98		53.58	16.6
10-7-98		59.0	16.0

2 days all

Shallow Well Recharge Information

Well Number SM-09A

Well Depth 170.70

Date	Well Elev.	DTW	Gallons
Oct. 97	252.73		
11-17-97	|	49.30	19.8
11-18-97	"	Dry	—
11-19-97	"	DRY	—
11-21-97	"	Dry	—
11-24-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	74.50	15.7
12-24-97	"	68.66	18.9
1-8-98	"	52.88	19.2
4-10-98		47.93	20.0
4-14-98		Dry	—
4-16-98		Dry	—
5-11-98		65.0	17.2
7-21-98		48.60	19.9
10-7-98		50.65	20

At least 13 days for any

Shallow Well Recharge Information

Well Number SM-10

Check Incline Study # Well Depth 88.96'

Date	Well Elev.	DTW	Gallons
Oct. 97	**228.03**		
11-18-97	228.03	M.O 55.0 / C.O 50.3	6.3
11-19-97	"	Dry	—
11-21-97	"	M.O 86.80 / C.O 81.3	~~7.7~~ 1.2
11-24-97	"	M.C. 87.00 / 82.3	~~6.6~~
11-26-97	"	86.50 / 81.3	1.2
12-03-97	"	68.6 / 63.3	4.2
12-24-97	"	60.2 / 55.3	5.4
1-7-98	"	57.4 / 52.0	6.0
4-10-98		55.72	
4-14-98		86.72	
4-16-98		83.01	
5-11-98		65.66	
7-16-98		55.3	5.5
9-30-98		53.62	5.8

at least 7 days for VOA 13 days for rest

Shallow Well Recharge Information

Well Number SM-10A

Check Incline Study!! Well Depth 146.96'

Date	Well Elev.	DTW	Gallons
Oct. 97	**228.60**		
11-18-97	228.60	MO 49.78 / C.D. 45.3	16.6
11-19-97	"	Dry	—
11-21-97	"	Dry	—
11-24-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	80.93 / 75.3	11.7
12-24-97	"	50.25 / 45.3	16.6
1-7-98	"	44.2 / 39.5	17.5
4-10-98		50.68	
4-14-98		84.0	
4-16-98		82.3	
5-11-98		61.3	
7-16-98		52.3	15.4
9-30-98		46.25	16.4

at least 13 days for all

Shallow Well Recharge Information
Well Number SM-11

Well Depth 103.45

Date	Well Elev.	DTW	Gallons
Oct. 97	200.90		
11-24-97	"	8.36	15.5
11-25-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	78.20	4.1
12-24-97	"	63.55	~~13.0~~ 6.8
1-7-98	"	40.0	10.3
4-10-98		27.70	12.35
4-14-98		Dry	—
4-16-98		91.45	1.9
5-11-98		52.55	8.3
7.21.98		29.46	12
10-2-98		30.68	11.9

at least 8 days for all

Shallow Well Recharge Information
Well Number SM-12

Well Depth 66.14

Date	Well Elev.	DTW	Gallons
Oct. 97	195.75		
11-18-97	1	27.28	6.3
11-19-97	"	Dry	—
11-21-97		61.14	0.8
11-24-97	"	61.14	0.8
11-26-97	"	52.15	2.2
12-03-97	"	43.32	3.7
12-24-97	"	33.06	5.4
12-31-97	"	28.58	6.1
4-14-98	"	24.10	6.9
4-16-98		63.48	0.4
4-20-98		54.03	2.0
5-1-98		40.0	4.3
7-16-98		27.09	6.4
9-30-98		28.11	6.2

VOA in 5
others in 8

Shallow Well Recharge Information
Well Number SM-12A

Well Depth 133.08

Date	Well Elev.	DTW	Gallons
Oct. 97	**195.64**		
11-18-97	)	21.92	18.1
11-19-97	"	Dry	—
11-21-97	"	Dry	—
11-24-97	"	79.6	8.7
11-26-97	"	67.47	10.7
12-03-97	"	41.90	14.9
12-24-97	"	25.55	18.0
12-31-97	"	23.13	18.2
4-14-98		21.63	18.2
4-16-98		Dry	-
4-20-98		Dry	-
5-1-98		37.7	15.5
7-16-98		22.0	18.1
9-30-98		21.73	18.2

Add in 6 day

Shallow Well Recharge Information
Well Number SM-13

Well Depth 145.39

Date	Well Elev.	DTW	Gallons
Oct. 97	212.73		
12.03-97	"	29.86	18.8
12-24-97	"	42.55	16.8
1-8-98	"	36.65	18
4.14-98		29.71	18.9
4-16-98		Dry	–
4-20-98		Dry	–
5-1-98		66.9	12.8
7-20-98		31.73	18.5
10.1-98		31.68	18.5

all in 5 days

Shallow Well Recharge Information
Well Number SM-14

well Depth 72.96'

Date	Well Elev.	DTW	Gallons
Oct. 97	223.33		
11-19-97	"	19.73	8.7
11-21-97	"	39.41	5.5
11-24-97	"	27.94	7.3
11-26-97	"	26.0	7.7
12-03-97	"	21.90	8.3
12-24-97	"	20.88	8.5
1-2-98	"	19.47	9
4-14-98		19.42	8.7
4-16-98		62.05	1.8
4-20-98		25.75	7.7
5-1-98		21.0	8.8
7-20-98		20.11	8.6
10-1-98		20.10	9.0

fill in 2 days

Shallow Well Recharge Information
Well Number SM-14A

Well Depth 83.60'

Date	Well Elev.	DTW	Gallons
Oct. 97	222.61		
11-19-97	"	18.60	10.6
11-21-97	"	75.40	1.3
11-24-97	"	55.30	4.6
11-26-97	"	54.0	4.8
12-03-97	"	27.33	9.2
12-24-97	"	20.66	16.3
1-2-98	"	18.18	11
4-14-98		17.95'	10.7
4-16-98		79.66	0.6
4-20-98		17.5	10.8
5-1-98		23.6	9.8
7-20-98		18.93	10.5
10-1-98		18.91	10.5

all in 3 days / VOA in 1

Shallow Well Recharge Information
Well Number SM-15

well depth 93.50

Date	Well Elev.	DTW	Gallons
Oct. 97	226.43		
12-03-97	"	19.55	12.1
12-24-97	"	22.85	11.5
1-8-98	"	20.58	11.9
4-8-98		19.58	12.0
4-14-98		19.58	12.0
4-16-98		88.88	0.7
4-20-98		72.62	3.4
5-1-98		36.1	9.4
7-20-98		22.72	11.5
10-1-98		20.56	11.9

all in 5 days

Shallow Well Recharge Information
Well Number SM-16

Well Depth 90.20'

Date	Well Elev.	DTW	Gallons
Oct. 97	**251.84**		
11-21-97	"	31.32	9.6
11-24-97	"	39.14	8.3
11-26-97	"	38.55	8.4
12-03-97	"	34.20	~~10.8~~ 9.1
12-24-97	"	32.15	~~14.1~~ 9.5
1-8-98	"	32.15	9.5
4.[illegible].98		31.50	9.6
4-16-98		85.67	0.7
4-20-98		80.22	1.6
5-1-98		32.55	9.3
5-11-98		31.83	9.5
7-22-98		31.63	9.5
10-2-98		31.98	9.5

all in 1 day

Shallow Well Recharge Information

Well Number SM-16A

Well Depth 101.50'

Date	Well Elev.	DTW	Gallons
Oct. 97	**251.04**		
11-21-97	"	32.30	11.3
11-24-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	37.53	~~13.7~~
12-14-97	"	32.20	~~14.8~~ 11.3
1-8-98	"	32.20	11.3
4-14-98		31.22	11.5
4-16-98		79.66	3.6
4-20-98		62.34	6.4
5-1-98		38.70	10.2
5-11-98		33.28	11.1
7-22-98		31.26	11.4
10-2-98		31.84	11.4

all in 7 days

Shallow Well Recharge Information
Well Number SM-17

Well Depth 34.00

Date	Well Elev.	DTW	Gallons
Oct. 97	179.53		
11-24-97	"	8.36	5.5
11-25-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	7.9	4.3
12-221-97	"	7.8	4.3
1-8-98		7.15	4.4
4-15-98		7.4	4.3
4-16-98		32.0	0.3
4-20-98		7.2	4.3
5-1-98		7.2	4.3
5-13-98		7.4	4.3
7-17-98		8.40	4.2
10-1-98		9.30	4.0

all in 10 days

Shallow Well Recharge Information

Well Number SM-18

Well Depth 41.50'

Date	Well Elev.	DTW	Gallons
Oct. 97	204.52		
11-25-97	"	21.93	3.4
11-26-97	"	24.80	2.7
12-03-97	"	28.85	2.1
12-24-97	"	25.66	2.6
4-15-98		28.88	2.0
4-16-98		38.25	0.5
4-20-98		29.0	2.03
5-1-98		28.65	2.09
5-11-98		21.55	3.3
7-9-98		29.00	2
8-12-98		29.43	2
10-8-98 *		~~41.50~~ 29.82	2

all in 5 day

Shallow Well Recharge Information

Well Number SM-19

Well Depth 78.50'

Date	Well Elev.	DTW	Gallons
Oct. 97	202.45		
12-04-97	"	19.0	9.7
12-24-97	"	57.5	3.4
12-29-97	"	49.58	4.7
~~1-8~~			
4-16-98	"	18.0	9.9
4-20-98		62.4	2.6
5-1-98		45.32	5.4
5-13-98		22.42	9.14
7-17-98		15.0	10.3
9-28-98		13.95	11

all in 5 day

Shallow Well Recharge Information
Well Number SM-20

Well Depth 68.50'

Date	Well Elev.	DTW	Gallons
Oct. 97	179.60		
11-26-97	"	16.25'	8.5
12-03-97	"	59.84'	1.4
12-25-97	"	~~39~~.33'	~~4.06~~ 4.8
12-29-97	"	35.35'	5.4
4-15-98	"	19.44'	8.0
4-16-98	"	63.45	0.8
4-20-98	"	60.33'	1.33
5-1-98	"	48.62	3.2
5-11-98		34.62	5.5
7-14-98		17.34	8.3
9-28-98		20.50	8

all in 5 days

Shallow Well Recharge Information

Well Number SM-21

Well Depth 93.50'

Date	Well Elev.	DTW	Gallons
Oct. 97	**200.64**		
11-26-97	"	17.87	12.3
12-03-97	"	74.56	3.1
12-24-97	"	35.68	~~11.0~~9.4
12-29-97	"	31.42	10.1
4-15-98		17.80	12.3
4-16-98		89.89	0.6
4-20-98		64.0	4.8
5-1-98		48.62	7.3
5-11-98		24.64	11.2
7-21-98		17.57	12.4
10-6-98		18.20	4.1

all in 5 days

Shallow Well Recharge Information

Well Number SM-22

Well Depth 93.50'

Date	Well Elev.	DTW	Gallons
Oct. 97	200.53		
11-26-97	"	24.30'	11.3
12-03-97	"	83.20'	1.7
12-24-97	"	65.18'	~~11.5~~ 4.6
1-8-98	"	39.50'	4.4
4.15.98		25.5'	11.1
4-16-98		90.10'	1.0
4-20-98		84.82'	1.4
5-1-98		65.92	4.5
5-13-98		40.32	9.0
7-14-98		25.60	11.1
9-28-98		27.68	11

at least 15 days

Shallow Well Recharge Information
Well Number SM-23

Well Depth 55.0'

Date	Well Elev.	DTW	Gallons
Oct. 97	175.79		
11-24-97	"	9.55	6
11-25-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	44.57	1.7
12-24-97	"	18.38	6.0
1-8-98	"	17.35	6.1
4-15-98		6.85	7.8
4-16-98		Dry	Dry
4-20-98		46.95	1.3
5-1-98		38.12	2.8
5-13-98		28.37	4.3
7-16-98		8.31	7.6

at least 4 days

Shallow Well Recharge Information
Well Number ___SM-23A

Well Depth 68.50

Date	Well Elev.	DTW	Gallons
Oct. 97	176.05		
11-24-97	"	11.46	9.1
11-25-97	"	Dry	—
11-26-97	"	Dry	—
12-03-97	"	44.03	4.0
12-24-97		16.22	8.5
12-30-97	"	14.15	8.8
4-15-98		6.3	10.1
4-16-98		Dry	—
4-20-98		53.91	2.4
5-1-98		29.0	6.4
5-13-98		16.0	8.55
7-16-98		6.62	10.1
9.28.98		7.65	10

at least 15 day

Shallow Well Recharge Information

Well Number SM-24

Well Depth 58.50

Date	Well Elev.	DTW	Gallons
Oct. 97	183.59		
11-13-97	"	17.80	6.6
11-14-97	"	Dry	—
11-17-97	"	56.00	0.41
11-19-97	"	53.75	0.77
11-21-97	"	52.98	0.9
11-24-97	"	51.90	1.1
11-26-97	"	51.25	1.2
12-03-97	"	47.04	1.9
12-09-97	"	40.02	3.01
12-17-97	"	30.66	4.5
12-22-97	"	24.87	5.4
~~12-24-97~~	~~"~~	~~23.55~~	~~5.7~~
12-24-97	"	DRY	
4-7-98		15.37	
7-8-98	"	15.4	7.03
9-24-98		14.35	7.2

at least 20 days

Shallow Well Recharge Information

Well Number ___SM-27

107.50

Date	Well Elev.	DTW	Gallons
Nov. 97			
1-5-98	255.62	36.52	11.6
3-6-98	"	36.0	11.7
4-17-98		36.15	11.6
4-21-98		38.05	3.17
5-1-98		50.22	9.34
5-13-98		36.45	11.6
7-23-98		34.0	12.0
9-29-98		35.20	11.8

4 days

Shallow Well Recharge Information
Well Number SM-28

97.0'

Date	Well Elev.	DTW	Gallons
~~Nov. 97~~ 1-5-98	242.22	11.92	13.9
1-26-98	242.22	13.13	13.7
1-30-98	242.22	40.03	9.3
3-6-98	"	12.18	13.8
4-17-98		11.80	13.9
4-21-98		83.48	2.2
5-1-98		40.25	9.3
5-13-98		12.57	13.8
7-14-98		12.0	13.4
9-29-98		12.69	13.7

Shallow Well Recharge Information
Well Number SM-29

Date	Well Elev.	DTW	Gallons 103.00
Nov. 97 1-5-98	247.72	29.16	12.0
1-26-98	247.72	30.37	11.8
1-30-98	247.72	58.32	7.3
3-6-98	″	28.63	12.1
4-17-98		28.70	12.1
4-21-98		78.55	3.9
5-1-98		52.43	8.2
5-13-98		29.17	1203
7-14-98		30.01	11.9
9-29-98		28.88	12.1

Shallow Well Recharge Information
Well Number SMBG-01

100.70

Date	Well Elev.	DTW	Gallons
Oct. 97	297.12		
11-26-97	"	69.20	5.1
12-03-97	"	95.70	0.8
12-24-97	"	88.78	~~5.5~~ 1.9
12-30-97	"	88.20	2.0
4-16-98		69.03	
7-21-98		68.46	5.3
9-28-98		74.6	4.3

at least ~~35~~ 15 days

Shallow Well Recharge Information
Well Number SMBG-02

100.60

Date	Well Elev.	DTW	Gallons
Oct. 97	263.25		
12-04-97	"	18.88	13.3
12-24-97	"	20.0	13.1
4-17-98		14.40	
7-23-98		25.83	12.2
10-1-98		31.88	11.2

at least 7 days

Shallow Well Recharge Information

Well Number SM30

well depth 122.94

Date	Well Elev.	DTW (ft)	Gallons	
2/8/99	195.34	3'	19.55	purged
2/17/99		50.2	11.85	
~~2/17/99~~				
2/22/99		34.9	14.35	
2/26/99		27.8	15.50	
4/9/99		88.91	18.58	purged
5/9/99		50.74	11.77	purged
5/14/99		65.60	9.34	
5/21/99		42.20	13.16	purged
10/12/99		30.58	15.05	purged
12/16/99		29.04	15.30	purged
3/23/00		3.1	19.5	purged

Shallow Well Recharge Information
Well Number SM31

Well depth 125.43

Date	Well Elev.	DTW (ft)	Gallons	
2/8/99	207.80	10'	18.85	purged
2/17/99		28.1	15.86	
2/22/99		33.4	15.00	
2/26/99		19.3	17.30	
4/9/99		18.9	17.36	purged
5/9/99		40.64	13.82	purged
5/14/99		41.95	13.60	
5/21/99		27.01	16.40	purged
10/12/99		22.61	16.76	purged
12/16/99		21.98	16.86	purged
3/23/00		19.95	17.19	purged

Shallow Well Recharge Information
Well Number SW132

Well depth 120.19

Date	Well Elev.	DTW (ft)	Gallons	
2/8/99	209.70	17.5	16.73	purged
2/17/99		61.2	9.6	
2/22/99		51.9	11.13	
2/26/99		43.3	12.5	
4/9/99		18.8	16.5	purged
5/9/99		72.96	7.69	purged
5/14/99		79.96	6.55	
5/21/99		57.85	10.16	purged
10/12/99		20.32	16.28	purged
12/16/99		19.15	16.47	meas.
3/24/00		18.80	16.52	purged

Shallow Well Recharge Information

Well Number SM33

well depth 112.95

Date	Well Elev.	DTW (ft)	Gallons	
2/8/99	208.38	5.05	17.58	purged
2/17/99	112.95	65.7	7.70	
2/22/99		53.4	9.70	
2/26/99		47.6	10.65	
4/9/99		19.25	15.27	purged
5/9/99		72.23	6.63	purged
5/14/99		73.66	6.40	
5/21/99		59.45	8.72	purged
10/12/99		13.59	16.19	purged
12/16/99		12.04	16.45	meas.
3/24/00		12.35	16.39	purged

APPENDIX E-8

DOCUMENT 4

Golder Associates Inc.

3730 Chamblee Tucker Road
Atlanta, GA USA 30341
Telephone (404) 496-1893
Fax (404) 934-9476

Golder Associates

REVISED LETTER REPORT ON

WELL DEVIATION STUDY

Submitted to:

Chemical Waste Management, Inc.
P.O. Box 55
Rt. 17 at Milepost 163
Emelle, Alabama 35459

DISTRIBUTION:

4 Copies - Chemical Waste Management, Inc.
1 Copy - Golder Associates Inc.

August 1993

933-3513

OFFICES IN AUSTRALIA, CANADA, GERMANY, HUNGARY, ITALY, SWEDEN, UNITED KINGDOM, UNITED STATES

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Golder Associates

August 10, 1993

933-3513

Mr. Clyde Pendergrass
Chemical Waste Management, Inc.
P.O. Box 55
Rt. 17 at Milepost 163
Emelle, AL 35459

RE: REVISED LETTER REPORT ON WELL DEVIATION STUDY

Dear Mr. Pendergrass:

Golder Associates Inc. (Golder Associates) is pleased to present this report on the monitoring well deviation study conducted on two wells at the Chemical Waste Management, Inc. (CWMI) Emelle Facility. The purpose of the study was to provide monitoring well dip and azimuth data so future water level depth measurements can be corrected to water level elevations. In addition to the well deviation study, Golder Associates was asked to attempt to remove the existing groundwater sampling pumps from the wells and to establish the prospects of using a geophysical tool by running a dummy probe down the wells. The addition of these tasks to this project was based on communications between Mr. Clyde Pendergrass of CWMI and Mr. Randall Sullivan of Golder Associates on July 17, 1993. This report summarizes the findings of the study and the procedures utilized to obtain measurements from the monitoring wells.

BACKGROUND INFORMATION

CWMI owns and operates the Emelle treatment, storage and disposal (TSD) facility near Emelle, Alabama. During October of 1991, a slope failure (slide) occurred near disposal Trench 21. As a result of this slide, monitoring wells SM-10 and SM-10A were deflected near the slide failure surface. Subsequently earthen materials and PVC well pipe were removed to a depth of approximately five feet to six feet below the failure surface. Monitoring wells SM-10 and SM-10A were then both extended in stages during the backfilling process. The soil around the wells was compacted during the backfilling process, causing deflection in the wells. Based on survey data, the wells were extended approximately 33 feet in elevation, in addition to the six feet that were originally excavated. Therefore, these monitoring wells are likely to have primary deflection from near the failure surface extending up to the recently established ground surface. The wells are expected to be fairly straight and plumb below 38 feet or 39 feet in vertical depth.

To accurately establish the groundwater elevation in most monitoring wells, a fundamental assumption is that the wells are straight and plumb (vertical). With this assumption, the water level elevation is calculated by simply subtracting the measured depth to water in the wells (the water level depth) from the top of casing elevation of the well. However, monitoring wells SM-10 and SM-10A have been deflected and are neither straight nor plumb. Therefore, this deviation study was proposed to evaluate the extent of deflection and to allow for water level elevation corrections to estimate the vertical distance to the water surface in the well from the top of the well.

PROPOSED APPROACH

The planned approach to the study was to use a downhole geophysical tool to measure the orientation of the casing as the tool was run down the well. This would require first that the sampling pumps be removed since the geophysical tool might not fit inside the well with tubing in the well. Second, the change in orientation could not be severe or the tool would not pass any major deflection points in the wells. Accordingly, a tool was found that could provide the required measurements. The proposed and preferred tool used a digital slimhole magnetometer/tiltmeter probe for downhole measurements. This probe's overall dimensions were: 1.75 inches in diameter by 5.5 feet in length. Prior to mobilization to the site, the tool was rented and tested, and a dummy probe of these dimensions was acquired to check tool passage before inserting the tool in the wells.

CLEANING AND HANDLING

The proposed study required evaluation of groundwater monitoring installations. Golder Associates was concerned about compromising the use of the monitoring wells by potentially contaminating them during the study. Therefore, all materials were cleaned with alconox and rinsed with deionized water prior to insertion into the wells. Further, all material were handled with latex gloves and placed on plastic adjacent to the well (not on the ground).

PUMP REMOVAL

Prior to conducting the deviation study in the wells, the groundwater sampling pumps had to be removed from the wells. The sample pumps (QED Well Wizard bladder pumps) have dimensions of about 1.75 inches in diameter and about 2.5 feet in length and are connected to the surface with plastic tubing which serves to transmit compressed gas (N_2) and sample water.

An attempt was made to pull the pump out of monitoring well SM-10. However, the pump became stuck after pulling approximately 78 feet of tubing from the hole. Golder Associates personnel managed to force the pump back down the well by applying downward pressure on the plastic tubing connected to the pump. No further attempts were made to remove the sampling pump from well SM-10 because of the possibility of getting the pump stuck and thus rendering the well useless. This decision was also made, in part, because the downhole magnetometer/tiltmeter tool has larger dimensions than does the sampling pump and, therefore, was not likely to be of use in this well. The sample pump tubing inside the 2-inch diameter PVC well casing also prohibited the geophysical tools available from fitting down the well.

Golder Associates personnel then attempted to carefully pull the sampling pump from SM-10A. This pump became stuck after pulling only 18 feet of tubing. This correlates to a depth of about 125 feet to 130 feet below the top of casing (Ft.TOC). The pump could not be forced back down the hole, rather it was dislodged by twisting the tubing and pulling upward with more force. The pump again became stuck at approximately 38 Ft.TOC and could not be dislodged by twisting and pulling the tubing. One inch diameter PVC pipe was then used to force the pump back down the well, however, the air tubing was damaged in the process, rendering the pump unusable. Since the pump was not functioning, an attempt was made to pull hard on the tubing such that the tubing would break off and the pump could be pushed to the bottom of the well, and a smaller pump installed. However, with two people pulling very hard, the pump was removed from the well without breaking off the tubing.

PUMP REPLACEMENT

Golder Associates personnel investigated various small diameter pump options for use in well SM-10A based on the criteria of fitting down the well pipe and being able to pump water up 150 feet. Dummy probes of specific dimensions were placed down the well to help determine which pumps would fit. From this evaluation at least two, and possibly three, pumps will fit down the well and handle the necessary 150 feet of head. These pumps and their general dimensions are:

- Fultz Pump - 1.75 inches in diameter by 9.16 inches long;
- Solinst Pump - 5/8 inches in diameter by 12 inches long; and
- QED Well Wizard T1300 - 1 inch in diameter by 46.75 inches long.

A dummy probe was not run for the Well Wizard pump because pump dimensions were not obtained from QED prior to obtaining materials for constructing the dummy probes. A dummy probe with these dimensions should be run if this pump is considered. Descriptions and specifications for each of these pumps is included in Attachment 1. The QED pump is recommended (assuming it fits down the well) since CWMI already uses this system in the other monitoring wells at the site. The Fultz pump and the Solinst pump would cost approximately $2,000 to $2,500. The QED pump would be much less expensive (less than $1,000) because CWMI already owns a QED controller and well seals. Additional costs will also be incurred for shipping, installation, and documentation of the replacement pump.

ORIENTATION MEASUREMENTS

As previously stated, the program was initially proposed using a digital slimhole magnetometer/tiltmeter probe. The dummy probe, consisting of PVC pipe with the same dimensions as the slimhole probe, was first placed down the wells. The probe could not fit in well SM-10 because of the tubing attached to the pump. In well SM-10A the dummy probe became stuck at a fairly shallow depth (about 30 feet). Therefore the magnetometer/tiltmeter tool was not used on the well and an alternate approach was adopted.

The Pajari, a mechanical gyroscopic tool with smaller dimensions than the magnetometer/tiltmeter tool, was acquired for downhole measurements. The tool is designed to measure both angle of dip and azimuth. However, the compass measurement did not lock in properly and the resulting azimuth data was considered unreliable. The tool is encased in a cylindrical brass container with dimensions of about 1.75 inches in diameter by 16 inches long. The Pajari is equipped with a mechanical timer and is lowered into the hole to a specified depth and allowed to stabilize for 10 minutes to 15 minutes before the measurement is taken. The tool is then removed from the hole and the reading is recorded. The tool could not pass by the tubing in well SM-10, and was not used in the well. In well SM-10A, this procedure was repeated six times at depths of ten feet, 20 feet, 25 feet, 30 feet, 35 feet and 36 feet. The instrument would not go past 36 feet down the well. The measurements are summarized in Table 1.

As a rough check, well casing orientations for both wells were estimated using a Brunton compass. A measurement was taken at the surface of SM-10A using a Brunton compass and a PVC extension (placed inside the well casing and extended out away from the protective casing). This measurement is also included in Table 1. The aluminum protective casing for well SM-10 was also measured with the Brunton compass, resulting in dip and azimuth measurements similar to those of well SM-10A.

Survey data was also obtained for this evaluation. Each well had previously been surveyed by CWMI in 1986, prior to well movement, and in 1992 following the extension of each well. These survey readings are:

WELL NO.	NORTHING	EASTING	ELEVATION (Ft.MSL)
SM-10 (1986)	10748.80	5477.40	195.90
SM-10 (1992)	10751.84	5459.11	228.75
SM-10A (1986)	10759.10	5478.00	195.90
SM-10A (1992)	10760.31	5459.83	229.33

EVALUATIONS

The inclination measurements obtained from well SM-10A were plotted using a CAD system, as shown on Figure 1. As discussed above, the last measurement was taken at a depth of 36 feet. Since no dip measurements were obtained below this depth, the last dip angle (81 degrees) was continued to a depth of about 38 vertical feet, at which point the well was assumed to be vertical (90 degrees). The plotted dip angles resulted in a horizontal displacement of 18.2 feet from the top of the existing casing to the point where the well deviation is assumed to begin. This matches the horizontal displacement calculated from the survey coordinates (before and after the well extension) as discussed below. The well inclination plot does not take into account possible azimuth deviations (winding) in the well casing.

Horizontal coordinates of wells SM-10 and SM-10A were plotted from survey data obtained before and after deflection and extension of the wells occurred. Net horizontal displacement and the displacement direction were calculated and compared with the inclination plot results and dip direction measurements taken at the surface in SM-10A (see Attachment 2).

	SURVEY RESULTS	FIELD MEASUREMENT RESULTS
SM-10A Horizontal Displacement Dip Direction	18.21 ft. N94° E	18.2 ft. N97° E
SM-10 Horizontal Displacement Dip Direction	18.54 ft. N99° E	— N111° E

As shown in the above comparison, the displacement predicted in the inclination plot and the measured dip direction in well SM-10A were very similar to the calculated displacement distance and direction obtained from the survey data. This would indicate that there is very little azimuth deviation (winding) in the casing between the existing well location and the original well location. If significant azimuth deviations were present the inclination plot would extend far beyond the predicted 18.2 feet before returning to vertical. Based on the available data, the inclination plot is believed to be reasonably accurate and reliable.

Apparent measured depths (down-hole depths) were correlated to calculated vertical depths on the inclination plot (Figure 1). This was accomplished by enlarging the plot several times and measuring along the downhole well plot at various increments (ranging from 0.1 foot to 1.0 foot) with an engineering scale. This method of correlation was deemed appropriate considering the level of accuracy in the data used to construct the plot. The corresponding calculated vertical depths were recorded and a table was constructed relating measured depths, depth corrections, actual depths, and water level elevations for well SM-10A (see Table 2). Although the depth corrections were estimated to an accuracy of 0.1 feet, as shown in Table 2, it should be noted that these are only estimations and are based on limited available data. Depth correlations are reported at 1 foot intervals from the top of casing down to 30 feet, at 0.1 foot intervals from 30 feet down to 45 feet, and at again at 1 foot intervals from 45 feet to 100 feet below the top of casing. The water level in SM-10A is expected to remain below 30 Ft.BG, therefore, depth correlations were reported at 0.1 foot intervals below this depth.

The same depth corrections used in well SM-10A can be used for well SM-10, based on the similarities in inclination, displacement direction and calculated displacement distance. The estimated depth corrections for well SM-10, based on the TOC elevation for this well, are tabulated in Table 3. The resulting estimated water level elevations for well SM-10 would be considered less reliable than those for well SM-10A.

RESULTS

Based on the above evaluations, Tables 2 and 3 present the estimated depth correlations for wells SM-10A and SM-10, respectively. These tables can be used to estimate water level elevations in each well based on measured water levels below the top of PVC casing (TOC). As an example, during the latest sampling event in February 1993, water levels were measured at depths of 40.89 feet below the top of PVC casing (Ft.TOC) in monitoring well SM-10A and 57.45 Ft.TOC in monitoring well SM-10. Using the depth corrections presented in Tables 2 and 3, the actual depths would be 36.2 Ft.TOC and 52.7 Ft.TOC, which correspond to water level elevations of 193.1 Feet Mean Sea Level (Ft.MSL) and 176.0 Ft.MSL in wells SM-10A and SM-10, respectively. These correlations are estimated to be accurate to the nearest 0.1 feet in well SM-10A. The level of accuracy would be slightly lower for well SM-10.

Golder Associates appreciates the opportunity to work with CWMI on this project. If you have any questions or need further clarification of the contents of this report, please do not hesitate to call.

Very truly yours,

GOLDER ASSOCIATES INC.

Jonathan S. Radtke
Project Hydrogeologist

John F. Clerici, P.E.
Principal

JSR/JFC:maa

Attachments

FN: 3513-CWM.LTR\2\MAA

TABLE 1

INCLINATION MEASUREMENTS
MONITORING WELL SM-10A

MEASUREMENT DEPTH (FT.TOC)(1)	DIP ANGLE(2) (DEGREES)	DIP DIRECTION(3) (DEGREES)
0	54°	N97°E
10	58°	—
20	62°	—
25	65°	—
30	68°	—
35	78°	—
36	81°	—

Notes:
1. FT.TOC - Feet below top of PVC casing.
2. Dip angle measured in degrees from horizontal using a Pajari Inclinometer.
3. Dip direction measured at surface using a Brunton compass.

3513TAB1.WK1/JSR

TABLE 2

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10A
PAGE 1 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
0.0	0.0	0.0	229.3
1.0	-0.2	0.8	228.5
2.0	-0.3	1.7	227.6
3.0	-0.6	2.4	226.9
4.0	-0.8	3.2	226.1
5.0	-1.0	4.0	225.3
6.0	-1.2	4.8	224.5
7.0	-1.4	5.6	223.7
8.0	-1.5	6.5	222.8
9.0	-1.7	7.3	222.0
10.0	-1.8	8.2	221.1
11.0	-2.0	9.0	220.3
12.0	-2.2	9.8	219.5
13.0	-2.3	10.7	218.6
14.0	-2.5	11.5	217.8
15.0	-2.6	12.4	216.9
16.0	-2.8	13.2	216.1
17.0	-3.0	14.0	215.3
18.0	-3.1	14.9	214.4
19.0	-3.2	15.8	213.5
20.0	-3.3	16.7	212.6
21.0	-3.4	17.6	211.7
22.0	-3.5	18.5	210.8
23.0	-3.6	19.4	209.9
24.0	-3.7	20.3	209.0
25.0	-3.8	21.2	208.1
26.0	-3.9	22.1	207.2
27.0	-4.0	23.0	206.3
28.0	-4.1	23.9	205.4
29.0	-4.2	24.8	204.5
30.0	-4.3	25.7	203.6
30.1	-4.3	25.8	203.5
30.2	-4.3	25.9	203.4
30.3	-4.3	26.0	203.3
30.4	-4.3	26.1	203.2
30.5	-4.3	26.2	203.1
30.6	-4.3	26.3	203.0
30.7	-4.3	26.4	202.9
30.8	-4.3	26.5	202.8
30.9	-4.3	26.6	202.7
31.0	-4.3	26.7	202.6
31.1	-4.4	26.7	202.6
31.2	-4.4	26.8	202.5
31.3	-4.4	26.9	202.4
31.4	-4.4	27.0	202.3
31.5	-4.4	27.1	202.2
31.6	-4.4	27.2	202.1
31.7	-4.4	27.3	202.0
31.8	-4.4	27.4	201.9
31.9	-4.4	27.5	201.8
32.0	-4.4	27.6	201.7
32.1	-4.4	27.7	201.6
32.2	-4.4	27.8	201.5
32.3	-4.4	27.9	201.4
32.4	-4.5	27.9	201.4
32.5	-4.5	28.0	201.3
32.6	-4.5	28.1	201.2
32.7	-4.5	28.2	201.1
32.8	-4.5	28.3	201.0
32.9	-4.5	28.4	200.9
33.0	-4.5	28.5	200.8
33.1	-4.5	28.6	200.7
33.2	-4.5	28.7	200.6
33.3	-4.5	28.8	200.5
33.4	-4.5	28.9	200.4
33.5	-4.6	28.9	200.4
33.6	-4.6	29.0	200.3
33.7	-4.6	29.1	200.2
33.8	-4.6	29.2	200.1
33.9	-4.6	29.3	200.0
34.0	-4.6	29.4	199.9
34.1	-4.6	29.5	199.8
34.2	-4.6	29.6	199.7
34.3	-4.6	29.7	199.6
34.4	-4.6	29.8	199.5
34.5	-4.6	29.9	199.4
34.6	-4.6	30.0	199.3
34.7	-4.6	30.1	199.2
34.8	-4.6	30.2	199.1
34.9	-4.6	30.3	199.0

3513TAB2.WK1/JSR

TABLE 2

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10A
PAGE 2 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
35.0	-4.6	30.4	198.9
35.1	-4.6	30.5	198.8
35.2	-4.6	30.6	198.7
35.3	-4.6	30.7	198.6
35.4	-4.6	30.8	198.5
35.5	-4.6	30.9	198.4
35.6	-4.6	31.0	198.3
35.7	-4.6	31.1	198.2
35.8	-4.6	31.2	198.1
35.9	-4.6	31.3	198.0
36.0	-4.6	31.4	197.9
36.1	-4.6	31.5	197.8
36.2	-4.6	31.6	197.7
36.3	-4.6	31.7	197.6
36.4	-4.6	31.8	197.5
36.5	-4.6	31.9	197.4
36.6	-4.6	32.0	197.3
36.7	-4.6	32.1	197.2
36.8	-4.6	32.2	197.1
36.9	-4.6	32.3	197.0
37.0	-4.6	32.4	196.9
37.1	-4.6	32.5	196.8
37.2	-4.6	32.6	196.7
37.3	-4.6	32.7	196.6
37.4	-4.6	32.8	196.5
37.5	-4.6	32.9	196.4
37.6	-4.6	33.0	196.3
37.7	-4.6	33.1	196.2
37.8	-4.6	33.2	196.1
37.9	-4.6	33.3	196.0
38.0	-4.6	33.4	195.9
38.1	-4.6	33.5	195.8
38.2	-4.6	33.6	195.7
38.3	-4.6	33.7	195.6
38.4	-4.6	33.8	195.5
38.5	-4.6	33.9	195.4
38.6	-4.6	34.0	195.3
38.7	-4.6	34.1	195.2
38.8	-4.6	34.2	195.1
38.9	-4.6	34.3	195.0
39.0	-4.6	34.4	194.9
39.1	-4.6	34.5	194.8
39.2	-4.6	34.6	194.7
39.3	-4.6	34.7	194.6
39.4	-4.6	34.8	194.5
39.5	-4.7	34.8	194.5
39.6	-4.7	34.9	194.4
39.7	-4.7	35.0	194.3
39.8	-4.7	35.1	194.2
39.9	-4.7	35.2	194.1
40.0	-4.7	35.3	194.0
40.1	-4.7	35.4	193.9
40.2	-4.7	35.5	193.8
40.3	-4.7	35.6	193.7
40.4	-4.7	35.7	193.6
40.5	-4.7	35.8	193.5
40.6	-4.7	35.9	193.4
40.7	-4.7	36.0	193.3
40.8	-4.7	36.1	193.2
40.9	-4.7	36.2	193.1
41.0	-4.7	36.3	193.0
41.1	-4.7	36.4	192.9
41.2	-4.7	36.5	192.8
41.3	-4.7	36.6	192.7
41.4	-4.7	36.7	192.6
41.5	-4.7	36.8	192.5
41.6	-4.7	36.9	192.4
41.7	-4.7	37.0	192.3
41.8	-4.7	37.1	192.2
41.9	-4.7	37.2	192.1
42.0	-4.7	37.3	192.0
42.1	-4.7	37.4	191.9
42.2	-4.7	37.5	191.8
42.3	-4.7	37.6	191.7
42.4	-4.7	37.7	191.6
42.5	-4.7	37.8	191.5
42.6	-4.7	37.9	191.4
42.7	-4.7	38.0	191.3
42.8	-4.7	38.1	191.2
42.9	-4.7	38.2	191.1

3515TAB2 WK1/JSR

TABLE 2

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10A
PAGE 3 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
43.0	-4.7	38.3	191.0
43.1	-4.7	38.4	190.9
43.2	-4.7	38.5	190.8
43.3	-4.7	38.6	190.7
43.4	-4.7	38.7	190.6
43.5	-4.7	38.8	190.5
43.6	-4.7	38.9	190.4
43.7	-4.7	39.0	190.3
43.8	-4.7	39.1	190.2
43.9	-4.7	39.2	190.1
44.0	-4.7	39.3	190.0
44.1	-4.7	39.4	189.9
44.2	-4.7	39.5	189.8
44.3	-4.7	39.6	189.7
44.4	-4.7	39.7	189.6
44.5	-4.7	39.8	189.5
44.6	-4.7	39.9	189.4
44.7	-4.7	40.0	189.3
44.8	-4.7	40.1	189.2
44.9	-4.7	40.2	189.1
45.0	-4.7	40.3	189.0
46.0	-4.7	41.3	188.0
47.0	-4.7	42.3	187.0
48.0	-4.7	43.3	186.0
49.0	-4.7	44.3	185.0
50.0	-4.7	45.3	184.0
51.0	-4.7	46.3	183.0
52.0	-4.7	47.3	182.0
53.0	-4.7	48.3	181.0
54.0	-4.7	49.3	180.0
55.0	-4.7	50.3	179.0
56.0	-4.7	51.3	178.0
57.0	-4.7	52.3	177.0
58.0	-4.7	53.3	176.0
59.0	-4.7	54.3	175.0
60.0	-4.7	55.3	174.0
61.0	-4.7	56.3	173.0
62.0	-4.7	57.3	172.0

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
63.0	-4.7	58.3	171.0
64.0	-4.7	59.3	170.0
65.0	-4.7	60.3	169.0
66.0	-4.7	61.3	168.0
67.0	-4.7	62.3	167.0
68.0	-4.7	63.3	166.0
69.0	-4.7	64.3	165.0
70.0	-4.7	65.3	164.0
71.0	-4.7	66.3	163.0
72.0	-4.7	67.3	162.0
73.0	-4.7	68.3	161.0
74.0	-4.7	69.3	160.0
75.0	-4.7	70.3	159.0
76.0	-4.7	71.3	158.0
77.0	-4.7	72.3	157.0
78.0	-4.7	73.3	156.0
79.0	-4.7	74.3	155.0
80.0	-4.7	75.3	154.0
81.0	-4.7	76.3	153.0
82.0	-4.7	77.3	152.0
83.0	-4.7	78.3	151.0
84.0	-4.7	79.3	150.0
85.0	-4.7	80.3	149.0
86.0	-4.7	81.3	148.0
87.0	-4.7	82.3	147.0
88.0	-4.7	83.3	146.0
89.0	-4.7	84.3	145.0
90.0	-4.7	85.3	144.0
91.0	-4.7	86.3	143.0
92.0	-4.7	87.3	142.0
93.0	-4.7	88.3	141.0
94.0	-4.7	89.3	140.0
95.0	-4.7	90.3	139.0
96.0	-4.7	91.3	138.0
97.0	-4.7	92.3	137.0
98.0	-4.7	93.3	136.0
99.0	-4.7	94.3	135.0
100.0	-4.7	95.3	134.0

3513TAB2.WK1/JSR

TABLE 3

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10
PAGE 1 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
0.0	0.0	0.0	228.8
1.0	-0.2	0.8	228.0
2.0	-0.3	1.7	227.1
3.0	-0.6	2.4	226.4
4.0	-0.8	3.2	225.6
5.0	-1.0	4.0	224.8
6.0	-1.2	4.8	224.0
7.0	-1.4	5.6	223.2
8.0	-1.5	6.5	222.3
9.0	-1.7	7.3	221.5
10.0	-1.8	8.2	220.6
11.0	-2.0	9.0	219.8
12.0	-2.2	9.8	219.0
13.0	-2.3	10.7	218.1
14.0	-2.5	11.5	217.3
15.0	-2.6	12.4	216.4
16.0	-2.8	13.2	215.6
17.0	-3.0	14.0	214.8
18.0	-3.1	14.9	213.9
19.0	-3.2	15.8	213.0
20.0	-3.3	16.7	212.1
21.0	-3.4	17.6	211.2
22.0	-3.5	18.5	210.3
23.0	-3.6	19.4	209.4
24.0	-3.7	20.3	208.5
25.0	-3.8	21.2	207.6
26.0	-3.9	22.1	206.7
27.0	-4.0	23.0	205.8
28.0	-4.1	23.9	204.9
29.0	-4.2	24.8	204.0
30.0	-4.3	25.7	203.1
30.1	-4.3	25.8	203.0
30.2	-4.3	25.9	202.9
30.3	-4.3	26.0	202.8
30.4	-4.3	26.1	202.7
30.5	-4.3	26.2	202.6
30.6	-4.3	26.3	202.5
30.7	-4.3	26.4	202.4
30.8	-4.3	26.5	202.3
30.9	-4.3	26.6	202.2

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
31.0	-4.3	26.7	202.1
31.1	-4.4	26.7	202.1
31.2	-4.4	26.8	202.0
31.3	-4.4	26.9	201.9
31.4	-4.4	27.0	201.8
31.5	-4.4	27.1	201.7
31.6	-4.4	27.2	201.6
31.7	-4.4	27.3	201.5
31.8	-4.4	27.4	201.4
31.9	-4.4	27.5	201.3
32.0	-4.4	27.6	201.2
32.1	-4.4	27.7	201.1
32.2	-4.4	27.8	201.0
32.3	-4.4	27.9	200.9
32.4	-4.5	27.9	200.9
32.5	-4.5	28.0	200.8
32.6	-4.5	28.1	200.7
32.7	-4.5	28.2	200.6
32.8	-4.5	28.3	200.5
32.9	-4.5	28.4	200.4
33.0	-4.5	28.5	200.3
33.1	-4.5	28.6	200.2
33.2	-4.5	28.7	200.1
33.3	-4.5	28.8	200.0
33.4	-4.5	28.9	199.9
33.5	-4.6	28.9	199.9
33.6	-4.6	29.0	199.8
33.7	-4.6	29.1	199.7
33.8	-4.6	29.2	199.6
33.9	-4.6	29.3	199.5
34.0	-4.6	29.4	199.4
34.1	-4.6	29.5	199.3
34.2	-4.6	29.6	199.2
34.3	-4.6	29.7	199.1
34.4	-4.6	29.8	199.0
34.5	-4.6	29.9	198.9
34.6	-4.6	30.0	198.8
34.7	-4.6	30.1	198.7
34.8	-4.6	30.2	198.6
34.9	-4.6	30.3	198.5

3513TAB3.WK1/JSR

TABLE 3

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10
PAGE 2 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
35.0	-4.6	30.4	198.4
35.1	-4.6	30.5	198.3
35.2	-4.6	30.6	198.2
35.3	-4.6	30.7	198.1
35.4	-4.6	30.8	198.0
35.5	-4.6	30.9	197.9
35.6	-4.6	31.0	197.8
35.7	-4.6	31.1	197.7
35.8	-4.6	31.2	197.6
35.9	-4.6	31.3	197.5
36.0	-4.6	31.4	197.4
36.1	-4.6	31.5	197.3
36.2	-4.6	31.6	197.2
36.3	-4.6	31.7	197.1
36.4	-4.6	31.8	197.0
36.5	-4.6	31.9	196.9
36.6	-4.6	32.0	196.7
36.7	-4.6	32.1	196.7
36.8	-4.6	32.2	196.6
36.9	-4.6	32.3	196.5
37.0	-4.6	32.4	196.3
37.1	-4.6	32.5	196.2
37.2	-4.6	32.6	196.2
37.3	-4.6	32.7	196.1
37.4	-4.6	32.8	195.9
37.5	-4.6	32.9	195.8
37.6	-4.6	33.0	195.7
37.7	-4.6	33.1	195.7
37.8	-4.6	33.2	195.5
37.9	-4.6	33.3	195.4
38.0	-4.6	33.4	195.3
38.1	-4.6	33.5	195.2
38.2	-4.6	33.6	195.1
38.3	-4.6	33.7	195.0
38.4	-4.6	33.8	194.9
38.5	-4.6	33.9	194.8
38.6	-4.6	34.0	194.7
38.7	-4.6	34.1	194.6
38.8	-4.6	34.2	194.5
38.9	-4.6	34.3	194.4

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
39.0	-4.6	34.4	194.4
39.1	-4.6	34.5	194.3
39.2	-4.6	34.6	194.2
39.3	-4.6	34.7	194.1
39.4	-4.6	34.8	194.0
39.5	-4.7	34.8	194.0
39.6	-4.7	34.9	193.9
39.7	-4.7	35.0	193.8
39.8	-4.7	35.1	193.7
39.9	-4.7	35.2	193.6
40.0	-4.7	35.3	193.5
40.1	-4.7	35.4	193.4
40.2	-4.7	35.5	193.3
40.3	-4.7	35.6	193.2
40.4	-4.7	35.7	193.1
40.5	-4.7	35.8	193.0
40.6	-4.7	35.9	192.9
40.7	-4.7	36.0	192.8
40.8	-4.7	36.1	192.7
40.9	-4.7	36.2	192.6
41.0	-4.7	36.3	192.5
41.1	-4.7	36.4	192.4
41.2	-4.7	36.5	192.2
41.3	-4.7	36.6	192.2
41.4	-4.7	36.7	192.1
41.5	-4.7	36.8	192.0
41.6	-4.7	36.9	191.8
41.7	-4.7	37.0	191.7
41.8	-4.7	37.1	191.7
41.9	-4.7	37.2	191.6
42.0	-4.7	37.3	191.4
42.1	-4.7	37.4	191.3
42.2	-4.7	37.5	191.2
42.3	-4.7	37.6	191.2
42.4	-4.7	37.7	191.0
42.5	-4.7	37.8	190.9
42.6	-4.7	37.9	190.8
42.7	-4.7	38.0	190.7
42.8	-4.7	38.1	190.6
42.9	-4.7	38.2	190.5

3513TAB3.WK1/JSR

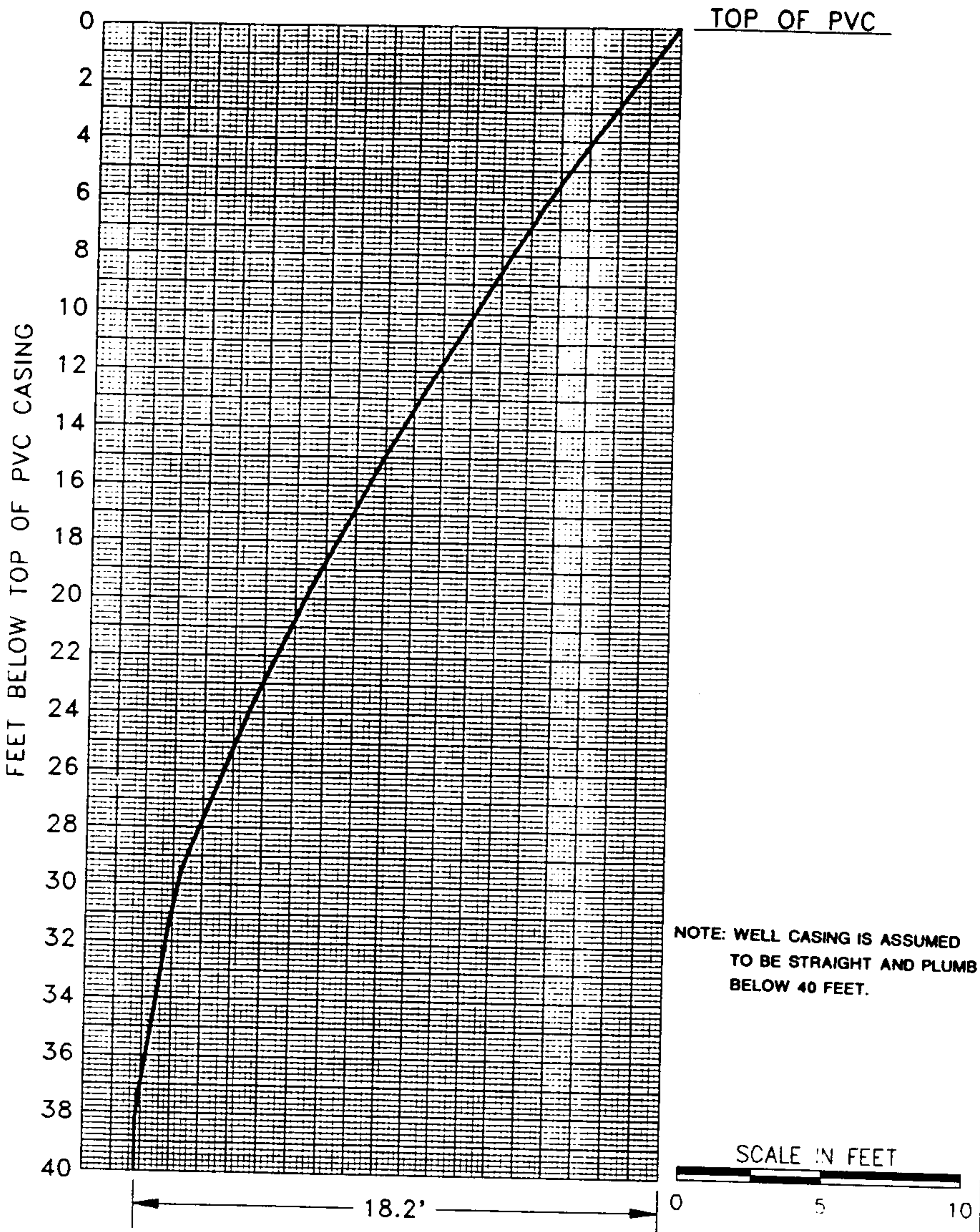
TABLE 3

ESTIMATED WATER LEVEL CORRECTIONS
MONITORING WELL SM-10
PAGE 3 OF 3

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
43.0	-4.7	38.3	190.5
43.1	-4.7	38.4	190.4
43.2	-4.7	38.5	190.3
43.3	-4.7	38.6	190.2
43.4	-4.7	38.7	190.1
43.5	-4.7	38.8	190.0
43.6	-4.7	38.9	189.9
43.7	-4.7	39.0	189.8
43.8	-4.7	39.1	189.7
43.9	-4.7	39.2	189.6
44.0	-4.7	39.3	189.5
44.1	-4.7	39.4	189.4
44.2	-4.7	39.5	189.3
44.3	-4.7	39.6	189.2
44.4	-4.7	39.7	189.1
44.5	-4.7	39.8	189.0
44.6	-4.7	39.9	188.9
44.7	-4.7	40.0	188.7
44.8	-4.7	40.1	188.7
44.9	-4.7	40.2	188.6
45.0	-4.7	40.3	188.5
46.0	-4.7	41.3	187.5
47.0	-4.7	42.3	186.5
48.0	-4.7	43.3	185.5
49.0	-4.7	44.3	184.5
50.0	-4.7	45.3	183.5
51.0	-4.7	46.3	182.5
52.0	-4.7	47.3	181.5
53.0	-4.7	48.3	180.5
54.0	-4.7	49.3	179.5
55.0	-4.7	50.3	178.5
56.0	-4.7	51.3	177.5
57.0	-4.7	52.3	176.5
58.0	-4.7	53.3	175.5
59.0	-4.7	54.3	174.5
60.0	-4.7	55.3	173.5
61.0	-4.7	56.3	172.5
62.0	-4.7	57.3	171.5

MEASURED DEPTH (FT.TOC)	DEPTH CORRECTION (FEET)	CALCULATED DEPTH (FT.TOC)	WATER LEVEL ELEVATION (FT.MSL)
63.0	-4.7	58.3	170.5
64.0	-4.7	59.3	169.5
65.0	-4.7	60.3	168.5
66.0	-4.7	61.3	167.5
67.0	-4.7	62.3	166.5
68.0	-4.7	63.3	165.5
69.0	-4.7	64.3	164.5
70.0	-4.7	65.3	163.5
71.0	-4.7	66.3	162.5
72.0	-4.7	67.3	161.5
73.0	-4.7	68.3	160.5
74.0	-4.7	69.3	159.5
75.0	-4.7	70.3	158.5
76.0	-4.7	71.3	157.5
77.0	-4.7	72.3	156.5
78.0	-4.7	73.3	155.5
79.0	-4.7	74.3	154.5
80.0	-4.7	75.3	153.5
81.0	-4.7	76.3	152.5
82.0	-4.7	77.3	151.5
83.0	-4.7	78.3	150.5
84.0	-4.7	79.3	149.5
85.0	-4.7	80.3	148.5
86.0	-4.7	81.3	147.5
87.0	-4.7	82.3	146.5
88.0	-4.7	83.3	145.5
89.0	-4.7	84.3	144.5
90.0	-4.7	85.3	143.5
91.0	-4.7	86.3	142.5
92.0	-4.7	87.3	141.5
93.0	-4.7	88.3	140.5
94.0	-4.7	89.3	139.5
95.0	-4.7	90.3	138.5
96.0	-4.7	91.3	137.5
97.0	-4.7	92.3	136.5
98.0	-4.7	93.3	135.5
99.0	-4.7	94.3	134.5
100.0	-4.7	95.3	133.5

5513TAB3.WK1/JSR



Golder Associates Atlanta, Georgia

TITLE: WELL INCLINATION MEASUREMENTS SM-10A

CLIENT/PROJECT: CHEMICAL WASTE MANAGEMENT, INC. EMELLE FACILITY

DRAWN R.C.A.	DATE 7/23/93	JOB NO. 933-3513
CHECKED J.S.R.	SCALE AS SHOWN	DWG NO. / REV. NO.
REVIEWED JFC	FILE NO. 933-3513	SUBTITLE / FIGURE NO. 1

ATTACHMENT 1

PUMP SPECIFICATIONS

Where there's a well, there's a way.

The Fultz Pump Pak SP-300

SP 300 Model Standard Equipment and Specifications

PUMP: 1.75 inch diameter x 9.1 inch length 304 stainless steel and virgin Teflon. Stainless steel Teflon rotors (wear item, field replaceable), high efficiency motor.

CONTROL PANEL: Run/Off/charge switch. Forward/Reverse switch allows back wash of screen. Internal/external switch. External power supplies available.

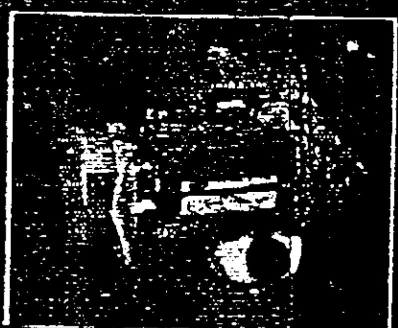
PACK FRAME: Welded aluminum frame with padded straps and belt.

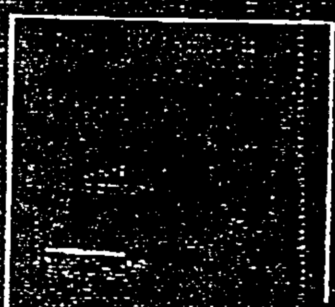
BATTERY PACK: Gel batteries supplied. Approximately four hours charge depending on pumping height.

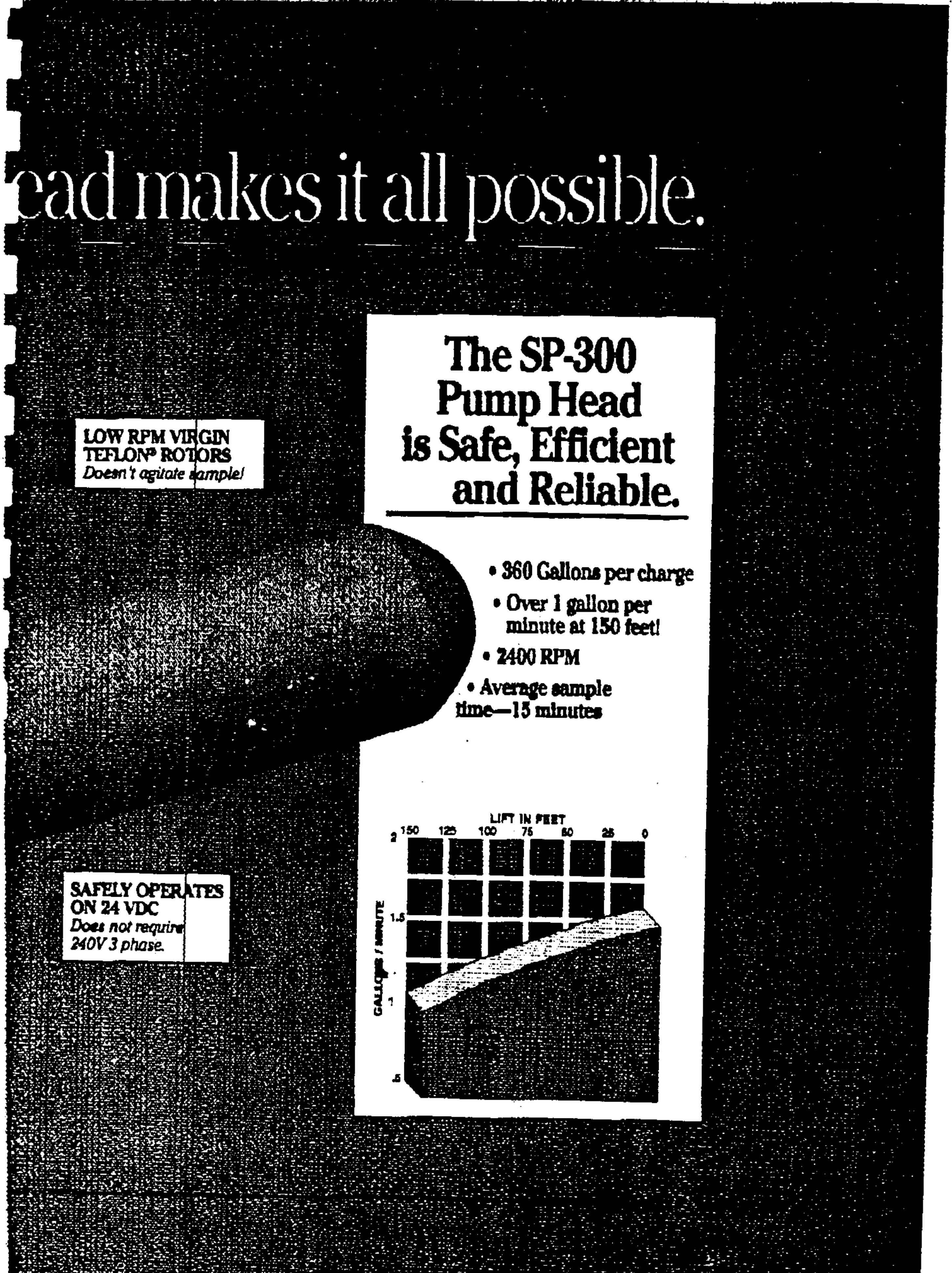
HOSE: 100 feet of polyethylene hose with integrated power wire for extreme safety. Optional inert Teflon hose is available.

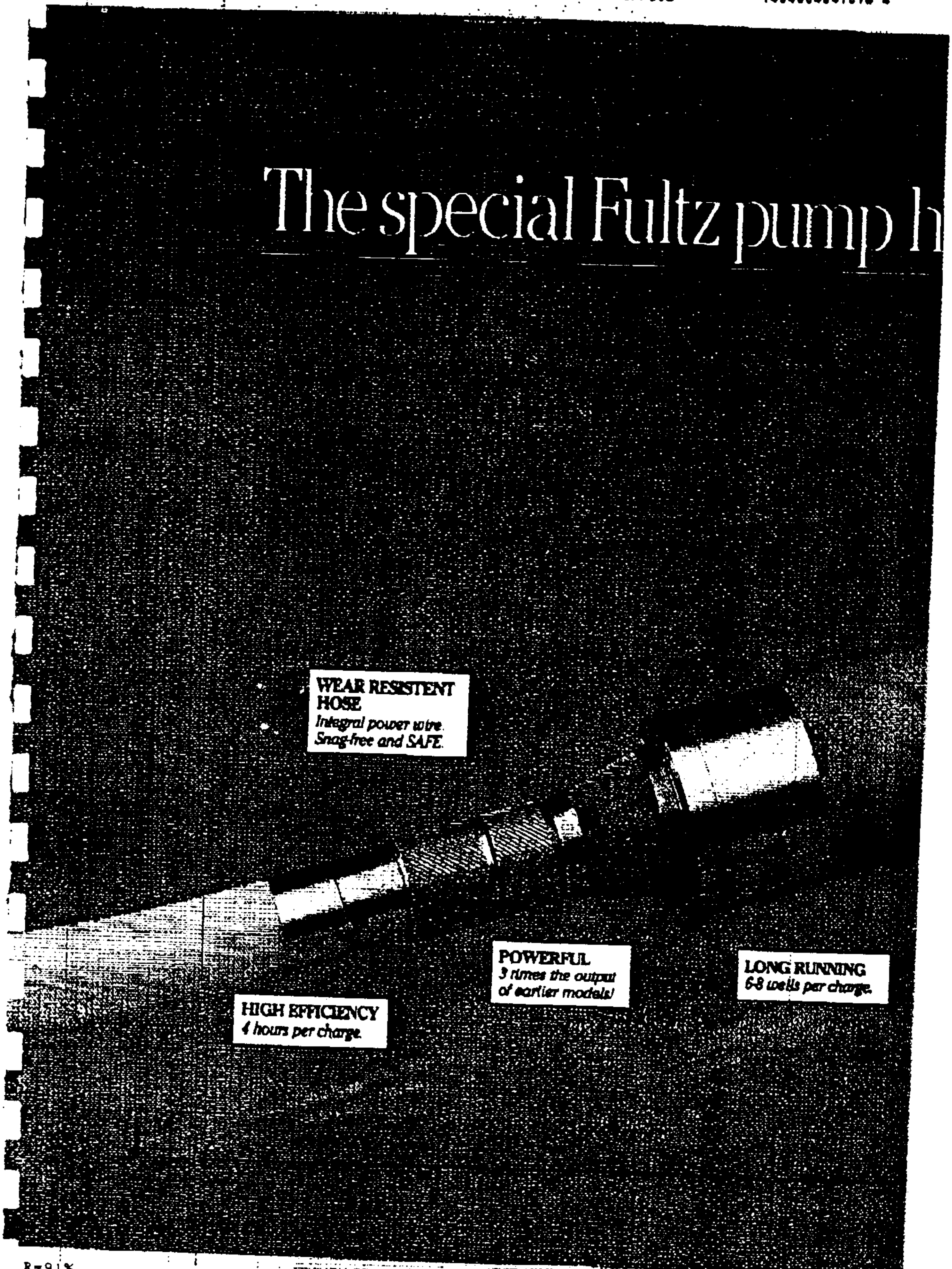
BATTERY CHARGER: 110 Volt AC to 24 volt DC

Optional Teflon Hose Available!






ead makes it all possible.
LOW RPM VIRGIN TEFLON® ROTORS
Doesn't agitate sample!
The SP-300 Pump Head is Safe, Efficient and Reliable.
• 360 Gallons per charge
• Over 1 gallon per minute at 150 feet!
• 2400 RPM
• Average sample time—15 minutes
SAFELY OPERATES ON 24 VDC
Does not require 240V 3 phase.
LIFT IN FEET
150
125
100
75
50
25
0
GALLONS / MINUTE
2
1.5
1
.5


The special Fultz pump h
WEAR RESISTENT HOSE
Integral power wire.
Snag-free and SAFE.
HIGH EFFICIENCY
4 hours per charge.
POWERFUL
3 times the output
of earlier models!
LONG RUNNING
6-8 wells per charge.

Solinst Double Valve & Bladder Pumps

Model 403/405/406 Data Sheet

Groundwater Sampling and Leachate Removal

Solinst offers a choice of sampling pumps, including the pneumatic-drive Double Valve Pump, a drive-point version, and the Bladder Pump described here. Also available are the Model 404: WaTerra Pump, which is ideal for low cost dedication, and the Model 402: Triple Tube Sampler, for sampling from very small diameter tubes, as narrow as 3/8" (9.5 mm) I.D.

Discrete interval samplers, bailers, and pressurized bailers are described in the Model 420 Series data sheet.

Double Valve Pump: Model 403

For high quality samples, from any depth, the Double Valve Pump offers field serviceability, no bladder replacement, a variety of sizes, and higher flow rates. The pump has been field tested in hundreds of applications.

High Quality Samples: - gives excellent VOC results, comparable with bladder pump results. (See paper on VOC Retention by Baerg et al, presented at 1992 National Groundwater Sampling Symposium - available through Solinst.)

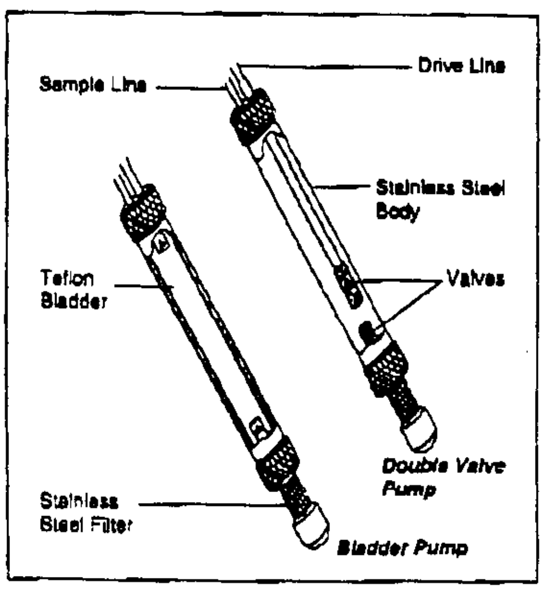
Deep Applications: - used to depths of 2000 ft. (600m).

Direct Burial: - can reduce costs in dedicated and multilevel applications. The bladder-free design allows reliable, maintenance-free operation, over time. Pump filters are available to suit your application.

Portable Models: - can be made for any size or depth of application. No tools required for field decontamination.

Non-Vertical Applications: - operates effectively at any angle and can be placed under landfills, tailings, storage tanks or plumes.

Miniature Model: - allows cost effective sampling from wells as small as 3/4" dia. (1.9 cm).



Bladder Pump: Model 405

Allows consistent high quality samples from all types of applications. The Solinst Bladder Pump utilizes most of the same parts as the Double Valve Pump. The standard size is 1.5" dia. by 2' (3.8 x 61 cm) Conversion from one to the other is efficient and easy (approx. 2 min.), requiring no tools. This is especially useful for portable pumps. It allows faster purging as a Double Valve Pump and sampling as a Bladder Pump when desired.

Low Level VOC Monitoring: - the Solinst Bladder Pump is designed to meet the most rigorous U.S. E.P.A. standards for groundwater monitoring. The pump body is stainless steel, with a Teflon® bladder. It can be used with Teflon® sample tubing for sampling of the highest integrity.

The bladder ensures that drive air or gas does not contact the sample. Bladders and filters only take a few minutes to replace. No tools are needed. Other sizes and materials available.

Features of Both Pumps

High-Flow Valves: - larger intake for increased purge rates.

Zero-Submergence Capability: - allows sampling from low-yield wells and complete emptying of well.

Easy Decontamination: - no tools required; everything easily accessible; replaceable and interchangeable parts; all stainless steel components. All components can be cleaned with LIQUI-NOX®, Hexane, etc.

Leachate/Product Pumping: - the stainless steel, pneumatic drive pumps are well suited for pumping contaminant liquids. Easily and economically pump high solids content, strong solvents and corrosive chemicals. Survive dry pumping, dirty air and sand.

Solinst

Dedicated Pumps

For long term monitoring it is best to dedicate Bladder Pumps or Double Valve Pumps, to reduce sampling time and avoid cross-contamination. The Double Valve Pump offers maintenance-free installations. All dedicated installations are available with well head and protective well cover.

Portable Pumps

For less frequent sampling, portable systems allow access to multiple monitoring wells, even in remote locations. Reel mounted portable units have a convenient carrying handle where tubing length permits. All are available with a lowering guide and depth counter.

Automatic Control Unit

The fully pneumatic control unit requires no battery, is fully automatic, and has a quick exhaust valve for faster pumping. Fill and discharge cycles can be adjusted separately and give high flow rates for purging, and precise low flow to ensure representative samples. (100 ml/m for VOC sampling.)

Gas/air can be prevented from entering the Double Valve Pump sample line, as Solinst controllers allow careful control of the pressure and vent cycles. The convenient lightweight case is rugged and dependable in all environments.

Quick connect fittings allow instant attachment to dedicated well heads and portable reels.

Size & Material Options

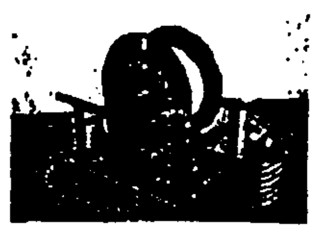
Model 405: Bladder Pump - The pump body of the standard model is a convenient 1.5" dia. x 2 ft long (3.8 cm x 61 cm). The construction is all 316 stainless steel, with Viton® o-rings, and a Teflon® bladder. Other sizes are available on request.

Model 403: Double Valve Pump - The two standard pump body sizes are: 5/8" dia. x 1 ft long (1.6 cm x 30 cm)
1.5" dia. x 2 ft long (3.8 cm x 61 cm)

Other sizes are available on request. Construction is all 316 stainless steel, with Viton® o-rings. The small 5/8" dia. model is adapted slightly for use in the Waterloo System.

Tubing - Teflon®, Teflon®-lined polyethylene, and nylon tubing is available in a variety of sizes. The standard is dual-line, bonded polyethylene:

1/4" for the 5/8" pump (6 mm for 1.6 cm pump)
1/2" for the 1.5" pump (12 mm for 3.8 cm pump)



Flow Rates

Flow rates vary with depth of pump, depth below water level, size of drive and sample tube, drive and vent cycle times, gas pressure applied, aquifer recharge, and size of pump body.

The Solinst Bladder Pump compares favourably with published data for similar sized bladder pumps under similar conditions.

- **2'x1.5" Bladder Pump** at 120 psi, with 1/2" drive and sample lines, at 150' (50 m) below water level gives 1.5 l/min.
- **2'x1.5" Double Valve Pump** at 120 psi, with 1/2" drive and sample lines, at 150' (50 m) below water level gives 3.3 l/min.

Drive-Point Double Valve Pump: Model 406

Allows direct placement of a pump for sampling without drilling a borehole. The Drive-Point Double Valve Pump can be driven directly into soft sands and clays to 65 ft. (20m) and more.

The pump allows sampling at various depths during placement. A vacuum may be applied for low-flow conditions. A unique bladder seals the filter during driving to keep sediment out. It creates a surging action on the screen to help develop a sand pack around the pump and prevent the screen from clogging. The 1" dia. by 10" (2.54 x 25.4 cm) stainless steel pump achieves flow rates up to 1 l/min. Drive-in accessories are available, including extension rods, tubing, well head, pump control units.

Accessories

Controllers - automatic and manual models available.
Air Compressor: - to suit application.
Buggy: - for compact field transport of pump and accessories.
Packers: - minimize purge time by reducing the purge volume required and the cost of disposal and labour.
Filters: - 700 sq. cm filter area, disposable, with a barbed fitting to connect to a variety of tube sizes.
Sample Labeler™: - software offers better quality control of sampling schedules. Pre-print sample labels and a summary list from a data base. Avoids forgotten or illegible samples and expensive repeat samples.
Well Head, Protective Well Cover, Lowering Guide, Depth Counter.

Ordering Information

Double Valve and Bladder Pumps

Specify: Model 403, 405 or 406
- Dedicated or portable use
- Size required
- Depth to sampling point(s)
- Special materials
- Accessories

Printed in Canada
03/93

For further information contact: Solinst Canada Ltd.
The Williams Mill, 515 Main Street, Glen Williams, ON, L7G 3S9
Fax: (416) 873-1992 Tel: (416) 873-2255 or (800) 661-2023

Solinst

Pneumatic Bladder Sampling Pumps

Well Wizard pumps come in an unmatched range of sizes and materials—plus a 10-year warranty.

THE BEST PUMPS FOR YOUR PROJECT-GUARANTEED!

No matter how demanding your application, we've got the pump. Need samples from over 600 feet? Testing in the ppb range? What about other tough sample collection problems—aggressive/corrosive environments, non-standard well casings, difficult site conditions? No matter what the challenge, QED makes a pump that will do the job better.

So much better, we guarantee it. Dedicated Well Wizard bladder pumps with protective intake screens are guaranteed for ten years against pump failure. They'll keep on working or QED will repair or replace them free. Nobody else in the business offers this level of protection.

PURGE AND SAMPLE WITH THE SAME PUMP

In many situations, a Well Wizard bladder pump can be used for both purging and sampling. For low purge volumes, a standard model (1100, 1200, or 1300-series) may be the choice. Model T1200 is most commonly used. For greater volumes, a high-rate 1500-series Power Pump will cut purging times (and labor costs) by approximately 50%.

The advantages are obvious. A single-pump system is simple to specify and install; extremely economical; and delivers unmatched bladder-pump sample quality. Large purge volumes may require the use of an accessory, such as a Purge Mizer™ inflatable packer or a purge pump; see pp. 18-19 for details.

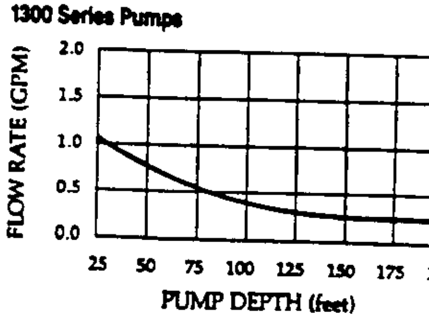
Top to bottom: P1101S, P1201, T1100, T1200, T1300 Pumps

SPECIFICATIONS:

MODEL NO.	PUMP MATERIAL	BLADDER MATERIAL	INTAKE SCREEN	FITTING MATERIAL	MAXIMUM LIFT (ft.)	LENGTH (Dimension in inches)	DIA	WEIGHT (lbs)
T1100	Teflon	Teflon	Opt	Teflon	250	40.33	1.66	4
P1101S	PVC	Teflon	Std	Polypro	300	52.00	1.66	3
ST1101P	316 S.S.	Teflon	Std	316 S.S.	1000	49.00	1.66	10
T1200	Teflon/316 S.S.	Teflon	Opt	316 S.S.	300	41.14	1.50	5
P1201	PVC/316 S.S.	Teflon	Opt	Polypro	300	41.23	1.50	4
P1201H	PVC/316 S.S.	Teflon	Opt	316 S.S.	600	41.37	1.50	4
T1300*	Teflon/316 S.S.	Teflon	Std	316 S.S.	200	46.75	1.00	3
Power Pumps								
P1500*	PVC/316 S.S.	Teflon	Opt	316 S.S.	200	93.00	1.50	9
T1500*	Teflon/316 S.S.	Teflon	Opt	316 S.S.	200	93.00	1.50	9

* T1300, P1500, and T1500 require Clamp Tool No. 35188 for field attachment of tubing. Clamps are provided w/ pump.

1300 Series Pumps



Note: Flow rates are based on pump submergence 25 feet and operating gas pressure of 100 psi from 3111HR Air Source/Controller. Call for flow rates under other conditions.

ATTACHMENT 2

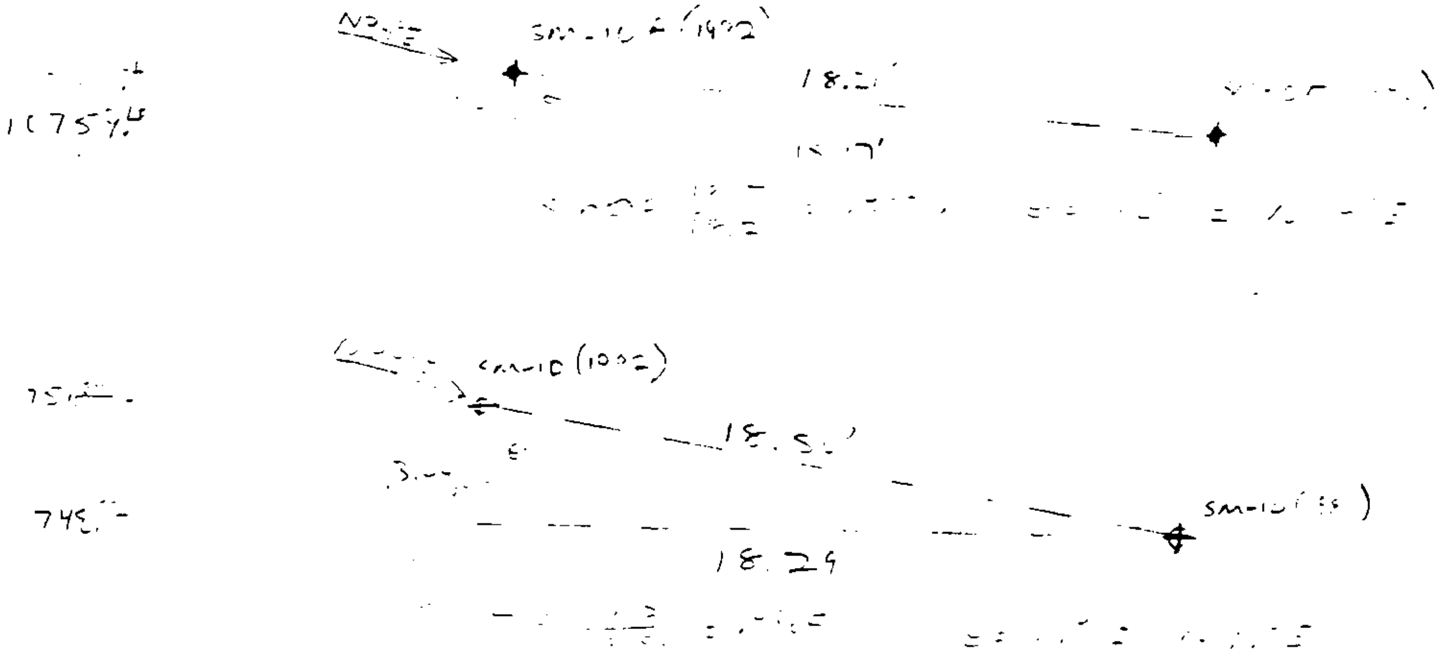
CALCULATIONS

Golder Associates

SUBJECT Well Deviation / Emelle AL.		
Job No. 933-3513	Made by JSE	Date 7/22/93
Ref.	Checked	Sheet 2 of 2
	Reviewed	

5459.83   5478.00

Horizontal Displacement of SM-10 + SM-10A + Vertical



Horizontal Displacement

SM-10 = 18.54 ft. Dip Direction N 74°E.

SM-10A = 18.21 ft. Dip Direction N 74°E

Total Displacement

$$SM\text{-}10 = \sqrt{(18.54\text{ ft})^2 + (33.56\text{ ft})^2} = 38.34\text{ ft}$$

$$SM\text{-}10A = \sqrt{(18.21\text{ ft})^2 + (33.03')^2} = 38.07\text{ ft}$$

Attachment 2

Golder Associates	SUBJECT Well Deviation / EMELLE, AL		
	Job No. 933-3513 Ref.	Made by JSR Checked Reviewed	Date 7/22/93 Sheet 1 of 2

RE: Determine well displacement from elevation + horizontal coordinates before and after well extensions.

1991 SM-10 ELEV. TOC = 195.19'

N 10,748.80' E 5477.[illegible]'

SM-10A ELEV. TOC = 195.90'

N 10754.[illegible] E 5478.[illegible]

1992 SM-10 ELEV. TOC = 228.75' FT MSL

N 10,751.[illegible] E 545[illegible]

SM-10A ELEV. TOC = 229.33 FT. MSL

N 10,760.31 E 5459.[illegible]

Vertical Displacement

SM-10 228.75' - 195.19' = 33.56'

SM-10A 229.33' - 195.90' = 33.43'

WELL INSTALLATION LOG / Also PCO Wells

APR - 1 1988

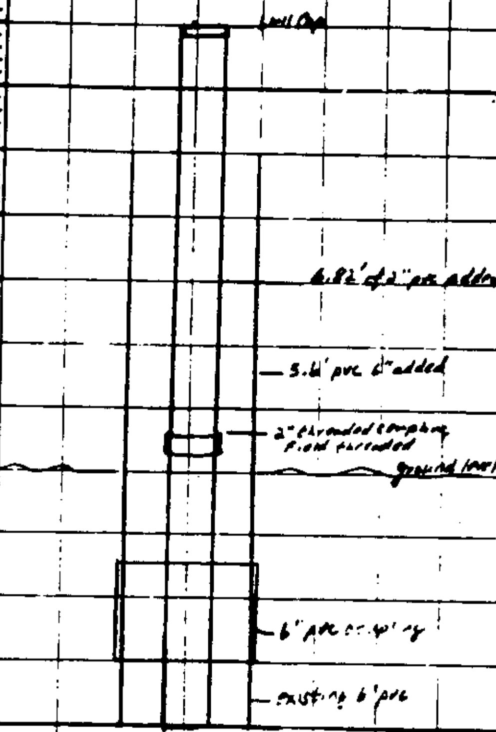
JOB NO.	PROJECT Closure Trench 16 Well raised
WELL NO. PM 17	SHEET ___ OF
GA INSP.	DRILLING METHOD
GROUND ELEV. 247.2	WATER DEPTH
WEATHER	DRILLING COMPANY
COLLAR ELEV. 250.94	DATE/TIME
TEMP.	DRILL RIG
DRILLER	STARTED 5/16/86 (TIME / DATE)
COMPLETED	

MATERIALS INVENTORY

WELL CASING ___ in. dia. ___ LF	WELL SCREEN ___ in. dia. ___ LF	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	

WELL SKETCH



INSTALLATION NOTES

Well raised in stage[s]
Two 2'x4' barrier [illegible]
shown. Well had previ[ously]
been raised before [illegible]

PVC + tools steam clea[ned]
Well field threaded. [illegible]
added. Threads teflon [illegible]
6" pvc added to [illegible]
6" pvc from previous rai[se]
5 gal bentonite pellets [illegible]
6" annulus.
Well barrier 6" steel
with locking cap set
new elev. msl 250.9[illegible]

WELL DEVELOPMENT NOTES

taken from Closure report 8-18 + 20 1986 pages 1-9

(1)

WELL INSTALLATION LOG

JOB NO. ______ PROJECT *Trench 16 Closure Well raised* WELL NO. *GM 18* SHEET *1*

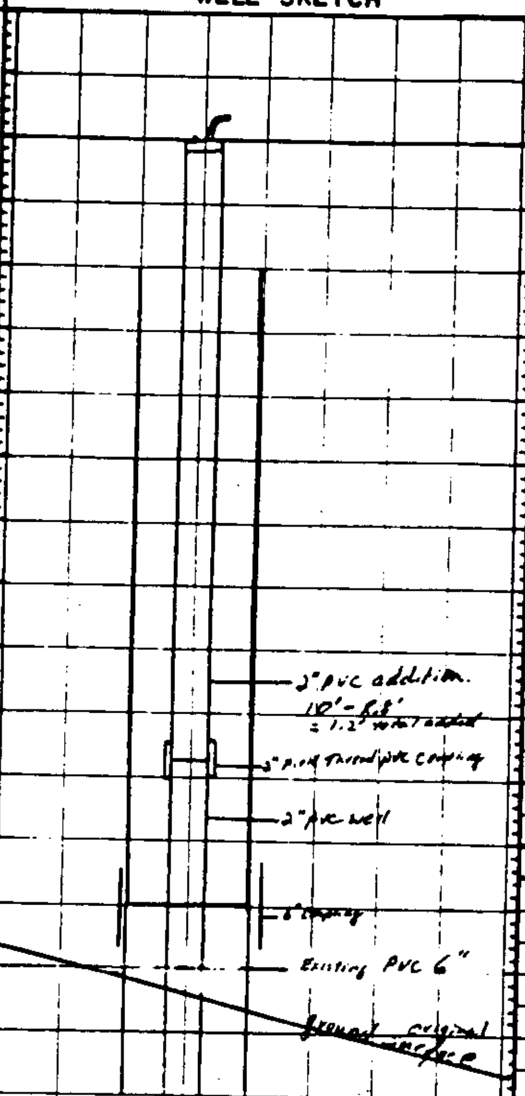
GA ENGR. ______ DRILLING METHOD ______ GROUND ELEV. *198.6* WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ Top of Casing / COLLAR ELEV. *201.02* DATE/TIME ______

TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED *5/ / 5/16/86* COMPLETED ______

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f.	WELL SCREEN ____ in. dia. ____ l.f.	BENTONITE SEAL ____
CASING TYPE ____	SCREEN TYPE ____	INSTALLATION METHOD ____
JOINT TYPE ____	SLOT SIZE ____	FILTER PACK QTY. ____
GROUT QUANTITY ____	CENTRALIZERS ____	FILTER PACK TYPE ____
GROUT TYPE ____	DRILLING MUD TYPE ____	INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
0.0	GROUND SURFACE		*5-16-86 Well raised. 10.0' section added to 6" pvc connected to existing pvc. Well cap replaced placed over well.* *Final grade elevation changed. Addition to well cut off so that only a [illegible] of 1.2' added to well. 2'x4' concrete [illegible] Steel well locking cap, Bentonite pellets in [illegible] Steel annulus.* *NGD msl elev. 201.0[illegible] Well depth 198.6'*

WELL DEVELOPMENT NOTES

WELL INSTALLATION LOG

[redacted] PROJECT *T30 Closure Well raising* WELL NO. *MS4* SHEET *1* OF

GE NAME [redacted] DRILLING METHOD [redacted] GROUND ELEV. *0*(?) WATER DEPTH

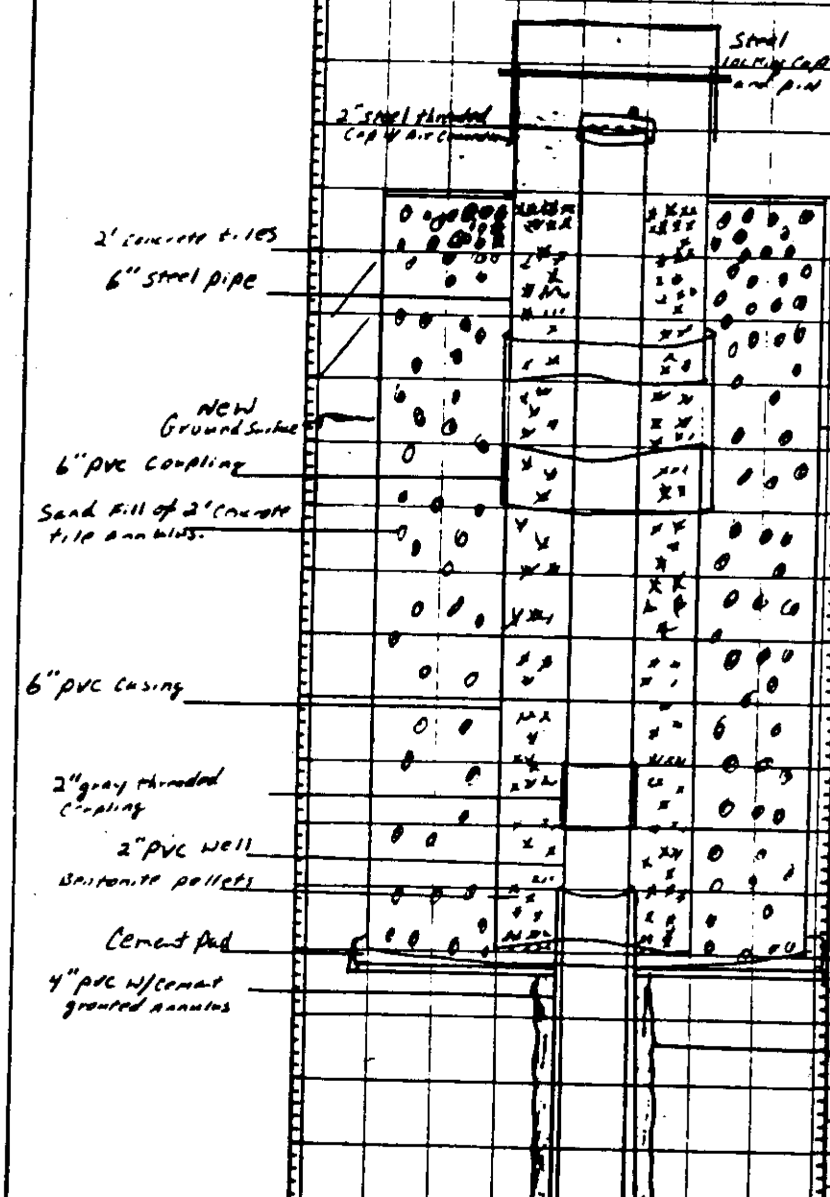
WEATHER [redacted] DRILLING COMPANY [redacted] COLLAR ELEV. *246.13* DATE/TIME

TEMP. [redacted] STARTED ___ TIME / DATE COMPLETED ___ TIME /

MATERIALS INVENTORY

WELL CASING *2* [redacted]	WELL SCREEN ___ in. dia. ___ ft	BENTONITE SEAL
CASING TYPE *4" and 6"*	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE *threaded*	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
0.0	GROUND SURFACE		



INSTALLATION NOTES

2" pvc cut off with ... hacksaw 3" below the gl... joint attached 6-29-94 ... 2" pvc rethreaded with field threader, wrapped ... teflon tape and joined w... a threaded 2" pvc coupling ... All tools and new pvc ... steam cleaned and ... Well in plastic 2' x 4' ... concrete tiles placed ... raised well to protect ... fill. 10' section ... to well ... Well ... unlocated until final grade ... Plastic bag over ... interim. WR197 2.15' ... off and well protection ... 7.85' total added new ca... Pick elev. 246.13

Bentonite pellets poured in 6" ... ground surface

WELL DEVELOPMENT NOTES

6" borehole w/ portland cement grout

MONITORING WELL INSTALLATION LOG

JOB NO.: ______ PROJECT: Albany Trenches 18+17 well raised WELL NO. M57 SHEET 1

GA MGR. [redacted] GROUND ELEV. 203.6 WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ COLLAR ELEV. 207.40 DATE/TIME ______

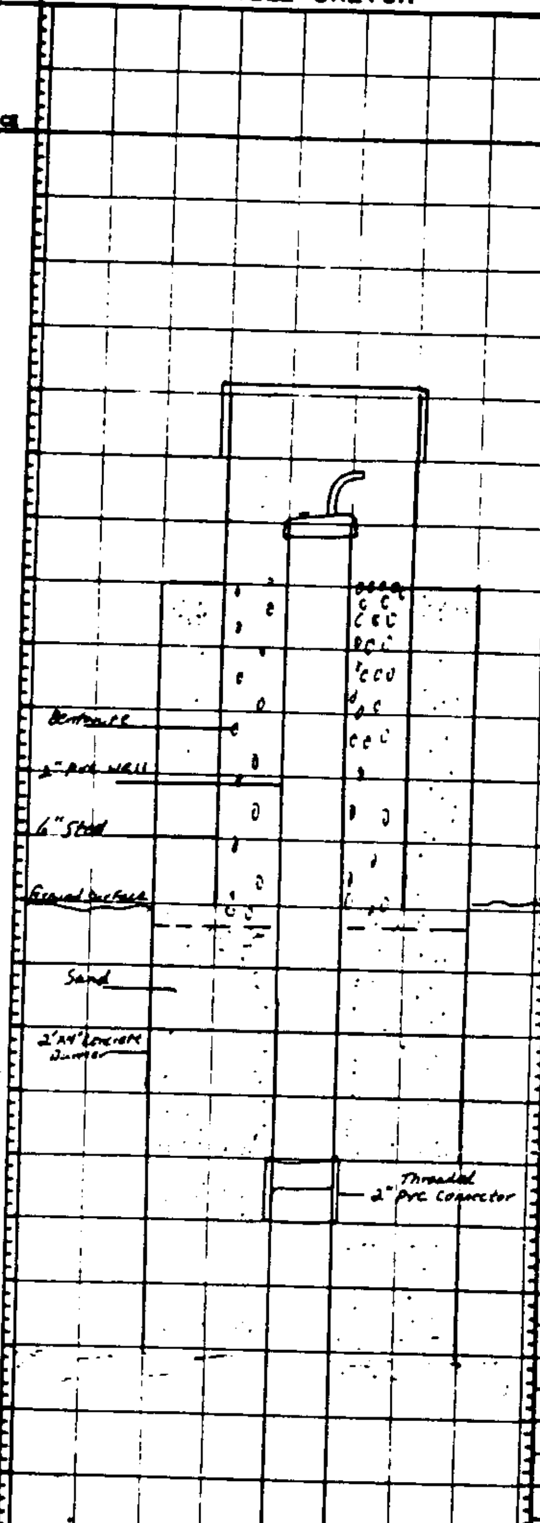
TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED 9:00 5-19-86 (TIME / DATE) COMPLETED ______

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ LF	WELL SCREEN ______ in. dia. ______ LF	BENTONITE SEAL ______
CASING TYPE ______	SCREEN TYPE ______	INSTALLATION METHOD ______
JOINT TYPE ______	SLOT SIZE ______	FILTER PACK QTY. ______
GROUT QUANTITY ______	CENTRALIZERS ______	FILTER PACK TYPE ______
GROUT TYPE ______	DRILLING MUD TYPE ______	INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	GROUND SURFACE		
0.0			

WELL SKETCH



INSTALLATION NOTES

6" steel protective pi[...] and cap removed. Conc[...] pad broken to remov[...] steel.

2" well field threaded [...] taped threads. 6.7" add[...] (Two) 2'x4' concrete barri[...] tiles placed around well [...] bentonite pellets poured [...] annulus.

WELL DEVELOPMENT NO[TES]

MONITORING WELL INSTALLATION LOG

JOB NO. ______ PROJECT ______ WELL NO. M62 SHEET 1 OF ______

GA INSP. ______ DRILLING METHOD ______ GROUND ELEV. 252.6 WATER DEPTH ______

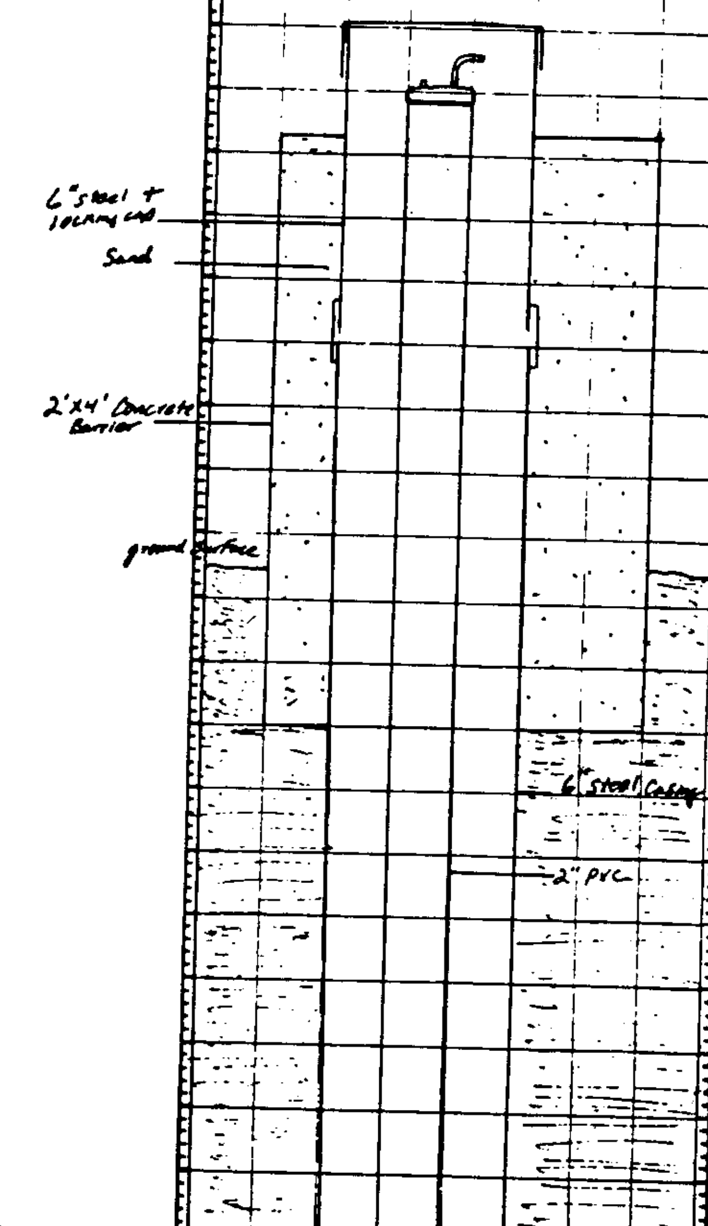
WEATHER ______ DRILLING COMPANY ______ TOP OF CASING ELEV. 260.83 DATE/TIME ______

TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED 4-2-86 TIME / DATE COMPLETED ______

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ LF	WELL SCREEN ______ in. dia. ______ LF	BENTONITE SEAL ______
CASING TYPE ______	SCREEN TYPE ______	INSTALLATION METHOD ______
JOINT TYPE ______	SLOT SIZE ______	FILTER PACK QTY ______
GROUT QUANTITY ______	CENTRALIZERS ______	FILTER PACK TYPE ______
GROUT TYPE ______	DRILLING MUD TYPE ______	INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH
	GROUND SURFACE	
0.0		



INSTALLATION NOTES

4-2-86 removed barrier ... well. Cut away approx. 6' of 6" steel casing f... well. Some sand fell ... 6" annulus no grout ... at top. 2" PVC drill ... threaded for resetting ... cap tubing. Total 4.9' ... cut from well. ... New elev shot 260.83 ... New well depth 161.6' ... 2'x4' Concrete barrier ... 6" steel with locking ca... set over well when final grade reached. B... (5 gal) poured in 6" stee...

WELL DEVELOPMENT NOTES

MONITORING WELL INSTALLATION LOG

JOB NO. ____ PROJECT Trans Chem Well mixed WELL NO. M64 SHEET 1 OF ____
ENGINEER ____ DRILLING METHOD ____ GROUND ELEV. 270.7 WATER DEPTH ____
WEATHER ____ DRILLING COMPANY ____ COLLAR ELEV. 274.60 DATE/TIME ____
TEMP ____ DRILL RIG ____ DRILLER ____ STARTED 5/16/86 COMPLETED 7-2[illegible]

MATERIALS INVENTORY

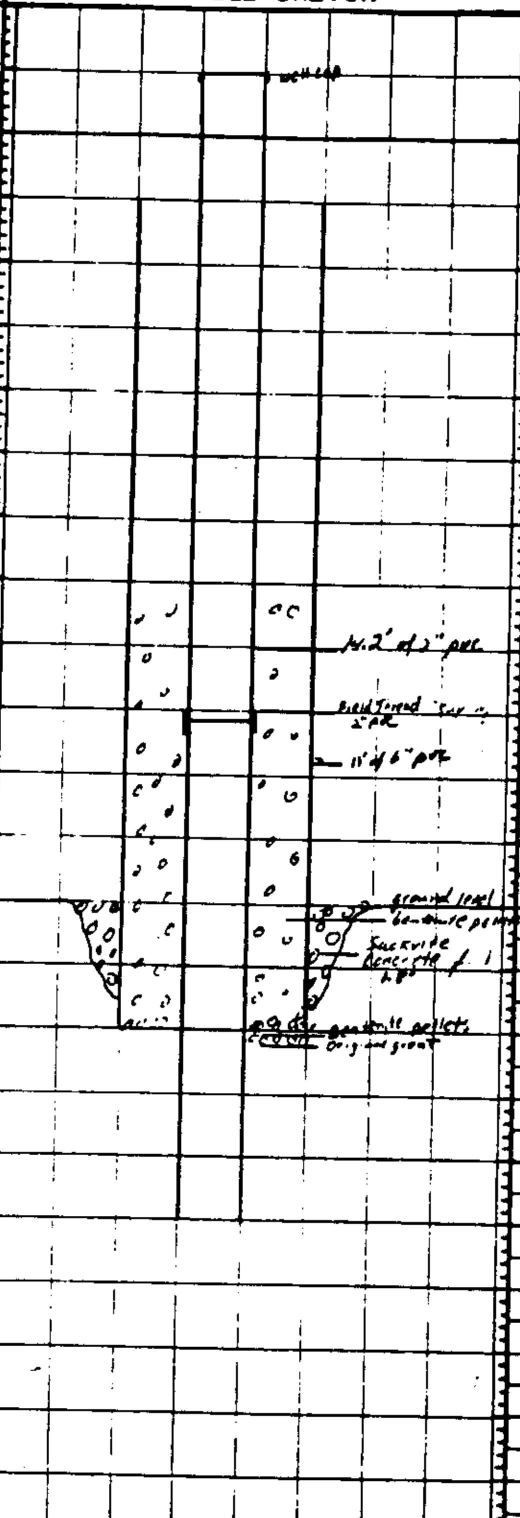
WELL CASING ____ in. dia. ____ LF
CASING TYPE ____
JOINT TYPE ____
GROUT QUANTITY ____
GROUT TYPE ____

WELL SCREEN ____ in. dia. ____ LF
SCREEN TYPE ____
SLOT SIZE ____
CENTRALIZERS ____
DRILLING MUD TYPE ____

BENTONITE SEAL ____
INSTALLATION METHOD ____
FILTER PACK QTY. ____
FILTER PACK TYPE ____
INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	

WELL SKETCH



INSTALLATION NOTES

pvc + tools steamed [illegible]
threaded joints teflon [illegible]
6" pvc added to protect
well from fill. bentonite
pellets around bottom of 6"
in annulus. 14.2' added
well total.

Concrete pad 6" steel
and locking cap placed
around well. not shown
New coll elev 274.6[illegible]
depth of well 153.99'

WELL DEVELOPMENT NOTES

JOB NO. ______ PROJECT *Trench Closure Well raised* WELL NO. *M66* SHEET *1* OF ___

SA INSP. ______ DRILLING METHOD ______ GROUND ELEV. *249.97* WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ *Top of Casing* COLLAR ELEV. *251.99* DATE/TIME ______

TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED ______ TIME / DATE COMPLETED ______ TIME /

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ l.f. WELL SCREEN ______ in. dia. ______ l.f. BENTONITE SEAL ______

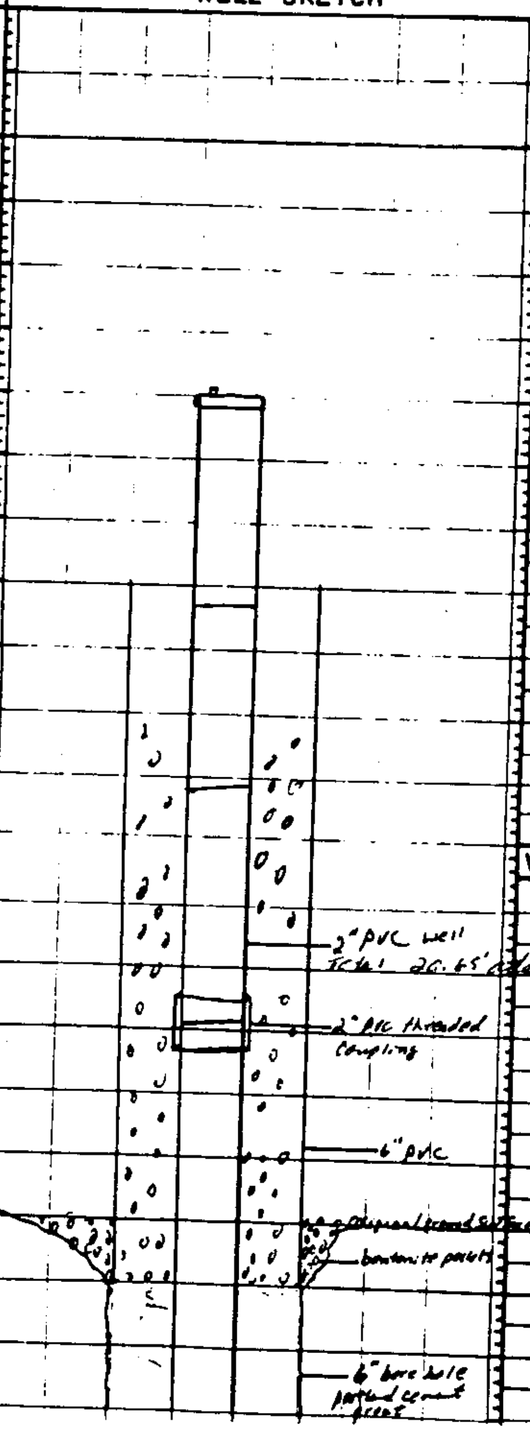
CASING TYPE ______ SCREEN TYPE ______ INSTALLATION METHOD ______

JOINT TYPE ______ SLOT SIZE ______ FILTER PACK QTY. ______

GROUT QUANTITY ______ CENTRALIZERS ______ FILTER PACK TYPE ______

GROUT TYPE ______ DRILLING MUD TYPE ______ INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	~~GROUND SURFACE~~		
0.0			



INSTALLATION NOTES

Well raised in Stages as fill was placed. PVC 2" [illegible] Steam Cla[illegible] Carried to well and kep[illegible] wrapped in plastic. 2" PVC field threaded joi[illegible] wrapped w/ teflon tape. 6" PVC placed on top [illegible] what looked like 6" bor[illegible] grout. 6" PVC held [illegible] fill placed around well. [illegible] bag placed over well [illegible] while [illegible] Fill allowed to settle + [illegible] 2'x4' Concrete barrier [illegible] Steel with locking cap placed around well. N+SH[illegible] New elev. 251.99 ms[illegible] New depth 122.0' fr[illegible] Top of Casing. Bentonite pellets [illegible] down 6" steel [illegible]

WELL DEVELOPMENT NOTES

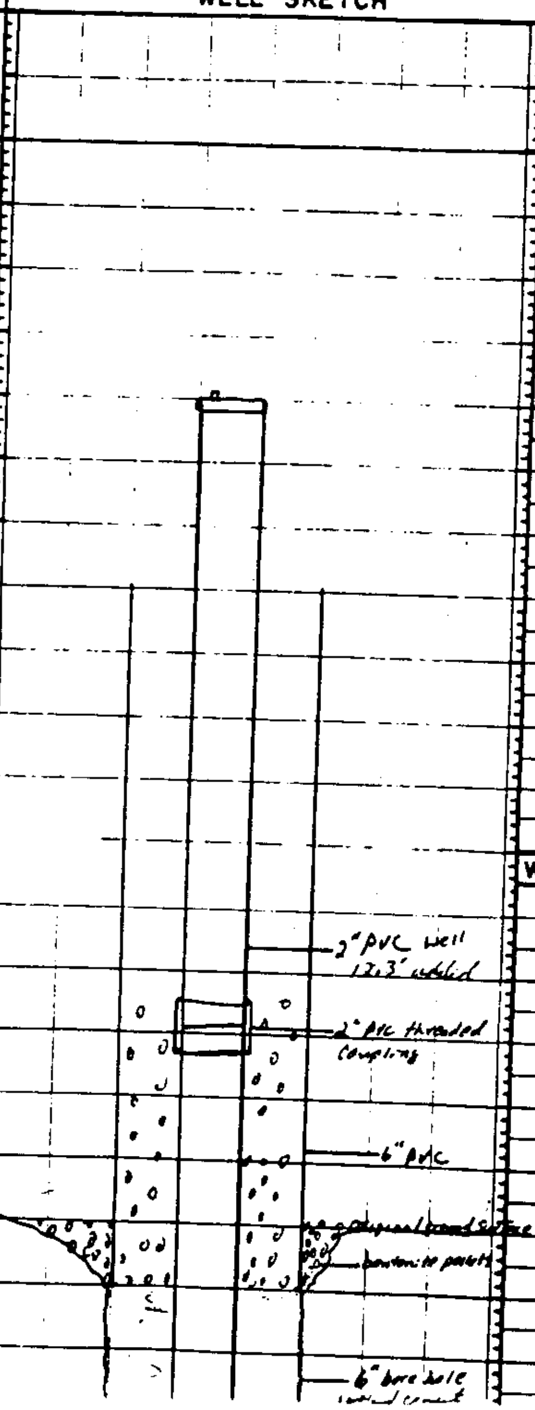
JOB NO. ______ PROJECT Trench Closure Well raised for road WELL NO. M 68 SHEET 1 OF ______
GA INSP. ______ DRILLING METHOD ______ GROUND ELEV. 198.3 WATER DEPTH ______
WEATHER ______ DRILLING COMPANY ______ Top of Casing COLLAR ELEV. 202.08 DATE/TIME ______
TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED ______ TIME / DATE COMPLETED ______ TIME

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ l.f. WELL SCREEN ______ in. dia. ______ l.f. BENTONITE SEAL ______
CASING TYPE ______ SCREEN TYPE ______ INSTALLATION METHOD ______
JOINT TYPE ______ SLOT SIZE ______ FILTER PACK QTY. ______
GROUT QUANTITY ______ CENTRALIZERS ______ FILTER PACK TYPE ______
GROUT TYPE ______ DRILLING MUD TYPE ______ INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	~~GROUND SURFACE~~		
0.0			

WELL SKETCH



INSTALLATION NOTES

Well protection removed 2" PVC field threaded 12.3' added to well. Teflon taped threaded joints. 6" PVC placed over well with crane bentonite pellets placed at bottom. 6" PVC held while fill placed 2'x2' concrete [illegible] with 6" steel pad locking Cap placed 2 [illegible] [illegible] Fill finished to final grade.
Bentonite pellets in annulus.
[illegible] elev. MSL 202.[illegible]
Well depth 122.0'

WELL DEVELOPMENT NOTES

JOB NO. ____ PROJECT *Trench Closure Well raised* WELL NO. *M69* SHEET *1* OF ____

GA INSP. ____ DRILLING METHOD ____ GROUND ELEV. *232.4* WATER DEPTH ____

WEATHER ____ DRILLING COMPANY ____ *Top of Casing* COLLAR ELEV. *234.62* DATE/TIME ____

TEMP. ____ DRILL RIG ____ DRILLER ____ STARTED ____ (TIME / DATE) COMPLETED ____ (TIME)

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f. | WELL SCREEN ____ in. dia. ____ l.f. | BENTONITE SEAL ____

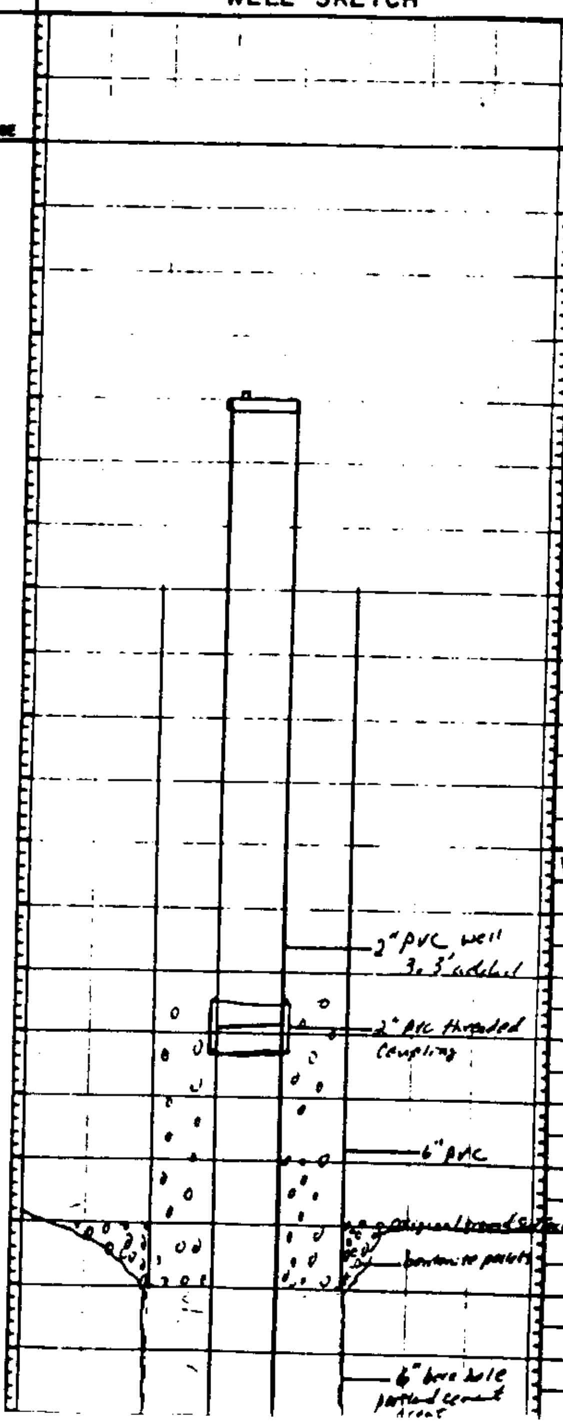
CASING TYPE ____ | SCREEN TYPE ____ | INSTALLATION METHOD ____

JOINT TYPE ____ | SLOT SIZE ____ | FILTER PACK QTY. ____

GROUT QUANTITY ____ | CENTRALIZERS ____ | FILTER PACK TYPE ____

GROUT TYPE ____ | DRILLING MUD TYPE ____ | INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	~~GROUND SURFACE~~		
0.0			



INSTALLATION NOTES

Well barrier remove[d]
2" PVC full threaded
6" and 2" PVC tools
steam cleaned. 2"
added first, threaded
teflon threads. Well
cap next. 6" PVC
lowered over well.
pellets placed at bottom
2'x4' concrete barrier
set. Fill placed a[round]
well. Another 2'x4'
barrier placed on to[p]
Annular filled w/ sa[nd]
Bentonite in 6" an[nulus]
6" steel well cap set.
Concrete top poured.
New elev. TOC 234.
new depth 147.5

WELL DEVELOPMENT NOTES

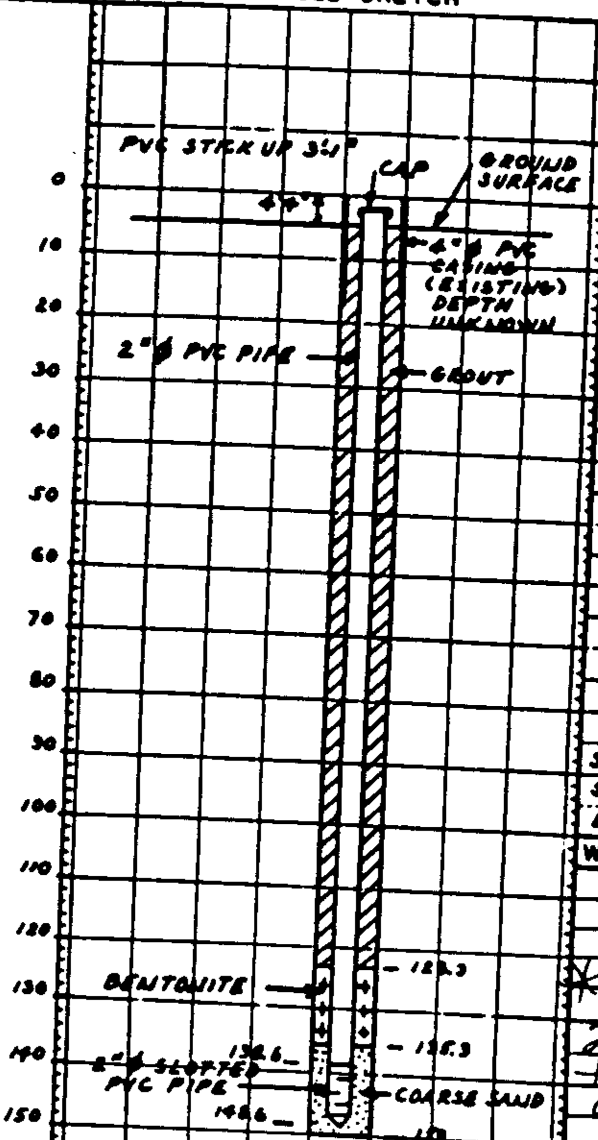
MONITORING WELL INSTALLATION LOG

[illegible] 884-1308	PROJECT SWM/EMELLE/ALA.	WELL NO. MSS	SHEET 1 OF 1
[illegible] CSH/JVR	DRILLING METHOD HAND COMPLETED	GROUND ELEV.	DEPTH [illegible]
WEATHER SUNNY	DRILLING COMPANY —	(PVC TOP) ELEV. 222.40 ✱	DATE/TIME 10-17-89
TEMP WARM	DRILL RIG —	DRILLER —	STARTED — TIME / DATE — COMPLETED — TIME / DATE

MATERIALS INVENTORY

WELL CASING 2 IN. DIA. 140 FT	WELL SCREEN 2 IN. DIA. 10 FT	BENTONITE SEAL ✓
CASING TYPE BK TRILOCK SCH 40 PVC	SCREEN TYPE SLOTTED PVC TRILOCK	INSTALLATION METHOD HAND POURED
JOINT TYPE FLUSH THREADED	SLOT SIZE 0.010	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS NONE	FILTER PACK TYPE COARSE SAND
GROUT TYPE PORTLAND CEMENT		INSTALLATION METHOD HAND POURED

DEPTH/ELEV	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
			WELL WAS PREVIOUSLY DRILLED



INSTALLATION NOTES

INSERT PVC
ADD SAND
135.3' TOP OF SAND
ADD BENTONITE
123.3' TOP OF BENTONITE

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

✱ approximately 25' was added to the well after damage in 1991.

The elevation at the top of PVC is 248.95

REDRAWN BY SAR

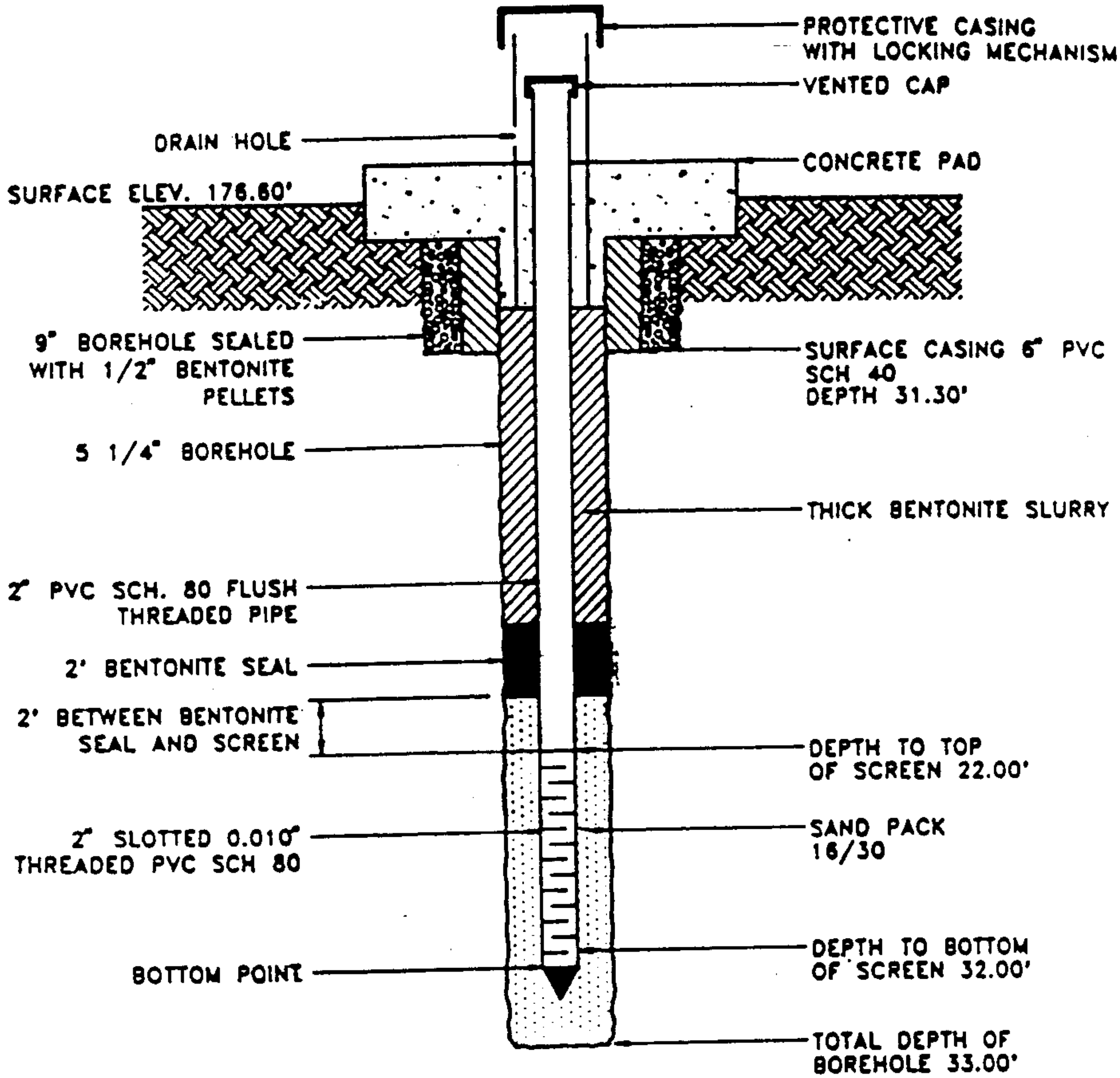
Attachemnt 2
TSCA Well Summary
Well ID Chart
Average

Date : November 1997

Well Id. Number	Active or Inactive	Purpose	Gradient	Northing	Easting	Well Depth	Elev. Top of PVC Casing	Elev. Top of Casing (Original)
M-3	A	TSCA	Down	14,405	6198	161.2	178.68	182.35
PM-17	A	TSCA	Down	11,309	5511	151.9	204.84	191.34
PM-18	A	TSCA	Down	11,111	5859	150	225.64	202.59
M-54	A	TSCA	Down	11,091	6690	154.6	245.16	238.91
M-55	A	TSCA	Down	10,815	6372	171.0	248.95	222.16
M-56	A	TSCA	Down	14,112	5861	93.9	204.90	191.51
M-57	A	TSCA	Down	13,795	7112	157	207.34	207.40
M-58	A	TSCA	Down	12,689	7048	206.5	252.96	247.68
M-59	A	TSCA	Down	13,884	5675	105.7	196.30	196.30
M-61	A	TSCA	Down	12,995	9349	110.6	218.37	218.37
M-62	A	TSCA	Down	12,500	9679	166.8	260.84	265.84
M-64	A	TSCA	Down	12,287	6997	141.1	274.69	264.40
M-65	A	TSCA	Down	11,625	7154	130.24	278.66	278.66
M-66	A	TSCA	Down	11,425	6531	118.0	252.22	231.37
M-68	A	TSCA	Down	12,464	5268	117.2	201.95	189.77
M-69	A	TSCA	Down	13,171	7442	143.05	234.03	231.32

APPENDIX E-8

DOCUMENT 5



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

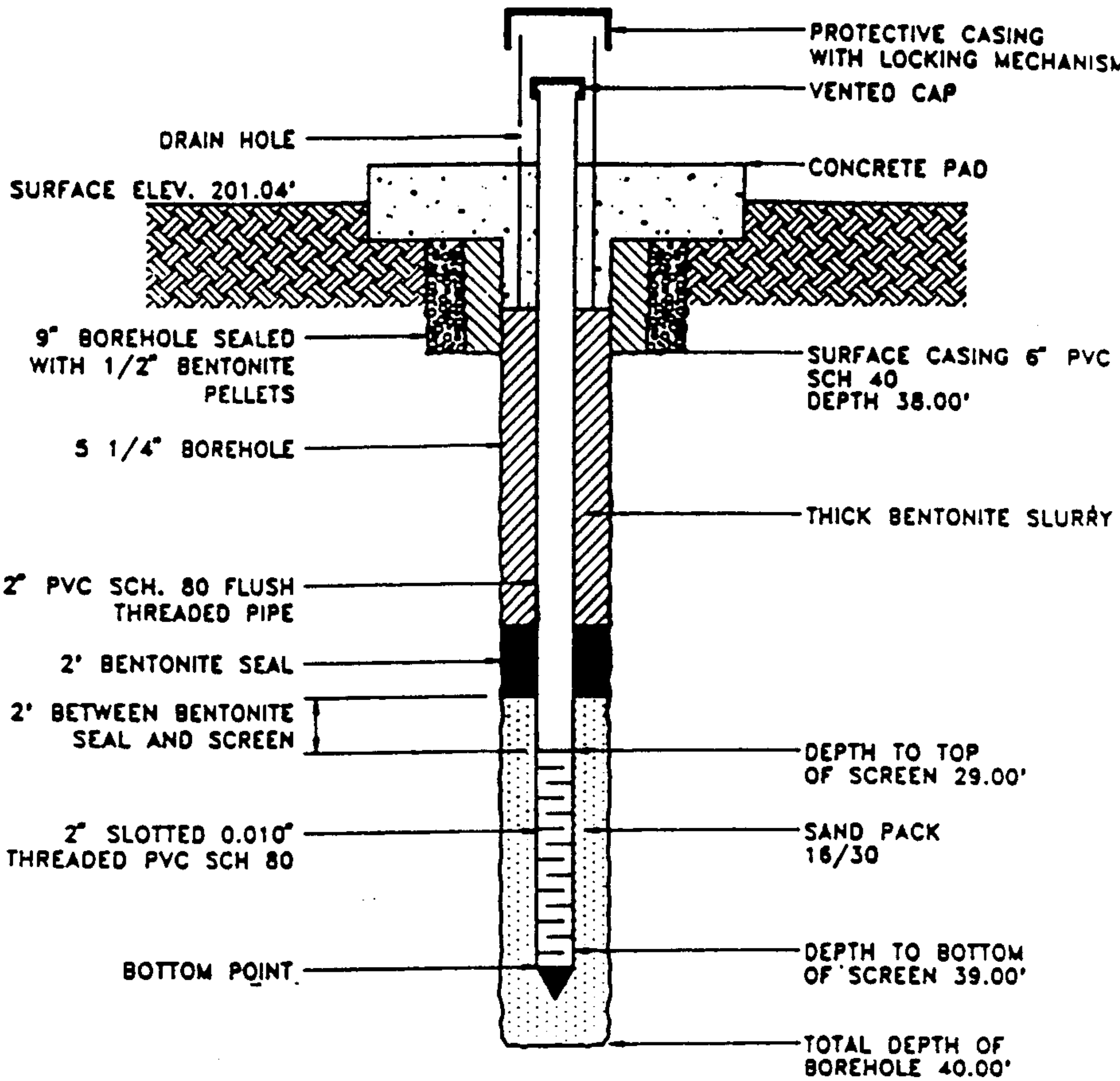
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-17

Woodward-Clyde

NOT TO SCALE

FIGURE: 1



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

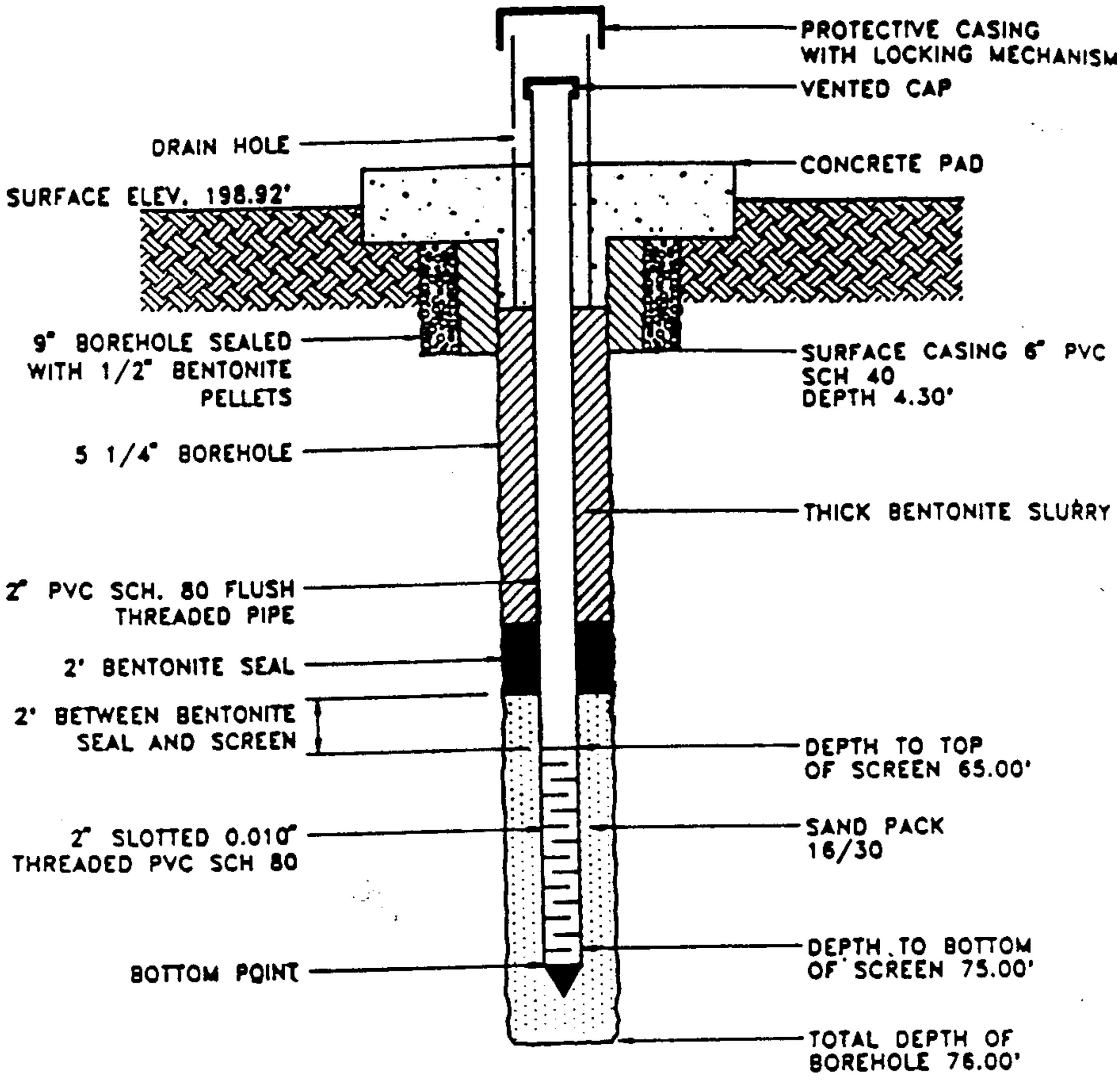
ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-18

Woodward-Clyde
Consulting Engineers, Geologists and Environmental Scientists

Job No.: [illegible]	Drawing No. [illegible]	Date: [illegible]
Drawn by: [illegible]	Checked by: [illegible]	FIGURE:
Scale: NOT TO SCALE		2



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

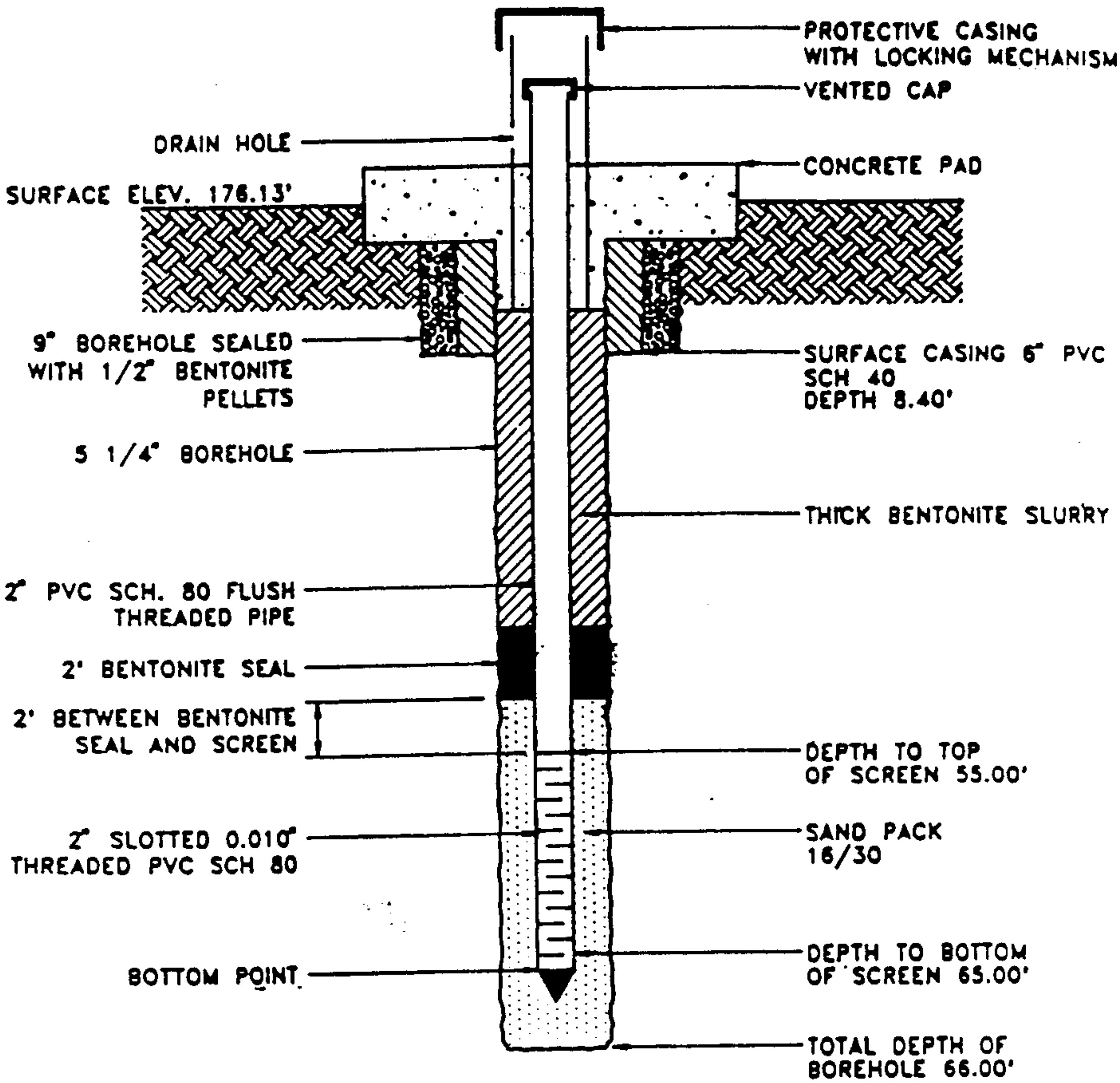
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-19

Woodward-Clyde

NOT TO SCALE

FIGURE:
3



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

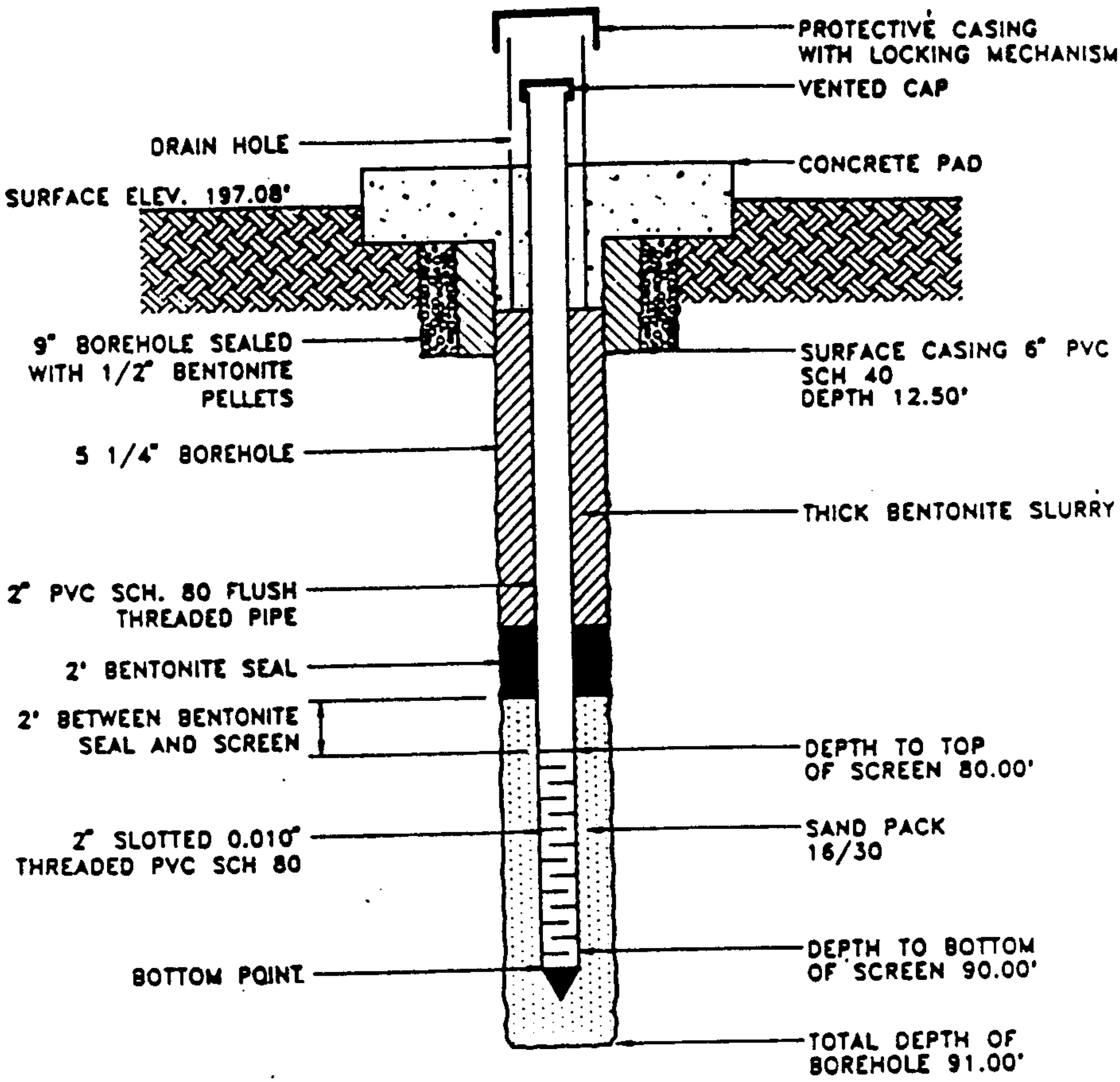
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-20

Woodward-Clyde

NOT TO SCALE

FIGURE: 4



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

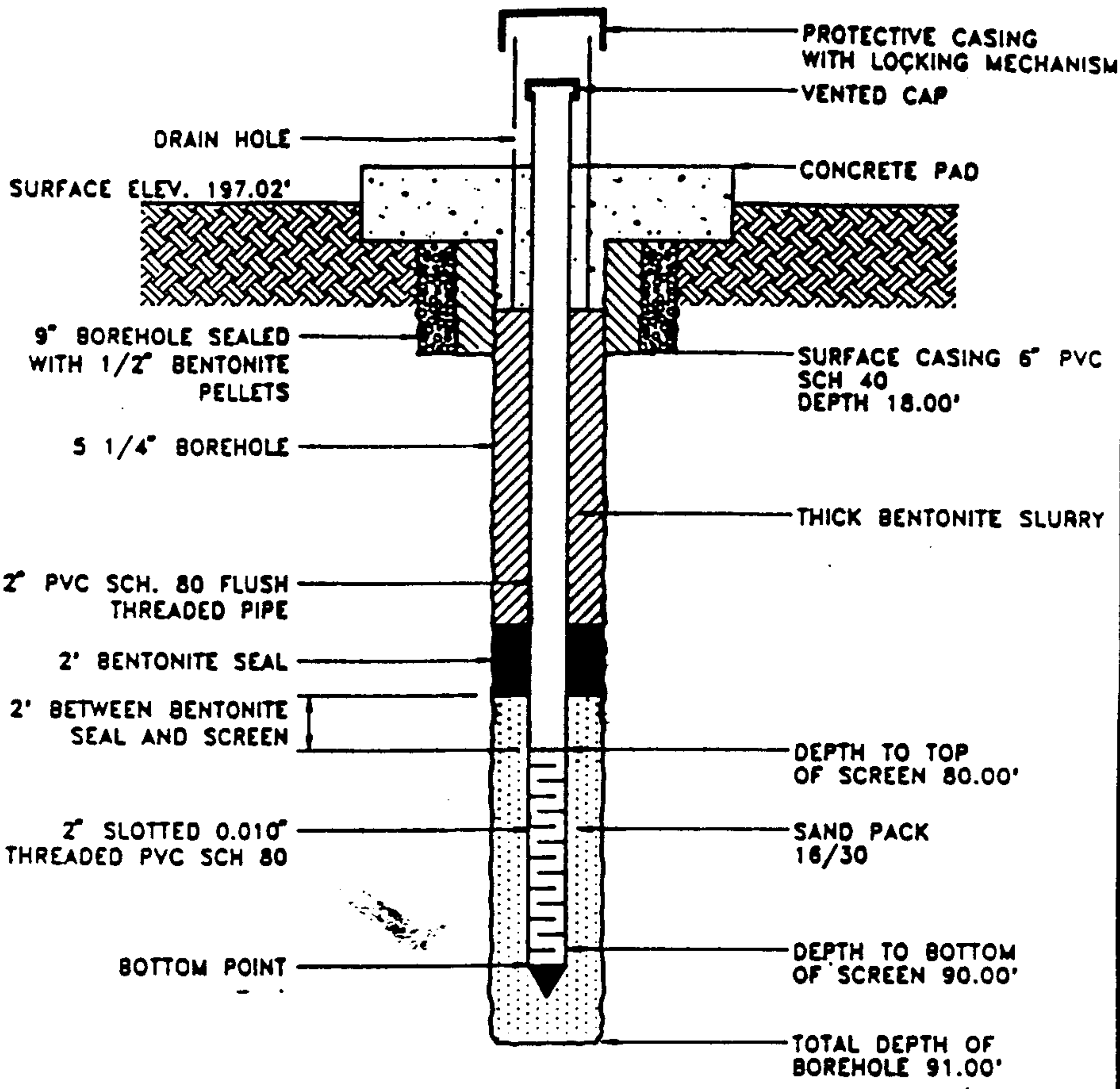
ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-21

Woodward-Clyde
[illegible]

Job No.: [illegible]	Drawing No.: [illegible]	Date: [illegible]
Drawn by: [illegible]	Checked by: [illegible]	FIGURE:
Scale: NOT TO SCALE		5



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

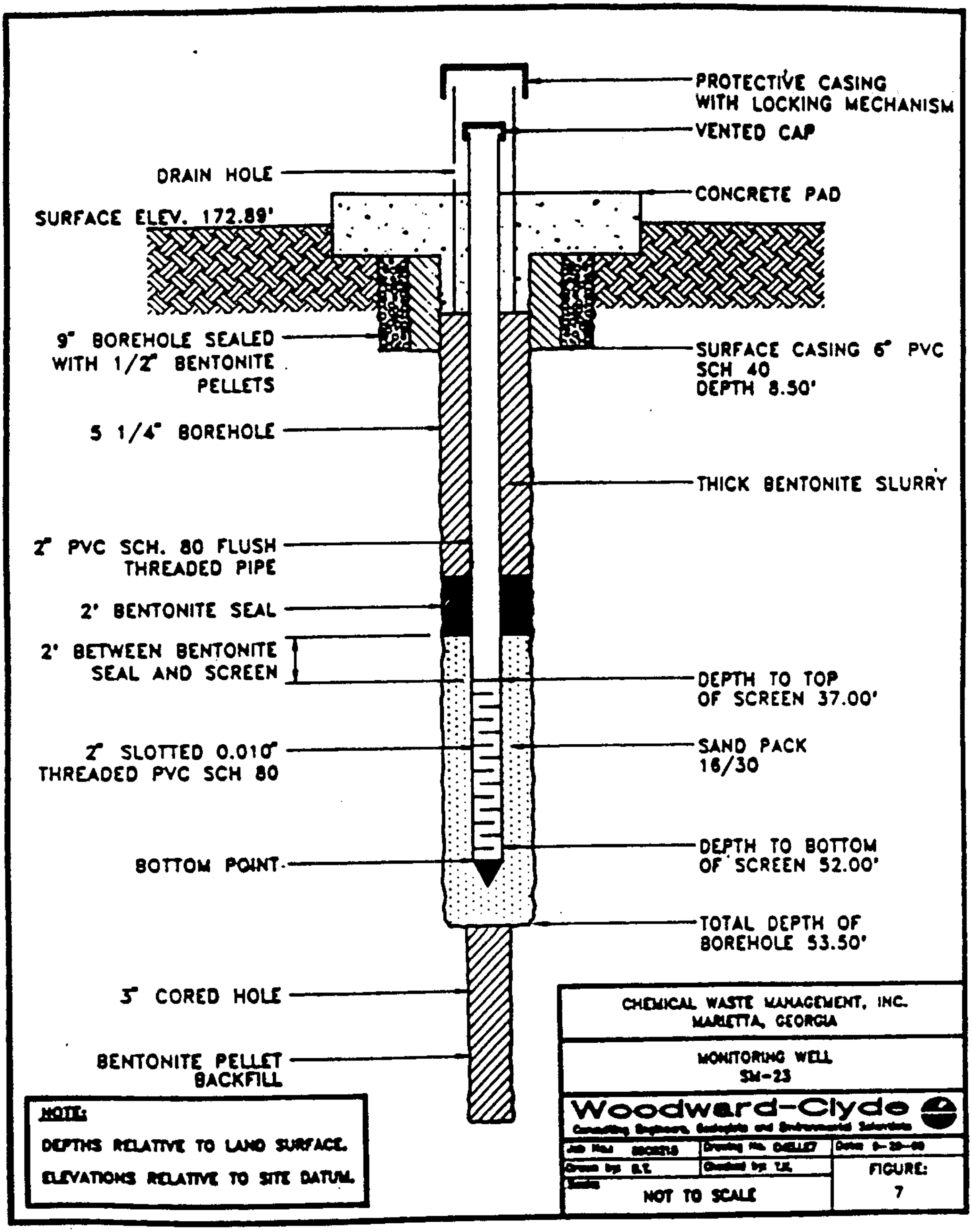
ELEVATIONS RELATIVE TO SITE DATUM.

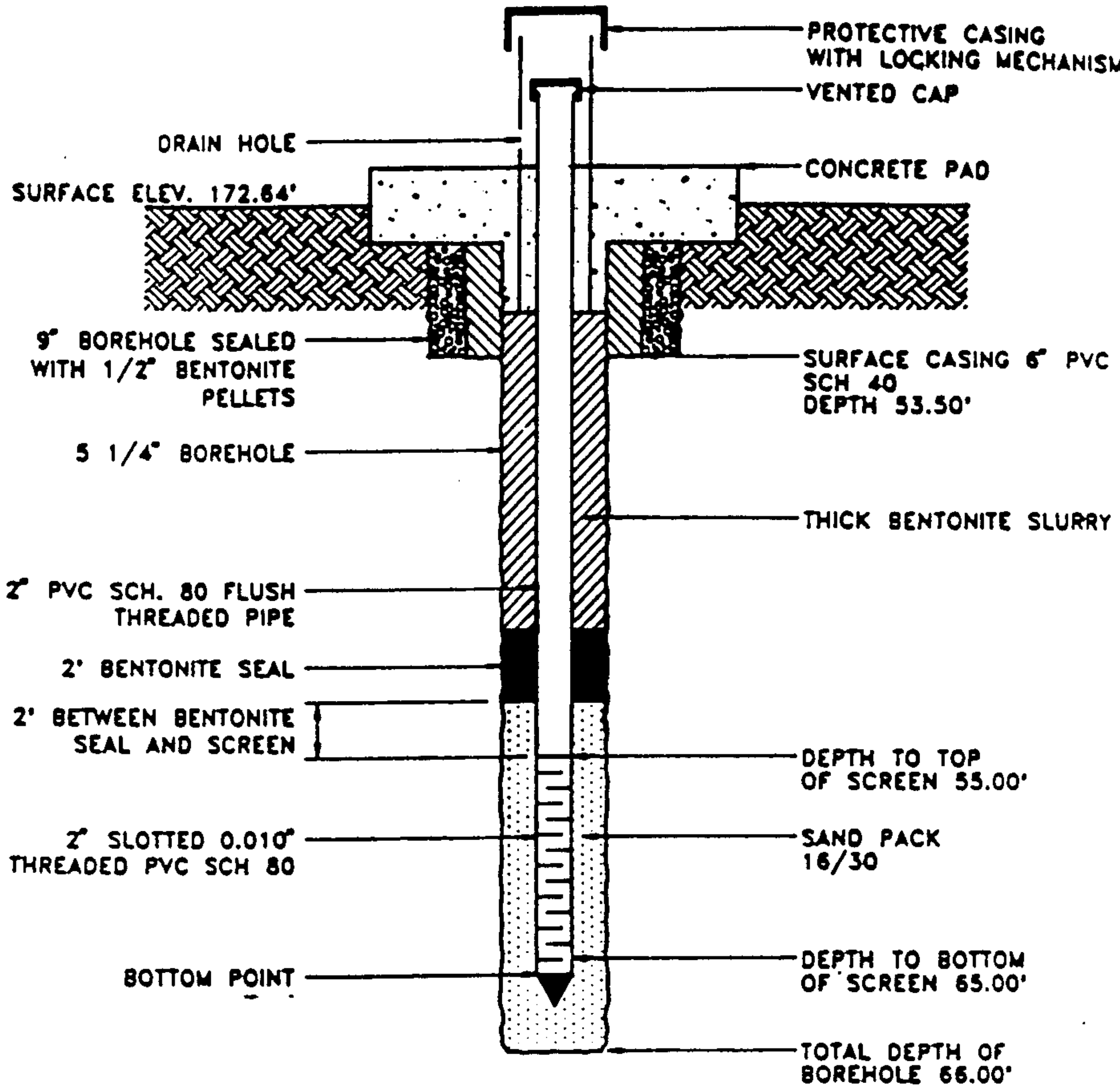
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-22

Woodward-Clyde
Consulting Engineers, Geologists and Environmental Scientists

Job No.:	Drawing No.:	Date:
Drawn by: S.T.	Checked by: T.K.	FIGURE:
Scale: NOT TO SCALE		6


PROTECTIVE CASING
WITH LOCKING MECHANISM
VENTED CAP
DRAIN HOLE
CONCRETE PAD
SURFACE ELEV. 172.89'
9" BOREHOLE SEALED
WITH 1/2" BENTONITE
PELLETS
SURFACE CASING 6" PVC
SCH 40
DEPTH 8.50'
5 1/4" BOREHOLE
THICK BENTONITE SLURRY
2" PVC SCH. 80 FLUSH
THREADED PIPE
2' BENTONITE SEAL
2' BETWEEN BENTONITE
SEAL AND SCREEN
DEPTH TO TOP
OF SCREEN 37.00'
2" SLOTTED 0.010"
THREADED PVC SCH 80
SAND PACK
16/30
BOTTOM POINT
DEPTH TO BOTTOM
OF SCREEN 52.00'
TOTAL DEPTH OF
BOREHOLE 53.50'
3" CORED HOLE
BENTONITE PELLET
BACKFILL
NOTE:
DEPTHS RELATIVE TO LAND SURFACE.
ELEVATIONS RELATIVE TO SITE DATUM.
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA
MONITORING WELL
SM-23
Woodward-Clyde
NOT TO SCALE
FIGURE:
7

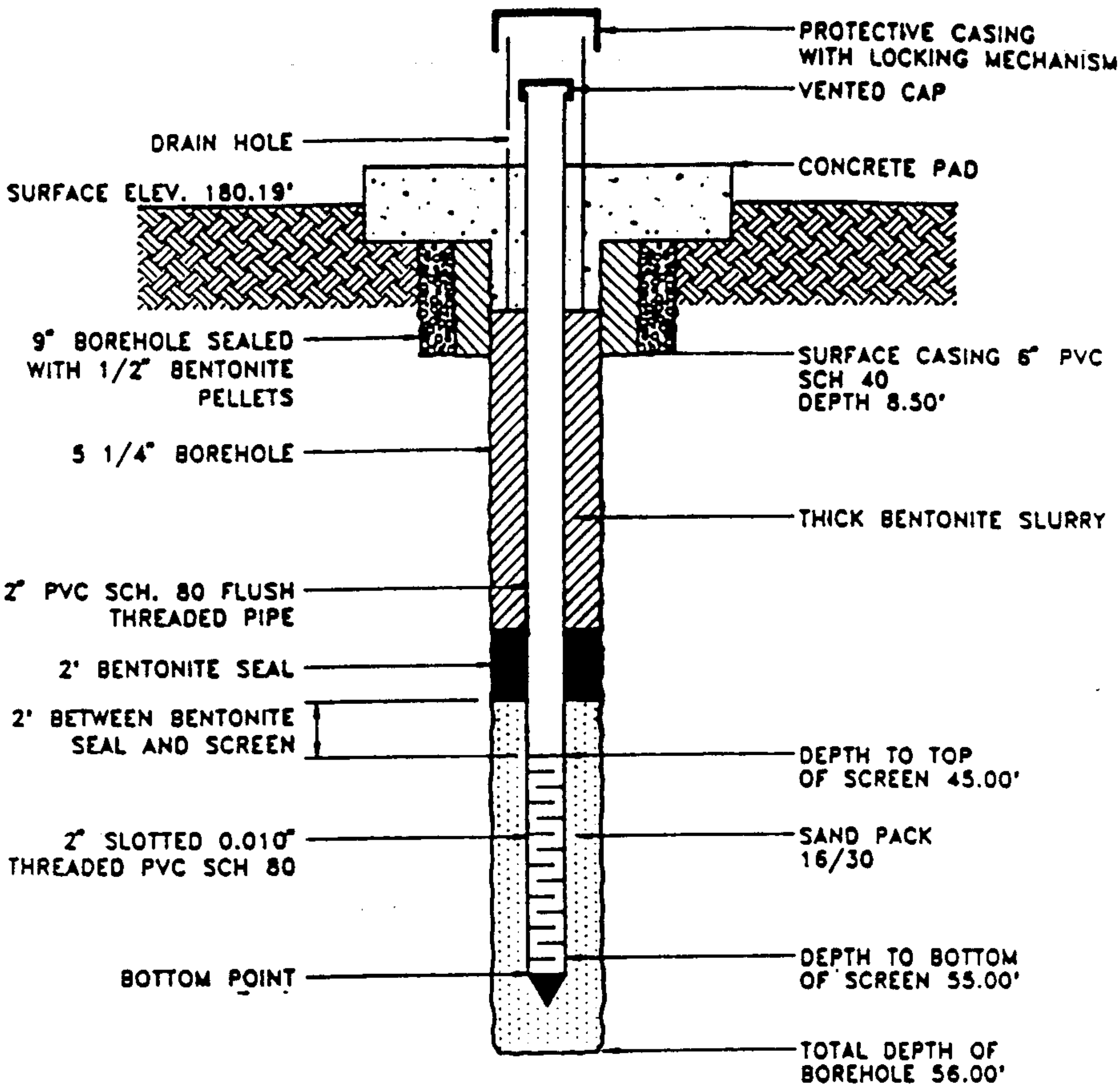


NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC. MARIETTA, GEORGIA
MONITORING WELL SM-23A
Woodward-Clyde
NOT TO SCALE — FIGURE: 8



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-24

Woodward-Clyde

NOT TO SCALE

FIGURE: 9

TABLE 5-2 GROUNDWATER MONITORING SYSTEM SUMMARY

ITE: EMELLE

DATE: Sept 1995

		Type					Location					Sampling Equipment		
WMI Well ID No.	Former Well Id (if different from WMI)	Agency Well ID (if different from WMI)	Active/ Inactive/ Decomm. (A/I/D)	Source Code	Program Type	Sampling Frequency	On-Site Off-Site	Location	N/S Coord. E/W Coord.	Formation at Screen	Gradient	Purge and Sample Equipment	Filtering Equipment	Sample Tubing Material
SM-17	CA-17		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-18	CA-18		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-19	CA-19		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-20	CA-20		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-21	CA-21		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-22	CA-22		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-23	CA-23		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-23A	CA-23A		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-24	CA-24		A	W	PC	S	ON	N		Demopolis Chalk	D	W/W	IN	PE
SM-05B	N/A		A	W	PLAN	M	ON	NE		Demopolis Chalk	D	W/W	IN	PE
SM-05C	N/A		A	W	PLAN	M	ON	NE		Demopolis Chalk	D	W/W	IN	PE
SM-05D	N/A		A	W	PLAN	M	ON	NE		Demopolis Chalk	D	W/W	IN	PE
SM-05E	N/A		A	W	PLAN	M	ON	NE		Demopolis Chalk	D	W/W	IN	PE
SM-18A	N/A		A	W	PLAN	S	ON	NW	14,199.46 5,756.37	Demopolis Chalk	D	W/W	IN	PE
SM-18B	N/A		A	W	PLAN	S	ON	NW	14,266.33 5,792.00	Demopolis Chalk	D	W/W	IN	PE
SM-18C	N/A		A	W	PLAN	S	ON	NW	14,208.17 5,800.94	Demopolis Chalk	D	W/W	IN	PE
SM-18D	N/A		A	W	PLAN	S	ON	NW	14,180.03 5,784.77	Demopolis Chalk	D	W/W	IN	PE

SITE: EMELLE

GROUNDWATER MONITORING SYSTEM SUMMARY (continued)
WELL CONSTRUCTION INFORMATION (continued)

DATE: Sept 1995

WMI Well ID No.	Top of External Casing (feet MSL)	Bottom of External Casing (feet MSL)	External Casing Stick Up (feet) Protective CASING	Conn. To WMI Spec. (Y/N)	Const. Date	Drilling Firm	Drilling Method	Devel. Method	Packing Material	Packing Length	Length of Filter Sand Above Packing (feet)	Length of Bentonite Seal (feet)	Length of Filter Sand Above Seal (in.)	Type of Grout	Grout Length	Comments
SM-17	179.62	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-18	204.56	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-19	202.44	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-20	179.65	uk	3.0	Y	1987	Tri-State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-21	200.60	uk	3.0	Y	1987	Tri-State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-22	200.54	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-23	175.91	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-23A	176.16	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-24	183.71	uk	3.0	Y	1987	Tri State	RW	N/A	S	uk	N/A	2.0	N/A	Bent.	uk	
SM-05B			3.0	Y	1987	Tri State	RW	N/A	S		N/A					
SM-05C		well	3.0	Y	1987	Tri State	RW	N/A	S		N/A		See	Well		
SM-05D	see	logs	3.0	Y	1987	Tri State	RW	N/A	S		N/A			Logs		
SM-05E			3.0	Y	1987	Tri State	RW	N/A	S		N/A			Bent.		
SM-18A	206.27	172.3	3.0	Y	12/94	A.T.&E	RW	N/A	S	29.0'	N/A	2.1	N/A	Bent.		
SM-18B	204.72	171.7	3.0	Y	12/94	A.T.&E	RW	N/A	S	30.0'	N/A	4.0	N/A	Bent.		
SM-18C	201.93	172.9	3.0	Y	12/94	A.T.&E	RW	N/A	S	24.5	N/A	3.9	N/A	Bent.		
SM-18D	203.14	177.1	3.0	Y	12/94	A.T.&E	RW	NA	S	26.5		2.3	N/A			

E: EMELLE

GROUNDWATER MONITORING SYSTEM SUMMARY (continued)
WELL CONSTRUCTION INFORMATION

DATE: Sept 1995

Well ID No.	Well Depth (feet)	Bottom of Well Elev. (feet MSL)	Ground Elev. (feet MSL)	Internal Casing Material	Internal Casing ID (in.)	Top of Internal Casing or Well Wizard Cap (feet MSL)	Bottom of Internal Casing (feet MSL)	Internal Casing Length (feet)	Internal Casing Stick Up (feet)	A Top of Screen Elev. (feet MSL)	B Bottom of Screen Elev. (feet MSL)	A - B Screened Length (feet)	Screen Material	External Casing Material	External Casing ID (in)	Comments
SM-17	34.00	143.60	176.60	PVC	2.0		179.04	22.0	uk	179.04	169.04	10.0	PVC	PVC	PVC 6.0	
SM-18	41.50	161.04	201.04	PVC	2.0		172.04	29.0	uk	172.04	162.04	10.0	PVC	PVC	6.0	
SM-19	78.50	122.92	~~201.04~~ 198.92	PVC	2.0		133.92	65.0	uk	133.92	123.92	10.0	PVC	PVC	6.0	
SM-20	68.50	110.13	176.13	PVC	2.0		121.13	55.0	uk	121.13	111.13	10.0	PVC	PVC	6.0	
SM-21	93.50	106.08	197.08	PVC	2.0		117.08	80.0	uk	117.08	107.08	10.0	PVC	PVC	6.0	
SM-22	93.50	106.02	197.02	PVC	2.0		117.02	80.0	uk	117.02	107.02	10.0	PVC	PVC	6.0	
SM-23	55.00	119.39	172.89	PVC	2.0		135.89	37.0	uk	135.89	120.89	15.0	PVC	PVC	6.0	
SM-23A	68.50	106.64	172.64	PVC	2.0		117.64	55.0	uk	117.64	107.64	10.0	PVC	PVC	6.0	
SM-24	58.50	124.19	180.19	PVC	2.0		135.19	45.0	uk	135.19	125.19	10.0	PVC	PVC	6.0	
SM-05B				PVC	2.0								PVC	PVC	6.0	
SM-05C		SEE WELL LOGS		PVC	2.0			SEE WELL LOGS					PVC	PVC	6.0	
SM-05D				PVC	2.0								PVC	PVC	6.0	
SM-05E				PVC	2.0								PVC	PVC	6.0	
SM-18A	45.0	153.3	203.3	PVC	2.0		158.3	45.0	1.0	158.3	148.3	10.0	PVC	PVC	6.0	
SM-18B	44.0	156.7	201.7	PVC	2.0		158.7	44.0	1.0	158.7	[illegible]	10.0	PVC	PVC	6.0	
SM-18C	40.0	158.9	198.9	PVC	2.0		159.9	40.0	1.0	159.9	149.9	10.0	PVC	PVC	6.0	
SM-18D	40.5	161.1	200.1	PVC	2.0		160.6	40.5	1.0	160.6	150.6	10.0	PVC	PVC	6.0	

Jordan
Jones &
Goulding
INCORPORATED

2000 CLEARVIEW AVE., N.E.
ATLANTA, GEORGIA 30340
PHONE: (770) 455-8555 □ FAX: (770) 455-7391

ATLANTA
ATHENS
COLUMBUS
COLUMBIA
CHARLESTON
KNOXVILLE
LEXINGTON
LOUISVILLE
MIAMI
PUERTO RICO

November 12, 1997

Ms. Teresa Williams
Chemical Waste Management, Inc.
Route 17 at Milepost 163
Emelle, Alabama 35459

RE: Installation of Monitoring Well SM-27

Dear Teresa:

Jordan, Jones & Goulding, Inc. (JJ&G) was retained by the Chemical Waste Management, Inc. Emelle, Alabama, facility (CWM-Emelle) to install three monitoring wells, SM-27 through SM-29, inclusive, adjacent to Trench 22 Cells 1 and 2. The installation of these groundwater monitoring wells is in partial fulfillment of the requirements of Part X of the Facility Part B Permit. This report summarizes the drilling and installation procedures for groundwater monitoring well SM-27. The installation report for the other two monitoring wells will be submitted upon completion of the drilling and installation.

Drilling Operations

JJ&G arranged for Atlanta Testing & Engineering, Inc. (AT&E) to conduct drilling operations and install wells at the CWM-Emelle facility. AT&E mobilized a CME 750, all terrain drill rig, equipment and personnel to the CWM-Emelle facility on October 27, 1997. Drilling operations began on October 28, 1997, and coring was concluded on October 29, 1997. The well installation was completed on November 4, 1997. A JJ&G geologist provided oversight for drilling operations and collected lithologic data. The boring and well installation log for SM-27 is enclosed with this letter.

Upon arrival at the CWM-Emelle facility, a decontamination (decon) pad, a small area covered with polyethylene sheeting, was constructed by AT&E personnel. The decon pad was constructed to the south of Trench 22 Cell 2. The back of the drill rig, hollow stem augers, drill rods, core barrels, drill bits, and tools were steam cleaned, washed with Alconox and water, and steam rinsed upon arrival at the SM-27 area. Water used in steam cleaning was collected in a sump area of the decon pad and eventually evaporated. The source of water used to steam clean equipment was on-site well RCRA-5.

The boring for SM-27 was advanced through weathered chalk and into the unweathered chalk using 3 1/4-inch inside diameter (I.D.) hollow stem augers (HSA). This portion of the boring was continuously sampled, using a split spoon sampler, from the ground surface to a depth of 20.0 feet below the ground surface (bgs). Samples were logged by the JJ&G geologist.

After reaching a depth of 20.0 feet bgs with the 3 1/4-inch HSA, the borehole was reamed with 6 1/4-inch I.D., 10 1/4-inch outside diameter (O.D.) HSA. A 6-inch I.D. PVC surface casing was installed from the ground surface to a depth of 20.0 feet bgs. The annular space surrounding the PVC casing was tremie grouted from the bottom upward with a mixture of Pure Gold bentonite and water. The grout was allowed to set for several hours before coring was begun to extend the boring. Auger spoils generated during drilling were spread onto the ground surface.

The boring was cored from the base of the PVC surface casing to approximately 25 feet below the pressure relief sump in Trench 22 Cell 2. The total depth of the boring was 106 feet bgs. The boring was advanced through the unweathered chalk with a NQ-size core barrel. The core was logged, placed in labeled core boxes and photographed. The core samples also are stored at the CWM-Emelle facility.

Well Installation

An ADEM representative, Mr. Wayne Payton, was on site during the coring operations for SM-27. The well construction plan for SM-27 was established on site by representatives from ADEM, CWM-Emelle, and JJ&G. A letter summarizing the agreement reached on October 29, 1997 was prepared by JJ&G and dated October 30, 1997. CWM-Emelle submitted the letter prepared by JJ&G to ADEM. The following paragraphs briefly describe the as-built construction of groundwater monitoring well SM-27.

After coring, the corehole was reamed using wash rotary drilling techniques with a 5 7/8-inch drag bit. Water used in drilling was obtained from on-site well RCRA-5. Immediately after reaming the core hole to a nominal 6-inch diameter, a well was constructed in the borehole. Three well screens were installed in the SM-27 borehole to straddle three zones of fractures identified by evaluation of the core. These screens were separated by lengths of solid pipe, and the annular space between these screens was sealed with bentonite pellets. The enclosed boring log and well construction diagram detail the installed well geometry and the quantities of materials used during the installation process.

Well screen sections and riser pipes were delivered to the site and stored in sealed plastic wrappers. Immediately prior to use, the well screen sections, riser pipe, and end cap were steam cleaned at the decon area. All "O" rings were removed from well materials prior to decontamination. Drilling personnel wore new, clean, latex gloves when handling well materials. Sand and bentonite used in well construction were free of additives and were delivered to the CWM-Emelle facility in unopened containers.

Monitoring well SM-27 was constructed of 2-inch I.D., flush threaded, Schedule 80 PVC. Well joints were taped with Teflon tape. The well screens consist of three 5-foot sections of 0.010-inch, factory slotted PVC. An end cap, approximately 0.5-feet long, was placed on the bottom of the deepest well screen.

The riser pipe, well screen and end cap were threaded together and placed in the open borehole. A sand pack of graded silica sand, Number 1 DSI, was poured into the annular space surrounding each of the three well screens. A minimum 2.0-foot layer of bentonite pellets or chips were placed between each screened interval to provide an adequate seal between each screened section. The remaining annular space above the highest bentonite seal was grouted with a mixture of Pure Gold bentonite and water that was tremied into place.

Following grouting, an anodized aluminum, locking, protective cover was installed over the riser pipe that extends above ground surface. A weep hole was installed at the base of the protective casing to ensure drainage. A 3-foot by 3-foot by 4-inch thick square concrete pad was then poured around the protective casing.

At the completion of well installation, the well was purged until dry with a BK hand pump. The pump was steam cleaned prior to, and following, use. Because wet rotary drilling methods were used during drilling, and because wells installed in the chalk recover very slowly, the enclosed boring and well installation log does not indicate a stabilized water level in the well. Stabilized water levels will be obtained by CWM-Emelle personnel during well sampling, in accordance with standard procedures.

The enclosed boring and well installation log also does not indicate surveyed horizontal coordinates or the elevation of the top of the inner well casing or the ground surface at the well. Survey information for well SM-27 will be obtained after wells SM-28 and SM-29 have also been installed. This survey information, along with an updated boring and well installation log, will be submitted to ADEM as additional information when available. JJ&G and CWM-Emelle do not consider survey information necessary in order for ADEM to review and approve the installation of well SM-27. ADEM approval of well SM-27 installation is required by the Part B Permit prior to CWM-Emelle using the cell for waste disposal.

JJ&G trusts that this information meets your needs. If you have further comments or need additional information, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Heather Caudill
Geologist

Michael T. Feeney, P.E.
Manager, Geosciences

ALABAMA
REGISTERED
No. 15395
PROFESSIONAL
ENGINEER
M. T. FEENEY

hlc/mtf
Enclosures
1186.009(5B1)
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Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle Facility	**Inspector**	H. Caudill	**Boring No.**	SM-27
Project Number	1186.009	**Weather**	Cloudy	**Sheet**	1 of 2
Drilling Company	AT&E	**Temperature**	62 F	**Surface Elev.**	~254
Drill Rig	CME 750	**Depth Hole**	106.0 ft	**Datum**	msl
Wt Hammer	140 lb **Drop** 30 "	**Hole Diam.**	10 ¼ ", 6 "	**Started**	10/28/97 9:15 am
Driller	Scott Towe	**Drilling Mud**	NA	**Completed**	11/4/97 10:50 am
Sampling Method	Split Spoon, Triple Barrel Core	**No. Dist. S.A.**	9	**No. UD. S.A.**	NA
Depth W.L.	NA	**Time W.L.**	NA	**Date W.L.**	NA

Well Materials Inventory

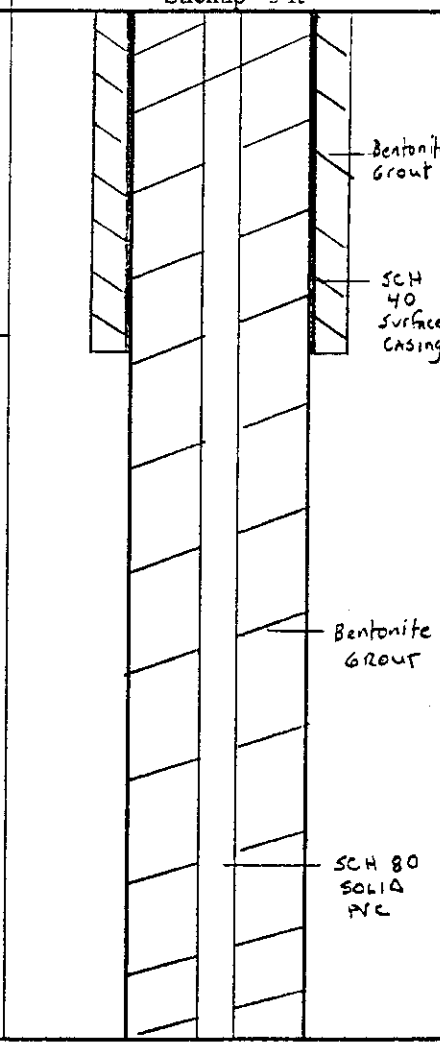
Well I.D.	SM-27	**Filter Pack Qty**	3.36 cu ft	**Grout Install**	Tremie
Well Casing Dia.	2 **L.F.** 92.5	**Pack Type & Size**	DSI #1 - Filter Pack	**End Cap/Sump**	0.5 ft
Casing Type	SCH 80 PVC	**Install Method**	Tremie	**Prot. Casing: Y**	X **N**
Joint Type	Flush Threaded, Teflon Taped, 'O'ring Removed	**Seal Type**	Cetco Bentonite 3/8" Pellets	**Well Pad Size**	3 ft x 3 ft x 4 in
Well Screen Dia.	2 **L.F.** 15	**Qty/Install Method**	2.5 cu ft, pour / tap	**TOC Elevation**	NA
Screen Type	Factory Slotted	**Grout Type & Qty**	Pure Gold Bentonite / 11 cu ft	**Water Level**	76.14
Slot Size	0.010 in	**Mix Ratio**	1 50 lb Bentonite/ 14 gal H_2O	**Date**	11/5/97 **Time** 3:45 pm

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
1.0	SS-1	7-8-9-13	100		
3.0	SS-2	3-5-8-9	100		Yellow Brown Weathered
5.0	SS-3	4-4-7-8	100		CHALK with shell fragments
7.0	SS-4	3-3-5-7	100		
9.0	SS-5	3-3-7-9	100		
11.0	SS-6	4-5-7-8	100		
13.0	SS-7	4-5-11-13	100		
15.0	SS-8	7-10-14-20	100		
17.0	SS-9	7-8-16-23	100		
19.0					
	Run 1	20.0 - 25.0	100		Unweathered Blue Gray
					Fossiliferous CHALK
	Run 2	25.0 - 36.0	100		
30					
	Run 3	36.0 - 46.0	100		
40					
				f - 42.2 ft	55°
				f - 42.5 ft	54°, Slickensides, Calcite coated
				f - 46.1 ft	54°, Slickensides
	Run 4	46.0 - 56.0	100		
50					
	Run 5	56.0 - 66.0	100		
60					

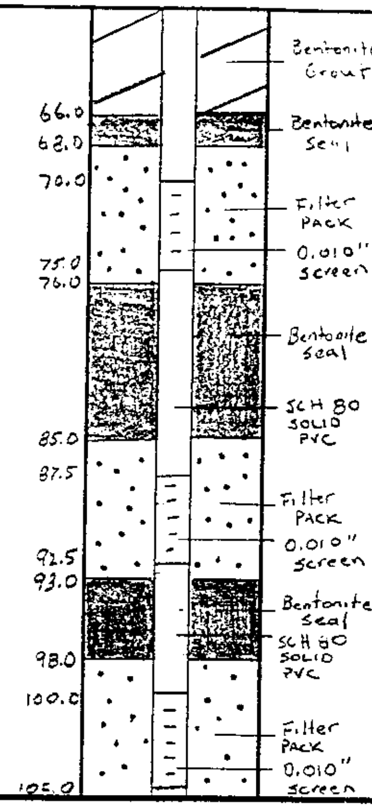
Well Diagram / Comments

Stickup - 3 ft



Notes:
1. Continuous split spoon sampling through HSA Augers to 20.0 ft. Set 6" SCH 40 surface casing and grouted in place.
2. Cored through surface casing from 20.0 ft to 106.0 ft with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Well Diagram / Comments
	Run 5 cont.	56.0 - 66.0	100			
	Run 6	66.0 - 76.0	100			
70						
				f - 72.3 ft	42°, Slickensides, Pyrite, Calcite coated	
				f- 73.9 ft	64°, Slickensides, Calcite coated	
	Run 7	76.0 - 86.0	100			
80						
	Run 8	86.0 - 96.0	100			
90						
				f- 90.2 ft	40°, Slickensides, Calcite coated	
	Run 9	96.0 - 106.0	100			
100						
				f-105.0 ft	57°, Slickensides, Calcite coated	



Coring Terminated at 106.0 ft

NOTES CONTINUED:

4. f - fracture
5. Recorded fracture dip is the apparent dip.
6. Breaks in the core other than those noted above were drilling induced, often along shell planes (approx. horizontal), or broken by the geologist during logging.
7. Survey data including the horizontal coordinates, surface elevation, and top of casing elevation will be submitted separately.

Jordan Jones & Goulding
INCORPORATED

2000 CLEARVIEW AVE., N.E.
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ATLANTA
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KNOXVILLE
LEXINGTON
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MIAMI
PUERTO RICO

December 4, 1997

Ms. Teresa Williams
Chemical Waste Management, Inc.
Route 17 at Milepost 163
Emelle, Alabama 35459

RE: Installation of Monitoring Wells SM-28 and SM-29

Dear Teresa:

Jordan, Jones & Goulding, Inc. (JJ&G) was retained by the Chemical Waste Management, Inc. Emelle, Alabama, facility (CWM-Emelle) to install three monitoring wells, SM-27 through SM-29, inclusive, adjacent to Trench 22 Cells 1 and 2. The installation of these groundwater monitoring wells is in partial fulfillment of the requirements of Part X of the Facility Part B Permit. A letter dated November 12, 1997, was submitted to ADEM documenting the installation of SM-27. The installation of SM-28 and SM-29 fulfills Condition X.B.1.f. of the Part B Facility Permit. This report summarizes the drilling and installation procedures for groundwater monitoring wells SM-28 and SM-29.

Drilling Operations

JJ&G arranged for Atlanta Testing & Engineering, Inc. (AT&E) to conduct drilling operations and install wells at the CWM-Emelle facility. AT&E mobilized a CME 750, all-terrain drill rig, equipment, and personnel to the CWM-Emelle facility on October 27, 1997. Drilling operations for SM-28 and SM-29 began on November 4, 1997, and coring was concluded on November 7, 1997. The well installations were completed on November 10 and 11, 1997. A member of JJ&G's environmental staff provided oversight for drilling operations and collected data. The boring and well installation logs for SM-28 and SM-29 are enclosed with this letter.

Upon arrival at the CWM-Emelle facility, a decontamination (decon) pad, a small area covered with polyethylene sheeting, was constructed by AT&E personnel. The decon pad was constructed to the south of Trench 22 Cell 2. The back of the drill rig, hollow-stem augers, drill rods, core barrels, drill bits, and tools were steam cleaned and rinsed prior to and between the drilling of SM-28 and SM-29. Water used in steam cleaning was collected in a sump area of the decon pad and eventually evaporated. The source of water used to steam clean equipment was on-site well RCRA-5.

The borings for SM-28 and SM-29 were advanced through weathered chalk and into the unweathered chalk using 3¼-inch inside diameter (I.D.) hollow stem augers (HSA). This portion of the boring was sampled continuously, using a split spoon sampler, from the ground surface to a depth of 17.0 and 20.0 feet, respectively, below the ground surface (bgs).

After reaching the depths indicated above with the 3¼-inch HSA, the borehole was reamed with 6¼-inch I.D., 10¼-inch outside diameter (O.D.) HSA. A 6-inch I.D. PVC surface casing was installed from the ground surface to a depth of 17.0 and 20.0 feet (ft) bgs for SM-28 and SM-29, respectively. The annular space surrounding the PVC casing was tremie grouted from the bottom upward with a mixture of Pure Gold bentonite and water. The grout was allowed to set for several hours before coring was begun to extend the boring. Auger spoils generated during drilling were spread onto the ground surface.

Each boring was cored from the base of the PVC surface casing to approximately 25 ft below the pressure relief sump in Trench 22 Cell 1. The total depth of the boring SM-28 was 94 ft bgs, while the depth of SM-29 was 100 feet bgs. The borings were advanced through the unweathered chalk with a NQ-size core barrel. The core was placed in labeled core boxes and photographed. The core samples also are stored at the CWM-Emelle facility.

Well Installation

An ADEM representative, Mr. Wayne Payton, was on site during the coring operations for SM-29. He also examined the core from SM-28. Well construction plans for SM-28 and SM-29 were established on site by representatives from ADEM, CWM-Emelle, and JJ&G. A well construction plan detail for each well was submitted to ADEM to document the agreements made on site. The following paragraphs briefly describe the as-built construction of groundwater monitoring wells SM-28 and SM-29.

After coring, the each corehole was reamed using wash rotary drilling techniques with a 5⅞-inch drag bit. Water used in drilling was obtained from on-site well RCRA-5. Immediately after reaming the core hole to a nominal 6-inch (in) diameter, a well was constructed in the borehole. Two well screens were installed in the SM-28 and SM-29 boreholes. In SM-28, a 10-ft screen was placed in the bottom of the well. A 5-ft screen section was installed higher in the well to monitor a fracture at 66.4 ft identified during observation of the core. In SM-29, two fracture zones were screened. Three fractures at the bottom of the borehole were screened using a 10-ft screen section. A 5-ft screen was placed higher in the well to monitor a fracture at 78.5 ft. The screen sections in each well were separated by lengths of solid pipe, and the annular space between these screens was sealed with bentonite pellets. The enclosed boring logs and well construction diagrams detail the installed well geometry and the quantities of materials used during the installation process.

Well screen sections and riser pipes were delivered to the site and stored in sealed plastic wrappers. Immediately prior to use, the well screen sections, riser pipe, and end cap were steam cleaned at the decon area. All "O" rings were removed from well materials prior to decontamination. Drilling personnel wore new, clean, latex gloves when handling well materials. Sand and bentonite used in well construction were free of additives and were delivered to the CWM-Emelle facility in unopened containers.

Monitoring wells SM-28 and SM-29 were constructed of 2-in I.D., flush-threaded, Schedule 80 PVC. Well joints were taped with Teflon tape. The well screens consist of 5-ft and 10-ft sections of 0.010-in, factory-slotted PVC. An end cap, approximately 0.5-ft long, was placed on the bottom of the deepest well screen.

The riser pipe, well screen, and end cap were threaded together and placed in each open borehole. A sand pack of graded silica sand, Number 1 DSI, was poured into the annular space surrounding each of the well screens. A minimum 2-ft layer of bentonite pellets or chips were placed between each screened interval to provide an adequate seal between each screened section. The remaining annular space above the highest bentonite seal was grouted with a mixture of Pure Gold bentonite and water that was tremied into place.

Following grouting, an anodized aluminum, locking, protective cover was installed over the riser pipe that extends above ground surface. A weep hole was installed at the base of the protective casing to ensure drainage. A 3-ft by 3-ft by 4-in thick square concrete pad then was poured around the protective casing.

At the completion of well installation, the well was purged until dry using a disposable bailer. The bailers were steam cleaned prior to, and following, use. Because wet rotary drilling methods were used during drilling and because wells installed in the chalk recover very slowly, the enclosed boring and well installation logs do not indicate a stabilized water level in the well. Stabilized water levels will be obtained by CWM-Emelle personnel during well sampling, in accordance with standard procedures.

The enclosed boring and well installation logs also do not indicate surveyed horizontal coordinates or the elevation of the top of the inner well casing or the ground surface at the well. Survey information for wells SM-28 and SM-29 will be collected later this month. This survey information, along with updated boring and well installation logs, will be submitted to ADEM as additional information when available.

JJ&G trusts that this information meets your needs. If you have further comments or need additional information, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Michael T. Feeney, P.E.
Manager, Geosciences

ALABAMA
REGISTERED
No. 15895
PROFESSIONAL
ENGINEER
M. T. FEENEY

hlc/mtf
Enclosures
1186.009(5B1)
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Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle Facility	Inspector	H. Caudill ✓MJ4	Boring No.	SM-28
Project Number	1186.009	Weather	Clear	Sheet	1 of 2
Drilling Company	AT&E	Temperature	58 F	Surface Elev.	~238.90
Drill Rig	CME 750	Depth Hole	94.0 ft	Datum	msl
Wt Hammer	140 lb Drop 30 "	Hole Diam.	10 ¼ ", 6 "	Started	11/4/97 1:45 pm
Driller	Scott Towe	Drilling Mud	NA	Completed	11/11/97 1:50 pm
Sampling Method	Split Spoon, Triple Barrel Core	No. Dist. S.A.	8	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

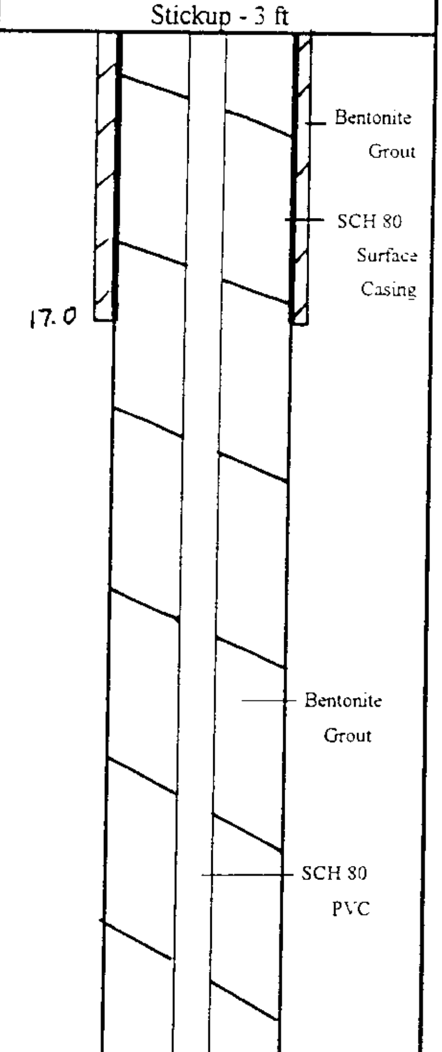
Well Materials Inventory

Well I.D.	SM-28	Filter Pack Qty	3.20 cu ft	Grout Install	Tremie
Well Casing Dia.	2 L.F. 82.0	Pack Type & Size	DSI #1 - Filter Pack	End Cap/Sump	0.5 ft
Casing Type	SCH 80 PVC	Install Method	Tremie	Prot. Casing: Y	X N
Joint Type	Flush Threaded, Teflon Taped, 'O'ring Removed	Seal Type	Cetco Bentonite 3/8" Pellets	Well Pad Size	3 ft x 3 ft x 4 in
Well Screen Dia.	2 L.F. 15	Qty/Install Method	2.3 cu ft, pour / tap	TOC Elevation	NA
Screen Type	Factory Slotted	Grout Type & Qty	Pure Gold Bent. / 10.4 cu ft	Water Level	NA
Slot Size	0.010 in	Mix Ratio	1 50 lb Bentonite/ 14 gal H_2O	Date	Time

Boring and Well Diagram

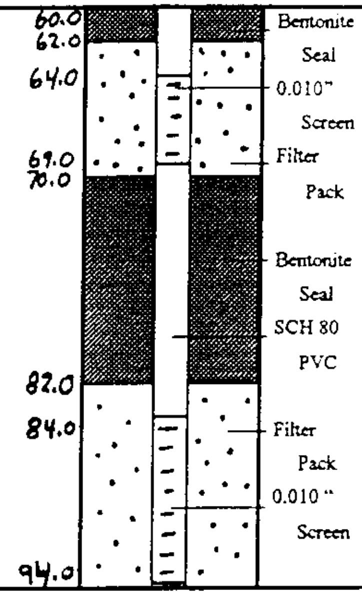
Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
1.0	SS-1	1-3-3-6	100		Fill Material
3.0	SS-2	4-5-7-8	100		
5.0	SS-3	3-4-5-5	75		
7.0	SS-4	3-3-5-6	100		Yellow Brown Weathered CHALK with Shell Fragments
9.0	SS-5	3-5-5-6	100		
11.0	SS-6	5-7-10-10	100		
13.0	SS-7	7-10-14-23	100		
15.0	SS-8	6-13-17-25	100		
17.0					
20	Run 1	17.0 - 27.0	93		Unweathered Blue Gray Fossiliferous CHALK
30	Run 2	27.0 - 36.7	100		
40	Run 3	36.7 - 47.2	100		
				f - 43.5 ft	52°, Slickensides, Calcite coated
				f - 43.8 ft	47°, Slickensides, Calcite coated
				f - 45.3 ft	50°
50	Run 4	47.2 - 57.2	100		
60	Run 5	57.2 - 67.0	100		

Well Diagram / Comments
Stickup - 3 ft



Notes:
1. Continuous split spoon sampling through HSA Augers to 17.0 ft. Set 6" SCH 40 surface casing and grouted in place.
2. Cored through surface casing from 17.0 ft to 94.0 ft with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Well Diagram / Comments
	Run 5 cont.	57.2 - 67.0	100			
				f - 66.4 ft	67°, Slickensides	
70	Run 6	67.0 - 77.0	100			
80	Run 7	77.0 - 87.0	100			
90	Run 8	87.0 - 94.0	100			



Coring Terminated at 94.0 ft

NOTES CONTINUED:

4. f - fracture
5. Recorded fracture dip is the apparent dip.
6. Breaks in the core other than those noted above were drilling induced, often along shell planes (approx. horizontal), or broken by the inspector during logging.
7. Survey data including the horizontal coordinates, surface elevation, and top of casing elevation will be submitted separately.

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle Facility	Inspector	H. Caudill	Boring No.	SM-29
Project Number	1186.009	Weather	Clear	Sheet	1 of 2
Drilling Company	AT&E	Temperature	53 F	Surface Elev.	~244.37
Drill Rig	CME 750	Depth Hole	94.0 ft	Datum	msl
Wt Hammer	140 lb Drop 30 "	Hole Diam.	10 ¼ ", 6 "	Started	11/5/97 4:10 pm
Driller	Scott Towe	Drilling Mud	NA	Completed	11/10/97 3:45 pm
Sampling Method	Split Spoon, Triple Barrel Core	No. Dist. S.A.	10	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

Well Materials Inventory

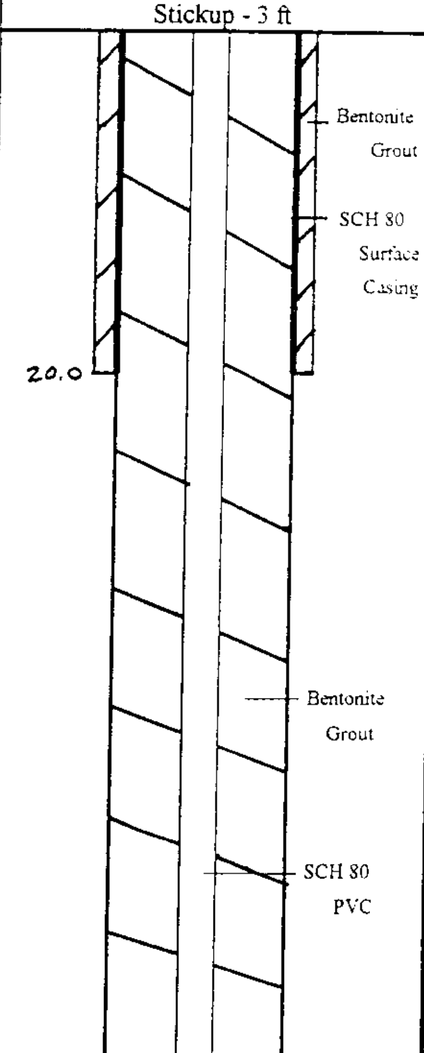
Well I.D.	SM-29	Filter Pack Qty	3.36 cu ft	Grout Install	Tremie
Well Casing Dia.	2 L.F. 88.0	Pack Type & Size	DSI #1 - Filter Pack	End Cap/Sump	0.5 ft
Casing Type	SCH 80 PVC	Install Method	Tremie	Prot. Casing: Y	X N
Joint Type	Flush Threaded, Teflon Taped, 'O'ring Removed	Seal Type	Cetco Bentonite 3/8" Pellets	Well Pad Size	3 ft x 3 ft x 4 in
Well Screen Dia.	2 L.F. 15	Qty/Install Method	1.7 cu ft, pour / tap	TOC Elevation	NA
Screen Type	Factory Slotted	Grout Type & Qty	Pure Gold Bent. / 11.6 cu ft	Water Level	NA
Slot Size	0.010 in	Mix Ratio	1 50 lb Bentonite/ 14 gal H_2O	Date	Time

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
1.0	SS-1	3-3-4-5	100		Fill Material
3.0	SS-2	4-5-5-5	100		
5.0	SS-3	4-5-5-7	100		
7.0	SS-4	3-4-5-7	100		Yellow Brown Weathered CHALK
9.0	SS-5	4-6-10-12	100		with Shell Fragments
11.0	SS-6	6-9-11-14	100		
13.0	SS-7	5-6-8-12	100		
15.0	SS-8	7-11-14-23	100		
17.0	SS-9	6-18-10-13	100		
19.0	SS-10	10-13-24-30	100		
21.0					
	Run 1	20.0 - 26.0	92		Unweathered Blue Gray
					Fossiliferous CHALK
30					
	Run 2	26.0 - 36.2	100	f - 32.8 ft	50°, Slickensides
				f - 33.8 ft	39°, Slickensides
40					
	Run 3	36.2 - 46.2	100		
50					
	Run 4	46.2 - 56.1	100		
60					

Well Diagram / Comments

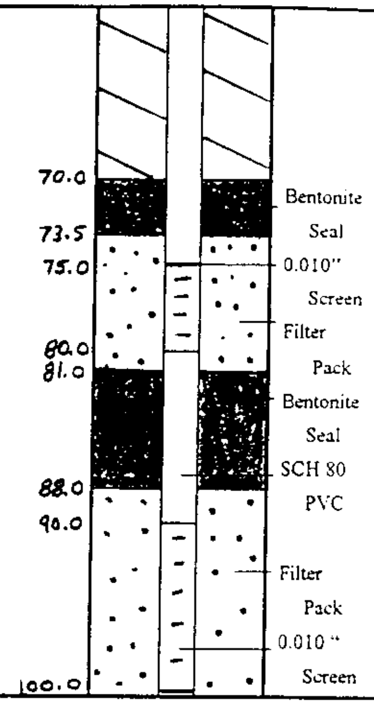
Stickup - 3 ft



Notes:
1. Continuous split spoon sampling through HSA Augers to 20.0 ft. Set 6" SCH 40 surface casing and grouted in place.
2. Cored through surface casing from 20.0 ft to 100.0 ft with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	56.1 - 66.0	100		
70					
	Run 6	66.0 - 76.0	100		
80				f - 78.5 ft	25°
	Run 7	76.0 - 86.0	100		
90					
	Run 8	86.0 - 96.0	100		
				f - 98.1 ft	80°, Slickensides
				f - 99.3 ft	57°, Slickensides, Wavy
100	Run 9	96.0 - 100.0	100	f - 99.7 ft	73°, Slickensides

Well Diagram / Comments



Coring Terminated at 100.0 ft

NOTES CONTINUED:

4. f - fracture
5. Recorded fracture dip is the apparent dip.
6. Breaks in the core other than those noted above were drilling induced, often along shell planes (approx. horizontal), or broken by the inspector during logging.
7. Survey data including the horizontal coordinates, surface elevation, and top of casing elevation will be submitted separately.

1357

Jordan Jones & Goulding
INCORPORATED

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February 11, 1999

Ms. Teresa Williams
Chemical Waste Management, Inc.
Route 17 at Milepost 163
Emelle, Alabama 35459

RE: Installation of Monitoring Wells SM-30, SM-31, SM-32 and SM-33

Dear Teresa:

Jordan, Jones & Goulding, Inc. (JJ&G) was retained by the Chemical Waste Management, Inc. Emelle, Alabama, facility (CWM-Emelle) to install four monitoring wells, SM-30 through SM-33, inclusive, adjacent to Trench 21 Cells 2, 3, and 4. The installation of these groundwater monitoring wells fulfills the requirements described in condition X.B.1 of the Facility Alabama Hazardous Waste Management and Minimization Act and of Section E of the Facility Permit Application. This report summarizes the drilling and installation procedures for groundwater monitoring wells SM-30 through SM-33.

Drilling Operations

JJ&G subcontracted with Atlanta Testing & Engineering, Inc. (AT&E) to conduct drilling operations at the CWM-Emelle facility. AT&E mobilized a CME 750, an all-terrain drill rig, equipment, and personnel to the CWM-Emelle facility on December 7, 1998. Drilling operations began on December 8, 1998. The well installations were completed on December 23, 1998. A geologist from JJ&G's environmental staff supervised the drilling operations and collected data. The boring and well installation logs for SM-30 through SM-33 are included in this report.

Upon arrival at the CWM-Emelle facility, a decontamination (decon) area was constructed by AT&E personnel. The decon area was constructed to the west of Trench 21 Cell 2. The back of the drill rig, hollow-stem augers (HSA), drill rods, core barrels, drill bits, and tools were steam cleaned and rinsed prior to and between the drilling of SM-30, SM-31, SM-32, and SM-33. The water used for steam cleaning went into the sediment pond adjacent to Trench 21 Cells 1 and 2. The source of water used to steam clean equipment was well RCRA-5.

The borings for SM-30, SM-31, SM-32, and SM-33 were advanced through weathered chalk and into the unweathered chalk using 3¼-inch inside diameter (I.D.) HSA. This portion of each boring was sampled continuously, using a split spoon sampler, from the ground surface to a depths ranging from 20.0 to 22.0 feet below the ground surface (bgs) in wells SM-30, SM-32, and SM-33. As shown in the boring logs, unweathered chalk was encountered at 4.5 feet bgs at SM-31. Continuous sampling was terminated at 10.0 feet bgs and the surface casing was set from 20.0 feet bgs to ground surface. Cuttings observed from 10.0 to 20.0 feet bgs confirm the presence of gray unweathered chalk.

After reaching the depths indicated above with the 3¼-inch HSA, the boreholes for SM-30, SM-31, and SM-32 were reamed using wash rotary drilling techniques with a 10¼-inch outside diameter (O.D.) drag bit. The water used for drilling was obtained from on-site RCRA-5. SM-33 was reamed with 6¼-inch I.D., 10¼-inch O.D. HSA. A 6-inch I.D. PVC surface casing was installed from the ground surface to a depth of 23.5 feet bgs for SM-30, 20.0 feet bgs for SM-31 and SM-32, and 22.0 feet bgs for SM-33. The annular space surrounding the PVC casing was tremie grouted from the bottom upward with a mixture of Pure Gold bentonite grout, Portland cement, and water. The grout was allowed to set at least overnight before coring was begun to extend the boring. Auger spoils generated during drilling were spread onto the ground surface.

Each boring was cored from the base of the PVC surface casing to approximately 25 feet below the pressure relief sumps in Trench 21 Cells 2, 3, and 4. The total depth of the boring SM-30 was 120 feet bgs; SM-31 was 122 feet bgs; SM-32 was 117 feet bgs; and SM-33 was 109 feet bgs. The borings were advanced through the unweathered chalk with a NQ-size core barrel. The core was placed in labeled core boxes and stored at the CWM-Emelle facility.

Well Installation

Well construction plans for SM-30 through SM-33 were established on site by representatives from CWM-Emelle and JJ&G. The following paragraphs briefly describe the as-built construction of groundwater monitoring wells SM-30 through SM-33.

After coring, each corehole was reamed using wash rotary drilling techniques with a 5⅞-inch O.D. drag bit. The water used for drilling was obtained from on-site well RCRA-5. The water remaining in the borehole following completion of wash rotary drilling techniques was bailed out prior to installation of well materials in wells SM-30, SM-31, and SM-32.

Wells then were constructed in the boreholes. Three well screens were installed at different intervals in the SM-31 borehole. In SM-31, a 10-foot screen was placed in the bottom of the well. A 5-foot screen section was installed from 67 to 72 feet bgs to monitor fractures at 68.4, 69.25, and 70.5 feet bgs identified during observation of the core. A 2.5-foot screen section also was placed from 52 to 54.5 feet bgs to monitor fractures occurring at 53 feet and 54.3 feet bgs. In SM-32, two well screens were installed. One 10-foot screen was placed in the bottom of the well and a 5-foot screen was installed from 57 to 62 feet bgs, to monitor a fracture at 59.4 feet bgs. The screen sections in each of these two wells were separated by lengths of solid pipe, and the annular space between these screens was sealed with bentonite chips. Wells SM-30 and SM-33 each contain one 10-foot screen placed at the bottom of the well, because no fractures were observed in the core from these borings. The enclosed boring logs and well construction diagrams detail the installed well geometry and the quantities of materials used during the installation process.

Well screen sections and riser pipes were delivered to the site and stored in sealed plastic wrappers. Immediately prior to use, the well screen sections, riser pipe, and end cap were steam cleaned at the decon area. All "O" rings were removed from well materials prior to decontamination. Drilling personnel wore new clean latex gloves when handling well materials. Sand and bentonite used in well construction were free of additives and were delivered to the CWM-Emelle facility in unopened containers.

Monitoring wells SM-30 through SM-33 were constructed of 2-inch I.D., flush-threaded, Schedule 40 PVC. The well screens consist of 2.5-, 5-, and 10-foot sections of 0.010-inch, factory-slotted PVC, as previously described and as noted on the boring logs. An end cap approximately 0.5 feet long was placed on the bottom of the deepest well screen.

The riser pipe, well screen, and end cap were threaded together and placed in each open borehole. A sand pack of graded silica sand, Number 1 DSI, was placed into the annular space surrounding each of the well screens. A minimum 2-foot layer of bentonite chips was placed between each screened interval when multiple screens in one well were used, to provide an adequate seal between each screened section. The remaining annular space was filled to the ground surface with Pure Gold bentonite chips and hydrated with water from the well RCRA-5.

CWM-Emelle personnel installed anodized aluminum, locking, protective covers over the riser pipe that extends above ground surface. Weep holes were installed at the base of each casing to ensure proper drainage. A 4-foot by 4-foot by 4-inch thick square concrete pad then was poured around the protective casings.

Because wet rotary drilling methods were used during drilling and because wells installed in the chalk recover very slowly, the enclosed boring and well installation logs do not indicate a stabilized water level in the well. Stabilized water levels will be obtained by CWM-Emelle personnel during well development and sampling in accordance with standard procedures.

Horizontal coordinates, as well as ground surface and top of casing elevations were surveyed by Almon Associates, Inc. of Tuscaloosa, Alabama. Coordinates and elevations are included with the boring and well installation logs.

JJ&G trusts that this information meets your needs. If you have further comments or need additional information, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Russell H. Patterson

FOR Sherri H. Clark, P.G.
Project Geologist

Michael T. Feeney

Michael T. Feeney, P.E.
Manager, Geosciences

ALABAMA
REGISTERED
No. 15895
PROFESSIONAL
ENGINEER
M. T. FEENEY

rap/mtf
Enclosures
1186.018(5B1)
P:\1186-018\SM30-33report.doc

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	Inspector	R. Patterson	Boring No.	SM-30
Project Number	1186.018	Weather	Cloudy, Rainy	Sheet	1 of 2
Drilling Company	AT&E	Temperature	45 F	Surface Elev.	192.4'
Drill Rig	CME-750	Depth Hole	120.0' bgs	Datum	msl
Wt Hammer	140 lb. Drop 30"	Hole Diam.	10 ¼ " / 6"	Started	12-8-98 / 10:00 am
Driller	Pat Bergman	Drilling Mud	NA	Completed	12-15-98 / 12:45pm
Sampling Method	S.S. / NQWL Core	No. Dist. S.A.	11	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

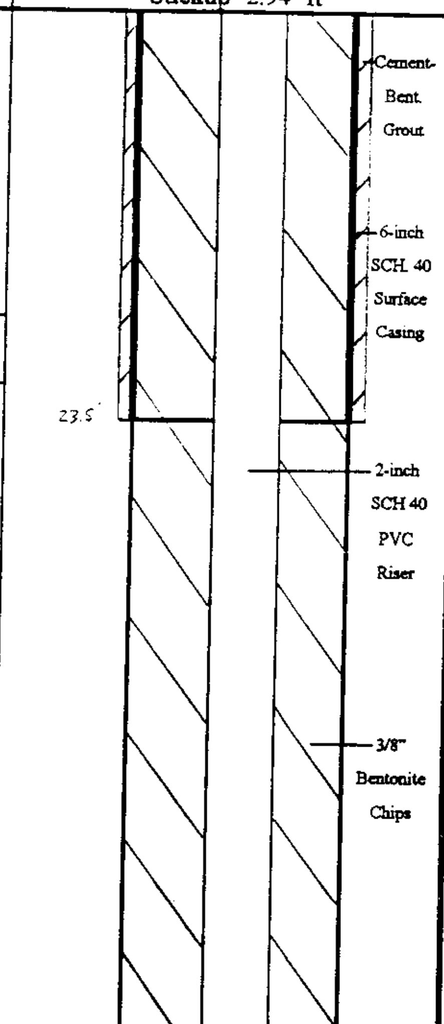
Well Materials Inventory

Well I.D.	SM-30	Filter Pack Qty	2.0 cu. ft.	Grout Install	Tremie around surface casing
Well Casing Dia.	2" L.F. 110'	Pack Type & Size	DSI #1 - Filter Sand	End Cap/Sump	0.5'
Casing Type	Sch. 40 PVC	Install Method	Pour	Prot. Casing: Y N	X
Joint Type	Flush Threaded, O-Rings Removed	Seal Type	3/8" Pure Gold Medium Bentonite Chips (Well annulus)	Well Pad Size	4' X 4' X 4"
Well Screen Dia.	2" L.F. 10'	Qty/Install Method	17.0 cu. ft. / Pour (To surface)	TOC Elevation	195.34'
Screen Type	Factory Slotted	Grout Type & Qty	Cement-Bentonite / 8.9 cu. ft.	Water Level	NA
Slot Size	0.010"	Mix Ratio	564 lbs cement/ 13 lbs bentonite/ 60 gal. H20	Date WL NA	Time NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	2-5-7-9	100		
	S.S. 2	3-4-6-7	100		
	S.S. 3	3-4-4-5	100		
	S.S. 4	4-6-9-8	50		Soft to compact, tan, brown, and gray chalk fill
10	S.S. 5	2-4-5-6	75		
	S.S. 6	2-3-4-5	80		
	S.S. 7	2-3-2-3	75		
	S.S. 8	2-4-5-5	80		
	S.S. 9	2-4-4-7	100		
20	S.S. 10	4-14-31-50	90		19.0' Tan to light brown
	S.S. 11	14-29-48-50	100		21.0' weathered CHALK
	Run 1	23.0-25.0	75		Gray, unweathered, fossiliferous CHALK
30					
	Run 2	25.0-35.0	98		
40					
	Run 3	35.0-45.0	73		
50					
	Run 4	45.0-55.0	99		
60					

Well Diagram / Comments
Stickup -2.94' ft

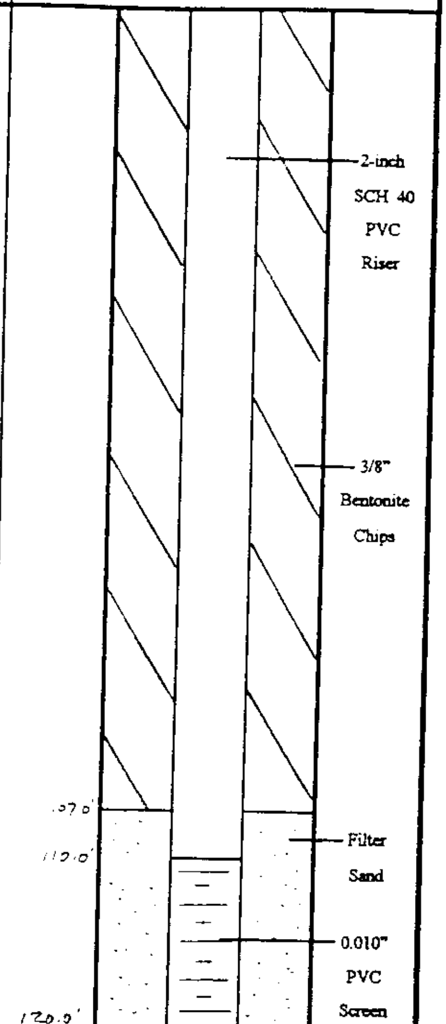


Notes: 1. Continuous split spoon sampling to 22.0'. Set 6" Sch. 40 surface casing to 23.5' and grouted in place.
2. Cored through surface casing from 23.0' to 120.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Boring / Monitoring Well Installation Log Page 2 of 2
Boring No. / Well ID SM-30

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	55.0-65.0	98		
70					
	Run 6	65.0-75.0	98		
80					Gray, unweathered, fossiliferous CHALK
	Run 7	75.0-85.0	87		
90					
	Run 8	85.0-95.0	99		
100					
	Run 9	95.0-105.0	57		
110					
	Run 10	105.0-115.0	79		
120	Run 11	115.0-120.0	100		

Well Diagram / Comments



Coring terminated at 120.0'

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	**Inspector**	R. Patterson	**Boring No.**	SM-31
Project Number	1186.018	**Weather**	Clear, Cool	**Sheet**	1 of 2
Drilling Company	AT&E	**Temperature**	50 F	**Surface Elev.**	207.8'
Drill Rig	CME-750	**Depth Hole**	122.0' bgs	**Datum**	msl
Wt Hammer	140 lb. **Drop** 30"	**Hole Diam.**	10 ¼" / 6"	**Started**	12-9-98 / 10:05 am
Driller	Pat Bergman	**Drilling Mud**	NA	**Completed**	12-17-98 / 2:30 pm
Sampling Method	S.S. / NQWL Core	**No. Dist. S.A.**	5	**No. UD. S.A.**	NA
Depth W.L.	NA	**Time W.L.**	NA	**Date W.L.**	NA

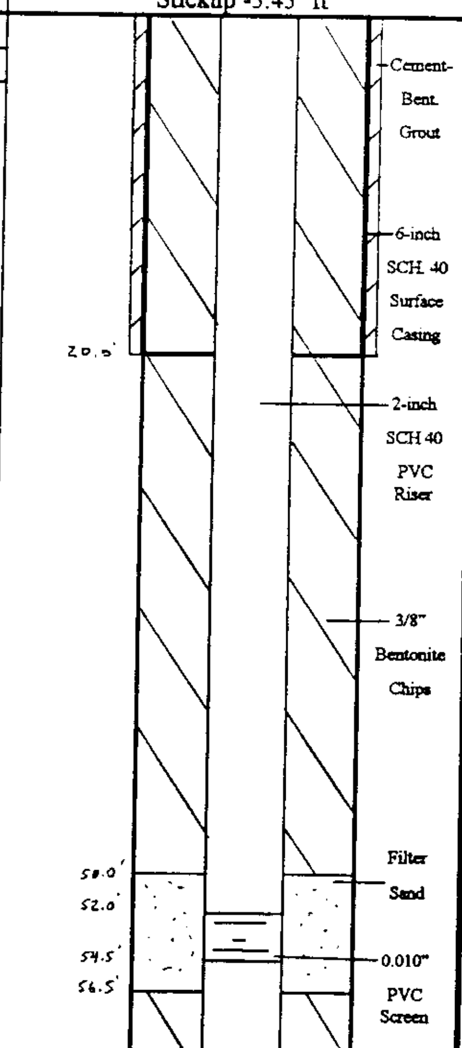
Well Materials Inventory

Well I.D.	SM-31	**Filter Pack Qty**	4.4 cu. ft.	**Grout Install**	Tremie around surface casing
Well Casing Dia.	2" **L.F.** 104.5'	**Pack Type & Size**	DSI #1 - Filter Sand	**End Cap/Sump**	0.5'
Casing Type	Sch. 40 PVC	**Install Method**	Tremie / Pour	**Prot. Casing: Y**	X **N**
Joint Type	Flush Threaded, O-Rings Removed	**Seal Type**	3/8" Pure Gold Medium Bentonite Chips(Well annulus)	**Well Pad Size**	4' X 4'X 4"
Well Screen Dia.	2" **L.F.** 17.5'	**Qty/Install Method**	15.0 cu. ft. / Pour(To surface)	**TOC Elevation**	211.23'
Screen Type	Factory Slotted	**Grout Type & Qty**	Cement-Bentonite/7.6 cu. ft.	**Water Level**	NA
Slot Size	0.010"	**Mix Ratio**	564 lbs. Cement/ 12 lbs. Bentonite/ 55 gal. H20	**Date WL** NA	**Time** NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	3-3-5-5	60		Fill material
	S.S. 2	4-4-7-7	100		4.5' Tan to light brown, weathered CHALK
	S.S. 3	3-8-24-34	100		Gray, unweathered, fossiliferous CHALK
	S.S. 4	6-21-27-33	100		
10	S.S. 5	7-21-27-37	100		
20				f - 20.6'	42°, Slickensides
				f - 20.8'	60°, Slickensides
	Run 1	20.0-25.0	90	f - 24.7'	60°, Slickensides
30				f - 28.5'	52°, Slickensides
				f - 30.2'	30°, Slickensides
	Run 2	25.0-35.0	89		
40					
	Run 3	35.0-45.0	97		
50					
				f - 53.0'	54°, Slickensides
				f - 54.3'	41° Slickensides
	Run 4	45.0-55.0	98		
60					

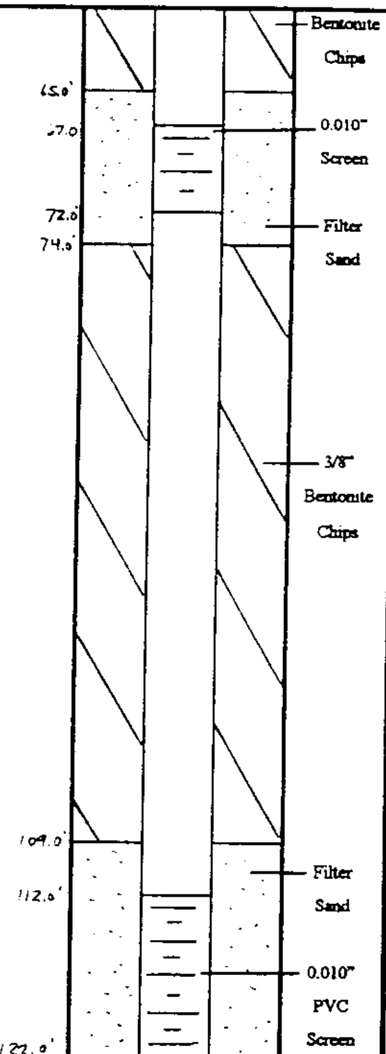
Well Diagram / Comments
Stickup -3.43' ft



Notes:
1. Continuous split spoon sampling to 10.0'. Set 6" Sch. 40 surface casing to 20.0' and grouted in place.
2. Cored through surface casing from 20.0' to 122.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	55.0-65.0	98		
				f - 68.4'	58°, Slickensides
70				f - 69.25'	40°, Slickensides
				f - 70.5'	45°, Slickensides
	Run 6	65.0-75.0	97		
80					Gray, unweathered, fossiliferous CHALK
	Run 7	75.0-85.0	100		
90					
	Run 8	85.0-95.0	98		
100					
	Run 9	95.0-105.0	100		
110					
	Run 10	105.0-115.0	98		
120					
	Run 11	115.0-122.0	99		

Well Diagram / Comments



Coring terminated at 122.0' bgs

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	Inspector	R. Patterson ✓mn	Boring No.	SM-32
Project Number	1186.018	Weather	Cloudy, Cool	Sheet	1 of 2
Drilling Company	AT&E	Temperature	55 F	Surface Elev.	209.7'
Drill Rig	CME-750	Depth Hole	117.0' bgs	Datum	msl
Wt Hammer	140 lb. Drop 30"	Hole Diam.	10 ¼" / 6"	Started	12-9-98 / 2:45 pm
Driller	Pat Bergman	Drilling Mud	NA	Completed	12-21-98 / 3:45 pm
Sampling Method	S.S. / NQWL Core	No. Dist. S.A.	10	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

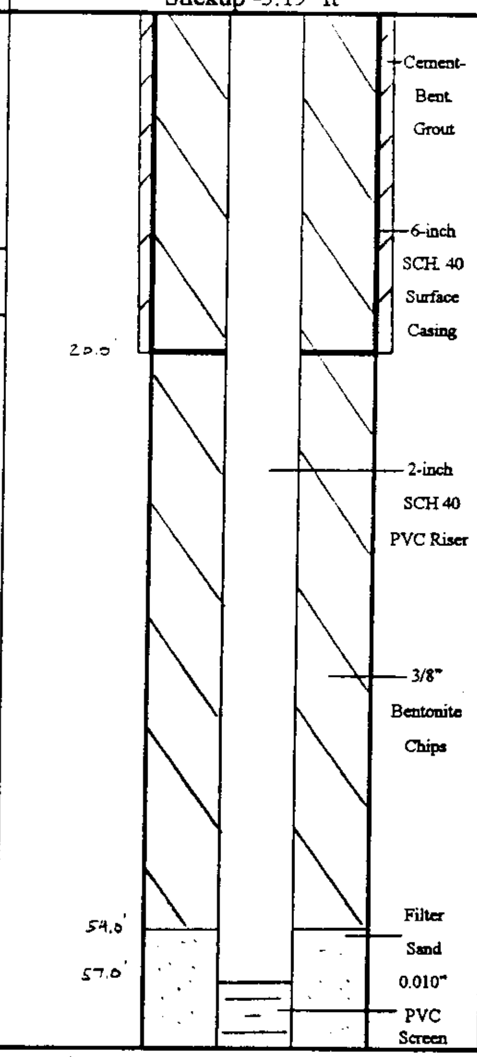
Well Materials Inventory

Well I.D.	SM-32	Filter Pack Qty	3.5 cu. ft.	Grout Install	Tremie around surface casing
Well Casing Dia.	2" L.F. 112'	Pack Type & Size	DSI #1 - Filter Sand	End Cap/Sump	0.5'
Casing Type	Sch. 40 PVC	Install Method	Pour	Prot. Casing: Y / N	X
Joint Type	Flush Threaded, O-Rings Removed	Seal Type	3/8" Pure Gold Medium Bentonite Chips(Well annulus)	Well Pad Size	4' X 4' 4"
Well Screen Dia.	2" L.F. 15'	Qty/Install Method	15.3 cu. ft. / Pour (To Surface)	TOC Elevation	212.89'
Screen Type	Factory Slotted	Grout Type & Qty	Cement-Bentonite/7.6 cu. ft.	Water Level	NA
Slot Size	0.010"	Mix Ratio	564 lbs cement/12 lbs Bentonite/ 60 gal H20	Date WL NA	Time NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	9-14-14-21	100		Soft to compact, tan, brown, and gray chalk fill
	S.S. 2	8-8-18-24	100		
	S.S. 3	7-7-8-9	100		
	S.S. 4	5-5-6-12	100		
10	S.S. 5	5-5-5-8	100		
	S.S. 6	5-8-19-18	100		
	S.S. 7	2-3-4-5	80		
	S.S. 8	4-5-10-19	100		15.0' Tan to light brown, weathered
	S.S. 9	8-19-22-31	100		17.5' CHALK
20	S.S. 10	5-23-29-56	100		Gray, unweathered, fossiliferous CHALK
	Run 1	20.0-25.0	84		
30				f - 32.6'	35°
	Run 2	25.0-35.0	98		
40					
	Run 3	35.0-45.0	97		
50					
	Run 4	45.0-55.0	98		
60				f - 59.4'	28°, Slickensides

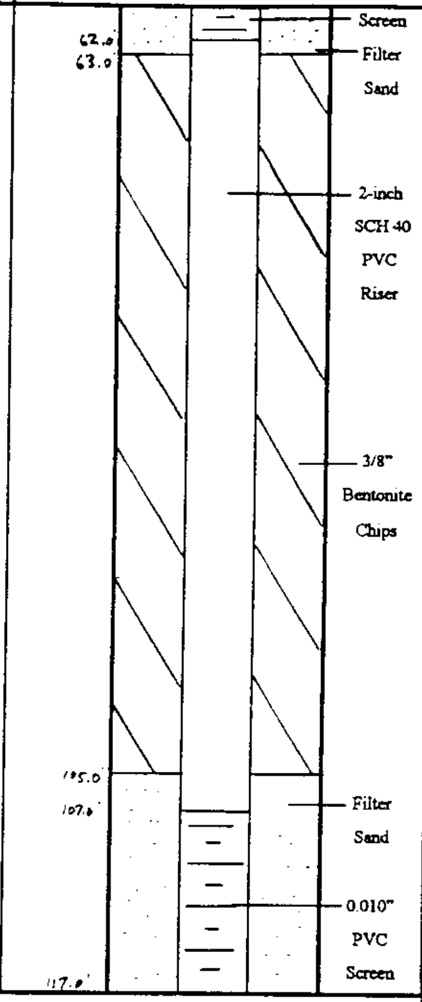
Well Diagram / Comments
Stickup -3.19' ft



Notes:
1. Continuous split spoon sampling to 20.0'. Set 6" Sch. 40 surface casing to 20.0' and grouted in place.
2. Cored through surface casing from 20.0' to 117.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	55.0-65.0	98		
70					
	Run 6	65.0-75.0	97		
80					Gray, unweathered, fossiliferous CHALK
	Run 7	75.0-85.0	85		
90					
	Run 8	85.0-95.0	98		
100					
	Run 9	95.0-105.0	96		
110					
	Run 10	105.0-115.0	95		
	Run 11	115.0-117.0	100		

Well Diagram / Comments



Coring terminated at 117.0' bgs

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	Inspector	R. Patterson (initialed)	Boring No.	SM-33
Project Number	1186.018	Weather	Clear, Cool	Sheet	1 of 2
Drilling Company	AT&E	Temperature	50 F	Surface Elev.	204.43'
Drill Rig	CME-750	Depth Hole	109.0' bgs	Datum	msl
Wt Hammer	140 lb. Drop 30"	Hole Diam.	10 ¼" / 6"	Started	12-17-98 / 3:25 pm
Driller	Pat Bergman	Drilling Mud	NA	Completed	12-23-98 / 1:15 pm
Sampling Method	S.S. / NQWL Core	No. Dist. S.A.	10	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

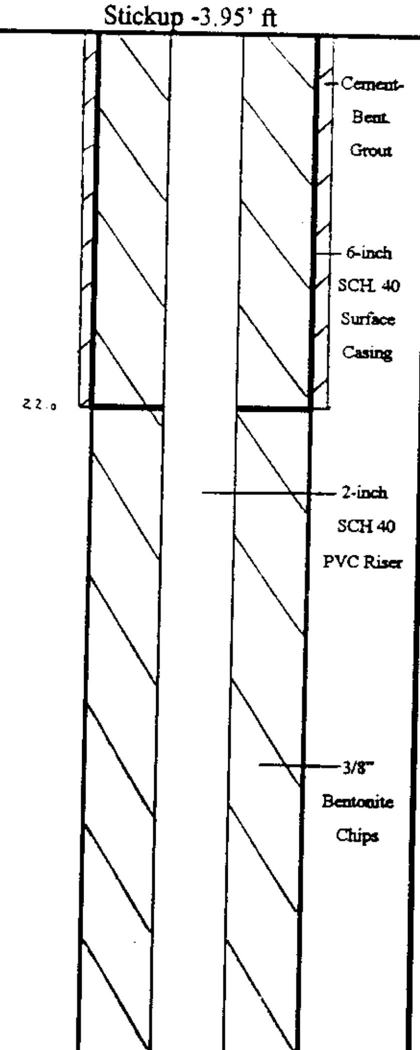
Well Materials Inventory

Well I.D.	SM-33	Filter Pack Qty	2.0 cu. ft.	Grout Install	Tremie around surface casing
Well Casing Dia.	2" L.F. 99'	Pack Type & Size	DSI #1 - Filter Sand	End Cap/Sump	0.5'
Casing Type	Sch. 40 PVC	Install Method	Pour	Prot. Casing: Y N	X
Joint Type	Flush Threaded, O-Rings Removed	Seal Type	3/8" Pure Gold Medium Bentonite Chips(Well annulus)	Well Pad Size	4' X 4' X 4"
Well Screen Dia.	2" L.F. 10'	Qty/Install Method	15.0 cu. ft. / Pour (To Surface)	TOC Elevation	208.38'
Screen Type	Factory Slotted	Grout Type & Qty	Cement-Bentonite / 8.4 cu. ft.	Water Level	NA
Slot Size	0.010"	Mix Ratio	564 lbs cement / 13 lbs bentonite / 60 gal. H20	Date WL NA	Time NA

Boring and Well Diagram

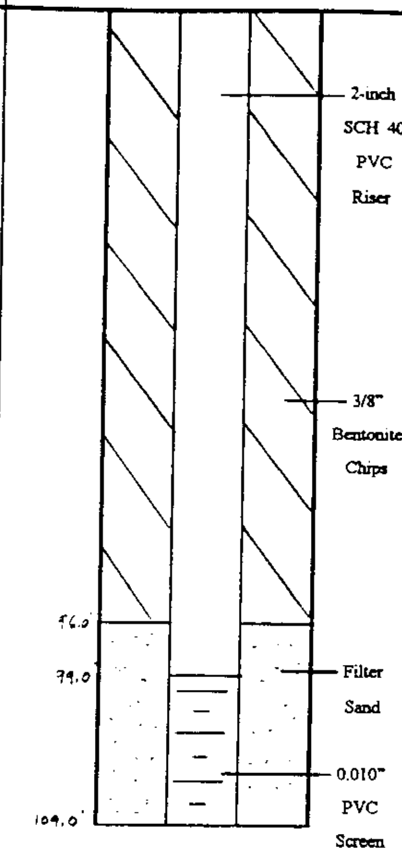
Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	2-4-5-7	80		Soft to compact, tan, brown, and gray chalk fill
	S.S. 2	3-6-9-13	100		
	S.S. 3	6-11-19-18	100		
	S.S. 4	11-14-17-18	100		
10	S.S. 5	7-12-13-14	100		
	S.S. 6	4-6-7-10	70		
	S.S. 7	4-5-5-8	80		
	S.S. 8	4-5-5-7	100		
	S.S. 9	5-11-14-16	100		17.0' Tan to light brown weathered
20	S.S. 10	5-10-17-29	100		19.5' CHALK
	Run 1	22.0-25.0	53		Gray, unweathered, fossiliferous CHALK
30					
	Run 2	25.0-35.0	98		
40					
	Run 3	35.0-45.0	93		
50					
	Run 4	45.0-55.0	99		
60					

Well Diagram / Comments
Stickup -3.95' ft



Notes: 1. Continuous split spoon sampling to 20.0'. Set 6" Sch. 40 surface casing to 22.0' and grouted in place.
2. Cored through surface casing from 22.0' to 109.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Well Diagram / Comments
	Run 5	55.0-65.0	98			
70						
	Run 6	65.0-75.0	98			
80						
					Gray, unweathered, fossiliferous CHALK	
	Run 7	75.0-85.0	99			
90						
	Run 8	85.0-95.0	99			
100						
	Run 9	95.0-105.0	98			
110	Run 10	105.0-109.0	98			



Coring terminated at 109.0' bgs

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Surveying

Almon Associates, Inc.

Robert N. Almon, PE/LS
Robert F. Evans, PE
Thomas S. Hughes, PLS
Gary R. Nevin, PE
James N. Ezell. II, PE
James R. Brown, PE

CHEMICAL WASTE MANAGEMENT
EMELLE, ALABAMA
MONITORING WELL ELEVATIONS
TRENCH #21, CELL #3 AND CELL #4

WELL NUMBER	TOP OF 2" PVC	TOP OF CONCRETE	GROUND SHOT
SM-30	195.34	192.58	192.4
SM-31	211.23	208.22	207.8
SM-32	212.89	209.80	209.7
SM-33	208.38	204.62	204.43

WELL NUMBER	NORTH	EAST
SM-30	10386.920	5351.478
SM-31	9926.530	5372.605
SM-32	9550.473	5323.801
SM-33	8705.229	5913.173

2008 12th Street P.O. Drawer 2729 Tuscaloosa, Alabama 35403 205/349-2100 Fax 205/349-2107

JORDAN
JONES &
GOULDING

6801 Governors Lake Parkway
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Norcross, Georgia 30071
T 770.455.8555
F 770.455.7391
www.jjg.com

August 2, 2005

Ms. Teresa Williams
Chemical Waste Management, Inc.
36964 Alabama Highway 17
Emelle, Alabama 35459

RE: Installation of Monitoring Well SM-34
Trench 22, Cell 3
Emelle, Alabama Facility

Dear Ms. Williams:

Jordan, Jones & Goulding, Inc. (JJG) was retained by the Chemical Waste Management, Inc. Emelle, Alabama, facility (CWM-Emelle) to install one monitoring well, SM-34, adjacent to Cell 3 of Trench 22. In fulfillment of Condition IX.B.1.g.i of the CWM-Emelle Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) Hazardous Waste Facility Permit (Permit), a well installation plan dated February 24, 2005 was submitted to the Alabama Department of Environmental Management (ADEM). This well installation letter report has been prepared to satisfy Condition IX.B.1.g of the Permit and provides drilling and installation procedures, survey data, and a well log for groundwater monitoring well SM-34.

Drilling Operations

JJG arranged for Qore Property Sciences (Qore) of Atlanta, Georgia (Georgia Bond No. 145017087281) to install well SM-34 adjacent to Cell 3 of Trench 22 at the CWM-Emelle facility. Qore mobilized a CME 550 all-terrain drill rig, equipment, and personnel to the CWM-Emelle facility on May 2, 2005. Drilling of SM-34 began on May 3, 2005, and was completed on May 6, 2005. A JJG geologist provided oversight for decontamination, drilling, well installation, and well development operations. Additionally, JJG logged the boring and prepared a monitoring well log.

The boring and well installation log for SM-34 is enclosed with this letter. Survey information for monitoring well SM-34 is included on the boring and well installation log..

Upon arrival at the CWM-Emelle facility, a decontamination (decon) pad consisting of a small area covered with polyethylene sheeting, was constructed by Qore personnel. The decon pad was constructed to the southwest of Trench 22, Cell 3. Prior to drilling, the back of the drill rig, hollow-stem augers, drill rods, core barrels, drill bits, and tools were steam cleaned and rinsed with water obtained from the clean on-site well, RCRA-8. Water used in steam cleaning was collected in a sump area of the decon pad and pumped into drums for disposal at CWM-Emelle.

To complete the installation of SM-34, the weathered chalk was continuously logged and a surface casing was installed down to the unweathered chalk to seal off the weathered chalk zone. The unweathered chalk was then continuously cored to a depth of 93.5 ft below ground surface (bgs) and the cores were inspected for native fractures. The corehole was then reamed and well construction materials were installed through the borehole.

The weathered chalk was continuously sampled to a depth of 18 ft bgs using a split spoon sampler with 3¼-inch inside diameter (I.D.) hollow stem augers (HSA). The boundary between the weathered and unweathered chalk was observed to be approximately 10.5 ft bgs. To ensure the bottom of the weathered chalk had been clearly delineated, continuous split-spoon sampling continued into the unweathered chalk to a depth of 18 ft bgs. Following confirmation of the bottom of the unweathered chalk, the borehole was reamed with 6¼-inch I.D., 10¼-inch outside diameter (O.D.) HSA. A 6-inch I.D. PVC surface casing was installed from the ground surface to a depth of 15.5 feet bgs. The annular space surrounding the PVC casing was tremie grouted from the bottom upward with a mixture of Pure Gold bentonite and water from RCRA-8. The grout was allowed to set for several hours before coring was begun to extend the boring. Auger spoils generated during drilling were spread onto the ground surface.

Using a NQ-size core barrel, unweathered chalk in SM-34 was cored from the base of the PVC surface casing to 93.5 ft bgs - approximately 25 ft below the design elevation of the pressure relief sump in Trench 22, Cell 3. The core was placed in labeled core boxes, photographed, and retained at the CWM-Emelle facility for storage.

Well Installation

ADEM representatives, Mr. Keith West, Permit Engineer, and Mr. David Lovoy, Hydrgeologist, were present at the facility on May 4, 2005 during the coring operations for SM-34. Both Mr. West and Mr. Lovoy examined the core while on site. Based upon the core examination, it was determined that no significant fractures were present in the core that would require a separate screen section to be installed in monitoring well SM-34. As a result, ADEM verbally approved the installation of a single 10-ft screen at the bottom of the monitoring well. The following paragraphs briefly describe the as-built construction of SM-34.

Following coring, the corehole was reamed using wash rotary drilling techniques with a 5⅞-inch drag bit. Water used in drilling was obtained from on-site well RCRA-8. After reaming the core hole to a nominal 6-inch diameter, a monitoring well was constructed in the borehole. The enclosed boring log and well construction diagram detail the installed well geometry and the quantities of materials used during the installation process.

Well screen sections and riser pipes were delivered to the site and stored in sealed plastic wrappers. Immediately prior to use, the well screen sections, riser pipe, and end cap were steam cleaned at the decon area. All "O" rings were removed from well materials prior to decontamination. Drilling personnel wore new, clean, latex gloves when handling well materials. Sand and bentonite used in well construction were free of additives and were delivered to the CWM-Emelle facility in unopened containers.

Monitoring well SM-34 was constructed of 2-in I.D., flush-threaded, Schedule 80 PVC. Well joints were taped with Teflon tape. The total depth of the monitoring well was 93.5 ft bgs. An end cap, approximately 0.5-ft long, was placed on the bottom of the 10-ft long, 0.010-inch factory-slotted PVC well screen. The SM-34 well screen extends from 83 ft to 93 ft bgs. A sand pack of graded silica sand, DSI Number 1A, was tremmied into the annular space surrounding the well screen and extended up to 76.4 ft bgs. The remaining annular space was grouted with a mixture of Pure Gold bentonite grout and water and was tremmied into place. No bentonite seal is needed between the sand pack and the Pure Gold bentonite grout because it contains no cement.

Following grouting, an anodized aluminum, locking, protective well cover was installed over the riser pipe that extends above ground surface. A 4-ft by 4-ft by 4-in thick square concrete pad was then poured around the protective casing.

At the completion of well installation, the well was purged until dry using a disposable bailer. Because wet rotary drilling methods were used during drilling and because wells installed in the Selma chalk recover very slowly, the enclosed boring and well installation logs do not indicate a stabilized water level in the well. Stabilized water levels will be obtained by CWM-Emelle personnel during well sampling, in accordance with standard procedures. In accordance with Permit Condition IX.B.1.g, monitoring well SM-34 will be added to the Selma Chalk Monitoring Program.

JJG trusts that this information meets your needs. If you have further comments or need additional information, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Stephen Lathrop

Stephen Lathrop, P.E.

Enclosures

CC: Mike Feeney, JJG
File 01186035

\\ATL-PROJECTS\Projects\01\01186\035\SM-34 Well Installation\SM-34 Well Installation Report.1.doc

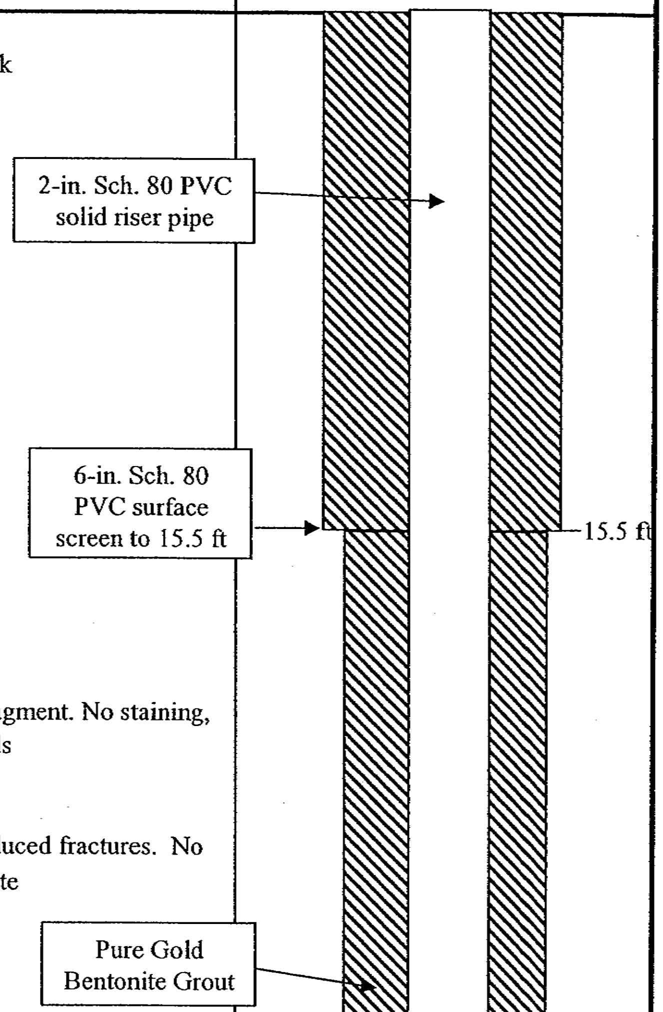
Boring Log

Project Name	CWM-Emelle SM-34	**Logger** CHF	**Reviewer** SBL	**Boring No.**	SM-34
Project Number	01186035.01	**Weather**	Clear - Warm	**Sheet**	1 of 3
Drilling Company	QORE	**Temperature**	~75 degrees F	**Surface Elev.**	249.1 ft (note 3)
Drill Rig	CME 550	**Depth of Hole**	93.5 ft bgs	**Location**	North – 8988.06
Hammer Data	140-lb – 30 inches	**Hole Diam.**	5 5/8 inches		East – 7307.31
Driller	Dan Bergman	**Drilling Mud**	N/A	**Started**	3 May 2005
Sampling Method	Split spoon / NQ3	**Disturbed Samples**	12	**Completed**	6 May 2005
Depth to Water	N/A (note 1)	**Time Water Meas.**	N/A (note 1)	**Undisturbed Samples**	None

Boring Diagram

Scale	Depth (ft)		Blow Count	N-Value	% Rec	Stratigraphic Description
0						
	0	1.5	2-3-5	8	100	Orange-brown weathered chalk
	1.5	3	2-5-6	11	100	Grey-green weathered chalk
5	3	4.5	4-7-11	18	100	
	4.5	6	4-6-7	13	100	
	6	7.5	4-6-7	13	100	
	7.5	9	3-8-11	19	100	Light-brown weathered chalk
10						
	9	10.5	2-9-10	19	100	Dark-grey unweathered chalk
	10.5	12	6-14-16	30	100	
	12	13.5	6-16-24	40	100	
15	13.5	15	6-12-16	28	100	Dark-grey unweathered chalk
	15	16.5	8-12-16	28	100	
	16.5	18	8-14-13	27	100	Dark-grey unweathered chalk
			RUN 1	RQD		
20						Dark-grey fossiliferous chalk
						20.5 ft: fracture along shell fragment. No staining, Mineral infilling, or slickensids
25				6.22	100	25.5 ft and 26.3 ft: drilling induced fractures. No Staining, slickensides, or calcite
			Run 2			
30						

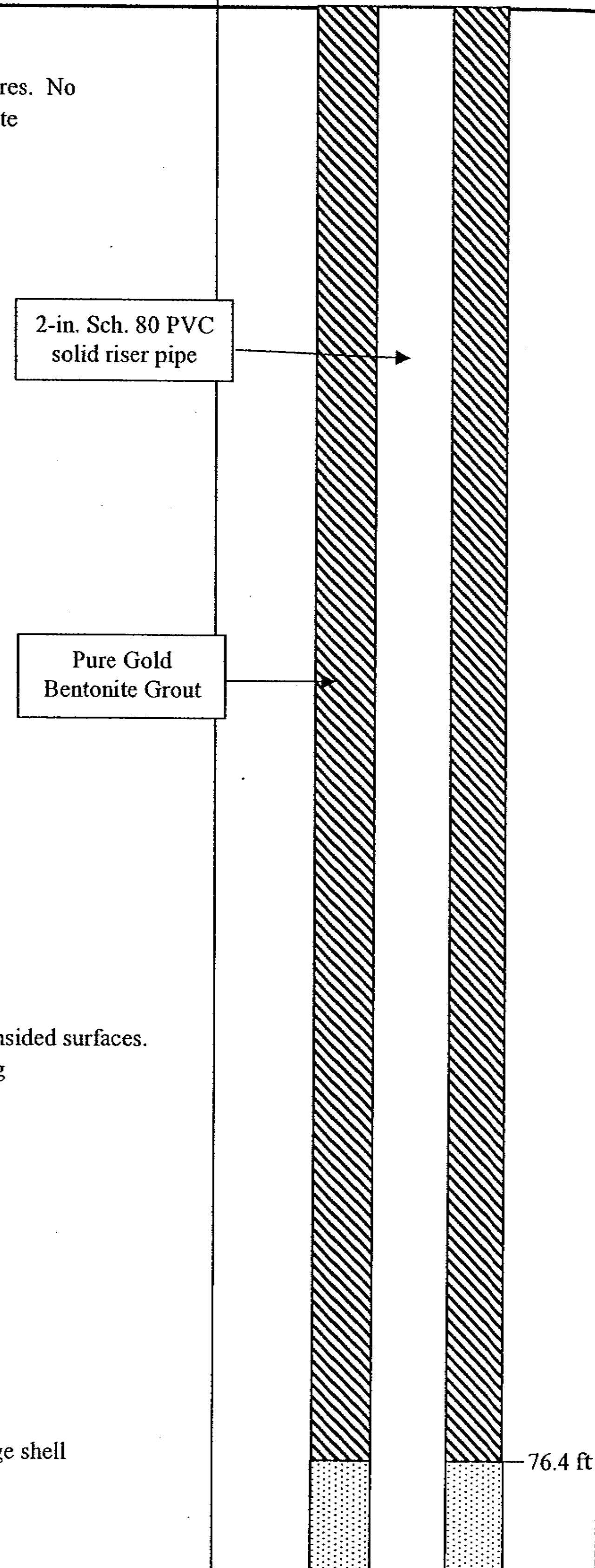
Well Diagram



Notes:
1) Due to slow recovery in chalk, static water levels will be collected by CWM-Emelle staff during next sampling event.
2) Low recovery and RQD due to drilling problems. Core slipped out of barrel while pulling barrel. Attempts to recover core unsuccessful.
3) Ground Elevation = 249.1 ft MSL
Top of PVC Casing Elevation = 252.26 ft MSL

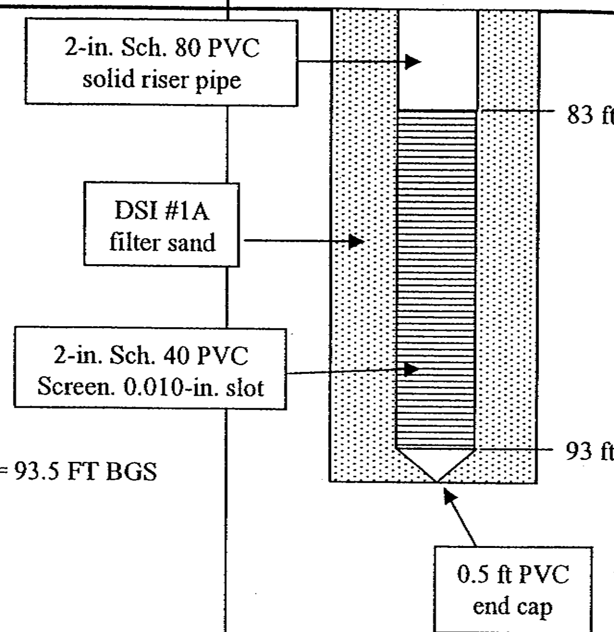
Depth (ft)	Sample Number	RQD	% Rec	Stratigraphic Description
				33.1 ft: drilling induced fractures. No Staining, slickensides, or calcite
35		10.3	100	
	Run 3			
				Dark-grey fossiliferous chalk
40				
45		10	100	
	Run 4			
50				
55		9.7	100	
	Run 5			
		3.2	100	
		58.1 ft		
60	Run 6			
				63.0 ft: Tight fracture. Slickensided surfaces. No staining or mineral infilling
65		6.8	99	
	Run 7			
				Dark-grey fossiliferous chalk
70				
75		5.9	77	See note 2
	Run 8			76.0 ft: core broken along large shell
80				

Well Diagram



Depth (ft)	Sample Number	RQD	% Rec	Stratigraphic Description
80	↓			
				Dark-grey fossiliferous chalk
85	↓	10	100	
	Run 9			
	↓			Dark-grey fossiliferous chalk
90				
		8.5	100	
		93.5 ft		BOTTOM OF BORING = 93.5 FT BGS
95				

Well Diagram



May 29, 2012 11390080

Metz Duites
Alabama Department of Environmental Management
1400 Coliseum Boulevard, P.O. Box 301463
Montgomery, Alabama 36130-1463

**RE: MONITORING WELL INSTALLATION AND DEVELOPMENT
CHEMICAL WASTE MANAGEMENT HAZARDOUS WASTE LANDFILL, EMELLE, ALABAMA
PERMIT NUMBER ALD 000 622 464**

Dear Mr. Duites:

Golder Associates Inc. (Golder) has prepared this report on behalf of Chemical Waste Management (CWM) to summarize monitoring well installation and development activities conducted at the CWM Hazardous Waste Landfill (Site) located in Emelle, Alabama. These activities were performed in accordance with information specified in the Permit Modification Request for Installation of Two Correction Action Monitoring Wells (dated July 7, 2011) and the Permit Modification Request for Installation of Selma Chalk Monitoring Wells (dated July 6, 2011), respectively. These Permit Modification Requests include well installation plans that satisfy Condition IX.B.1.g of the Permit.

DRILLING ACTIVITIES

Selma Chalk Groundwater Wells

Technical Drilling Services installed a total of four (4) permanent Selma Chalk groundwater monitoring wells (SM-35, SM-35B, SM-36 and SM-37) between January 9 and April 26, 2012 with a CME 75 drill rig. Prior to arriving on-site, the drill rig, hollow stem augers (HSA), drill rods, core barrels, drill bits and tools were steam cleaned and rinsed with water. The well locations were surveyed prior to installation to establish the installation location of the corresponding wells in accordance with the approved permit modification requests. A Golder geologist observed drilling, logged samples and soil cuttings, logged rock core and documented well construction details.

Each boring was drilled using 4.25-inch diameter HSA with continuous standard penetration test (SPT) sampling to below the interface between weathered and unweathered chalk. The depth to the weathered/unweathered chalk interface was determined based on color, since the weathered chalk is tan or light brown and the unweathered chalk is grey. Borings were extended beyond the weathered / unweathered chalk interface until bedrock was competent enough to permit the removal of quality rock core. Each boring was drilled to 30 ft below ground surface (ft bgs) with HSA before coring. The unweathered chalk was continuously cored with an HQ-size (2.5” diameter core) core barrel to depths corresponding with approximately 25 feet (ft) below the design elevation of the pressure relief sump in the neighboring trench or the depth of identified fractures.

Fractures, fracture sets, and zones of fracturing including measurements and observations such as apparent dip, fracture roughness, filling or coating material were documented on the boring logs. Natural fractures were differentiated from mechanical fractures based on their physical appearance and angle. Mechanical fractures are generally clean, fresh, with irregular surfaces that are oriented at close to 90° and/or that can be rejoined with only a hair-line separation. Fractures with these characteristics are typically driller induced. Surfaces that are stained, weathered, contain infilling or coatings, occur at some angle other than near-perpendicular to the core axis, or cannot be rejoined cleanly were counted as natural fractures. All mechanical breaks identified in the core or caused by handling the core or breaking the core to fit into the core boxes were marked with an X with a permanent marker. Recovery, rock quality designation (RQD), drilling condition and lithology were also logged during coring. The core was photographed, boxed and retained on-Site.

Drilling cuttings and washwater generated during drilling were containerized on-Site. Washwater used during drilling was from a source provided by the Site. A sample of the washwater collected from the driller's water storage tank was submitted for 8260B volatile organic compound (VOC) analysis and 8260C semi-volatile organic compound (SVOC) analysis. No VOCs or SVOCs were detected in the washwater. The laboratory reports for this analysis are included in Attachment A.

Section 5-a of the Facility Permit application requires an evaluation of the core data following drilling activities and the completion of a well construction plan for ADEM approval. Golder submitted verbal, email and letter report well construction plans during the construction of the SM-35, SM-35B, SM-36 and SM-37 wells. ADEM representatives, Mr. David Lovoy, Mr. Metz Duitz and Mr. Clay Messer were on-site to observe coring activities from January 9th to January 11th 2012. On January 11th Mr. Lovoy verbally approved the construction of SM-36. Verbal well installation plans were previously accepted as a well construction plan by ADEM during the installation of SM-34 (Jordan Jones & Goulding 2005)[1]. Afterwards, ADEM personnel indicated that their schedule would not permit them to remain on-site during all coring and well installation activities. Following discussions with Mr. Lovoy, an email summary was recommended to replace the well construction plan. The SM-36 email well construction plan was submitted on January 16th, 2012. Mr. Lovoy indicated that the construction of SM-36 was appropriate. The SM-35 email well construction plan was submitted on February 15th, 2012. This plan was rejected by ADEM in an email received on February 15th. ADEM required additional activities at the Site. In accordance with the facility permit, coring was proposed to verify the presence of these fractures in the proposed well. On April 25, 2012, SM-35B was advanced adjacent to SM-35 to a depth of 88.9 ft bgs. A well completion plan was submitted and approved by ADEM on April 26, 2012.

CMI Groundwater Monitoring Wells

Technical Drilling Services installed a total of two (2) permanent groundwater wells (CMI-1 and CMI-2) between January 9 and February 17, 2012 with a CME 75 drill rig. A Golder geologist observed drilling, logged samples and soil cuttings and documented well construction details for the two new groundwater wells. Each boring was drilled using 4.25-inch diameter HSA with continuous SPT sampling to interface between weathered chalk and chalk. Well depths were determined based upon the location of the weathered/unweathered chalk interfaced. The depth of the weathered/unweathered chalk interface was determined based on color, since the weathered chalk is tan or light brown and the unweathered chalk is grey.

Boring logs for Selma Chalk and CMI groundwater monitoring wells are included in Attachment B.

WELL CONSTRUCTION ACTIVITIES

Selma Chalk Groundwater Wells

Following approval of well construction, the weathered chalk was reamed with a 61/4-inch inside diameter (ID), 10 ¼ inch outside diameter (OD) HSA to 30 ft bgs in each Selma Chalk Well. The unweathered chalk coreholes were then reamed with a 5 7/8 inch drag bit. The final ID of the borehole was approximately 6 inches within the cored interval. Following drilling, groundwater monitoring wells at SM-35, SM-36 and SM-37 were constructed in the boreholes according to the following specifications:

- 2" diameter Schedule 40 PVC casing and screen with flush-threaded joints and o-ring seals
- Well screen ten ft of 0.010-inch factory slotted PVC with a bottom cap or sump
- Filter sand pack to two ft above screen

[1] Jordan, Jones & Goulding. (2005). *Installation of Monitoring Well SM-34.* Norcross, GA: Author

- Bentonite seal (hydrated) at least two ft above filter sand
- Cement-bentonite grout tremied from top of seal to within two to three ft of ground surface; allowed to cure for 24 hours and more added if necessary to bring to within two to three ft of ground surface
- Concrete pad 2' x 2'
- Locking protective casing with pea gravel and weep hole at base

Groundwater monitoring well SM-35B was designed to intersect two slickensided discontinuities encountered in SM-35 and was constructed in the borehole according to the following specifications:

- 2" diameter Schedule 40 PVC casing and screen with flush-threaded joints and o-ring seals
- Five foot 0.010-inch factory slotted PVC screens from 59 to 64 ft bgs and from 84 to 89 ft bgs.
- Filter sand pack (i.e., 20-30 mesh) to two ft above the lower screen
- Bentonite seal (hydrated) below the upper screen
- Filter sand pack below the upper screen to at least two ft above the upper screen
- Bentonite seal (hydrated) at least two ft above filter sand
- Cement-bentonite grout tremied from top of seal to within two to three ft of ground surface; allowed to cure for 24 hours and more added if necessary to bring to within two to three ft of ground surface
- Concrete pad 2' x 2'
- Locking protective casing with pea gravel and weep hole at base

CMI Groundwater Wells

Following drilling, groundwater monitoring wells were constructed in the boreholes according to the following specifications:

- 2" diameter Schedule 40 PVC casing and screen with flush-threaded joints and o-ring seals
- Well screen ten ft of 0.010-inch factory slotted PVC with a bottom cap or sump
- Filter sand pack (i.e., 20-30 mesh) to two ft above screen
- Bentonite seal (hydrated) at least two ft above filter sand
- Cement-bentonite grout tremied from top of seal to within two to three ft of ground surface; allowed to cure for 24 hours and more added if necessary to bring to within two to three ft of ground surface
- Concrete pad 2' x 2'
- Locking protective casing with pea gravel and weep hole at base

Tables 1 and 1A provide Selma Chalk and CMI groundwater well construction details including drilling information, total depth, screen interval, and construction material depths. Survey information is included in Table 2. As-built diagrams are included in Attachment C.

WELL DEVELOPMENT ACTIVITIES

Selma Chalk Groundwater Wells

Selma Chalk groundwater monitoring wells were developed between February 15 and May 1, 2012 by alternately pumping and surging using a submersible electric Grundfos Pump. Development was conducted until discharge was sediment-free with turbidity values less than 20 nephelometric turbidity units (NTUs), or until the well went dry. Because of the low recharge rates for the Selma Chalk wells, the addition of laboratory deionized water was necessary to remove sediment from the well screen. This development method is consistent with previous practices on-Site. The deionized water was surged and removed. Volumes of deionized water removed were verified to ensure that the deionized water did not infiltrate into the Selma Chalk formation.

CMI Groundwater Wells

CMI groundwater wells were developed during the weeks of January 18 and February 17, 2012 by alternately pumping and surging using a pneumatic Durham Geo Arch Pump and/or submersible electric Grundfos Pump. Turbidity was measured during development with a calibrated Horiba turbidity meter. Well development continued until turbidity dropped below 20 NTUs.

Table 3 summarizes development results for CMI and Selma Chalk groundwater wells. Final turbidity readings ranged from 9.55 to >1000 NTUs. It is likely that the turbidity at these locations is derived from Selma Chalk particulates encountered within the screened zone rather than artifacts of drilling and/or well construction, based on the development duration and volume of water removed during development. Although some of the final turbidity values are higher than the target 20 NTUs preferred for sampling, Selma Chalk particulates are expected to settle out of the water column. Using a dedicated bladder pump will likely further reduce the turbidity at these locations.

WELL SURVEYING

A licensed surveyor with Garrison Surveying, Inc. surveyed the new groundwater monitoring wells on May 22, 2012. The northing and easting were surveyed to the nearest 0.01 foot in the Alabama state plane coordinate system, and the top of casing and ground surface elevations were surveyed to the nearest 0.01 foot relative to mean sea level.

SUMMARY AND CLOSURE

Golder trusts that this information meets the requirements specified in the Facility Permit No. ALD 000 622 464 Conditions IX.B.1.d and IX.B.1.g. Please contact us at (770) 496-1893 with any questions or concerns regarding this report.

Sincerely,

GOLDER ASSOCIATES INC.

Michael Jay Smilley Project Geologist	Jeffery J.C. Paul, P.G. Principal and Practice Leader

Attachments:

Tables
Attachment A – Washwater Laboratory Report
Attachment B – Boring and Coring Logs
Attachment C – As-built Well Diagrams

TABLES

TABLE 1
GROUNDWATER WELL CONSTRUCTION DETAILS
CHEMICAL WASTE MANAGEMENT (CWM), EMELLE, ALABAMA

Well	Date Completed	Supervising Geologist	Drilling Company	Drill Rig	Driller	Drilling Method	Well Depth (ft BGS)	Screen Interval (ft BGS)	Filter Interval (ft BGS)	Seal Interval (ft BGS)	Grout Interval (ft BGS)	Surface Completion
SM-35	15-Feb-12	M. Smilley	Technical Drilling Services	CME 75	Curtis Lee	H.S.A. / W.R.	105.0	95-105	93-105	86-93	2-86	2x2 Concrete pad
SM-35B	01-May-12	M. Smilley	Technical Drilling Services	CME 75	Curtis Lee	H.S.A. / W.R.	89.0	59-64, 84-89	57-70, 82-89	43-57, 70-82	2-43	2x2 Concrete pad
SM-36	13-Jan-12	M. Smilley	Technical Drilling Services	CME 75	Curtis Lee	H.S.A. / W.R.	84.0	74-84	72-84	66-72	2-66	2x2 Concrete pad
SM-37	12-Jan-12	M. Smilley	Technical Drilling Services	CME 75	Curtis Lee	H.S.A. / W.R.	156.0	146-156	144-156	140.5-144	2-140.5	2x2 Concrete pad
CMI-1	21-Jan-12	M. Smilley	Technical Drilling Services	CME 75	Curtis Lee	H.S.A.	39.0	29-39	27-40	24.5-27	2-24.5	2x2 Concrete pad
CMI-2	18-Jan-12	M. Smilley	Technical Drilling Services	CME 75	Curtis Lee	H.S.A.	18.4	8.4-18.4	6.4-18.4	4.4-6.4	2-4.4	2x2 Concrete pad

Notes:
H.S.A. - hollow stem auger; W.R. - Water Rotary / HQ Wireline; ft BGS - feet below ground surface; N/A - not applicable; concrete installed to top of seal

Golder Associates

TABLE 1A
WELL CONSTRUCTION DETAILS
OAK GROVE LANDFILL EXPANSION, WINDER, GA

Well	Filter Material Size	Filter Quantity	Filter Volume (ft3)	Filter Installation Method	Seal Material Size	Seal Quantity	Seal Volume (ft3)	Seal Method	Grout Mixture	Grout Volume (ft3)	Grout Method
SM-35	Sand Mesh 20-40	3 bag	1.5	Tremie	3/8" Pellet	1 bag	1	Gravity	C-B	16	Tremie
SM-35B	Sand Mesh 20-40	5 bag	2.5	Tremie	3/8" Pellet	3 bag	3	Gravity	C-B	13	Tremie
SM-36	Sand Mesh 20-40	3 bag	1.5	Tremie	3/8" Pellet	1 bag	1	Gravity	C-B	13	Tremie
SM-37	Sand Mesh 20-40	4 bag	2.0	Tremie	3/8" Pellet	1 bag	1	Gravity	C-B	25	Tremie
CMI-1	Sand Mesh 20-40	6 bag	3.0	Tremie	3/8" Pellet	1 bag	1	Gravity	C-B	8	Tremie
CMI-2	Sand Mesh 20-40	6 bag	3.0	Tremie	3/8" Pellet	1 bag	1	Gravity	C-B	5	Tremie

Notes:

ft3 - cubic feet;

C-B - cement-bentonite grout consisting of 3-5 pounds of bentonite and 5-6 gallons of water per 94-pound bag of bentonite

Golder Associates

TABLE 2
AS-BUILT SURVEY DATA FOR NEW GROUNDWATER WELLS
CHEMICAL WASTE MANAGEMENT (CWM), EMELLE, ALABAMA

Well	Type	Northing Coordinate (feet)	Easting Coordinate (feet)	Ground Surface Elevation (ft MSL)	PVC Casing Elevation (ft MSL)
SM-35	Groundwater	8938.37	6777.50	256.60	259.89
SM-35B	Groundwater	8937.88	6782.73	256.60	259.78
SM-36	Groundwater	14847.10	7519.47	192.40	195.08
SM-37	Groundwater	14120.58	7674.03	194.90	198.08
CMI-1	Groundwater	14419.69	5221.66	194.40	197.77
CMI-2	Groundwater	14560.40	6829.46	173.80	176.75

Notes:

Wells surveyed by Paul E Burkhalter (AL License No. 18109) on May 22, 2012. Northing and easting coordinates provided in state plane coordinate system; ft MSL - feet above mean sea level.

Golder Associates

TABLE 3
GROUNDWATER WELL DEVELOPMENT SUMMARY
OAK GROVE LANDFILL EXPANSION, WINDER, GA

Well	Development Date (2012)	Pumping Duration (minutes)	Volume Removed (gallons)	Initial DTW (ft BTOC)	Final DTW (ft BTOC)	Initial Depth (ft BTOC)	Final Depth (ft BTOC)	Final Turbidity (NTU)	DI Volume Added (gallons)	DI Volume Removed (gallons)
SM-35	2/17	50	15	23.90	NA	107.40	107.50	>1000	30	29.9
SM-35B	5/1	60	30	13.32	NA	92.89	92.93	>1000	20	19.9
SM-36	1/19, 2/16	50	7	49.62	NA	87.31	87.33	375	25	24.9
SM-37	1/19, 2/15, 2/16	90	35	25.81	NA	159.71	159.71	174	15	15
CMI-1	1/18, 1/19, 2/15, 2/17	180	90	19.88	19.75	42.20	42.32	17.3	NA	NA
CMI-2	1/18, 1/19, 2/16	120	50	3.68	4.58	21.38	4.58	9.55	NA	NA

Notes:

DTW - depth to water; ft BTOC - feet below top of casing; NTU - nephelometric turbidity units; DI - Deionized Water

Golder Associates

ATTACHMENT A

WASH WATER LABORATORY REPORT

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

ESC LAB SCIENCES
YOUR LAB OF CHOICE

Mr. Michael Smilley
Golder & Associates - GA
3730 Chamblee Tucker Road
Atlanta, GA 30341

Report Summary

Friday February 24, 2012

Report Number: L560869
Samples Received: 02/16/12
Client Project:

Description: Alabama

The analytical results in this report are based upon information supplied by you, the client, and are for your exclusive use. If you have any questions regarding this data package, please do not hesitate to call.

Entire Report Reviewed By: ______________________________

Craig Cothron , ESC Representative

Laboratory Certification Numbers

A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 01157CA, CT - PH-0197,
FL - E87487, GA - 923, IN - C-TN-01, KY - 90010, KYUST - 0016,
NC - ENV375/DW21704/BIO041, ND - R-140. NJ - TN002, NJ NELAP - TN002,
SC - 84004, TN - 2006, VA - 460132, WV - 233, AZ - 0612,
MN - 047-999-395, NY - 11742, WI - 998093910, NV - TN000032011-1,
TX - T104704245-11-3, OK - 9915, PA - 68-02979

Accreditation is only applicable to the test methods specified on each scope of accreditation held by ESC Lab Sciences.
Note: The use of the preparatory EPA Method 3511 is not approved or endorsed by the CA ELAP.

Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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REPORT OF ANALYSIS

Mr. Michael Smilley
Golder & Associates - GA
3730 Chamblee Tucker Road
Atlanta, GA 30341

February 24, 2012

ESC Sample # : L560869-01

Date Received : February 16, 2012
Description : Alabama

Site ID :

Sample ID : OW-1

Project # :

Collected By :
Collection Date : 02/14/12 14:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Volatile Organics						
Acetone	BDL	0.050	mg/l	8260B	02/20/12	1
Acrolein	BDL	0.050	mg/l	8260B	02/20/12	1
Acrylonitrile	BDL	0.010	mg/l	8260B	02/20/12	1
Benzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Bromobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Bromodichloromethane	BDL	0.0010	mg/l	8260B	02/20/12	1
Bromoform	BDL	0.0010	mg/l	8260B	02/20/12	1
Bromomethane	BDL	0.0050	mg/l	8260B	02/20/12	1
n-Butylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
sec-Butylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
tert-Butylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Carbon tetrachloride	BDL	0.0010	mg/l	8260B	02/20/12	1
Chlorobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Chlorodibromomethane	BDL	0.0010	mg/l	8260B	02/20/12	1
Chloroethane	BDL	0.0050	mg/l	8260B	02/20/12	1
2-Chloroethyl vinyl ether	BDL	0.050	mg/l	8260B	02/20/12	1
Chloroform	BDL	0.0050	mg/l	8260B	02/20/12	1
Chloromethane	BDL	0.0025	mg/l	8260B	02/20/12	1
2-Chlorotoluene	BDL	0.0010	mg/l	8260B	02/20/12	1
4-Chlorotoluene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,2-Dibromo-3-Chloropropane	BDL	0.0050	mg/l	8260B	02/20/12	1
1,2-Dibromoethane	BDL	0.0010	mg/l	8260B	02/20/12	1
Dibromomethane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,2-Dichlorobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,3-Dichlorobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,4-Dichlorobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Dichlorodifluoromethane	BDL	0.0050	mg/l	8260B	02/20/12	1
1,1-Dichloroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,2-Dichloroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1-Dichloroethene	BDL	0.0010	mg/l	8260B	02/20/12	1
cis-1,2-Dichloroethene	BDL	0.0010	mg/l	8260B	02/20/12	1
trans-1,2-Dichloroethene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,2-Dichloropropane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1-Dichloropropene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,3-Dichloropropane	BDL	0.0010	mg/l	8260B	02/20/12	1
cis-1,3-Dichloropropene	BDL	0.0010	mg/l	8260B	02/20/12	1
trans-1,3-Dichloropropene	BDL	0.0010	mg/l	8260B	02/20/12	1
2,2-Dichloropropane	BDL	0.0010	mg/l	8260B	02/20/12	1
Di-isopropyl ether	BDL	0.0010	mg/l	8260B	02/20/12	1
Ethylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Hexachloro-1,3-butadiene	BDL	0.0010	mg/l	8260B	02/20/12	1
Isopropylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
p-Isopropyltoluene	BDL	0.0010	mg/l	8260B	02/20/12	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
L560869-01 (SV8270BNA) - Second extraction also had low SURR recovery. Matrix effect.

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REPORT OF ANALYSIS

Mr. Michael Smilley
Golder & Associates - GA
3730 Chamblee Tucker Road
Atlanta, GA 30341

February 24, 2012

Date Received : February 16, 2012
Description : Alabama

Sample ID : OW-1

Collected By :
Collection Date : 02/14/12 14:00

ESC Sample # : L560869-01

Site ID :

Project # :

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
2-Butanone (MEK)	BDL	0.010	mg/l	8260B	02/20/12	1
Methylene Chloride	BDL	0.0050	mg/l	8260B	02/20/12	1
4-Methyl-2-pentanone (MIBK)	BDL	0.010	mg/l	8260B	02/20/12	1
Methyl tert-butyl ether	BDL	0.0010	mg/l	8260B	02/20/12	1
Naphthalene	BDL	0.0050	mg/l	8260B	02/20/12	1
n-Propylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Styrene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1,1,2-Tetrachloroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1,2,2-Tetrachloroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1,2-Trichlorotrifluoroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
Tetrachloroethene	BDL	0.0010	mg/l	8260B	02/20/12	1
Toluene	BDL	0.0050	mg/l	8260B	02/20/12	1
1,2,3-Trichlorobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,2,4-Trichlorobenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1,1-Trichloroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
1,1,2-Trichloroethane	BDL	0.0010	mg/l	8260B	02/20/12	1
Trichloroethene	BDL	0.0010	mg/l	8260B	02/20/12	1
Trichlorofluoromethane	BDL	0.0050	mg/l	8260B	02/20/12	1
1,2,3-Trichloropropane	BDL	0.0025	mg/l	8260B	02/20/12	1
1,2,4-Trimethylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,2,3-Trimethylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
1,3,5-Trimethylbenzene	BDL	0.0010	mg/l	8260B	02/20/12	1
Vinyl chloride	BDL	0.0010	mg/l	8260B	02/20/12	1
Xylenes, Total	BDL	0.0030	mg/l	8260B	02/20/12	1
Surrogate Recovery						
Toluene-d8	99.6		% Rec.	8260B	02/20/12	1
Dibromofluoromethane	96.3		% Rec.	8260B	02/20/12	1
4-Bromofluorobenzene	95.0		% Rec.	8260B	02/20/12	1
Base/Neutral Extractables						
Acenaphthene	BDL	0.0010	mg/l	8270C	02/21/12	1
Acenaphthylene	BDL	0.0010	mg/l	8270C	02/21/12	1
Anthracene	BDL	0.0010	mg/l	8270C	02/21/12	1
Benzidine	BDL	0.010	mg/l	8270C	02/21/12	1
Benzo(a)anthracene	BDL	0.0010	mg/l	8270C	02/21/12	1
Benzo(b)fluoranthene	BDL	0.0010	mg/l	8270C	02/21/12	1
Benzo(k)fluoranthene	BDL	0.0010	mg/l	8270C	02/21/12	1
Benzo(g,h,i)perylene	BDL	0.0010	mg/l	8270C	02/21/12	1
Benzo(a)pyrene	BDL	0.0010	mg/l	8270C	02/21/12	1
Bis(2-chlorethoxy)methane	BDL	0.010	mg/l	8270C	02/21/12	1
Bis(2-chloroethyl)ether	BDL	0.010	mg/l	8270C	02/21/12	1
Bis(2-chloroisopropyl)ether	BDL	0.010	mg/l	8270C	02/21/12	1
4-Bromophenyl-phenylether	BDL	0.010	mg/l	8270C	02/21/12	1
2-Chloronaphthalene	BDL	0.0010	mg/l	8270C	02/21/12	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
L560869-01 (SV8270BNA) - Second extraction also had low SURR recovery. Matrix effect.

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REPORT OF ANALYSIS

Mr. Michael Smilley
Golder & Associates - GA
3730 Chamblee Tucker Road
Atlanta, GA 30341

February 24, 2012

ESC Sample # : L560869-01

Date Received : February 16, 2012
Description : Alabama

Site ID :

Sample ID : OW-1

Project # :

Collected By :
Collection Date : 02/14/12 14:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
4-Chlorophenyl-phenylether	BDL	0.010	mg/l	8270C	02/21/12	1
Chrysene	BDL	0.0010	mg/l	8270C	02/21/12	1
Dibenz(a,h)anthracene	BDL	0.0010	mg/l	8270C	02/21/12	1
3,3-Dichlorobenzidine	BDL	0.010	mg/l	8270C	02/21/12	1
2,4-Dinitrotoluene	BDL	0.010	mg/l	8270C	02/21/12	1
2,6-Dinitrotoluene	BDL	0.010	mg/l	8270C	02/21/12	1
Fluoranthene	BDL	0.0010	mg/l	8270C	02/21/12	1
Fluorene	BDL	0.0010	mg/l	8270C	02/21/12	1
Hexachlorobenzene	BDL	0.0010	mg/l	8270C	02/21/12	1
Hexachloro-1,3-butadiene	BDL	0.010	mg/l	8270C	02/21/12	1
Hexachlorocyclopentadiene	BDL	0.010	mg/l	8270C	02/21/12	1
Hexachloroethane	BDL	0.010	mg/l	8270C	02/21/12	1
Indeno(1,2,3-cd)pyrene	BDL	0.0010	mg/l	8270C	02/21/12	1
Isophorone	BDL	0.010	mg/l	8270C	02/21/12	1
Naphthalene	BDL	0.0010	mg/l	8270C	02/21/12	1
Nitrobenzene	BDL	0.010	mg/l	8270C	02/21/12	1
n-Nitrosodimethylamine	BDL	0.010	mg/l	8270C	02/21/12	1
n-Nitrosodiphenylamine	BDL	0.010	mg/l	8270C	02/21/12	1
n-Nitrosodi-n-propylamine	BDL	0.010	mg/l	8270C	02/21/12	1
Phenanthrene	BDL	0.0010	mg/l	8270C	02/21/12	1
Benzylbutyl phthalate	BDL	0.0010	mg/l	8270C	02/21/12	1
Bis(2-ethylhexyl)phthalate	BDL	0.0010	mg/l	8270C	02/21/12	1
Di-n-butyl phthalate	BDL	0.0010	mg/l	8270C	02/21/12	1
Diethyl phthalate	BDL	0.0010	mg/l	8270C	02/21/12	1
Dimethyl phthalate	BDL	0.0010	mg/l	8270C	02/21/12	1
Di-n-octyl phthalate	BDL	0.0010	mg/l	8270C	02/21/12	1
Pyrene	BDL	0.0010	mg/l	8270C	02/21/12	1
1,2,4-Trichlorobenzene	BDL	0.010	mg/l	8270C	02/21/12	1
Acid Extractables						
4-Chloro-3-methylphenol	BDL	0.010	mg/l	8270C	02/21/12	1
2-Chlorophenol	BDL	0.010	mg/l	8270C	02/21/12	1
2,4-Dichlorophenol	BDL	0.010	mg/l	8270C	02/21/12	1
2,4-Dimethylphenol	BDL	0.010	mg/l	8270C	02/21/12	1
4,6-Dinitro-2-methylphenol	BDL	0.010	mg/l	8270C	02/21/12	1
2,4-Dinitrophenol	BDL	0.010	mg/l	8270C	02/21/12	1
2-Nitrophenol	BDL	0.010	mg/l	8270C	02/21/12	1
4-Nitrophenol	BDL	0.010	mg/l	8270C	02/21/12	1
Pentachlorophenol	BDL	0.010	mg/l	8270C	02/21/12	1
Phenol	BDL	0.010	mg/l	8270C	02/21/12	1
2,4,6-Trichlorophenol	BDL	0.010	mg/l	8270C	02/21/12	1
Surrogate Recovery						
2-Fluorophenol	0.110		% Rec.	8270C	02/21/12	1
Phenol-d5	0.530		% Rec.	8270C	02/21/12	1
Nitrobenzene-d5	80.5		% Rec.	8270C	02/21/12	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
L560869-01 (SV8270BNA) - Second extraction also had low SURR recovery. Matrix effect.

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Est. 1970

REPORT OF ANALYSIS

Mr. Michael Smilley
Golder & Associates - GA
3730 Chamblee Tucker Road
Atlanta, GA 30341

February 24, 2012

ESC Sample # : L560869-01

Date Received : February 16, 2012
Description : Alabama

Site ID :

Sample ID : OW-1

Project # :

Collected By :
Collection Date : 02/14/12 14:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
2-Fluorobiphenyl	77.6		% Rec.	8270C	02/21/12	1
2,4,6-Tribromophenol	144.		% Rec.	8270C	02/21/12	1
p-Terphenyl-d14	97.8		% Rec.	8270C	02/21/12	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
The reported analytical results relate only to the sample submitted.

.
Reported: 02/24/12 09:58 Printed: 02/24/12 09:59
L560869-01 (SV8270BNA) - Second extraction also had low SURR recovery. Matrix effect.

Attachment A
List of Analytes with QC Qualifiers

Sample Number	Work Group	Sample Type	Analyte	Run ID	Qualifier
L560869-01	WG578757	SAMP	n-Nitrosodiphenylamine	R2042812	J4
	WG578757	SAMP	4-Chloro-3-methylphenol	R2042812	J4
	WG578757	SAMP	Phenol	R2042812	J4
	WG578757	SAMP	2-Fluorophenol	R2042812	J2
	WG578757	SAMP	Phenol-d5	R2042812	J2

Attachment B
Explanation of QC Qualifier Codes

Qualifier	Meaning
J2	Surrogate recovery limits have been exceeded; values are outside lower control limits
J4	The associated batch QC was outside the established quality control range for accuracy.

Qualifier Report Information

ESC utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program and as required by most certifying bodies including NELAC. In addition to the EPA qualifiers adopted by ESC, we have implemented ESC qualifiers to provide more information pertaining to our analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC. Data qualifiers are intended to provide the ESC client with more detailed information concerning the potential bias of reported data. Because of the wide range of constituents and variety of matrices incorporated by most EPA methods,it is common for some compounds to fall outside of established ranges. These exceptions are evaluated and all reported data is valid and useable "unless qualified as 'R' (Rejected)."

Definitions

Accuracy - The relationship of the observed value of a known sample to the true value of a known sample. Represented by percent recovery and relevant to samples such as: control samples, matrix spike recoveries, surrogate recoveries, etc.

Precision - The agreement between a set of samples or between duplicate samples. Relates to how close together the results are and is represented by Relative Percent Differrence.

Surrogate - Organic compounds that are similar in chemical composition, extraction, and chromotography to analytes of interest. The surrogates are used to determine the probable response of the group of analytes that are chemically related to the surrogate compound. Surrogates are added to the sample and carried through all stages of preparation and analyses.

TIC - Tentatively Identified Compound: Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates.

Summary of Remarks For Samples Printed
02/24/12 at 09:59:08

TSR Signing Reports: 034
R5 - Desired TAT

Sample: L560869-01 Account: GOLASAGA Received: 02/16/12 09:00 Due Date: 02/23/12 00:00 RPT Date: 02/24/12 09:58

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Est. 1970

Golder & Associates - GA
Mr. Michael Smilley
3730 Chamblee Tucker Road

Atlanta, GA 30341

Quality Assurance Report
Level II

L560869

February 24, 2012

Laboratory Blank

Analyte	Result	Units	% Rec	Limit	Batch	Date Analyzed
1,1,1,2-Tetrachloroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,1,1-Trichloroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,1,2,2-Tetrachloroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,1,2-Trichloroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,1,2-Trichlorotrifluoroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,1-Dichloroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,1-Dichloroethene	< .001	mg/l			WG579366	02/20/12 14:03
1,1-Dichloropropene	< .001	mg/l			WG579366	02/20/12 14:03
1,2,3-Trichlorobenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,2,3-Trichloropropane	< .001	mg/l			WG579366	02/20/12 14:03
1,2,3-Trimethylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,2,4-Trichlorobenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,2,4-Trimethylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,2-Dibromo-3-Chloropropane	< .005	mg/l			WG579366	02/20/12 14:03
1,2-Dibromoethane	< .001	mg/l			WG579366	02/20/12 14:03
1,2-Dichlorobenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,2-Dichloroethane	< .001	mg/l			WG579366	02/20/12 14:03
1,2-Dichloropropane	< .001	mg/l			WG579366	02/20/12 14:03
1,3,5-Trimethylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,3-Dichlorobenzene	< .001	mg/l			WG579366	02/20/12 14:03
1,3-Dichloropropane	< .001	mg/l			WG579366	02/20/12 14:03
1,4-Dichlorobenzene	< .001	mg/l			WG579366	02/20/12 14:03
2,2-Dichloropropane	< .001	mg/l			WG579366	02/20/12 14:03
2-Butanone (MEK)	< .01	mg/l			WG579366	02/20/12 14:03
2-Chloroethyl vinyl ether	< .05	mg/l			WG579366	02/20/12 14:03
2-Chlorotoluene	< .001	mg/l			WG579366	02/20/12 14:03
4-Chlorotoluene	< .001	mg/l			WG579366	02/20/12 14:03
4-Methyl-2-pentanone (MIBK)	< .01	mg/l			WG579366	02/20/12 14:03
Acetone	< .05	mg/l			WG579366	02/20/12 14:03
Acrolein	< .025	mg/l			WG579366	02/20/12 14:03
Acrylonitrile	< .01	mg/l			WG579366	02/20/12 14:03
Benzene	< .001	mg/l			WG579366	02/20/12 14:03
Bromobenzene	< .001	mg/l			WG579366	02/20/12 14:03
Bromodichloromethane	< .001	mg/l			WG579366	02/20/12 14:03
Bromoform	< .001	mg/l			WG579366	02/20/12 14:03
Bromomethane	< .005	mg/l			WG579366	02/20/12 14:03
Carbon tetrachloride	< .001	mg/l			WG579366	02/20/12 14:03
Chlorobenzene	< .001	mg/l			WG579366	02/20/12 14:03
Chlorodibromomethane	< .001	mg/l			WG579366	02/20/12 14:03
Chloroethane	< .005	mg/l			WG579366	02/20/12 14:03
Chloroform	< .005	mg/l			WG579366	02/20/12 14:03
Chloromethane	< .0025	mg/l			WG579366	02/20/12 14:03
cis-1,2-Dichloroethene	< .001	mg/l			WG579366	02/20/12 14:03
cis-1,3-Dichloropropene	< .001	mg/l			WG579366	02/20/12 14:03
Di-isopropyl ether	< .001	mg/l			WG579366	02/20/12 14:03
Dibromomethane	< .001	mg/l			WG579366	02/20/12 14:03
Dichlorodifluoromethane	< .005	mg/l			WG579366	02/20/12 14:03
Ethylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
Hexachloro-1,3-butadiene	< .001	mg/l			WG579366	02/20/12 14:03
Isopropylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
Methyl tert-butyl ether	< .001	mg/l			WG579366	02/20/12 14:03
Methylene Chloride	< .005	mg/l			WG579366	02/20/12 14:03
n-Butylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
n-Propylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
Naphthalene	< .005	mg/l			WG579366	02/20/12 14:03
p-Isopropyltoluene	< .001	mg/l			WG579366	02/20/12 14:03
sec-Butylbenzene	< .001	mg/l			WG579366	02/20/12 14:03
Styrene	< .001	mg/l			WG579366	02/20/12 14:03
tert-Butylbenzene	< .001	mg/l			WG579366	02/20/12 14:03

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Quality Assurance Report
Level II

L560869

February 24, 2012

Laboratory Blank

Analyte	Result	Units	% Rec	Limit	Batch	Date Analyzed
Tetrachloroethene	< .001	mg/l			WG579366	02/20/12 14:03
Toluene	< .005	mg/l			WG579366	02/20/12 14:03
trans-1,2-Dichloroethene	< .001	mg/l			WG579366	02/20/12 14:03
trans-1,3-Dichloropropene	< .001	mg/l			WG579366	02/20/12 14:03
Trichloroethene	< .001	mg/l			WG579366	02/20/12 14:03
Trichlorofluoromethane	< .005	mg/l			WG579366	02/20/12 14:03
Vinyl chloride	< .001	mg/l			WG579366	02/20/12 14:03
Xylenes, Total	< .003	mg/l			WG579366	02/20/12 14:03
4-Bromofluorobenzene		% Rec.	95.32	82-120	WG579366	02/20/12 14:03
Dibromofluoromethane		% Rec.	93.99	82-126	WG579366	02/20/12 14:03
Toluene-d8		% Rec.	102.6	92-112	WG579366	02/20/12 14:03
1,2,4-Trichlorobenzene	< .01	mg/l			WG578757	02/19/12 14:06
2,4,6-Trichlorophenol	< .01	mg/l			WG578757	02/19/12 14:06
2,4-Dichlorophenol	< .01	mg/l			WG578757	02/19/12 14:06
2,4-Dimethylphenol	< .01	mg/l			WG578757	02/19/12 14:06
2,4-Dinitrophenol	< .01	mg/l			WG578757	02/19/12 14:06
2,4-Dinitrotoluene	< .01	mg/l			WG578757	02/19/12 14:06
2,6-Dinitrotoluene	< .01	mg/l			WG578757	02/19/12 14:06
2-Chloronaphthalene	< .001	mg/l			WG578757	02/19/12 14:06
2-Chlorophenol	< .01	mg/l			WG578757	02/19/12 14:06
2-Nitrophenol	< .01	mg/l			WG578757	02/19/12 14:06
3,3-Dichlorobenzidine	< .01	mg/l			WG578757	02/19/12 14:06
4,6-Dinitro-2-methylphenol	< .01	mg/l			WG578757	02/19/12 14:06
4-Bromophenyl-phenylether	< .01	mg/l			WG578757	02/19/12 14:06
4-Chloro-3-methylphenol	< .01	mg/l			WG578757	02/19/12 14:06
4-Chlorophenyl-phenylether	< .01	mg/l			WG578757	02/19/12 14:06
4-Nitrophenol	< .01	mg/l			WG578757	02/19/12 14:06
Acenaphthene	< .001	mg/l			WG578757	02/19/12 14:06
Acenaphthylene	< .001	mg/l			WG578757	02/19/12 14:06
Anthracene	< .001	mg/l			WG578757	02/19/12 14:06
Benzidine	< .01	mg/l			WG578757	02/19/12 14:06
Benzo(a)anthracene	< .001	mg/l			WG578757	02/19/12 14:06
Benzo(a)pyrene	< .001	mg/l			WG578757	02/19/12 14:06
Benzo(b)fluoranthene	< .001	mg/l			WG578757	02/19/12 14:06
Benzo(g,h,i)perylene	< .001	mg/l			WG578757	02/19/12 14:06
Benzo(k)fluoranthene	< .001	mg/l			WG578757	02/19/12 14:06
Benzylbutyl phthalate	< .001	mg/l			WG578757	02/19/12 14:06
Bis(2-chlorethoxy)methane	< .01	mg/l			WG578757	02/19/12 14:06
Bis(2-chloroethyl)ether	< .01	mg/l			WG578757	02/19/12 14:06
Bis(2-chloroisopropyl)ether	< .01	mg/l			WG578757	02/19/12 14:06
Bis(2-ethylhexyl)phthalate	< .001	mg/l			WG578757	02/19/12 14:06
Chrysene	< .001	mg/l			WG578757	02/19/12 14:06
Di-n-butyl phthalate	< .001	mg/l			WG578757	02/19/12 14:06
Di-n-octyl phthalate	< .001	mg/l			WG578757	02/19/12 14:06
Dibenz(a,h)anthracene	< .001	mg/l			WG578757	02/19/12 14:06
Diethyl phthalate	< .001	mg/l			WG578757	02/19/12 14:06
Dimethyl phthalate	< .001	mg/l			WG578757	02/19/12 14:06
Fluoranthene	< .001	mg/l			WG578757	02/19/12 14:06
Fluorene	< .001	mg/l			WG578757	02/19/12 14:06
Hexachloro-1,3-butadiene	< .01	mg/l			WG578757	02/19/12 14:06
Hexachlorobenzene	< .001	mg/l			WG578757	02/19/12 14:06
Hexachlorocyclopentadiene	< .01	mg/l			WG578757	02/19/12 14:06
Hexachloroethane	< .01	mg/l			WG578757	02/19/12 14:06
Indeno(1,2,3-cd)pyrene	< .001	mg/l			WG578757	02/19/12 14:06
Isophorone	< .01	mg/l			WG578757	02/19/12 14:06
n-Nitrosodi-n-propylamine	< .01	mg/l			WG578757	02/19/12 14:06
n-Nitrosodimethylamine	< .01	mg/l			WG578757	02/19/12 14:06

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Level II

L560869

February 24, 2012

Laboratory Blank

Analyte	Result	Units	% Rec	Limit	Batch	Date Analyzed
n-Nitrosodiphenylamine	< .01	mg/l			WG578757	02/19/12 14:06
Naphthalene	< .001	mg/l			WG578757	02/19/12 14:06
Nitrobenzene	< .01	mg/l			WG578757	02/19/12 14:06
Pentachlorophenol	< .001	mg/l			WG578757	02/19/12 14:06
Phenanthrene	< .001	mg/l			WG578757	02/19/12 14:06
Phenol	< .01	mg/l			WG578757	02/19/12 14:06
Pyrene	< .001	mg/l			WG578757	02/19/12 14:06
2,4,6-Tribromophenol		% Rec.	125.0	16-147	WG578757	02/19/12 14:06
2-Fluorobiphenyl		% Rec.	78.75	29-127	WG578757	02/19/12 14:06
2-Fluorophenol		% Rec.	51.69	10-75	WG578757	02/19/12 14:06
Nitrobenzene-d5		% Rec.	81.72	17-119	WG578757	02/19/12 14:06
Phenol-d5		% Rec.	39.23	10-63	WG578757	02/19/12 14:06
p-Terphenyl-d14		% Rec.	81.06	40-174	WG578757	02/19/12 14:06

Laboratory Control Sample

Analyte	Units	Known Val	Result	% Rec	Limit	Batch
1,1,1,2-Tetrachloroethane	mg/l	.025	0.0260	104.	77-128	WG579366
1,1,1-Trichloroethane	mg/l	.025	0.0230	92.0	71-126	WG579366
1,1,2,2-Tetrachloroethane	mg/l	.025	0.0216	86.6	78-130	WG579366
1,1,2-Trichloroethane	mg/l	.025	0.0232	93.0	81-121	WG579366
1,1,2-Trichlorotrifluoroethane	mg/l	.025	0.0233	93.2	53-143	WG579366
1,1-Dichloroethane	mg/l	.025	0.0218	87.4	73-123	WG579366
1,1-Dichloroethene	mg/l	.025	0.0207	82.9	54-134	WG579366
1,1-Dichloropropene	mg/l	.025	0.0205	81.9	67-127	WG579366
1,2,3-Trichlorobenzene	mg/l	.025	0.0264	106.	77-130	WG579366
1,2,3-Trichloropropane	mg/l	.025	0.0230	92.0	68-130	WG579366
1,2,3-Trimethylbenzene	mg/l	.025	0.0245	97.8	70-127	WG579366
1,2,4-Trichlorobenzene	mg/l	.025	0.0283	113.	76-127	WG579366
1,2,4-Trimethylbenzene	mg/l	.025	0.0244	97.7	77-129	WG579366
1,2-Dibromo-3-Chloropropane	mg/l	.025	0.0242	96.9	55-142	WG579366
1,2-Dibromoethane	mg/l	.025	0.0226	90.4	78-124	WG579366
1,2-Dichlorobenzene	mg/l	.025	0.0252	101.	82-121	WG579366
1,2-Dichloroethane	mg/l	.025	0.0221	88.5	69-128	WG579366
1,2-Dichloropropane	mg/l	.025	0.0220	88.2	77-121	WG579366
1,3,5-Trimethylbenzene	mg/l	.025	0.0246	98.2	78-127	WG579366
1,3-Dichlorobenzene	mg/l	.025	0.0243	97.2	77-127	WG579366
1,3-Dichloropropane	mg/l	.025	0.0234	93.5	78-117	WG579366
1,4-Dichlorobenzene	mg/l	.025	0.0253	101.	79-117	WG579366
2,2-Dichloropropane	mg/l	.025	0.0253	101.	63-130	WG579366
2-Butanone (MEK)	mg/l	.125	0.126	101.	58-144	WG579366
2-Chloroethyl vinyl ether	mg/l	.125	0.108	86.2	26-172	WG579366
2-Chlorotoluene	mg/l	.025	0.0242	96.8	78-123	WG579366
4-Chlorotoluene	mg/l	.025	0.0244	97.5	78-122	WG579366
4-Methyl-2-pentanone (MIBK)	mg/l	.125	0.110	88.4	58-147	WG579366
Acetone	mg/l	.125	0.0916	73.3	49-153	WG579366
Acrolein	mg/l	.125	0.0271	21.7	10-181	WG579366
Acrylonitrile	mg/l	.125	0.0991	79.3	53-153	WG579366
Benzene	mg/l	.025	0.0208	83.3	72-119	WG579366
Bromobenzene	mg/l	.025	0.0234	93.5	76-121	WG579366
Bromodichloromethane	mg/l	.025	0.0227	90.9	75-127	WG579366
Bromoform	mg/l	.025	0.0228	91.4	61-136	WG579366
Bromomethane	mg/l	.025	0.0244	97.4	42-172	WG579366
Carbon tetrachloride	mg/l	.025	0.0212	84.9	63-129	WG579366
Chlorobenzene	mg/l	.025	0.0246	98.2	78-123	WG579366
Chlorodibromomethane	mg/l	.025	0.0240	95.9	73-128	WG579366
Chloroethane	mg/l	.025	0.0245	98.1	52-164	WG579366
Chloroform	mg/l	.025	0.0227	90.8	76-122	WG579366
Chloromethane	mg/l	.025	0.0194	77.5	50-141	WG579366

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Level II

L560869

February 24, 2012

Analyte	Units	Laboratory Control Sample Known Val	Result	% Rec	Limit	Batch
cis-1,2-Dichloroethene	mg/l	.025	0.0213	85.0	75-121	WG579366
cis-1,3-Dichloropropene	mg/l	.025	0.0225	90.0	74-124	WG579366
Di-isopropyl ether	mg/l	.025	0.0228	91.3	66-129	WG579366
Dibromomethane	mg/l	.025	0.0239	95.7	77-124	WG579366
Dichlorodifluoromethane	mg/l	.025	0.0189	75.7	33-173	WG579366
Ethylbenzene	mg/l	.025	0.0245	97.8	77-124	WG579366
Hexachloro-1,3-butadiene	mg/l	.025	0.0248	99.0	71-134	WG579366
Isopropylbenzene	mg/l	.025	0.0265	106.	74-126	WG579366
Methyl tert-butyl ether	mg/l	.025	0.0234	93.6	67-127	WG579366
Methylene Chloride	mg/l	.025	0.0204	81.6	67-122	WG579366
n-Butylbenzene	mg/l	.025	0.0257	103.	74-130	WG579366
n-Propylbenzene	mg/l	.025	0.0246	98.4	77-125	WG579366
Naphthalene	mg/l	.025	0.0253	101.	70-134	WG579366
p-Isopropyltoluene	mg/l	.025	0.0250	100.	77-132	WG579366
sec-Butylbenzene	mg/l	.025	0.0247	99.0	77-130	WG579366
Styrene	mg/l	.025	0.0235	93.8	69-145	WG579366
tert-Butylbenzene	mg/l	.025	0.0255	102.	76-131	WG579366
Tetrachloroethene	mg/l	.025	0.0231	92.6	69-131	WG579366
Toluene	mg/l	.025	0.0225	90.2	75-114	WG579366
trans-1,2-Dichloroethene	mg/l	.025	0.0206	82.5	63-127	WG579366
trans-1,3-Dichloropropene	mg/l	.025	0.0221	88.4	69-124	WG579366
Trichloroethene	mg/l	.025	0.0228	91.3	69-131	WG579366
Trichlorofluoromethane	mg/l	.025	0.0242	97.0	53-161	WG579366
Vinyl chloride	mg/l	.025	0.0209	83.5	55-142	WG579366
Xylenes, Total	mg/l	.075	0.0716	95.5	77-123	WG579366
4-Bromofluorobenzene				95.91	82-120	WG579366
Dibromofluoromethane				95.87	82-126	WG579366
Toluene-d8				103.0	92-112	WG579366
1,2,4-Trichlorobenzene	mg/l	.01	0.00563	56.3	34-97	WG578757
2,4,6-Trichlorophenol	mg/l	.01	0.00905	90.5	38-113	WG578757
2,4-Dichlorophenol	mg/l	.01	0.00953	95.3	46-105	WG578757
2,4-Dimethylphenol	mg/l	.01	0.0103	103.	47-108	WG578757
2,4-Dinitrophenol	mg/l	.01	0.00630	63.0	10-121	WG578757
2,4-Dinitrotoluene	mg/l	.01	0.0107	107.	59-117	WG578757
2,6-Dinitrotoluene	mg/l	.01	0.00990	99.0	57-110	WG578757
2-Chloronaphthalene	mg/l	.01	0.00744	74.4	47-106	WG578757
2-Chlorophenol	mg/l	.01	0.00753	75.3	37-90	WG578757
2-Nitrophenol	mg/l	.01	0.00976	97.6	40-112	WG578757
3,3-Dichlorobenzidine	mg/l	.01	0.00959	95.9	58-116	WG578757
4,6-Dinitro-2-methylphenol	mg/l	.01	0.0104	104.	21-119	WG578757
4-Bromophenyl-phenylether	mg/l	.01	0.00952	95.2	63-120	WG578757
4-Chloro-3-methylphenol	mg/l	.01	0.0111	111.*	50-105	WG578757
4-Chlorophenyl-phenylether	mg/l	.01	0.00812	81.2	58-115	WG578757
4-Nitrophenol	mg/l	.01	0.00415	41.5	10-53	WG578757
Acenaphthene	mg/l	.01	0.00826	82.6	52-107	WG578757
Acenaphthylene	mg/l	.01	0.00908	90.8	55-119	WG578757
Anthracene	mg/l	.01	0.00944	94.4	65-114	WG578757
Benzidine	mg/l	.01	0.00262	26.2	10-55	WG578757
Benzo(a)anthracene	mg/l	.01	0.00976	97.6	68-113	WG578757
Benzo(a)pyrene	mg/l	.01	0.00970	97.0	68-115	WG578757
Benzo(b)fluoranthene	mg/l	.01	0.00986	98.6	67-114	WG578757
Benzo(g,h,i)perylene	mg/l	.01	0.00982	98.2	52-132	WG578757
Benzo(k)fluoranthene	mg/l	.01	0.00975	97.5	62-116	WG578757
Benzylbutyl phthalate	mg/l	.01	0.0115	115.	12-166	WG578757
Bis(2-chlorethoxy)methane	mg/l	.01	0.00807	80.7	56-116	WG578757
Bis(2-chloroethyl)ether	mg/l	.01	0.00697	69.7	39-109	WG578757
Bis(2-chloroisopropyl)ether	mg/l	.01	0.00772	77.2	43-108	WG578757

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February 24, 2012

Analyte	Units	Laboratory Control Sample Known Val	Result	% Rec	Limit	Batch
Bis(2-ethylhexyl)phthalate	mg/l	.01	0.0118	118.	61-147	WG578757
Chrysene	mg/l	.01	0.00938	93.8	65-114	WG578757
Di-n-butyl phthalate	mg/l	.01	0.0104	104.	56-133	WG578757
Di-n-octyl phthalate	mg/l	.01	0.0107	107.	59-143	WG578757
Dibenz(a,h)anthracene	mg/l	.01	0.0101	101.	54-130	WG578757
Diethyl phthalate	mg/l	.01	0.0100	100.	33-136	WG578757
Dimethyl phthalate	mg/l	.01	0.00958	95.8	10-152	WG578757
Fluoranthene	mg/l	.01	0.00972	97.2	66-120	WG578757
Fluorene	mg/l	.01	0.00898	89.8	58-110	WG578757
Hexachloro-1,3-butadiene	mg/l	.01	0.00526	52.6	34-115	WG578757
Hexachlorobenzene	mg/l	.01	0.00892	89.2	55-117	WG578757
Hexachlorocyclopentadiene	mg/l	.01	0.00341	34.1	20-121	WG578757
Hexachloroethane	mg/l	.01	0.00458	45.8	24-93	WG578757
Indeno(1,2,3-cd)pyrene	mg/l	.01	0.0102	102.	56-129	WG578757
Isophorone	mg/l	.01	0.00740	74.0	55-108	WG578757
n-Nitrosodi-n-propylamine	mg/l	.01	0.00815	81.5	50-115	WG578757
n-Nitrosodimethylamine	mg/l	.01	0.00531	53.1	12-68	WG578757
n-Nitrosodiphenylamine	mg/l	.01	0.00936	93.6	55-98	WG578757
Naphthalene	mg/l	.01	0.00754	75.4	42-103	WG578757
Nitrobenzene	mg/l	.01	0.00856	85.6	39-102	WG578757
Pentachlorophenol	mg/l	.01	0.00805	80.5	10-101	WG578757
Phenanthrene	mg/l	.01	0.00929	92.9	61-110	WG578757
Phenol	mg/l	.01	0.00541	54.1*	10-53	WG578757
Pyrene	mg/l	.01	0.00935	93.5	65-116	WG578757
2,4,6-Tribromophenol				126.2	16-147	WG578757
2-Fluorobiphenyl				88.24	29-127	WG578757
2-Fluorophenol				61.66	10-75	WG578757
Nitrobenzene-d5				89.95	17-119	WG578757
Phenol-d5				53.28	10-63	WG578757
p-Terphenyl-d14				80.94	40-174	WG578757

Analyte	Units	Laboratory Control Sample Duplicate Result	Ref	%Rec	Limit	RPD	Limit	Batch
1,1,1,2-Tetrachloroethane	mg/l	0.0246	0.0260	98.0	77-128	5.33	20	WG579366
1,1,1-Trichloroethane	mg/l	0.0221	0.0230	88.0	71-126	4.04	20	WG579366
1,1,2,2-Tetrachloroethane	mg/l	0.0217	0.0216	87.0	78-130	0.330	20	WG579366
1,1,2-Trichloroethane	mg/l	0.0227	0.0232	91.0	81-121	2.49	20	WG579366
1,1,2-Trichlorotrifluoroethane	mg/l	0.0221	0.0233	88.0	53-143	5.23	20	WG579366
1,1-Dichloroethane	mg/l	0.0205	0.0218	82.0	73-123	6.47	20	WG579366
1,1-Dichloroethene	mg/l	0.0194	0.0207	77.0	54-134	6.72	20	WG579366
1,1-Dichloropropene	mg/l	0.0199	0.0205	80.0	67-127	2.92	20	WG579366
1,2,3-Trichlorobenzene	mg/l	0.0267	0.0264	107.	77-130	0.860	20	WG579366
1,2,3-Trichloropropane	mg/l	0.0228	0.0230	91.0	68-130	0.870	20	WG579366
1,2,3-Trimethylbenzene	mg/l	0.0236	0.0245	94.0	70-127	3.52	20	WG579366
1,2,4-Trichlorobenzene	mg/l	0.0270	0.0283	108.	76-127	4.89	20	WG579366
1,2,4-Trimethylbenzene	mg/l	0.0230	0.0244	92.0	77-129	5.88	20	WG579366
1,2-Dibromo-3-Chloropropane	mg/l	0.0251	0.0242	100.	55-142	3.70	20	WG579366
1,2-Dibromoethane	mg/l	0.0230	0.0226	92.0	78-124	1.98	20	WG579366
1,2-Dichlorobenzene	mg/l	0.0244	0.0252	98.0	82-121	3.05	20	WG579366
1,2-Dichloroethane	mg/l	0.0214	0.0221	86.0	69-128	3.28	20	WG579366
1,2-Dichloropropane	mg/l	0.0216	0.0220	86.0	77-121	1.98	20	WG579366
1,3,5-Trimethylbenzene	mg/l	0.0232	0.0246	93.0	78-127	5.87	20	WG579366
1,3-Dichlorobenzene	mg/l	0.0234	0.0243	94.0	77-127	3.68	20	WG579366
1,3-Dichloropropane	mg/l	0.0226	0.0234	90.0	78-117	3.35	20	WG579366
1,4-Dichlorobenzene	mg/l	0.0244	0.0253	98.0	79-117	3.75	20	WG579366
2,2-Dichloropropane	mg/l	0.0246	0.0253	98.0	63-130	2.80	20	WG579366
2-Butanone (MEK)	mg/l	0.135	0.126	108.	58-144	6.88	20	WG579366
2-Chloroethyl vinyl ether	mg/l	0.112	0.108	89.0	26-172	3.49	22	WG579366

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Mr. Michael Smilley
3730 Chamblee Tucker Road

Atlanta, GA 30341

Quality Assurance Report
Level II

L560869

February 24, 2012

Analyte	Units	Laboratory Control Sample Duplicate Result	Ref	%Rec	Limit	RPD	Limit	Batch
2-Chlorotoluene	mg/l	0.0226	0.0242	90.0	78-123	6.70	20	WG579366
4-Chlorotoluene	mg/l	0.0226	0.0244	90.0	78-122	7.55	20	WG579366
4-Methyl-2-pentanone (MIBK)	mg/l	0.117	0.110	93.0	58-147	5.49	20	WG579366
Acetone	mg/l	0.102	0.0916	81.0	49-153	10.4	21	WG579366
Acrolein	mg/l	0.0338	0.0271	27.0	10-181	22.1	30	WG579366
Acrylonitrile	mg/l	0.104	0.0991	83.0	53-153	4.66	20	WG579366
Benzene	mg/l	0.0198	0.0208	79.0	72-119	5.05	20	WG579366
Bromobenzene	mg/l	0.0224	0.0234	90.0	76-121	4.24	20	WG579366
Bromodichloromethane	mg/l	0.0215	0.0227	86.0	75-127	5.63	20	WG579366
Bromoform	mg/l	0.0228	0.0228	91.0	61-136	0.0200	20	WG579366
Bromomethane	mg/l	0.0227	0.0244	91.0	42-172	7.06	20	WG579366
Carbon tetrachloride	mg/l	0.0200	0.0212	80.0	63-129	5.93	20	WG579366
Chlorobenzene	mg/l	0.0233	0.0246	93.0	78-123	5.32	20	WG579366
Chlorodibromomethane	mg/l	0.0228	0.0240	91.0	73-128	5.02	20	WG579366
Chloroethane	mg/l	0.0236	0.0245	94.0	52-164	3.70	20	WG579366
Chloroform	mg/l	0.0214	0.0227	86.0	76-122	5.93	20	WG579366
Chloromethane	mg/l	0.0178	0.0194	71.0	50-141	8.39	20	WG579366
cis-1,2-Dichloroethene	mg/l	0.0202	0.0213	81.0	75-121	5.29	20	WG579366
cis-1,3-Dichloropropene	mg/l	0.0223	0.0225	89.0	74-124	0.740	20	WG579366
Di-isopropyl ether	mg/l	0.0218	0.0228	87.0	66-129	4.61	20	WG579366
Dibromomethane	mg/l	0.0239	0.0239	96.0	77-124	0.0800	20	WG579366
Dichlorodifluoromethane	mg/l	0.0175	0.0189	70.0	33-173	8.00	20	WG579366
Ethylbenzene	mg/l	0.0227	0.0245	91.0	77-124	7.30	20	WG579366
Hexachloro-1,3-butadiene	mg/l	0.0248	0.0248	99.0	71-134	0.0100	20	WG579366
Isopropylbenzene	mg/l	0.0248	0.0265	99.0	74-126	6.65	20	WG579366
Methyl tert-butyl ether	mg/l	0.0229	0.0234	92.0	67-127	2.18	20	WG579366
Methylene Chloride	mg/l	0.0201	0.0204	80.0	67-122	1.54	20	WG579366
n-Butylbenzene	mg/l	0.0240	0.0257	96.0	74-130	6.74	20	WG579366
n-Propylbenzene	mg/l	0.0228	0.0246	91.0	77-125	7.45	20	WG579366
Naphthalene	mg/l	0.0248	0.0253	99.0	70-134	1.89	20	WG579366
p-Isopropyltoluene	mg/l	0.0233	0.0250	93.0	77-132	6.99	20	WG579366
sec-Butylbenzene	mg/l	0.0233	0.0247	93.0	77-130	5.91	20	WG579366
Styrene	mg/l	0.0224	0.0235	90.0	69-145	4.51	20	WG579366
tert-Butylbenzene	mg/l	0.0234	0.0255	94.0	76-131	8.60	20	WG579366
Tetrachloroethene	mg/l	0.0222	0.0231	89.0	69-131	4.18	20	WG579366
Toluene	mg/l	0.0222	0.0225	89.0	75-114	1.67	20	WG579366
trans-1,2-Dichloroethene	mg/l	0.0197	0.0206	79.0	63-127	4.60	20	WG579366
trans-1,3-Dichloropropene	mg/l	0.0222	0.0221	89.0	69-124	0.580	20	WG579366
Trichloroethene	mg/l	0.0216	0.0228	86.0	69-131	5.46	20	WG579366
Trichlorofluoromethane	mg/l	0.0231	0.0242	92.0	53-161	4.67	20	WG579366
Vinyl chloride	mg/l	0.0199	0.0209	80.0	55-142	4.84	20	WG579366
Xylenes, Total	mg/l	0.0679	0.0716	90.0	77-123	5.24	20	WG579366
4-Bromofluorobenzene				96.58	82-120			WG579366
Dibromofluoromethane				95.48	82-126			WG579366
Toluene-d8				103.1	92-112			WG579366
1,2,4-Trichlorobenzene	mg/l	0.00527	0.00563	53.0	34-97	6.48	21	WG578757
2,4,6-Trichlorophenol	mg/l	0.00883	0.00905	88.0	38-113	2.50	29	WG578757
2,4-Dichlorophenol	mg/l	0.00901	0.00953	90.0	46-105	5.65	20	WG578757
2,4-Dimethylphenol	mg/l	0.00962	0.0103	96.0	47-108	6.70	20	WG578757
2,4-Dinitrophenol	mg/l	0.00560	0.00630	56.0	10-121	11.8	40	WG578757
2,4-Dinitrotoluene	mg/l	0.0107	0.0107	107.	59-117	0.496	20	WG578757
2,6-Dinitrotoluene	mg/l	0.0101	0.00990	100.	57-110	1.52	20	WG578757
2-Chloronaphthalene	mg/l	0.00724	0.00744	72.0	47-106	2.84	20	WG578757
2-Chlorophenol	mg/l	0.00757	0.00753	76.0	37-90	0.430	21	WG578757
2-Nitrophenol	mg/l	0.00978	0.00976	98.0	40-112	0.235	22	WG578757
3,3-Dichlorobenzidine	mg/l	0.00950	0.00959	95.0	58-116	0.989	20	WG578757
4,6-Dinitro-2-methylphenol	mg/l	0.0109	0.0104	109.	21-119	5.23	40	WG578757

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Quality Assurance Report
Level II

L560869

February 24, 2012

		Laboratory Control Sample Duplicate						
Analyte	Units	Result	Ref	%Rec	Limit	RPD	Limit	Batch
4-Bromophenyl-phenylether	mg/l	0.00983	0.00952	98.0	63-120	3.21	20	WG578757
4-Chloro-3-methylphenol	mg/l	0.0105	0.0111	105.	50-105	5.79	20	WG578757
4-Chlorophenyl-phenylether	mg/l	0.00798	0.00812	80.0	58-115	1.75	20	WG578757
4-Nitrophenol	mg/l	0.00362	0.00415	36.0	10-53	13.7	40	WG578757
Acenaphthene	mg/l	0.00840	0.00826	84.0	52-107	1.69	20	WG578757
Acenaphthylene	mg/l	0.00893	0.00908	89.0	55-119	1.72	20	WG578757
Anthracene	mg/l	0.00992	0.00944	99.0	65-114	4.95	20	WG578757
Benzidine	mg/l	0.00298	0.00262	30.0	10-55	12.6	40	WG578757
Benzo(a)anthracene	mg/l	0.00955	0.00976	95.0	68-113	2.26	20	WG578757
Benzo(a)pyrene	mg/l	0.00970	0.00970	97.0	68-115	0.0520	20	WG578757
Benzo(b)fluoranthene	mg/l	0.0105	0.00986	105.	67-114	6.29	20	WG578757
Benzo(g,h,i)perylene	mg/l	0.00967	0.00982	97.0	52-132	1.62	20	WG578757
Benzo(k)fluoranthene	mg/l	0.00901	0.00975	90.0	62-116	7.89	20	WG578757
Benzylbutyl phthalate	mg/l	0.0113	0.0115	113.	12-166	1.40	20	WG578757
Bis(2-chlorethoxy)methane	mg/l	0.00766	0.00807	77.0	56-116	5.15	20	WG578757
Bis(2-chloroethyl)ether	mg/l	0.00681	0.00697	68.0	39-109	2.26	23	WG578757
Bis(2-chloroisopropyl)ether	mg/l	0.00784	0.00772	78.0	43-108	1.56	20	WG578757
Bis(2-ethylhexyl)phthalate	mg/l	0.0115	0.0118	115.	61-147	2.64	20	WG578757
Chrysene	mg/l	0.00958	0.00938	96.0	65-114	2.13	20	WG578757
Di-n-butyl phthalate	mg/l	0.0108	0.0104	108.	56-133	3.54	20	WG578757
Di-n-octyl phthalate	mg/l	0.0104	0.0107	104.	59-143	2.10	20	WG578757
Dibenz(a,h)anthracene	mg/l	0.0102	0.0101	102.	54-130	0.610	20	WG578757
Diethyl phthalate	mg/l	0.0102	0.0100	102.	33-136	1.82	20	WG578757
Dimethyl phthalate	mg/l	0.00969	0.00958	97.0	10-152	1.22	22	WG578757
Fluoranthene	mg/l	0.00996	0.00972	100.	66-120	2.44	20	WG578757
Fluorene	mg/l	0.00906	0.00898	90.0	58-110	0.820	20	WG578757
Hexachloro-1,3-butadiene	mg/l	0.00468	0.00526	47.0	34-115	11.7	22	WG578757
Hexachlorobenzene	mg/l	0.00968	0.00892	97.0	55-117	8.17	20	WG578757
Hexachlorocyclopentadiene	mg/l	0.00297	0.00341	30.0	20-121	14.0	27	WG578757
Hexachloroethane	mg/l	0.00439	0.00458	44.0	24-93	4.26	25	WG578757
Indeno(1,2,3-cd)pyrene	mg/l	0.0102	0.0102	102.	56-129	0.110	20	WG578757
Isophorone	mg/l	0.00721	0.00740	72.0	55-108	2.60	20	WG578757
n-Nitrosodi-n-propylamine	mg/l	0.00788	0.00815	79.0	50-115	3.29	20	WG578757
n-Nitrosodimethylamine	mg/l	0.00460	0.00531	46.0	12-68	14.3	31	WG578757
n-Nitrosodiphenylamine	mg/l	0.0101	0.00936	101*	55-98	7.42	20	WG578757
Naphthalene	mg/l	0.00760	0.00754	76.0	42-103	0.725	20	WG578757
Nitrobenzene	mg/l	0.00837	0.00856	84.0	39-102	2.27	20	WG578757
Pentachlorophenol	mg/l	0.00823	0.00805	82.0	10-101	2.16	40	WG578757
Phenanthrene	mg/l	0.00959	0.00929	96.0	61-110	3.09	20	WG578757
Phenol	mg/l	0.00467	0.00541	47.0	10-53	14.7	20	WG578757
Pyrene	mg/l	0.00912	0.00935	91.0	65-116	2.40	20	WG578757
2,4,6-Tribromophenol				130.8	16-147			WG578757
2-Fluorobiphenyl				89.96	29-127			WG578757
2-Fluorophenol				55.48	10-75			WG578757
Nitrobenzene-d5				85.32	17-119			WG578757
Phenol-d5				44.74	10-63			WG578757
p-Terphenyl-d14				80.01	40-174			WG578757

		Matrix Spike						
Analyte	Units	MS Res	Ref Res	TV	% Rec	Limit	Ref Samp	Batch
1,1,1,2-Tetrachloroethane	mg/l	0.0250	0	.025	99.8	71-130	L560836-01	WG579366
1,1,1-Trichloroethane	mg/l	0.0239	0	.025	95.7	58-137	L560836-01	WG579366
1,1,2,2-Tetrachloroethane	mg/l	0.0222	0	.025	88.6	64-149	L560836-01	WG579366
1,1,2-Trichloroethane	mg/l	0.0237	0	.025	94.6	73-128	L560836-01	WG579366
1,1,2-Trichlorotrifluoroethane	mg/l	0.0246	0	.025	98.4	36-159	L560836-01	WG579366
1,1-Dichloroethane	mg/l	0.0227	0	.025	90.7	58-133	L560836-01	WG579366
1,1-Dichloroethene	mg/l	0.0229	0	.025	91.6	32-152	L560836-01	WG579366
1,1-Dichloropropene	mg/l	0.0228	0	.025	91.4	50-140	L560836-01	WG579366

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February 24, 2012

Analyte	Units	MS Res	Matrix Spike Ref Res	TV	% Rec	Limit	Ref Samp	Batch
1,2,3-Trichlorobenzene	mg/l	0.0282	0	.025	113.	68-135	L560836-01	WG579366
1,2,3-Trichloropropane	mg/l	0.0225	0	.025	90.2	74-137	L560836-01	WG579366
1,2,3-Trimethylbenzene	mg/l	0.0250	0	.025	99.9	67-133	L560836-01	WG579366
1,2,4-Trichlorobenzene	mg/l	0.0296	0	.025	118.	67-133	L560836-01	WG579366
1,2,4-Trimethylbenzene	mg/l	0.0250	0	.025	100.	62-141	L560836-01	WG579366
1,2-Dibromo-3-Chloropropane	mg/l	0.0257	0	.025	103.	55-148	L560836-01	WG579366
1,2-Dibromoethane	mg/l	0.0246	0	.025	98.4	71-129	L560836-01	WG579366
1,2-Dichlorobenzene	mg/l	0.0259	0	.025	103.	75-125	L560836-01	WG579366
1,2-Dichloroethane	mg/l	0.0232	0	.025	93.0	59-135	L560836-01	WG579366
1,2-Dichloropropane	mg/l	0.0223	0	.025	89.3	68-126	L560836-01	WG579366
1,3,5-Trimethylbenzene	mg/l	0.0250	0	.025	100.	67-136	L560836-01	WG579366
1,3-Dichlorobenzene	mg/l	0.0245	0	.025	98.0	69-131	L560836-01	WG579366
1,3-Dichloropropane	mg/l	0.0236	0	.025	94.5	70-122	L560836-01	WG579366
1,4-Dichlorobenzene	mg/l	0.0262	0	.025	105.	70-123	L560836-01	WG579366
2,2-Dichloropropane	mg/l	0.0275	0	.025	110.	51-141	L560836-01	WG579366
2-Butanone (MEK)	mg/l	0.109	0	.125	86.9	51-149	L560836-01	WG579366
2-Chloroethyl vinyl ether	mg/l	0.0204	0	.125	16.3	10-161	L560836-01	WG579366
2-Chlorotoluene	mg/l	0.0242	0	.025	96.8	65-133	L560836-01	WG579366
4-Chlorotoluene	mg/l	0.0244	0	.025	97.6	67-129	L560836-01	WG579366
4-Methyl-2-pentanone (MIBK)	mg/l	0.115	0	.125	91.9	53-154	L560836-01	WG579366
Acetone	mg/l	0.109	0	.125	87.4	34-146	L560836-01	WG579366
Acrolein	mg/l	0.180	0	.125	144.	10-189	L560836-01	WG579366
Acrylonitrile	mg/l	0.108	0	.125	86.6	49-162	L560836-01	WG579366
Benzene	mg/l	0.0221	0	.025	88.4	51-134	L560836-01	WG579366
Bromobenzene	mg/l	0.0234	0	.025	93.5	64-130	L560836-01	WG579366
Bromodichloromethane	mg/l	0.0225	0	.025	90.0	67-132	L560836-01	WG579366
Bromoform	mg/l	0.0231	0	.025	92.5	59-137	L560836-01	WG579366
Bromomethane	mg/l	0.0271	0	.025	108.	23-177	L560836-01	WG579366
Carbon tetrachloride	mg/l	0.0230	0	.025	91.9	49-140	L560836-01	WG579366
Chlorobenzene	mg/l	0.0246	0	.025	98.5	69-126	L560836-01	WG579366
Chlorodibromomethane	mg/l	0.0234	0	.025	93.5	68-130	L560836-01	WG579366
Chloroethane	mg/l	0.0275	0	.025	110.	32-177	L560836-01	WG579366
Chloroform	mg/l	0.0225	0	.025	90.1	64-130	L560836-01	WG579366
Chloromethane	mg/l	0.0234	0	.025	93.8	27-155	L560836-01	WG579366
cis-1,2-Dichloroethene	mg/l	0.0221	0	.025	88.4	54-137	L560836-01	WG579366
cis-1,3-Dichloropropene	mg/l	0.0227	0	.025	90.8	63-127	L560836-01	WG579366
Di-isopropyl ether	mg/l	0.0230	0	.025	92.1	58-133	L560836-01	WG579366
Dibromomethane	mg/l	0.0245	0	.025	98.0	68-131	L560836-01	WG579366
Dichlorodifluoromethane	mg/l	0.0252	0	.025	101.	16-188	L560836-01	WG579366
Ethylbenzene	mg/l	0.0240	0	.025	96.2	64-135	L560836-01	WG579366
Hexachloro-1,3-butadiene	mg/l	0.0275	0	.025	110.	64-140	L560836-01	WG579366
Isopropylbenzene	mg/l	0.0267	0	.025	107.	62-134	L560836-01	WG579366
Methyl tert-butyl ether	mg/l	0.0244	0	.025	97.5	55-136	L560836-01	WG579366
Methylene Chloride	mg/l	0.0219	0	.025	87.5	52-130	L560836-01	WG579366
n-Butylbenzene	mg/l	0.0268	0	.025	107.	62-142	L560836-01	WG579366
n-Propylbenzene	mg/l	0.0251	0	.025	100.	62-137	L560836-01	WG579366
Naphthalene	mg/l	0.0263	0	.025	105.	65-140	L560836-01	WG579366
p-Isopropyltoluene	mg/l	0.0255	0	.025	102.	64-142	L560836-01	WG579366
sec-Butylbenzene	mg/l	0.0254	0	.025	101.	67-139	L560836-01	WG579366
Styrene	mg/l	0.0237	0	.025	94.9	58-152	L560836-01	WG579366
tert-Butylbenzene	mg/l	0.0253	0	.025	101.	66-139	L560836-01	WG579366
Tetrachloroethene	mg/l	0.0244	0	.025	97.5	56-139	L560836-01	WG579366
Toluene	mg/l	0.0233	0	.025	93.0	61-126	L560836-01	WG579366
trans-1,2-Dichloroethene	mg/l	0.0228	0	.025	91.2	45-137	L560836-01	WG579366
trans-1,3-Dichloropropene	mg/l	0.0230	0	.025	92.0	59-130	L560836-01	WG579366
Trichloroethene	mg/l	0.0223	0	.025	89.2	40-155	L560836-01	WG579366
Trichlorofluoromethane	mg/l	0.0280	0	.025	112.	35-177	L560836-01	WG579366
Vinyl chloride	mg/l	0.0249	0	.025	99.4	32-159	L560836-01	WG579366
Xylenes, Total	mg/l	0.0725	0	.075	96.6	64-133	L560836-01	WG579366

* Performance of this Analyte is outside of established criteria.
For additional information, please see Attachment A 'List of Analytes with QC Qualifiers.'

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Quality Assurance Report
Level II

L560869

February 24, 2012

Analyte	Units	MSD	Ref	%Rec	Limit	RPD	Limit	Ref Samp	Batch
		Matrix Spike Duplicate							
4-Bromofluorobenzene					96.70	82-120			
Dibromofluoromethane					98.20	82-126			
Toluene-d8					102.0	92-112			

Analyte	Units	MSD	Ref	%Rec	Limit	RPD	Limit	Ref Samp	Batch
		Matrix Spike Duplicate							
1,1,1,2-Tetrachloroethane	mg/l	0.0241	0.0250	96.3	71-130	3.62	20	L560836-01	WG579366
1,1,1-Trichloroethane	mg/l	0.0235	0.0239	94.1	58-137	1.69	20	L560836-01	WG579366
1,1,2,2-Tetrachloroethane	mg/l	0.0237	0.0222	94.7	64-149	6.63	20	L560836-01	WG579366
1,1,2-Trichloroethane	mg/l	0.0236	0.0237	94.5	73-128	0.110	20	L560836-01	WG579366
1,1,2-Trichlorotrifluoroethane	mg/l	0.0240	0.0246	96.0	36-159	2.54	21	L560836-01	WG579366
1,1-Dichloroethane	mg/l	0.0214	0.0227	85.4	58-133	6.01	20	L560836-01	WG579366
1,1-Dichloroethene	mg/l	0.0226	0.0229	90.2	32-152	1.58	20	L560836-01	WG579366
1,1-Dichloropropene	mg/l	0.0217	0.0228	87.0	50-140	4.96	20	L560836-01	WG579366
1,2,3-Trichlorobenzene	mg/l	0.0274	0.0282	110.	68-135	2.73	20	L560836-01	WG579366
1,2,3-Trichloropropane	mg/l	0.0254	0.0225	102.	74-137	11.9	20	L560836-01	WG579366
1,2,3-Trimethylbenzene	mg/l	0.0233	0.0250	93.2	67-133	6.96	20	L560836-01	WG579366
1,2,4-Trichlorobenzene	mg/l	0.0286	0.0296	114.	67-133	3.61	20	L560836-01	WG579366
1,2,4-Trimethylbenzene	mg/l	0.0240	0.0250	95.9	62-141	4.15	20	L560836-01	WG579366
1,2-Dibromo-3-Chloropropane	mg/l	0.0273	0.0257	109.	55-148	5.97	22	L560836-01	WG579366
1,2-Dibromoethane	mg/l	0.0241	0.0246	96.6	71-129	1.88	20	L560836-01	WG579366
1,2-Dichlorobenzene	mg/l	0.0245	0.0259	97.9	75-125	5.48	20	L560836-01	WG579366
1,2-Dichloroethane	mg/l	0.0221	0.0232	88.4	59-135	5.05	20	L560836-01	WG579366
1,2-Dichloropropane	mg/l	0.0216	0.0223	86.2	68-126	3.53	20	L560836-01	WG579366
1,3,5-Trimethylbenzene	mg/l	0.0240	0.0250	96.0	67-136	4.22	20	L560836-01	WG579366
1,3-Dichlorobenzene	mg/l	0.0235	0.0245	93.9	69-131	4.21	20	L560836-01	WG579366
1,3-Dichloropropane	mg/l	0.0233	0.0236	93.3	70-122	1.21	20	L560836-01	WG579366
1,4-Dichlorobenzene	mg/l	0.0248	0.0262	99.4	70-123	5.40	20	L560836-01	WG579366
2,2-Dichloropropane	mg/l	0.0258	0.0275	103.	51-141	6.10	20	L560836-01	WG579366
2-Butanone (MEK)	mg/l	0.124	0.109	99.6	51-149	13.6	22	L560836-01	WG579366
2-Chloroethyl vinyl ether	mg/l	0.00305	0.0204	2.44*	10-161	148.*	40	L560836-01	WG579366
2-Chlorotoluene	mg/l	0.0231	0.0242	92.3	65-133	4.78	20	L560836-01	WG579366
4-Chlorotoluene	mg/l	0.0242	0.0244	96.7	67-129	0.950	20	L560836-01	WG579366
4-Methyl-2-pentanone (MIBK)	mg/l	0.128	0.115	103.	53-154	11.1	21	L560836-01	WG579366
Acetone	mg/l	0.126	0.109	101.	34-146	14.3	22	L560836-01	WG579366
Acrolein	mg/l	0.195	0.180	156.	10-189	7.68	30	L560836-01	WG579366
Acrylonitrile	mg/l	0.118	0.108	94.8	49-162	9.01	20	L560836-01	WG579366
Benzene	mg/l	0.0215	0.0221	85.9	51-134	2.83	20	L560836-01	WG579366
Bromobenzene	mg/l	0.0229	0.0234	91.4	64-130	2.27	20	L560836-01	WG579366
Bromodichloromethane	mg/l	0.0222	0.0225	88.7	67-132	1.49	20	L560836-01	WG579366
Bromoform	mg/l	0.0237	0.0231	94.8	59-137	2.43	20	L560836-01	WG579366
Bromomethane	mg/l	0.0259	0.0271	104.	23-177	4.69	21	L560836-01	WG579366
Carbon tetrachloride	mg/l	0.0226	0.0230	90.2	49-140	1.87	20	L560836-01	WG579366
Chlorobenzene	mg/l	0.0239	0.0246	95.5	69-126	3.10	20	L560836-01	WG579366
Chlorodibromomethane	mg/l	0.0232	0.0234	92.7	68-130	0.860	20	L560836-01	WG579366
Chloroethane	mg/l	0.0268	0.0275	107.	32-177	2.82	21	L560836-01	WG579366
Chloroform	mg/l	0.0225	0.0225	89.8	64-130	0.310	20	L560836-01	WG579366
Chloromethane	mg/l	0.0216	0.0234	86.5	27-155	8.04	20	L560836-01	WG579366
cis-1,2-Dichloroethene	mg/l	0.0213	0.0221	85.1	54-137	3.81	20	L560836-01	WG579366
cis-1,3-Dichloropropene	mg/l	0.0220	0.0227	88.0	63-127	3.17	20	L560836-01	WG579366
Di-isopropyl ether	mg/l	0.0216	0.0230	86.5	58-133	6.22	20	L560836-01	WG579366
Dibromomethane	mg/l	0.0244	0.0245	97.7	68-131	0.320	20	L560836-01	WG579366
Dichlorodifluoromethane	mg/l	0.0247	0.0252	99.0	16-188	1.71	22	L560836-01	WG579366
Ethylbenzene	mg/l	0.0235	0.0240	93.8	64-135	2.42	20	L560836-01	WG579366
Hexachloro-1,3-butadiene	mg/l	0.0266	0.0275	106.	64-140	3.20	20	L560836-01	WG579366
Isopropylbenzene	mg/l	0.0262	0.0267	105.	62-134	1.73	20	L560836-01	WG579366
Methyl tert-butyl ether	mg/l	0.0236	0.0244	94.5	55-136	3.07	20	L560836-01	WG579366
Methylene Chloride	mg/l	0.0206	0.0219	82.4	52-130	6.02	20	L560836-01	WG579366

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Quality Assurance Report
Level II

L560869

February 24, 2012

Analyte	Units	MSD	Ref	%Rec	Limit	RPD	Limit	Ref Samp	Batch
		Matrix Spike Duplicate							
n-Butylbenzene	mg/l	0.0257	0.0268	103.	62-142	4.31	20	L560836-01	WG579366
n-Propylbenzene	mg/l	0.0247	0.0251	98.9	62-137	1.34	20	L560836-01	WG579366
Naphthalene	mg/l	0.0269	0.0263	108.	65-140	2.25	20	L560836-01	WG579366
p-Isopropyltoluene	mg/l	0.0252	0.0255	101.	64-142	1.01	20	L560836-01	WG579366
sec-Butylbenzene	mg/l	0.0249	0.0254	99.4	67-139	2.00	20	L560836-01	WG579366
Styrene	mg/l	0.0231	0.0237	92.3	58-152	2.81	20	L560836-01	WG579366
tert-Butylbenzene	mg/l	0.0248	0.0253	99.4	66-139	1.99	20	L560836-01	WG579366
Tetrachloroethene	mg/l	0.0236	0.0244	94.5	56-139	3.19	20	L560836-01	WG579366
Toluene	mg/l	0.0231	0.0233	92.2	61-126	0.820	20	L560836-01	WG579366
trans-1,2-Dichloroethene	mg/l	0.0220	0.0228	88.0	45-137	3.57	20	L560836-01	WG579366
trans-1,3-Dichloropropene	mg/l	0.0225	0.0230	90.2	59-130	2.06	20	L560836-01	WG579366
Trichloroethene	mg/l	0.0222	0.0223	88.8	40-155	0.510	20	L560836-01	WG579366
Trichlorofluoromethane	mg/l	0.0265	0.0280	106.	35-177	5.55	23	L560836-01	WG579366
Vinyl chloride	mg/l	0.0234	0.0249	93.8	32-159	5.89	21	L560836-01	WG579366
Xylenes, Total	mg/l	0.0705	0.0725	94.0	64-133	2.82	20	L560836-01	WG579366
4-Bromofluorobenzene				98.78	82-120				WG579366
Dibromofluoromethane				97.81	82-126				WG579366
Toluene-d8				103.0	92-112				WG579366

Batch number /Run number / Sample number cross reference

WG579366: R2042792: L560869-01
WG578757: R2042812: L560869-01

* * Calculations are performed prior to rounding of reported values.
* Performance of this Analyte is outside of established criteria.
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Quality Assurance Report
Level II

L560869

February 24, 2012

The data package includes a summary of the analytic results of the quality control samples required by the SW-846 or CWA methods. The quality control samples include a method blank, a laboratory control sample, and the matrix spike/matrix spike duplicate analysis. If a target parameter is outside the method limits, every sample that is effected is flagged with the appropriate qualifier in Appendix B of the analytic report.

Method Blank - an aliquot of reagent water carried through the entire analytic process. The method blank results indicate if any possible contamination exposure during the sample handling, digestion or extraction process, and analysis. Concentrations of target analytes above the reporting limit in the method blank are qualified with the "B" qualifier.

Laboratory Control Sample - is a sample of known concentration that is carried through the digestion/extraction and analysis process. The percent recovery, expressed as a percentage of the theoretical concentration, has statistical control limits indicating that the analytic process is "in control". If a target analyte is outside the control limits for the laboratory control sample or any other control sample, the parameter is flagged with a "J4" qualifier for all effected samples.

Matrix Spike and Matrix Spike Duplicate - is two aliquots of an environmental sample that is spiked with known concentrations of target analytes. The percent recovery of the target analytes also has statistical control limits. If any recoveries that are outside the method control limits, the sample that was selected for matrix spike/matrix spike duplicate analysis is flagged with either a "J5" or a "J6". The relative percent difference (%RPD) between the matrix spike and the matrix spike duplicate recoveries is all calculated. If the RPD is above the method limit, the effected samples are flagged with a "J3" qualifier.

ATTACHMENT B

BORING AND CORING LOGS

RECORD OF BOREHOLE CMI-1

SHEET 1 of 1

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 16, 2012 / 4:15:00 PM
DRILLING END: January 16, 2012 / 4:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,420
E: 5,222

GS ELEVATION: 194.4
TOC ELEVATION: 197.8

DEPTH (ft)	BORING METHOD	DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC / ATT (inch) / CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 18.0 Firm, moist, dark gray and tan, mottled, CLAY, trace fine to medium sand.		0.0	1	D.O.	1-1-3-5	4	16.8/24		
					2	D.O.	3-6-8-10	14	21.6/24		
5					3	D.O.	2-2-4-7	6	21.6/24		
					4	D.O.	2-4-4-6	8	24/24		
					5	D.O.	3-3-6-7	9	24/24		
10					6	D.O.	2-3-4-5	7	24/24		
					7	D.O.	1-2-4-4	6	21.6/24		
15					8	D.O.	2-3-3-3	6	15.6/24		
				176.4	9	D.O.	1-2-2-3	4	22.8/24		
		18.0 - 36.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		18.0	10	D.O.	WH-3-4-5	7	21.6/24		
20					11	D.O.	2-4-6-8	10	24/24		
					12	D.O.	1-2-2-3	4	24/24		
25					13	D.O.	1-1-5-8	6	24/24		
					14	D.O.	4-4-7-10	11	24/24		
					15	D.O.	3-4-6-8	10	24/24		
30					16	D.O.	3-5-7-8	12	24/24		
					17	D.O.	3-5-7-8	12	24/24		
35				158.4	18	D.O.	2-4-5-6	9	19.2/24		
		36.0 - 40.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		36.0	19	D.O.	1-19-36-48	55	24/24		
				154.4	20	D.O.	13-30-50/3"	80	15/15		
40		Drilling terminated at 40 ft. BGS									
45											
50											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE CMI-2

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 18, 2012 / 8:20:00 AM
DRILLING END: January 18, 2012 / 1:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,560
E: 6,829

GS ELEVATION: 173.8
TOC ELEVATION: 176.8

SOIL PROFILE

DEPTH (ft)	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)
0.0 – 8.0	Hollow Stem Auger	0.0 - 8.0 Soft, tan-gray mottled, silty CLAY, trace fine to medium sand. No odor. Moist [Weathered Chalk].	0.0 / 165.8
8.0 – 18.0	Hollow Stem Auger	8.0 - 18.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	8.0 / 155.8
18.0		Drilling terminated at 18 ft. BGS	

SAMPLE / RUN

NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)
1	D.O.	1-3-4-2	7	21/24
2	D.O.	2-3-4-7	7	24/24
3	D.O.	3-4-7-7	11	21/24
4	D.O.	2-2-4-4	6	12/24
5	D.O.	8-20-22-18	42	21/24
6	D.O.	5-8-9-13	17	24/24
7	D.O.	10-29-25-50/3'	54	24/24
8	D.O.	16-35-47-50/4'	82	24/24
9	D.O.	9-25-33-50/4"	58	24/24

PENETRATION RESISTANCE BLOWS / ft ■ — RQD (%) — WATER CONTENT (PERCENT) W_p — W — W_l (20, 40, 60, 80)

NOTES
WATER LEVELS

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-35

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: February 12, 2012 / 9:20:00 AM
DRILLING END: February 12, 2012 / 12:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,778

SHEET 1 of 3
GS ELEVATION: 256.6
TOC ELEVATION: 259.9

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) W_p — O — W_l (20, 40, 60, 80)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 22.5 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}	0.0	1	DO	5-7-7-11	14	24/24		
				2	DO	8-7-11-13	18	24/24		
5				3	DO	6-5-3-6	8	24/24		
				4	DO	5-6-7-8	13	24/24		
				5	DO	3-5-5-6	10	24/24		
10				6	DO	3-5-3-7	8	24/24		
				7	DO	3-5-5-5	10	13/24		
15				8	DO	2-2-2-1	4	15/24		
				9	DO	2-2-5-7	7	24/24		
				10	DO	2-2-4-6	6	24/24		
20				11	DO	2-2-4-6	6	24/24		
		22.5 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.	234.1 22.5	12	DO	5-18-21-38	39	24/24		
25				13	DO	9-14-25-50/5"	39	24/24		
				14	DO	8-16-19-33	35	24/24		
				15	DO	5-13-18-24	31	24/24		
30	HQ Wire Line, Water Rotary	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	226.6 30.0							
35				1	RC			100		
40										
45				2	RC			100		
50										

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-35

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: February 12, 2012 / 9:20:00 AM
DRILLING END: February 12, 2012 / 12:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,778

GS ELEVATION: 256.6
TOC ELEVATION: 259.9

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp ⊢—○—⊣ Wl 20 40 60 80	NOTES WATER LEVELS
50	HQ Wire Line, Water Rotary	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*									
55					3	RC			100		
60		61.2 - 61.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.									
65					4	RC			100		
70											
75					5	RC			100		
80		83.2 - 83.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.									
85					6	RC			100		
90											
95					7	RC			100		
100		Log continued on next page									

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-35

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: February 12, 2012 / 9:20:00 AM
DRILLING END: February 12, 2012 / 12:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,778

GS ELEVATION: 256.6
TOC ELEVATION: 259.9

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■; RQD (%); WATER CONTENT (PERCENT) Wp ⊢—○—⊣ Wl 20 40 60 80	NOTES WATER LEVELS
100		30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*			8	RC			100		
105				150.6							
		Drilling terminated at 106 ft. BGS									
110											
115											
120											
125											
130											
135											
140											
145											
150											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-35B

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama
DRILLING START: April 24, 2012 / 10:00:00 AM
DRILLING END: April 24, 2012 / 4:00:00 PM
DRILL RIG: CME 75
COORDS: N: 8,938 E: 6,783
SHEET 1 of 2
GS ELEVATION: 256.6
TOC ELEVATION: 259.8

DEPTH (ft)	BORING METHOD	DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 22.0 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}		0.0	1	DO	3-3-4-5	7	22/24		
					2	DO	2-4-5-7	9	17/24		
5					3	DO	5-4-5-5	9	24/24		
					4	DO	3-3-5-7	8	24/24		
					5	DO	2-1-3-4	4	19/24		
10					6	DO	2-3-5-7	8	24/24		
					7	DO	2-2-4-5	6	20/24		
15					8	DO	2-3-3-5	6	24/24		
					9	DO	3-3-5-6	8	22/24		
					10	DO	2-3-4-5	7	23/24		
20				234.6	11	DO	2-4-9-19	13	24/24		
		22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		22.0	12	DO	5-15-23-26	38	24/24		
25					13	DO	4-15-25-50/5"	40	24/24		
					14	DO	10-16-20-40	36	24/24		
				226.6	15	DO	7-15-23-44	38	24/24		
30	HQ Wire Line, Water Rotary	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		30.0							
35					1	RC			100		
40											
45					2	RC			100		
50					3	RC			100		

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee
LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-35B

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: April 24, 2012 / 10:00:00 AM
DRILLING END: April 24, 2012 / 4:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,783

GS ELEVATION: 256.6
TOC ELEVATION: 259.8

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp ⊢—○—⊣ Wl (20 40 60 80)	NOTES WATER LEVELS
50	HQ Wire Line, Water Rotary	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*			3	RC			100		
55											
60		60.0 - 60.5 Slickensided (K), Polished (P), discontinuity at a 50 degree angle with respect to the core axis.			4	RC			100		
65											
70					5	RC			100		
75											
80					6	RC			100		
85		85.6 - 86.2 Slickensided (K), Polished (P), discontinuity at a 55 degree angle with respect to the core axis.		167.8							
		Drilling terminated at 88.8 ft. BGS									
90											
95											
100											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-36

SHEET 1 of 2

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 12, 2012 / 3:45:00 PM
DRILLING END: January 12, 2012 / 3:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,847 E: 7,519

GS ELEVATION: 192.4
TOC ELEVATION: 195.1

DEPTH (ft)	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	NOTES WATER LEVELS
0	Hollow Stem Auger / Water Rotary	0.0 - 10.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]	0.0	1	DO	2-4-7-19	11	18/24	
				2	DO	23-30-50/4"	100	16/16	
5				3	DO	14-18-25-35	43	24/24	
				4	DO	7-16-18-32	34	24/24	
			182.4	5	DO	2-6-14-18	20	24/24	
10		10.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.	10.0	6	DO	9-16-24-50/2"	25	20/20	
				7	DO	4-8-24-24	32	24/24	
15				8	DO	3-17-23-39	40	24/24	
				9	DO	11-20-30-50/2'	50	24/24	
				10	DO	12-26-43-50/3'	69	24/24	
20				11	DO	7-24-28-50/4"	53	22/22	
				12	DO	9-23-30-50/5"	53	23/23	
25				13	DO	6-29-34-50/4"	63	23/23	
				14	DO	12-29-43-50/2'	72	20/20	
			162.4	15	DO	11-28-40-50/2'	67	20/20	
30	HQ Wire Line, Water Rotary	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	30.0						
35				1	RC			100	
40									
45				2	RC			100	
				3	RC			100	
50									

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-36

SHEET 2 of 2

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 12, 2012 / 3:45:00 PM
DRILLING END: January 12, 2012 / 3:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,847
E: 7,519

GS ELEVATION: 192.4
TOC ELEVATION: 195.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) W_p — W_l (20 40 60 80)	NOTES WATER LEVELS
50	HQ Wire Line, Water Rotary	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*								
55				3	RC			100		
60–65				4	RC			100		
70–75		74.0 - 74.4 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		5	RC			100		
		75.3 - 75.7 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.								
80–85			105.1	6	RC			100		
87.3		Drilling terminated at 87.3 ft. BGS								
90										
95										
100										

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-37

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

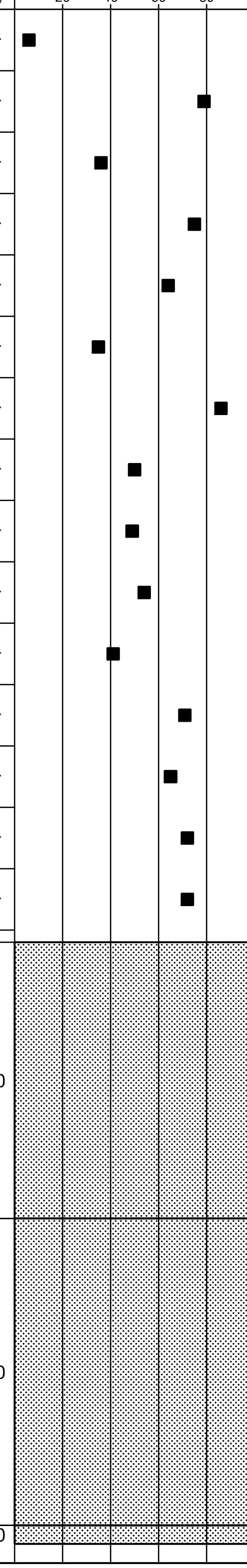
DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,121
E: 7,674

GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 5.0 Stiff, moist, gray tan, CLAY, trace medium to coarse sand, trace fine gravel (rock fragments). [Soft Weathered Chalk] {FILL}		0.0	1	DO	WH-2-4-10	6	18/24	
					2	DO	29-30-49-50/5'	79	24/24	
5		5.0 - 22.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		189.9 / 5.0	3	DO	5-19-17-50	36	24/24	
					4	DO	12-30-45-50/3'	75	24/24	
					5	DO	12-37-27-50/3'	64	24/24	
10					6	DO	10-12-23-50/4'	35	24/24	
					7	DO	4-38-48-50/4"	86	24/24	
15					8	DO	6-20-30-50/3"	50	24/24	
					9	DO	9-21-28-50/4"	49	24/24	
					10	DO	7-23-31-50/3"	54	24/24	
20					11	DO	4-16-25-50/5"	41	24/24	
		22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		172.9	12	DO	14-28-43-50/3'	71	24/24	
25					13	DO	7-27-38-50/3"	65	24/24	
					14	DO	8-26-46-50/2"	72	24/24	
				164.9	15	DO	7-24-48-50/3"	72	24/24	
30	HQ Wireline, Air Rotary	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		30.4						
35					1	RC			100	
40										
45					2	RC			100	
50					3	RC			100	

PENETRATION RESISTANCE BLOWS / ft ■
RQD (%)
WATER CONTENT (PERCENT) W_p — W — W_l
20 40 60 80



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DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-37

SHEET 2 of 4

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,121
E: 7,674

GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE / RUN – NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp —O— W Wl (20 40 60 80)	NOTES WATER LEVELS
50	HQ Wireline, Air Rotary	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*								
55				3	RC			100		
60										
65				4	RC			100		
70		70.8 - 71.2 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.								
		71.3 - 71.7 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.								
75		73.3 - 73.7 Calcite fused discontinuity at a 15 degree angle with respect to the core axis. Only apparent when mechanically broken.		5	RC			100		
80										
		83.0 - 83.4 Calcite fused discontinuity at a 18 degree angle with respect to the core axis. Only apparent when mechanically broken.								
85		83.8 - 84.2 Calcite fused discontinuity at a 30 degree angle with respect to the core axis. Only apparent when mechanically broken.		6	RC			100		
90										
95				7	RC			100		
100		Log continued on next page								

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-37

SHEET 3 of 4

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,121
E: 7,674

GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp ⊢—○—⊣ Wl 20 40 60 80	NOTES WATER LEVELS
100	HQ Wireline, Air Rotary	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*			8	RC			100		
105					8	RC			100		
115					9	RC			100		
120					10	RC			100		
125					11	RC			99		
135					12	RC			100		
145					13	RC			100		
150					14	RC			100		

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-37

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama
DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75
COORDS: N: 14,121
E: 7,674
SHEET 4 of 4
GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) W_p 20 40 60 80 W_l	NOTES WATER LEVELS
150		30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*		41.3	14	RC			100		
155		Drilling terminated at 156 ft. BGS									
160											
165											
170											
175											
180											
185											
190											
195											
200											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee
LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

ATTACHMENT C

AS-BUILT WELL DIAGRAMS

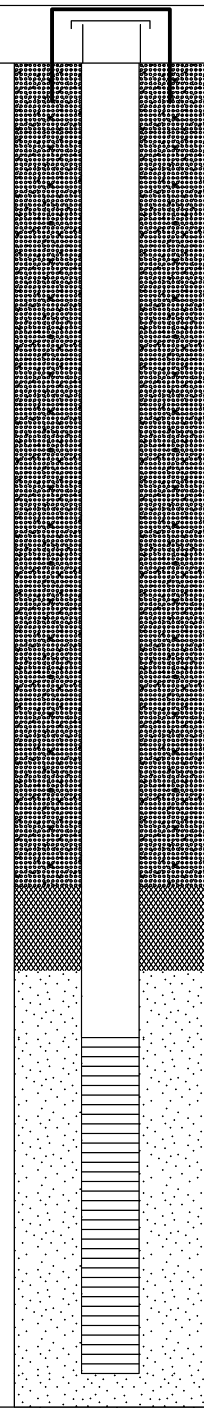
WELL CMI-1

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	January 16, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	194.4 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	197.77 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface 0.0 - 18.0 Firm, moist, dark gray and tan, mottled, CLAY, trace fine to medium sand.	(0' - 24.5' bgs) Cement grout	For material quantities see Tables 1,1A.
18	18.0 - 36.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]	(24.5' - 27' bgs) Bentonite seal (27' - 40' bgs) Sand filter (29' - 39' bgs) Slotted PVC	DEVELOPMENT NOTES For well development details see Table 3.
36	36.0 - 40.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40



Bottom of borehole at 40.0 feet.

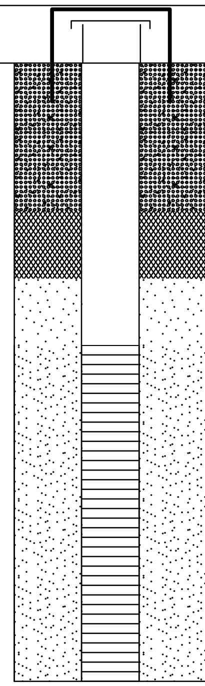
WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL CMI-2

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	January 18, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	173.8 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	176.75 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface 0.0 - 8.0 Soft, tan-gray mottled, silty CLAY, trace fine to medium sand. No odor. Moist [Weathered Chalk].	(0' - 4.4' bgs) Cement-bentonite grout (4.4' - 6.4' bgs) Bentonite seal	For material quantities see Tables 1,1A.
8	8.0 - 18.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	(6.4' - 18.4' bgs) Filter sand (8.4' - 18.4' bgs) Slotted PVC	
18	Bottom of borehole at 18.0 feet.		



Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

DEVELOPMENT NOTES

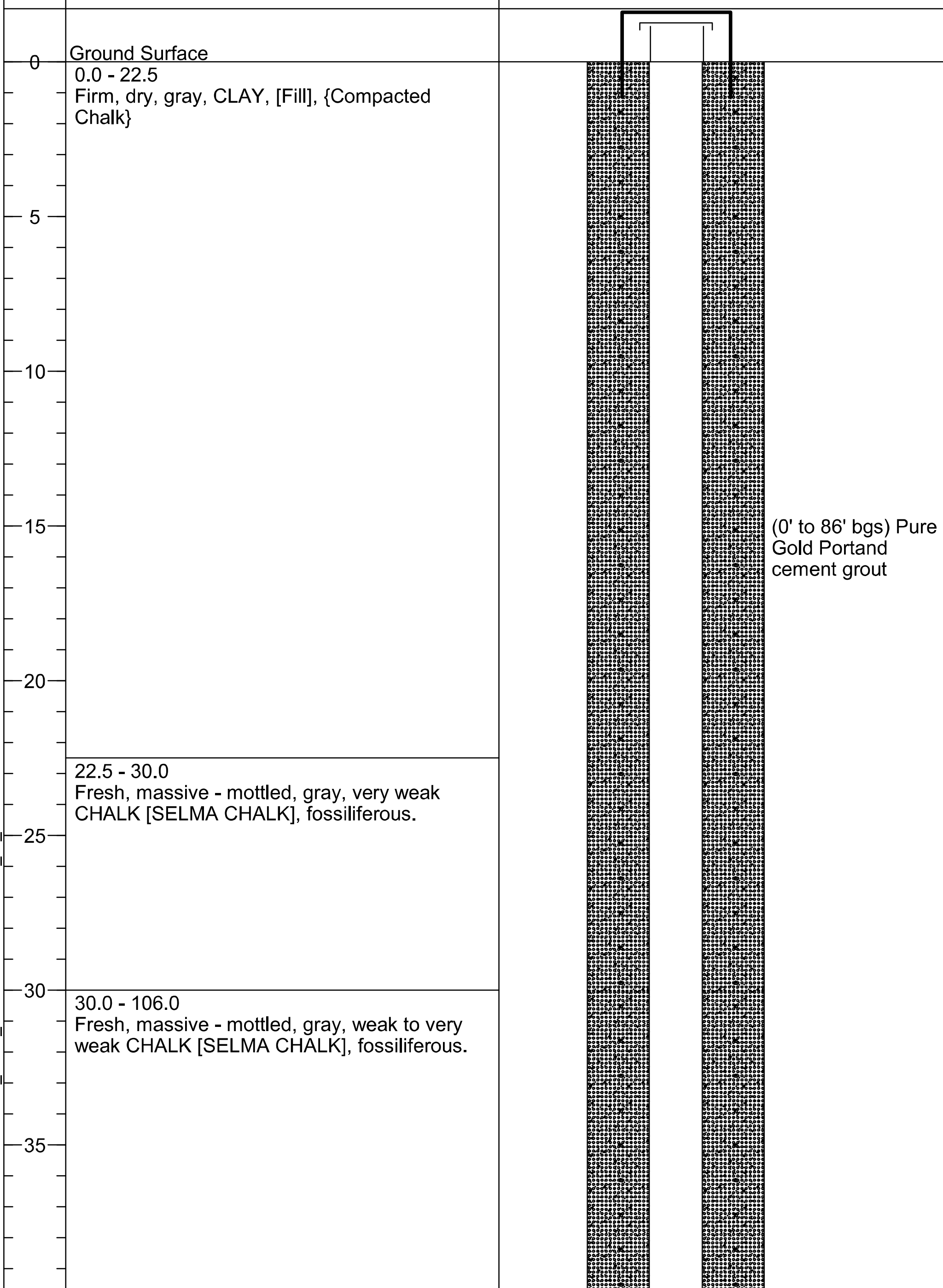
For well development details see Table 3.

WELL SM-35

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	February 12, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	256.6 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	259.89 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

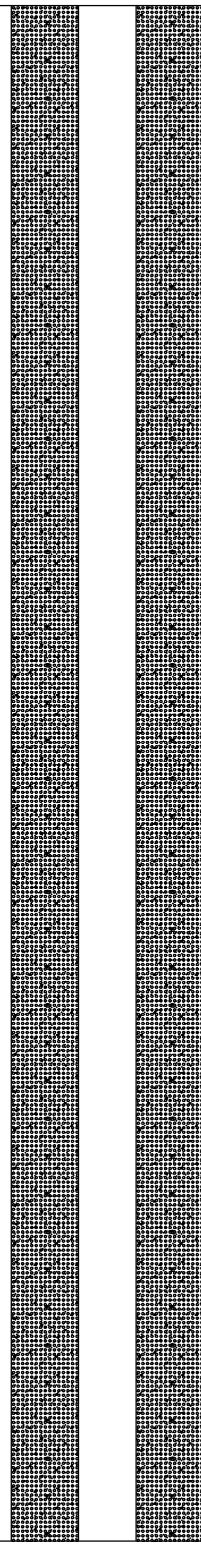
Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	Ground Surface		
0	0.0 - 22.5 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}	(0' to 86' bgs) Pure Gold Portand cement grout	For material quantities see Tables 1,1A.
22.5	22.5 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		**DEVELOPMENT NOTES** For well development details see Table 3.
30	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		



Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** February 12, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

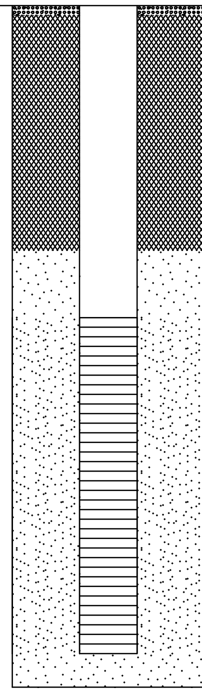
Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
45			
50			
55			
60			
	61.2 - 61.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		
65			
			DEVELOPMENT NOTES
70			For well development details see Table 3.
75			
80			
	83.2 - 83.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		
85			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

PROJECT NUMBER 11390080 **DATE STARTED** February 12, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

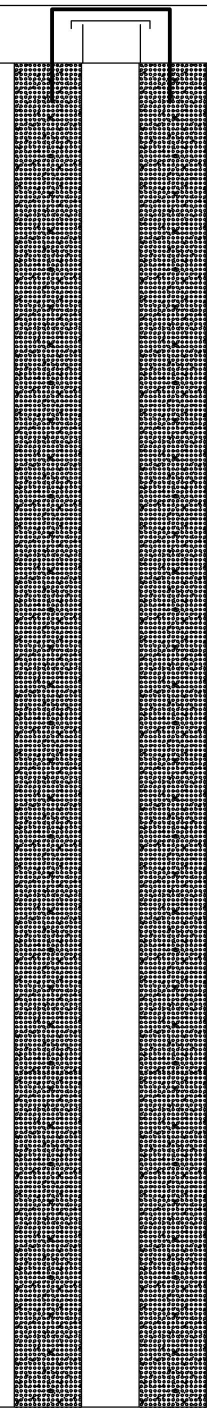
Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
90		(86' to 93' bgs) Bentonite seal	
95			
100		(93' to 106' bgs) Sand filter pack (95' to 105' bgs) Slotted PVC	
105			
	Bottom of borehole at 106.0 feet.		
110			
115			**DEVELOPMENT NOTES** For well development details see Table 3.
120			
125			
130			

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	April 24, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	256.6 ft MSL	**GROUT TYPE/QUANTITY**	Aquagard / See Tables 1,1A
TOP OF CASING	259.78 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface 0.0 - 22.0 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}	(0' to 43' bgs) Aquagard Portand cement grout	For material quantities see Tables 1,1A.
22	22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		DEVELOPMENT NOTES For well development details see Table 3.
30	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		



Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

WELL SM-35B

Golder Associates

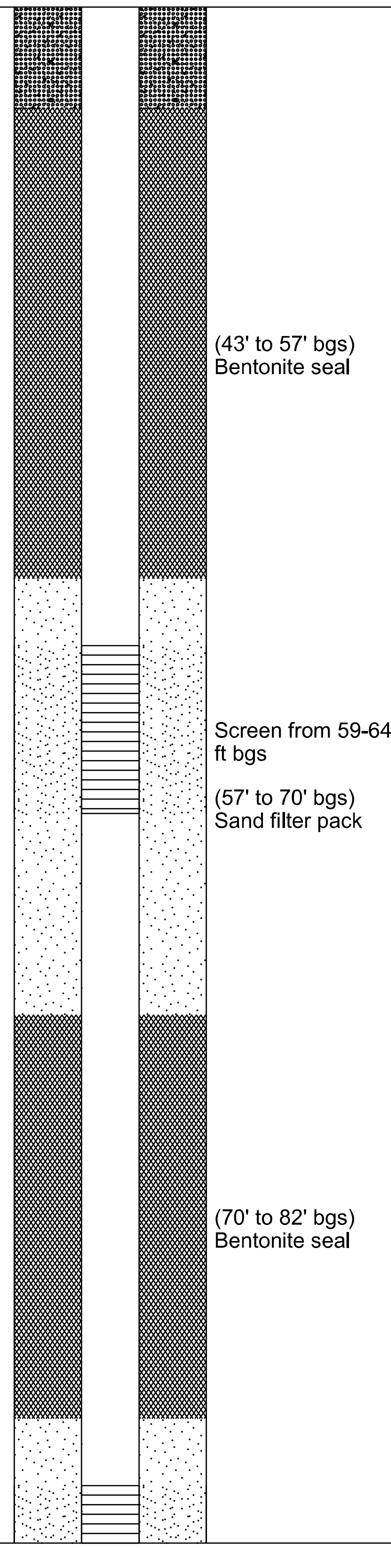
PROJECT NUMBER 11390080 **DATE STARTED** April 24, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
60	60.0 - 60.5 Slickensided (K), Polished (P), discontinuity at a 50 degree angle with respect to the core axis.		

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75, 80, 85



DEVELOPMENT NOTES

For well development details see Table 3.

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** April 24, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

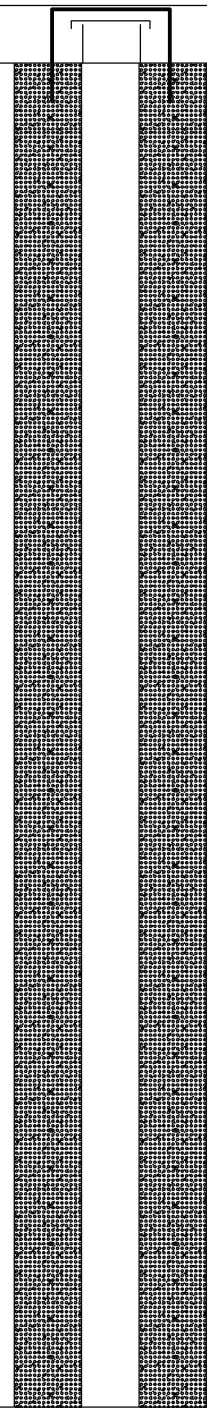
Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)* 85.6 - 86.2 Slickensided (K), Polished (P), discontinuity at a 55 degree angle with respect to the core axis. *(continued)*	(82' to 89' bgs) Sand filter pack Screen from 84-89 ft bgs	For material quantities see Tables 1,1A.
90	Bottom of borehole at 88.8 feet.		
95			
100			
105			
110			
115			DEVELOPMENT NOTES For well development details see Table 3.
120			
125			
130			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	January 12, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	192.4 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	195.08 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface 0.0 - 10.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		For material quantities see Tables 1,1A.
5			
10	10.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		
15			
20			DEVELOPMENT NOTES
25			For well development details see Table 3.
30	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		
35		(0' - 66' bgs) pure gold cement bentonite grout	
40			



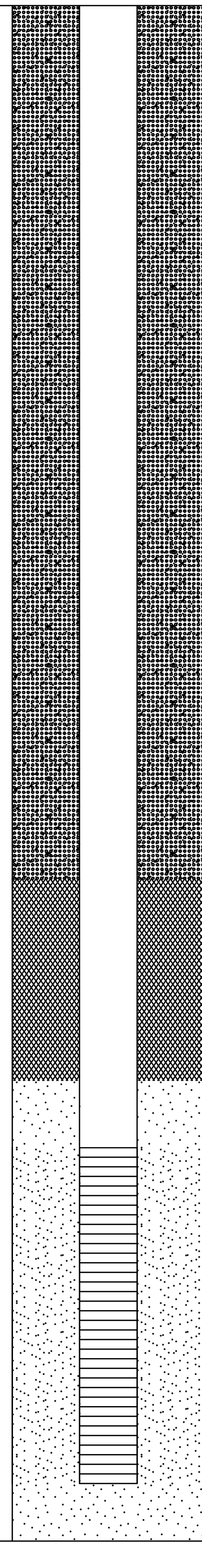
WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

Golder Associates

PROJECT NUMBER 11390080
DATE STARTED January 12, 2012
PROJECT NAME Chemical Waste Management
BOREHOLE DIAMETER 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
45			
50			
55			
60			
65			
			DEVELOPMENT NOTES
70		(66' - 70' bgs) bentonite seal	For well development details see Table 3.
75	74.0 - 74.4 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis. 75.3 - 75.7 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		
80		(70' - 84' bgs) sand filter (74' - 84' bgs) slotted PVC	
85			



WELL SM-36

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** January 12, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

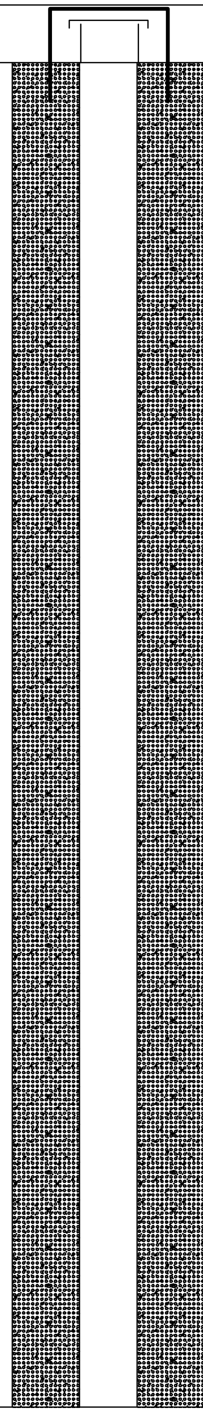
Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	Bottom of borehole at 87.3 feet.		For material quantities see Tables 1,1A.
90			
95			
100			
105			
110			
115			DEVELOPMENT NOTES For well development details see Table 3.
120			
125			
130			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	January 9, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	194.9 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	198.08 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface		
0	0.0 - 5.0 Stiff, moist, gray tan, CLAY, trace medium to coarse sand, trace fine gravel (rock fragments). [Soft Weathered Chalk] {FILL}		For material quantities see Tables 1,1A.
5	5.0 - 22.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		
10			
15			
20			
22	22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		**DEVELOPMENT NOTES** For well development details see Table 3.
25			
30	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		
35			
40			



WELL SM-37

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** January 9, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

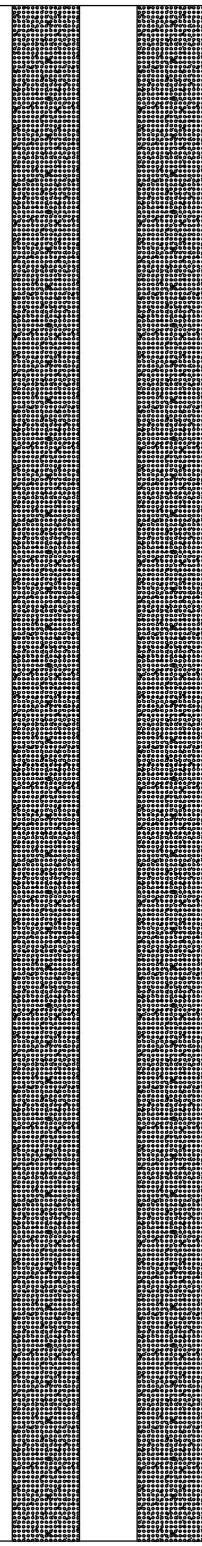
Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
45			
50			
55			
60			
65			
			DEVELOPMENT NOTES
70			For well development details see Table 3.
	70.8 - 71.2 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.		
	71.3 - 71.7 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.		
75		(0-140.5' bgs) Pure Gold cement bentonite grout	
	73.3 - 73.7 Calcite fused discontinuity at a 15 degree angle with respect to the core axis. Only apparent when mechanically broken.		
80			
	83.0 - 83.4 Calcite fused discontinuity at a 18 degree angle with respect to the core axis. Only apparent when mechanically broken.		
85			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

PROJECT NUMBER 11390080 **DATE STARTED** January 9, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
90	83.8 - 84.2 Calcite fused discontinuity at a 30 degree angle with respect to the core axis. Only apparent when mechanically broken. 30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
95			
100			
105			
110			**DEVELOPMENT NOTES**
115			For well development details see Table 3.
120			
125			
130			

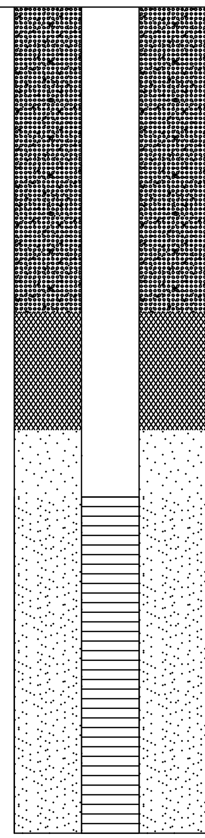
WELL SM-37

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** January 9, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
135, 140, 145, 150	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
155, 160, 165, 170, 175	Bottom of borehole at 156.0 feet.		**DEVELOPMENT NOTES** For well development details see Table 3.

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

TRANSMITTAL

Date:	July 24, 2013	**Project No.:**	1139008005
To:	Clay Messer	**Company:**	ADEM –
From:	Michael Smilley/kds	**Address:**	Groundwater Branch Land Division 1400 Coliseum Blvd Montgomery, AL 36130-1463
cc:			
Email:	msmilley@golder.com		

RE:

MONITORING WELL INSTALLATION AND DEVELOPMENT REPORT

- ☒ Federal Express (priority, standard, 2-day, 3-day)
- ☐ UPS
- ☐ DHL
- ☐ Email ______________________
- ☐ U.S. Mail
- ☐ Courier
- ☐ Hand Delivery
- ☐ Other ______________________

Quantity	Item	Description
1	Letter	Monitoring Well Installation and Development Report Chemical Waste Management Landfill Permit No. ALD 000 622 464 Emelle, AL

Notes:

Please advise us if enclosures are not as described.

ACKNOWLEDGEMENT REQUIRED:

☐ Yes ☒ No

RECEIVED JUL 2013 LAND DIVISION

x:\clients\waste management\11390080 emelle lf\100_correspondence\120 outgoing correspondence\transmittals\adem messer 24july2013.docx

Golder Associates Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341 USA
Tel: (770) 496-1893 Fax: (770) 934-9476 www.golder.com

July 24, 2013 1139008005

Mr. Clay Messer
Alabama Department of Environmental Management
1400 Coliseum Boulevard, P.O. Box 301463
Montgomery, Alabama 36130-1463

RE: MONITORING WELL INSTALLATION AND DEVELOPMENT REPORT
CHEMICAL WASTE MANAGEMENT HAZARDOUS WASTE LANDFILL, EMELLE, ALABAMA
PERMIT NUMBER ALD 000 622 464

Dear Mr. Messer:

Golder Associates Inc. (Golder) has prepared this report on behalf of Chemical Waste Management (CWM) to summarize monitoring well installation and development activities conducted at the CWM Hazardous Waste Landfill (Site) located in Emelle, Alabama. These activities were performed in accordance with information specified in the Permit Modification Request for Installation of the CMI-3 Correction Action Monitoring Well (dated April 16, 2013). The Permit Modification Request includes well installation plans that satisfy requirements specified in the Site Permit No. ALD 000 622 464 Conditions IX.B.1.d and IX.B.1.g.

DRILLING ACTIVITIES

Richard Simmons Drilling installed groundwater monitoring well CMI-3 between June 27 and June 28, 2013 with a CME 45 drill rig with hollow stem auger (HSA) tooling at the location shown in Figure 1. All drilling equipment was steam-cleaned prior to arrival onsite. A Golder field geologist observed drilling, logged samples and soil cuttings, and documented well construction details for the new groundwater well. The boring was advanced using 4.25-inch HSA tooling with continuous standard penetration test (SPT) sampling to the depth determined to be the interface between weathered chalk and unweathered chalk. The interface between the weathered/unweathered chalk was determined based on color; weathered chalk is tan or light brown and the unweathered chalk is grey. The unweathered/weathered interface was identified 18 feet below ground surface (BGS), and the total well depth was 22 feet BGS to screen across the weathered/unweathered Selma Chalk interface. Groundwater was encountered between 6 and 7 feet BGS.

The CMI-3 boring log information is included in Attachment A.

WELL CONSTRUCTION SPECIFICATIONS

Following drilling, CMI-3 was designed to the following specifications:

- **Well Riser:** 2-inch diameter American Society for Testing and Materials (ASTM) Schedule 40 PVC casing and screen with flush-threaded joints and o-ring seals.
- **Well screen:** Ten feet of 0.010-inch factory slotted ASTM Schedule 40 PVC with a bottom cap with sump.
- **Filter Pack:** DSI Filter Sand (i.e., 20-30 mesh) gravity fed to two feet above the screen.
- **Bentonite Seal:** Hole Plug Bentonite seal (hydrated) two feet above filter sand.
- **Grout Seal:** Pure Gold Cement-bentonite grout tremied from top of seal to within two feet of ground surface and allowed to settle and cure. The cement-bentonite grout consisted

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3730 Chamblee Tucker Road
Atlanta, GA 30341 USA
Tel: (770) 496-1893 Fax: (770) 934-9476 www.golder.com

of approximately 5% bentonite powder by weight. This corresponds to 3 to 5 pounds of powdered bentonite per bag of cement.

- **Surface Completion:** Concrete pad 2-feet by 2-feet with locking protective casing, pea gravel and weep hole at base.

An as-built well diagram is included in Attachment A with material quantities.

WELL DEVELOPMENT ACTIVITIES

CMI-3 was developed on June 28, 2013 after the grout cured following well construction by alternately pumping and surging using a submersible 12-volt Proactive Pump. Turbidity was measured during development with a Hach 2100p Turbidity Meter. The development record is included in Attachment B. The final turbidity reading was 17 NTUs.

WELL SURVEYING

A licensed surveyor with Almon Associates, Inc. surveyed well CMI-3 on June 28, 2013. The latitude and longitude were surveyed to the nearest 0.01 foot in the Alabama state plane coordinate system, and the top of casing and ground surface elevations were surveyed to the nearest 0.01 foot relative to mean sea level. Survey data are included in Attachment C.

SUMMARY AND CLOSURE

The requirement to install the well was specified in the Permit Modification Request for Installation of the CMI-3 Correction Action Monitoring Well (dated April 16, 2013). The Permit Modification Request includes well installation plans that satisfy requirements specified in the Site Permit No. ALD 000 622 464 Conditions IX.B.1.d and IX.B.1.g. A professional certification statement is included in Attachment D. Please contact us at (770) 496-1893 with any questions or concerns regarding this report.

Sincerely,

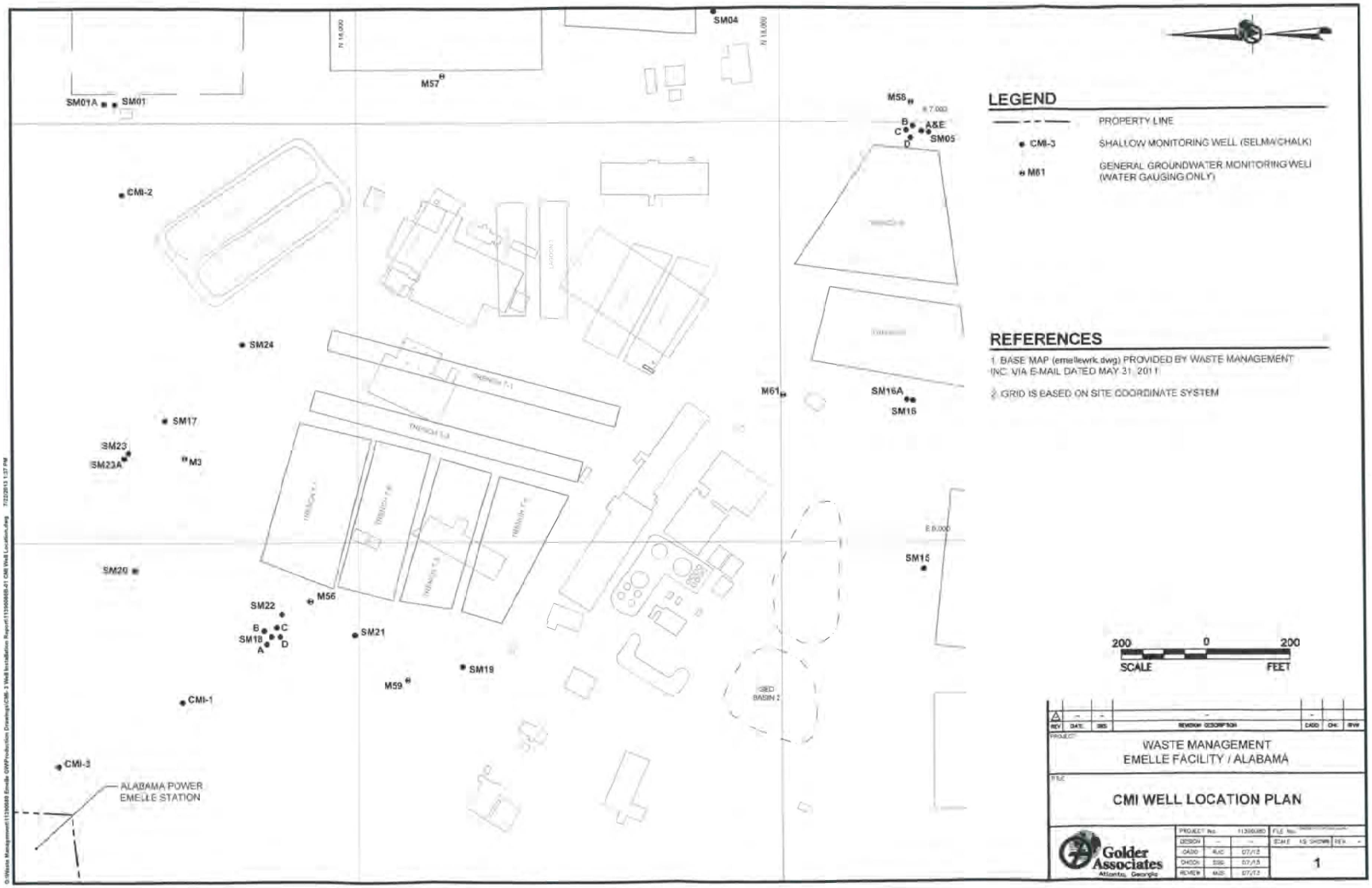
GOLDER ASSOCIATES INC.

Michael Jay Smilley
Project Geologist

Jeffery J.C. Paul, P.G. 796
Principal and Senior Executive

Attachments:
Figure 1 – Monitoring Well Location
Attachment A – As-Built Well Diagram
Attachment B – Well Development Log
Attachment C – Survey Data
Attachment D – Report Certification Statement

FIGURE


SM04
M57
SM01A
SM01
M58
B
A&E
C
SM05
D
CMI-2
SM24
M61
SM16A
SM16
SM17
SM23
SM23A
M3
SM15
SM20
M56
SM22
B
C
SM18
D
A
SM21
SM19
M59
CMI-1
CMI-3
ALABAMA POWER
EMELLE STATION
LEGEND
PROPERTY LINE
CMI-3
SHALLOW MONITORING WELL (SELMA CHALK)
M61
GENERAL GROUNDWATER MONITORING WELL
(WATER GAUGING ONLY)
REFERENCES
1. BASE MAP (emellewrk.dwg) PROVIDED BY WASTE MANAGEMENT INC. VIA E-MAIL DATED MAY 31, 2011
2. GRID IS BASED ON SITE COORDINATE SYSTEM
200
0
200
SCALE
FEET
WASTE MANAGEMENT
EMELLE FACILITY / ALABAMA
CMI WELL LOCATION PLAN
Golder Associates
Atlanta, Georgia
1

ATTACHMENT A

AS-BUILT WELL DIAGRAM

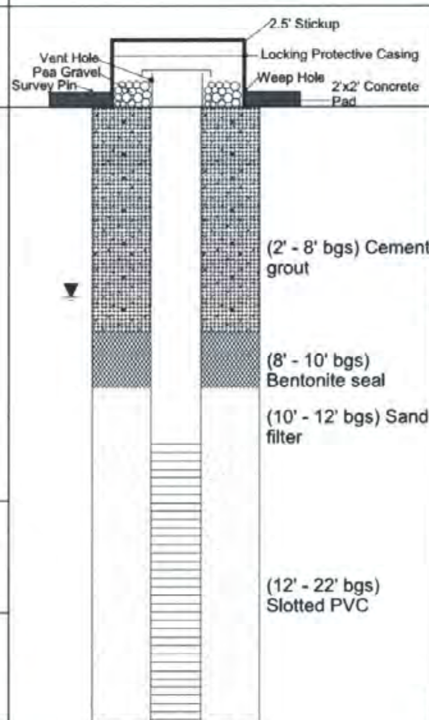
WELL CMI-3

PAGE 1 OF 1

Golder Associates

PROJECT NUMBER 11390080	**DATE STARTED** June 26, 2013
PROJECT NAME Chemical Waste Management	**BOREHOLE DIAMETER** 10.25 inches
LOCATION Emelle, Alabama	**CASING TYPE/DIAMETER** PVC / 2"
DRILLING METHOD HSA	**SCREEN TYPE/SLOT** #10 Slot Schedule 40
SAMPLING METHOD Split-Spoon Sampler	**FILTER PACK TYPE /QUANTITY** DSI Filter Sand / 5.5 cubic feet
GROUND ELEVATION 173.96 ft MSL	**GROUT TYPE/QUANTITY** Pure Gold cement bentonite / 3 cubic feet
TOP OF CASING 176.41 ft MSL	**DEPTH TO WATER** 6.81 ft BTOC
LOGGED BY MJS	**GROUND WATER ELEVATION** 169.60 ft MSL
REMARKS	

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface 0.0 - 14.0 Firm, moist, dark gray and tan, mottled, CLAY, trace fine to medium sand.		Well installed following drilling on 6/27/2013. Well constructed with schedule 2" diameter 40 PVC screen and riser. DSI filter sand to 2' above screen. 1 bag pelletized bentonite installed 2' above sand and hydrated. Cement-bentonite grout tremied to two feet below ground surface. Well completed with 2x2' concrete pad and locking protective casing. Three protective bollards were placed around the well.
5			
10			
15	14.0 - 18.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		
20	18.0 - 22.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		**DEVELOPMENT NOTES**
25	Bottom of borehole at 22.0 feet.		CMI-3 developed on 6/28/2013 after grout dried. Depth to water prior to development was 6.81 feet below top of casing. Total well depth prior to development was 22.0 feet below top of casing. Approximately 180 gallons were removed during development. Final turbidity was 17.0 NTU.
30			
35			
40			



JENN'S LOG EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 7/22/13

ATTACHMENT B

WELL DEVELOPMENT LOG

WELL DEVELOPMENT FIELD RECORD

Job Name CWM / Emelle / CMI-3 Job No. 11390080 Well No. CMI-3

Developed By M. Smilley Date Of Installation 7/28/2013 Sheet 1 Of 1

Started Development 7/28/2013 / 1155 (DATE / TIME) Completed Development 7/28/2013 / 1425 (DATE / TIME)

W.L. Before Development 6.81 ft bgs 1135 7/28/2013 (DATE / TIME) After Development 6.83 1435 7/28/2013 (DATE / TIME)

Well Depth:

Before Development 22.0 After Development 25.37 Well Diameter 2 in.

Standing Water Column (Ft.) 18.54 Standing Well Volume 3.0 gal.

Screen Length 10 feet Drilling Water Loss NA gal.

DATE/TIME	VOLUME REMOVED (GALS)	FIELD PARAMETERS SPEC.COND. (unhos/cm)	TEMP (C)	pH (s.u.)	TURB. ~~OTHER~~ (NTU	REMARKS
/ 1300	55	NA	NA	NA	>1000	
/ 1305	65	↓	↓	↓	>1000	* Surged well
/ 1315	75				>1000	
/ 1330	110				>1000	
/ 1335	125				434	
/ 1340	130				109	
/ 1345	135				93	
/ 1400	150				764	* Surged well
/ 1405	155				341	
/ 1410	160				36	
/ 1415	170				17	
/ 1420	180				17	
/ 1425	DEVELOPMENT COMPLETE					
/						
	180	= TOTAL VOLUME REMOVED (gal.)				

DEVELOPMENT METHOD: Alternately pumping and surging using a submersible Proactive Pump.

NOTES:

ATTACHMENT C

SURVEY DATA

Almon Associates, Inc.
P.O. Drawer 2729
Tuscaloosa, AL 35403

2008 12th Street
Tuscaloosa, AL 35401

phone: 205.349.2100
fax: 205.349.2107
web: www.almonassociates.com

Asbuilt Date: 6/28/2013

West Well

CMI-3

Point#	Northing	Easting	Elevation	Description
4041	14712.03	5470.14	173.96	Brass Cap
4042	14712.42	5468.91	176.41	Top Inner Pipe
4043	14712.42	5468.91	176.83	Top Outer Cap

East Well

CMI-2

Point#	Northing	Easting	Elevation	Description
4044	14560.58	6829.95	174.63	Brass Disk
4045	14560.18	6829.53	177.41	Top Outer Cap
4046	14560.18	6829.53	177.07	Top Inner Pipe

ATTACHMENT D

REPORT CERTIFICATION STATEMENT

PROFESSIONAL CERTIFICATION STATEMENT

I certify that I am a qualified groundwater scientist as defined in ADEM Administrative Code R. 335-13-1-.013(125) who has "received a baccalaureate or post-graduate degree in the natural sciences or engineering and has sufficient training and experience in groundwater hydrology and related field as may be demonstrated by state registration, professional certification, or completion of accredited university programs that enable that individual to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and corrective action."

I further certify that this well installation report has been prepared under my direction and that the interpretations conform to sound professional judgments.

GOLDER ASSOCIATES INC.

Jeffery J.C Paul, P.G.
Alabama Professional Geologist No. 796

APPENDIX E-9

SECTION E

CWM MANUAL FOR GROUNDWATER SAMPLING

Revision No.

5.0

APPENDIX E-9

SECTION E

LIST OF DOCUMENTS

Document 1: Chemical Waste Management, Inc., Manual for Groundwater Sampling, Version 1.1, Revised June 2010.

CHEMICAL WASTE MANAGEMENT INC.

MANUAL FOR GROUNDWATER SAMPLING

November 2009
Revised June 2010

Version 1.1

MANUAL FOR GROUNDWATER SAMPLING

1.0 MANUAL FOR GROUNDWATER SAMPLING OVERVIEW

The Manual for Groundwater Sampling (MGWS) outlines the requirements for groundwater sample collection at the Chemical Waste Management Inc. (CWM) Emelle, Alabama facility. This MGWS is derived, in part, from the guidelines set forth in the following Environmental Guidance Documents:

ADEM Alabama Environmental Investigation and Remediation Guidance (2005)

USEPA Region 4 SESDPROC-301-R1, Groundwater Sampling (2007)

As well as other industry guidelines, practices, and published standards (e.g., ASTM).

The site sampling technician and/or consultant (sampling team) is responsible for the proper collection of samples at groundwater sampling points at the Emelle, Alabama facility. The sampling team must be familiar with the contents of this MGWS prior to the initiation of a sampling event. The sampling team is also responsible for ensuring that all sampling requirements described in the site's operating permit are complied with in full.

It is the responsibility of the sample team leader to confer with the designated environmental representative of CWM prior to initiation of sampling. The sampling team is responsible for meeting all safety related regulatory requirements when sampling groundwater and should meet with the site manager prior to sampling to identify and address any site-specific safety requirements.

It is the CWM Environmental Representative’s responsibility to ensure that sampling is conducted in accordance with this MGWS, and that this MGWS is made available to the sampling team. It is the sampling teams’ responsibility that sampling methodologies and protocol are performed in accordance with this MGWS.

Questions or comments on the MGWS should be directed to the designated CWM Environmental Representative.

2.0 MGWS REVIEW REQUIREMENT

This MGWS must be reviewed by all sampling team members prior to initiation of routine or special groundwater sampling events at the Emelle, Alabama facility. All sampling team members must sign a Signature Page, verifying that they have read and understand this MGWS and note any exceptions to the MGWS. A copy of the Signature Page is presented in Attachment 1. **The completed Signature Page(s) must be maintained on file at the facility and updated whenever there is a new sampling team, sampling team member, or there are documented changes to the sampling program that affect this MGWS.** A copy of the signed signature should be retained by sampling personnel. All well construction information and documentation of completed sampling events should be filed and available at the facility.

In the event that unique conditions encountered during an individual sampling event necessitate a deviation from the MGWS as described herein, the sampling team leader must coordinate with the CWM Environmental Representative and document any such deviation.

3.0 SAMPLING EQUIPMENT, PRE-SAMPLING PROCEDURES, AND DOCUMENTATION

Before sampling is performed at the facility, the sampling team must complete a number of preliminary tasks which include:

- Verifying that no changes have been made to the sampling plan,
- Reviewing the site permit and this MGWS,
- Reviewing the laboratory bottle order documentation,
- Confirming well/sample point locations and characteristics and sampling point order,
- Identifying the parameters to be analyzed,
- Identifying any short hold time samples (< 5 days hold time) and coordinating sample delivery with the laboratory,
- Coordinating the sampling schedule with the site and laboratory,
- Preparing or procure calibration standards and calibrating field meters,
- Preparing non-dedicated sampling equipment and power supplies (if applicable),
- Procuring sampling supplies (gloves, deionized water, etc.),
- Procuring necessary field documentation forms and collecting historical field data.
- If non-dedicated sampling equipment is to be used, determine the order wells will be sampled based on the presence of contamination (i.e. the wells with non-dedicated equipment should be sampled from the least contaminated to the most contaminated).

Pre-sampling activities should begin at least two weeks prior to a routine sampling event. For unplanned sampling events (Special Events), coordinate as appropriate with the site and laboratory. A Special Event Notification Form is shown in Attachment 2. This form will aid in communicating and coordinating special event requirements with the laboratory.

3.1 Scheduling and Communication

3.1.1 Site Notification

The sampling team must communicate with the CWM Environmental Representative to ensure access to the facility before the sampling event so that the event may proceed on schedule.

3.1.2 Laboratory Notification

The designated CWM Environmental Representative is responsible for arranging sample container shipment from the laboratory in a timely manner and for ensuring that the laboratory has the correct shipping address/location.

3.1.3 Short Hold Time Samples

Any samples with hold time of < 5 days should be noted in advance of sampling, and the laboratory should be contacted to coordinate sample delivery or courier pick-up at the site to allow for sample analysis within the hold time.

3.2 Field Equipment and Supplies Preparation

All non-dedicated field equipment should be cleaned and/or decontaminated, checked to ensure that it is functioning properly, and calibrated before going in the field. Quality Control procedures (e.g. equipment blanks) are discussed in Section 4.2.5.

3.2.1 Site Related Monitoring Requirements

The sampling team should keep copies of relevant portions of the MGWS in the sampling vehicle for reference in case of questions about procedures and sampling requirements. Copies of the Field Information Forms (FIFs) from the previous sampling event should be available for reference.

3.2.2 Dedicated Pumps

All groundwater wells at the Emelle, Alabama facility are equipped with dedicated pumps. The Detection Monitoring Program well system (Eutaw Aquifer), which consists of wells RCRA-6, RCRA-7, RCRA-8, RCRA-9, and RCRA-10A, are equipped with dedicated high flow-rate submersible pumps for purging and dedicated, air-operated, bladder-type pumps (installed approximately 10 to 20 feet below the submersible pump) for sample collection.

The Selma Chalk Groundwater Surveillance Program well system, which consists of an array of fifty-two (52) wells (designated as SM-wells), are equipped with dedicated, air-operated, bladder-type sampling pumps.

3.2.3 Non-Dedicated Pumps

Non-dedicated pumps must only be used on a temporary basis with approval from the designated CWM Environmental Representative. Conditions that could warrant the use of a non-dedicated pump include immediately after a new well is installed (prior to order and installing a dedicated pump) or when the dedicated pump is not functioning properly to collect a sample. When non-dedicated pumps or sampling devices are used, stringent cleaning procedures must be followed between sampling locations (see Section 3.3). Plastic sheeting must be placed on the ground around the well to provide a clean working area, and equipment blanks must also be obtained in accordance with Section 4.2.5 of this MGWS.

Non-dedicated pumps used for purging may consist of a variety of pumps including peristaltic, submersible turbine, bladder, centrifugal, gear-driven positive displacement, or other appropriate pumps. When a non-dedicated pump is required, bladder pumps constructed of Teflon® and stainless steel or PVC are preferred. Pumps without check valves, or other mechanisms to prevent backflow should not be used during purging. The pump inlet should be set as close to the middle of the well screen as possible. If a non-dedicated pump other than a bladder pump is used, all components of the pump that come in contact with the sample water should be constructed of Teflon® or stainless steel.

3.2.4 Power Supplies

- Power supplies (e.g., generators, compressors, batteries, voltage inverters) should be tested to confirm proper operation prior to going to the site.
- Power supplies that require fuel or lubricants must be transported in a manner to prevent sample equipment contamination.

- Power supplies and any fuel or lubricants must be isolated from sample coolers and sampling equipment and supplies throughout the sampling event.

3.2.5 Bailers

Bailers are only to be used on a temporary basis if it is determined by the CWM representative that the existing dedicated pumps are not functioning properly and are unable to be used to collect a groundwater sample. In the event that bailers are used, only disposable, closed-top, Teflon® bailers (or the equivalent) with bottom valves should be used. If a bailer is to be used, plastic sheeting shall be placed on the ground around the well to provide a clean working area.

When bailers are used, the bailer cord shall be fastened securely to the bailer and shall be constructed of nylon, stainless steel, or polypropylene, and be specifically manufactured for use in collection of environmental samples. This cord must be new, clean, and in good condition. Rope, twine or other "off-the-shelf" cord shall not be used for securing the bailer.

3.2.6 Instrument Condition, Calibration, and Standards

The proper measurement and documentation of field analyses are a critical part of the monitoring program. Before going to the field, all equipment must be cleaned and checked for any malfunctions. The sampling team must calibrate all meters each morning before using them in the field following the manufacturers' calibration procedures. In the absence of manufacturer guidance, field equipment should be calibrated to within +/- 5% of the standard (or 0.1 standard units for pH meters).

Equipment calibration shall be conducted daily at a minimum during sampling events. Calibration solutions must be freshly prepared or bottled from non-expired bulk containers. If using field analytical equipment from a rental vendor, the sampling team must request enough calibration solution from the rental vendor to calibrate at least daily. Calibration of field specific conductance should be verified against a chilled standard to verify temperature compensation.

Equipment that fails calibration should be taken out of service and replaced or repaired prior to sampling. It is recommended that calibration checks be conducted periodically (e.g. mid-day and at the end of the day) to document any instrument drift. If there is significant instrument drift (e.g. >10% or 0.2 standard units for pH) then the meters should be recalibrated. In all cases, it is the sampling team's responsibility to ensure proper documentation of all calibration procedures for each sampling event, including calibration methodology (one or two point calibration), calibration measurements, source of standard, standard concentration(s) and expiration date, and any discrepancies.

It is the sampling team's responsibility to document the calibration of field instruments and verify that field instruments are performing within design parameters for the instrument. Sampling should not occur if field instruments are not working properly. Verification of field meter calibration is to be recorded on the Meter Calibration Log, included in Attachment 3. Meter Calibration Logs should be maintained and kept with the Field Information Form and Chain-of-Custody form for each sampling event. These forms may be maintained separately on site as requested by CWM.

3.2.7 Sampling Supplies

The sampling team should procure all field supplies prior to arriving at the site for the sampling event. These supplies should include:

- Gloves – non-powdered nitrile is preferred; non-powdered latex can be used. Powdered and PVC gloves should not be used to prevent possible sample contamination.
- Deionized (DI) water of known chemistry for field decontamination.
- Disposable laboratory wipes or similar.
- Purge water buckets of known capacity.
- Graduated cylinder, beaker or other measuring container for determining flow rate from pumps.

3.2.8 Sample Coolers and Sample Bottles

The CWM Environmental Representative is responsible for arranging the sample container shipment from the laboratory in a timely manner (at least two weeks in advance) and for ensuring that the laboratory has the correct shipping address/location. At least two days before traveling to the site, the sampling team should contact the site to confirm that the sample coolers and containers have arrived from the laboratory. Upon arrival to the site and before initiating any sampling activities, the sampling team must inspect the bottle order and verify that all required sample containers are present. The sampling team leader must contact the laboratory if any sample coolers or containers are missing or broken. The sampling team is also responsible for obtaining proper ice packs (i.e. frozen water ice in plastic bags) prior to the sampling event. The sample coolers will not contain ice packs upon receipt from the laboratory. Ice packs must be in the sampling coolers when samples are collected. Ice bags and sample coolers must not leak water. Express carriers will reject shipments that are leaking. It is important that sample coolers and bottles be stored, transported, and handled in a manner that prevents exposure to solvents, cleaners, gasoline, diesel fuels, exhaust, or other potential contaminants.

Upon receipt, an inventory of the coolers and bottles and their condition should be noted in field notes and documented on the Field Information Form. Each sample bottle is provided with its own bottle I.D., which refers to the laboratory group, preservative type, sample point/location, analytical method, and bottle size. This information must be checked, verified, and included on Field Information Forms and Chain-of-Custody records. Should an error occur within the bottle set, the laboratory must be notified immediately.

The laboratory will provide and determine the proper number of sample containers in each sample cooler, unless otherwise specified or requested by the CWM Environmental Representative. The type of bottle will vary depending on the analysis required. Each sample bottle either is provided with a label or is labeled with a sticker to identify the preservative type.

Each sample cooler that includes bottles for volatile organic analyses must include a Trip Blank (see Section 4.2.5 of this MGWS) unless otherwise specified by the CWM Environmental Representative. When volatile organic analyses have been requested, the sample cooler will contain a Trip Blank regardless of whether a request has been placed for the analysis of the Trip Blank. An effort to pack all

VOAs in one cooler should be made to reduce trip blank costs. Prior to shipment, the Laboratory checks each Trip Blank vial to ensure that it has no air bubbles. If large (i.e., pea sized) bubbles are present, utilize the initial trip blank and note the bubble size on the field information forms.

Empty bottles will be included within the sample cooler for Field Blanks (duplicates and equipment blanks if necessary) analyses (see Section 4.2.5). The sampling team should coordinate with the laboratory to identify the number of Field Blanks required for sampling. Duplicates will be analyzed on an as-requested basis only.

3.3 Decontamination Procedures for Non-Dedicated, Down-Hole Equipment

All non-dedicated, sample-contacting and down-hole equipment must be thoroughly decontaminated prior to its use in sample collection activities. This includes non-dedicated pumps, non-dedicated bailers, groundwater level measurement devices, and field parameter measurement devices. The sample team shall have a water level probe that is dedicated to groundwater monitor well use only. Unless otherwise required, no other non-dedicated downhole equipment should be used during sampling. Under no circumstances shall the groundwater level measuring probe be used to measure other liquid levels (such as leachate or grossly contaminated wells).

Decontamination procedures of down-hole equipment must, at a minimum, consist of washing with an acceptable cleaning liquid followed by a series of rinses (i.e. 2 to 3) with control water (i.e. water of a known chemistry) and one rinse with deionized water.

Acceptable cleaning liquids include phosphate-free laboratory detergent (e.g., Liquinox®), pesticide-grade isopropanol, deionized water, and tap water obtained from any municipal water treatment system (only used if other acceptable cleaning liquids are not available).

Decontamination of non-dedicated pumps must, at a minimum, consist of circulation of three pump and tubing volumes of clean water through the pump system and all associated discharge tubing at separate stations. A series of three pre-cleaned liquid storage containers will aid in this respect. The first container should contain an acceptable cleaning liquid (i.e., phosphate-free detergent). The remaining two should consist of water of a known chemistry. Specific decontamination procedures for the various types of non-dedicated pumps and associated materials can be found in the *ADEM Alabama Environmental Investigation and Remediation Guidance (2005)*, or most current version at the time of sampling. In order to reduce the amount of decontamination needed when using non-dedicated equipment, all disposable elements of the sampling equipment (e.g., tubing) should be disposed of between sampling points.

If non-dedicated purging/sampling equipment is used, Equipment Blanks must be collected following decontamination based on a schedule of one sample for each day of sample collection when the non-dedicated equipment is being used (see Section 4.2.5). Equipment Blanks will be analyzed for all sample matrices, analytical tests, and equipment configurations.

Other non-dedicated equipment including water level indicators and field analytical equipment should be decontaminated between sampling events and between individual wells during sampling events. Between sampling events, non-dedicated water level indicators should be washed with phosphate-free soap and tap water and then rinsed with tap water. Following the wash, they should be rinsed with analyte-free water and allowed to air-dry overnight. Once the water level indicator is dry, it should be wrapped in aluminum foil, sealed in plastic, dated, and stored in a non-contaminated area until the next sampling event. Field instruments for in-situ water analysis (if not obtained each event from a equipment rental vendor) should be wiped with a clean, damp cloth. The probes should be rinsed with analyte-free water and air-dried. Any desiccant in these instruments should be checked and replaced, if necessary, each time the equipment is cleaned. After cleaning, the field instruments should be stored in manufactures-provided case in a non-contaminated area until the next sampling event.

Non-dedicated water level indicators and field analytical equipment should be decontaminated between wells during individual sampling events. The water level indicator should be decontaminated while retrieving it from the well after collecting the water level depth information. A clean, soft, cloth soaked in a phosphate-free detergent and analyte-free water mixture should be wrapped around the water level tape and held in place by the sampler. Once the cloth is in place, the water level tape should be retracted back out of the well such that the tape runs through the cloth before reaching the water level indicator spool. The cloth should be re-soaked in the detergent mixed after 50-feet of tape is retracted and placed back around the water level tape, and this should continue until the water level is completed removed from the well. Once the water level indicator is completely removed from the well, it should be placed in a plastic bag and transported to the next sampling location.

Field analytical equipment should be wiped with a clean, damp cloth between sampling locations. The probes should be rinsed with analyte-free water after used at each well and the equipment should be placed back in the manufactures-provided case and transported to the next sampling location.

3.4 Field Record Keeping

Proper chain-of-custody documentation is a crucial part of the monitoring program's quality assurance and quality control (QA/QC). Comprehensive, consistent, and accurate documentation of field tests, measurements, decontamination procedures, meter calibration, and field observations is extremely important.

During each sampling event, the sampling team must fill out two forms: (1) Field Chain-of-Custody Record and (2) Field Information Form. The original copy of each form must be sent with the samples to the laboratory. **Under no circumstances should samples be shipped or analyzed without these forms.** The forms are returned to CWM with the analytical report. Copies of all forms are also to be maintained at the facility for easy reference. Sampling teams should keep a copy of the forms for their records. Examples of the approved Chain-of-Custody's and CWM Field Information Forms are provided as Attachment 5.

All field notes and forms must be completed with indelible black or blue ballpoint ink only. Pencils and felt-tip pens should not be used. Corrections should be made by striking through the error with a single line, writing in the correction, and dating and initialing the changes.

3.5 Field Notes

3.5.1 Field Information Forms

The Field Information Form contains information regarding site and well conditions, sampling and purging procedures, and field measurements. The Field Information Form must be filled out by the sampling team for each sample point and a copy placed along with the Chain-of-Custody Record in the cooler(s) shipped to the laboratory. At a minimum, the following must be documented on Field Information Forms:

- **Site Information:** Site Name, Site Number (from the CWM Representative), and Sample Point.
- **Purging Information:** Date, time, elapsed time, water volume in casing (for a 3 volume purge), required purge volume, and actual volume purged.
- **Purging and Sampling Equipment:** Dedicated equipment, pump type, tubing material, and size, etc.
- **Well Data:** Sample point elevation (use State/permit specified datum (e.g. NGVD), depth to water, and calculated groundwater elevation are required. Total depth (when required) stickup, and casing diameter and material should also be noted.
- **Stabilization Data:** depth to groundwater elevation and field measurements should be recorded to verify parameter stabilization or once per each casing volume for a multiple volume purge.
- **Field Data:** Sample date, and the final field measurements, prior to sampling, should be recorded in this section. Other field parameters such as dissolved oxygen, turbidity, and redox potential (note the unit value) should also be recorded, as necessary.
- **Field Comments:** Field observations should be recorded as noted in Section 3.5.2.

The Field Information Form has optional fields for recording parameter stabilization data during minimal drawdown sampling or for recording multiple field measurements as required by sampling protocol (e.g. a 3 volume purge) or by permit. Section 3.6 provides a more detailed discussion on collecting field measurements and Section 4.0 provides more detail for recording purge data.

The **Field Comments** section of the Field Information Form should include observations such as:

- Weather conditions: wind direction, speed, upwind activities (ensure that vehicles/gasoline compressors are not upwind of sampling activities), temperature, and barometric pressure (as required by the permit).
- Problems with condition of the well and/or dedicated equipment.
- Sample Appearance including odor, color, and turbidity,

Odor:	e.g. rotten eggs, earthy, strong, moderate, slight (do not sniff sample). Describe the characteristics of the odor, do not speculate as to the cause of the odor.	
Color:	Note the color of the sample.	
Turbidity:	(regardless of whether turbidity measurements are taken):	
	None:	sample is clear.
	Trace:	sediment slightly clouds or colors the sample; sediment does not accumulate in the bottle.
	Moderate:	definite cloudiness, sediment accumulates at the bottom of sample bottle.
	High:	muddy/dark brown appearance.

In general, a turbidity-measuring device should be used and measurements be provided in nephelometric turbidimetry units (NTU's). Section 4.2.1 provides additional guidance on turbidity.

Record all calculations for purge volumes (see Attachment 4) and temperature conversions, if necessary. Note when wells are purged dry (this will likely be the case for all Selma Chalk Surveillance wells) or why the required casing volumes were not removed. Other factors, such as collection of a duplicate sample, field blanks, sample splits with regulatory agencies, potential safety or health hazards (e.g., fire ants, bees, presence of landfill gas in well) should be noted in the comments field. Note whether sampling occurred downwind from site disposal or other activity that could affect sample results. Record the names and affiliations of all observers and have all sampling team members write their name and sign the Field Information Forms.

Sampling Certification: On the bottom of the Field Information Form, the sample team leader must sign the form certifying that the sampling procedures were in accordance with the site permit and this MGWS. The person(s) providing the sampling certification assumes full responsibility that the sample process satisfied the above criteria.

3.5.2 Well Condition Inspection Forms

The condition of the well and its surrounding area must be observed and problems and changes recorded on the Well Condition Inspection Forms (included in Attachment 6) upon arrival at the well location. Conditions that may affect sample integrity, such as a damaged well casing, should also be recorded on the Field Information Form.

Wells should not be sampled if it is suspected that the integrity has been compromised either due to damage, natural conditions or tampering. If these conditions exist, do not sample, and notify CWM immediately. Upon completion of the sampling event, provide the Well Condition Inspection Forms to the CWM Environmental Representative. It is the responsibility of sampling personnel to notify the CWM Environmental Representative of well maintenance or well condition problems.

3.5.3 Chain-of-Custody Record

Strict chain-of-custody procedures are necessary. From the time the sample bottles leave the laboratory until the issuance of the analytical laboratory results, the samples and/or sample containers must be in the custody of assigned CWM personnel, an assigned agent, or the laboratory. A written record of sample bottle possession and any transfers of samples must be maintained and documented on the Field Chain-of-Custody Record.

The Sample Chain-of-Custody must contain, at a minimum, the following information:

- Site Name
- Well Identification
- Date Samples are collected
- Time Sample Collected
- Type of Sample (Composite, Grab, Groundwater)
- Number of containers per sample point
- Preservatives
- Analysis Required
- Special Remarks

The Field Chain-of-Custody Record must further be signed with the date and time for the following activities:

- Receipt of the sample cooler(s)
- Each time the sample cooler is transferred to the custody of another person
- Immediately before sealing the sample cooler for transport to the laboratory (The form must be signed and enclosed within the cooler in a watertight bag).

Samples from the same sample point that are placed in more than one sample cooler require a Field Chain-of-Custody Record in each sample cooler. Any problems with the sample cooler's contents must also be noted on the form. Upon receipt of the sample cooler by the lab, the condition of the samples, temperature, date, and time are recorded on the Field Chain-of-Custody Record by the log-in personnel receiving the sample coolers. The Field Chain-of-Custody Record indicates by bottle and analysis group whether samples are preserved. An example of the WM Field Chain of Custody Form is provided as Attachment 5.

3.6 Field Measurements

3.6.1 Static Water Level Measurements

The depth to water and elevation of the water level (MSL or permit/regulatory specified datum (i.e. NVGD)) should be recorded to the nearest hundredth of a foot (i.e. 0.01-ft). Water levels should be collected on the same day prior to purging to produce a representative static groundwater elevation contour map. To alleviate potential errors, previous water level data should be used for comparison purposes during field activities. Water levels are preferably collected prior to purging and as close, temporally, as possible, to minimize interference due to drawdown or barometric pressure effects.

Measuring the depth to the free groundwater surface must be accomplished by utilizing an electronic water level indicator capable of measuring to the nearest 0.01-ft. All water levels must be made to the established surveyed reference point on the well casing. The reference point should be tied in with the site datum (i.e. NVGD). All water levels should be documented on the Field Information Forms.

Non-dedicated water-level indicators should be decontaminated in accordance with Section 3.3 between well locations to avoid cross-contamination.

3.6.2 Depth of Well Measurements

All wells at the facility are equipped with dedicated pump systems; and therefore, require the removal of the pump systems to obtain total depth measurements. Realizing the importance of total depth measurements relative to well integrity but also realizing the possible risk of accidental introduction of contaminants when temporarily pulling a dedicated pump system in the field, the facility will initiate the following measurement procedures.

3.6.2.1 Eutaw Monitoring Wells

The facility will obtain total depth measurements from the Eutaw monitoring wells once every five years initiating within 30 days of the conclusion of the next sampling event after the permit has been issued by ADEM.

When total well depth measurements are collected from the Eutaw monitoring wells, they will first be compared to the original construction depths recorded at the time of installation. If the measured depths are comparable to the original construction depths, the wells will be considered in good operating condition. Wells with more than 30% of screen occlusion will be redeveloped to remove sediment. Should redevelopment prove unsuccessful, and the well is determined to be comprised, efforts will be made to repair the well and ADEM will be informed of the well status. All activities related to total well depth investigations will be documented by CWM personnel and submitted to ADEM if necessary.

3.6.2.2 Selma Chalk Wells

The facility will initially obtain total depth measurements from the Selma chalk wells within 30 days of the conclusion of the next sampling event after the permit has been issued by ADEM. After the initial total depth measurements, the facility will obtain total well depths from Selma Chalk wells when there is a visible/significant increase (100 NTU or higher) in turbidity within the well.

When elevated turbidity (> 100 NTU) in the Selma Chalk wells is observed, CWM will redevelop the well. Should redevelopment prove unsuccessful, and the well is determined to be comprised, efforts will be made to repair the well and ADEM will be informed of the well status. All activities related to total well depth investigations will be documented by CWM personnel and submitted to ADEM if necessary.

When collected from the Selma Chalk wells, the well depth measurements should be compared to the pump intake depths. The pump intake should be located at the middle of the screen or lower, depending on the screen length and well recharge characteristics, maintaining a minimum of two feet (where possible) between the pump intake and the bottom of the well. This will not apply to the Eutaw monitoring wells because the pump intakes are located below the static water level, but less than 100 feet below ground surface. It is the sampling team's responsibility to notify the CWM Environmental Representative if there is suspicion that the pump location within a Selma Chalk well is not appropriate for collecting representative samples. The CWM Environmental Representative or designate (i.e. sampling team) is responsible for evaluating and responding to excessive sediment accumulation and/or pump placement adjustments. Total depth measurements can stir up settled solids, so these measurements should be taken AFTER routine sampling is completed or at some time other than the routine sampling event to prevent high bias/false positive results.
The total well depth measurement techniques, which can be used to determine the total well depth, include the bell sounder, weighted tape, and electronic water level indicators. This is accomplished by lowering the tape or cable until the weighted end is felt resting on the bottom of the well. All total well depth measurements should be made and recorded to the nearest 0.1-ft. All total well depth measurements should be made to an established reference point on the well casing. The reference point should be tied in with the site datum (i.e. NVGD). All total well depth measurements should be documented on the Field Information Forms. Total well depth measurements should be compared to previous total depth measurements and the construction depth of the well.

When pulling a dedicated pump system in order to collect a total depth measurement, special care should be used by the sampling team to ensure that no component of the dedicated pump system comes in contact with anything other than the sampler's gloved hands. An adequately-sized new plastic bag or sheeting should be used to cover and store the dedicated pump system while the total well depth measurement is being obtained. Once the total well depth measurement is obtained, the dedicated pump should be re-installed, using the same level of care as was used when pulling the pump. The sampling team should inspect the dedicated pump system while it is pulled and document any damaged or significantly worn components of the pump system. This information should be placed on the Well Condition Inspection Forms and communicated to the CWM Environmental Representative.

3.6.3 Additional Measurements

Well casing stickup length (feet), well casing diameter (inches), and material of construction must be recorded on the Field Information Form. The stickup length should be verified, as required, during each sampling event, or if a change in the immediate surroundings has occurred. The condition of locks must also be recorded after every sample event. Other items that should be noted include; any physical alterations to the well, any alterations to the surrounding soils and associated drainage, or any other notable changes in conditions near the well. All such changes and/or observations should be recorded on the Well Condition Inspection Forms.

4.0 GROUNDWATER SAMPLING PROCEDURES

The well purging protocol to be used for each well should be identified prior to commencing sampling activities. The sampling team will need to communicate with the CWM Environmental Representative prior to each sampling event to determine if there have been any changes to the purging protocol for any of the site wells.

The order of purging and sampling of wells should follow site-specific requirements, which should be confirmed by the sampling team prior to conducting sampling activities. In general, known impacted wells should be sampled last if non-dedicated downhole equipment will be used and consideration should be given to wells with short hold-time samples.

The site permit and the CWM Environmental Representative will define the proper method for the disposal of purge water. The sampling team must be aware of the disposal requirements for each sampling event. In cases where the purge water can be discharged to ground surface, it should be discarded far enough away from the well head to prevent the possibility of affecting shallow soils or groundwater near the well.

4.1 Purging Procedures

Purging is the process of removing stagnant water from a monitoring well immediately prior to sampling. Purging is conducted to ensure that all stagnant water has been removed from the well and that collected groundwater samples are representative of actual aquifer conditions. In order to determine when a well has been adequately purged, the sampling team should monitor the pH, specific conductance, temperature, and turbidity of the groundwater removed during purging. In addition, a minimum of 3 to 5 total well volumes should be removed. Prior to purging, the amount of water standing in the water column (water inside the well riser and screen) should be determined. Initially, the sampling team should determine the diameter of the well. The water level and the total depth should then be measured and recorded (refer to Section 3.6). The volume of water to be purged can then be determined by using several methods. One equation is $V=0.041d^2h$, where h = depth of water in feet, d = diameter of well in inches, and V = volume of water in gallons. Alternatively, the purge volume graphs included in Attachment 4 can also be used to determine purge volumes. An adequate purge is achieved when a minimum of 3 to 5 total well volumes of standing water has been removed, and when the pH, specific conductance, and temperature of groundwater have stabilized and the turbidity has either stabilized or is below 10 NTUs. Stabilization of groundwater chemistry parameters occurs when pH measurements remain constant within 0.1 SU, specific conductance varies no more than 10%, and the temperature is constant for at least three consecutive readings. Standard procedure is to collect an initial set of the groundwater chemistry parameters prior to all purging activities, with a set of parameters measured after each well volume has been removed. The conditions of all purging and sampling activities should be noted on the Field Information Forms. If a well is pumped dry (likely all Selma Chalk wells), this is considered an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). It is not necessary to evacuate the well to dryness three times before it is sampled.

After the necessary initial field measurements/observations are made and the depth to water has been determined from every well, the purging process can begin.

4.1.1 Detection Monitoring Program (Eutaw Aquifer)

The dedicated two pump systems installed in the Detection Monitoring Program wells require two-phases of purging prior to groundwater sampling. For the first phase, pump no less than three full well casing volumes using the dedicated submersible pump. **Do not** sample from the submersible pump discharge. Verify that field parameters (pH, conductivity, temperature) become stabilized during the purge. Purge water may be discarded on the ground adjacent to the well unless the well is currently the subject of additional investigations. Wells being investigated or subjected to additional sampling shall have all purge water collected and handled as investigation derived waste. Prior to each sampling event, the sampling team will be responsible for contacting the CWM Environmental Representative to determine if any of the detections wells are currently subject of additional investigations.

Perform the second phase of the well purge using the dedicated sample pump. Pump no less than three times the volume of water within the sample pump configuration. This volume is equal to the length of the sample pump tubing multiplied by the inside area of the tubing plus the volume of the pump. Verify that field parameters (pH, conductivity, temperature) become stabilized during the purge. Stabilization occurs with three successive readings that are within ± 0.1 for pH, ± 10% for conductivity, ± 10 NTU for turbidity, and the temperature is constant.

4.1.2 Selma Chalk Groundwater Surveillance Program

The Groundwater Surveillance Program wells installed in the Selma Chalk require a unique purging process. The transmissivity of the Selma Chalk is extremely low; and therefore, recharge rates into wells installed in this geologic unit cannot sustain purging at any practical rate. As a result, the Surveillance Program wells will be purged dry during every sampling event using the method outlined below.

The air-operated pump should be used to purge the well of all standing water to a depth determined by the pump (i.e. only the groundwater at and above the pump intake will be purged) and well geometry. Purge water may be discarded on the ground adjacent to the well unless the well is currently the subject of additional investigations. Wells being investigated or subjected to additional sampling shall have all purge water collected and handled as investigation derived waste. Prior to each sampling event, the sampling team will be responsible for contacting the CWM Environmental Representative to determine if any of the surveillance wells are currently subject of additional investigations.

The purge will be considered adequate once all groundwater above the pump intake is removed. For these wells, an extended recovery period will be required, as defined during a well recovery investigation conducted by CWM in 1998 (refer to Appendix E-8 Document 3). Once sufficient groundwater has recharged the well, sampling will need to proceed (refer to Section 4.2).

4.2 Sampling the Well

The following section describes the procedures for collecting samples from the Detection Monitoring Program and Groundwater Surveillance Program wells subsequent to purging activities. Methodologies for the collection of field measurements, as well as Field/Equipment and Trip Blanks are also presented.

4.2.1 <u>When Not to Sample</u>

During a sampling event, all scheduled wells must be sampled, except in the following cases:

- If the well has been destroyed or otherwise rendered unsampleable (e.g., casing broken off or severely bent so as to preclude sampling)
- If the well is dry or frozen
- If the well is new and has not been properly developed (pH, temperature, and specific conductance must be stabilized, turbidity minimized, and drilling effects eliminated from the well)
- If the well has extreme turbidity or very high settleable solids

The CWM Environmental Representative should be notified immediately if a well is deemed unable to be sampled due to any of the reasons listed above.

If extreme turbidity prevents a well from being sampled, CWM will take the following actions in sequential order until the turbidity problem is resolved:

- Conduct an extended period of over-purging using the wells dedicated pump system
- Remove the sample pump and collect a total well depth measurement (refer to Section 3.6.2 for procedures on collecting total depth measurements)
- Redevelop the well using a combination of well purging and surging
- Implement a field filtering sampling protocol for subsequent review and approval by ADEM
- Design and install a replacement well (only after all other possible measures have been exhausted)
-

4.2.2 <u>Field Measurements</u>

Field measurements must be collected in accordance with this MGWS during each sampling event. At a minimum, field measurements for pH, specific conductance, turbidity and temperature must be collected at each sample point during purging and as required for sampling.

For the Detection Monitoring Program, purging at each well must continue until the final three consecutive measurements for each parameter agree to within the stabilization requirements outlined in this MGWS (refer to Section 4.1.1). Measurements should be taken at appropriate intervals (based on total volume to be purged) during the purging process to determine stabilization. Measurements must be recorded on the Field Information Form, <u>during purging</u>. Multiple pages can be used when necessary. All extra pages must be copied and reported as designated by the CWM Environmental Representative. All pH meters must provide a reading to the nearest hundredth [e.g. 7.14]. When field measurement errors occur, a line should be drawn through any error or correction, and the entry initialed and dated (this applies to all errors, on any of the field forms or chain-of-custody records, see Section 3.4).

If the values obtained are not within the normal ranges, as indicated on previous Field Information Forms, determine if the readings are the result of inadequate purging, instrument malfunction, or a change in the character of the groundwater. The instruments should be recalibrated as a first check. If after recalibration the values remain abnormal and there appears to be a change in the character of the groundwater, notify the CWM Environmental Representative, who may request that additional samples are collected to ascertain the cause of the abnormal readings. All calibration information must be documented.

Groundwater samples should be collected in the shortest possible time subsequent to purging the well, typically within 24 hours. Exceptions can be made, with CWM approval, to allow sediment to settle out in turbid wells.

4.2.3 Sample Filtration - Reserved

4.2.4 Filing Sample Bottles

Sample bottles should be filled directly from the dedicated sample pump with minimal air contact. Volatile Organic Analyses (VOA) and Total Organic Halides (TOX), and alkalinity (if collected) bottles should be headspace-free (i.e. no air bubbles in the sample bottle).

When filling the sample bottles, the following procedures and precautions should be adhered to:

- Bottle caps should be removed carefully so that the inside of the cap is not touched. Caps should never be put on the ground.
- The sampling team should wear appropriate non-powdered latex or nitrile gloves. Gloves must be changed between wells or on a more frequent basis. Gloves must also be changed any time the sampler leaves the well head area and contacts other equipment, e.g., starting or servicing a compressor or generator.
- Tubing or hoses from the sampling systems must not touch or be placed in the sample bottles nor should tubing or hoses touch the ground; an empty cooler or stable flat surface placed by the well head can assist in facilitating this requirement.
- TOX, alkalinity and VOA vials must be filled so that they are headspace-free. These sample bottles, therefore, need to be slightly overfilled (water tension will maintain a convex water surface in the bottle). The caps for these bottles should be replaced gently, to eliminate any air bubbles in the sample. These bottles must then be checked by inverting them and tapping them sharply with a finger. If any air bubbles appear, open the bottle, add more water, and repeat this process until all air bubbles are gone. Do not empty the bottle and refill it. Do not overfill any containers that have been pre-preserved for any reason. Do not add additional preservatives to these bottles.
- Sample bottles, caps, or septums that fall on the ground should be discarded and new pre-cleaned bottles used. In the event new bottles are not available, before filling the bottle, it must be thoroughly rinsed with sample water before being used. All circumstances regarding dropped caps or bottles, and their subsequent rinsing and use, must be noted on the Field Information Form.
- The sampling team must collect a sufficient volume of liquid to allow for analysis of all required parameters. In the event that an insufficient volume of water exists for collection of the required suite of samples, the sample collection order specified by the CWM Environmental Representative should be followed.
- The sequence of filling bottles should ensure that samples are representative of natural

groundwater conditions. This is accomplished by evenly distributing the discharged water amongst containers by analyte type. For example, all sample vials designated for VOA analysis should be filled prior to proceeding to sample bottles for another analyte type.

- Under no circumstances should bottles (sample or Pre-filtration) or caps not supplied by the laboratory be used for any sampling.
- Samples must be placed in coolers immediately after collection.

All sampling equipment, including pumps, water level measurement equipment, etc., which comes in contact with the water in the well, should be decontaminated in accordance with Section 3.3 of this MGWS.

4.2.5 Quality Assurance; Trip, Field, Equipment Blanks and Duplicates

Trip Blanks, Field Blanks and Equipment Blanks are used to detect constituents that may be introduced in the field (either from the atmosphere or from sampling equipment), in transit to or from the sampling site, in bottle preparation (Quality Assurance), or sample storage at the laboratory. Duplicates are used to confirm analytical results from a given sample point (Quality Control). Upon return to the laboratory, Trip Blanks, Field Blanks, Equipment Blanks and Duplicates will be analyzed using the same laboratory procedures and methods that are used for the collected field samples.

4.2.5.1 Trip Blanks

Trip Blanks are samples of volatile organic-free, laboratory quality water (e.g. Type II reagent grade) that are prepared at the laboratory. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Trip Blank sample bottles are not opened at any time during this process. Trip Blanks are to be reported in the laboratory results as separate samples, using the designations TB- (#) as their sample point designation. If Trip Blank sample bottles are accidentally opened, note this fact on the Field Chain-of-Custody Record.

The frequency of analyses for both trip blanks and field blanks should be in accordance with the facility's permit requirements. If the frequency is not specified, then a minimum of one Trip Blank per cooler (that contains at least one VOA field sample) is recommended. Generally, each sample cooler that includes groundwater samples for volatile organic analyses should include a Trip Blank; however, this number may be reduced. When volatile organic analyses have been requested, the sample cooler will contain a Trip Blank regardless of whether a request has been placed for analysis of the Trip Blank.

4.2.5.2 Field Blanks

Field Blanks are prepared in the field (at the sampling site), using laboratory-supplied bottles and the deionized or laboratory reagent quality water. Each Field Blank should be prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. The well at which the Field Blank is prepared must be identified on the Field Information Form along with any information/observations that may explain any anomalous results (e.g., prevailing winds, upwind sources of potential degradation, etc.). Once a Field Blank is collected, it is handled and shipped in the same manner as the rest of the samples.

Field Blank results will be reported as separate samples; use the designations FB- (#) as their sample designation point. The frequency of analyses for both trip blanks and field blanks should be in accordance with the facility's permit requirements. If the frequency is not specified, then a minimum of one Field Blank for every 10 sampled wells, or one Field Blank per day if less than ten wells are sampled, is recommended. Equipment Blanks can be substituted for Field Blanks with CWM approval.

4.2.5.3 Equipment Blanks

Equipment Blanks are required for all sampling events where non-dedicated downhole (i.e. portable pumps or bailers) equipment may contact the sample. In some cases, if an Equipment Blanks is required, a Field Blank is not collected. Decontamination procedures for non-dedicated equipment are outlined in Section 3.3 of this MGWS. Equipment Blanks for non-dedicated equipment are collected by pouring the deionized or laboratory reagent quality water into or over the sampling device (e.g., the bailer) after it has been properly decontaminated, then pouring the sample into the Equipment Blank bottles. The well at which the Equipment Blank is prepared must be identified on the Field Information Form along with any information/observations that may explain any anomalous results (e.g., equipment type, prevailing winds, upwind sources of potential degradation, etc.). Non-dedicated sampling equipment blanks should be analyzed for all analytes. Blank water should be placed into the Equipment Blank bottles.

Equipment Blank results will be reported as separate samples; use the designations EB- (#) as their sample designation point. A minimum of one Equipment Blank for each day that monitor wells are sampled is recommended.

4.2.5.4 Duplicates and Split Samples

Duplicate samples are collected in the field using a matching set of laboratory-supplied bottles and sampling from the selected well on an as-requested basis. Each Duplicate should be sampled by alternating between the regular sample bottles and the duplicate sample bottles, proceeding in the designated sampling order (i.e. VOAs first). Duplicates should not be physically different in color, turbidity, or other physical parameters. The well at which the Duplicate is collected must be identified on the Field Information Form along with any information/observations that may explain any anomalous results (e.g., physical differences between samples, prevailing winds, upwind sources of potential degradation, etc.). All duplicates should be blind (i.e. the well designation is not listed on the Chain-of-Custody). Once a duplicate is collected, it is handled and shipped in the same manner as the rest of the samples.

Duplicate results will be reported as separate samples; use the designations DUP-(#) as their sample designation point.

Split Samples are collected when co-sampling of a well is conducted with a third party (i.e. ADEM, USEPA, or external consultant). Split Samples should be collected using the same method as a Duplicate, alternating between sample bottles, and proceeding in the designated sampling order. The well at which the Split Sample(s) is collected must be identified on the Field Information Form. The sampling team should coordinate split sample analysis with the CWM Environmental Representative and third party to assure that samples for any additional non-routine analysis are performed (e.g. where third party will perform additional analysis not routinely performed at the site).

NOTE: When samples are split with regulatory agencies, document appropriately on the Field Information Form the condition of the bottles or preservatives, sample collection methods if different from the CWM standard, and the selected agency laboratory.

5.0 SAMPLE PACKAGING AND SHIPMENT

5.1 Temperature Control

The sample container and samples should be cooled to 4 - 6 degrees Celsius from the time the sample is collected through the time of analysis. It is the sampler's responsibility to ensure that provisions have been made in advance if the facility does not have accommodations to freeze the wet ice packs.

5.2 Sample Packing and Storage

5.2.1 Checking Sample Designations and Numbers

Prior to packing the sample bottles into the shipment coolers, the sampling team must record the sample designations in the appropriate spaces on the Field Chain-of-Custody Records and Field Information Form. It is important that the proper designations be recorded in the proper space on the form and that they be double-checked before sealing the sample cooler.

All bottles filled from the same sample point at the same time must have identical sample designations (except Field Duplicates). Samples that are split with regulatory agencies should also be checked for consistent sample point designation numbers and for other methods of identification used by the agency.

5.2.2 Sample Packing

The frozen ice packs should be placed into the sample cooler such that they are not in direct contact with sample bottles. Bottle holders/cushions and/or bubble wrap should be used for glass bottles to protect them from potential breakage. Do not overpack the coolers with samples. Do not ship leachate or other highly impacted samples in the same cooler as groundwater samples.

All bottles should be wiped clean before placement in the sample cooler. The sample cooler must be kept as clean as possible to minimize the potential for degradation. All bottle caps should be checked to ensure they are tight and will not become loose when inserted in the sample cooler. Bottle caps should not be taped.

The Field Chain-of-Custody Records (see Section 3.5.3) and Field Information Forms must then be reviewed to ensure that they have been completed properly. All original paperwork should be placed in a plastic bag, sealed, and placed inside the sample cooler of taped to the inside lid of the cooler. The sampling team should maintain a copy of all Chain-of-Custody documents and Field Information Forms for verification purposes. Copies should be maintained at the facility.

The sample cooler should be taped and sealed. Custody seals, when provided, should be initialed and dated by the sampling team and placed across the front opening of the cooler. The shipping company should not sign the Chain-of-Custody or the custody seals.

5.3 Sample Delivery

Samples must be delivered to the laboratory as soon as possible. Typically overnight sample shipment is pre-arranged by CWM's contract laboratory — it is the sampling teams responsibility to verify shipping arrangements. Sampling teams may need to make special arrangement for short-hold-time samples.

A member of the sampling team must be appointed to arrange sample pickup and/or transportation to the laboratory. Friday shipment of samples to the laboratory should be avoided to ensure that holding times are not exceeded over the weekend. Delivery requested on Saturday must be noted specifically on the shipping/packing air bill for the courier. The laboratory must be notified at least 48 hours preceding the anticipated delivery. In the event of a holiday, contact the laboratory in advance for shipping instructions.

Sample coolers are to be returned by the sampling team using the laboratory designated shipper and shipping labels (i.e. Airborne, Federal Express, United Parcel Service), unless delivery service by the laboratory specified shipper is not available at the facility. The CWM Environmental Representative and laboratory contact should resolve any return shipping issues (i.e. service, rush service availability) prior to sample delivery. In the absence of such specification, the CWM Environmental Representative should determine the shipment method.

When contacting the courier for transport of a sample, specify the sample cooler contents. Alert the courier to the potential problems of the samples freezing in the winter or ice packs melting in the summer, and note these potential problems on the shipping/packing label. Sample coolers should be received at the laboratory within 24 hours of when the frozen ice packs were placed in the sample cooler. This is necessary for temperature preservation and to meet required holding times of some analyses. Any necessary delay in shipment of the coolers to the laboratory must be documented on the Field Chain-of-Custody Record, and is the responsibility of the sampling team.

ATTACHMENT 1

SIGNATURE PAGE

SIGNATURE PAGE

The following persons have read and agree to follow the WM Sampling Standard. Exceptions to the Standard are to be noted below.

SITE/LOCATION: _________________/____________________

SITE SPECFIC EXCEPTIONS: **Reference:**

____

____

____

SITE/LOCATION: _________________/____________________

SITE SPECFIC EXCEPTIONS: **Reference:**

____

____

____

SITE/LOCATION: _________________/____________________

SITE SPECFIC EXCEPTIONS: **Reference:**

____

____

____

SITE/LOCATION: _________________/____________________

SITE SPECFIC EXCEPTIONS: **Reference:**

____

____

____

____________________	____________________	____________________	__________
SAMPLING TEAM COMPANY	**PROJECT MANAGER**	**SIGNATURE**	**DATE**

1____________________	____________________	________	3________________	________________	________
SAMPLER NAME	**SIGNATURE**	**DATE**	**SAMPLER NAME**	**SIGNATURE**	**DATE**
2____________________	____________________	________	4________________	________________	________
SAMPLER NAME	**SIGNATURE**	**DATE**	**SAMPLER NAME**	**SIGNATURE**	**DATE**

____________________________	____________________	________
CHEMICAL WASTE MANAGEMENT	**SIGNATURE**	**DATE**

Multiple copies can be made for additional sites/facilities/samplers. The Sampling Team/Company should notify CWM of any changes in field personnel and should forward an updated copy of this signature page prior to going into the field.

ATTACHMENT 2

SPECIAL EVENT NOTIFICATION FORM

WASTE MANAGEMENT, INC
SPECIAL EVENT ADDENDA
NOTIFICATION/BOTTLE REQUEST FORM

Attention:	Fax No.:
Addendum No.:	Event Description: ❑ Verification ❑ Resample ❑ Non-Routine ❑ Other______________________
Date Requested:	Date Bottles Required:
Site: Name: _________________________________ Location: ______________________________	TAT: ❑ 24hr. ❑ 48hr. ❑ 72hr. ❑ 1 week ❑ Standard (21 CD)
Sample Locations: ____ ____ ____ ____ ____ ____ ____ ____ __________	Parameters Requested: ____ ____ ____ ____ ____ ____ ____ ____ __________________
Send Bottles to: Attn: ____ Co.: ____ Address:____ ____	
Special Instructions: ____ ____ ____ ____ ____________________	
Requested by: ________________/__________________ Name Signature	Confirmed by: ________________/__________________ Name Signature
Notes: WM should fax and confirm verbally with Laboratory Contact. Lab should return faxed copy to confirm event.	

ATTACHMENT 3

METER CALIBRATION LOG

WASTE MANAGEMENT

METER CALIBRATION LOG

PROJECT NAME:______________________________ DATE:______________________________
PROJECT NUMBER:______________________________ SAMPLER:______________________________
MODEL:______________________________ SERIAL NO.:______________________________

pH METER

Time	pH 10 Buffer Check	pH 7 Buffer Check	pH 4 Buffer Check	Calibration Solution Temp (°C)

Buffer Lot Numbers: pH 4:______________ pH 7:__________ pH 10:__________

CONDUCTIVITY METER

Temp. of Calibration Solution	Corrected Cond. @ 25°C	*Time*

Calibration Solution Lot Number:______________
Calibration Range for Solution ______________

REDOX METER

Temp (°C)	E_H Reading (mV)	Time

Calibration Solution Lot Number:______________
Calibration Range for Solution ______________

MODEL:______________________________ **SERIAL NO.**:______________________________

Turbidity Meter

Gel Value (NTU)	Reading (NTU)	Time
0 – 10 range		
0 – 100 range		
0 – 1,000 range		
0 – 10 range		
0 – 100 range		
0 – 1,000 range		

Problems/Corrective Actions:______________________________

Signature:______________________________ Date:______________________________

QC'd By:______________________________ Date:______________________________

ATTACHMENT 4

PURGE VOLUME GRAPH

ATTACHMENT 5

FIELD INFORMATION FORM

CHAIN OF CUSTODY FORM

ATTACHMENT 6

WELL CONDITION INSPECTION FORMS

WELL CONDITION INSPECTION FORM

Site: ____________________ Personnel: ____________________

Date: ____________________ Page ______ of ______

Well ID	Protective Casing	Well Casing	Label	Lock	Sample Equipment Type	General Turbidity	Well Yield	Comments/Observations *
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No		☐ Clear ☐ Turbid	☐ OK ☐ Inadequate	

* Note ponding water, weep holes, or any other information pertaining to well condition. Provide additional details on listed items.

Return this form to Site Manager and Groundwater Program Manager

WASTE MANAGEMENT

Well Condition Inspection Form

Facility: ___________________________ Well/Piezometer Name: ________________________

Evaluator: _________________________ Evaluation Date: ______________________________

	Y	N	N/A
Is the well's location appropriately shown on a facility map?			
Is the well adequately flagged if hard to find?			
Is the well elevation information inscribed at or on the well correct?			
Is the well: ❑ flush with surface? ❑ above ground?			
Is the well free of physical damage?			
Is the well labeled on the inside?			
Is the well labeled on the outside?			
Does the well have protective posts, if necessary?			
Do above ground wells have weep holes at the base of the protective casing?			
Does the area around the well appear clean?			
Is the casing secure (attempt to move along two perpendicular axes)?			
Is the surface seal void of differential erosion around and under the base?			
Is the surface seal free of cracks that might affect the integrity of the seal?			
Is the surface seal sloped to prevent ponding around the well?			
Is the well free from standing or ponded water?			
Is there any evidence of well subsidence?			
Is the well locked to prevent unauthorized access?			
Is the protective casing cap void of large gaps which would breach security?			
Is the locking cap free of rust?			
Is there a survey mark on the riser/wellhead assembly cap?			
Is the riser cap vented?			
Is the annular space free of animal/insect nests?			
Is the annular space appropriately filled with filtering material?			
If a pump, can it be lifted a few inches? (do not test prior to sampling)			
Is the well free of kinks or bends?			

COMMENTS: ____

APPENDIX E-10

SECTION E

SYNOPTIC SUMMARY OF INDICATOR PARAMETER STUDIES UTILIZING THE LOCKHEED/EPA-EMSL-LV HAZARDOUS WASTE GROUNDWATER DATABASE

<u>Revision No.</u>
5.0

APPENDIX E-10

SECTION E

LIST OF DOCUMENTS

Document 1: Synoptic Summary of Indicator Parameter Studies Utilizing the Lockheed/EPA-EMSL-LV Hazardous Waste Ground-Water Database, prepared by Lockheed Engineering and Management Services Company, Inc.

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Synoptic Summary of Indicator Parameter Studies Utilizing the Lockheed/EPA-EMSL-LV Hazardous Waste Ground-Water Database

by

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ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89114

Synoptic Summary of Indicator Parameter Studies Utilizing the Lockheed/EPA-EMSL-LV Hazardous Waste Ground-Water Database

Russell H. Plumb Jr.
Lockheed Engineering and Management Services Company, Inc.
Las Vegas, Nevada

1. BACKGROUND

One of the major concerns at all hazardous waste disposal sites is the possibility of ground-water contamination and subsequent off-site migration of the chemical contaminants. This concern was addressed when the U.S. Environmental Protection Agency promulgated a regulatory program under the auspices of the Resource Conservation and Recovery Act (RCRA) to protect ground-water quality in the vicinity of hazardous waste disposal sites (40 CFR Part 265, Subpart F, May 19, 1980; 40 CFR Part 264 Subpart F, February 5, 1981; and 40 CFR Part 264 Subpart F, July 26, 1982). These regulations require the owners and operators of facilities developed for the treatment, storage, and disposal of hazardous wastes to implement a two-stage site management plan. The first stage in this strategy is the preparation and implementation of a plan to minimize leachate generation in individual waste management units. The intent of this stage is to identify all hazardous materials entering a site and to specify procedures that will be used to minimize the formation of leachate that have the potential for entering the subsurface environment and migrating offsite. The second stage in the strategy is the preparation and utilization of a ground-water monitoring program to ensure the effectiveness of the management plan.

Each site-specific ground-water monitoring program must describe a detection monitoring phase (interim status), an assessment monitoring phase, and a corrective action phase. Each phase of the monitoring program has a distinct purpose. The principal activities during detection monitoring (interim status) are the establishment of a monitoring well network and the routine sampling of these wells to detect potential leakage that may be migrating offsite. When leakage is detected during this phase, the site is placed in assessment monitoring. The principal activities during this phase are to identify all the contaminants that are involved in the leakage event and to describe the hydrogeological distribution of the contaminants involved in the leakage event. These objectives generally require the use of a larger monitoring network and more extensive sample characterization than specified in the detection monitoring (interim status) phase. When assessment monitoring results indicate that ground-water protection standards have been exceeded, the corrective action phase of the monitoring program is implemented for the protection of human health and the environment. Thus, detection monitoring (interim status) results are evaluated to determine whether a site has caused ambient ground-water conditions to change, the assessment monitoring results are quantitatively evaluated to determine whether the detected change has caused one or more ground-water protection standards to be exceeded, and the corrective action phase describes a remedial action program.

Since it was recognized that a considerable period of time would be required in order to develop site-specific ground-water monitoring programs, the U.S. Environmental Protection Agency specified a universal ground-water monitoring program to be followed by all facilities in the detection monitoring (interim status) phase. This program consisted of quadruplicate measurements for pH, specific conductance, total organic carbon (TOC), and total organic halogen (TOX), and analysis for 26 other water quality constituents for which primary or secondary drinking water standards have been established (11 metals or metalloids, 6 pesticides, 4 anions, 3 radioactive constituents, one organic compound, and one biological parameter).

A key component of the RCRA detection monitoring (interim status) strategy is the designation of four analytes that have been specified for use as indicator parameters during this phase of a site monitoring program. Each of the four indicator parameters, (pH, specific conductance, TOC, and TOX) was selected to serve as a tracer or surrogate for broad classes of ground-water contaminants in order to identify hazardous waste disposal facilities that may be leaking and for which more extensive site monitoring is required while simultaneously minimizing the universal need for extensive and expensive sample analysis. Specific conductance was selected because an increase in the abundance of inorganic constituents would be expected to increase the conductivity of monitoring samples. Also, significant changes in pH should detect changes in the occurrence of acids and bases and may suggest a possible change in the level of inorganic contamination. Similarly, TOC was selected because organic compounds migrating from a site should increase the organic carbon concentration of ground water. Finally, TOX was selected because organic compounds containing one or more halogens (fluoride, chloride, bromide, or iodide) that are migrating from the site should cause an increase in the organic halogen concentration of the ground water. Thus, two of the designated indicator parameters (pH and specific conductance) were selected to monitor for broad changes in inorganic contamination and two designated indicator parameters (TOC and TOX) were selected to monitor broad changes in organic contamination.

The monitoring results for each indicator parameter must be submitted in quadruplicate and statistically analyzed at the 0.01 level of significance using a version of the Student's t-Test.

When the upgradient and downgradient results for each indicator are statistically equivalent, the facility remains in the detection monitoring (interim status) phase and the universal detection monitoring (interim status) program is repeated during the next regularly scheduled sampling period. However, if a statistically significant increase in specific conductance, TOC, or TOX is detected in a downgradient well, or a statistically significant change in pH is detected in a downgradient well, the monitoring network is to be immediately resampled. Should the second set of sampling results confirm a significant change in the contamination of one or more indicator parameter, the facility must implement the assessment monitoring phase of the ground-water monitoring program. This change in the regulatory classification of a facility presently requires monitoring samples to be more extensively analyzed for the 222 Appendix IX constituents (U.S. EPA, 1987).

The preceding discussion provides an overview of the RCRA regulatory framework and illustrates the operational importance of the indicator parameters in the current hazardous waste disposal site ground-water monitoring strategy. The indicator parameters were selected to minimize monitoring costs during the detection monitoring phase of a ground-water monitoring program on the assumption that any contaminants migrating from a hazardous waste disposal facility would cause a significant change in the ambient concentration of pH, specific conductance, total organic carbon, and/or total organic halogen. Furthermore, significant changes in the ambient concentration of one or more of the indicator parameters triggers the need for more aggressive assessment monitoring of ground water conditions at a hazardous waste disposal facility.

Due to the importance of the four designated indicator parameters, a project was initiated to evaluate their performance. Existing ground-water quality data obtained during the routine monitoring or investigation of hazardous waste disposal facilities were compiled to achieve the following objectives.

1. assess the capability of RCRA detection monitoring (interim status) indicator parameters (specific conductance, pH, TOC, and TOX) to detect ground-water contamination emanating from a regulated waste disposal facility,

2. determine possible correlations between the indicator parameters and other ground-water constituents,

3. identify alternate indicator parameters or alternate strategies that can be used for monitoring ground-water conditions in the vicinity of hazardous waste disposal facilities.

Data Acquisition

The approach that was selected to achieve the stated objectives consisted of compiling monitoring data from ongoing site investigations across the nation. This approach was selected for several reasons. First, the approach takes advantage of the extensive amount of ground-water monitoring data that have been generated in the last five years. Second, the use of a composite database provides a means to evaluate the performance of an indicator parameter at several sites in each of the EPA regions. Third, the analytical costs associated with a single site investigation would be substantial and the analytical costs associated with multiple site investigations would be impractical. Fourth, the results from a single site investigation would not provide sufficient basis to determine whether a national monitoring strategy based on indicator parameters was operating effectively. All of the data included in the study were generated through the routine monitoring of RCRA hazardous waste disposal facilities or the investigation of uncontrolled hazardous waste disposal sites (CERCLA or Superfund sites). This information was obtained with the cooperation and assistance of personnel in the EPA Office of Solid Waste, the EPA Office of Emergency and Remedial Response, each of the EPA regional offices, the EPA Regional Field Investigation Team (FIT) contractors, the Texas Department of Water Resources, and the Louisiana Department of Natural Resources.

The first step in the data collection process was to review information supplied by the EPA Contract Laboratory Program (CLP) in order to identify CERCLA landfills and hazardous waste disposal sites within each EPA region for which monitoring results should be available. Subsequently, each regional office, or a designated FIT contractor office, was visited to obtain available information including ground-water quality data, sampling locations, sample collection dates, site maps, sampling procedures, hydrogeologic data, and site history. The visits to the EPA regional offices also resulted in the acquisition of monitoring data for several sites not previously identified in the CLP records (i.e., samples were analyzed in EPA Regional Laboratories rather than CLP laboratories). The visitation dates and the number of sites within each EPA region for which all or a portion of the above information was obtained is indicated in Table 1.

Ground-water quality data generated as a result of routine monitoring of RCRA Subtitle C sites were obtained from several sources. The EPA Office of Solid Waste provided one year of interim status monitoring data for each of 20 RCRA sites located throughout the nation. This information consisted of quarterly monitoring data for the four indicator parameters, the 26 other required RCRA analytes, water level data, and a site sketch. A second source of RCRA data was the Texas Department of Water Resources. Site files were reviewed in the Austin office in May,

Table 1. Regional Distribution of CERCLA Sites Included in the Database

EPA Region	Visitation Dates	Disposal Sites*
1	13-15 September 1983	22
2	11-13 April 1983	14
3	14-15 April 1983	21
4	26-29 April 1983	24
5	23-26 May 1983	61
6	9-11 May 1983	22
7	12-13 May 1983	10
8	15-17 June 1983	9
9	30-31 August 1983	6
10	27-30 June 1983	23

*Disposal sites refers to the number of sites for which monitoring information was available and not the total number of sites in the region.

1984 to obtain hardcopy information on monitoring results, sampling locations, sample collection dates, site maps, and site history. Although most of the monitoring data were limited to the 30 parameters required in the detection monitoring (interim status) phase of the RCRA Program, this effort provided one to three years of data for 119 sites in Texas. Monitoring data from an additional 16 RCRA sites were obtained from the Louisiana Department of Natural Resources in August, 1984.

A third subset of disposal site monitoring data was obtained from a source in the regulated community (RCS). This source became aware of the indicator parameter project and offered to supply all of their monitoring data for use during the project. A tape transfer resulted in the acquisition of several years of monitoring data at approximately 160 sites. This information consists of over 1,000,000 analytical records for more than 450 chemical analytes. At this time, hydrogeological data and the location of these sites is not included in the database.

A fourth subset of ground-water data was obtained from the EPA Ground-Water Task Force. This information consists of site characterization data and monitoring results from 50 sites. Although the hardcopy information has been received, a tape of the monitoring results has not been received and the data have yet to be included in the database.

The data were coded into INFORM and stored on a PDP 11/70 computer. The database has subsequently been converted to FORTRAN and is presently stored on a VAX. Specific information that has been incorporated into the database includes: (1) a coded site name, (2) a site location (by EPA Region, State, and ground-water region), (3) regulatory classification of the site (RCRA or CERCLA), (4) type of facility (landfill, surface impoundment, spill), (5) geologic characteristics (sand, gravel, clay, shale, relative permeability), (6) well type (monitoring well, private well, commercial water supply well), (7) well location (on site, off site, upgradient, downgradient), (8) sampling date, (9) chemical contaminants for which analyses were attempted, (10) concentration of contaminants detected in collected samples, (11) replicate results, when available, (12) CAS number of specific contaminants, (13) analytical classification of each contaminant (metal, volatile, pesticide), and (14) the existing criteria for each contaminant (primary drinking water standard, aquatic toxicity limit, carcinogenic risk level). Presently, the database includes analytical records for more than 1150 chemical contaminants for which analyses have been attempted on samples collected from one or more of the 7500 sampling wells at 493 sites.

All of the data included in the database and support files were passively collected from the sources identified above. There was no project influence on the number or location of wells in a site investigation, the frequency of sample collection, or extent of sample characterization. Also, there was no attempt to edit the data that were obtained (i.e., the data represent the level of effort that had been reported at the time the site file was reviewed and were used at face value).

Because of the diverse nature of the information sources, quality assurance/quality control (QA/QC) practices varied widely. The CERCLA data were subjected to QA/QC procedures and data auditing procedures developed and implemented by the CLP at the time the data were generated. To the extent that it is available, the site files contain information on sampling procedures, instrument calibration, replicate sample analysis, field blank analysis, laboratory blank analysis, and check sample analysis. Also, a copy of the QA/QC program followed by RCS personnel during their site monitoring activities is on file. Unfortunately, the documented level of quality assurance associated with most of the RCRA data is limited to the required replicate analyses for each for the designated indicator parameters. However, it is felt that the assembled information becomes representative of existing conditions in ground water in the vicinity of hazardous waste disposal sites by virtue of the large number of sites included in the database.

Database Content

The present database was the first attempt to compile hazardous waste disposal site ground-water monitoring data on a national scale. While there are several national databases such as STORET and WATSTORE, the Lockheed/EMSL-LV database is unique in that it is dedicated exclusively to hazardous waste disposal site ground-water conditions (i.e., all the data were obtained during actual site investigations and/or monitoring activities). The following profile listings will provide the reader with an overview of the database content.

The sites presently included in the database were compared to the Hazardous Waste Sites National Priorities List (U.S. EPA, 1983). The approximate ranking of the database sites are summarized in Table 2. This effort indicates that the database contains ground-water monitoring data for six of the top ten NPL sites in the country, 17 of the top 58 NPL sites in the country, 74 of the top 593 sites in the country, and 123 sites that were not ranked. Thus, the database represents a cross section of the type of sites to be encountered across the nation.

Table 2. Comparison of Database Sites to NPL Ranking*

NPL Site Ranking	Number of Database Sites
1 - 58	17
59 - 117	10
118 - 181	11
182 - 248	9
249 - 320	6
321 - 385	4
386 - 458	6
459 - 526	10
527 - 539	1
No Ranking	123

*This tables does not contain sites from Texas, Louisiana, or RCS portion of the database.

The regional distribution of the sites in the database (by EPA Region) is summarized in Table 3. The uneven distribution of the sites reflects the availability of data at the time of collection and regional differences in the occurrence of hazardous waste disposal sites.

Table 3. Regional Distribution of Sites in the CERCLA Portion of the Database

EPA Region	Number of Sites	Number of Wells
1	16	305
2	20	255
3	15	207
4	21	535
5	47	304
6	17	322
7	8	104
8	9	202
9	7	659
10	19	384

Information on the location of the monitoring wells relative to the site being investigated (i.e., upgradient or downgradient; on site or off site) and the type of well utilized in the data collection process is summarized in Table 4.

Table 4. Classification of Wells in CERCLA Investigations by Type and Site Location

Upgradient wells	267
Downgradient wells	1981
Gradient location not specified	1029
On site wells	1700
Off site wells	940
Relative site location not specified	637
Original purpose of well	
Monitoring well	1938
Private well	839
Public/Commercial supply well	208
Unknown	205
Production well	63
Livestock/Irrigation well	13
On site drinking water well	8
Other	3

The analytical results in the present database are summarized in Table 5. This information identifies the number of inorganic and organic contaminants that have been detected in the water at one or more sites. This data suggests that analyses have been attempted for approximately 155 inorganic contaminants and most of these contaminants have been detected in the ground water at one or more sites. (For the purpose of compiling analytical results, dissolved concentrations and total concentrations for the same inorganic contaminant were treated as two chemical contaminants). By comparison, analyses have been reported for 714 organic contaminants but less than half of these contaminants occurred at concentrations that were detectable and quantifiable. Also, the overall frequency of detection of organic contaminants is only 12.7 percent compared to an inorganic frequency of detection of 65 percent.

The current database contains analytical records for more than 1100 chemical contaminants that were generated during the investigation of approximately 500 hazardous waste disposal sites. The database reflects the highly variable efforts that have been used to characterize ground-water samples and the skewed distribution of these contaminants in the environment. For example, Figure 1 summarizes the reported number of analytical attempts and the frequency of detection for 721 organic contaminants based on 179

Frequency of Detectable Concentrations - Percent

Number of Analytical Attempts	0-5.0	5.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1-60.0	60.1-70.0	70.1-80.0	80.1-90.0	90.1-95.0	95.1-100.0
1-10	305M	1M	3M	10M	8M	21M	1M	7M	1M			93M
11-50	43M	4M	10M	9M	4M	3M	1M	3M	3M	1M	1M	2M
51-100	22M	3M	2M	2M	1M		1M					
101-500	11N 7M	1N 1M		2M		1M						1M
501-1000	5N	2N	1N									
1001-2500	1V 26P 10A 44B 2M		1A 1B									
2500+	14V	4V	6V	3V	1V	1M	1V					

V = Volatile Compound
A = Acid Extractable Compound
B = Base/neutral Compound
P = Pesticide
N = Non-standard Priority Pollutant
M = Miscellaneous Organic Compound

Figure 1. Cumulative frequency of detection of 721 organic contaminants in hazardous waste disposal site ground water.

CERCLA investigations. The number of analytical attempts ranges from a low of less than 10 attempts for each of 450 miscellaneous organic contaminants to a high of over 2500 attempts for only 30 organic contaminants. Also, although many organic contaminants have a high (>60 percent) frequency of detection, these compounds are generally miscellaneous organic compounds for which a small (<50) number of analytical attempts have been reported. The skewed distribution of the organic compounds in the database is also demonstrated by a plot of frequency of detection versus range of concentration for each contaminant (Figure 2). It should be noted that the only class of organic compounds that consistently have a high number of analytical attempts, a reasonably high frequency of detection, and elevated concentration levels (as indicated by the high range of observed concentrations) is volatile organic compounds.

Table 5. Summary of Ground-Water Monitoring Data in the Database by the Source of the Data

Data Source	Inorganic Compounds Attempted	Inorganic Compounds Detected	Analyses Reported	Detectable Events
CLP	155	141	80809	49413
RCS	99	96	209376	137972
Louisiana	70	65	11379	8792
Texas	50	49	73729	48265
Total			375293	244442

Data Source	Organic Compounds Attempted	Organic Compounds Detected	Analyses Reported	Detectable Events
CLP	714	336	283335	23999
RCS	368	223	350033	46759
Louisiana	136	49	10699	1794
Texas	9	9	18574	1451
Total			644067	74003

The Hazardous Waste Disposal Site Ground-Water database that has been developed under the sponsorship of EMSL-LV actually consists of four data subsets. These subsets are:

1. Monitoring data obtained during the investigation of 173 CERCLA sites and 20 RCRA sites that are distributed nationwide.

2. Data obtained during the routine monitoring of 119 RCRA sites in the State of Texas and 16 sites in the State of Louisiana.

Data Range-Orders of Magnitude

Frequency of Detection- %	1	2	3	4	5	6	7
0.0-5.0	11P 10B 3V	2A 6P 14B 2V	1A 6P 19B 7V	6A 5P 5B 7V	3A 3B 2V		1A 1V
5.1-10.0					1A 5V	1V	1P
10.1-15.0				1B		2V	1A 2V
15.1-20.0					1V	1V	1V
20.1-25.0							
25.1-30.0					2V	1V	
30.1-40.0							1V
40.1-50.0							
50.1-60.0						1V	

A = Acid extractable; B = Base/neutral; P = Pesticide; V = Volatile.

The number refers to the number of compounds in the classification.

Figure 2. Variability and skewedness of ground-water data for organic priority pollutants detected near hazardous waste disposal facilities.

concentrations are unchanged, the concentration of all other ground-water contaminants should be constant. Therefore, the performance of the RCRA indicator parameters were evaluated by plotting the observed concentration changes for each of the four designated indicators versus the observed concentration changes for all other ground-water contaminants for which data were available as suggested in Figure 3. This approach suggests that only 36 percent of the specific conductance-inorganic ground-water data at the site followed the desired response pattern that would be expected if specific conductance was an effective indicator parameter. Furthermore, the data suggests that there were 389 events (49 percent) where the indicator over estimated the concentration change of the inorganic contaminants and 359 (46 percent) of these events would be considered false positive events of regulatory importance that would trigger more expensive assessment monitoring. In addition, 116 events (15 percent) were underestimated by specific conductance of which 76 events (10 percent) would be considered false negative events of regulatory significance.

There are two additional points that should be made in conjunction with the evaluation process summarized in Figure 3. First, two methods were used to calculate concentration differences. When sufficient data were available, the Student's t-Test as specified in the RCRA program was utilized. When sufficient data were not available, a concentration differential of 10 percent was considered a change. Both approaches led to the same performance evaluation of the RCRA indicators (i.e., the use of a statistical procedure to evaluate monitoring data did not influence the evaluation of the monitoring strategy). Second, performance matrices similar to Figure 3 were prepared for specific inorganic contaminants (i.e., chloride vs. specific conductance, iron vs. specific conductance, manganese vs. specific conductance, etc.). This effort was not able to identify any specific inorganic constituents that could be indirectly monitored with the RCRA indicators in a reliable manner.

The approach outlined above was repeated for each RCRA indicator parameter at each site. The results from this effort were used to prepare summary performance diagrams as illustrated in Figure 4 for pH. The performance summaries (Table 6) prepared from these diagrams demonstrate that the poor performance of the original RCRA indicator parameters is not due to a small number of sites but is the type of performance that can be expected at a large number of geographically diverse sites. Since the indicator parameters do not appear to function well at the site level or the national level, and in fact appear to generate a higher frequency of false signals (false positives plus false negatives) than correct signals, it was concluded that the original RCRA indicator parameters (pH, specific conductance, TOC, and TOX) do not provide a reliable basis for an effective national hazardous waste disposal site monitoring strategy (Plumb and Fitzsimmons, 1984; Plumb, 1987).

3. Monitoring data obtained during the investigation of 160 sites located across the nation that are owned and/or operated by the regulated community (RCS).

4. Monitoring data obtained during the investigation of 50 RCRA sites selected for detailed study by the EPA Ground-Water Task Force. This information is presently available in hard copy only and has not been encoded for electronic storage and retrieval.

The site characterization data, when available, that has been electronically coded for storage and retrieval (as illustrated by the previous discussion) includes the following information: original purpose for installing the well, type of facility being monitored, regulatory classification of the facility, description of the aquifer material, location of the well relative to the site, location of the well relative to the hydraulic gradient, geographic location of the site (State and EPA Region), date of sampling, constituent for which analyses have been reported, and the analytical result for each constituent.

In addition to the chemical monitoring results that have been electronically stored and briefly described, there is a considerable amount of hard-copy information available to back up the database. This information, when available, includes site maps, geological logs, depth to water, description of site activities, and site history. Hard copy data of this nature is available for the sites in subset 1, a small portion of the sites in subset 2, none of the sites in subset 3, and all of the sites in subset 4.

3. IMPORTANT RESULTS OBTAINED WITH THE EMSL-LV DATABASE

The database is a valuable resource for evaluating a hazardous waste disposal site monitoring strategy since the efficacy of individual requirements can be tested at several levels. For example, the performance of the designated indicator parameters or an alternate monitoring strategy can be tested at the site level, the regional level, and the national level. This capability is important since a monitoring requirement that works well at one site is not necessarily an effective basis for a national monitoring strategy. Some of the more important evaluations and observations that have been obtained with the composite database are summarized below. Each of these topics are discussed in more detail in the project reports listed on pages 33 and 34.

RCRA Indicator Parameter Evaluation

An implicit assumption of the current RCRA ground-water monitoring requirements is that any substance migrating from a site will cause a significant concentration change in one or more of the designated indicator parameters. If this assumption is valid, any observed indicator parameter concentration change should be accompanied by a corresponding concentration change in one or more ground-water contaminants. Also, when the indicator

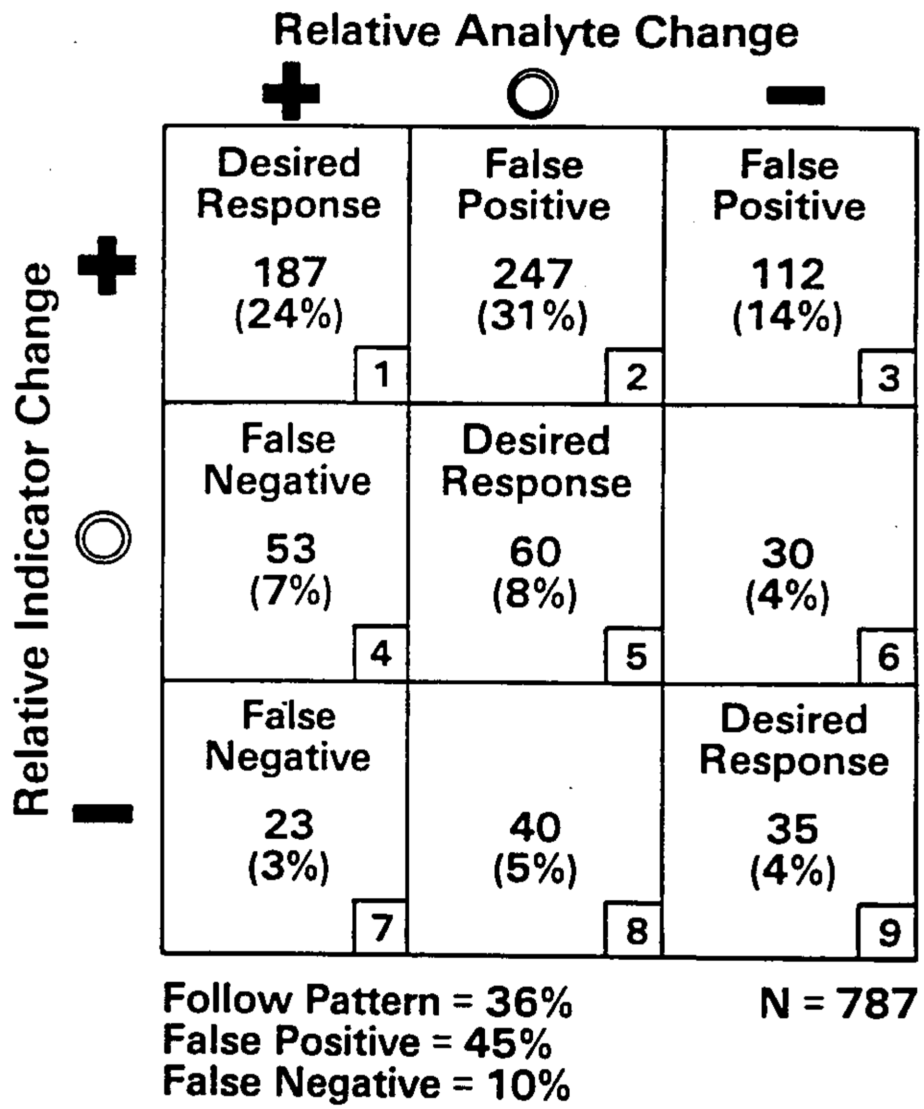


Figure 3. Performance evaluation of specific conductance as a ground-water indicator.

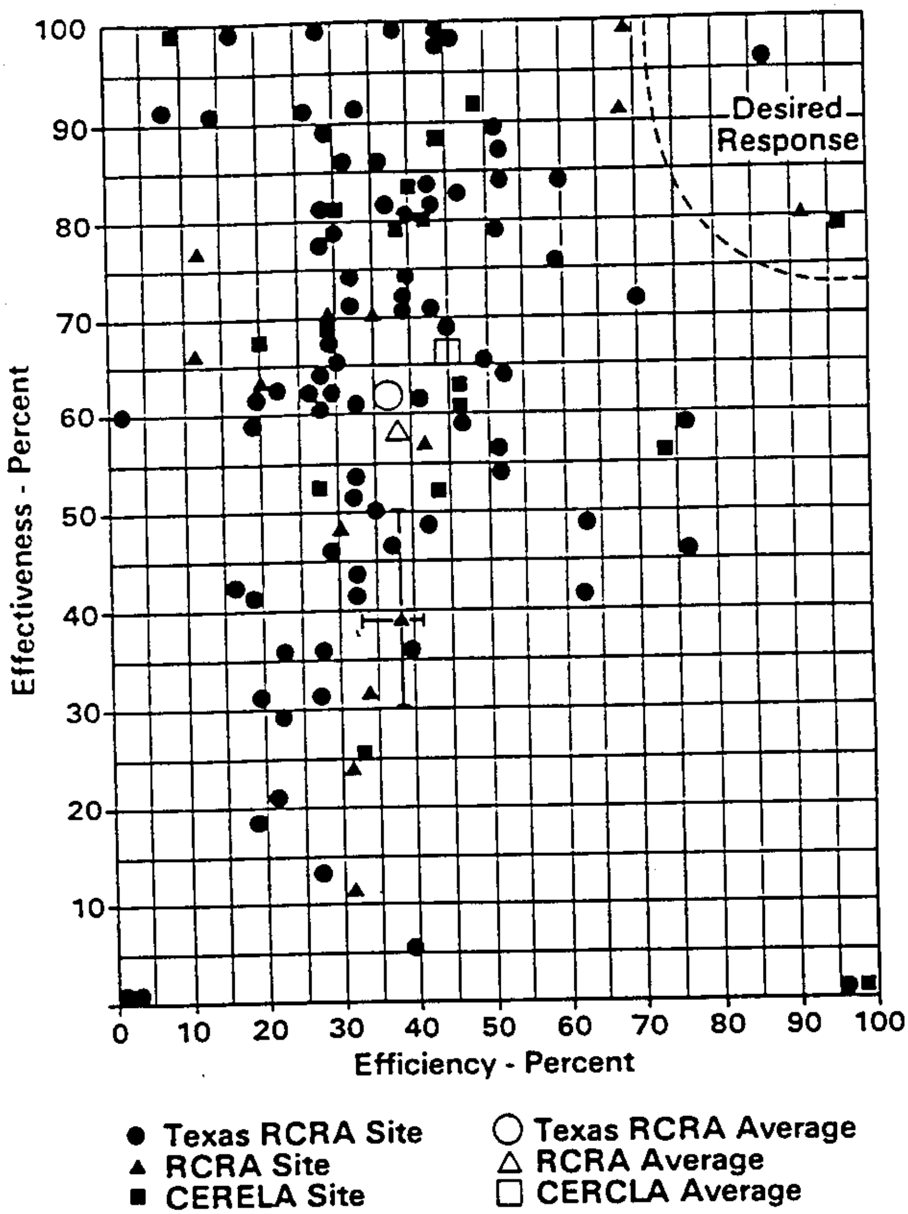


Figure 4. Summary performance of pH as an indicator of changes in ground-water quality in the vicinity of 113 hazardous waste disposal sites.

Table 6. Performance Evaluation of RCRA Ground-Water Indicator Parameters at 82 Texas RCRA Sites

RCRA Indicator Parameter	Mean Response %	Standard Deviation %
PH		
Follow Pattern	38	10
False Positives	39	18
False Negatives	13	10
Specific Conductance		
Follow Pattern	38	13
False Positives	34	21
False Negatives	12	11
TOC		
Follow Pattern	10	9
False Positives	43	24
False Negatives	2	6
TOX		
Follow Pattern	16	19
False Positives	35	29
False Negatives	2	7

Characterizing Ground-Water Conditions

Prior to the development of the database, the highest estimated number of contaminants reported to occur in ground-water was approximately 250 (Office of Technology Assessment, 1984). The database now documents the occurrence of more than 1100 ground-water contaminants that have been detected in the vicinity of hazardous waste disposal sites. This list includes approximately 950 organic contaminants and 150 inorganic contaminants. For the purpose of compiling the ground-water data, "dissolved" and "total" concentrations for the same inorganic contaminant were treated as two distinct chemical species. Thus, separate files were maintained for "dissolved" copper and "total" copper. Although a larger number of chemical contaminants can now be documented as occurring in the ground water, the amount of data available for many of these contaminants are too limited to define any regional or national distribution patterns. For example, there were less than ten analytical results for over 450 of the organic contaminants.

One trend of significance and potential utility that has been identified is the high occurrence of volatile organic compounds. As shown in Table 7, volatile compounds account for more than 75 percent of all the detectable events in ground water that involve organic contaminants. When the database is broken down into the component subsets, volatile compounds account for at least 50 percent of the detectable organic events in each subset except Texas. (This discrepancy is attributed to the fact that volatile organic analyses have not been attempted at any of the 119 sites in the Texas dataset.)

Table 7. Occurrence of Organic Contaminants in Disposal Site Ground Water by Classification and Data Source

Data Source	Volatile Priority Pollutants	Volatile Non-Priority Pollutants	Priority Pollutants	Total Detectable Events
CLP	15692	307	17243	19978
RCS	9032	272	11043	12453
Louisiana	176	0	321	351
Texas	0	0	125	270
Totals	24900	579	28732	33052
Percentage of total	75.3	1.8	86.9	100.0

The abundance of volatile organic contaminants in ground water relative to other organic contaminants can be demonstrated in several other ways. A rank-ordered listing of organic priority pollutants and miscellaneous priority pollutants (Keith and Telliard)* demonstrates that 9 of the top 10 most frequently detected organic contaminants, 16 of the top 20 most frequently detected organic contaminants, and 21 of the top 32 most frequently detected organic compounds are volatile compounds (Appendix 1). When these results are compared to a simple probabilistic frequency of occurrence, volatile compounds are the only group of organic contaminants that exceed probabilistic occurrence estimates (Table 8). In fact, the number of volatile compounds included in the list of top 32 compounds exceeds the expected number by a factor of 2.3 to 3.2. Furthermore, the

*The term priority pollutant refers to 31 volatile organic compounds routinely determined by SW-846 Method 8240, 45 base/neutral organic compounds routinely determined by SW-846 Method 8270, 11 acid extractable organic compounds routinely determined by SW-846 Method 8270, and 26 organic compounds routinely determined by SW-846 Method 8080. The term miscellaneous priority pollutant refers to 8 volatile organic compounds capable of being determined with SW-846 Method 8240 but not always reported, 8 base/neutral organic compounds capable of being determined by SW-846 Method 8270 but not always reported, 4 acid extractable organic compounds capable of being determined by SW-846 Method 8270 but not always reported, and 3 RCRA pesticides (2,4-D, silvex, and methoxychlor).

abundance of volatile organic compounds is so overwhelming that discrete pairs of volatile organic compounds have been detected more frequently in ground water than individual non-volatile organic contaminants (Figure 5).

Table 8. Comparison of the observed distribution of organic priority pollutants to an expected probabilistic distribution of the same compounds

Observed Rank Order Composition			
Analytical Classification	Rank Order of Ground-Water Contaminant 1 to 10	1 to 20	1 to 32
Volatile	9	16	21
Acids	1	1	4
Base/Neutrals	0	3	7
Pesticides	0	0	0

Probabilistic Rank Order Composition			
Analytical Classification	Rank Order of Ground-Water Contaminant 1 to 10	1 to 20	1 to 32
Volatiles	2.8	5.7	9.2
Acids	1.1	2.2	3.5
Base/Neutrals	3.9	7.8	12.5
Pesticides	2.1	4.3	6.8

Ratio of Observed Composition to Probabilistic Composition			
Analytical Classification	Rank Order of Ground-Water Contaminant 1 to 10	1 to 20	1 to 32
Volatile	3.21	2.81	2.28
Acids	0.91	0.45	1.14
Base/Neutrals	0.00	0.38	0.56
Pesticides	0.00	0.00	0.00

Each method of summarizing data that was mentioned above demonstrates the abundance of volatile organic contaminants in the national database. When the database was sorted into regional subsets, volatile compounds were still the dominant ground water contaminants. As shown in Table 9, the largest number of compounds per site in each EPA Region were volatile compounds. Also, although the database contains records for over 1100 compounds, only 20 organic compounds have been detected in the ground water of all EPA Regions and 16 of these compounds are volatile organic compounds.

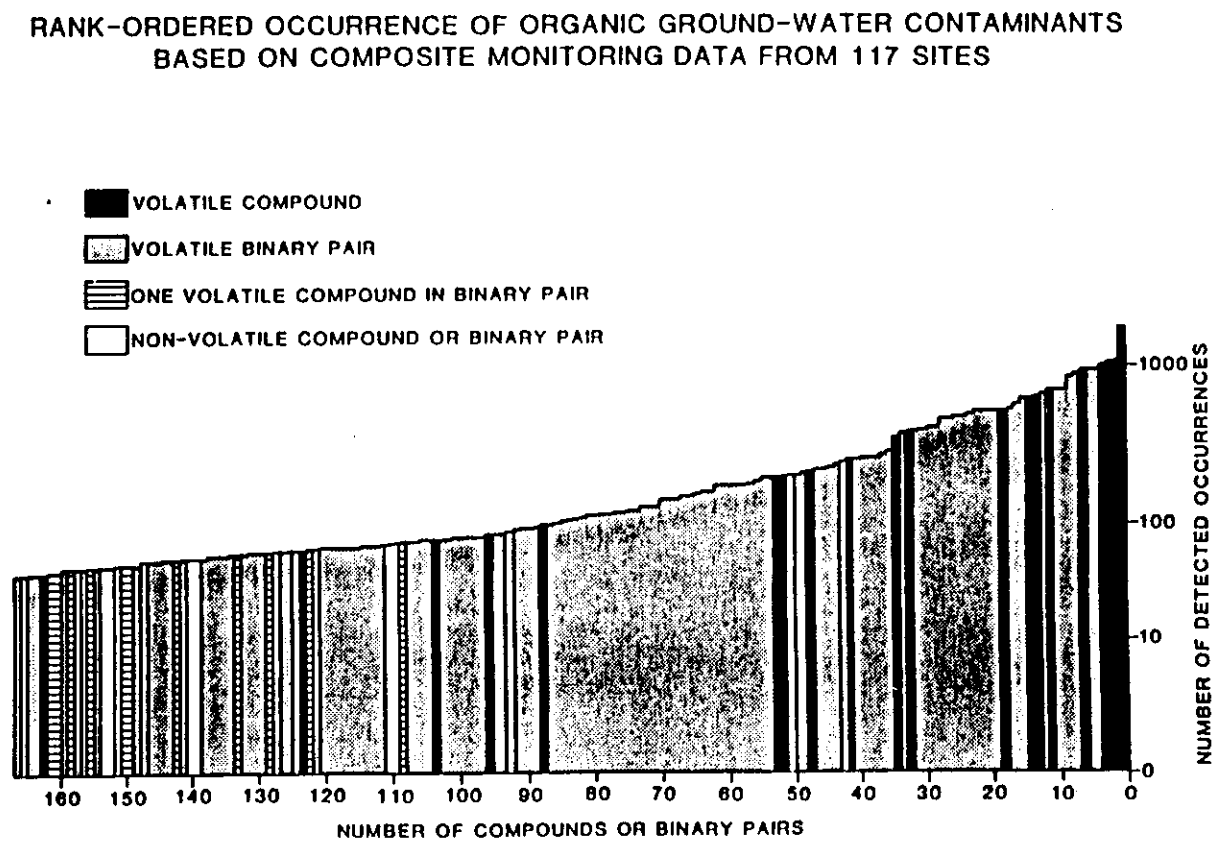


Figure 5. Rank-ordered occurrence of organic ground-water contaminants based on composite monitoring data from 117 waste site investigations

The database now documents that the number of organic compounds in ground water is 3 to 4 times higher than was previously thought. However, most of these compounds are site-specific problems rather than national problems. The one exception appears to be volatile organic compounds that are abundant in each of the national data subsets and regional subsets of the database.

Table 9. Average Number of Organic Compounds Detected Per Site in Ground Water in the Vicinity of Hazardous Waste Disposal Sites in each EPA Region

EPA Region	1	2	3	4	5	6	7	8	9	10
Number of Sites	6	10	9	15	37	11	6	5	3	15
Volatiles	11.3	6.8	5.8	6.0	3.1	4.9	2.5	11.0	14.3	7.3
Acids	0.8	1.5	0.8	0.4	0.4	0.9	0.2	1.0	0.3	1.5
Base/Neutrals	2.5	3.1	3.4	2.1	1.1	2.9	0.7	4.2	4.0	2.9
Pesticides	0.0	0.9	0.4	0.9	0.5	2.3	1.5	3.6	0.3	1.3
Nonstandard Priority Pollutants	1.0	0.6	0.2	0.9	0.4	0.1	0.0	1.0	0.0	0.8
Other Organics	4.0	1.1	2.8	5.8	0.1	0.3	0.5	2.0	1.7	0.2

Therefore, mandatory monitoring for volatile organic compounds has been recommended as an essential component of a national monitoring strategy (Plumb, 1985; Plumb and Pitchford, 1985).

Volatile Organic Analysis as an Alternative Indicator

A continually recurring observation within the database was the high occurrence of volatile compounds relative to other classes of organic contaminants. This point was further demonstrated by plotting a cumulative rank-ordered curve for the volatile compounds and each of the other analytical groups. This produced a family of curves as shown in Figure 6. The pattern in Figure 6 suggests the possibility of using volatile organic analyses as a qualitative screening technique to estimate the need for more extensive organic analysis of monitoring samples during the investigation of hazardous waste disposal sites. An encouraging aspect of the pattern shown in Figure 6 is that it was repeatedly seen with national data sets, regional data sets, and site-specific data sets (although the latter patterns tended to collapse to step functions because of limited data).

The potential use of volatile organic analyses as a screening technique was investigated in more detail by plotting the number of volatile compounds detected during site monitoring against the

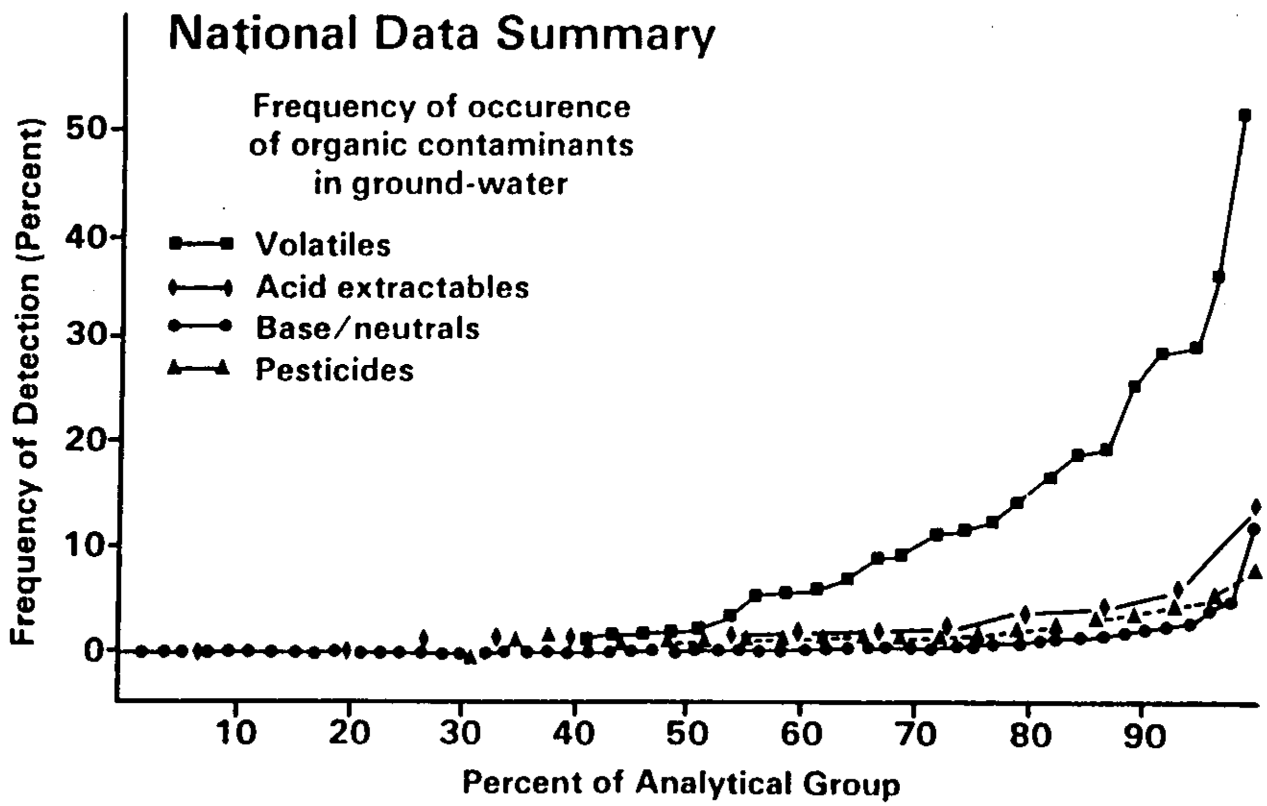


Figure 6. Cumulative rank-ordered curves for volatile organic contaminants and other organic contaminants that have been detected in ground water during waste site investigations.

total number of organic priority pollutants detected (volatile compounds, base/neutral compounds, acid extractable compounds, and pesticides). This effort resulted in the development of a linear relationship that had a high linear correlation coefficient (0.95). This original relationship was derived using monitoring data from 114 sites located nationwide. Subsequently, monitoring data from an additional 49 sites (the RCS portion of the database), at which all four priority pollutant groups (volatiles, base/neutrals, acid extractables, and pesticides) were determined, were made available to validate the original volatile organic-priority pollutant relationship. As shown in Figure 7, data from the two independent data sets produced linear relationships with nearly identical slopes (1.35 vs. 1.39) and similar correlation coefficients (0.908 vs. 0.955). These results demonstrate that the volatile organic-priority pollutant relationship is not unique to a small portion of the composite database. Furthermore, the fact that an identical empirical relationship can be derived from two large, independent sets of data reinforces the potential utility of using volatile organic analyses to estimate the need for more extensive and more expensive analyses of ground-water samples during a specific site investigation.

The linear relationship developed in Figure 7 suggests that it should be possible to define a level of volatile organic contamination that would trigger the need for additional organic analyses (i.e., if the number of detected volatile compounds is less than X, no further organic analyses are required; if the number of detected volatile compounds exceeds Y, additional organic analyses are advisable). This evaluation was undertaken by using the RCS portion of the database as a test case for the volatile organic-priority pollutant relationship developed using the CLP portion of the database. These results suggest that the proposed use of volatile organic analyses as an alternative indicator parameter would provide a correct estimate of the need for additional organic analyses more than 90 percent of the time (Table 10). Also, the estimated likelihood of false positive and false negative events would both be less than 6 percent. By comparison, the performance characteristics for the original RCRA indicator parameters suggest that they provide a correct estimate of the need for additional analyses less than 40 percent of the time, false positive events occur 45 percent of the time, and false negative events occur 2 to 15 percent of the time.

Based on the information presented in Table 10, a volatile action limit of six to eight compounds has been suggested as a practical yet effective limit. (i.e., If the number of detected volatile compounds is less than six to eight, no additional organic analyses would be required during the site monitoring; however, if the number of detected volatile organic compounds exceeded six to eight, then more extensive sample characterization should be undertaken). Although a better performance rating was obtained for the detection of two volatile compounds, this limit was considered too low to be practical since it would defeat the purpose of a screening strategy.

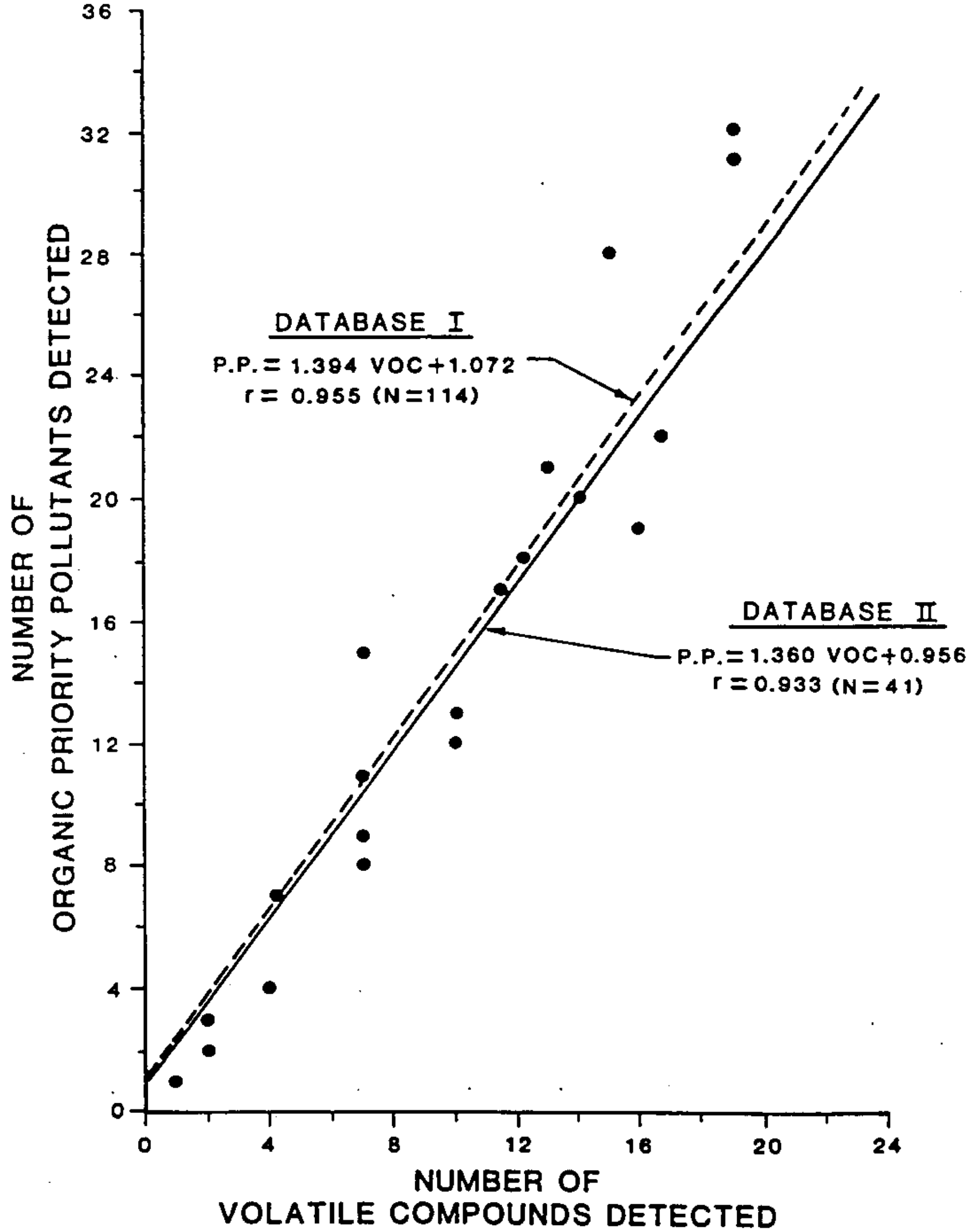


Figure 7. Comparison of volatile organic-priority pollutant relationship derived from Database I (dashed line) and Database II (solid line). Database I consists of 114 CERCLA sites and Database II consists of 49 RCS sites.

These results strongly suggest that the RCRA monitoring program can be significantly improved by incorporating routine monitoring for volatile organic contaminants and deleting the current requirements to monitoring for total organic carbon and total organic halogen. This change would provide direct monitoring for the most prevalent class of organic ground-water contaminants, improve the performance of the organic monitoring strategy from less than 20 percent to approximately 90 percent, and reduce the occurrence of false positive events from 40 percent to six percent or less (Plumb and Pitchford, 1985; Plumb, 1988).

Table 10. Estimated performance of the volatile screening technique as a function of potential action limits*

Performance Characteristics	Suggest Volatile Action Limit Number of detectable volatile compounds						
	>2	>4	>6	>8	>10	>12	>16
Desirable Response	98	94	92	92	92	84	86
Overanalyze (false positive)	0	0	6	2	0	8	6
Underanalyze (false positive)	2	6	2	6	8	8	8
Frequency of additional analyses	78	71	67	53	45	41	27

*Tabulated values represent the percentage of sites that produced the indicated response.

Comparison of RCRA and CERCLA Monitoring Strategies

The project database contains ground-water data obtained during the monitoring of both RCRA and CERCLA (Superfund) sites. Therefore, the database was sorted according to the regulatory classification of the sites in order to compare and contrast the two approaches being used by each program.

This effort indicated that the CERCLA program generally uses smaller sampling networks that are sampled less frequently than the RCRA program. Although 94 percent of the RCRA sites utilized a sampling network of four wells or larger, 33 percent of the CERCLA investigation utilized a sampling network of three wells or less. Monitoring networks of this size are rarely, if ever, sufficient to determine the direction of migration or even to definitely identify the source of any contamination that may be detected in the ground water.

Another distinction between the two approaches is that samples collected as part of CERCLA investigations are generally subjected to more extensive chemical analyses. For example, composite data from 178 CERCLA sites indicate that at least 102 inorganic chemical constituents and 378 organic compounds have been detected in the ground water and an additional 220 organic compounds have been tentatively identified as being present. A similar review of composite RCRA monitoring data from 156 sites suggests that only 33 inorganic substances and 54 organic compounds are present in the ground water. This discrepancy is considered to be the result of the limited organic monitoring requirements of the present RCRA program and the fact that the specific RCRA organic analytes are not representative of the most frequently detected organic ground-water contaminants. For example, there is no required monitoring for volatile organic compounds in the RCRA detection monitoring program and, in fact, there have been no reported volatile organic analyses at the 119 RCRA sites in Texas or the 20 miscellaneous RCRA sites in the database. Consequently, there is essentially no RCRA data for 9 of the top 10 and 16 of the top 20 most frequently detected organic ground-water contaminants (Table 8, Appendix 1). Furthermore, of the seven organic analytes for which RCRA detection monitoring is required, only one analyte (phenol) is included in the top 15 most frequently detected organic compounds while three of the RCRA detection monitoring analytes (endrin, methoxychlor, and toxaphene) were ranked 58th, or lower, in frequency of detection (Table 11).

Table 11. Comparison of Frequency of Detection Data for Required RCRA Organic Analytes Using CERCLA and RCRA Data

Required RCRA Analyte	CERCLA Detection Frequency (%)	CERCLA Rank	RCRA Detection Frequency (%)	RCRA Rank
Phenol	13.6	10	40.6	2
2,4-D	7.7*	17	2.3	35
Lindane	4.8	22	1.8	39
Silvex	2.4*	33	1.4	44
Endrin	0.9	58	1.3	47
Methoxychlor	0.7*	66	0.8	64
Toxaphene	0.2	97	1.1	53

*Based on less than 500 analyses. All other detection frequencies are based on more than 1500 analytes.

One observation of potential significance is the high degree of similarity between ground-water monitoring results at CERCLA and RCRA sites. The frequency of detection for general classes of ground-water contaminants at CERCLA sites decreased in the following order: indicators, inorganics, miscellaneous organic compounds, volatile organic compounds, acid extractable compounds, base/neutral compounds, and pesticides. The composite data from RCRA sites followed an identical progression. In fact, the calculated frequency of detection for inorganics, base/neutral compounds, acid extractable compounds, pesticides, and indicators were the same in the composite data from both programs (Table 12). Since the environmental problem is essentially the same at both types of sites and the available data suggests that conditions in the vicinity of these sites are similar, it has been suggested that consideration be given to the development of a common technical ground-water monitoring strategy to be utilized in both regulatory programs. While there may be political and/or economic reasons for maintaining two separate programs, the use of a common technical strategy to address a common technical problem should provide more effective ground-water monitoring in each program (Plumb, 1987).

Table 12. Frequency of detection of classes of ground-water contaminants based on the regulatory classification on the site.

Class of Compounds	CERCLA DATA Total Analyses Reported	CERCLA DATA Detection Frequency (%)	RCRA DATA Total Analyses Reported	RCRA DATA Detection Frequency (%)
Indicators	13,572	96	33,684	91
Inorganics	71,752	57	61,369	54
Miscellaneous Organics	12,523	15*	103*	48*
Volatiles	139,371	12	2,640	4
Non-standard Priority Pollutants##	12,523	3	0	0
Acid Extractables	16,229	2	464	4
Base/Neutrals	66,347	1	1,736	1
Pesticides	42,670	1	16,864	1

*Detection frequency for miscellaneous organic compounds is biased high due to the method of reporting results.
##Non-standard priority pollutants are organic compounds capable of being determined with one of the four priority pollutant groups but not routinely reported.

Data Utilization

The current RCRA monitoring strategy assumes that any chemical contaminants migrating from a waste disposal facility will cause a significant change in the concentration of one or more of the designated indicator parameters and that this change will be detected in a downgradient monitoring location. In addition to the previously discussed problems with the performance of the RCRA indicator parameters, a review of the project database suggests that the downgradient migration model may not be universally valid when applied to the (relatively) small scale involved in site investigations. One indication of this potential problem is shown in Figure 3. The data presented for the evaluation of specific conductance as an indicator parameter suggests there were 177 events (22 percent) where the analyte concentration decreased by 10 percent, or more in a downgradient direction. There were also 98 events (12 percent) where conductivity decreased in a downgradient direction. Furthermore, a comparison of the observed concentration distributions for each ground-water contaminant in upgradient and downgradient locations indicates considerable deviation from the model. As shown in Figure 8, 25 percent of the organic priority pollutants have demonstrated a potential for migrating in an unexpected manner even when detected ground-water concentrations are less than 500 $\mu g/l$. This observation could be due to errors in the analysis of samples, incomplete or inaccurate site characterization, and/or the fact that some contaminants are capable of migrating in an upgradient direction. In any event, it is suggested that there are problems and limitation associated with a simple comparison of data based on the hydrostatic level of the sampling location. The magnitude of this effect is also demonstrated by the fact that the overall frequency of detection for 40 contaminants was higher in upgradient locations and the average concentration for 36 contaminants was higher in upgradient locations. The occurrence of events that are not consistent with the current regulatory model is not limited to the project database since Silver (1986) has reported that more than 50 percent of the statistically significant increases reported in a site investigation occurred in upgradient locations.

There are several factors that can contribute to the observations discussed above. From a conceptual perspective, it is possible for leachate (either inorganic or organic) to form density currents that are stable in low kinetic energy groundwater environments and migrate under the influence of gravity rather than the hydraulic gradient. Schwille (1985) has used physical models to demonstrate that upgradient contaminant migration is possible in some situations. There are also several complex hydrogeologic situations in which the contaminants actually migrate downgradient but it will be difficult to apply the upgradient-downgradient data evaluation procedure. For example, when the hydraulic gradient changes with time due to the influence of tidal effects, extreme storm events, or intermittent upgradient production well operation, the current RCRA data evaluation technique may not function reliably because background conditions become less well defined. Another factor that can contribute to the observed data distribution is the commission of errors during the data collection process.

The observed occurrence and distribution of ground-water contaminants in upgradient locations raises issues that need to be addressed in order to develop and implement a more effective hazardous waste disposal site monitoring strategy. First, since background conditions are not as pristine as originally perceived, the use of a single upgradient well in a monitoring network will not be adequate. Therefore, the current strategy should be

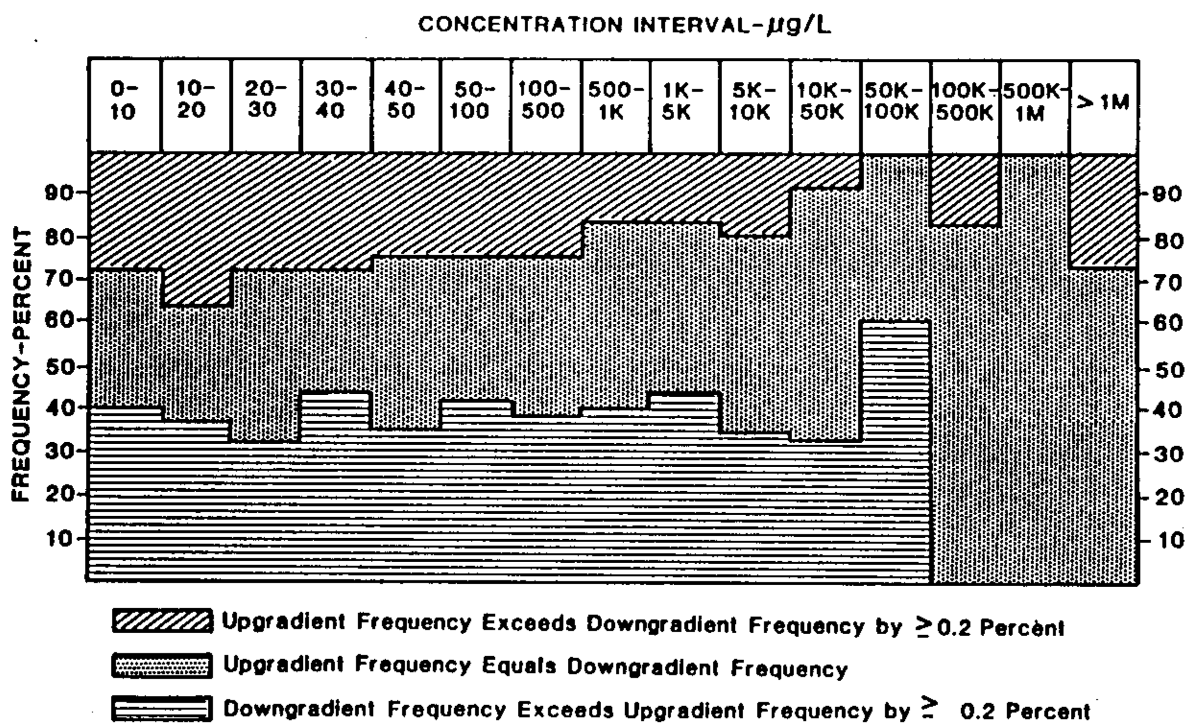


Figure 8. Cumulative Summary of upgradient-downgradient differences for 112 organic priority pollutants.

revised to require more extensive background (upgradient) monitoring. This will result in improved site characterization and also increase the likelihood of detecting non-standard migration of contaminants should it occur. Second, the practice of evaluating monitoring data for significant downgradient concentration increases will not be effective when upgradient migration of contaminants occurs and it may be difficult to apply when the ground-water gradient changes with time. Thus, although the upgradient-downgradient method will work for many situations, it will not work for the general case. Therefore, there is a need for an alternative method of evaluating hazardous waste disposal site ground-water monitoring data that overcomes these identified limitations of the present strategy (Plumb, 1985; Plumb, 1988).

Assessment Monitoring Evaluation

One function of the indicator parameters is to identify hazardous waste disposal facilities that should implement a more aggressive assessment monitoring of ground-water conditions. During the evolution of the RCRA program, assessment monitoring requirements have changed from a site specific plan developed by site owners and/or operators (until November, 1985), to analysis of samples for the 359 constituents included on Appendix VIII (November, 1985 until July, 1987), to analysis of samples for the 222 constituents included on Appendix IX (July, 1987 to the present). Because of the extensive nature and expensive costs associated with these assessment monitoring requirements, and the fact that the need for these monitoring requirements are triggered by the RCRA Indicator Parameters that have not been shown to function in a satisfactory manner, the project database was used to estimate the efficacy of the RCRA assessment monitoring requirements.

The organic contaminates that have been detected in ground water during hazardous waste disposal site investigations were classified as being volatile compounds, priority pollutant compounds, priority pollutants and non-standard priority pollutants, Appendix IX constituents, and Appendix VIII constituents (Table 13). These results suggests that routine monitoring for volatile organic compounds would directly target 75 percent of the ground water contamination problem. By comparison, a monitoring strategy based on priority pollutants analyses would target 87 percent of the organic contamination but the monitoring costs would increase by an estimated 400 percent. The current RCRA requirement to analyze assessment monitoring samples for Appendix IX constituents targets an estimated 90 percent of the ground water contamination problem. However, the 15 percent gain in problem resolution compared to analysis for volatile organic compounds will cost 1100 percent more than an approach based on the analysis of volatile organic compounds. Also, the Appendix IX approach will cost three times as much as a monitoring strategy based on the analyses of priority pollutant compounds but only provide data for an additional 3 percent of the detectable events. The composite information in the database suggests that an Appendix VIII monitoring strategy will only address 0.4 percent more of the total detectable events than an Appendix IX strategy, 3.5 percent more of the total detectable events than a priority pollutant monitoring strategy, and 15 percent more of the detectable events than a volatile monitoring strategy. The Appendix VIII approach would cost 67 percent more per sample than an Appendix IX approach, 400 percent more per sample than a priority pollutant approach, and 1900 percent more per sample than an approach based on volatile organic compounds. Since the incremental cost of an Appendix IX approach can not be justified by the incremental amount of information obtained, and all of the analytical methods needed to implement an Appendix IX strategy have not been fully validated, and the Appendix IX strategy will require monitoring for 74 compounds that have not been reported to occur in ground water, it is recommended that the Appendix IX monitoring requirement be revised or replaced.

Table 13. Assessment of possible ground-water monitoring strategies based on contaminants that have been detected in ground water during 500 waste site investigations

Analytical Group	Detectable Events	Percent of Events	Increase over Volatiles	Cost per Sample	Incremental Cost per Sample
Volatiles	24,900	75.3	----	$250	----
Priority Pollutants	28,735	86.9	11.6	$1000	$750
Priority Pollutants and Non-Priority Pollutants	29,383	88.9	13.6	$1000	$750
Appendix IX	29,760	90.0	14.7	$3000	$2750
Appendix VIII	29,864	90.4	15.1	$5000	$4750
Total	33052	100.0	24.7	----	----

Development of an Alternative Data Evaluation Technique

In response to the recurring observation that it is possible for upgradient concentrations to exceed downgradient concentrations, a condition that is not consistent with the current hazardous waste disposal site monitoring strategy, effort was directed at developing a data evaluation technique that was not dependent on an assumed chemical behavior pattern. Starting with the condition that upgradient and downgradient ground-water concentrations would be expected to be equivalent if a hazardous waste disposal facility was not leaking (which is essentially the same condition on which the current RCRA strategy is based), it was possible to develop an alternative evaluation procedure based on the variance of ground-water monitoring data. When a site is not leaking, the variance of a set of monitoring data will be minimized (and ideally approach zero) and a plot of variance over time will parallel the time axis (Figure 9). However, when leakage occurs, the variance of the data set will increase exponentially in proportion to the magnitude of the detected leakage event. Furthermore, a different cum-sum type chart is produced for each chemical migration pattern (i.e., radial migration events produce different variance plots than uni-directional leakage events).

As a consequence of the identification of variance as a potential data evaluation technique, the database was used to develop preliminary contaminant-specific action levels expressed in terms of variance for 30 volatile organic compounds, 45 base/neutral organic compounds, 11 acid extractable organic compounds, 26 pesticides, and 20 inorganic constituents (Appendix 2). This was accomplished by calculating the variance for each of the 132 ground-water contaminants on a site-by-site basis, rank-ordering the resultant values, and preparing a cumulative variance curve for each contaminant. The resultant curves were graphically analyzed to estimate a lower non-leakage limit and an upper action limit for 112 organic priority pollutants and 20 inorganic substances. These pragmatically developed limits suggest that a site would not be considered to be leaking if the monitoring data variance for a four well network is less than 100 to 500 (depending on the contaminant of interest) while a variance greater than 500 to 2000 would be indicative of a site that may be leaking. The existence and refinement of these limits will permit inorganic and organic priority pollutant data to be used directly and consistently in site assessments.

Benefits that can be realized from the implementation of these limits include more effective utilization of monitoring data (only 38 percent of the RCRA detection monitoring data is used in the present program), the problems that have been identified with the RCRA indicator parameters and the statistical analysis of the indicator data can be avoided, monitoring costs can be reduced six to eight million dollars a year since replicate indicator analyses would no longer be necessary, and the approach would be equally applicable to RCRA Subtitle C, RCRA Subtitle D, and CERCLA site investigations (Plumb, 1987).

Assessment of Analytical Methods

The RCRA program requires owners and operators of waste disposal facilities to use analytical procedures equivalent to those listed in OSW-846 (U.S. EPA, 1986). However, when the Texas and Louisiana subsets of the database were reviewed in terms of detection limits, there was circumstantial evidence that this requirements was not being universally followed. Specifically,

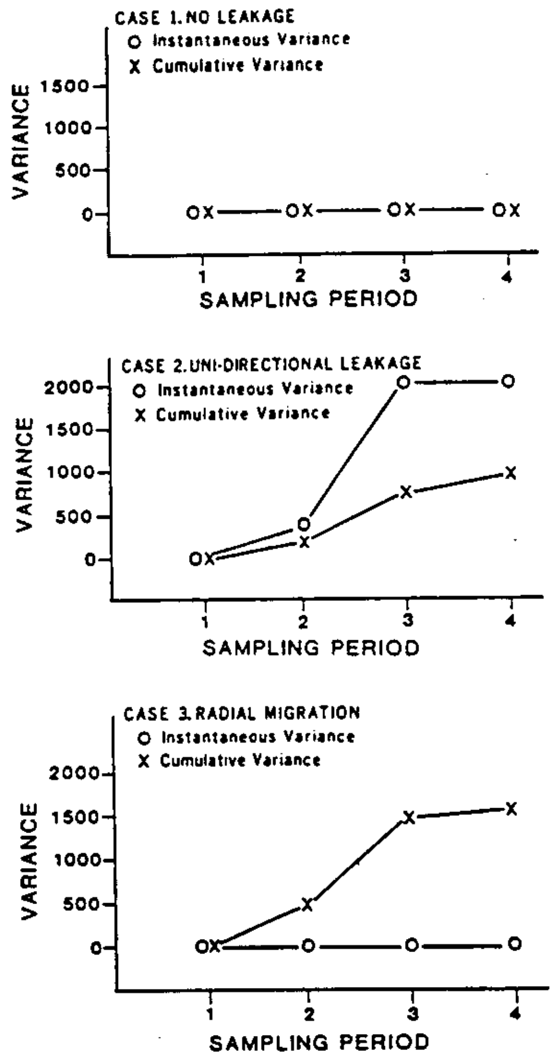


Figure 9. Variance patterns for simulated hazardous waste disposal site monitoring data representing different types of contaminant migration in ground water.

the detection limit listed with the non-detect results were higher than the EPA method detection limit more than 50 percent of the time. Thus, either the correct method was being used but the sample size was less than specified or an alternate analytical method was being used. This situation complicates some of the analytical problems identified earlier. Not only does the requirement to analyze for pesticides not target the major organic contamination problem, utilization of methods that are insensitive reduces the ability to detect minor organic contaminants that may be present (Parolini and Scavetta, 1987).

Technical Reports and Presentations

The following technical reports and presentations have been prepared or are presently being prepared as part of the evaluation of ground-water indicators. Each of these reports discuss the important project findings in greater detail.

Plumb, R. H. Jr. and S. Nacht. "Evaluation of Indicator Parameters for Ground-Water Monitoring. An Interim Report." EPA-600/X-84-053. 55p. 1984.

Plumb, R. H. Jr. and C. K. Fitzsimmons. "Performance Evaluation of RCRA Indicator Parameters." Presentation at the First Canadian/American Conference on Hydrogeology. Practical Applications of Ground Water Geochemistry. Banff, Alberta, Canada. June 20-24, 1984. Proceedings published by the Alberta Research Council/National Water Well Association, p129-137, 1985.

Plumb, R. H. Jr. "Ground-Water Contamination - The Monitoring Problem." Presentation at the Conference on Ground-Water Protection in Mining Areas. Nicolet College, Rhinelander, Wisconsin. March 19, 1985.

Plumb, R. H. Jr. "Disposal Site Monitoring Data: Observations and Strategy Implications." Presentation at the Second Canadian/American Conference on Hydrogeology: "Hazardous Waste in Ground Water - A Soluble Dilemma." Banff, Alberta, Canada. June 22-26 1985. Proceedings published by the Alberta Research Council/National Water Well Association, p69-77, 1986.

Plumb, R. H. Jr. "An Assessment of the RCRA Indicator Parameters for Ground-Water Monitoring." Presentation at the Conference on Waste Disposal: The Coming Crisis. National Solid Wastes Management Association, Boston, Massachusetts. October 28-30, 1985.

Plumb, R. H. Jr. and A. Pitchford. "Volatile Organic Scans: Implications for Ground-Water Monitoring." Presentation at the Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water - Prevention, Detection, and Restoration. Houston, Texas, November 13-15, 1985. Proceedings published by the American Petroleum Institute/National Water Well Association, p207-221, 1986.

Plumb, R. H. Jr. "Water Quality Parameters - Are We On The Right Path." Presentation at the Rocky Mountain Ground Water Conference. Phoenix, Arizona, September 15-17, 1986.

Plumb, R. H. Jr. "A Practical Alternative to the RCRA Organic Indicators." Proceedings at HAZMACON - 87. Association of Bay Area Governments, Santa Clara, California, p135-150. April 21-23, 1987.

Plumb, R. H. Jr. "A Comparison of Ground-Water Monitoring Data from CERCLA and RCRA Sites." Ground Water Monitoring Review, Fall, 1987, pp94-100.

Plumb, R. H. Jr. and J. R. Parolini. "Organic Contamination of Ground Water Near Hazardous Waste Disposal Sites: A synoptic Overview." Presented at the annual Geological Society of America Conference, Phoenix, Arizona. October 26-29, 1987.

Plumb, R. H. Jr. and J. R. Parolini. "An overview of Organic Contamination in Ground Water Near Hazardous Waste Disposal Sites." Presently undergoing revision.

Plumb, R. H. Jr. "Monitoring Data Variance: A New Strategy to Evaluate Ground-Water Monitoring Data. Presented at the Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water, American Petroleum Institute/National Water Well Association, Houston, Texas. November 17-19, 1987.

Plumb, R. H. Jr. "A Critique of the RCRA Ground-Water Monitoring Program." An internal report being prepared for the U.S. Environmental Protection Agency. 1988.

Plumb, R. H. Jr. "Assessment of Volatile Organic Scans as an Alternative RCRA Indicator Parameter." Presently undergoing EPA Policy Review. 1988.

Parolini, J. R. and R. D. Scavetta. "Evaluation of Detection Limit Variability for Ground-Water Monitoring Data From RCRA Sites in Texas and Louisiana." Internal Report prepared for EPA-EMSL-LV. Presently undergoing review. 1987. 36 p.

4. ASSESSMENT OF INDICATOR PARAMETER PERFORMANCE

The concept of using one substance or measurement as an indicator parameter for another substance or a class of compounds is not new in the environmental field. Examples that demonstrate this are:

1. The use of E. coli to monitor for the presence of pathogens in treated water supplies;
2. The development of the BOD procedure to estimate the concentration of organic carbon;
3. The development of the COD procedure to estimate the concentration of organic carbon;
4. The use of carbon-14 to measure algal productivity;
5. The use of dyes, salts, or radioisotopes to estimate ground-water flow patterns and/or velocity.

While each of the indicators mentioned above have been useful in the capacity cited, there are usually limitations on the performance of any indicator. In the examples provided, pathogens may be present in unusual circumstances even though E Coli are absent (Standard Methods, 1985); not all compounds are oxidized equally and the presence of growth-inhibiting concentrations can invalidate BOD test results (Standard Methods, 1985); several reduced inorganic species (sulfide, manganese, and iron) can increase COD results that are incorrectly interpreted as equivalent carbon concentrations (Plumb, 1981); the rate of uptake of carbon-14 by algae is different than the rate of uptake for carbon-12 (Plumb, 1973); and dyes and salts may migrate at a different rate than the ground water that is being monitored. Thus, a prerequisite for selecting any indicator is to determine the conditions or situations for which it functions effectively.

Three sets of performance characteristics have been identified that can be used to assess the utility and effectiveness of indicator parameters for ground-water monitoring. The first set of characteristics for evaluating the performance of potential ground-water indicators includes the 9 functional criteria listed in Table 14 (Miller, 1987). A second set of characteristics is based on technical factors that must be considered when selecting a tracer (indicator parameter) for potential use (Table 15). The third set of factors quantitatively describe the performance of the indicators based on composite monitoring data in the project database. The characteristics in each of these three sets were used to assess the potential for pH, specific conductance, total organic carbon, total organic halogen, and volatile organic analyses to be used as ground-water monitoring indicator parameters. A descriptive assessment of each criterion in the three sets of characteristics is presented in Appendix 3.

Table 14. Functional Criteria Suggested to Assess Indicator Parameters Usefulness*

1. Conceptual Accuracy.
2. Level at which the Indicator Functions.
3. Availability of Data/Ease of Collection.
4. Sampling Accuracy.
5. Measurement Accuracy.
6. Overall Consistency.
7. Time Period to Detect Changes.
8. Volume of Data Required for Implementation.
9. Definition of Baseline Condition.

*After (Miller, 1987).

Table 15. Technical Factors to Consider in Selecting a Tracer (Indicator Parameter) for Ground-Water Monitoring*

1. Should be naturally absent from system being monitored.

2. Should be related to the conditions of concern.
   a. Mechanically (cause and effect)
   b. Mathematically.

3. Environmental behavior of tracer should be similar to the condition or contaminants being monitored.
   a. Natural cycles should be the same.
   b. Tracer should be chemically conservative.
   c. Travel velocity of the tracer should be the same as the contaminant(s) being monitored.

4. Analytical performance characteristics should be known.
   a. Method should be sensitive enough to respond to changes in the constituent of interest.
   b. Method should have suitable precision and accuracy.
   c. Tracer method should be less expensive than direct measurement of the condition or constituent of interest.

*After Plumb and Nacht, 1984.

The functional criteria (Miller, 1987) suggest several differences between the individual ground-water monitoring parameters. For example, both TOC and TOX are conceptually accurate for the intended use but pH is not related to any inorganic constituents except hydrogen ion and hydroxyl ion. Therefore, it would be inappropriate to use observed changes in pH as a basis for requiring more extensive organic characterization of monitoring samples. On the other hand, there are several potential analytical problems associated with the use of the original RCRA organic indicators. One specific example of these limitations is the fact that detection limits for the organic indicators are one to three orders of magnitude above the concentration level necessary to detect organic contaminants when they occur in ground water. Also, the analytical methods for TOX were never subjected to interlaboratory verification before it was selected for use. By comparison, the analytical techniques for volatile organic compounds have been more fully validated, they directly target the largest source of organic contamination, and a pragmatically developed relationship will permit volatile organic analyses to be used as an organic screening technique.

Each of the indicators being evaluated would seem to be limited to some extent by the availability of data. Specific conductance, pH, and TOC are naturally occurring conditions but there is usually insufficient data to define background conditions, differences in regional distribution, or natural temporal cycles. The problem associated with TOX and volatile organic compounds is that data for these parameters have only started to become available in the last five to seven years. Two of the functional criteria, Level of Environmental Data, and Time Period to Reflect Change, do not appear to differentiate between the suitability and utility of the individual indicator parameters.

When the indicators were assessed based on the second set of technical criteria, the results generally reinforced the evaluation summarized above. For example, since pH, specific conductance, and TOC are not naturally absent from an environmental system, their use would be complicated by the need to obtain more data to define background conditions.

While there could be several antropogenic sources for volatile compounds and those detectable with the TOX procedure, their potential use as a tracer should be less complicated than a naturally occurring substance. Other potential problems with each indicator that can be identified with the technical criteria are the fact that pH is not related to a larger class of inorganic constituents, it is not chemically conservative, and the natural cycles, reactivity and travel velocity of specific conductance, TOC and TOX would change from site to site as the contaminants contributing to that group change. Although this would also be true for volatile organic scans, the specific contaminants would be directly monitored. The technical criteria also identify two potential analytical problems. First, only the use of volatile analyses relies on a procedure that is analytically sensitive at the level of interest (i.e., conductivity and TOC are particularly insensitive, pH is not functionally related to other constituents, and TOX is marginally sensitive for detection monitoring). Second, the cost of the TOX procedure is not effective when it is remembered that four replicates per sample are necessary to implement the RCRA strategy.

The project database was used to provide quantitative estimates of the performance of each indicator. This effort suggests that all four of the original RCRA indicators provide a correct response (follow pattern) less than 40 percent of the time and they provide false positive responses between 35 and 43 percent of the time (Table 6). These results, based on monitoring data from several hundred site investigations, suggest that the present method of using RCRA Indicator Parameters is more likely to produce a false positive response than a correct estimate of changing ground-water conditions. By comparison, the performance estimate of volatile scans is that they would provide a correct response 92 percent of the time and the false positive rate and the false negative rate would both be less than 6 percent. Thus, the use of volatile scans would be two to three times more effective than the RCRA (organic) indicators which would improve the level of confidence that can be placed in the monitoring strategy and the cost of false positive responses would be reduced by approximately one order of magnitude.

When the three sets of indicator characteristics are combined, it is possible to arrive at a composite assessment for each of the ground-water indicators. The use of pH is limited by the fact that it is not related, either conceptually or pragmatically, to the large class of inorganic compounds for which it is used as an indicator, pH is not naturally absent from ground-water systems, pH is not chemically conservative, and there is usually insufficient data to define background conditions. The use of conductance is limited by the fact that it is not naturally absent from the system being monitored, there is usually not enough data to define background conditions, the analytical techniques are too insensitive for most applications, and specific conductance was not pragmatically related to other inorganic contaminants at the national, regional, or the site level. The use of specific conductance is further compromised by the measurement of "total" inorganic concentrations rather than "dissolved" inorganic concentrations. The use of TOC as an indicator is limited by the fact that it is not naturally absent from the systems being monitored, there is insufficient data to define background conditions, the analytical techniques are too insensitive for most applications, and TOC was not pragmatically related to other organic contaminants at the national, regional, or the site level. The use of TOX as an indicator is conceptually much stronger than TOC. However, the principal drawbacks to its use as an indicator are related to the absence of data to define background conditions, the marginal sensitivity of the analytical technique, the fact that the analytical techniques have never been validated, and the fact that its use is not cost effective when the required replicate analyses are considered. Furthermore, available data suggests that TOX was not pragmatically related to other organic contaminants at the national, regional, or site level. The major problem with the use of volatile organic analysis as an indicator appears to be due to the limited amount of data to define background conditions. Volatile scan results are not conceptually related to other organic contaminants but this factor appears to be offset by the pragmatic relationship between volatile organic compounds and other organic contaminants that has been developed with the project database.

5. TECHNICAL RATIONALE FOR INDICATOR EVALUATION AND USE

This section shall summarize the rationale for the derivation of the original RCRA indicators and volatile organic analysis, the computations and assumptions relied upon to assess each indicator, the performance of each indicator, and recommendations for the continued use and/or further evaluation of each indicator.

pH as an Indicator

This indicator is useful for monitoring the potential migration of acidic or basic wastes. However, the rationale for using this indicator to monitor other classes of inorganic contaminants is not sufficient to justify its use for this purpose. As stated earlier, pH is not conceptually related to the other classes of inorganic constituents and the performance evaluation of pH as an indicator suggests that it is more likely to give a false response than a correct indication of changing conditions in the ground-water system being monitored. The assumptions that were made in arriving at this performance assessments were (1) that any change in pH should be accompanied by a corresponding concentration change in one or more inorganic analytes and (2) a lack of pH change should be accompanied by a lack of change in all other inorganic constituents. When the data were summarized in a two-dimensional matrix as illustrated in Figure 3, the information in the project database suggests that pH provides a correct assessment of changing ground-water conditions only 39 percent of the time and provides a false indication of changing ground-water conditions over 60 percent of the time.

Since the RCRA program specifies a statistical procedure to determine whether a concentration change has occurred in a downgradient location, this was used when sufficient data were available. However, since the non-indicator parameters do not have to be replicated, relative concentration changes of 10 percent, 25 percent, 50 percent, etc. were used to define concentration changes in order to complete the performance evaluation matrices. Both approaches suggest that pH is a poor surrogate for inorganic constituents (The statistical assessment of change resulted in a performance evaluation roughly equivalent to a 10 percent concentration change and an increasing concentration differential [i.e., 50 percent versus 10 percent] produced a lower level of false positive events and a higher level of false negative events but did not improve the overall performance of the indicator).

The performance evaluation for pH suggests that this parameter should be discontinued as an indicator. Because of the fundamental importance of pH to water quality investigations and the low cost of analysis, pH should be continued to be monitored during site investigations in order to detect potential leakage events involving acids and bases but pH results should not be used to justify the need for more extensive characterization of site monitoring samples.

Specific Conductance as an Indicator

This indicator is conceptually related to virtually all dissolved inorganic chemical species and any organic chemical compound that ionizes in water. Since the ionized organic species would be expected to be a small contributor to the conductivity of a sample, specific conductance was chosen as an indicator of changes in inorganic constituents in ground water. The approach selected to evaluate the performance of specific conductance was the same as that used with pH and the assumptions were the same. If a conductivity increase is detected in a downgradient location, there should be a corresponding concentration increase in one or more inorganic species. Also, if the conductivity does not change in the downgradient location, all of the other inorganic species should remain constant. When these conditions were tested with the project database, the conductivity-analyte data followed a useful pattern only 38 percent of the time. The use of specific conductance as an indicator under these conditions would also have produced 34 percent false positive responses and 12 percent false negative responses.

During the development of the specific conductance performance evaluation matrices, concentration changes were determined statistically and by selecting several concentration differentials ranging from 10 percent to 200 percent. As previously reported for pH, the statistical approach produced results equivalent to those obtained with a 10 percent concentration differential. Also, increasing the concentration differential from 10 percent to 200 percent only increased the occurrence of false negative events at the expense of false positive events (i.e., the method of determining concentration changes did not influence the performance evaluation and only demonstrated that it was not possible to simultaneously reduce the occurrence of false positive and false negative events).

There are at least five factors that contribute to the poor performance of specific conductance as an indicator. First, conductance is a cumulative factor and an increase due to one constituent can be offset or masked by decreases in one or more other constituents. Second, all inorganic constituents do not have the same effect on conductivity. Third, the techniques for measuring conductivity are several orders of magnitude too insensitive to respond to some of the inorganic concentration changes that have been observed. Fourth, the use of conductivity that is specific for ionic chemical species is inconsistent with a monitoring philosophy that measures the total ("dissolved" plus "suspended") concentration of chemical contaminants in collected samples. (At a minimum, this factor will increase the variability of site monitoring data and it could increase the occurrence of false negative events if high total concentrations occur in upgradient locations or it could increase the occurrence of false positive events if high total concentrations occur in downgradient locations). Fifth, since conductivity will change by 2 percent per degree as the temperature of the sample changes between collection and analysis, certain precautions are necessary when analyzing samples and reporting results.

Although the performance estimates for specific conductance would be subjected to change if more complete data were available (more complete data might reduce the level of false positive events but would not effect the level of false negative events), the results suggest that specific conductance is not functioning as an effective indicator parameter. When the project database was reviewed at the national, regional, and site level, it was not possible to define conditions under which conductance was performing in an acceptable or expected manner. Also, it was not possible to identify specific inorganic constituents for which specific conductance was a reliable indicator for general monitoring purposes. Therefore, it is suggested that specific conductance be discontinued as a national indicator parameter for hazardous waste disposal site monitoring. However, specific conductance does provide useful information in its own right (conductance can be used to check anion-cation balances and to determine completeness of analysis) and its use should be continued during site investigations.

TOC as an Indicator

This parameter is conceptually related to all organic compounds that may be detected during a site investigation because all organic compounds contain some carbon which is the substance being measured with the TOC procedure. Therefore, the same matrix approach was used to evaluate the performance of TOC. The conditions that should be met if TOC is an effective indicator are (1) when TOC increases in downgradient locations, then one or more specific organic compound should also increase and (2) when TOC remains constant, all specific organic compounds should remain constant. The performance evaluation for this parameter suggests that TOC provides a correct indication of changing levels of organic contamination in ground water only 10 percent of the time and that false positive events occurred 43 percent of the time. Also, although only 2 percent of the events were false negative events of regulatory concern (a concentration increase associated with a specific organic contaminants not detected by the indicator), the evaluation process suggests that 36 percent of the events would mathematically be considered as false negative events.

During the evaluation of TOC, concentration changes were determined in two ways. Regardless of whether ground-water concentration changes were determined statistically or as a relative change from background, the assessment of TOC as an indicator was the same. As previously reported for pH and specific conductance, the statistical data evaluation procedure specified in the RCRA program produced an indicator evaluation that was roughly equivalent to a concentration differential of 10 percent.

Several factors can be identified as contributing to the poor performance of TOC as an indicator. First, the concentration at which most specific organic compounds are of regulatory concern and the concentration at which most compounds have been detected in ground water during site investigations is generally in the ug/L range. Since the detection limit for both TOC analytical procedures are in the mg/L range, the analytical techniques are too insensitive by 2 to 3 orders of magnitude. Second, the TOC analytical method provides a cumulative value for all organic compounds in the sample being analyzed. Thus, it is possible for an increase in one constituent to be offset or masked by concentration decreases in one or more other constituents. Third, naturally occurring humic acids and fulvic acid compounds may not be completely converted to carbon dioxide in the analytical process and will contribute to site-specific variability. Fourth, samples to be analyzed for TOC are not required to be hermetically sealed during the sample collection process (U.S. EPA, 1986; Standard Methods, 1985; Plumb, 1984). Samples that are collected in a manner suitable for TOC analysis could result in a loss of volatile organic contaminants during the collection, transport, and storage process. The loss of some organic contaminants would contribute to and/or cause the poor correlation between analytical results for specific compounds and TOC.

Although the performance estimates for TOC as an indicator would be subject to change if more complete data were available (more complete data might reduce the level of false positive events but would not effect the level of false negative events), the results suggest that TOC is not functioning as a reliable ground-water indicator. This parameter might be effective in some site-specific situations but its use at the national level and the regional level should be discontinued because the analytical procedures are too insensitive to detect the presence or concentration changes of specific organic contaminants that are being monitored with this indicator.

TOX as an Indicator

This parameter is conceptually related to all organic compounds that have been halogenated (i.e., any organic compound containing one or more atoms of iodide, chloride, bromide, or fluoride). Therefore, the same matrix evaluation approach used for pH, specific conductance, and TOC was used since 1. a downgradient increase in one or more halogenated organic compounds should also increase TOX and 2. a constant level of halogenated organic compounds should be accompanied by a constant TOX concentration. However, the performance evaluation suggests that only 16 percent of the events followed a useful, predictive pattern (Table 6). In contrast, approximately 35 percent of the results in the project database would be considered as false positive events. Thus, information in the database suggests that TOX is not an effective national indicator.

As previously explained with the other RCRA indicators, concentration changes were determined both statistically and for selected concentration differentials in order to develop the performance evaluation matrices. However, the use of different mathematical techniques to determine concentration changes in the ground-water data did not influence the evaluation of TOX as an indicator.

Many of the factors that potentially contribute to the poor performance of TOX as an indicator are similar to those that have been previously mentioned for TOC. First, the detection limit for the TOX procedure is on the order of 25 ug/L. While this is an improvement over TOC, it is still relatively high compared to the concentration events that have been detected and reported for most halogenated organic contaminants. Second, the TOX analytical method provides a cumulative value for all organic compounds that contain halogen atoms in the sample being analyzed. Thus, it is possible for an increase in one constituent to be offset or masked by concentration decreases in one or more other constituents. Third, the TOX analytical procedure is subject to interference from inorganic halides such as chloride that can be highly variable and more abundant than halogenated organic compounds. Fourth, if TOX samples are not handled as volatile samples and hermetically sealed at the time of collection, halogenated volatile compounds can be lost during collection, transport, and storage of samples prior to analysis.

A review of the project database suggests that TOX could be a conceptually effective indicator because the most abundant organic ground-water contaminants at the national and the regional level are halogenated volatile organic compounds. However, the use of TOX as an indicator appears to be limited by practical factors related to the development and evaluation of the analytical procedure. Therefore, the use of TOX as an indicator should be discontinued until the analytical procedure, including the effects of inorganic ions, sample concentration, sample desorption, and the temperature at which compounds are decomposed, have been more fully evaluated and documented for the wide range of contaminants to be encountered in ground-water samples. Also, sample collection guidance associated with the use of the TOX procedure should stress the importance of handling TOX samples in a manner that reduces the potential loss of volatile organic compounds prior to analysis.

Volatile Organic Analysis as an Indicator

A review of the project database has suggested the possible utility of volatile organic analysis as an alternative hazardous waste disposal site ground-water indicator. The use of volatile organic analyses in this capacity is based on a series of trends that have been observed in the database. For example, 9 of the top 10 and 16 of the top 20 most frequently detected organic contaminants are volatile organic compounds. A ranking of ground-water contaminants based on average concentration, maximum concentration, or number of sites at which the compounds were reported would also indicate the predominance of volatile organic compounds. Furthermore, the national database, regional subsets of the database, and site-specific subsets of the database produced cumulative detection curves such as those presented in Figure 6. The pattern displayed by this family of curves suggested that it might be possible to use analysis for volatile organic compounds as a screening technique to determine the need for more extensive organic analysis of hazardous waste disposal site monitoring samples (i.e., if volatile compounds are absent or present at some low level, the family of curves in Figure 6 would suggest that there is no need to analyze for acid extractable compounds, base/neutral compounds, or pesticides). The predominance of volatile compounds in ground water is also demonstrated by the fact that pairs of volatile compounds have been detected more frequently than single occurrences of non-volatile organic contaminants (Figure 5). Eventually, the observations concerning the abundance of volatile organic compounds in ground water led to the development of a quantitative relationship between the number of volatile organic compounds and the total number of organic compounds detected during a site investigation (Figure 7). This relationship was originally developed with monitoring data from 114 site investigations and subsequently validated with independent data from 49 site investigations.

A matrix approach was also used to evaluate the performance of volatile organic analysis as an indicator. However, instead of plotting relative downgradient change, the matrix consisted of a plot of number of detected volatile compounds versus number of detected organic compounds. As summarized in Table 10, this information suggests that volatile organic scans would provide a useful response 92 percent of the time with 0 to 6 percent false positive events and 2 to 6 percent false negative events. Corresponding estimates for the original RCRA indicators were 10 to 40 percent useful responses, 35 to 45 percent false positive responses, and 2 to 12 percent false negative responses.

The quantitative relationship provides a means to develop a monitoring strategy based on the occurrence of volatile organic contaminants. An evaluation of this approach with the project database suggests that this strategy would be more effective than one based on the original RCRA indicators. Although this approach was pragmatically developed in response to observed trends in the database rather than being conceptually developed (as was the case with the RCRA indicators), it is possible to provide additional rationalization in support of the use of volatile organic analysis as a ground-water indicator. Specifically, volatile compounds are generally manufactured in greater quantities than most non-volatile organic compounds and the strategy would directly target the (generally) most soluble and (generally) most mobile class of organic contaminants that are likely to be migrating from a hazardous waste disposal site. Finally, more extensively evaluated analytical methods are available to analyze samples for volatile organic compounds (SW 846 Method 8240 and SW 846 Method

8010) and the optimum instrumental detection limits associated with these methods are in the low ug/l range, or lower (U.S. EPA, 1986).

A comparison of the passive evaluation of volatile organic compounds as an indicator to those obtained for TOC and TOX suggests that the effectiveness of the RCRA monitoring program can be improved by using an alternative organic strategy based on the occurrence of volatile organic contaminants. First, the volatile strategy would directly target the organic contaminants produced in the largest quantity. Also, this approach would target the specific organic contaminants demonstrated to be most frequently detected in ground water and generally considered to be the most mobile class of contaminants (based on a consideration of their octanol-water partitioning coefficient). Second, the volatile strategy was evaluated as being 90 to 95 percent effective compared to 10 to 17 percent effective for TOX and TOC. Third, the volatile strategy reduces the level of false responses (false negative plus false positive) to less than 10 percent compared to 45 to 50 percent for TOC and TOX. Fourth, evaluated analytical methods are available for volatile compounds (which is not the case for TOX) and these methods are one to three orders of magnitude more sensitive than those available for either TOC or TOX. Thus, the volatile strategy offers a practical alternative that also avoids the identified analytical weaknesses of the original RCRA ground-water monitoring strategy.

The database compiled to evaluate indicator parameters consists of RCRA Subtitle C monitoring data, CERCLA monitoring data, and municipal landfill data. Since volatile compounds were shown to be the predominant organic contaminant in each subset of the database and volatile organic analysis was apparently more effective than either of the RCRA organic indicator parameters, it is recommended that routine monitoring for volatile organic compounds should be an integral portion of any national regulatory strategies for monitoring RCRA Subtitle C sites, RCRA Subtitle D sites, and Superfund sites. It is also recommended that a proactive program be initiated to conduct further evaluations of the performance of volatile organic analysis as an alternative indicator. This would essentially involve the use of volatile organic analyses in on-going site investigations in order to arrive at real-time assessments of the accuracy of the volatile strategy under various conditions.

Inorganic Indicators

The RCRA program specified two indicators, pH and specific conductance, to be used for monitoring changes in concentration and abundance of inorganic constituents in ground water. Since the performance evaluation based on information contained in the project database suggest that the specified indicators are not working in a reliable manner, there is a continued need to develop an alternative inorganic indicator or an alternative strategy for using inorganic site monitoring data. Therefore, it is recommended that efforts continue to be expended to identify an appropriate inorganic monitoring strategy. It is too early to determine whether one approach would function in several programs (as with the suggested use of volatile organic analysis) or whether each regulatory program would require a different inorganic monitoring strategy. However, based on problems identified with the use of specific conductance as an indicator, it is further recommended that the development of an inorganic ground-water monitoring strategy focus on the "dissolved" or filtered portion of the inorganic constituents that may be present. This recommendation is based on the fact that "dissolved" or ionic constituents would be expected to be more mobile in ground-water environments (because migration of particulate chemical species would not be the major transport mechanism in quiescent, laminar flow systems). Besides avoiding the problem of sample contamination with particulate matter during collection, this approach will permit inorganic data to be used in conjunction with conductivity data for completeness of inorganic analysis calculations and anion/cation balances (QA/QC considerations).

Utilization of Indicator Parameter Data

One critical element of any indicator strategy is a mechanism to use the resultant data in a decision-making process. The current conceptual approach is based on the detection of increased concentration levels of the indicators and other parameters being monitored in downgradient locations. While this approach works in large regional studies, a review of the project database suggests that it may not be universally applicable at the smaller scale of a waste site investigation. For example, 25 percent of the organic priority pollutants have shown some tendency for high concentrations and/or frequencies of detection in upgradient locations (Figure 8). Since it would be possible for density current formation, vadose zone diffusion, fluctuating water table conditions, and human error to account for these observations, a second ground-water monitoring data evaluation technique was developed as an alternative to the classical upgradient-downgradient approach.

The alternative data evaluation technique is based on the variance of the monitoring data. When a facility is not leaking, the upgradient and downgradient monitoring data should be essentially identical and the calculated variance of data from the monitoring network will be minimal and ideally approach zero. However, when contaminants migrate from the facility, the variance of the data will increase exponentially. As suggested in Figure 9, this approach is not dependent on an assumed chemical migration pattern and even produces different fingerprints for distinct migration patterns. Thus, the alternative use of variance addresses the universal case of contaminant migration in ground water while the upgradient-downgradient approach only addresses one specific case.

The project database was used to develop action levels expressed in terms of variance in order to implement the alternative data evaluation technique. For each ground-water contaminant, the data were used to calculate the variance at each site in the database. These values were then used to prepare a cumulative variance curve for each contaminant. As shown in Figure 10, these cumulative variance curves displayed an apparent discontinuity at the upper portion of the curve that was attributed to the occurrence of leakage events (The lower portion of the curve represents non-leakage situations by definition, the middle of the curve represents variance that might be expected due to analytical uncertainty and natural variability during monitoring, and the upper portion of the curve represents the higher variability that would be associated with leakage events and low quality data). This discontinuity, or point of inflection, was present in the cumulative variance curves for volatile compounds, acid extractable compounds, base/neutral compounds, pesticides, and inorganic constituents and provided the basis for initial variance action limits for 132 ground-water contaminants (Appendix 2).

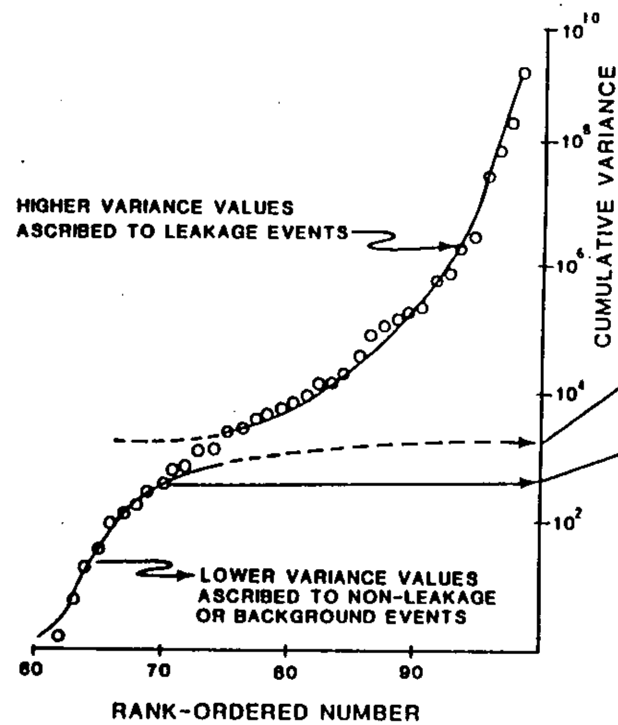
A preliminary assessment of the variance action limits suggests that they are reasonably rugged. When the limits were applied to the CERCLA portion of the database, 618 apparent leakage events were identified. After the action limits were arbitrarily doubled and applied to the same portion of the data base, 94 percent of the same events were identified. Furthermore, when the variance action limits were applied to the CERCLA database, the identified leakage events were not randomly distributed across the sites. In fact, when the leakage action limits were exceeded at a site, the situation usually involved three or more contaminants at the same site (i.e., there was a clustering of contaminants that appeared to be leaking).

The variance action limits were coupled with the previously discussed concept of using volatile organic analysis as an organic screening technique to develop an alternative protocol for evaluating disposal site monitoring data. This protocol, Figure 11, is consistent with the philosophy encompassed in the RCRA strategy documents (install a monitoring network, conduct a detection monitoring program to identify sites that require more extensive monitoring, and identify a more aggressive assessment monitoring program for sites that may be functioning improperly). The essential elements of this protocol are:

1. Install a monitoring well network. Multiple upgradient and multiple downgradient wells are suggested.

2. Sample the network at routine intervals.

3. Analyze filtered samples for two groups of inorganic constituents (essentially major ions and trace metals).



RANK ORDER	CUMULATIVE VARIANCE VALUE	INDIVIDUAL VARIANCE VALUE
83	15092	4074
82	11018	3352
81	7666	1368
80	6298	1356
79	4942	1242
78	3700	600
77	3100	592
76	2508	590
75	1918	551
74	1367	306
73	1061	247
72	814	241
71	573	230
70	343	77
69	266	76
68	190	63
67	127	48
66	79	43
65	36	19
64	16.5	11
63	5.5	4
62	1.5	1

SUGGESTED VARIANCE ACTION LIMIT

SUGGESTED NON-LEAKAGE LIMIT

Figure 10. Development of variance action limits for 1,1-Dichloroethene.

ALTERNATIVE HAZARDOUS WASTE DISPOSAL SITE GROUND-WATER MONITORING PROTOCOL

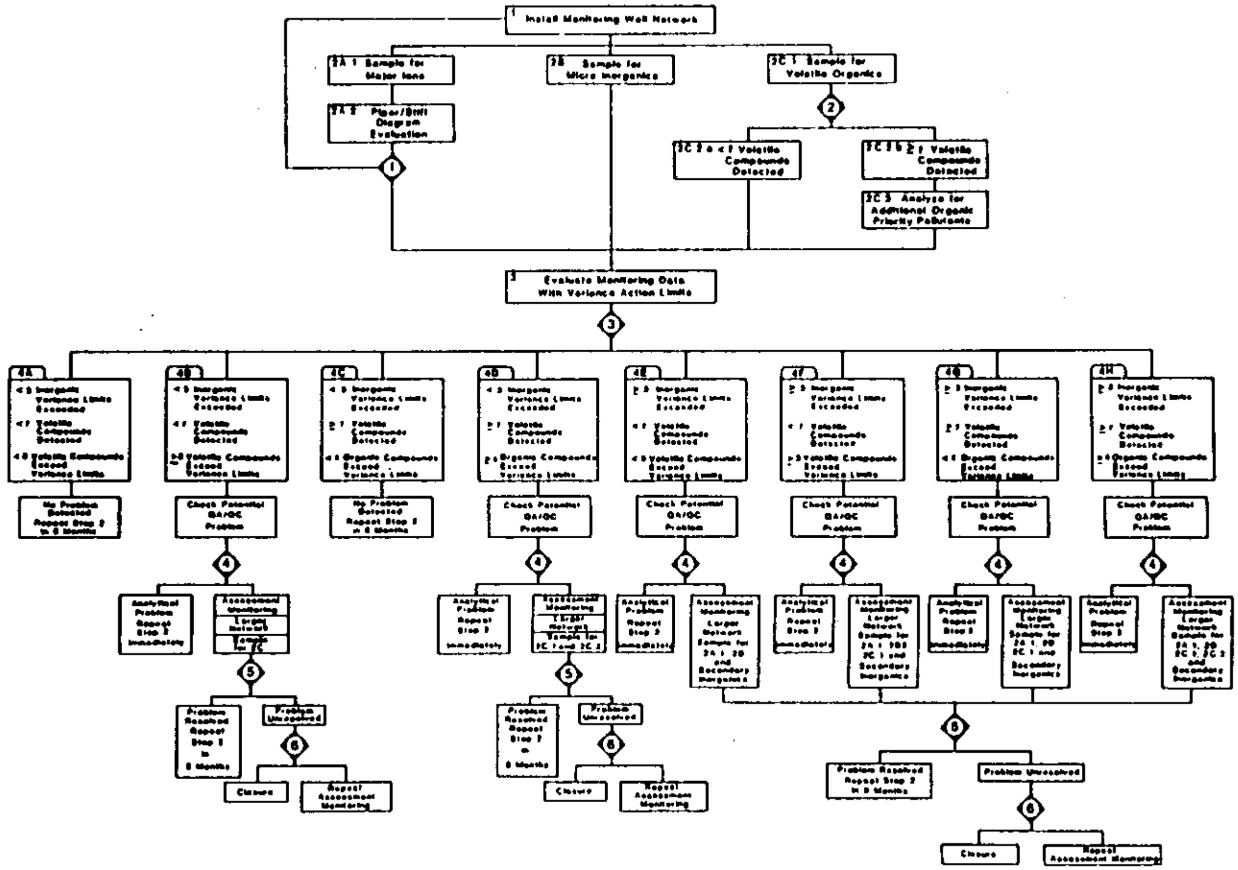


Figure 11. Alternative hazardous waste disposal site protocol for ground-water monitoring.

4. Analyze samples for the presence of volatile organic constituents. If the number of volatile compounds detected exceeds six, additional priority pollutant analysis would be triggered.

5. Determine the data variance for each contaminant that is being monitored.

6. Based on the number and chemical classification of the contaminants that exceed the variance action limits, follow the graduated assessment monitoring program that corresponds to a suggested site specific assessment monitoring program.

The alternative protocol offers several perceived advantages. First, the approach incorporates routine volatile organic monitoring which directly targets the most frequently detected class of organic contaminants in ground water in the vicinity of waste disposal sites. Second, it uses volatile organic analysis results as an indicator to determine the need for more extensive organic analysis. Third, additional organic analysis is restricted to the organic priority pollutants based on composite monitoring results at approximately 500 sites. Fourth, the protocol specifies filtered inorganic analyses which should target the most mobile inorganic phase. Fifth, the protocol uses variance to evaluate monitoring data so that all the monitoring data can be more effectively used in a consistent manner during a site evaluation. Sixth, the protocol decision tree defines a graduates assessment monitoring response based on detection monitoring results.

The ground-water monitoring protocol has potential applicability to several national-scale monitoring programs. It is recommended that consideration be given to the use of this alternative protocol during RCRA Subtitle C site investigations because of the advantages that can be realized and the identified problems of the current RCRA monitoring approach that can be avoided. Furthermore, the approach embodied in the protocol should result in more cost effective monitoring at RCRA sites that have filed for closure. Also, because of the diverse nature of the database used to develop the protocol, it is recommended that the protocol be considered for use in the RCRA Subtitle D program and for CERCLA investigations.

There are three specific areas of the alternative protocol that require additional effort. First, the initial variance action limits for inorganic constituents are based on "total" concentration monitoring results and are therefore probably biased high. Additional effort is needed to compile "dissolved" or filtered inorganic monitoring results in order to develop more effective inorganic action limits. Second, inorganic classifications in the protocol are subjective. With additional effort, it might be possible to define a more practical or more functional classification of required inorganic analyses. Third, a general effort is needed to verify the usefulness and performance of the initial variance action limits that have been developed.

6. DATABASE APPLICATION OF OTHER RESEARCH PROJECTS

The project database was initially compiled to evaluate the performance of the four indicator parameters (pH, specific conductance, total organic carbon, and total organic halogen) specified for use in the Detection Monitoring phase of the RCRA program. The database has subsequently been used to explore other topics of interest to the RCRA program. As discussed earlier, these topics include the summation of reported organic contamination of ground water in the vicinity of hazardous waste disposal sites, the efficacy of an Appendix VIII or an Appendix IX monitoring strategy, the identification of an alternative organic monitoring strategy (volatile scans), the evaluation of volatile action limits to implement the use of volatile scans, limitations of the upgradient-downgradient data evaluation technique, the development of an alternative data evaluation technique (variance), and the development of initial contaminant specific action limits to implement the alternative data evaluation technique. In addition to the utilization of the database for research efforts conducted in support of the RCRA program, the database was used as a resource during other cooperative research projects. The following list identifies the organizations and/or projects that have utilized the information summarized in the project database.

1. EPA-OMSQA funded Research Triangle Institute and Lockheed-EMSCO to compile quality assurance data for Routinely Used Measurement Methods (RUMM). The project database was used to prioritize the order in which analytical methods were included in the RUMM study (i.e., since volatile compounds were most abundant, these methods were summarized first, followed by base/neutral compounds, etc.). May, 1986-September, 1987.

2. The database provided the first comprehensive summary of the frequency of occurrence and concentration range of chemical contaminants in disposal site ground water. Summary printouts of the database were provided to Dave Bottrell, EMSL-LV. Rather than subjectively preparing QC check samples for laboratories participating in the Contract Laboratory Program (CLP), Bottrell used the database to prepare QC check samples and preaward samples that reflected the chemical contaminants and concentration ranges that would be expected during site investigations. Thus, the database was used to modify the QA/QC activities on an Agency-wide analytical support program (CLP). 1986 to present.

3. Monitoring results for 35 organic contaminants, mostly volatile compounds, were provided to Steve Clark, EPA-Headquarters. This data was used as background information in the development of national water quality criteria for the 35 compounds. September, 1985.

4. A portion of the database was provided to Charles Whitehurst after he assumed Directorship of the NASA facility in Bay St. Louis, Mississippi. The data related to a spatial variability problem but the ultimate use of the data is unknown. March, 1986.

5. A duplicate copy of the database was provided to Dr. Rajagopal, University of Iowa. The data will be used to statistically analyze the occurrence and distribution of ground-water contaminants. October, 1986 to present.

6. Portions of the RCS database were provided to Dr. Tom Starks, UNLV-ERC. The data is being used to identify time-series trends in the ground-water data and to conduct other statistical assessments of the data. December, 1986 to present.

7. State-by-state summaries of the database were provided to Alan Welsh of the U.S. Geological Survey, Carson City, Nevada at the request of Ann Pitchford, EPA-EMSL-LV Task Monitor. The use of the data was not specified. January, 1987.

8. Data summaries were provided to Ed Lawless and Gerry Flora of Midwest Research Institute, Kansas City, Missouri. The information is being used to evaluate an EPA requirement to analyze ground-water samples for the Appendix IX constituents. December, 1986 and April, 1987.

9. Database summaries were provided to Dean Radtke, U.S. Geological Survey, Tucson, Arizona. The information is being used as part of an urban run-off contamination study. December, 1986.

10. On several occasions, database summaries have been provided to Sobatka, Inc. in Washington, D.C. The company was working on a project funded by EPA-Headquarters to evaluate Appendix VIII monitoring requirements. June, 1987.

11. Data from the CERCLA portion of the database were sent to EPA-Headquarters in return for updated information on the National Priorities Site List. This is part of an ongoing study by Lockheed-EMSCO to evaluate the current Hazard Ranking System used to classify and rank waste disposal sites. February, 1987.

12. Regional database summaries were sent to each of the EPA offices for general use and information.

13. Based on feedback received in response to data and published reports, project output has been influential in modifying the monitoring programs in at least four states (Wisconsin, West Virginia, South Dakota, and New York).

14. Waste Management, Inc. has cited various project outputs as justification in seeking a variance from the RCRA program requirements. The outcome of these requests is unknown.

15. More than 500 copies of project reports have been distributed in response to requests that have been received.

Based on the cooperative research projects mentioned above, the project database has been or is currently being used by five federal agencies (EPA-Headquarters, EPA-EMSL-LV, USGS-NV, USGS-AZ, and NASA-MS), four states (Wisconsin, West Virginia, South Dakota, and New York), two universities (University of Iowa and University of Nevada Las Vegas), four private firms (Sobotka, Inc., MRI, Labatt Anderson, and WMI), and at least three internal Lockheed projects.

7. SUMMARY

This report describes activities that have been conducted on a project undertaken to evaluate the use of indicator parameters for ground-water monitoring as specified in the RCRA program. The approach used to achieve the project objectives consisted of compiling ground-water monitoring data from approximately 500 ongoing site investigations across the nation. The resultant dedicated database presently consists of analytical records for more than 1100 chemical contaminants that have been detected in the ground water at one or more sites.

The project database has been valuable resource for evaluating specific requirements of a national ground-water monitoring strategy. Important results and observations that are based on a review of the database include:

1. Each of the original four RCRA indicator parameters are functioning poorly and are more likely to give an incorrect assessment of changing ground-water conditions than a correct assessment.

2. The abundance of volatile organic contaminants in independent subsets of the national database and regional subsets has been documented.

3. A quantitative relationship has been developed and verified between volatile organic compounds and organic priority pollutants that would permit routine analysis for volatile organic compounds to be used as an indicator to estimate the need for more extensive organic analysis of ground-water samples. A performance evaluation of this

proposed alternative organic indicator suggests that it would be 92 percent effective compared to performance estimates of less than 40 percent for the original RCRA indicators.

4. Information in the database suggests that the upgradient-downgradient model used in the evaluation of indicator parameter monitoring data may not be universally valid since 25 percent of the organic priority pollutants have displayed inconsistent behavior. An alternative method of evaluating monitoring data based on variance has been identified that is independent of the direction of contaminant migration. First-generation action limits that would permit the implementation of the variance concept have also been developed. It is believed that the application of these limits can increase the effective utilization of data and reduce annual monitoring costs.

An evaluation of the suitability and performance of indicator parameters for ground-water monitoring was completed using functional criteria, technical criteria, and pragmatic performance estimates developed with the aid of the project database. This approach has identified several factors that contribute to the poor performance of the original RCRA indicators and provides additional support for the use of routine volatile organic analysis as an alternative ground-water indicator. First, although both specific conductivity and TOC are conceptually related to the substances of concern that are being indirectly monitored, the analytical methods are insensitive. The compounds being indirectly monitored occur in the ground water at the μg/L level but the detection limit for TOC and specific conductance are at the mg/L (1000 μg/L) level. Thus, the analytical techniques for these indicators are 2 to 3 orders of magnitude too insensitive for most applications. Second, the same assessment appears to be valid for TOX except that the method is only insensitive by one order of magnitude. However, the analytical method has never been validated, its use is subject to interference by naturally occurring and variable concentrations of inorganic halides (notably chloride), and the technique is marginally cost ineffective when one considers that four replicates per location are required to use the indicator. Third, both TOC and TOX results can be biased by poor or improper sample collection, transportation, and storage procedures. Fourth, the use of pH as an inorganic indicator is limited because it is not related to the substances being monitored (either functionally or mathematically). Fifth, the use of pH, specific conductance, and TOC as indicators will be limited in situations that do not generate sufficient data to define background conditions. Sixth, routine volatile organic analysis appears to be a viable alternate organic indicator because it directly targets the most frequently detected class of organic ground-water contaminants, the analytical methods have been validated, the sensitivity of the analytical method is appropriate for the level of contamination that has been reported, and the performance estimate suggests that it would be 3 to 9 times more effective than either TOC or TOX.

Based on the results obtained from the evaluation of current ground-water indicators, the following recommendations are suggested for continued use and/or further evaluation.

1. Both pH and specific conductance should be discontinued as general purpose ground-water indicators. However, because both parameters represent useful water quality characteristics, they should be routinely incorporated in ground-water investigation/monitoring activities.

2. TOC should be discontinued as a general purpose indicator since the available analytical technique is too insensitive.

3. TOX should also be discontinued as a general purpose indicator at this time. However, the analytical technique should be validated and efforts should be continued to define conditions for which TOX might be useful.

4. Routine monitoring for volatile organic contaminants should be initiated as an alternative organic monitoring indicator. The composite information in the project database suggests that this would be an effective strategy at the national and regional level. Also, this alternative indicator appears to have potential utility for RCRA Subtitle D and CERCLA site monitoring programs. A field program should be initiated to further verify the use of volatile organic analyses in this capacity.

5. A review of the project database suggests that the current upgradient-downgradient model is based on an assumed chemical behavior pattern that may not be correct for all hazardous waste disposal site investigations. An alternate data evaluation technique based on monitoring data variance has been identified that avoids this problem. The variance approach would enhance the use of monitoring data and permit all data to be evaluated with the same method (currently, indicator data is statistically analyzed but non-indicator data can not be evaluated with this technique since the results are not required to be submitted in replicate). The approach also appears to be potentially applicable to RCRA Subtitle D and CERCLA investigations.

6. An alternate decision tree has been developed for the evaluation of disposal site monitoring data based on the use of volatile organic analysis and monitoring data variance. Since this approach corrects many of the identified weaknesses and limitations of the current RCRA program, it is recommended that this approach be implemented in the RCRA Subtitle C, RCRA Subtitle D, and the CERCLA ground-water monitoring programs.

7. Continued efforts are necessary to define a national inorganic indicator or monitoring strategy. It is recommended that this effort focus on the "filtered" or "dissolved" portion of the inorganic constituents in ground water. Total concentrations should be avoided since these results will not be representative of contaminants migrating from the site being monitored and the use of particulate concentration data will enhance data variability and the occurrence of false positive and false negative events.

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NOTICE

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APPENDIX 1

Ranking of Organic Priority Pollutants Based on Composite Monitoring Data from Approximately 500 Disposal Site Investigations

Rank	Chemical	Analytical Classification	Analytical Attempts	Detection Frequency
1	Methylene Chloride	Volatile	10815	33.24
2	Trichloroethene	Volatile	12321	30.11
3	Tetrachloroethene	Volatile	12776	21.23
4	trans-1,2-dichloroethene	Volatile	11188	20.12
5	Phenol	Acid	3303	18.80
6	Acetone	m. Volatile	1445	16.96
7	Chloroform	Volatile	11236	16.30
8	1,1-dichloroethene	Volatile	11012	13.91
9	1,1-dichloroethane	Volatile	11328	13.21
10	1,1,1-trichloroethane	Volatile	11994	12.13
11	bis-(2-ethylhexyl)phthalate	Base/neutral	2899	11.62
12	Naphthalene	Base/Neutral	2949	10.34
13	Toluene	Volatile	10729	10.15
14	Benzene	Volatile	10550	9.56
15	1,2-Dichloroethane	Volatile	11319	9.05
16	O-xylene	m. Volatile	1057	8.23
17	2-Butanone	m. Volatile	2248	6.90
18	Isophorone	Base/Neutral	2810	6.09
19	Ethyl Benzene	Volatile	9954	5.86
20	Vinyl Chloride	Volatile	8177	5.60
21	4-Methyl phenol	m. Acid	404	5.45
22	Chlorobenzene	Volatile	9793	5.37
23	2,4-Dimethylphenol	Acid	2724	4.51
24	2-Methylphenol	m. Acid	491	4.28
25	1,4-Dichlorobenzene	Base/Neutral	2842	4.26
26	Carbon Tetrachloride	Volatile	11133	4.05
27	Di-N-Butyl Phthalate	Base/Neutral	2820	3.87
28	1,2-Dichlorobenzene	Base/Neutral	2861	3.84
29	Chloroethane	Volatile	8090	3.11
30	4-Methyl-2-pentanone	m. Volatile	1274	3.06
31	Diethyl Phthalate	Base/Neutral	2843	3.02
32	Styrene	m. Volatile	1197	2.84
33	Fluorene	Base/Neutral	2722	2.61
34	Benzamine	m. Base/Neutral	467	2.57
35	Alpha BHC	Pesticides	2893	2.52
36	2,4-D	RCRA Pesticide	5039	2.48
37	Phenanthrene	Base/Neutral	2718	2.39
38	Butyl Benzyl Phthalate	Base/Neutral	2731	2.34
39	Fluoranthene	Base/Neutral	2767	2.31
40	Pentachlorophenol	Acid	2718	2.24
41	Fluorotrichloromethane	Volatile	8456	2.18
42	Lindane	Pesticide	7706	2.15
43	Delta-BHC	Pesticide	2853	2.14

Ranking of Organic Priority Pollutants Based on Composite Monitoring Data from Approximately 500 Disposal Site Investigations (cont'd)

Rank	Chemical	Analytical Classification	Analytical Attempts	Detection Frequency
44	Acenaphthene	Base/Neutral	2708	2.03
45	Pyrene	Base/Neutral	2696	2.00
46	Beta-BHC	Pesticide	2895	1.93
47	Dichlorodifluoromethane	Volatile	7874	1.75
48	2,4,6-Trichlorophenol	Acid	2724	1.58
49	1,2-Dichloropropane	Volatile	10223	1.54
50	1,2,4-Trichlorobenzene	Base/Neutral	2727	1.54
51	Di-N-Octyl Phthalate	Base/Neutral	2718	1.51
52	Silvex	RCRA Pesticide	4994	1.46
53	1,1,2-Trichloroethane	Volatile	13196	1.45
54	Hexachloroethane	Base/Neutral	2812	1.35
55	p-Chloro-m-cresol	Acid	2702	1.33
56	2,4-Dichlorophenol	Acid	2698	1.33
57	Dieldrin	Pesticide	2896	1.31
58	PCB-1260	Pesticide	3212	1.28
59	Anthracene	Base/Neutral	2694	1.26
60	PCB-1242	Pesticide	3212	1.25
61	Benzoic Acid	m. Acid	408	1.23
62	Hexachlorobutadiene	Base/Neutral	2794	1.22
63	Endosulfan Sulfate	Pesticide	2730	1.17
64	PCB-1254	Pesticide	3230	1.15
65	Acenaphthylene	Base/Neutral	2739	1.13
66	Endrin	Pesticide	7777	1.04
67	Methoxychlor	RCRA Pesticide	5074	1.02
68	2-Methylnaphthalene	m. Base/Neutral	407	0.98
69	bis-(2-chloroethyl)ether	Base/Neutral	2683	0.97
70	1,3-Dichlorobenzene	Base/Neutral	3155	0.95
71	2-Chlorophenol	Acid	2712	0.92
72	Dimethyl phthalate	Base/Neutral	2711	0.89
73	2-Hexanone	m. Volatile	964	0.83
74	4,4'-DDE	Pesticide	2831	0.81
75	Chlordane	Pesticide	2904	0.79
76	Hexachlorobenzene	Base/Neutral	2794	0.64
77	4,4'-DDD	Pesticide	2904	0.64
78	PCB-1248	Pesticide	2971	0.64
79	Toxaphene	Pesticide	8082	0.64
80	Carbon Disulfide	m. Volatile	1005	0.60
81	4,4'-DDT	Pesticide	2902	0.59
82	Bromodichloromethane	Volatile	10821	0.57
83	1,1,2,2-Tetrachloroethane	Volatile	10529	0.54
84	Vinyl Acetate	m. Volatile	926	0.54
85	2-Nitrophenol	Acid	2672	0.52
86	4-Nitrophenol	Acid	2745	0.47
87	N-Nitrosodiphenylamine	Base/Neutral	2662	0.45
88	Nitrobenzene	Base/Neutral	2742	0.44
89	2,4,5-Trichlorophenol	m. Acid	454	0.44
90	Chrysene	Base/Neutral	2757	0.40
91	bis(2-chloroisopropyl)ether	Base/Neutral	2707	0.33
92	Chloromethane	Volatile	8117	0.33
93	Benzo(a)pyrene	Base/Neutral	2706	0.33
94	PCB-1248	Pesticide	3211	0.31

Ranking of Organic Priority Pollutants Based on Composite Monitoring Data from Approximately 500 Disposal Site Investigations (cont'd)

Rank	Chemical	Analytical Classification	Analytical Attempts	Detection Frequency
95	Dichlorodifluoromethane	Volatile	7874	0.30
96	Hexachlorocyclopentadiene	Base/Neutral	2795	0.29
97	Heptachlor Epoxide	Pesticide	2823	0.28
98	Benzyl Alcohol	m. Base/Neutral	391	0.26
99	Dibenzofuran	m. Base/Neutral	391	0.26
100	4-Nitroaniline	m. Base/Neutral	402	0.25
101	Benzidine	Base/Neutral	2647	0.23
102	Benzo(a)anthracene	Base/Neutral	2748	0.22
103	Endosulfan I	Pesticide	2786	0.22
104	2-Chloroethylvinyl ether	Base/Neutral	9802	0.20
105	4-Chlorophenyl phenyl ether	Base/Neutral	2693	0.19
106	Bromoform	Volatile	10611	0.19
107	3,3'-Dichlorobenzidine	Base/Neutral	2706	0.15
108	2,4-Dinitrotoluene	Base/Neutral	2736	0.15
109	2,6-Dinitrotoluene	Base/Neutral	2707	0.15
110	2,4-Dinitrophenol	Acid	2707	0.15
111	Benzo(b)fluoranthene	Base/Neutral	2706	0.15
112	Endrin Aldehyde	Pesticide	2752	0.15
113	PCB-1016	Pesticide	3210	0.12
114	bis(2-Chloroethoxy)methane	Volatile	2710	0.11
115	2,4-Dinitro-2-methyl phenol	Acid	2695	0.11
116	N-Nitrosodi-N-Propylamine	Base/Neutral	2707	0.11
117	2-Chloronaphthalene	Base/Neutral	2735	0.11
118	Acrolein	Volatile	9662	0.10
119	PCB-1232	Pesticide	3209	0.09
120	Bromomethane	Volatile	8091	0.07
121	Benzo(k)fluoranthene	Base/Neutral	2703	0.07
122	Benzo(ghi)perylene	Base/Neutral	2702	0.07
123	Dibenzo(a,h)anthracene	Base/Neutral	2705	0.07
124	Aldrin	Pesticide	2878	0.07
125	trans-1,3-Dichloropropene	Volatile	9911	0.06
126	cis-1,3-Dichloropropene	Volatile	10464	0.06
127	Acrylonitrile	Volatile	9655	0.04
128	1,2-Diphenylhydrazine	Base/Neutral	2685	0.04
129	4-Bromophenyl phenyl ether	Base/Neutral	2707	0.04
130	PCB-1221	Pesticide	3209	0.03
131	Indeno(1,2,3-CD)pyrene	Base/Neutral	2705	0.00
132	Endosulfan II	Pesticide	2780	0.00
133	2,3,7,8,-TCDD	Pesticide	1555	0.00
134	4-Chloroaniline	m. Base/Neutral	433	0.00
135	2-Nitroaniline	m. Base/Neutral	390	0.00
136	3-Nitroaniline	m. Base/Neutral	390	0.00

An "m" designation signifies a miscellaneous compound. These substances are capable of being analyzed with the indicated analytical group but are frequently not reported. For example, acetone can be determined by EPA Method 8240 but is not routinely included in analytical results.

APPENDIX 2

Suggested Variance Non-Leakage Limits and Variance Action Levels
for Evaluating Hazardous Waste Disposal Site Ground-Water Monitoring Data

	Concentration Units	Non-Leakage Limit	Action Level	Below Non-Leakage	Above Action Level	Total %
VOLATILE COMPOUNDS						
Acrolein	µg/L	50	500	98	2	100
Acrylonitrile	µg/L	50		100	0	100
Benzene	µg/L	150	2000	71	23	94
Carbon Tetrachloride	µg/L	75	500	87	8	95
Chlorobenzene	µg/L	50	250	79	14	93
1,2-Dichloroethane	µg/L	150	500	80	16	96
1,1,1-Trichloroethane	µg/L	200	750	65	30	95
1,1-Dichloroethane	µg/L	250	1000	69	27	96
1,1,2-Trichloroethane	µg/L	50	250	88	11	99
1,1,2,2-Tetrachloroethane	µg/L	100	200	95	4	99
Chloroethane	µg/L	50	300	88	6	94
2-Chloroethylvinyl ether	µg/L	50		99		99
Chloroform	µg/L	100	500	68	26	94
1,1-Dichloroethene	µg/L	100	500	71	24	95
1,2-trans-Dichloroethene	µg/L	200	1000	64	32	96
1,2-Dichloropropane	µg/L	100	200	92	6	98
1,3-trans-Dichloropropane	µg/L	100	250	98	1	99
Ethyl Benzene	µg/L	200	1000	69	23	92
Methylene Chloride	µg/L	500	2500	69	28	97
Chloromethane	µg/L	100	250	95	3	98
Bromomethane	µg/L	50	500	99	1	100
Bromoform	µg/L	50	500	95	2	97
Bromodichloromethane	µg/L	50	200	95	4	99
Fluorotrichloromethane	µg/L	50	300	92	5	97

Suggested Variance Non-Leakage Limits and Variance Action Levels
for Evaluating Hazardous Waste Disposal Site Ground-Water Monitoring Data (cont'd)

	Concentration Units	Non-Leakage Limit	Action Level	Below Non-Leakage	Above Action Level	Total %
Dichlorodifluoromethane	µg/L	50	500	95	4	99
Chlorodibromomethane	µg/L	50	500	96	3	99
Tetrachloroethene	µg/L	200	1000	69	22	91
Toluene	µg/L	1000	2000	61	34	95
Trichloroethene	µg/L	500	2000	59	33	92
Vinyl chloride	µg/L	200	1500	77	20	97
BASE/NEUTRAL COMPOUNDS						
Acenaphthene	µg/L	50	250	96	2	98
Benzidine	µg/L	50	250	96	4	100
1,2,4-Trichlorobenzene	µg/L	50	250	94	4	98
Hexachlorobenzene	µg/L	50		100	0	100
Hexachloroethane	µg/L	50		100	0	100
Bis-(2-Chloroethyl)Ether	µg/L	50	250	96	4	100
2-Chloronaphthalene	µg/L	50		100	0	100
1,2-Dichlorobenzene	µg/L	50		87	9	96
1,2-Dichlorobenzene	µg/L	50	250	95	4	99
1,4-Dichlorobenzene	µg/L	50	250	92	6	98
3,3'-Dichlorobenzidine	µg/L	50		99		99
2,4-Dinitrotoluene	µg/L	50	250	99	1	100
2,6-Dinitrotoluene	µg/L	50	250	99	1	100
1,2-Diphenyl hydrazine	µg/L	50		100	0	100
Fluoranthene	µg/L	50	250	94	4	98
4-Chlorophenyl phenyl ether	µg/L	50	500	98	2	100
4-Bromophenyl phenyl ether	µg/L	50		100	0	100
Bis-(2-chloroisopropyl)ether	µg/L	50		100	0	100
Bis-(2-chloroethxy)ether	µg/L	50	500	98	1	99
Hexachlorobutadiene	µg/L	50		99		99
Hexachlorocyclopentadiene	µg/L	50		100	0	100
Isophorone	µg/L	100	500	94	6	100
Naphthalene	µg/L	100	500	88	9	97
Nitrobenzene	µg/L	100	500	96	4	100
N-nitrosodiphenylamine	µg/L	50	250	99	0	99

Suggested Variance Non-Leakage Limits and Variance Action Levels
for Evaluating Hazardous Waste Disposal Site Ground-Water Monitoring Data (cont'd)

	Concentration Units	Non-Leakage Limit	Action Level	Below Non-Leakage	Above Action Level	Total %
N-nitrosodi-N-propylamine	µg/L	100	500	99	1	100
Bis-(2-ethylhexyl)phthalate	µg/L	500	2500	68	21	89
Butyl Benzyl Phthalate	µg/L	100	500	93	6	99
Di-N-Butyl Phthalate	µg/L	100	1000	89	4	93
Di-N-Octyl Phthalate	µg/L	100	1000	93	1	94
Diethyl Phthalate	µg/L	100	500	92	7	99
Dimethyl Phthalate	µg/L	100	500	96	0	96
Benzo(A)Anthracene	µg/L	100		100	0	100
Benzo(A)Pyrene	µg/L	100		99		99
Benzo(A)Fluoranthene	µg/L	50		100	0	100
Benzo(K)Fluoranthene	µg/L	100		99		99
Chrysene	µg/L	100		99		99
Acenaphthalene	µg/L	100	500	99	1	100
Anthracene	µg/L	100	500	99	1	100
Benzo(GHI)Perylene	µg/L	100		99		99
Fluorene	µg/L	100	500	98	2	100
Phenanthrene	µg/L	100	500	98	1	99
Dibenzo(A,H)Anthracene	µg/L	100		100	0	100
Indeno(1,2,3-CD)Pyrene	µg/L	100		100	0	100
Pyrene	µg/L	100	500	98	2	100
ACID EXTRACTABLE						
2,4,6-Trichlorophenol	µg/L	100	500	94	5	99
p-Chloro-m-cresol	µg/L	100	500	99	1	100
2-Chlorophenol	µg/L	100	500	94	5	99
2,4-Dichlorophenol	µg/L	100	500	91	6	97
2,4-Dimethylphenol	µg/L	100	1000	89	6	95
2-Nitrophenol	µg/L	100	500	96	4	100
4-Nitrophenol	µg/L	100	500	98	1	100
2,4-Dinitrophenol	µg/L	100		99		99
4,5-Dinitro-2-methylphenol	µg/L	100		99		99
Pentachlorophenol	µg/L	100	1000	89	10	99
Phenol	µg/L	500	2000	79	21	100

Suggested Variance Non-Leakage Limits and Variance Action Levels
for Evaluating Hazardous Waste Disposal Site Ground-Water Monitoring Data (cont'd)

	Concentration Units	Non-Leakage Limit	Action Level	Below Non-Leakage	Above Action Level	Total %
PESTICIDE COMPOUNDS						
Dieldrin	µg/L	50	200	99	1	100
Chlordane	µg/L	50	200	99	1	100
4,4'-DDT	µg/L	50	200	99	1	100
4,4'-DDE	µg/L	50	200	99	1	100
4,4'-DDD	µg/L	50	200	99	1	100
Endosulfan I	µg/L	50		100	0	100
Endosulfan II	µg/L	50		100	0	100
Endosulfan Sulfate	µg/L	50		100	0	100
Endrin	µg/L	100	500	95	4	99
Endrin Aldehyde	µg/L	50		100	0	100
Heptachlor	µg/L	50		100	0	100
Heptachlor Epoxide	µg/L	50		100	0	100
Alpha-BHC	µg/L	50	200	98	1	99
Beta-BHC	µg/L	50	200	99	1	100
Delta-BHC	µg/L	50	200	97	3	100
Lindane	µg/L	50	250	91	6	97
PCB-1242	µg/L	50	200	99	1	100
PCB-1254	µg/L	50	200	99	1	100
PCB-1221	µg/L	50		100	0	100
PCB-1232	µg/L	50		100	0	100
PCB-1248	µg/L	50		100	0	100
PCB-1260	µg/L	50	200	99	1	100
PCB-1016	µg/L	50		100	0	100
Toxaphene	µg/L	50	200	91	6	97
2,3,7,8-Dioxin	µg/L	50		100	0	100
Aldrin	µg/L	50		100	0	100
INORGANIC PARAMERTERS						
Total Aluminium	mg/L	1.0×10^4	1.0×10^5	80	7	87
Total Antimony	µg/L	1000	4000	92	2	94
Total Arsenic	µg/L	5000	35000	68	18	86

Suggested Variance Non-Leakage Limits and Variance Action Levels for Evaluating Hazardous Waste Disposal Site Ground-Water Monitoring Data (cont'd)

	Concentration Units	Non-Leakage Limit	Action Level	Below Non-Leakage	Above Action Level	Total %
Total Barium	µg/L	2.5×10^6	2.5×10^7	77	11	88
Total Beryllium	µg/L	100	500	86	8	94
Total Cadmium	µg/L	750	2500	78	15	93
Total Calcium	mg/L	1.0×10^5	5.0×10^5	78	10	88
Total Copper	µg/L	2.5×10^6	1.0×10^7	87	10	97
Total Iron	mg/L	1.0×10^5	1.0×10^6	75	10	85
Total Lead	µg/L	1.5×10^5	7.5×10^5	84	9	93
Total Magnesium	mg/L	7000	20000	69	22	91
Total Manganese	mg/L	250	2000	85	7	92
Total Nickel	µg/L	7.5×10^4	3.0×10^5	77	14	91
Total Silver	µg/L	1000	5000	91	4	95
Total Sodium	mg/L	1.0×10^6	5.0×10^6	77	14	91
Total Zinc	mg/L	150	1000	77	15	92
Total Mercury	µg/L	100	1000	86	10	96
Total Selenium	µg/L	1.5×10^4	3.0×10^4	88	7	95
Chloride	mg/L	5.0×10^7	1.0×10^8	88	5	93
Total Sulfate	mg/L	1.0×10^7	4.0×10^7	83	5	88

APPENDIX 3

ASSESSMENT OF INDICATOR PERFORMANCE

The U.S. EPA Office of Ground-Water Protection sponsored a workshop in September, 1986 to develop indicators for measuring the environmental results of regulatory programs that pertain to ground water (Miller, 1987). This workshop prepared a draft list of 9 evaluation criteria that can be used for this purpose. These criteria are listed and briefly defined in Table A3-1. In addition to these functional criteria, there are 8 technical criteria that can be used to evaluate the suitability of tracers and indicators for particular environmental investigations (Plumb and Nacht, 1984). Both sets of indicator criteria were used to assess the performance of the four original indicator parameters specified in the RCRA ground-water monitoring requirements and alternate indicators identified through an analysis of the project database.

Because of the diverse nature of the criteria that can be used to assess the suitability of an indicator, there was no attempt to weight each criterion and develop a numerical index. However, a qualitative assessment of each indicator based on information in the project database or the technical literature was prepared for each criterion. The results of this effort are summarized in Table A3-2, Table A3-3, Table A3-4, Table A3-5, and Table A3-6. In reviewing this information, it should be kept in mind that a potential indicator could be considered unsuitable if it does not rate satisfactorily in all areas (i.e., if a potential indicator is not related to the substances it is being used to monitor, or if the analytical techniques are insensitive, a high rating for all other indicator criteria can not overcome this weakness or deficiency). The assessments summarized in this appendix suggest that pH would be a poor indicator because it is not related to other parameters. Specific conductance would be a poor indicator because the analytical techniques are too insensitive. TOC would be a poor indicator because the analytical techniques are too insensitive and there is insufficient data to define background conditions. The limiting weaknesses of TOX are that the analytical techniques have never been standardized and validated, the technique is marginally insensitive, and there is insufficient data to define background conditions. These analytical problems do not appear to be a serious impediment to the use of volatile organic compounds as an indicator. Criteria that do not appear to be significant in this assessment are response period, and level of environmental decision making.

Table A3-1. Criteria for Evaluating the Performance of Indicator Parameters for Ground-Water Monitoring*

1. **Conceptual Accuracy.** How directly does the indicator measure changes in the conditions being monitored?

2. **Level of Environmental Data.** Is the indicator a measure of government action, source action, or ambient changes.

3. **Availability of Data.** Does the indicator require generation of new data or utilization of existing data? Will the cost be high or low?

4. **Sampling Accuracy.** Is the indicator a representative and unbiased estimate of the conditions being monitored?

5. **Measurement Accuracy.** Is the indicator measurable with existing, validated methods?

6. **Overall Consistency.** Can measurements from different locations be aggregated and fairly compared?

7. **Time Periods over which Changes are Reflected.** Are changes a measure of short term, medium term, or long term changes?

8. **Volume of Data Required.** How much data will be required to use the indicator in a decision-making process?

9. **Existence of Baseline.** Do baseline data already exist for comparison to new monitoring results?

*After C. Miller (1987)

Table A3-2. Synopsis of pH as a Ground-Water Indicator

1. **Conceptual Accuracy.** This parameter will be effective for the detection of acidic or basic wastes that are migrating from a site. However, there is no functional relationship to detect other contaminants based on a detected change in pH. This problem will be enhanced because of a significant change in pH will increase dissolution from the aquifer material. Thus, increased concentrations of inorganic constituents could be due to dissolution of aquifer material as a result of the pH change rather than inorganic wastes migrating from a site.

2. **Level of environmental data.** This parameter is a measure of change in the ambient concentrations during a site investigation.

3. **Availability of data.** This parameter requires collection of site-specific data. The cost per analysis is small but, since pH is a naturally occurring condition, extensive amounts of data may be required to define site-specific background conditions.

4. **Sampling accuracy.** This parameter is not conservative and can change between collection and analysis of the sample (gaseous exchange of carbon dioxide being one factor). Samples must be analyzed within a few hours of collection.

5. **Measurement accuracy.** Rapid measurement techniques are universally available that can measure pH to within 0.05 units. This limit does not translate into a detection limit for other contaminants.

6. **Overall consistency.** The data from different locations or different sampling times are directly comparable. However, if results span more than one pH unit, they should not be arithmetically averaged together since pH is a log function.

7. **Time period to reflect changes.** This parameter will reflect changes as they occur. However, the problem will be to distinguish changes due to natural variation from changes induced by contaminants migrating from a site.

8. **Volume of Data.** Since pH is a natural condition, a considerable amount of data could be required to define background conditions.

9. **Existence of Baseline.** Because of the ease of measurement, some data is likely to be available but there may not be enough data to define background conditions.

Table A3-3. Synopsis of Specific Conductance as a Ground-Water Indicator

1. **Conceptual Accuracy.** All ionic contaminants will contribute to the conductivity of a sample.

2. **Level of Environmental Data.** This indicator measures changes in ambient conditions.

3. **Availability of Data.** This parameter requires collection of site-specific data. The cost per analysis is small but, since specific conductance is a naturally occurring condition, extensive amounts of data may be required to define site-specific background conditions.

4. **Sampling Accuracy.** This parameter changes by approximately 2 percent per degree centigrade if the sample temperature changes between collection and analysis. Also, conductance is cumulative for all ionic species in the sample. Thus, an increase in one ionic component could be offset by a decrease in one or more other constituents.

5. **Measurement Accuracy.** Validated analytical methods are available to measure the indicator. However, there are several problems. First, it is not routinely possible to detect conductivity changes below 5 µmho/L which translates into a change of approximately 3.3 mg/L for inorganic constituents (i.e., inorganic concentration changes below 3.3 mg/L are essentially non-detectable with this indicator). Second, if total concentrations (dissolved plus suspended concentrations) are reported during a monitoring program, the indicator will not be a direct measure of the level of contamination or changes in the level of contamination.

6. **Overall Consistency.** Measurements from different locations and different sampling times can (generally) be compared and aggregated fairly if all results are temperature compensated.

7. **Time Period to Reflect Changes.** This indicator may detect changes in ambient conditions as they occur - with proper temperature compensation. (Offsetting changes in two or more constituents could mask actual changes).

8. **Volume of Data.** Since specific conductance is a natural condition, a considerable amount of data could be required to define background conditions. Also, the natural background conditions will fluctuate with each individual ionic component.

9. **Existence of Data.** Measurements of specific conductance are usually available but the amount of data may not be sufficient to define background conditions.

Table A3-4. Synopsis of Total Organic Carbon as a Ground-Water Indicator

1. **Conceptual Accuracy.** All organic compounds contain carbon and should contribute to the organic carbon concentration of a sample.

2. **Level of Environmental Data.** This indicator measures changes in the organic carbon concentration of ground-water.

3. **Availability of Data.** The amount of data available for this indicator is usually limited. Therefore, sufficient data will have to be collected to define site-specific conditions.

4. **Sampling Accuracy.** Poor sampling technique could reduce the total organic carbon concentration of a sample if volatile compounds are a significant portion of the organic concentration. This consideration will vary from site to site.

5. **Measurement Accuracy.** There are several potential problems with this indicator. First, the analytical techniques rely on the conversion of carbon-containing compounds to either carbon dioxide or methane. However, inorganic carbon, which is usually more abundant, goes through the same reactions. Thus, the sample must be processed to separate inorganic carbon from the sample. Second, the detection limit of the procedures are generally on the order of 1 mg/L. The indicator can not reliably detect organic carbon changes below this concentration even though the level of concern with most individual organic compounds is frequently in the low µg/L range (i.e., three orders of magnitude below the limit of detection for the TOC procedure).

6. **Overall Consistency.** Results from different locations and different sampling times can generally be compared and aggregated if the same TOC method is used.

7. **Time Period to Reflect Changes.** This indicator may detect changes in ambient conditions as they occur. (Offsetting changes in two or more constituents could mask actual changes).

8. **Volume of Data.** A large amount of data may be necessary to use this indicator successfully. First, data will be required to define ambient conditions. Second, additional data may be required to demonstrate a change in the ambient levels of this indicator. Third, substantial organic analytical data may be required to demonstrate that the indicator is functioning properly.

9. **Existence of Baseline.** Baseline data for this parameter may not be universally available.

Table A3-5. Synopsis of Total Organic Halogen As a Ground-Water Indicator

1. **Conceptual Accuracy.** Conceptually, this indicator is directly related to all halogenated organic compounds. If the background TOX concentration at a site is zero, TOX should detect changes in the abundance of halogenated compounds. However, if the background TOX concentration at the site is greater than zero, offsetting concentration changes in two or more halogenated organic compounds could limit the performance of this indicator.

2. **Level of Environmental Data.** This indicator measures changes in ambient concentrations.

3. **Availability of Data.** Data for this indicator are extremely limited. There is essentially no data prior to 1980 and most situations with TOX data do not have specific organic analytical data to confirm the TOX results.

4. **Sampling Accuracy.** This indicator is subject to errors due to poor sample collection technique. Samples to be analyzed for TOX should be hermetically sealed and treated as a volatile organic sample. Otherwise, volatile compounds will be lost and the TOX results will be biased low.

5. **Measurement Accuracy.** The TOX analytical procedure was never validated before it was required for use in the RCRA program. There are several potential problems with this measurement technique. First, inorganic halides will bias results high if the samples are not properly prepared. Second, the optimum conditions for sorption and desorption of specific compounds have not been evaluated for all halogenated compounds or combinations of halogenated compounds. Third, the elemental conversion of all halogenated compounds at 900 °C, or the method sensitivity to small temperature fluctuations, has not been evaluated.

6. **Overall consistency.** Because of potential problems mentioned under measurement accuracy, overall consistency is unknown.

7. **Time period to Detect Change.** To the extent that the method works reliably, the indicator provides short term measurement of changes in ambient conditions.

8. **Volume of Data.** A large amount of data may be necessary to use this indicator successfully. First, the data will be required to define ambient conditions. Second, additional data may be required to demonstrate a change in the ambient levels of this indicator. Third, substantial organic analytical data may be required to demonstrate the indicator is functioning properly.

9. **Existence of Baseline.** Because of the relatively short period

of time over which the indicator has been used, reliable baseline data probably do not exist except for a limited number of specific sites.

Table A3-6. Synopsis of Volatile Organic Analysis as a Ground-Water Indicator

1. **Conceptual Accuracy.** Method provides direct measurement for the class of man-made contaminants that are manufactured in the largest quantities and has been most frequently detected in the ground-water environment. The basis for using volatile organic analyses to estimate the need for additional organic analyses was pragmatically derived from the project database.

2. **Level of Environmental Data.** This indicator measures changes in ambient conditions.

3. **Availability of Data.** The indicator does require tracking the occurrence of 31 separate organic compounds. Analyses have been completed for these compounds since the late 1970s but the data for the non-detected compounds may not be readily available (i.e., reports frequently summarize information on contaminants that have been detected but information is not always summarized for contaminants that have been looked for but not detected).

4. **Sampling Accuracy.** Correct sampling is critical to the proper functioning of this indicator to insure that volatile compounds are not lost between sample collection and sample analysis.

5. **Measurement Accuracy.** The method for this indicator has been validated in multiple-laboratory performance evaluations. The GC/MS method functions at the $\mu g/L$ level with an accuracy of ± 20 to 50 percent. The detection limit for the GC method is approximately one order of magnitude lower than the GC/MS method.

6. **Overall Consistency.** Results from different locations and different sampling times can be compared and aggregated.

7. **Time period to Detect Changes.** This indicator provides short term measurement of changes in ambient conditions.

8. **Volume of Data.** A considerable amount of data is available on the abundance of volatile organic compounds. However, the available data may not be in the most useful format.

9. **Existence of Baseline.** The available data may be too scattered and/or too fragmented to properly define baseline conditions.

17/02

APPENDIX E-11

SECTION E

EUTAW AQUIFER GRADIENT EVALUATION

Revision No.
5.0

APPENDIX E-11

SECTION E

LIST OF DOCUMENTS

Document 1: Eutaw Aquifer Gradient Evaluation for Chemical Waste Management, Inc Facility, Emelle, Alabama, prepared by Arcadis U.S., Inc., dated May 2, 2012.

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Subject:
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Dear Mr. Ramaley:

This letter summarizes the implementation and findings of a recent evaluation of the hydraulic gradient in the Eutaw Aquifer beneath the Chemical Waste Management, Inc. Facility, in Emelle, Alabama (the Facility). Waste Management, Inc. (WM) completed this investigation to address concerns raised by the Alabama Department of Environmental Management (ADEM) regarding the sufficiency of the existing monitoring well network to meet the Site's monitoring goals (ADEM, letter dated May 4, 2010). These concerns stem principally from variability in historical water-level data, which have created uncertainties about the direction of groundwater flow in the Eutaw aquifer.

As proposed in the June 2010 Eutaw Aquifer Gradient Evaluation Work Plan (Jordan, Jones and Goulding, Inc.), the gradient study included:

- Resurvey of the six Eutaw Aquifer monitoring wells at the Facility.
- Use of data-logging pressure transducers to record continuous water-level trends through a multiple-month study period.
- Analysis of the water-level trends to ascertain if a consistent gradient direction exists or, if not, what external hydraulic influences are driving temporal changes in the gradient.

Hydrogeologic Background

West Central Alabama is underlain by over 2,000 feet of Upper Cretaceous Period sediments. The two geologic units of direct concern to the Facility include:

- The Selma Chalk, an extremely low permeability aquitard extending from near the surface to greater than 600 feet deep.

- The Eutaw Formation, a 400 ft thick aquifer consisting of partially lithified sands, with intervals of silt and clay.

Though greater than 600 ft below the surface, the Eutaw Formation is the uppermost aquifer in the region as defined under ADEM Administrative Code Rule 335-14-1-.02 (40 CFR 260.10). The extremely low hydraulic conductivity of the shallower Selma Chalk (measured to be in the range of 2.0×10^{-8} to 1.8×10^{-9} cm/sec) renders it incapable of "yielding a significant amount of groundwater to wells or springs", the operative definition of an aquifer. The low permeability of the Selma Chalk was a primary factor in originally locating the Facility in Emelle.

Groundwater in the Eutaw Aquifer is confined. The potentiometric surface of the upper portion of the Eutaw Formation typically ranges in elevation from 127 feet mean sea level (MSL) to 130 ft MSL under the Facility, or about 80 ft below ground surface (bgs) in the active portion of the Facility. The top of the Eutaw Formation, by comparison ranges from -510 ft MSL to -450 ft MSL under the Facility.

Scope of Work

The study consisted of continuous water-level monitoring at the Facility's network of six deep monitoring wells, each completed in the top of the Eutaw Formation. Well locations are shown on **Figure 1**. The well specifications are as shown in the Table 1 below.

Table 1. Eutaw Aquifer Monitoring Well Network

Well ID	Measuring Point Elevation (ft MSL)	Screened Interval (ft bgs)	Average Depth to Water* (ft TOC)
RCRA-5	213.18	693-733	86.3
RCRA-6	163.60	606-646	35.7
RCRA-7	207.92	682-722	79.5
RCRA-8	142.08	668-708	12.3
RCRA-9	211.13	691-731	83.0
RCRA-10A	221.47	679-721	93.8

* Average for monitoring period 7/6/11 to 10/6/11. TOC: top of casing

The field water-level monitoring program consisted of the following:

- Confirmation that an appropriate reference point was marked on each well from which manual water-level measurements would be made. These marks were then resurveyed. The elevations listed in the table above reflect the revised survey.

- Deployment of a Schlumberger Mini-Diver data-logging pressure transducer in each well. The transducers were non-vented, therefore a separate barometric pressure data-logging transducer was deployed to permit level-data correction to remove the influence of barometric pressure changes. Transducers were rated for water-pressures of up to 33 ft, therefore the units were deployed at lesser depths (typically 10 to 15 feet below the water-level in each well). The units were hung on direct-read communication cables to permit data download without disturbing the transducer after it was installed.

- Initiation of monitoring starting July 6, 2011. Transducers were programmed to record a water-level every 15-minutes until stopped.

- Collection of periodic manual water-level measurements to confirm and calibrate the transducer data. A total of 11 manual measurements were completed through the monitoring period. Each time water-levels were measured, transducer data were downloaded to permit interim data checks.

- Termination of monitoring on February 22, 2012, after approximately 7.5 months.

Transducer data analysis included the following steps:

- The raw total pressure data recorded by each transducer were first corrected to remove barometric pressure variations using the correction utility in Schlumberger-Diver Office, a software package used to interface with the transducers. The correction involves subtracting the relative pressure change recorded by the barometric pressure data logger from the total pressure recorded by each of the down-well transducers (which includes both the atmosphere pressure and weight of the water of the water-column of the transducer). The corrected readings are equivalent to the height of the water-column above the transducer.

- The corrected water-column height values were then converted to water-level elevations by correlating transducer-recorded measurements to contemporaneous manual water-level measurements. The resulting correction factor developed from the contemporaneous measurement was then applied to the full transducer record.

- As additional manual water-level data were taken, data were checked for consistency and drift. Over long monitoring periods, a small amount of linear transducer measurement drift is common, and can be removed. A drift correction was applied to two wells to improve correlation with manual data (i.e., the records for RCRA-7 and RCRA-8 were corrected for drifts of 0.0026 ft/day and 0.0024 ft/day, respectively).

Findings

The study period encompassed approximately 7.5 months, starting July 6, 2011 and ending February 22, 2012. Throughout this period, an eastward hydraulic gradient is interpreted to have been present at all times. **Figures 2 through 5** illustrate the potentiometric surface in the Eutaw Aquifer on four dates spanning the observation period. In each of the eleven manual water-levels rounds (including the four shown in the figures) a consistent relationship exists:

- The highest water-level elevation observed occurs in the westernmost well (RCRA-8)

- The lowest water-level elevations are found in the two easternmost wells (RCRA-5 and RCRA-10).

Figure 6 presents the manual water-level data as a hydrograph. While some anomalous manual water-levels occur (a data quality issue discussed later), the overall west-to-east trend established by water-level elevations in RCRA-8 and

RCRA-5 is persistent. This eastward gradient is low in magnitude, averaging approximately 1.1 feet per mile; however, the direction and magnitude are highly consistent. **Table 1** summarizes all manual water-level measurements and gradient calculations.

Continuous monitoring with data-logging transducers shows that the gradient is steady on both long and short time scales. **Figure 7** presents a hydrograph of the first three months of monitoring data. The figure supports several important observations:

- The water-levels in all monitoring wells track consistently, maintaining a consistent eastward gradient.

- Water-levels show no evidence that they are influenced by any off-site pumping stresses.

- Water-levels respond consistently to external stresses, such as the tropical storm that occurred September 5, 2012. (Note that while the Eutaw Aquifer is isolated from direct recharge, the loading associated with a 7-inch rain event can raise water-levels in a deep aquifer by compressing the aquifer matrix.)

- The difference between some manual water-level measurements and the steady transducer data (i.e., the discrepancies between transducer and manual water-level data on the hydrograph- Figure 7) highlight the challenges of obtaining reliable manual water-level measurements at this Site. The observation suggests that prior interpretations of anomalous gradient directions reflect inaccurate measurements, not real changes in the gradient.

- The measuring points were resurveyed after it was noted in the field that the actual water level measurements were being taken from the top of the pump discharge pipe and not the top of casing. The new survey measurements for the top of pipe resulted in a higher gradient across the site than previously reported. The use of the incorrect datum also contributed to the noise in the historical water levels previously presented in the permit application response to comments.

Data Quality and Uncertainty

As discussed in the Eutaw Aquifer Gradient Evaluation Work Plan, prior interpretations of the water-level data in Eutaw Aquifer monitoring wells have been unable to resolve whether apparent variation in the mapped potentiometric surface reflect real changes in the aquifer, measurement problems, or a combination of the two. This study provides evidence that the gradient is steady, but that accurate measurement of water-levels poses significant challenges. In this study, difficulties were encountered with both manual water-level measurement and transducer monitoring. However, the multiple lines of evidence provided by manual levels and transducers are sufficiently robust to confirm the consistent, eastward flow of groundwater beneath the site.

Figure 8 presents the transducer and manual water-level record for the full monitoring period. The plot shows that, while the transducers generally operated reliably for the first three months of the study, significant anomalies began to occur in the second half of the data set. As shown on the figure:

- The consistency of manual water-level measurements throughout the period of anomalous transducers readings shows the transducer data are incorrect, not that actual water-level changes are occurring. Moreover, the transducer trends are physically improbable. Because the aquifer is tightly confined, any major changes in water-levels would be observed in all wells (similar to the tropical storm pulse discussed above).

- Though some of the transducer deviations can be attributed to known activities (for instance a groundwater sampling event in October for which the transducers were removed and then replaced), other variability has no obvious cause.

- In general, manual water-level measurements proved more reliable. As illustrated in **Figure 7** (showing a hydrograph for the period in which the transducers were operating properly), interpreted manual measurements errors of under 0.5 ft occurred periodically. For some wells, a series of three or more manual measurements were required to properly calibrate the transducers trends.

WM will continue to evaluate ways to improve data reliability, including minor well-head modifications to improve the ability to measure water-levels without potential interference from the dedicated down-hole equipment deployed in well.

Discussion

This study has shown that the hydraulic gradient in the Eutaw aquifer beneath the facility is steady and consistently eastward. No external stresses such as off-site pumping or barometric pressure swings have any measurable influence on the magnitude or direction of the gradient. The results of this study show that RCRA-8 is a satisfactory upgradient monitoring well for the facility (Comment 48 for the permit renewal). In addition, the water level isocontour maps show a consistent gradient toward the east and that the current network of wells can be used to reliably determine the direction of groundwater flow and that no additional wells are needed for this purpose (Comment 49 for the permit renewal).

Comment 59 for the permit renewal stated that the current Eutaw Monitoring Program does not appear capable of adequately determining the direction of groundwater movement nor is it capable of detection COCs that may migrate from the existing disposal areas. This comment further stated that an evaluation should be conducted to determine the most appropriate locations for new monitoring wells so that a clear determination of the direction of groundwater movement and an appropriate detection monitoring system is achieved.

As discussed above, the results of this hydraulic study show that the current Eutaw well network is sufficient to determine a clear direction of flow and that this flow is consistently to the east and northeast. Regarding the appropriateness of the detection monitoring system, it is important to note that the Eutaw monitoring network is only part of a comprehensive monitoring detection system for the disposal cells that are double lined. The monitoring system for the site consists of primary sump measurements and sampling, secondary liner measurements and sampling, Selma chalk well sampling, and the Eutaw monitoring wells.

- The primary sumps are monitored for leachate levels weekly and more frequent than the monthly permit requirement
- The secondary sumps are monitored daily for action leakage rates to ensure leakage rates are within permit specified levels
- The primary and secondary sumps are sampled for analytical analysis on a semi-annual basis. To date, there have been no significant detections in the secondary sumps.
- The primary and secondary detection systems provide the earliest indication of a potential issue with the primary liner. Although not sampled or measured, there is a third pressure relief system below the secondary that can be accessed if needed.

- The Selma chalk wells for each cell are positioned near sumps and along identified fractures. This placement allows for early detection should there be an issue with the primary and secondary liner systems. Further, the thickness and very low permeability of the Selma Chalk make it improbable that contaminants will ever migrate vertically to the Eutaw Aquifer. A simple groundwater velocity calculation using conservative parameters for the Selma Chalk (hydraulic conductivity of 1.7 x 10^{-7} cm/sec, porosity of 38%, reported in Sadler et al., 1992), a unit thickness of 680 ft, and a downward gradient of 0.1 ft/ft, shows that water would take greater than 14,000 years to reach the Eutaw Aquifer. In actuality, any groundwater flow path would move laterally as well as vertically, extending the distance and also the travel time. The long travel time and tortuous flow path of a potential contaminant migrating downward across the Selma Chalk would create a broadly dispersed plume that would be more easily detectable than a narrow concentrated plume.
- The hydraulic study shows the current Eutaw well network is situated downgradient of the disposal areas and is positioned along flow directions that would detect this wider plume and that additional wells are not required. Again, this is the fourth component to the monitoring system and is potentially over 10,000 years travel time away. The most important components of the detection monitoring system are the monthly sampling of the secondary sumps and the semi-annual sampling of the Selma Chalk wells. Because of the extreme low permeability of the Selma Chalk and long travel time, the site would have more than enough time to mitigate an issue prior to it reaching the Eutaw aquifer.

If there were new detections in the Selma Chalk unit, the first line of action would be to install additional wells in the Selma Chalk unit to determine the extent of vertical impact and then a corrective action would be developed as required by ADEM regulations and the site permit. This corrective action would include monitoring within the Selma Chalk unit to ensure no impacts were traveling further vertically. These additional wells then become a fifth component of the network. Therefore, the Eutaw aquifer becomes a secondary system with the primary emphasis on the Selma Chalk unit. Any impact in the Selma Chalk would not immediately travel to the Eutaw Aquifer and the site would have more than enough time (>10,000 yrs) to implement a response measure. Additional wells in the Eutaw Aquifer would only be appropriate if corrective action monitoring wells in the Selma Chalk Unit showed that vertical migration of contaminants would likely reach the Eutaw Aquifer and result in degradation of water quality. As stated earlier, this is highly improbable due to the extreme low permeability of the Chalk Unit.

Conclusions

This study has shown that the hydraulic gradient in the Eutaw aquifer beneath the facility is steady and consistently eastward. No external stresses such as off-site pumping or barometric pressure swings have any measurable influence on the magnitude or direction of the gradient. The current Eutaw well network is appropriate to reliably determine the direction of groundwater flow in the Eutaw Aquifer. The overall detection monitoring system for the site consists of primary and secondary detection systems and sampling, semi-annual Selma Chalk sampling, and semi-annual Eutaw Aquifer sampling. These four components together provide a robust detection monitoring network for any contaminants that may migrate from the existing disposal areas. Should any new impacts be detected in the Selma Chalk wells, additional wells would be installed to show the limit of vertical migration in the Chalk and would constitute an additional fourth component to the detection monitoring system. Therefore, any additional Eutaw Aquifer wells should be a response measure to supplement the primary components of the Selma Chalk system if the results from the Selma Chalk wells showed that impacts were likely to migrate through the 680 foot unit at concentrations that would adversely affect water quality in the Eutaw Aquifer.

Sincerely,

ARCADIS U.S., Inc.

Michael Cobb
Senior Geologist

David Wilderman, PG
Principal Hydrogeologist

Copies:
Robert Anthony, Waste Management
Scott Potter, ARCADIS

References:

Sadler, L.Y., Rahnama, M.B., and Whittle, G.P., 1992. Laboratory Measurement of the Permeability of Selma Chalk Using an Improved Experimental Technique, Hazardous Waste and Hazardous Materials. January 1992, Vol. 9, No. 4: 331-343

Jordan, Jones and Goulding, Inc., 2010. Eutaw Aquifer Gradient Evaluation Work Plan, Chemical Waste Management, Part B Permit Application, June 18, 2010.

TABLES

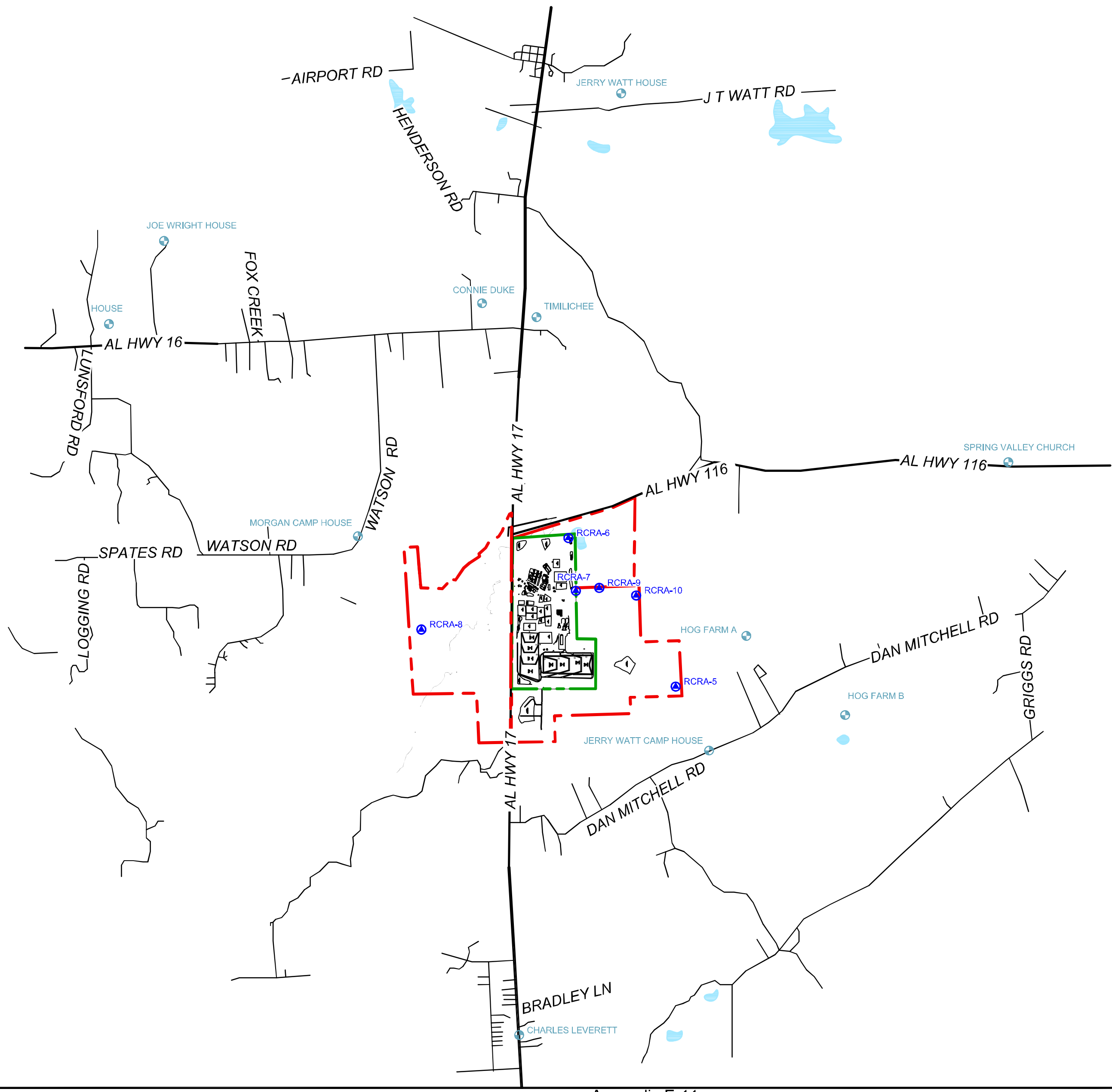
TABLE 1. SUMMARY OF MANUAL WATER-LEVEL DATA AND GRADIENT ANALYSIS

CHEMICAL WASTE MANAGEMENT FACILITY, EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

	MP Elevation	Depth to Water (ft below measuring point)										
Well ID	(ft AMSL)	7/6/2011	7/22/2011	8/3/2011	8/17/2011	8/31/2011	10/19/2011	10/28/2011	11/3/2011	1/11/2012	1/25/2012	2/22/2012
RCRA-5	213.18	85.95	86.09	86.33	86.00	86.54	85.52	85.51	85.76	85.49	85.53	85.35
RCRA-6	163.60	35.52	35.98	35.40	35.73	35.85	35.35	35.28	34.83	35.28	35.45	35.22
RCRA-7	207.92	79.45	79.35	79.45	79.86	79.74	79.56	79.42	79.89	79.35	79.3	79.12
RCRA-8	142.08	12.1	12.10	12.20	12.35	12.50	13.3	12.41	12.6	12.01	12	11.87
RCRA-9	211.13	82.9	NM	82.47	83.12	83.17	83.15	83.26	83.33	82.72	82.77	82.58
RCRA-10A	221.47	93.7	93.84	93.78	94.20	94	93.74	93.62	94	93.53	93.8	93.24
		Water-Level Elevation (ft above Mean Sea Level)										
RCRA-5	213.18	127.23	127.09	126.85	127.18	126.64	127.66	127.67	127.42	127.69	127.65	127.83
RCRA-6	163.60	128.08	127.62	128.2	127.87	127.75	128.25	128.32	128.77	128.32	128.15	128.38
RCRA-7	207.92	128.47	128.57	128.47	128.06	128.18	128.36	128.5	128.03	128.57	128.62	128.8
RCRA-8	142.08	129.98	129.98	129.88	129.73	129.58	128.78	129.67	129.48	130.07	130.08	130.21
RCRA-9	211.13	128.23	NM	128.66	128.01	127.96	127.98	127.87	127.8	128.41	128.36	128.55
RCRA-10A	221.47	127.77	127.63	127.69	127.27	127.47	127.73	127.85	127.47	127.94	127.67	128.23
		Eastward Gradient										
	ft/ft	0.00022	0.00023	0.00024	0.00020	0.00023	0.00009*	0.00016	0.00016	0.00019	0.00019	0.00019
	ft/mile	1.2	1.2	1.3	1.1	1.2	0.5*	0.8	0.9	1.0	1.0	1.0

Notes:
1) ft AMSL = feet above Mean Sea Level; MP Elevation = measuring point elevation
2) Gradient calculated between RCRA-5 and RCRA-8, based on an easting distance of 12,500 ft
3) * October 19 gradient skewed low based on a low-biased water-level measurement at RCRA-8 relating to concurent groundwater sampling

FIGURES



LEGEND:

- RCRA-6 — EUTAW AQUIFER MONITORING WELL
- NEIGHBORING WELL
- FACILITY BOUNDARY
- ACTIVE SITE BOUNDARY
- MAJOR ROAD
- LOCAL ROAD
- SURFACE WATER

NOTE:
1. PROPERTY BOUNDARIES ARE APPROXIMATE.

0 1 MILE 2 MILES
GRAPHIC SCALE

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

FACILITY LOCATION AND NEIGHBORING WELLS

ARCADIS

FIGURE
1

CITY:CM DIV/GROUP:ENVCAD DB:ENVCAD PM:(Reqd)
G:\ENVCAD\Roseville-CA\ACT\KE110005\0001\00001\DWG\KE110005 C02.dwg LAYOUT: 1 SAVED: 3/23/2012 12:35 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: TAB PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 3/23/2012 12:35 PM BY: ROBITAILLE, BEVERLY

CITY:(SYRACUSE) DIV/GROUP:ENVCAD DB: R.BASSETT LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\RETURN-TO\Roseville-CA\KE110005\0001\00001\DWG\KE110005 C01.dwg LAYOUT: 2 SAVED: 4/30/2012 4:55 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: A LAND PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 4/30/2012 4:56 PM BY: BASSETT, RICHARD
XREFS: IMAGES: PROJECTNAME: ----
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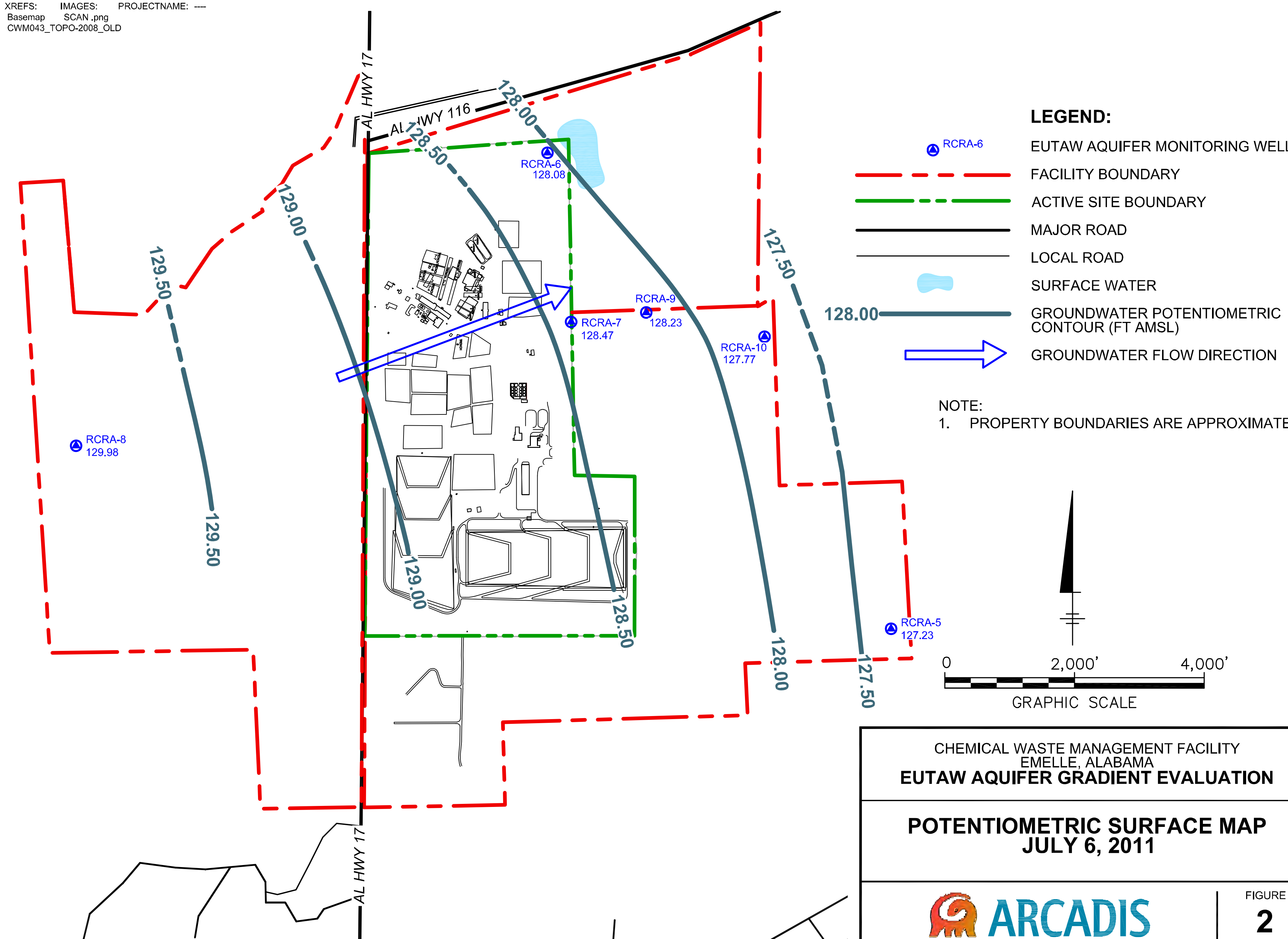
CWM043_TOPO-2008_OLD



NOTE:
1. PROPERTY BOUNDARIES ARE APPROXIMATE.

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

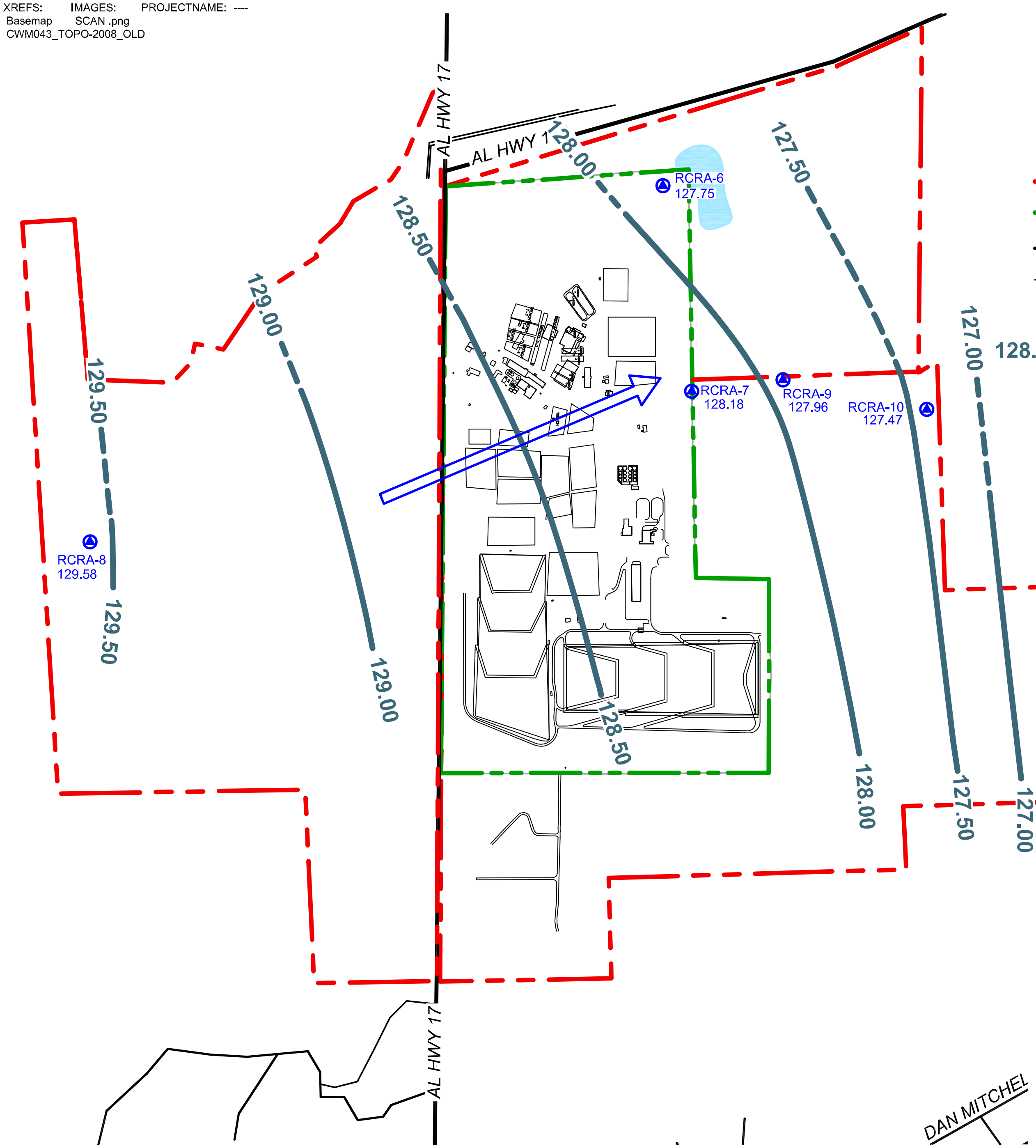
POTENTIOMETRIC SURFACE MAP
JULY 6, 2011

ARCADIS

FIGURE
2

CITY:SYRACUSE DIV/GROUP:ENVCAD DB:(R.BASSETT) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\RETURN-TO\Roseville-CA\KE110005\0001\00001\DWG\KE110005 C02.dwg LAYOUT: 3 SAVED: 4/30/2012 5:23 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: A LAND PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 4/30/2012 5:23 PM BY: BASSETT, RICHARD

XREFS: IMAGES: PROJECTNAME: ----
Basemap SCAN .png
CWM043_TOPO-2008_OLD



LEGEND:

- RCRA-6 — EUTAW AQUIFER MONITORING WELL
- FACILITY BOUNDARY
- ACTIVE SITE BOUNDARY
- MAJOR ROAD
- LOCAL ROAD
- SURFACE WATER
- 128.00 — GROUNDWATER POTENTIOMETRIC CONTOUR (FT AMSL) (DASHED WHERE INFERRED)
- GROUDWATER FLOW DIRECTION

NOTE:
1. PROPERTY BOUNDARIES ARE APPROXIMATE.

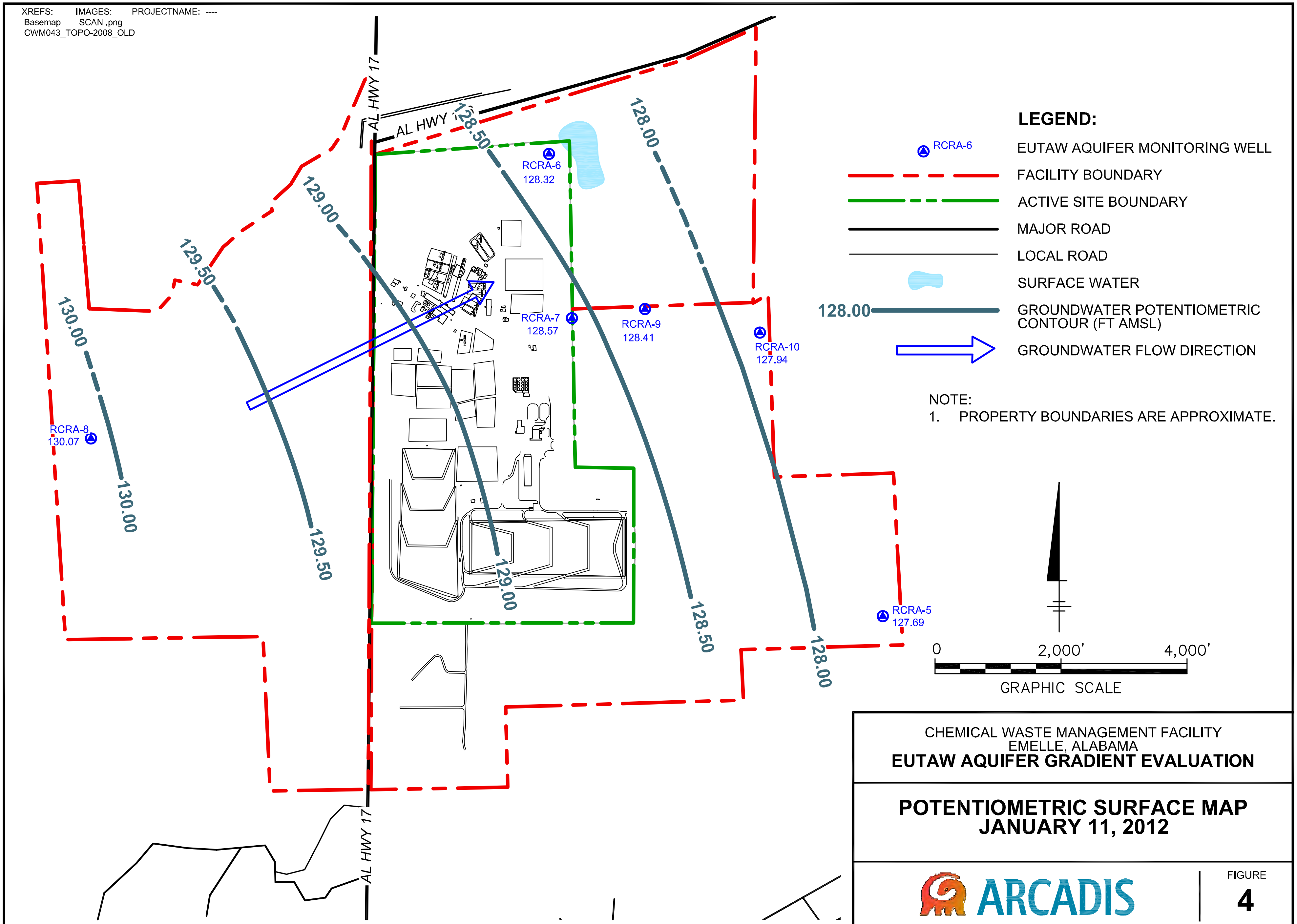
0 2,000' 4,000'
GRAPHIC SCALE

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

POTENTIOMETRIC SURFACE MAP
AUGUST 31, 2011

ARCADIS

FIGURE
3



NOTE:
1. PROPERTY BOUNDARIES ARE APPROXIMATE.

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

POTENTIOMETRIC SURFACE MAP
JANUARY 11, 2012

ARCADIS

FIGURE
4

CITY:SYRACUSE DIV/GROUP:ENVCAD DB:R. BASSETT LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\RETURN-TO\Roseville-CA\KE110005\0001\00001\DWG\KE110005 C04.dwg LAYOUT: 5 SAVED: 4/30/2012 5:55 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: A LAND PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 4/30/2012 5:55 PM BY: BASSETT, RICHARD
XREFS: IMAGES: PROJECTNAME: ----
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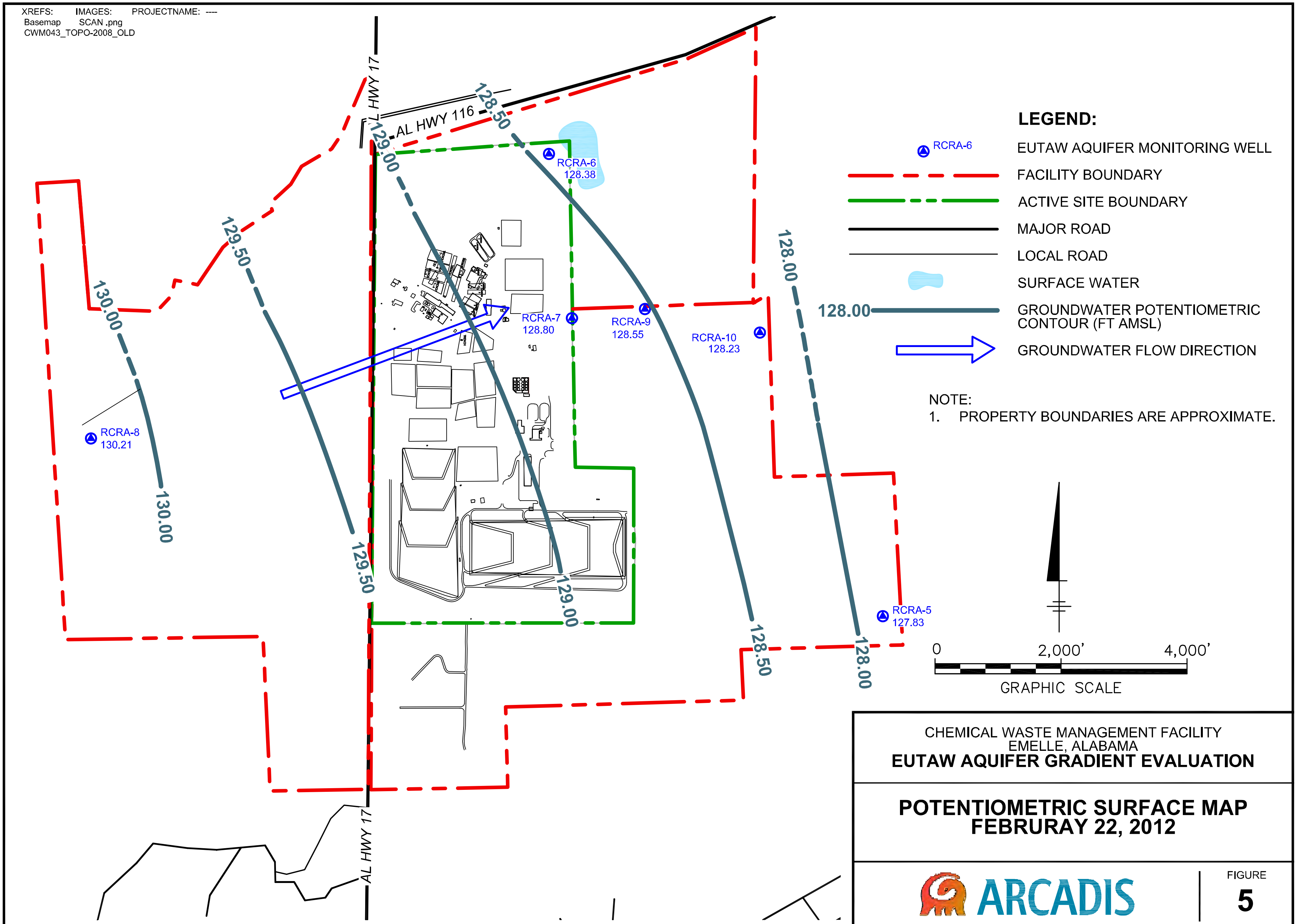
CWM043_TOPO-2008_OLD



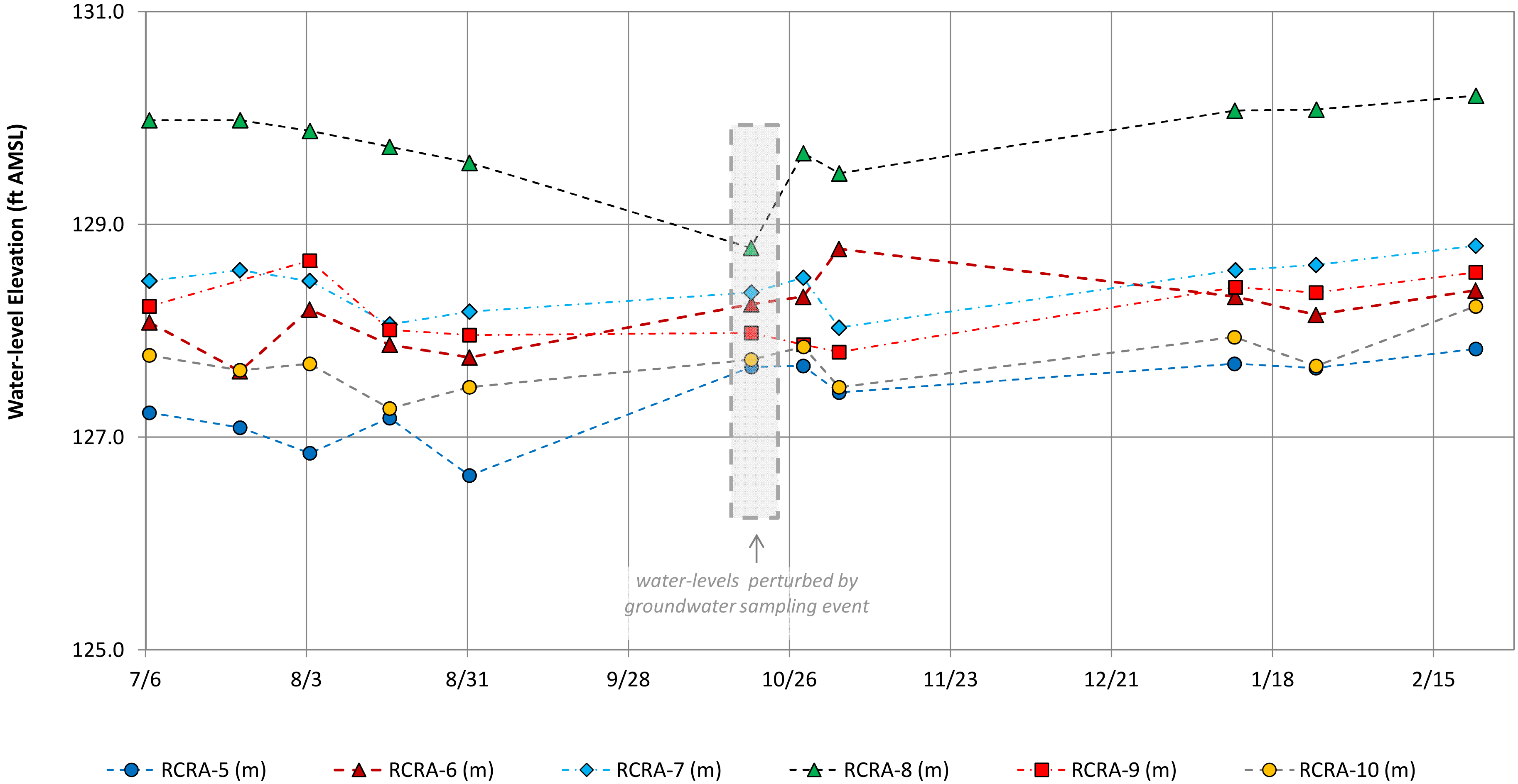
NOTE:
1. PROPERTY BOUNDARIES ARE APPROXIMATE.

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

POTENTIOMETRIC SURFACE MAP
FEBRURAY 22, 2012

ARCADIS

FIGURE
5



Notes:
1) ft AMSL = feet above Mean Sea Level
2) (m) denotes manual water-level measurements.
3) Transducer data calibrated to August 31, 2012 manual water-level measurements.
.

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

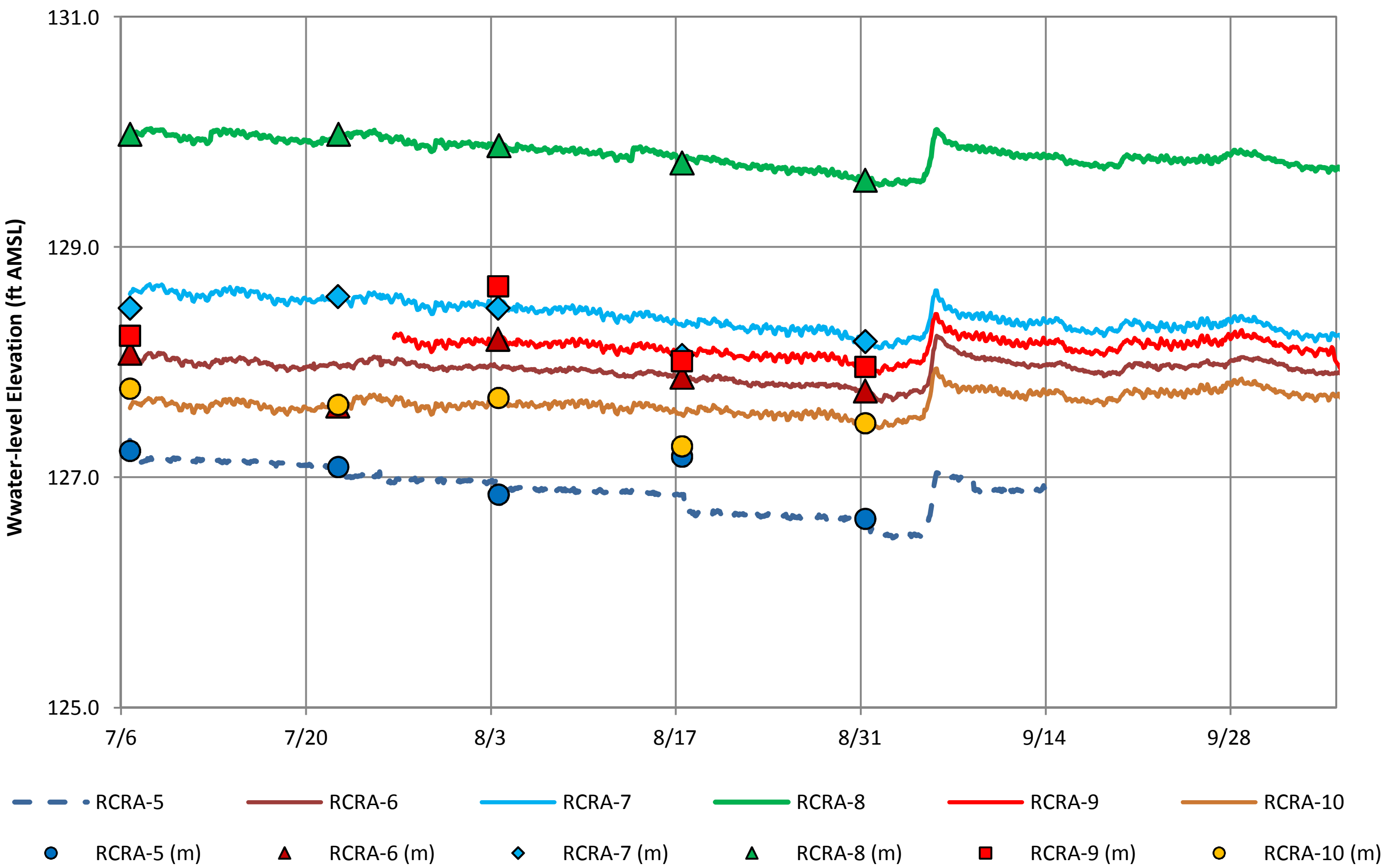
HYDROGRAPH OF MANUAL WATER-LEVEL DATA

ARCADIS

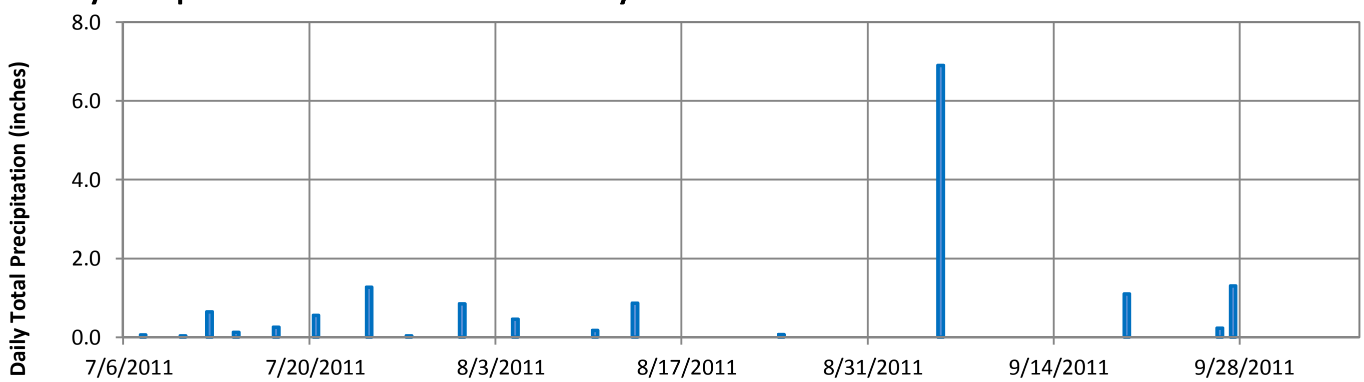
FIGURE
6

Eutaw_xd_120223.xlsm 3/29/2012

A. Three-Month Hydrograph Eutaw Aquifer Monitoring Wells



B. Daily Precipitation Totals Recorded at Facility



Note:
1) ft AMSL = feet above Mean Sea Level
2) (m) denotes manual water-level measurements.
3) Transducer data calibrated to August 31, 2012 manual water-level measurements.

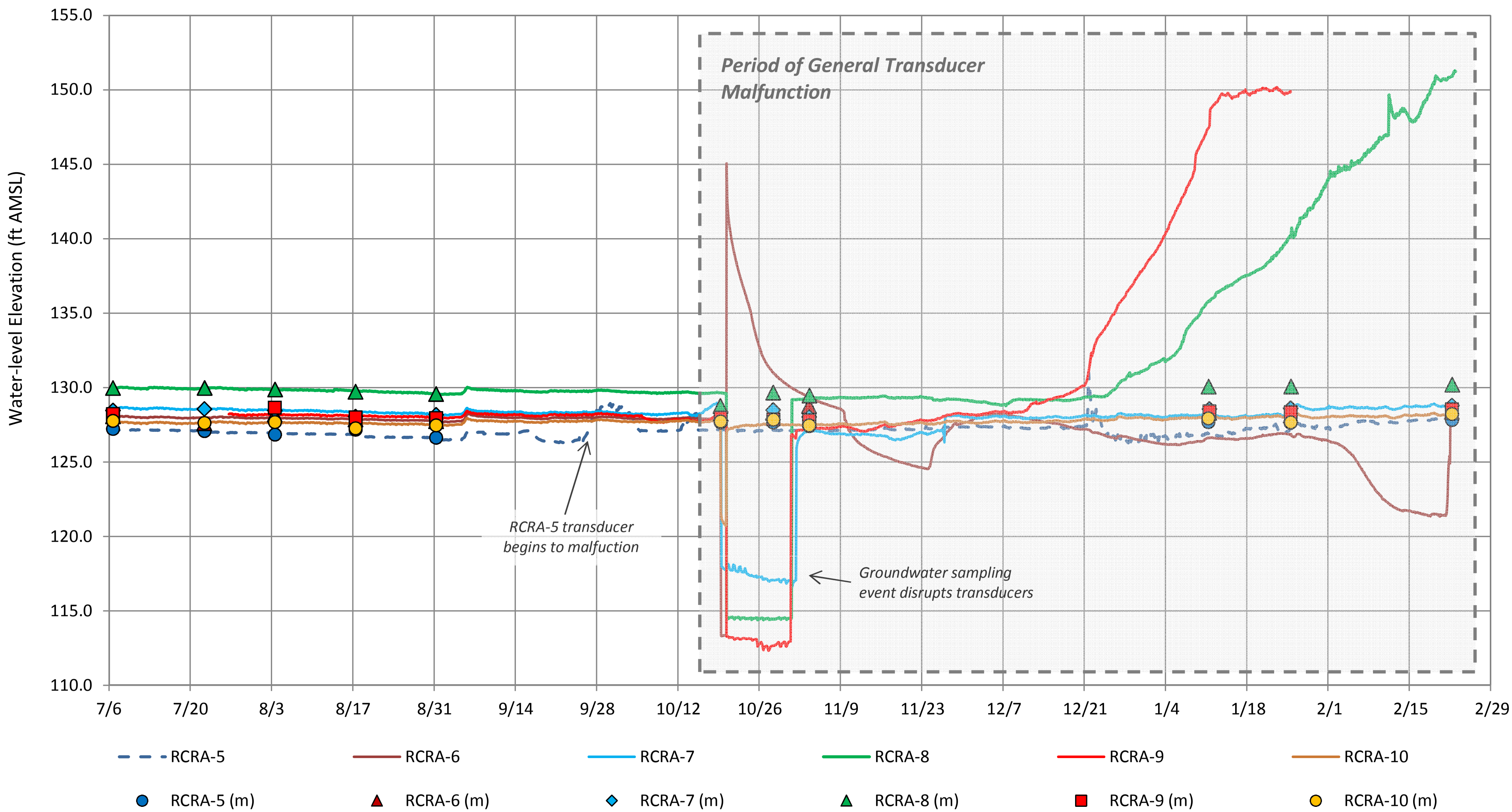
CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

THREE-MONTH HYDROGRAPH
JULY 6 TO OCTOBER 6, 2012

ARCADIS

FIGURE
7

Eutaw_xd_120223.xlsm 3/29/2012



Notes:
1) ft AMSL = feet above Mean Sea Level
2) (m) denotes manual water-level measurements.
3) Transducer data calibrated to August 31, 2012 manual water-level measurements.
4) Determination of transducer malfuction based on lack of agreement with manual water-level data.

CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA
EUTAW AQUIFER GRADIENT EVALUATION

COMPLETE MONITORING PERIOD RECORD
JULY 2011 TO FEBRUARY 2012

ARCADIS

FIGURE
8

Eutaw_xd_120223.xlsm 3/29/2012

APPENDIX E-12

SECTION E

MONITORING WELL BORING LOGS AND WELL CONSTRUCTION DIAGRAMS

Revision No.
5.0

APPENDIX E-12

SECTION E

LIST OF DOCUMENTS

Monitoring well boring logs and/or well construction diagrams are provided for the following monitoring wells at the Emelle Facility:

- SMBG-02
- SM-01
- SM-01A
- SM-02
- SM-03
- SM-04
- SM-05
- SM-05A
- SM-05B
- SM-05C
- SM-05D
- SM-05E
- SM-06
- SM-06A
- SM-07
- SM-07A
- SM-08
- SM-08A
- SM-09
- SM-09A
- SM-10
- SM-10A
- SM-11
- SM-12
- SM-12A
- SM-13
- SM-14
- SM-14A
- SM-15
- SM-16
- SM-16A
- SM-17
- SM-18
- SM-18A
- SM-18B
- SM-18C
- SM-18D
- SM-19
- SM-20
- SM-21
- SM-22
- SM-23
- SM-23A
- SM-24
- SM-27
- SM-28
- SM-29
- SM-30
- SM-31
- SM-32
- SM-33
- SM-34
- SM-35
- SM-35B
- SM-36
- SM-37
- CMI-1
- CMI-2
- CMI-3
- RCRA 1
- RCRA 2
- RCRA 3
- RCRA 4
- RCRA 5
- RCRA 6
- RCRA 7
- RCRA 8
- RCRA-8R
- RCRA 9
- RCRA 10
- RCRA 10R
- RCRA 10A

MONITORING WELL INSTALLATION LOG

JOB NO. 353-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. BG-2 SHEET 1 OF 1

GA INSP. EDD DRILLING METHOD ROTARY WASH GROUND ELEV 260.22' WATER DEPTH —

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 263.22' DATE/TIME —

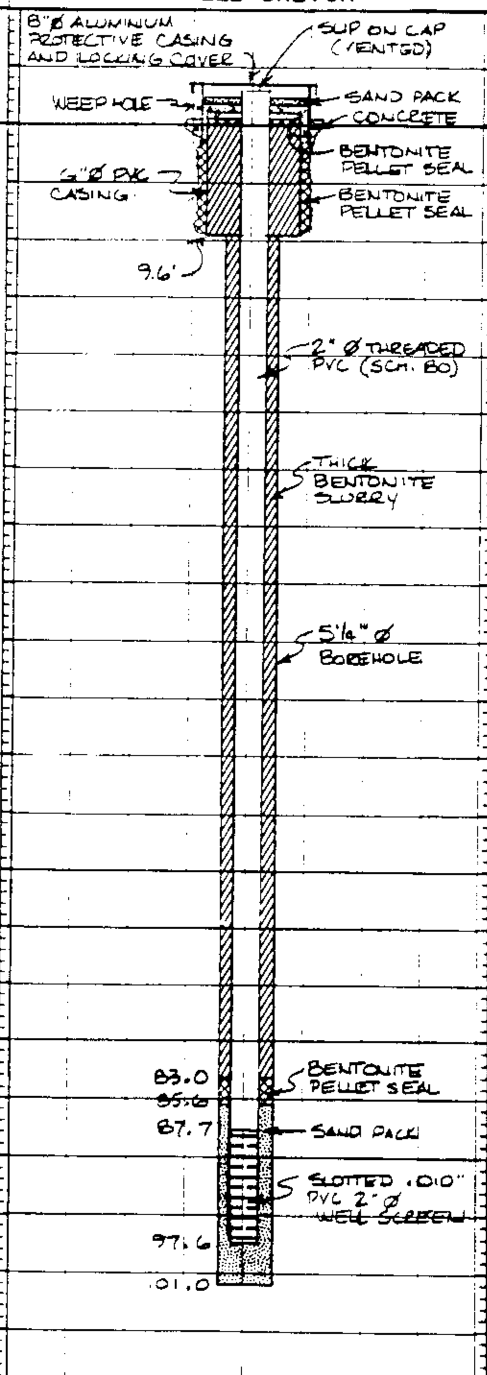
TEMP. 35° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:30AM/12-17-85 (TIME / DATE) COMPLETED 9:40AM/2-8-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 90.75 L.F.	WELL SCREEN 2 in. dia. 9.85 L.F.	BENTONITE SEAL 2 GAL PAILS 1/2" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2 1/4 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 14 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
260.22'	GROUND SURFACE
0.0 – 105.0	IN SITU CHALK (NO FRACTURES)

WELL SKETCH



INSTALLATION NOTES

2" Ø PVC STANDPIPE "STICKUP" = 3.0'

ALUMINUM PROTECTIVE CASING STICKUP 3.4'

WELL SCREEN INTERVAL SET AT DEPTHS BETWEEN 87.7' AND 97.6' AND NOT THE SPECIFIED DEPTH INTERVAL OF 89.0' TO 99.0' BECAUSE OF THE PIPE LENGTHS BEING CUT TOO SHORT. THE PIPE LENGTH DISCREPANCY WAS NOT NOTED UNTIL AFTER THE WELL WAS SET. THE DECISION WAS MADE TO LEAVE THE WELL SET AS SHOWN ON THE SKETCH.

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-1 SHEET 1 OF 1

GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 174.26' WATER DEPTH —

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 177.36' DATE/TIME —

TEMP. 40° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 2:35 PM/1-2-86 (TIME / DATE) COMPLETED 1:20 PM/2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2" in. dia. 49.35 L.F. WELL SCREEN 2" in. dia. 4.85 L.F. BENTONITE SEAL 2.3' THICK, 1/2 ø PELLETS, ABOVE SCREEN

CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND

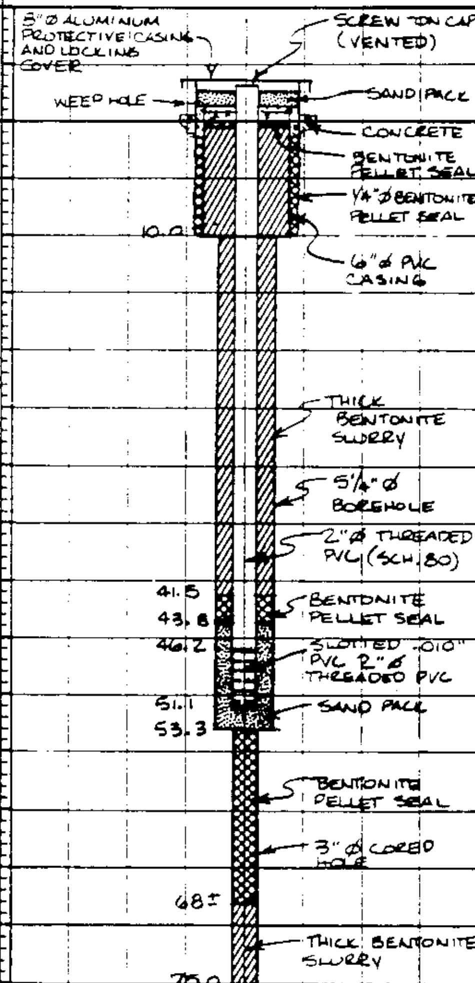
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 2 1/2 BAGS (50 LB BAGS)

GROUT QUANTITY APPROX. 3.0 FT ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND

GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
174.26	GROUND SURFACE
0.0	RECOMPACTED CHALK
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	INSITU CHALK
40.0	
45.0	FRACTURE ZONE 49.4'-50.2' ?
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	

WELL SKETCH



INSTALLATION NOTES

2" ø PVC STANDPIPE STICKUP = 3.1'

ALUMINUM PROTECTIVE CASING STICKUP = 3.6'

WELL DEVELOPMENT NOTES

Golder Associates

New Page May 19, 19..

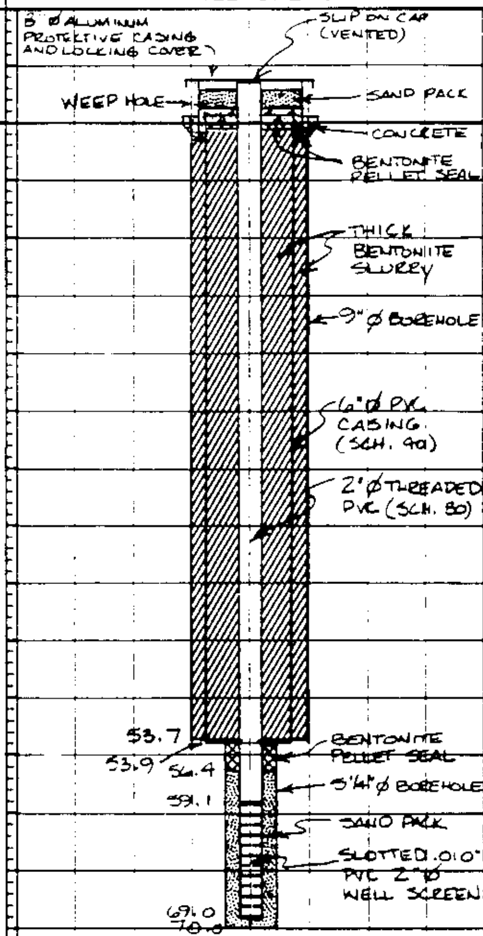
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-1A	SHEET 1 OF 1
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 174.17'	WATER DEPTH —
WEATHER SUNNY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 177.77'	DATE/TIME —
TEMP. 40° F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 3:10 PM / 1-3-86 (TIME / DATE) — COMPLETED 12:15 PM / 2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 62.75 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.5' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 1/4 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 20 CU FT ON OUTSIDE OF 6" PVC; APPROX. 10 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
174.17'	GROUND SURFACE		2" Ø PVC STANDPIPE STICKUP = 3.6'
0.0			ALUMINUM PROTECTIVE CASING STICKUP = 3.7'
5.0			WELL CA-1A LOCATED N12°E, 10' FROM CA-1 (SEE WELL LOCATION MAP)
10.0			
15.0			
20.0			
25.0			
30.0			
35.0	SEE LOG CA-1 FOR SOIL/ROCK DESCRIPTION		
40.0			
45.0			
50.0			
55.0			**WELL DEVELOPMENT NOTES**
60.0			
65.0			
70.0			
75.0			
80.0			



Golder Associates

New Page
May 19, 1985

MONITORING WELL INSTALLATION LOG

JOB NO. 353-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-2 SHEET 1 OF 2

GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 193.75' WATER DEPTH –

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 196.60' DATE/TIME –

TEMP. 40°F DRILL RIG MOBILE B-61 DRILLER DJ / WG STARTED 10:00 AM 1-13-86 (TIME / DATE) COMPLETED 1:10PM 1-14-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 138.0 ft. WELL SCREEN 2 in. dia. 9.85 ft. BENTONITE SEAL 2.3' THICK, 1/2"ø PELLETS ABOVE SCREEN

CASING TYPE PVC SCH. 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND

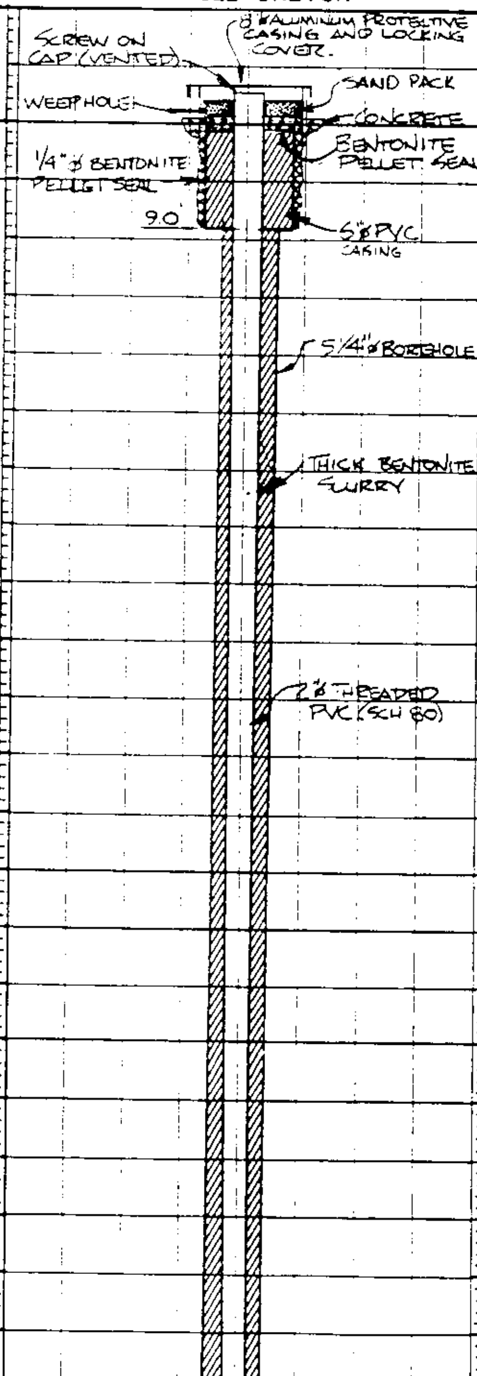
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 4 - 50LB BAGS

GROUT QUANTITY APPROX 15 CU.FT ABOVE PELLET SEAL CENTRALIZERS – FILTER PACK TYPE 14/30 GRADE BLASTING SAND

GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE & WATER W/WATER DRILLING MUD TYPE – INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
193.75'	GROUND SURFACE
0.0	RECOMPACTED CHALK
5.0	
10.0	IN SITU CHALK (NO FRACTURES)
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

WELL ORIGINALLY SET IN THIS HOLE ON 12/11/85 HOWEVER DUE TO THE FACT THAT THE PVC PIPE WAS CUT SHORT, THIS WELL WAS 2.3' TOO HIGH IN THE HOLE. THEREFORE THE 2" PVC WAS PULLED OUT, HOLE FLUSHED, AND THE WELL RESET TO ITS CORRECT DEPTH. A BENTONITE PELLET SEAL WAS ADDED TO THE BOTTOM OF THE HOLE.

2"ø PVC STANDPIPE STICKUP FROM GROUND SURFACE = 2.85'

ALUMINUM CASING STICKUP FROM GROUND SURFACE = 3.3'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1990

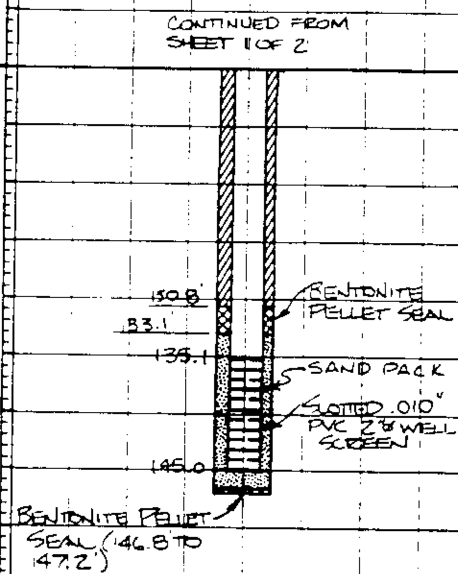
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-2 SHEET 2 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 193.75' WATER DEPTH —
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 196.60' DATE/TIME —
TEMP. 40°F DRILL RIG MOBILE B-61 DRILLER DJ / WG STARTED 10:00AM 1/13/86 (TIME / DATE) COMPLETED 4:10PM 1/14/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 138.0 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.3 THICK, 1/2" Ø PELLETS, 45cm SCREEN
CASING TYPE PVC SCH 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 4-50 LB BAGS
GROUT QUANTITY APPROX. 16 CU. FT ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/ WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
110.0		CONTINUED FROM SHEET 1 OF 2	
115.0			
120.0			
125.0	IN SITU CHALK (NO FRACTURES)		
130.0			
135.0			
140.0			
145.0			
150.0			



WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 198?

MONITORING WELL INSTALLATION LOG

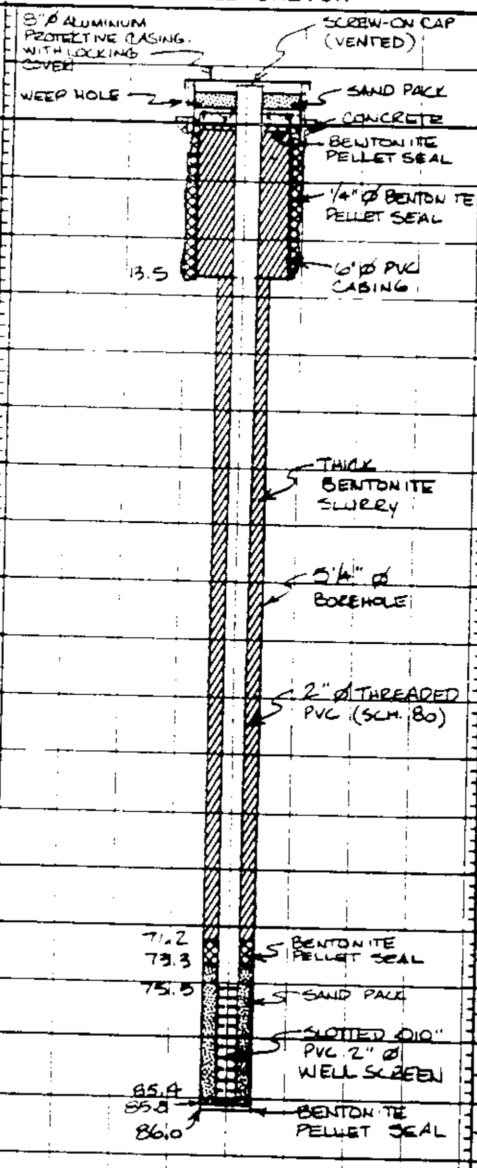
JOB NO 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-3 SHEET 1 OF 1
GA INSP. ZDD DRILLING METHOD ROTARY WASH GROUND ELEV. 204.25' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 207.60' DATE/TIME —
TEMP. 45° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 12:30 PM/1-17-86 (TIME / DATE) COMPLETED 4:40 PM/1-20-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 73.9 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.1' THICK, 1/2" ⌀ PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 1/3 BAGS (50.3 BAGS)
GROUT QUANTITY APPROX. 14 CU.FT. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
204.25'	GROUND SURFACE
0.0	
5.0	RECOMPACTED CHALK
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	IN SITU CHALK (NO FRACTURES)
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	

WELL SKETCH



INSTALLATION NOTES

WELL ORIGINALLY SET IN THIS HOLE ON 12-13-85. HOWEVER, DUE TO THE FACT THAT THE PVC PIPE WAS CUT SHORT, THIS WELL WAS 1.4' TOO HIGH IN THE HOLE. THEREFORE THE 2" PVC WAS PULLED OUT, HOLE FLUSHED, AND THE WELL RESET TO ITS CORRECT DEPTH. A BENTONITE PELLET SEAL WAS ADDED TO THE BOTTOM OF THE HOLE.

2" PVC STANDPIPE STICKUP FROM GROUND SURFACE = 3.35'

ALUMINUM CASING STICKUP FROM GROUND SURFACE = 3.6'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

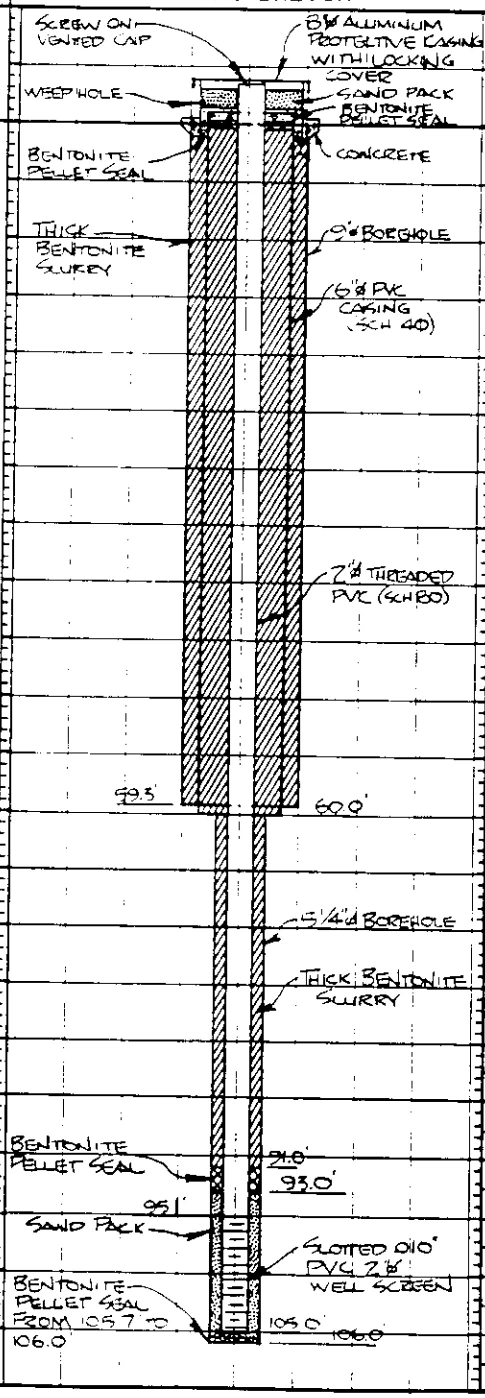
JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-4 SHEET 1 OF 1
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 225.0' WATER DEPTH —
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 228.45' DATE/TIME —
TEMP. 30°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 7:30 AM 1/15/86 (TIME / DATE) COMPLETED 10:20 AM 1/17/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 98.6 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.0 THICK 1/2" PELLETS ABOVE SCREEN
CASING TYPE PVC SCH. 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 4 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 16 CU FT AROUND 6" PVC; APPROX. 20 CU. FT. ABOVE PELLET SEAL CENTRALIZERS —
FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
225.0'	GROUND SURFACE
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	IN SITU CHALK (NO FRACTURES ABOVE LEACHATE)
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

WELL ORIGINALLY SET IN THIS HOLE ON 12/15/85. HOWEVER DUE TO THE FACT THAT THE PVC PIPE WAS CUT SHORT THIS WELL WAS 1.7' TOO HIGH IN THE HOLE. THEREFORE THE 2" PVC WAS PULLED OUT, HOLE FLUSHED, AND THE WELL RESET TO ITS CORRECT DEPTH. A BENTONITE PELLET SEAL WAS ADDED TO THE BOTTOM OF THE HOLE.

2" PVC STANDPIPE STICKUP FROM GROUND SURFACE = 3.45'

ALUMINUM CASING STICKUP FROM GROUND SURFACE = 3.5'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

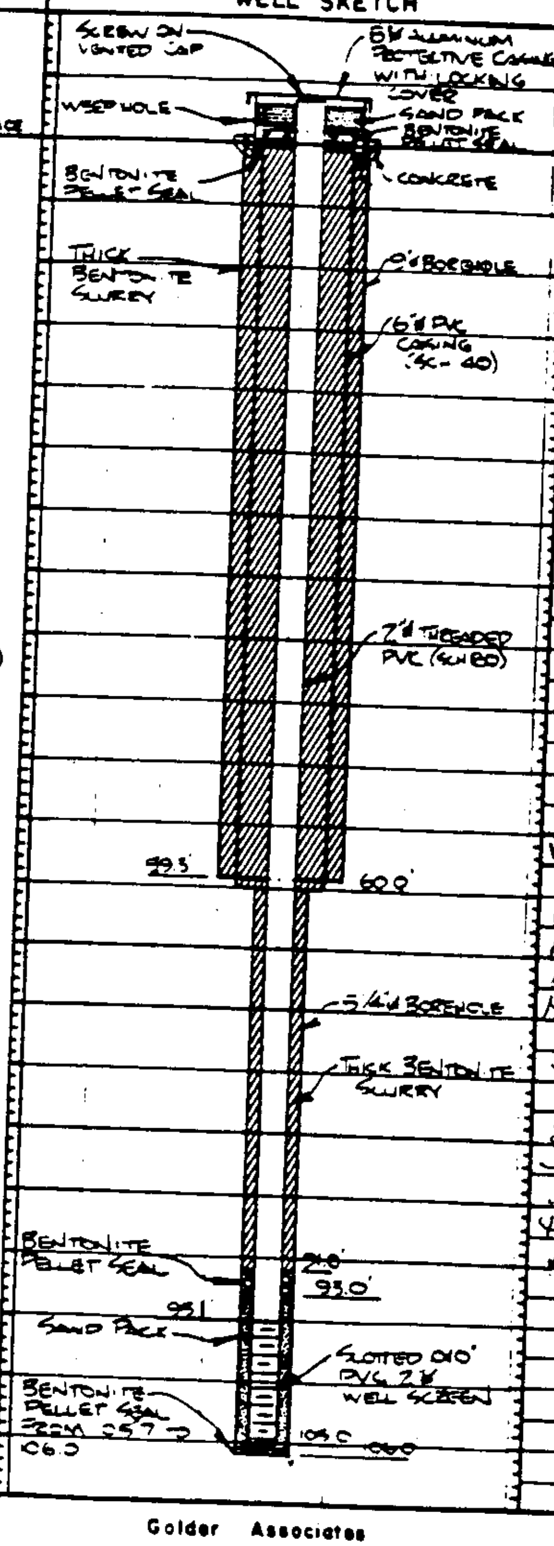
JOB NO	272 XXX3	PROJECT	CWM / CONSENT WELLS / EMELLE	WELL NO	LA-4	SHEET	OF
GA INSP	220	DRILLING METHOD	ROTARY WASH	GROUND ELEV	225.0'	WATER DEPTH	—
WEATHER	SUNNY	DRILLING COMPANY	TRI-STATE	PVC COLLAR ELEV	228.45'	DATE/TIME	—
TEMP	30°F	DRILL RIG	MOBILE B-61	DRILLER	J./WG	STARTED	7:30AM / 1986
						COMPLETED	[illegible]

MATERIALS INVENTORY

WELL CASING	2 " dia 98.6 LF	WELL SCREEN	2 " dia 9.5 LF	BENTONITE SEAL	2 3 BUCKS PELLETS [illegible]
CASING TYPE	PVC SCH 80	SCREEN TYPE	PVC SCH 80	INSTALLATION METHOD	BY HAND
JOINT TYPE	THREADED (TEFLON WRAPPED)	SLOT SIZE	.010 INCH	FILTER PACK QTY	4 BAGS, 50.3 BAGS
GROUT QUANTITY	APPROX. 6 CU FT AROUND 6" PVC APPROX. 20 CU FT ABOVE BENTONITE	CENTRALIZERS	—	FILTER PACK TYPE	[illegible]
GROUT TYPE	APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER	DRILLING MUD TYPE	—	INSTALLATION METHOD	BY HAND

ELEV/DEPTH	SOIL/ROCK DESCRIPTION
225.0' / 0.0	GROUND SURFACE
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	IN SITU CHALK (NO FRACTURES ABOVE LEACHATE)
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

WELL ORIGINALLY SET IN THE HOLE ON 2/15/85 HOWEVER DUE TO THE FACT THAT THE PVC PIPE WAS CUT SHORT THIS WELL WAS TOO HIGH IN THE HOLE. THEREFORE THE 2" PVC WAS PULLED, THE HOLE FLUSHED, AND THE WELL RESET TO THE CORRECT DEPTH. A BENTONITE PELLET SEAL WAS ADDED TO THE BOTTOM OF THE HOLE.

2" PVC STANDPIPE STICKUP FROM GROUND SURFACE: 3.45'

ALUMINUM CASING STICKUP FROM GROUND SURFACE = 3.5'

WELL DEVELOPMENT NOTES

On 9/28/[redacted] the well was extended 5' due to access road building for truck wash. The new elevation is 238.96 the well tubing was also extended to keep the pump @ the same elevation.

Golder Associates

MONITORING WELL INSTALLATION LOG

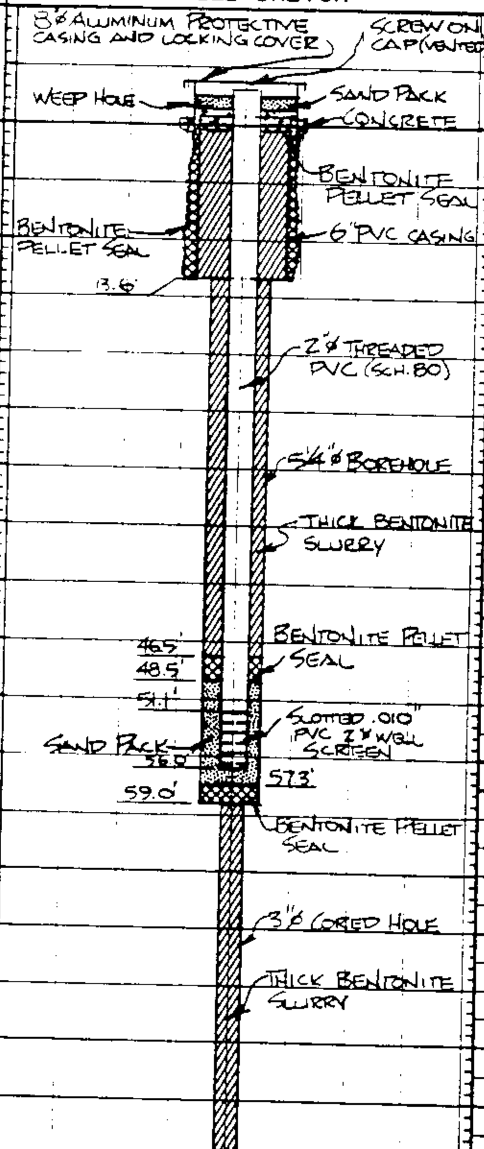
JOB NO. 853-3098.3 PROJECT SWM/CONSENT WELLS/ EMELLE WELL NO. CA 5 SHEET 1 OF 1
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 249.31' WATER DEPTH —
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 252.31' DATE/TIME —
TEMP. 20°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 5:10PM 1/5/86 (TIME / DATE) COMPLETED 2:15PM 3/6/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 54.2 l.f. WELL SCREEN 2 in. dia. 4.85 l.f. BENTONITE SEAL 2.0' THICK ½"ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCH. 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY. 2 BAGS (50LB BAGS)
GROUT QUANTITY APPROX. 8 cu. ft. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
249.31'	GROUND SURFACE
0.0	
5.0	RECOMPACTED CHALK
10.0	
15.0	
20.0	
25.0	IN SITU CHALK
30.0	
35.0	
40.0	
45.0	
50.0	FRACTURE ZONE 53.9'-54.1'
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	

WELL SKETCH



INSTALLATION NOTES

2"ø PVC STANDPIPE
STICKUP = 3.0'
ALUMINUM PROTECTIVE CASING STICKUP = 3.7'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1988

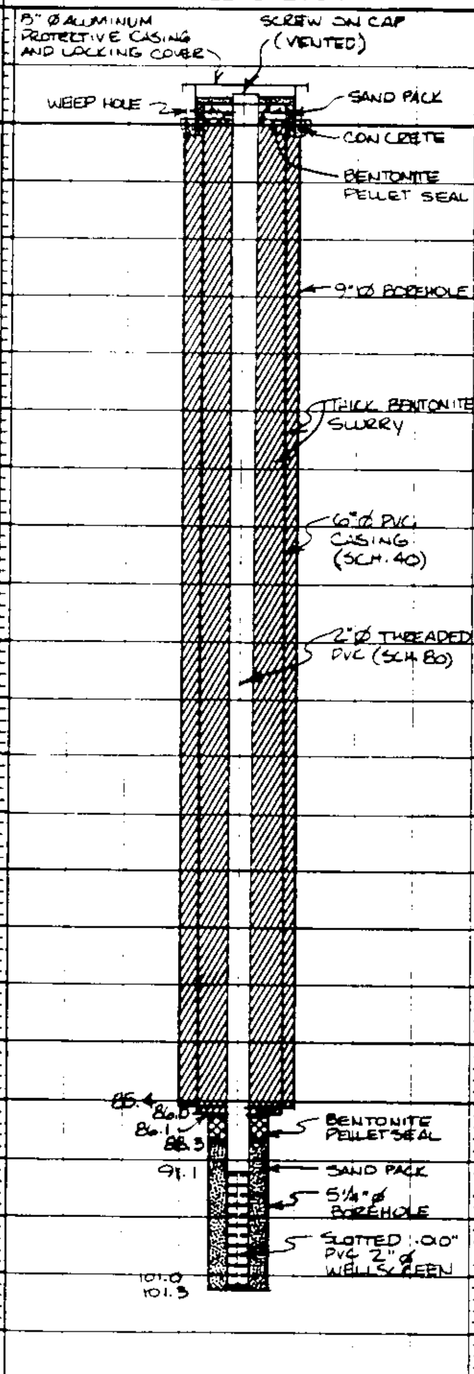
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-5A	SHEET 1 OF 1
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 249.58'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 252.03'	DATE/TIME —
TEMP. 40°F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 8:15AM/1-7-86 (TIME / DATE) — COMPLETED 12:50PM/3-6-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 93.6 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.2' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 15 CU FT AROUND 6" PVC, APPROX. 18 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
249.58'	GROUND SURFACE		2" Ø PVC STANDPIPE STICKUP = 2.45'
0.0			ALUMINUM PROTECTIVE CASING STICKUP = 3.3'
5.0			WELL CA-5A LOCATED 3° W. OF S. 10' FROM CA-5. (SEE WELL LOCATION MAP)
10.0			
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	SEE LOG CA-5 FOR SOIL/ROCK DESCRIPTION		
45.0			
50.0			
55.0			**WELL DEVELOPMENT NOTES**
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			



Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098 PROJECT CLWM GROUNDWATER WELLS ENCLE (?) WELL NO CACB SHEET 1 OF 1

GA INSP AES DRILLING METHOD WIRE ROTARY

WEATHER FAIR DRILLING COMPANY TRANSTATE TESTING GROUND ELEV — WATER DEPTH —

TEMP 80's DRILL RIG MOBILE B-61 DRILLER DOYLE COLLAR ELEV — DATE/TIME —

STARTED 7:30 / 9-9-86 (TIME / DATE) COMPLETED 6:30 / 9-10-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2" in dia. 50.0 l.f. — WELL SCREEN 2" in dia. 20.0 l.f. — BENTONITE SEAL 25# ½" PELLETS

CASING TYPE SCH 40 PVC — SCREEN TYPE MILLED SLOT PVC — INSTALLATION METHOD POURED

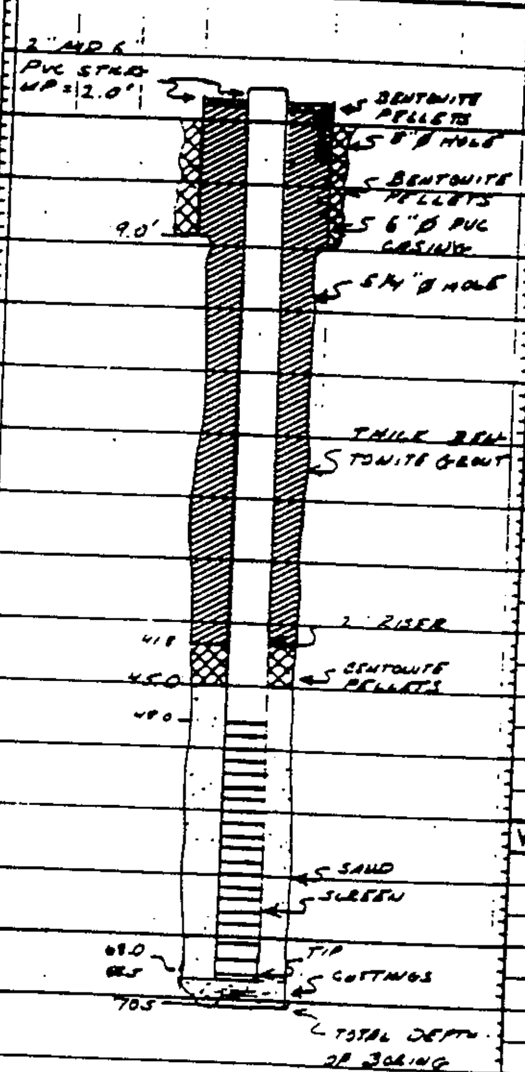
JOINT TYPE FLUSH THREADED TEFLON TAPED — SLOT SIZE 0.010 — FILTER PACK QTY 380#

GROUT QUANTITY 45 GAL. — CENTRALIZERS — — FILTER PACK TYPE 16-30 SAND

GROUT TYPE 1# COLLOIDAL BENTONITE : 1 GALLON H_2O — DRILLING MUD TYPE MUNICIPAL WATER — INSTALLATION METHOD POURED

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
0.0	GROUND SURFACE

WELL SKETCH



INSTALLATION NOTES

DRILLED 8" Ø HOLE TO 9'
SET 6" Ø PVC CASING USED
50# BENTONITE PELLETS TO
SET CASING. CORED (HQ)
9'-70.5' REAMED TO 70.5'
(5¼ Ø). CUTTINGS SETTLED
TO 68.5'. SET SCREEN
48.0'-68.0'
STEAM CLEANED SCREEN AND
RISER BEFORE SETTING

LET PELLETS HYDRATE
6 HRS BEFORE GROUT-
ING. CHECK GROUT 16 HRS
AFTER GROUTING. NO
BLEED OR SETTLEMENT
ADD 25 BENTONITE PEL-
LETS ABOVE GROUT

WELL DEVELOPMENT NOTES

JOB NO. 553-3400 PROJECT CWM - CONSENT WELLS - EMELLE WELL NO CA5C SHEET 1 OF 1

GA INSP AES/[illegible] DRILLING METHOD [illegible] ROTARY GROUND ELEV —

WEATHER [illegible] DRILLING COMPANY [illegible] TESTING COLLAR ELEV — WATER DEPTH —

TEMP 72° DRILL RIG MOBILE B-61 DRILLER [illegible] JONES STARTED 2:30 / 8-10-86 (TIME / DATE) DATE/TIME — COMPLETED 16:00 / 9-11 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2" in dia. 55.0 l.f.

CASING TYPE SCH 40 PVC

JOINT TYPE FLUSH THREADED

GROUT QUANTITY 50 GAL.

GROUT TYPE 1# [illegible] BENTONITE : 1 GALLON WATER

WELL SCREEN 2" in dia. 5 lf

SCREEN TYPE MILLED SLOT PVC

SLOT SIZE .010"

CENTRALIZERS —

DRILLING MUD TYPE MUNICIPAL WATER

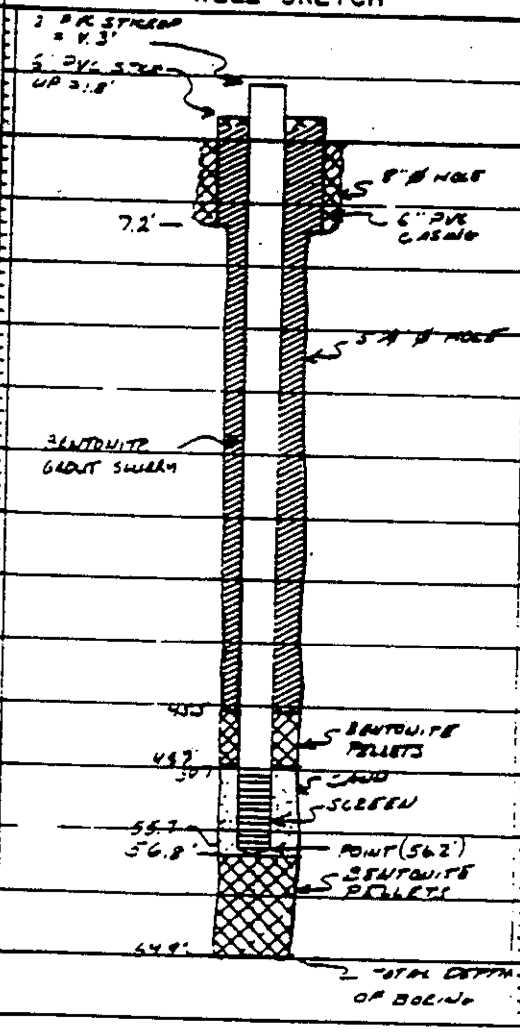
BENTONITE SEAL 25# 1/2" PELLETS

INSTALLATION METHOD POURED

FILTER PACK QTY 25 #

FILTER PACK TYPE 16/30 SAND

INSTALLATION METHOD POURED

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
0.0	GROUND SURFACE		DRILLED 8" HOLE TO 7.2 SET 6" PVC CASING [illegible] CORED (NX) 7.2 - [illegible] REAMED TO [illegible] STEAM CLEANED ALL SCREEN AND [illegible] BEFORE SETTING LET GROUT SET [illegible] HOURS [illegible] MIXED [illegible] BENTONITE PELLETS WITH [illegible] W TOP OF [illegible]

WELL DEVELOPMENT NOTES

Golder Associates

MONITORING WELL INSTALLATION LOG

JOB NO 553-3090 PROJECT CWM/Lewis/Lehigh WELL NO CA-5A SHEET 1 OF 1

GA INSP LWG DRILLING METHOD WASH ROTARY GROUND ELEV — WATER DEPTH —

WEATHER PTLY CLDY DRILLING COMPANY TRISTATE TESTING COLLAR ELEV — DATE/TIME —

TEMP 50's DRILL RIG MOBILE B-61 DRILLER DOYLE STARTED 8:25 9-10-86 (TIME / DATE) COMPLETED (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2.0" IN DIA. ______ LF

CASING TYPE SCH 40 PVC

JOINT TYPE FLUSH THREADED

GROUT QUANTITY ~60 GALS

GROUT TYPE ~1/4 BULDSEAL BENTONITE POWDER PER GALLON OF WATER

WELL SCREEN 2.0" IN DIA. 10.0 LF

SCREEN TYPE MACHINE SLOTTED

SLOT SIZE 0.010"

CENTRALIZERS —

DRILLING MUD TYPE MUNICIPAL WATER

BENTONITE SEAL ... PELLETS (~4.5 gals)

INSTALLATION METHOD POURED

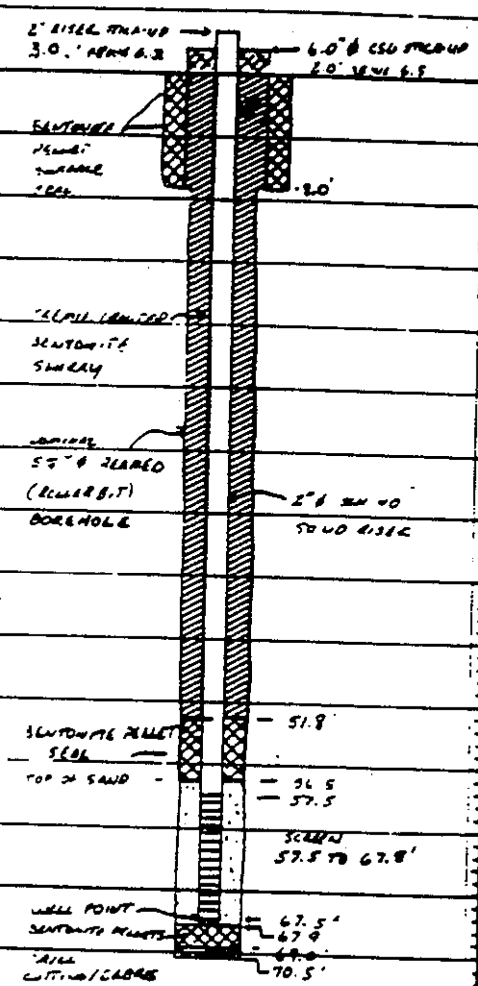
FILTER PACK QTY ~9 gals (1.4 c.f.)

FILTER PACK TYPE 16/30 SAND

INSTALLATION METHOD POURED

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
0.0	GROUND SURFACE

WELL SKETCH



INSTALLATION NOTES

DRILLED 8" Ø HOLE TO 9.0'; SET 6" PVC CASING TO 9.0. SEATED AND SEALED CASING WITH BENTONITE PELLETS.

CORED (NQ) FROM 7.8' TO 70.5 FEET BELOW GROUND SURFACE. REAMED WITH 5 7/8" Ø BIT TO 70.5 FEET.

STEAM CLEANED ALL SCREEN, WELL PIPE AND POINT & CAP BEFORE INSERTING DOWNHOLE.

LET BENTONITE PELLETS SET APPROX. 1/2 HRS BEFORE TREMIE GROUTING ABOVE SEAL.

WELL DEVELOPMENT NOTES

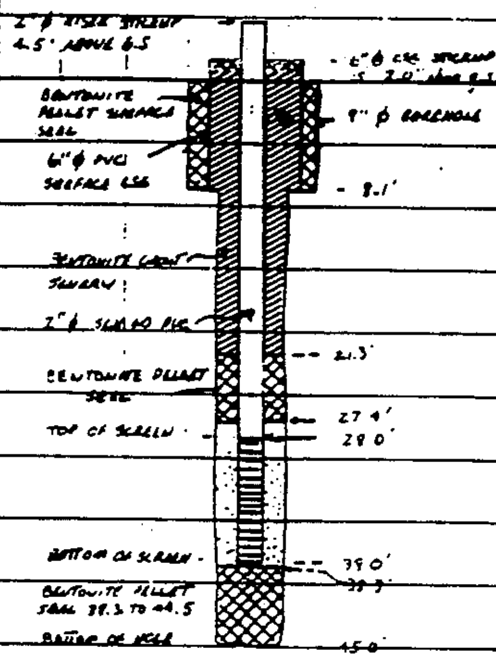
Golder Associates

MONITORING WELL INSTALLATION LOG

JOB NO 953-3049	PROJECT [illegible]	WELL NO CA-5E	SHEET 1 OF 1
GA WSP [illegible]	DRILLING METHOD [illegible] ROTARY	GROUND ELEV —	WATER DEPTH —
WEATHER [illegible]	DRILLING COMPANY TRI-STATE TESTING	COLLAR ELEV —	DATE/TIME —
TEMP 50 S	DRILL RIG [illegible]	DRILLER [illegible]	STARTED [illegible] / 9-15-96 (TIME / DATE) COMPLETED 1330 / 9-16 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2.0" in. dia. 42.5 ft	WELL SCREEN 2" in. dia. 10.0 ft	BENTONITE SEAL BENTONITE PELLETS [illegible]
CASING TYPE 2" ϕ SCH 40 PVC	SCREEN TYPE MACHINE SLOTTED	INSTALLATION METHOD POURED
JOINT TYPE FLUSH -	SLOT SIZE 0.010	FILTER PACK QTY ~ 9.5 [illegible]
GROUT QUANTITY ~ 55 gals	CENTRALIZERS —	FILTER PACK TYPE [illegible] SILICA SAND
GROUT TYPE - 1 lb [illegible] BENTONITE POWDER PER GAL OF WATER	DRILLING MUD TYPE CLEAR MUNICIPAL WATER	INSTALLATION METHOD POURED

ELEV/DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	GROUND SURFACE		
0.0			DRILLED [illegible]" ϕ HOLE TO 9.1'; SET 6" PVC CASING TO 9.0; SEALED 6" SURFACE WITH BENTONITE PELLETS (~ 4.5 GALS)
			[illegible] FROM 9.1' TO 45.0' BELOW GROUND SURFACE (BGS); REAMED [illegible] WITH 5 [illegible]" ϕ BIT FROM 6.5 TO 45.0'
			TOP BENTONITE PELLET SEAL - HYDRATION TIME BEFORE [illegible] GROUTING WAS 2 HRS
			FLUSHED HOLE THOROUGHLY WITH ~ 500 gals OF CLEAR MUNICIPAL WATER
			STEAM CLEANED ALL WELL PIPE AND SCREEN [illegible] INSERTING DOWNHOLE

WELL DEVELOPMENT NOTES

MONITORING WELL INSTALLATION LOG

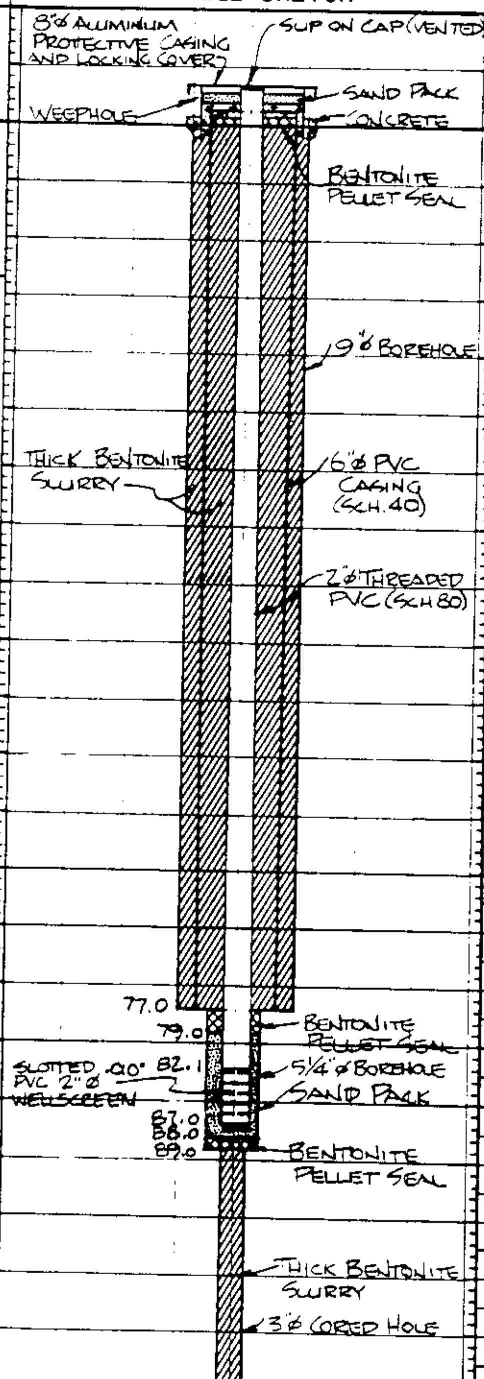
JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS/EMELLE WELL NO. CA-6 SHEET 1 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 262.79' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 265.89' DATE/TIME —
TEMP. 40°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 2:00 PM 2-27-86 (TIME / DATE) COMPLETED 5:20 PM 3-3-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 85.25 l.f. WELL SCREEN 2 in. dia. 4.85 l.f. BENTONITE SEAL 2.0' THICK ½" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCH 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 2 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 18 CU FT. AROUND 6" PVC, APPROX 16 CU FT. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
262.79'	GROUND SURFACE
0.0	
5.0	RECOMPACTED CHALK
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	IN SITU CHALK
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	FRACTURE ZONE 83.6'-84.0'
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

2" Ø PVC STANDPIPE STICKUP = 3.1'

ALUMINUM PROTECTIVE CASING STICKUP = 3.2'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

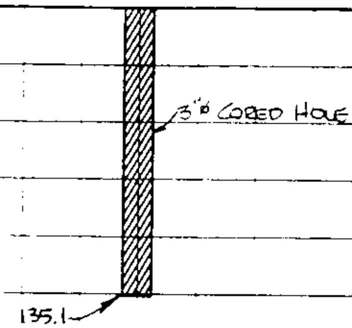
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-6	SHEET 2 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 262.79'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 265.89'	DATE/TIME —
TEMP. 40°F	DRILL RIG MOBILE B-61 / DRILLER DJ/WG	STARTED 2:00 PM/2-27-86 (TIME / DATE)	COMPLETED 5:20 PM/3-3-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 85.25 l.f.	WELL SCREEN 2 in. dia. 4.85 l.f.	BENTONITE SEAL 2.0' THICK, 1/2" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCH. 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2 BAGS (50-lb BAGS)
GROUT QUANTITY APPROX. 18 CU. FT. AROUND 6" PVC; APPROX. 16 CU. FT. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0	IN SITU CHALK		
125.0			
130.0			
135.0			
140.0			



WELL DEVELOPMENT NOTES

Golder Associates

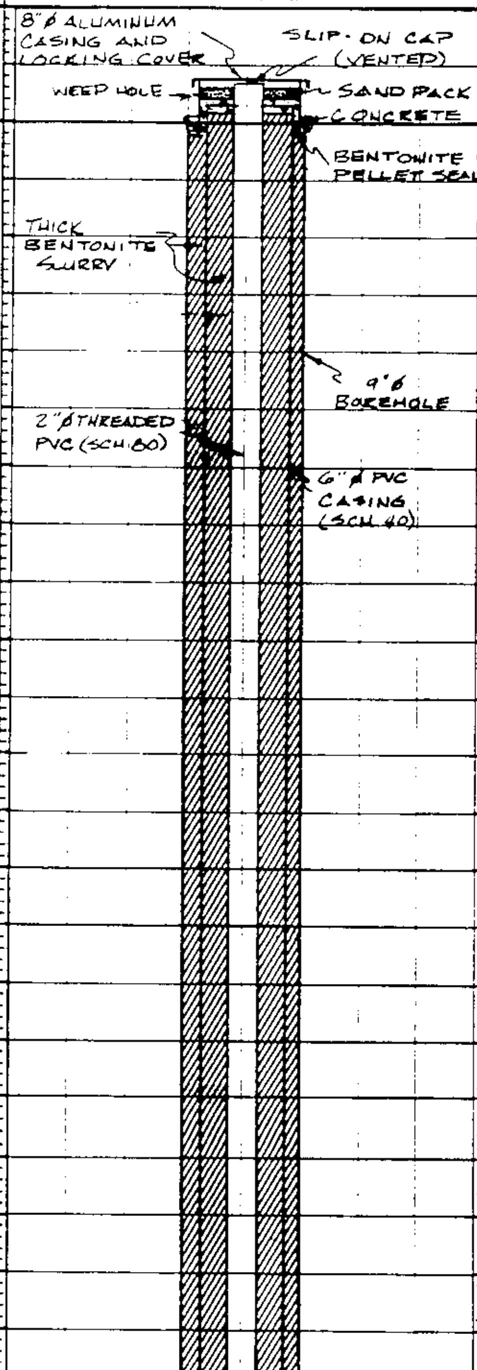
New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 353-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-6A SHEET 1 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 262.79' WATER DEPTH —
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 266.30' DATE/TIME —
TEMP. 45° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 8:00 AM/3-4-86 (TIME / DATE) COMPLETED 3:40 PM/3-6-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in dia. 121.66 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.0' THICK 1/2"ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCH 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY. 3 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 20 cu. FT AROUND 6" PVC; APPROX. 16 cu. FT ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 10/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
			2"ø PVC STANDPIPE "STICKUP" = 3.51
262.79'	GROUND SURFACE		ALUMINUM PROTECTIVE CASING "STICKUP" = 3.65
0.0			
5.0			WELL CA-6A LOCATED 10' SOUTH OF CA-6 ALONG N-S ALIGNMENT LINE (SEE WELL LOCATION MAP)
10.0			
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	SEE LOG CA-6 FOR SOIL/ROCK DESCRIPTION		
45.0			
50.0			
55.0			WELL DEVELOPMENT NOTES
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			
110.0			

Golder Associates

New Page
May 19, 1985

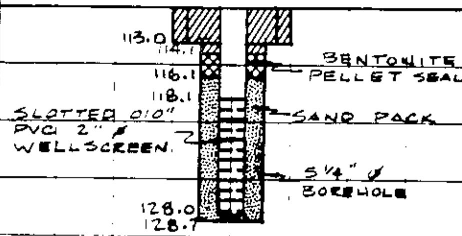
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-6A	SHEET 2 OF 2
GA INSP. EDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 262.79'	WATER DEPTH —
WEATHER SUNNY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 266.30'	DATE/TIME —
TEMP. 45° F	DRILL RIG MOBILE B-61 / DRILLER DJ/WG	STARTED 8:00 AM / 3/4/86 (TIME / DATE)	COMPLETED 3:40 PM / 3/6/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 121.66 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 20' THKE. 1/2" ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCH. 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 20 — " AROUND 6" PVC APPROX. 16 C.F. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CON'T FROM SHEET 1 OF 2	
110.0			
115.0			
120.0			
125.0			
130.0			



WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

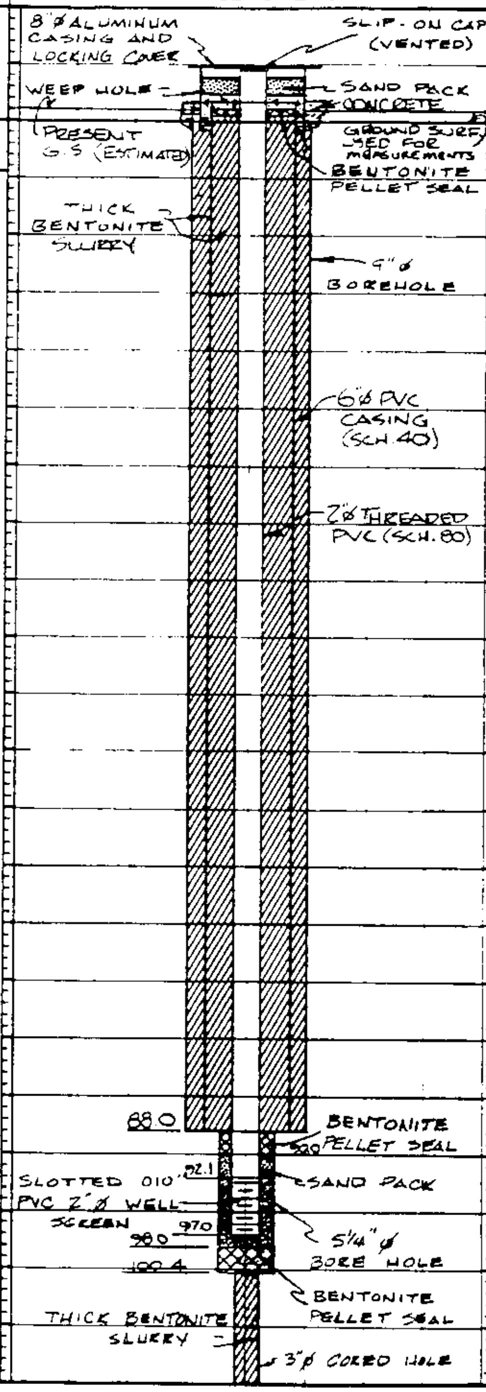
JOB NO. 853-3098.3	PROJECT CWM / CONSENT WELLS / EMELLE	WELL NO. CA-7	SHEET 1 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 266.94'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 271.34'	DATE/TIME —
TEMP. 50°F	DRILL RIG MOBILE B-61 / DRILLER DJ/WG	STARTED 8:40AM 3/11/86 (TIME / DATE)	COMPLETED 8:40AM 3-13-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in dia. 96.52 l.f.	WELL SCREEN 2 in. dia. 4.88 l.f.	BENTONITE SEAL 2.0' THICK 1/2" PELLETS ABOVE SCREEN
CASING TYPE PVC SCH 80	SCREEN TYPE PVC SCH 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2 BAGS (50 lb BAGS)
GROUT QUANTITY APPROX. 20 CU. FT. AROUND 6" PVC, APPROX. 15 CU. FT. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
266.94'	GROUND SURFACE
0.0	RECOMPACTED CHALK
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	IN SITU CHALK
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	FRACTURE ZONE 93.9'-94.9'
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

2"Ø PVC STANDPIPE STICKUP: 4.4'

ALUMINUM PROTECTIVE CASING STICKUP: 4.5

WELL DEVELOPMENT NOTES

Golder Associates

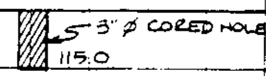
New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-7 SHEET 2 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 266.94' WATER DEPTH –
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 271.34' DATE/TIME –
TEMP. 50°F DRILL RIG MOBILE 3-61 DRILLER DJ/WG STARTED 8:40AM 3/11/86 (TIME / DATE) COMPLETED 8:40AM 3/13/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 96.52 l.f. WELL SCREEN 2 in. dia. 4.88 l.f. BENTONITE SEAL 2.0' THKK 1/2" PELLETS, ABOVE SCREEN
CASING TYPE PVC SCH. 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 2 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 20 CU. FT. AROUND 6" PVC, APPROX. 15 CU. FT. ABOVE PELLET SEAL CENTRALIZERS – FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER w/WATER DRILLING MUD TYPE – INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0			
			WELL DEVELOPMENT NOTES

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New Page
May 19, 1983

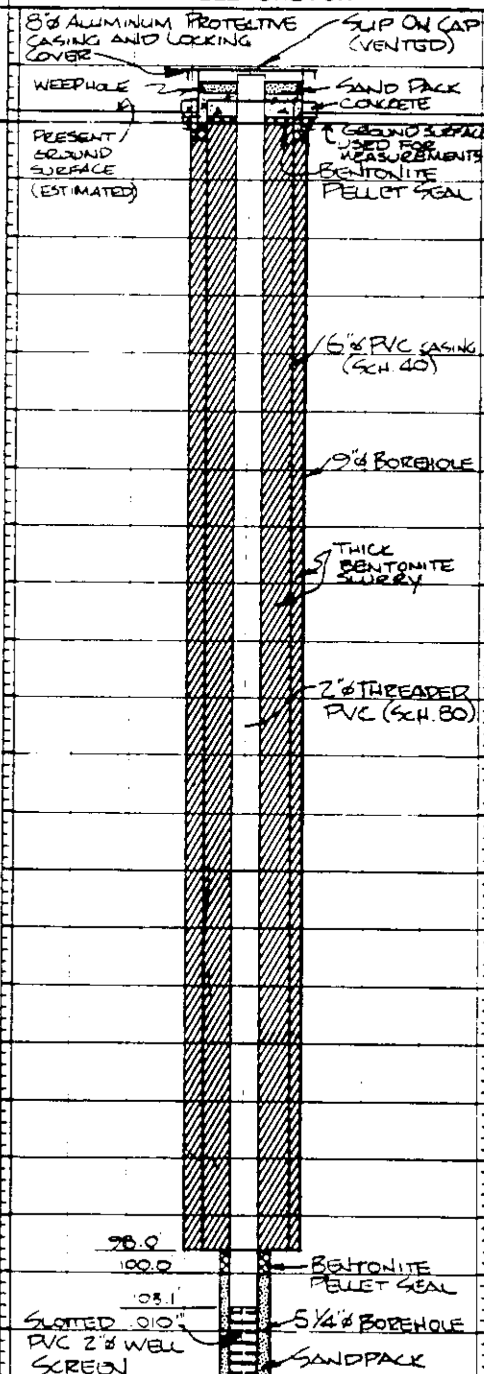
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM / CONSENT WELLS / EMELLE	WELL NO. CA-7A	SHEET 1 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 266.75'	WATER DEPTH —
WEATHER SUNNY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 270.95'	DATE/TIME —
TEMP. 50°F	DRILL RIG MOBILE 3-61 DRILLER DJ/WG	STARTED 4:10 PM 3-6-86 (TIME / DATE)	COMPLETED 8:40AM 3/11/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 107.35 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2' THICK 1/2" PELLETS ABOVE SCREEN
CASING TYPE PVC SCH. 80	SCREEN TYPE PVC SCH. 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 1/4 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 20 CU. FT ABOVE 2' SEAL (APPROX. 27 CU. FT AROUND 6" PVC)	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL COLD SEAL BENTONITE POWDER W/WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
266.75'	GROUND SURFACE		2" Ø PVC STANDPIPE STICKUP: 4.2'
0.0			ALUMINUM PROTECTIVE CASING STICKUP: 4.4'
5.0			
10.0			WELL CA-7A LOCATED 10' SOUTH OF CA-7 ALONG N-S ALIGNMENT LINE (SEE WELL LOCATION MAP)
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	SEE LOG CA-7 FOR SOIL/ROCK DESCRIPTION		
45.0			
50.0			
55.0			**WELL DEVELOPMENT NOTES**
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			
110.0			



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New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-7A SHEET 2 OF 2

GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 266.75' WATER DEPTH —

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 270.95' DATE/TIME —

TEMP. 50°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 4:10PM/3/6/86 (TIME / DATE) COMPLETED 8:40AM/5/11/86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 107.35 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2' THICK 1/2" PELLETS ABOVE SCREEN

CASING TYPE PVC SCH. 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND

JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3/4 BAGS (50LB BAGS)

GROUT QUANTITY APPROX. 20 CU. FT. ABOVE PELLET SEAL (APPROX. 2 CU. FT. AROUND 6" PVC) CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND

GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0			

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

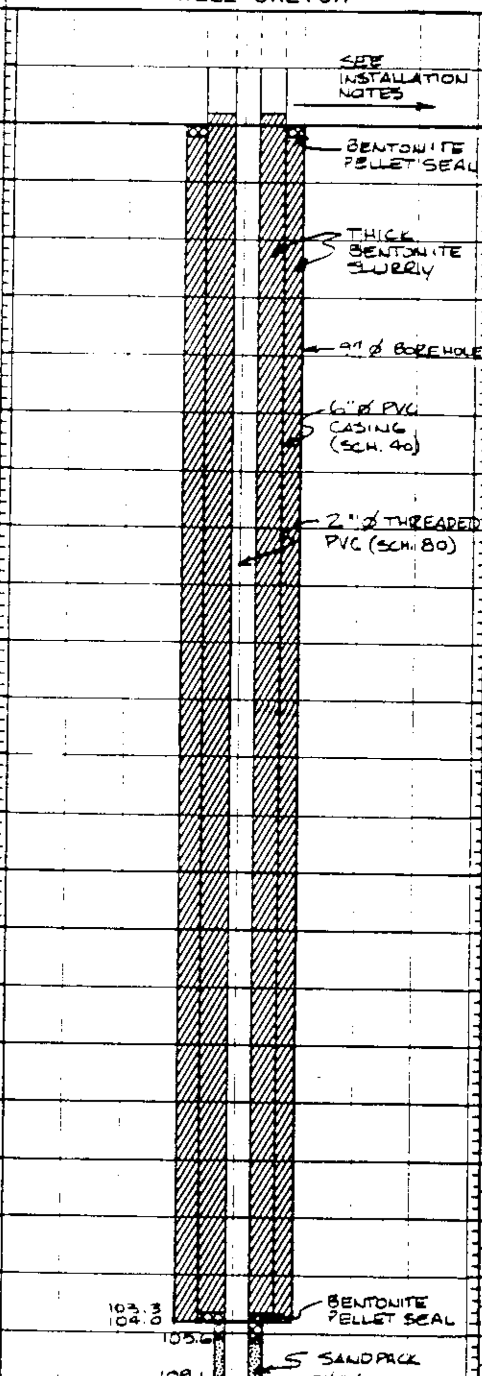
JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-8	SHEET 1 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 251.62'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 265.62'	DATE/TIME —
TEMP. 40° F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 9:05AM/1-22-86 (TIME / DATE) COMPLETED 8:20AM/2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 123.15 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.5' THICK, 1/2" ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 1/4 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 32 CU FT AROUND 6" PVC; APPROX. 20 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. ... RATIO AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

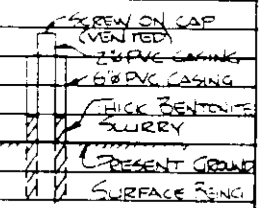
ELEV./DEPTH	SOIL/ROCK DESCRIPTION
251.62'	GROUND SURFACE
0.0	RECOMPACTED CHALK
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	IN SITU CHALK
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	FRACTURE ZONE 109.9'-117.3' ?
110.0	

WELL SKETCH



INSTALLATION NOTES

PROTECTIVE ALUMINUM COVER NOT INSTALLED BECAUSE OF THE GROUND SURFACE BEING RAISED IN THE DITCH WHERE CA-8 IS LOCATED. COULD AND ADDITIONAL BENTONITE SLURRY WILL HAVE TO BE ADDED LATER WHEN THE GROUND IS RAISED TO SPECIFIED GRADE.



PRESENT STICKUP OF 2" PVC STANDPIPE = 14.0'. PRESENT STICKUP OF 6" PVC STANDPIPE = 13.2'

ORIGINAL 3" ø BOREHOLE CAVED IN FROM 173.8' TO 175.0'

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-8 SHEET 2 OF 2

GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 251.62' WATER DEPTH —

WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 265.62' DATE/TIME —

TEMP. 40°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:05 A.M. / 1-22-86 (TIME / DATE) COMPLETED 8:20 AM / 2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 123.15 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.3' THICK, 1/2" Ø PELLETS ABOVE SCREEN

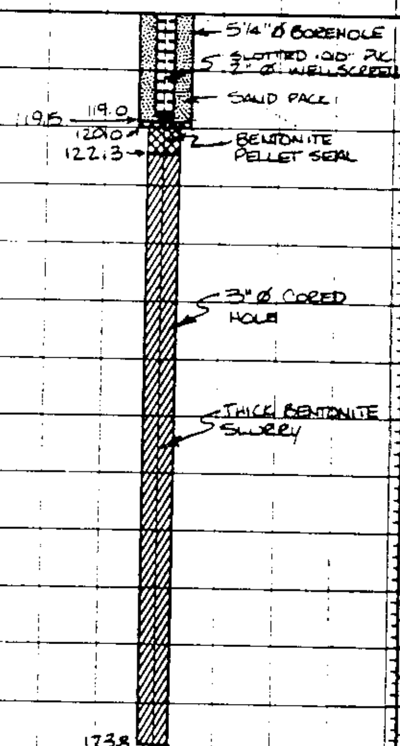
CASING TYPE PVC SCH. 80 SCREEN TYPE PVC SCH. 80 INSTALLATION METHOD BY HAND

JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 1/4 BAGS (50 LB BAGS)

GROUT QUANTITY APPROX. 32 CU FT AROUND 6" PVC, APPROX. 20 CU FT ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND

GROUT TYPE APPROX 1:1 RATIO AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0	FRACTURE ZONE 109.9' - 117.3'		
115.0			
120.0			
125.0			
130.0			
135.0			
140.0			
145.0			
150.0			
155.0			
160.0			
165.0			WELL DEVELOPMENT NOTES
170.0			
175.0			



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New Page
May 19, 1986

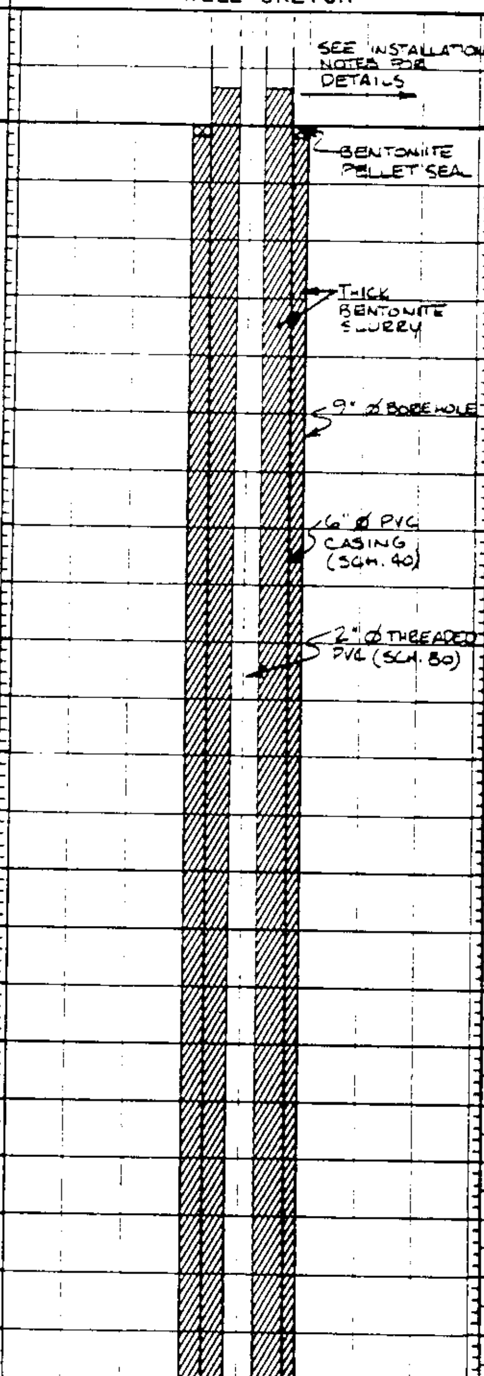
MONITORING WELL INSTALLATION LOG

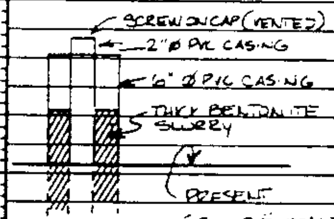
JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-8A SHEET 1 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 251.69' WATER DEPTH —
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 267.89' DATE/TIME —
TEMP. 35°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:55AM/1-29-86 (TIME / DATE) COMPLETED 9:30AM/2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 178.35 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.1' THICK, 1/2" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 24 CU.FT. ABOVE PELLET SEAL; APPROX 36 CU.FT. AROUND 6" PVC CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
251.69'	GROUND SURFACE		PROTECTIVE ALUMINUM COVER NOT INSTALLED BECAUSE OF THE GROUND SURFACE BEING RAISED IN THE DITCH WHERE CA-8A IS LOCATED. COVER AND ADDITIONAL BENTONITE SLURRY WILL HAVE TO BE ADDED LATER WHEN THE GROUND IS RAISED TO SPECIFIED GRADE
0.0			
5.0			
10.0			
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	SEE LOG CA-8 FOR SOIL/ROCK DESCRIPTION		PRESENT STICKUP OF 2" PVC STANDPIPE = 16.2'
45.0			PRESENT STICKUP OF 6" PVC STANDPIPE = 4.1'
50.0			
55.0			
60.0			WELL CA-8A LOCATED 10' NORTH OF CA-8 ALONG N-S ALIGNMENT LINE (SEE WELL LOCATION MAP)
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			
110.0			





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New Page
May 19, 1986

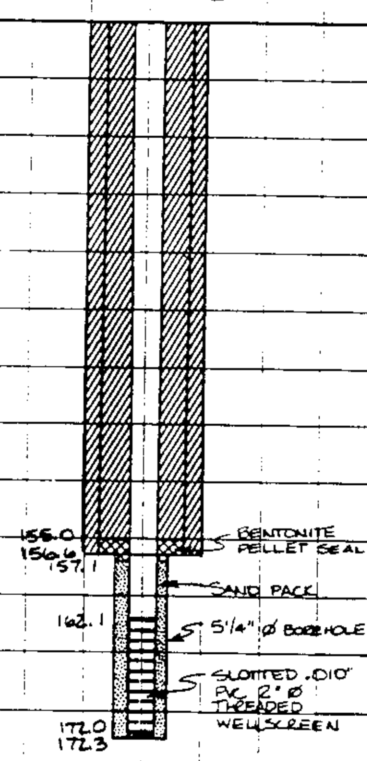
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-8A SHEET 2 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 251.69' WATER DEPTH —
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 267.89' DATE/TIME —
TEMP. 35° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:55AM/1-29-86 (TIME / DATE) COMPLETED 9:30AM/2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 178.35 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.1' THICK, 1/2" ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 36 CU. FT. AROUND 6" PVC APPROX. 24 CU. FT. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0			
125.0			
130.0			
135.0			
140.0	SEE LOG CA-8 FOR SOIL/ROCK DESCRIPTION		
145.0			
150.0			
155.0			
160.0			
165.0			WELL DEVELOPMENT NOTES
170.0			
175.0			
180.0			



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New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

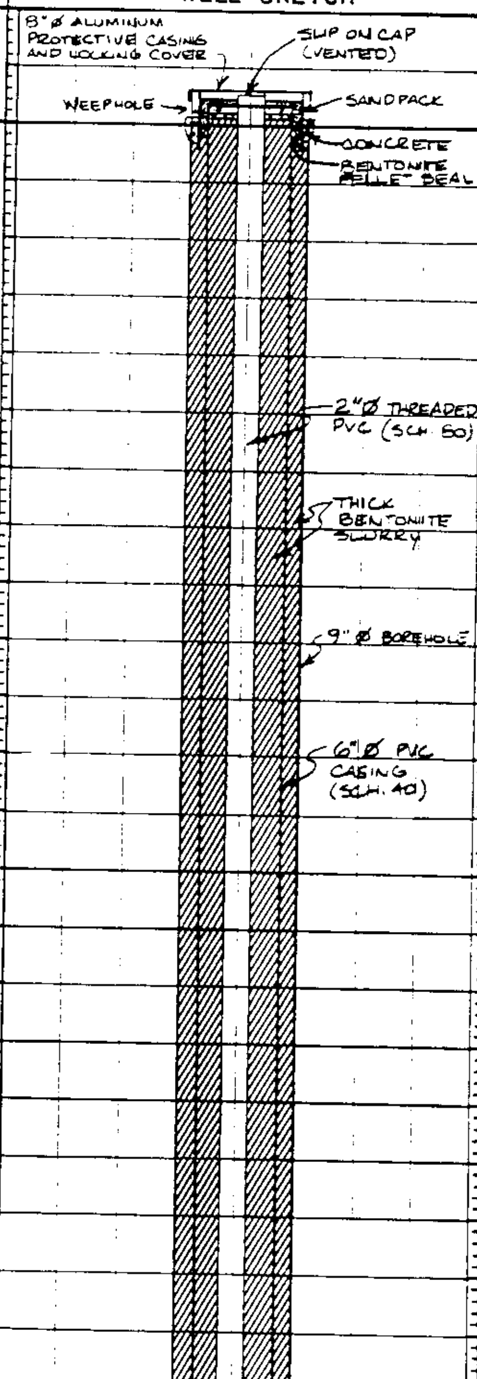
JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-9 SHEET 1 OF 2
GA INSP. EDD DRILLING METHOD ROTARY WASH GROUND ELEV. 242.7' WATER DEPTH —
WEATHER RAIN DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 245.28' DATE/TIME —
TEMP. 50°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:20AM/2-17-86 (TIME / DATE) COMPLETED 1:00PM/2-21-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 143.73 l.f.
CASING TYPE PVC SCHEDULE 80
JOINT TYPE THREADED (TEFLON WRAPPED)
GROUT QUANTITY APPROX. 24 cu ft AROUND 6" PVC; APPROX. 24 cu ft ABOVE PELLET SEAL
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLDSEAL BENTONITE POWDER WITH WATER

WELL SCREEN 2 in. dia. 4.85 l.f.
SCREEN TYPE PVC SCHEDULE 80
SLOT SIZE .010 INCH
CENTRALIZERS —
DRILLING MUD TYPE —

BENTONITE SEAL 2.5' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
INSTALLATION METHOD BY HAND
FILTER PACK QTY 1 BAG (50 LB BAGS)
FILTER PACK TYPE 16/30 GRADE BLASTING SAND
INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
242.7' / 0.0	GROUND SURFACE		2" Ø PVC STANDPIPE STICKUP = 2.58'; ALUMINUM PROTECTIVE CASING STICKUP = 2.95'
5.0			
10.0			
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	IN SITU CHALK		
45.0			
50.0			
55.0			WELL DEVELOPMENT NOTES
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			
110.0			

Golder Associates

New Page
May 19, 1986

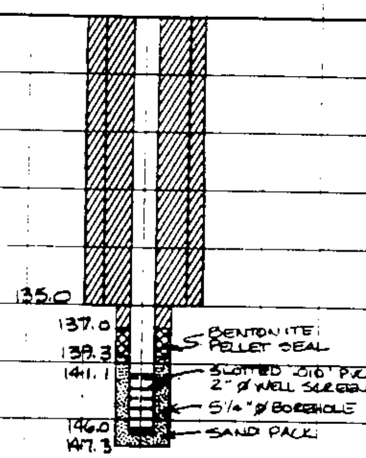
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT SWM/CONSENT WELLS/EMELLE	WELL NO. CA-9	SHEET 2 OF 2
GA INSP. ZDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 242.7'	WATER DEPTH —
WEATHER RAIN	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 245.28'	DATE/TIME —
TEMP. 50°F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 9:00AM/2-17-86 (TIME / DATE) — COMPLETED 1:50PM/2-21-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 143.73 l.f.	WELL SCREEN 2 in. dia. 4.85 l.f.	BENTONITE SEAL 2.5' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 30	SCREEN TYPE PVC SCHEDULE 30	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 1 BAG (50 LB. BAGS)
GROUT QUANTITY APPROX. 26 CU FT AROUND TO PVC; APPROX. 24 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLDSEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0	IN SITU CHALK		
125.0			
130.0			
135.0			
140.0	FRACTURE ZONE 143.0'–144.5'		
145.0			
150.0			
155.0			
160.0			



WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

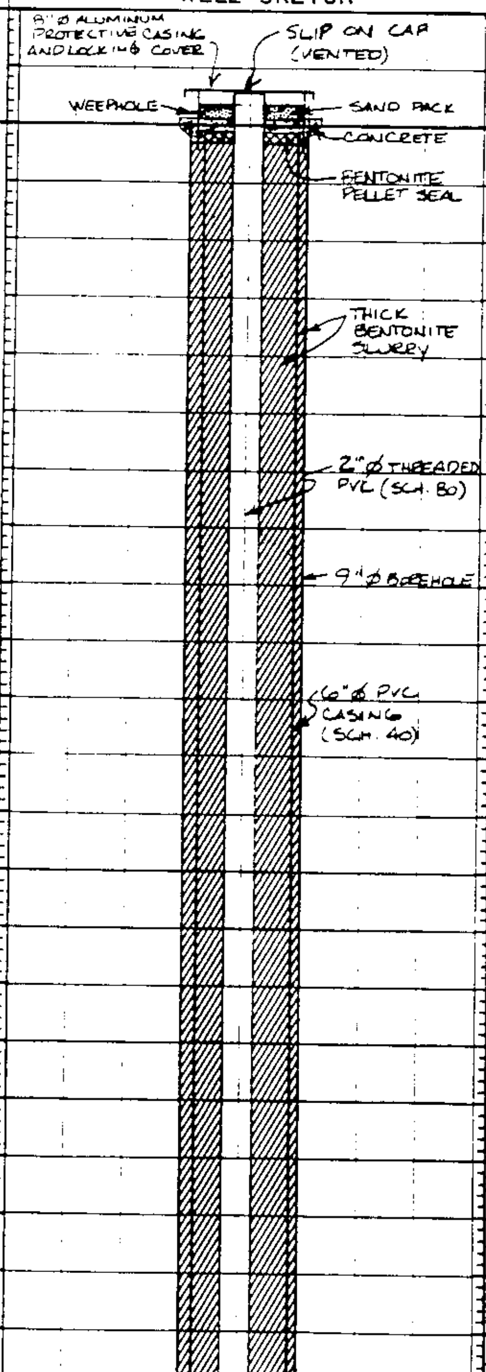
JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-9A	SHEET 1 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 242.96'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 245.77'	DATE/TIME —
TEMP. 55°F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 12:20 PM/2-19-86 (TIME / DATE) — COMPLETED 9:40 AM/2-25-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 153.96 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.1' THICK, 1/2" ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2 1/2 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 2.1 CU FT AROUND 6" PVC APPROX. 28 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/ WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
242.96'	GROUND SURFACE
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	SEE LOG CA-9 FOR SOIL/ROCK DESCRIPTION
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

2" ø PVC STANDPIPE STICKUP = 2.81'

ALUMINUM PROTECTIVE CASING STICKUP = 3.0'

WELL CA-9A LOCATED 2' EAST OF CA-9 ALONG E-W ALIGNMENT (SEE LOCATION MAP)

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

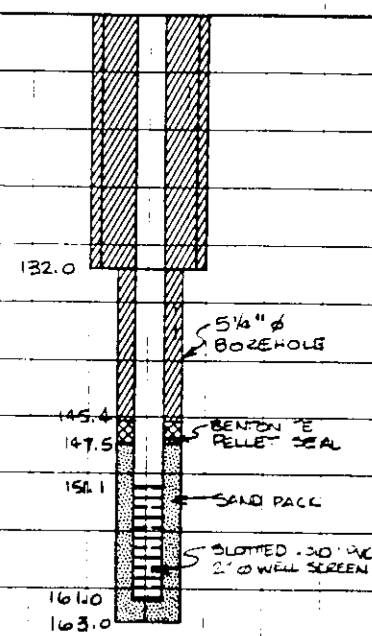
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-9A SHEET 2 OF 2
GA INSP. 200	DRILLING METHOD ROTARY WASH	GROUND ELEV. 242.96' WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 245.77' DATE/TIME —
TEMP. 55° F	DRILL RIG MOBILE B-61 DRILLER DJ/WG	STARTED 12:20 PM/2-19-86 (TIME / DATE) COMPLETED 9:40 AM/2-25-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 153.96 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.1' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2 1/2 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 24 CU FT AROUND 6" PVC; APPROX. 38 CU FT ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0			
125.0			
130.0	SEE LOG CA-9 FOR SOIL/ROCK DESCRIPTION		
135.0			
140.0			
145.0			
150.0			
155.0			
160.0			
165.0			WELL DEVELOPMENT NOTES
170.0			



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New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-10 SHEET 1 OF 1
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 191.26' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 194.76' DATE/TIME —
TEMP. 45°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 4:15 PM/2-4-86 (TIME / DATE) COMPLETED 3:00 PM/2-5-86 (TIME / DATE)

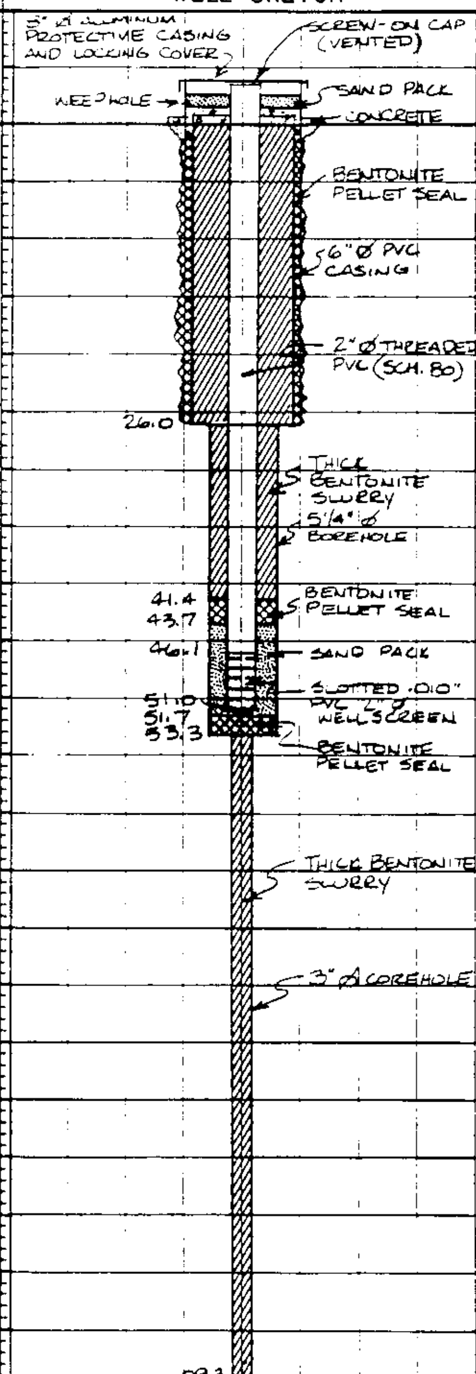
MATERIALS INVENTORY

WELL CASING 2 in. dia. 49.6 l.f. WELL SCREEN 2 in. dia. 4.90 l.f. BENTONITE SEAL 2.5' THICK, 1/2" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 2 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 8 CU. FT. ABOVE PELLET SEAL; APP 20 + CU FT TO 3" Ø CORE HOLE CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
191.26'	GROUND SURFACE
0.0 – 25.0	RECOMPACTED CHALK
25.0 – 48.9	
48.9	FRACTURE ZONE 48.9'
48.9 – 110.0	IN SITU CHALK

Depth scale: 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0, 100.0, 105.0, 110.0

WELL SKETCH



INSTALLATION NOTES

ORIGINAL 3" Ø COREHOLE CAVED IN FROM 109.3 TO 110.0'. ADDED BENTONITE SLURRY TO BOTTOM OF HOLE BUT HAD DIFFICULTY IN DETERMINING EXACT TOP OF SLURRY IN HOLE. 5¼" Ø HOLE REAMED TO 53.8' THEN BENTONITE PELLETS ADDED ONTO TOP OF SLURRY TO SEAL OFF BOTTOM OF HOLE.

2" Ø PVC STANDPIPE STICKUP = 3.5'

ALUMINUM PROTECTIVE CASING STICKUP = 3.6'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

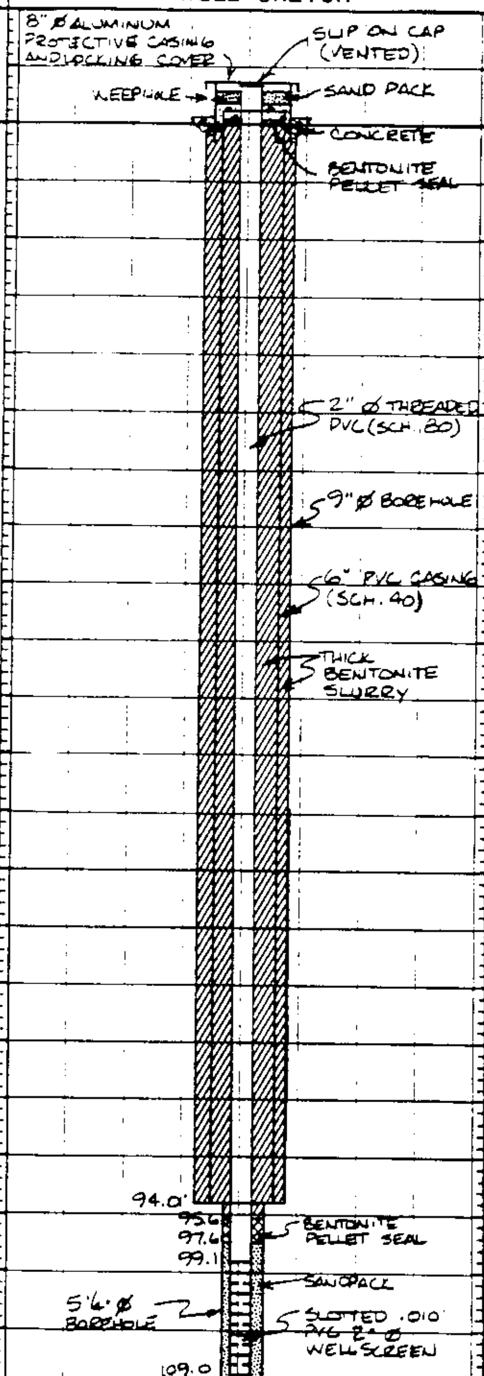
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO CA-10A	SHEET 1 OF 1
GA INSP. RDO	DRILLING METHOD ROTARY WASH	GROUND ELEV. 191.27'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 194.61'	DATE/TIME —
TEMP. 45° F	DRILL RIG MOBILE B-61 DRILLER DJ/WG	STARTED 3:00PM/2-5-86 (TIME / DATE)	COMPLETED 3:45PM/2-7-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 102.49 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.0' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 BAGS (50 lb BAGS)
GROUT QUANTITY APPROX. 20 CU.FT. AROUND 6" PVC; APPROX. 18 CU.FT. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
191.27'	GROUND SURFACE		2" Ø PVC STANDPIPE STICKUP = 3.34'
0.0			ALUMINUM PROTECTIVE CASING STICKUP = 3.6'
5.0			
10.0			WELL CA-10A LOCATED 14° E OF N, 10' FROM CA-10. (SEE WELL LOCATION MAP)
15.0			
20.0			
25.0			
30.0			
35.0	SEE LOG CA-10 FOR SOIL/ROCK DESCRIPTION		
40.0			
45.0			
50.0			
55.0			**WELL DEVELOPMENT NOTES**
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			
110.0			



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New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-11 SHEET 1 OF 1
GA INSP. RDO DRILLING METHOD ROTARY WASH GROUND ELEV. 197.66' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 201.11' DATE/TIME —
TEMP. 50° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:50AM/1-21-86 (TIME / DATE) COMPLETED 5:15PM/1-21-86 (TIME / DATE)

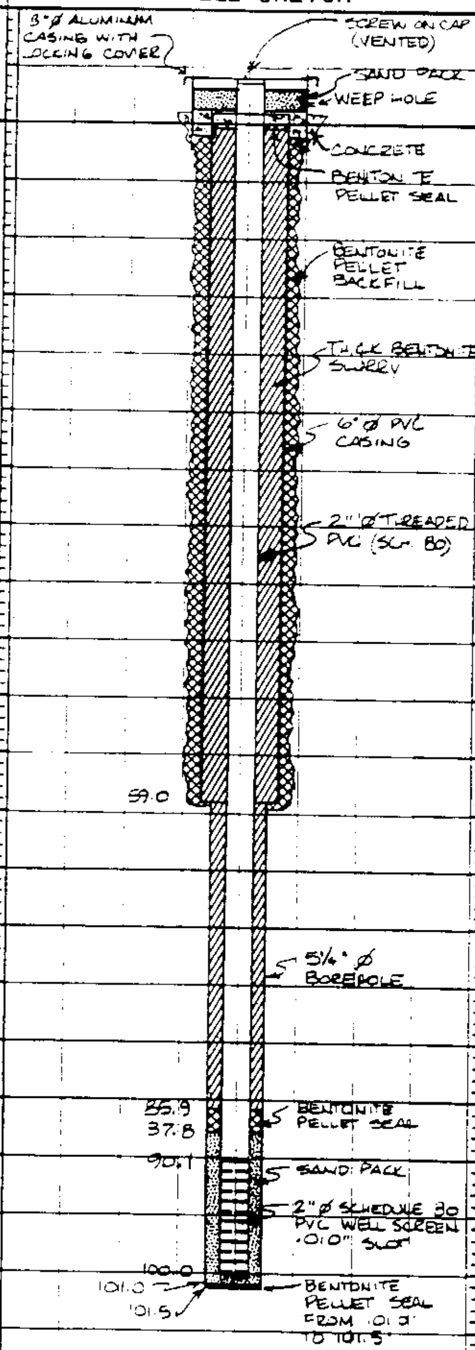
MATERIALS INVENTORY

WELL CASING 2 in. dia. 93.6 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 1.9' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 1/2 BAGS (50-LB BAGS)
GROUT QUANTITY APPROX. 12 CU.FT. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 10/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
197.66'	GROUND SURFACE
0.0 – 55.0	RECOMPACTED CHALK
55.0 – 105.0	IN SITU CHALK (NO FRACTURES)

Depth scale: 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0, 100.0, 105.0

WELL SKETCH



INSTALLATION NOTES

WELL ORIGINALLY SET IN THIS HOLE ON 2-19-86 HOWEVER, DUE TO THE FACT THAT THE PVC PIPE WAS CUT TOO SHORT, THIS WELL WAS 1.7' TOO HIGH IN THE HOLE. THEREFORE THE 2" PVC WAS PULLED OUT, HOLE FLUSHED, AND THE WELL RESET TO ITS CORRECT DEPTH. A BENTONITE PELLET SEAL WAS ADDED TO THE BOTTOM OF THE HOLE.

2" Ø PVC STANDPIPE STICKUP FROM G.S. = 3.45'

ALUMINUM CASING STICKUP FROM G.S. = 3.8'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

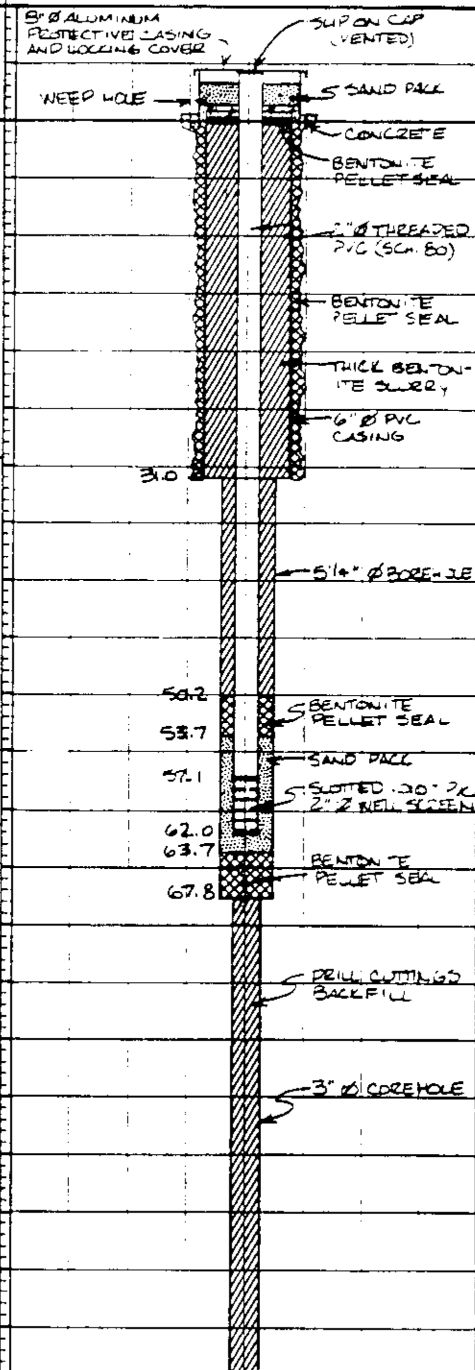
JOB NO. 253-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-12	SHEET 1 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 191.88'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 196.02'	DATE/TIME —
TEMP. 45° F	DRILL RIG MOBILE B-61 / DRILLER DJ/WG	STARTED 12:00 PM/2-8-86 (TIME / DATE)	COMPLETED 5:00 PM/2-12-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 61.29 l.f.	WELL SCREEN 2 in. dia. 4.85 l.f.	BENTONITE SEAL 3.5' THICK, 1/2" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2¼ BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 20 CU. FT. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
191.88'	GROUND SURFACE
0.0	
5.0	
10.0	RECOMPACTED CHALK
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	
50.0	FRACTURE ZONE 57.1'-61.3'
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	IN SITU CHALK
85.0	
90.0	
95.0	
100.0	
105.0	
110.0	

WELL SKETCH



INSTALLATION NOTES

ORIGINAL 3" Ø CORE HOLE COULD NOT BE FILLED WITH SLURRY BECAUSE OF AN OBSTRUCTION IN THE HOLE AT APPROX. 35.0' BELOW GROUND SURFACE. THE SLURRY HOSE WOULD NOT PASS BY THIS OBSTRUCTION THEREFORE THE 5¼" Ø HOLE WAS REAMED OUT TO 67.0' BELOW GROUND SURFACE AND ANY CUTTINGS WOULD FILL IN THE 3" Ø CORED HOLE. A BENTONITE PELLET SEAL WAS THEN PLACED FROM 63.0' TO 67.0' TO SEAL OFF THE BOTTOM OF THE HOLE.

2" Ø PVC STANDPIPE "STICKUP" = 4.14'

ALUMINUM PROTECTIVE CASING "STICKUP" = 4.2'

BENTONITE SLURRY LEVEL, BETWEEN THE 2" AND 6" PVC, DROPPED APPROX. 7.0' IN 1 HOUR WHEN SLURRY MIXTURE WAS FIRST INJECTED INTO THE WELL.

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-12 SHEET 2 OF 2
GA INSP. ZDD DRILLING METHOD ROTARY WASH GROUND ELEV. 191.88' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 196.02' DATE/TIME —
TEMP. 45°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 12:00 PM/2-8-86 (TIME / DATE) COMPLETED 5:00 PM/2-12-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 61.29 l.f. WELL SCREEN 2 in. dia. 4.85 l.f. BENTONITE SEAL 3.5' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 2 1/4 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX 20 CU FT ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 10/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	
110.0			
115.0			
120.0	IN SITU CHALK	3" Ø CORED HOLE	
125.0			
130.0		130.0	
135.0			
140.0			

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

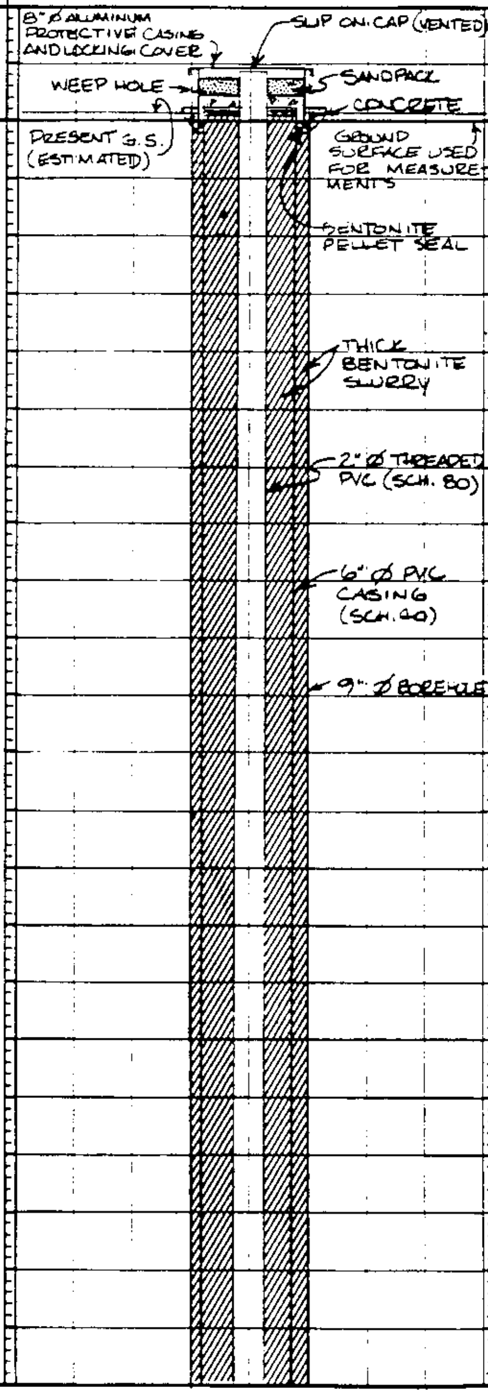
MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-12A SHEET 1 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 191.46' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 195.74' DATE/TIME —
TEMP. 25° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 1:40 PM/2-9-86 (TIME / DATE) COMPLETED 5:00 PM/2-12-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 123.23 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.0' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 BAGS (50 LB BAGS)
GROUT QUANTITY APPROX. 6 CU FT AROUND 6" PVC, APPROX. 20 CU FT ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 10/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
191.46'	GROUND SURFACE		WELL CA-12A LOCATED 10', IN THE DIRECTION 15° W OF N, FROM CA-12 (SEE WELL LOCATION MAP)
0.0			
5.0			2" Ø PVC STANDPIPE "STICKUP" = 4.28'
10.0			ALUMINUM PROTECTIVE CASING "STICKUP" = 4.57'
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	SEE LOG CA-12 FOR SOIL/ROCK DESCRIPTION		
45.0			
50.0			
55.0			**WELL DEVELOPMENT NOTES**
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			
105.0			
110.0			



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New Page
May 19, 1986

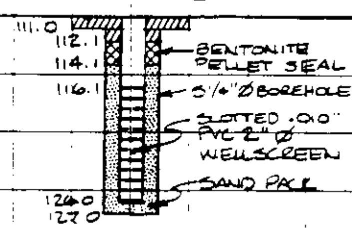
MONITORING WELL INSTALLATION LOG

JOB NO. 853 3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-12A	SHEET 2 OF 2
GA INSP. RDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 191.46'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 195.74'	DATE/TIME —
TEMP. 25° F	DRILL RIG MOBILE B-61 DRILLER DJ/WG	STARTED 1:40 PM/2-9-86 (TIME / DATE)	COMPLETED 5:00 PM/2-12-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 123.23 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.0' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 3 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 110 L.F. AROUND 2" PVC APPROX. 20 L.F. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	WELL CA-12A LOCATED 3' IN THE DIRECTION 13° N OF N, FROM CA-12. (SEE WELL LOCATION MAP)
110.0			
115.0			2" Ø PVC STANDPIPE "STICKUP" = 4.28'
120.0			
125.0			ALUMINUM PROTECTIVE CASING "STICKUP" = 4.57'
130.0			



WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

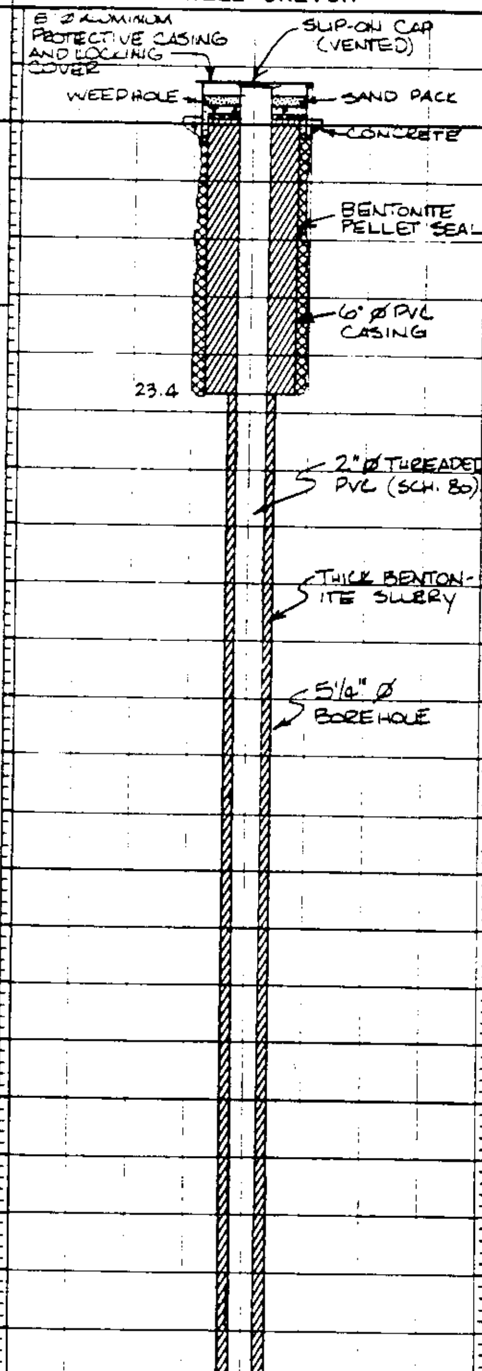
JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-13 SHEET 1 OF 2
GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 208.03' WATER DEPTH —
WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 211.28' DATE/TIME —
TEMP. 40° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 4:00 PM/1-9-86 (TIME / DATE) COMPLETED 12:15 PM/3-5-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 133.9 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.2' THICK; 1/2" Ø PELLETS ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX 16 CU. FT. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
208.03'	GROUND SURFACE
0.0	
5.0	RECOMPACTED CHALK
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	
50.0	IN SITU CHALK (NO FRACTURES)
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105	
110	

WELL SKETCH



INSTALLATION NOTES

2" Ø PVC STANDPIPE STICKUP = 3.25'

ALUMINIUM PROTECTIVE CASING "STICKUP" = 3.55

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 553-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-13 SHEET 2 OF 2

GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 208.03' WATER DEPTH —

WEATHER CLOUDY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 211.28' DATE/TIME —

TEMP. 60°F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 4:00 PM/1-9-86 (TIME / DATE) COMPLETED 12:15 PM/3-5-86 (TIME / DATE)

MATERIALS INVENTORY

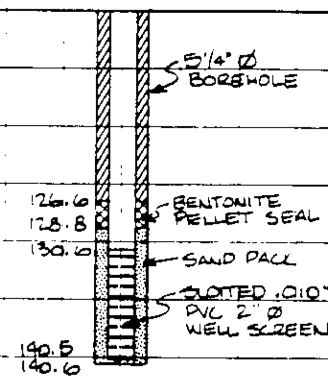
WELL CASING 2 in dia. 133.9 l.f. WELL SCREEN 2 in. dia. 9.85 l.f. BENTONITE SEAL 2.2' THICK, 1/2" Ø PELLETS, ABOVE SCREEN

CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND

JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 BAGS (50 LB. BAGS)

GROUT QUANTITY APPROX. 16 L.F. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND

GROUT TYPE APPROX 1:1 RATIO OF AQUAGEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
		CONTINUED FROM SHEET 1 OF 2	2" Ø PVC STANDPIPE STICKUP = 3.25'
110.0			ALUMINUM PROTECTIVE CASING "STICKUP" = 3.55'
115.0			
120.0	IN SITU CHALK (NO FRACTURES)		
125.0			
130.0			
135.0			
140.0			
145.0			
150.0			

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3	PROJECT CWM/CONSENT WELLS/EMELLE	WELL NO. CA-14	SHEET 1 OF 1
GA INSP. ROD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 212.26'	WATER DEPTH —
WEATHER CLOUDY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 217.33'	DATE/TIME —
TEMP. 65°F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 3:30 PM/3-17-86 (TIME / DATE) COMPLETED 6:00 PM/3-18-86 (TIME / DATE)

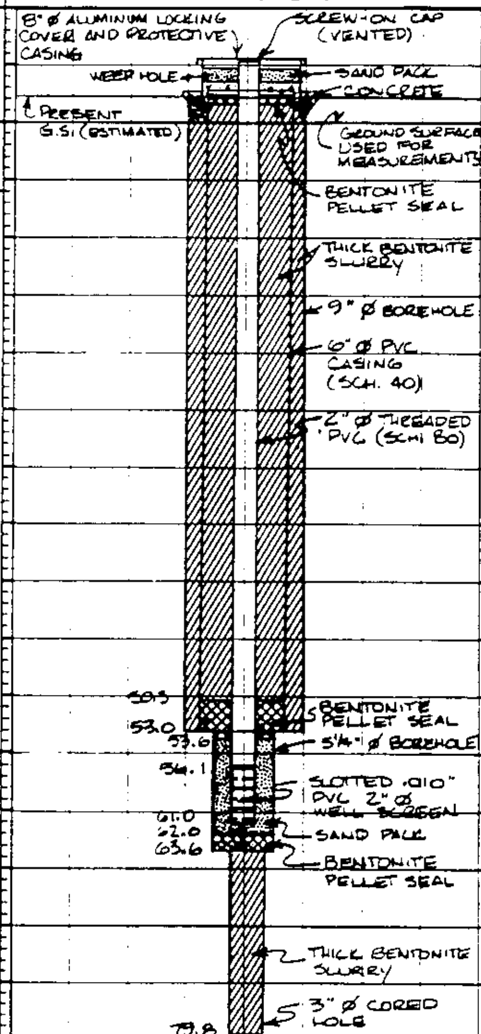
MATERIALS INVENTORY

WELL CASING 2 in. dia. 61.2 l.f.	WELL SCREEN 2 in. dia. 4.87 l.f.	BENTONITE SEAL 5.3' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED (TEFLON WRAPPED)	SLOT SIZE .010 INCH	FILTER PACK QTY 2 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX. 10 CU.FT. AROUND 6" PVC, APPROX. 12 CU.FT. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX. 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER WITH WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
212.26	GROUND SURFACE
0.0 – 5.0	RECOMPACTED CHALK
5.0 – 57.8	IN SITU CHALK
57.8 – 59.9	FRACTURE ZONE 57.8'-59.9'

Depth scale: 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0

WELL SKETCH



INSTALLATION NOTES

ORIGINAL 3" Ø CORE HOLE CAVED IN FROM 80.6' TO 79.8'

2" Ø PVC STANDPIPE "STICKUP" = 5.07'

ALUMINUM PROTECTIVE CASING STICKUP = 5.3'

"STICKUP" MEASURED FROM GROUND SURFACE ELEVATION 212.26'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

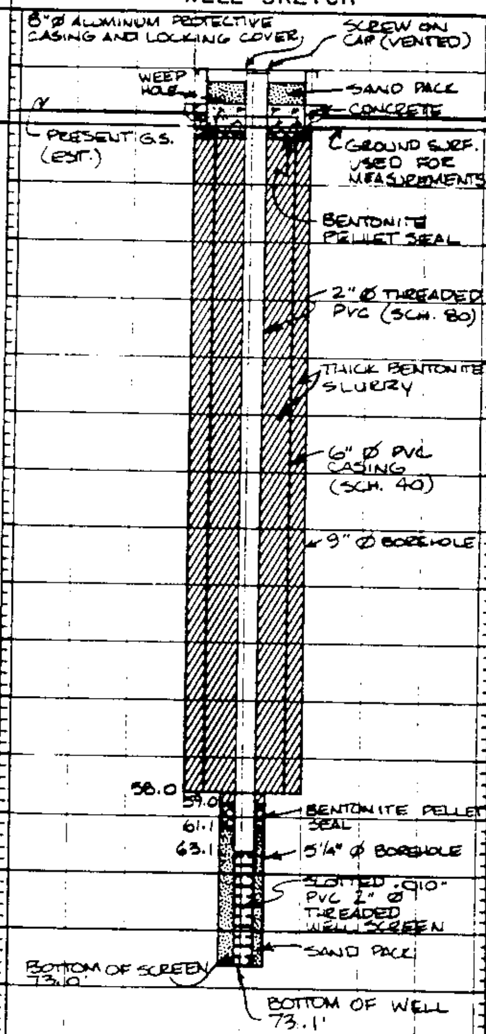
JOB NO. 853-3098.3	PROJECT CWM / CONSENT WELLS / EMELLE	WELL NO. CA-14A	SHEET 1 OF 1
GA INSP. EDD	DRILLING METHOD ROTARY WASH	GROUND ELEV. 212.24'	WATER DEPTH —
WEATHER SUNNY	DRILLING COMPANY TRI-STATE	2" PVC COLLAR ELEV. 217.01'	DATE/TIME —
TEMP. 70° F	DRILL RIG MOBILE B-61	DRILLER DJ/WG	STARTED 2:45PM / 3-13-86 (TIME / DATE) COMPLETED 3:30PM / 3-17-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 67.92 l.f.	WELL SCREEN 2 in. dia. 9.85 l.f.	BENTONITE SEAL 2.1' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
CASING TYPE PVC SCHEDULE 80	SCREEN TYPE PVC SCHEDULE 80	INSTALLATION METHOD BY HAND
JOINT TYPE THREADED, TEFLON WRAPPED) APPROX 1.6 CU.FT. AROUND 6" PVC	SLOT SIZE .010 INCH	FILTER PACK QTY 2 3/4 BAGS (50 LB. BAGS)
GROUT QUANTITY APPROX 13 CU.FT. ABOVE PELLET SEAL	CENTRALIZERS —	FILTER PACK TYPE 16/30 GRADE BLASTING SAND
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/ WATER	DRILLING MUD TYPE —	INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
212.24'	GROUND SURFACE
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	SEE LOG CA-14 FOR SOIL/ROCK DESCRIPTION
35.0	
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	

WELL SKETCH



INSTALLATION NOTES

2" Ø PVC STAND OF "STICKUP" = 4.77'

ALUMINUM PROTECTIVE CASING STICKUP = 4.9'

"STICKUP" MEASURED FROM GROUND SURFACE ELEVATION 212.24'

WELL CA-14A LOCATED 10' NORTH OF CA-14 ALONG N-S ALIGNMENT LINE. (SEE WELL LOCATION MAP)

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

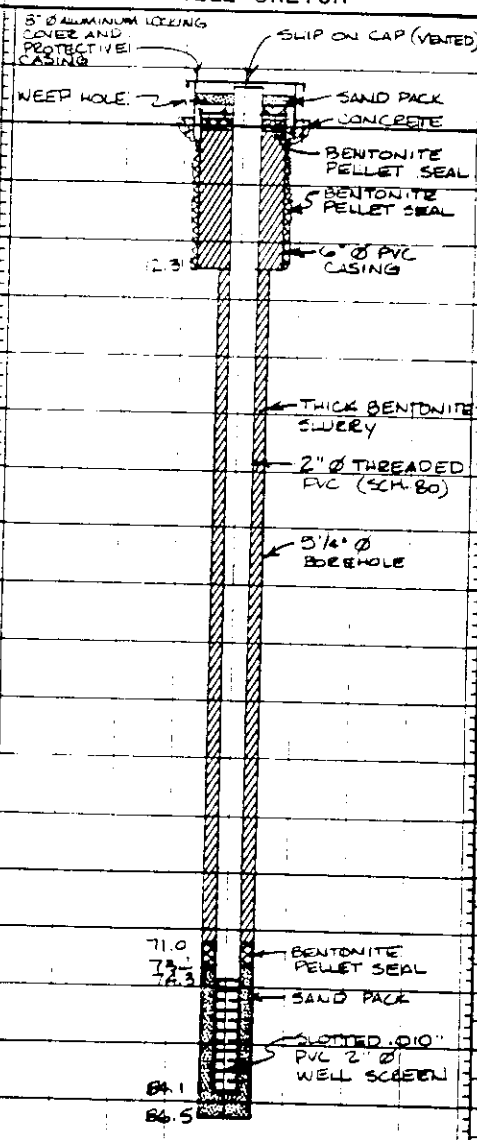
JOB NO. 853-3098.3 PROJECT CWM / CONSENT WELLS / EMELLE WELL NO. CA-15 SHEET 1 OF 1
GA INSP. JDO DRILLING METHOD ROTARY WASH GROUND ELEV. 217.18'
WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 220.48' WATER DEPTH —
TEMP. 45° F DRILL RIG MOBILE B-61 DRILLER DJ/WG DATE/TIME —
STARTED 1:55 PM / 12-19-85 (TIME / DATE) COMPLETED 1:30PM/3-5-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 77.6 l.f. WELL SCREEN 2 in. dia. 9.85 l.f.
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80
JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH
GROUT QUANTITY APPROX. 12 CU. FT. ABOVE PELLET SEAL CENTRALIZERS —
GROUT TYPE APPROX 1:1 RATIO OF AQUA GEL GOLD SEAL BENTONITE POWDER W/WATER DRILLING MUD TYPE —
BENTONITE SEAL 2.2' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
INSTALLATION METHOD BY HAND
FILTER PACK QTY 3 1/2 BAGS (50 LB BAGS)
FILTER PACK TYPE 16/30 GRADE BLASTING SAND
INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
217.18'	GROUND SURFACE
0.0	
5.0	RECOMPACTED CHALK
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	IN SITU CHALK (NO FRACTURES)
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	

WELL SKETCH



INSTALLATION NOTES

2" Ø PVC STANDPIPE STICKUP = 3.3'
ALUMINUM PROTECTIVE CASING "STICKUP" = 3.7'

WELL SCREEN INTERVAL FOR CA-15 AT ELEVATION 142.8' TO 133.0. SPECIFIED INTERVAL IS 142.4' TO 132.2'. WELL SCREEN INTERVAL DIFFERS FROM SPECIFIED INTERVAL DUE TO THE FACT THAT THIS WELL WAS INSTALLED BEFORE THE PVC PIPE LENGTH ERROR WAS NOTICED. DECISION WAS MADE TO LEAVE THE SCREEN AND PIPE AS ORIGINALLY SET. (THERE WERE NO FRACTURES FOUND IN THE ORIGINAL CORE HOLE)

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. CA-16 SHEET 1 OF 1

GA INSP. RDO DRILLING METHOD ROTARY WASH GROUND ELEV. 243.85' WATER DEPTH —

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 246.68' DATE/TIME —

TEMP. 50° F DRILL RIG MOBILE B-61 DRILLER DJ/WG STARTED 9:40 AM/2-25-86 (TIME / DATE) COMPLETED 9:45 AM/2-26-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 79.98 l.f.
CASING TYPE PVC SCHEDULE 80
JOINT TYPE THREADED (TEFLON WRAPPED)
GROUT QUANTITY APPROX. 13 CU.FT. ABOVE PELLET SEAL
GROUT TYPE APPROX. 1:1 RATIO OF AQUA-GEL GOLD SEAL BENTONITE POWDER WITH WATER

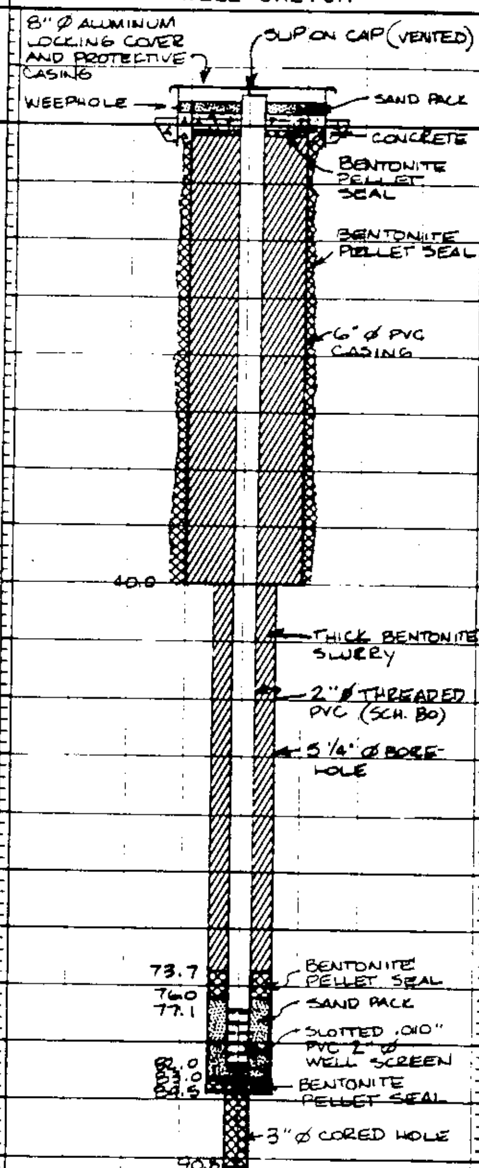
WELL SCREEN 2 in. dia. 4.85 l.f.
SCREEN TYPE PVC SCHEDULE 80
SLOT SIZE .010 INCH
CENTRALIZERS —
DRILLING MUD TYPE —

BENTONITE SEAL 2.5' THICK, 1/2" Ø PELLETS, ABOVE SCREEN
INSTALLATION METHOD BY HAND
FILTER PACK QTY 2 BAGS (50 LB BAGS)
FILTER PACK TYPE 1/30 GRADE BLASTING SAND
INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
243.85'	GROUND SURFACE
0.0 – 40.0	DECOMPACTED CHALK
40.0 – 80.5	IN SITU CHALK
	FRACTURE ZONE 79.4'-80.5'

Depth scale: 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0, 85.0, 90.0, 95.0

WELL SKETCH



INSTALLATION NOTES

ORIGINAL 3" Ø CORE HOLE CAVED IN FROM 90.8' TO 95.0'. BENTONITE PELLETS ADDED TO 3" Ø COREHOLE FROM 85.0' TO 90.8' BEFORE REAMING 5 1/4" Ø HOLE. ADDITIONAL BENTONITE PELLETS ADDED TO 83.0' AFTER 5 1/4" HOLE WAS REAMED AND FLUSHED OUT.

2" Ø PVC STANDPIPE "STICKUP" = 2.83'

ALUMINUM PROTECTIVE CASING "STICKUP" = 3.2'

WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/ CONSENT WELLS/EMELLE WELL NO. CA-16A SHEET 1 OF 1

GA INSP. RDD DRILLING METHOD ROTARY WASH GROUND ELEV. 243.74' WATER DEPTH —

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 247.41' DATE/TIME —

TEMP. 60°F DRILL RIG MOBILE B-61' DRILLER DJ/WG STARTED 9:50AM/2-26-86 (TIME / DATE) COMPLETED 2:00PM/2-27-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 87.82 ft. WELL SCREEN 2 in. dia. 9.85 ft. BENTONITE SEAL 1.7' THICK, 1/2" Ø PELLETS ABOVE SCREEN

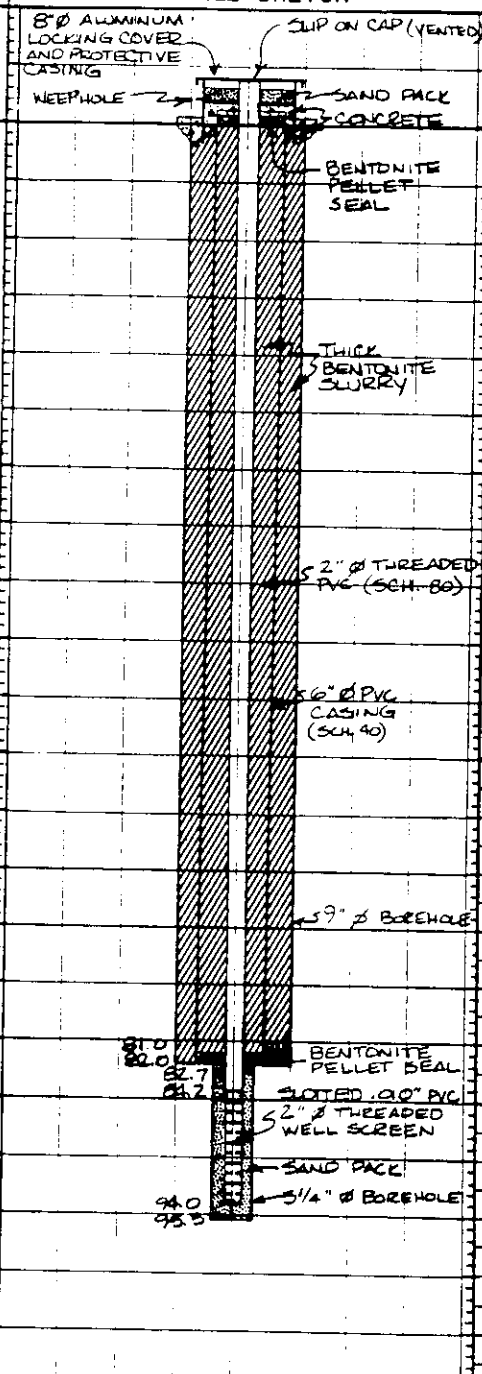
CASING TYPE PVC SCHEDULE 80 SCREEN TYPE PVC SCHEDULE 80 INSTALLATION METHOD BY HAND

JOINT TYPE THREADED (TEFLON WRAPPED) SLOT SIZE .010 INCH FILTER PACK QTY 3 1/4 BAGS (50 LB. BAGS)

GROUT QUANTITY APPROX. 12 CU. FT. AROUND 6" Ø PVC, APPROX. ½ CU. FT. ABOVE PELLET SEAL CENTRALIZERS — FILTER PACK TYPE 16/30 GRADE BLASTING SAND

GROUT TYPE APPROX. 1:1 RATIO OF AQUAGEL GOLD SEAL BENTONITE POWDER WITH WATER DRILLING MUD TYPE — INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
243.74'	GROUND SURFACE		2" Ø PVC STANDPIPE "STICKUP" = 3.67'
0.0			ALUMINUM PROTECTIVE CASING "STICKUP" = 3.85'
5.0			WELL CA-16A LOCATED 10' NORTH OF CA-16 ALONG N-S ALIGNMENT LINE. (SEE WELL LOCATION MAP)
10.0			
15.0			
20.0			
25.0			
30.0			
35.0			
40.0	SEE LOG CA-16 FOR SOIL/ROCK DESCRIPTION		
45.0			
50.0			
55.0			**WELL DEVELOPMENT NOTES**
60.0			
65.0			
70.0			
75.0			
80.0			
85.0			
90.0			
95.0			
100.0			



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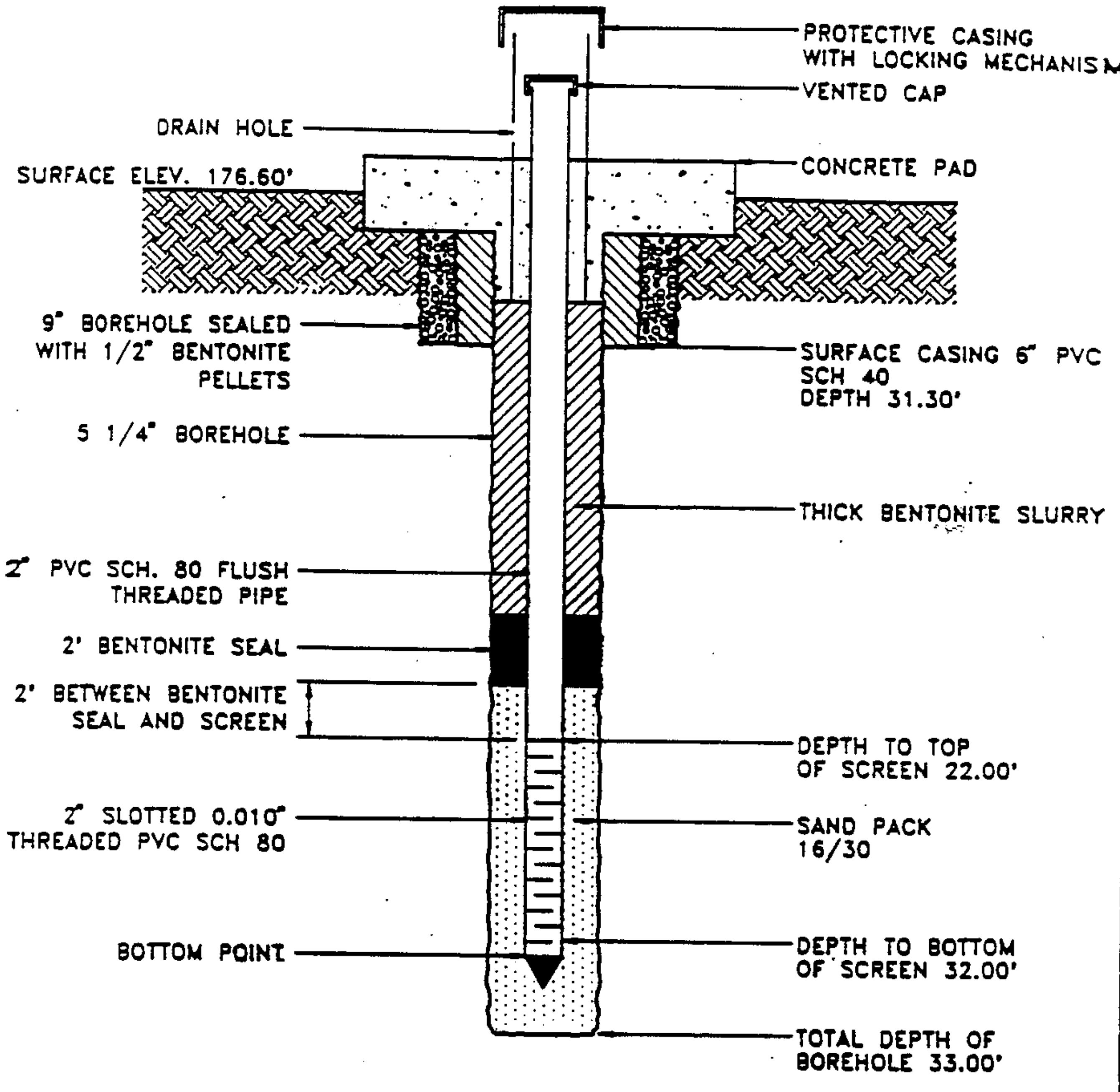
New Page
May 19, 1986



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

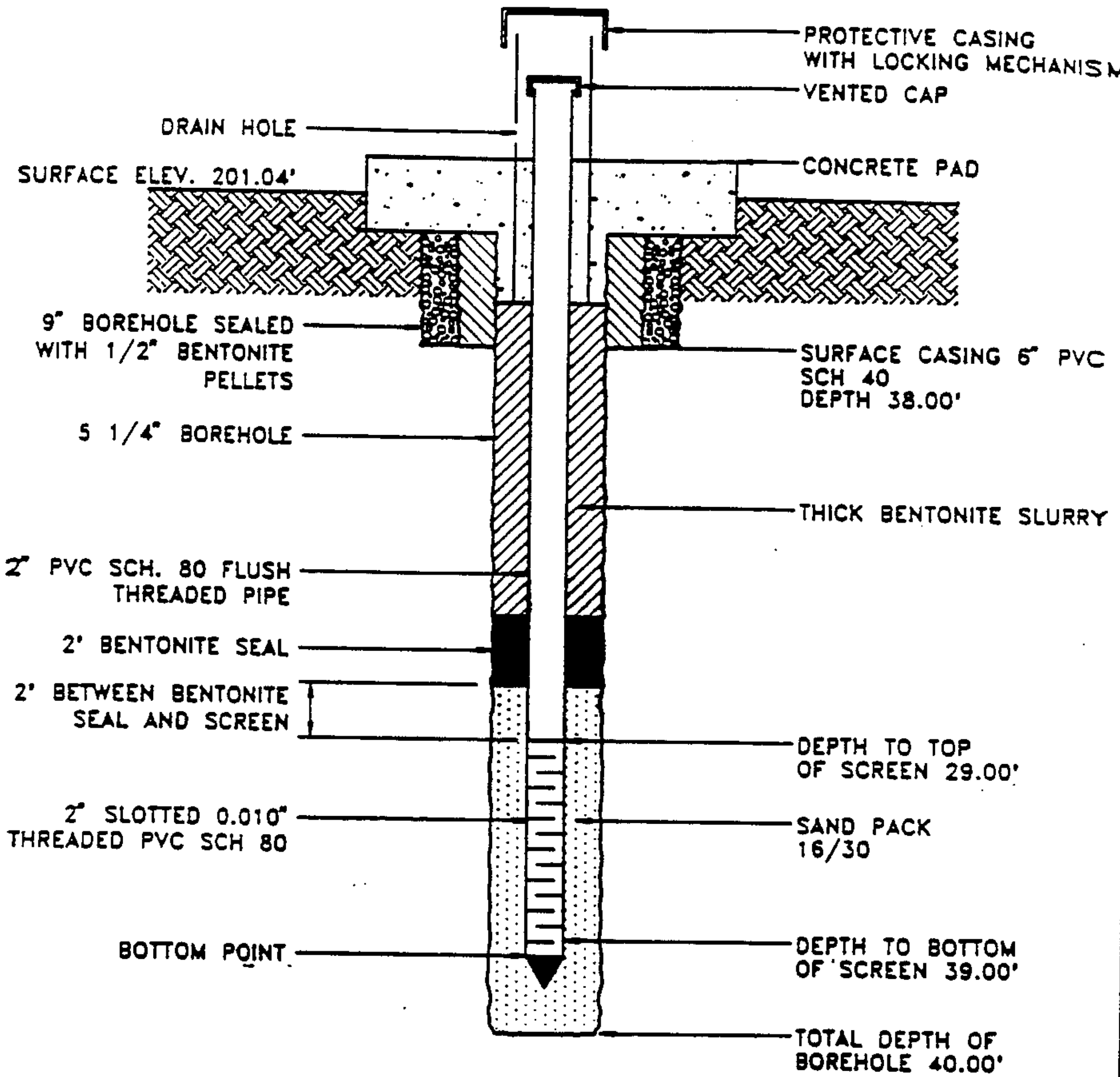
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-17

Woodward-Clyde

NOT TO SCALE

FIGURE: 1



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-18

Woodward-Clyde

Date: 9-29-90

Drawn by: E.T. | Checked by: T.K.

Scale: NOT TO SCALE

FIGURE: 2

Boring / Monitoring Well Installation Log

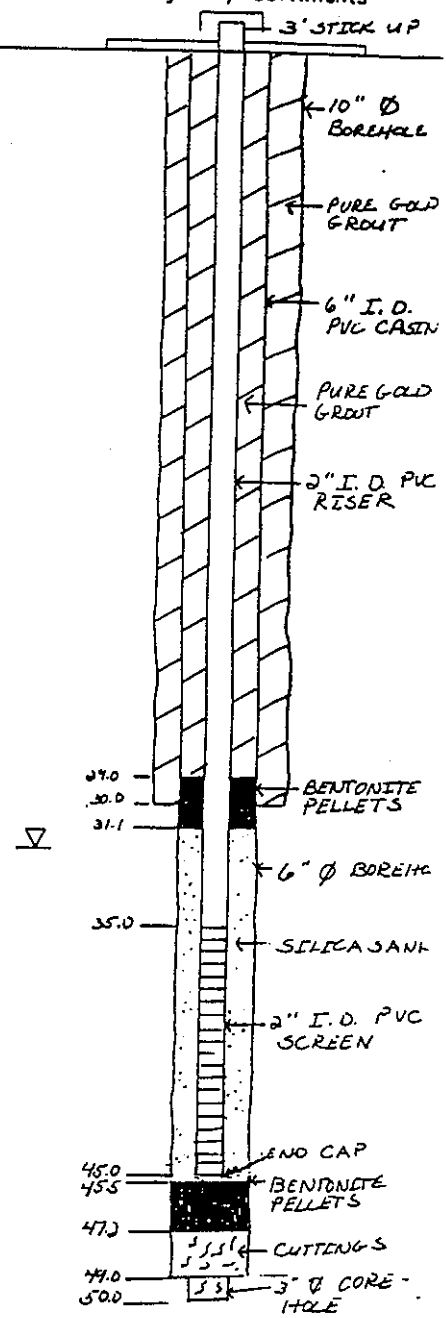
Job No. 1186.004.03	Depth Hole 50 ft	Project SM-18 STUDY	Boring No. SM-18 A
Inspector BEL	Sample Method CORE	Drilling Company A.T. & E	Sheet 1 of 1
Weather OVERCAST	No. Dist. S.A. —	Drilling Method HSA, CORING & WASHROT	Surface Elevation ~203.3
Temperature 60°F	No. UD. S.A. —	Drill Rig CME 550 (ATV)	Datum MSL
Depth WL 34.79' BTOC	Hole Diameter 10" & 6"	WT Sampler Hammer — LB — Drop	Started 11/30/94
Time WL 1247	Date WL 1/5/95	Drilling Mud Type —	Completed 12/8/94

Well Materials Inventory

Well Casing 2 In. Dia. 37 L.F.	Filter Pack Quantity 1 1/2 ft³	Grout Install Method TREMIED
Casing Type SCHEDULE 80 PVC	Pack Type & Size SILICA SAND, #2 DSI	End Cap/Sump 0.5 ft Quan
Joint Type FLUSH THREADED	Install Method POURED FROM SURFACE	Protective Casing Yes ✓ No
Well Screen 2 In. Dia. 10 L.F.	Seal Type 3/8" BENTONITE PELLETS	Well Pad Size 4 ft x 4 ft x 4 in
Screen Type SCHEDULE 80 PVC	Install Method POURED & TAPPED	TOC Elevation 206.27 ft MSL
Slot Size 0.010 in.	Grout Type & Quantity PURE GOLD/38 GAL	Water Level 171.48 ft MSL
Centralizers —	Mix Ratio 14 GAL WATER/BAG	Date WL 1/5/95 Time WL 1247

Depth (Ft.) / Elevation	Sample No.	Blows/ Foot	% REC	Lithologic Description
5 / 198.3				CONTINUOUSLY SAMPLED TO 30.0' WITH CME CONTINUOUS SAMPLER. REAMED HOLE WITH 10 1/4" O.D. HSA. SET 6" I.D. PVC CASING TO 30'.
10 / 193.3				Gray to brown, clay (FILL).
15 / 188.3				
20 / 183.3				
25 / 178.3				27.5
30 / 173.3				Yellow, weathered CHALK.
				33.0
35 / 168.3			69	Light blue and yellow, mottled, weathered CHALK.
				39.0
40 / 163.3				40.5 Light gray, slightly weathered CHALK
45 / 158.3			42	Gray, unweathered, fossiliferous, CHALK, no fractures or joints seen in core.
50 / 153.3				Boring terminated at 50'. Hole reamed to 6" diameter between 27.6' and 49' using wash rotary drilling techniques.

Well Diagram / Comments



COORDINATES:
NORTH 14,199.46
EAST 5,756.37

SM-18 built in this hole A-5

LOG of BORING No. SM-18 A

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 201.0 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–38						
38–43.2				Contact with unweathered chalk at 38.0 feet below land surface.		

Completion Depth: 43.2 Ft.

Drilling Method: CoreBarrel

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants

Boring / Monitoring Well Installation Log

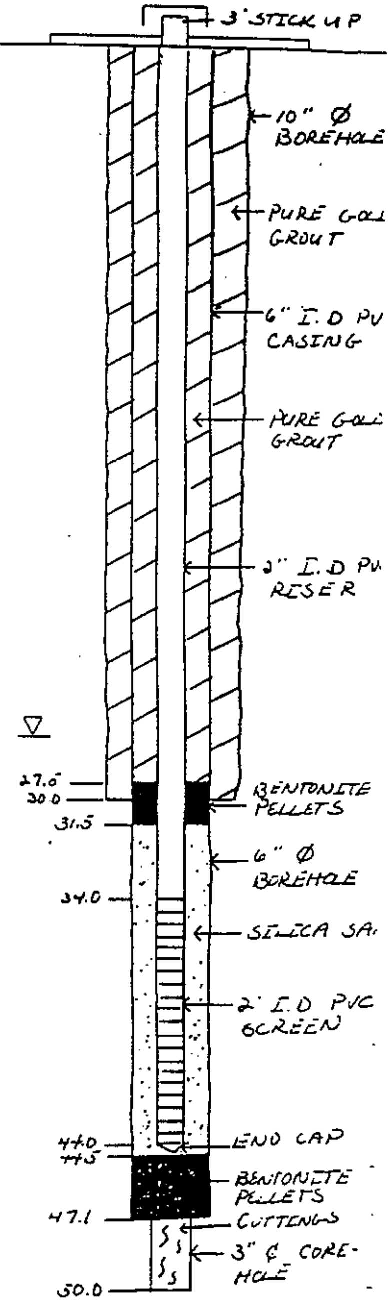
Job No. 1186.004.03	Depth Hole 50	Project SM-18 STUDY	Boring No. SM-18D
Inspector BEL	Sample Method CORING	Drilling Company A.T. & E	Sheet 1 of 1
Weather OVERCAST	No. Dist. S.A. —	Drilling Method HSA CORING & WASH ROT	Surface Elevation ≈201.7
Temperature 50°F	No. UD. S.A. —	Drill Rig CME 550 (ATV)	Datum MSL
Depth WL 30.49 ft BTOC	Hole Diameter 10" & 6"	WT Sampler Hammer — LB — Drop	Started 11/30/94
Time WL 1248	Date WL 1/5/95	Drilling Mud Type —	Completed 12/8/94

Well Materials Inventory

Well Casing 2 In. Dia. 37 L.F.	Filter Pack Quantity 1½ ft³	Grout Install Method TREMIED
Casing Type SCHEDULE 80 PVC	Pack Type & Size SILICA SAND #2 DST	End Cap/Sump 0.5 ft
Joint Type FLUSH THREADED	Install Method POURED FROM SURFACE	Protective Casing Yes ✓ No
Well Screen 2 In. Dia. 10 L.F.	Seal Type 3/8 in BENTONITE PELLETS	Well Pad Size 4ft x 4ft x 4in
Screen Type SCHEDULE 80 PVC	Install Method POURED & TAPPED	TOC Elevation 204.72 ft MSL
Slot Size 0.010 in	Grout Type & Quantity PURE	Water Level 174.23 ft MSL
Centralizers —	Mix Ratio 14 GAL WATER / BAG	Date WL 1/5/95 Time WL 1248

Depth (Ft.) / Elevation	Sample No.	Blows/Foot	% REC	Lithologic Description
				CONTINUOUSLY SAMPLED TO 30' WITH CME CONTINUOUS SAMPLER. REAMED HOLE WITH 10¼" O.D. HSA. SET 6" I.D. PVC CASING TO 30'.
5 / 196.7				
10 / 191.7				Dark gray, clay (FILL).
15 / 186.7				
20 / 181.7				
25 / 176.7				
				26.9
				Yellow, weathered CHALK.
30 / 171.7				
35 / 166.7			80	
40 / 161.7				40.0
				40.5 Buff, slightly weathered CHALK
45 / 156.7			100	Blue, unweathered fossiliferous, CHALK
50 / 151.7				Boring terminated at 50'. Hole reamed to 6" diameter between 30' and 47' using wash rotary drilling techniques

Well Diagram / Comments



COORDINATES:
NORTH 14,266.33
EAST 5,772.00

LOG of BORING No. SM-18 B

DATE September 1986 SURFACE ELEVATION 206.5 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0						
5						
10						
15						
20						
25						
30						
35						
40				Contact with unweathered chalk at 35.5 feet below land surface.		
45						
50						
55						
60						
65						
70						
75						
80						
85						
90						
95						

Completion Depth: 53.5 Ft.

Drilling Method: CoreBarrel

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants

Boring / Monitoring Well Installation Log

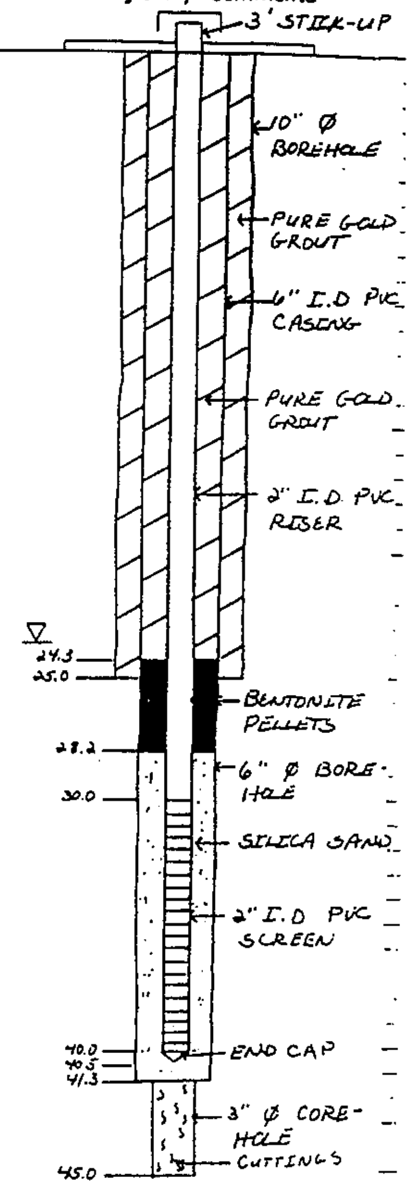
Job No. 1186.004.03	Depth Hole 45 ft	Project SM 18 STUDY		Boring No. SM 18C	
Inspector BEL	Sample Method CORING	Drilling Company A. T. & E		Sheet 1 of 1	
Weather OVERCAST	No. Dist. S.A. —	Drilling Method HSA, CORING, & ROTARY		Surface Elevation ~198.9	
Temperature 66°F	No. UD. S.A. —	Drill Rig CME 550 (ATV)		Datum MSL	
Depth WL 26.67 ft BTOC	Hole Diameter 10" & 6"	WT Sampler Hammer — LB — Drop		Started 12/1/94	
Time WL 1249	Date WL 1/6/95	Drilling Mud Type —		Completed 12/8/94	

Well Materials Inventory

Well Casing 2 In. Dia. 33 L.F.	Filter Pack Quantity 2 ft³	Grout Install Method TREMIED
Casing Type SCHEDULE 80 PVC	Pack Type & Size SILICA SAND, #20SI	End Cap/Sump 0.5 ft Quantit
Joint Type FLUSH THREADED	Install Method POURED FROM SURFACE	Protective Casing Yes ✓ No
Well Screen 2 In. Dia. 10 L.F.	Seal Type 3/8" BENTONITE PELLETS	Well Pad Size 4 ft x 4 ft x 4 in.
Screen Type SCHEDULE 80 PVC	Install Method POURED & TAPPED	TOC Elevation 201.93 ft MSL
Slot Size 0.010 in	Grout Type & Quantity PUREGOLD/32 GAL	Water Level 175.36 ft MSL
Centralizers —	Mix Ratio 14 GAL WATER/BAG	Date WL 1/5/95 Time WL 1249

Depth (Ft.) / Elevation	Sample No.	Blows/Foot	% REC	Lithologic Description
				CONTINUOUSLY SAMPLED TO 25' WITH CME CONTINUOUS SAMPLER. REAMED HOLE WITH 10¼" O.D. HSA SET 6" I.D PVC CASING TO 25'
5 / 193.9				
10 / 188.9				Gray, clay with old root fragments, FILL.
15 / 183.9				
20 / 178.9				Wet zone from 18.8 ft. to 19.9 ft.
				22.7
				Yellow, weathered, CHALK.
25 / 173.9				
			100	
30 / 168.9				
			80	32.5
				Yellow grading to gray, weathered to slightly weathered CHALK
35 / 163.9				34.7
			98	Blue, unweathered, fossiliferous, CHALK. No joints or fractures seen.
40 / 158.9				
			0	
			92	
45 / 153.9				BORING TERMINATED AT 45 ft.

Well Diagram / Comments



COORDINATES:
NORTH 14,208.17
EAST 5,800.94

LOG of BORING No. SM-18 C

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 204.9 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (Inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
41.5				Contact with unweathered chalk at 41.5 feet below land surface.		

Completion Depth: 43.5 Ft.

Drilling Method: CoreBarrel

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants

Boring / Monitoring Well Installation Log

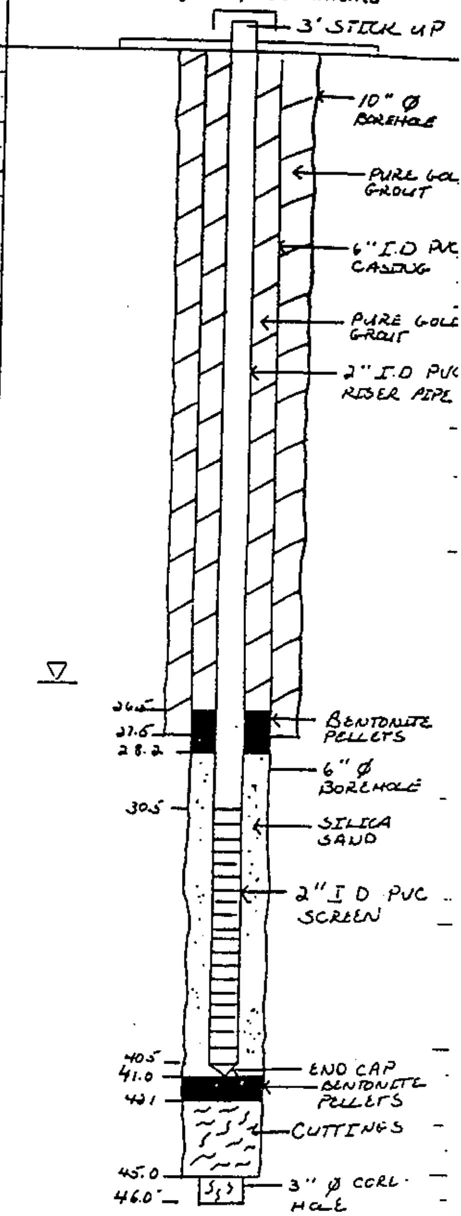
Job No. 1186.004.03	Depth Hole 46 ft	Project SM 18 STUDY	Boring No. SM-18D
Inspector BEL	Sample Method CORING	Drilling Company A.T.&E	Sheet 1 of 1
Weather OVERCAST	No. Dist. S.A. —	Drilling Method HSA, CORING & WASH RCT	Surface Elevation 200.1
Temperature ≈55°–60°F	No. UD. S.A. —	Drill Rig CME 550 (ATV)	Datum MSL
Depth WL 27.62 ft BTOC	Hole Diameter 10" & 6"	WT Sampler Hammer — LB — Drop	Started 12/1/94
Time WL 1250	Date WL 1/5/95	Drilling Mud Type —	Completed 12/8/94

Well Materials Inventory

Well Casing 2 In. Dia. 33.5 L.F.	Filter Pack Quantity 1½ ft³	Grout Install Method TREMIED
Casing Type SCHEDULE 80 PVC	Pack Type & Size SILICA SAND, #2 DSI	End Cap/Sump 0.5 ft
Joint Type FLUSH THREADED	Install Method POURED FROM SURFACE	Protective Casing Yes ✓ No
Well Screen 2 In. Dia. 10 L.F.	Seal Type & Quantity 3/8 in PELLETS	Well Pad Size 4ft x 4ft x 4in.
Screen Type SCHEDULE 80 PVC	Install Method POURED & TAPPED	TOC Elevation 203.14 ft MSL
Slot Size 0.010"	Grout Type & Quantity PURE GOLD / 35 GAL	Water Level 175.52 ft MSL
Centralizers —	Mix Ratio 14 GAL WATER / BAG	Date WL 1/5/95 Time WL 1250

Depth (Ft.) / Elevation	Sample No.	Blows/ Foot	% REC	Lithologic Description
				CONTINUOUSLY SAMPLED TO 27.5' WITH CME CONTINUOUS SAMPLER. REAMED HOLE WITH 10¼" O.D. HSA. SET 6" I.D. PVC CASING TO 27.5'.
5 / 196.1				Dark gray clay, (FILL)
10 / 191.1				
15 / 186.1				
20 / 181.1				
25 / 176.1				23.5' Yellow, weathered CHALK, shell fragments throughout grades to dark grey, weathered chalk at 32'
30 / 171.1			97	Cored from 27.6' to 46'.
35 / 166.1				Soft clay zone, approximately 0.2' thick
				36 / 37 Light grey, moderately to slightly weathered CHALK.
40 / 161.1			94	Grey, unweathered, fossiliferous, CHALK, no fractures or joints noted.
45 / 156.1				
				Boring terminated at 46'.
50 / 151.1				Hole reamed to 6" diameter, between 27.5' to 45.0; using wash rotary drilling techniques

Well Diagram / Comments



COORDINATES:
NORTH 14,180.03
EAST 5,784.77

A-8

LOG of BORING No. SM-18 D

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 198.5 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–26						
26–32				Contact with unweathered chalk at 26.0 feet below land surface.		

Completion Depth: 32.0 Ft.

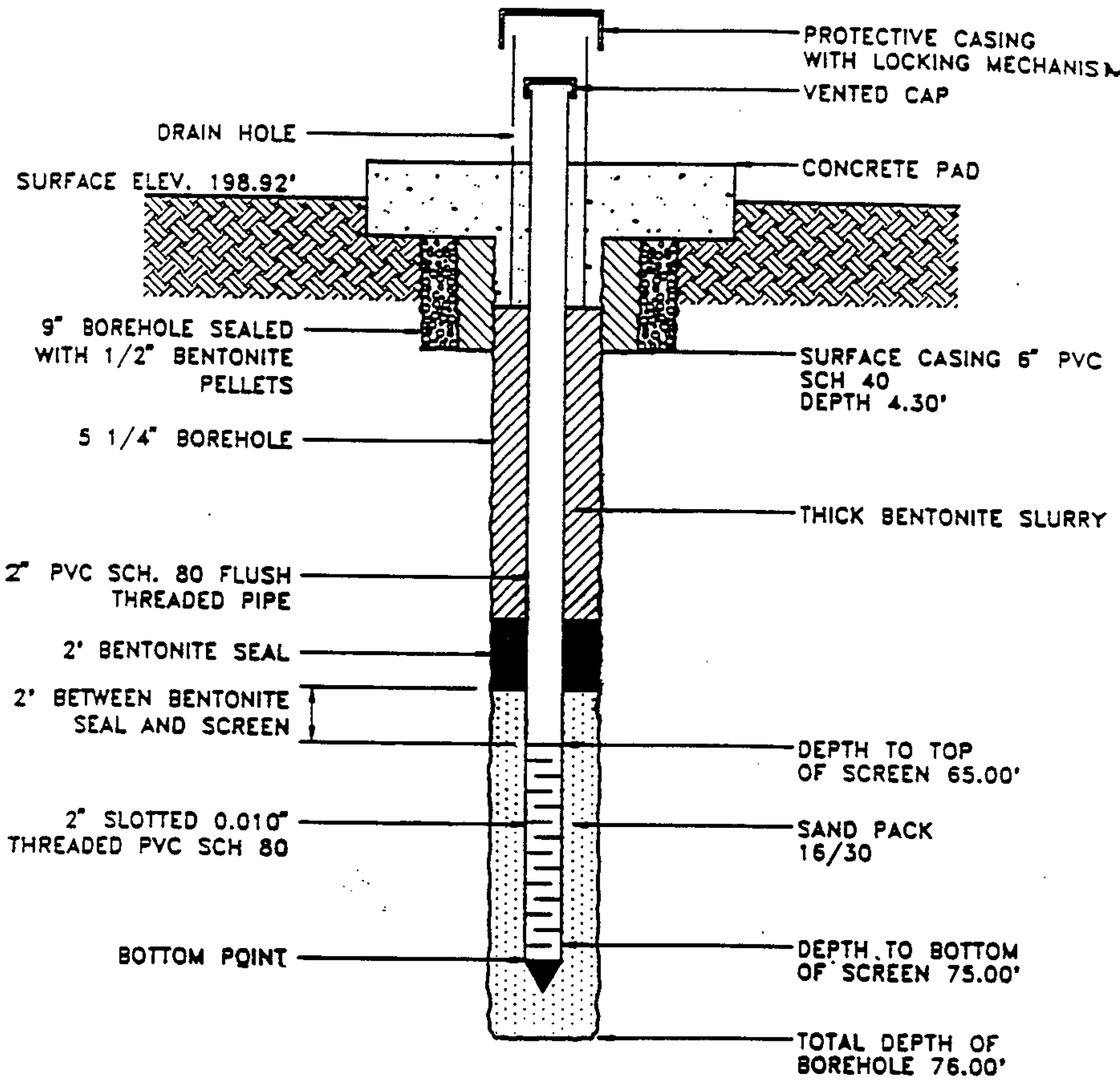
Drilling Method: CoreBarrel

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-19

Woodward-Clyde

Job No.: [illegible]	Drawing No. [illegible]	Date: 9-2[illegible]-90
Drawn by: B.T.	Checked by: T.K.	FIGURE:
Scale: NOT TO SCALE		3

LOG of BORING No. SM-19

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 198.9 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–15				**WEATHERED CHALK** Yellowish, tan-gray weathered chalk.		
15–75				**UNWEATHERED CHALK** Bluish-gray, hard unweathered chalk.		Bottom of adjacent trench T-4 is 40.97 feet below land surface.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95

Completion Depth: 75.0 Ft.

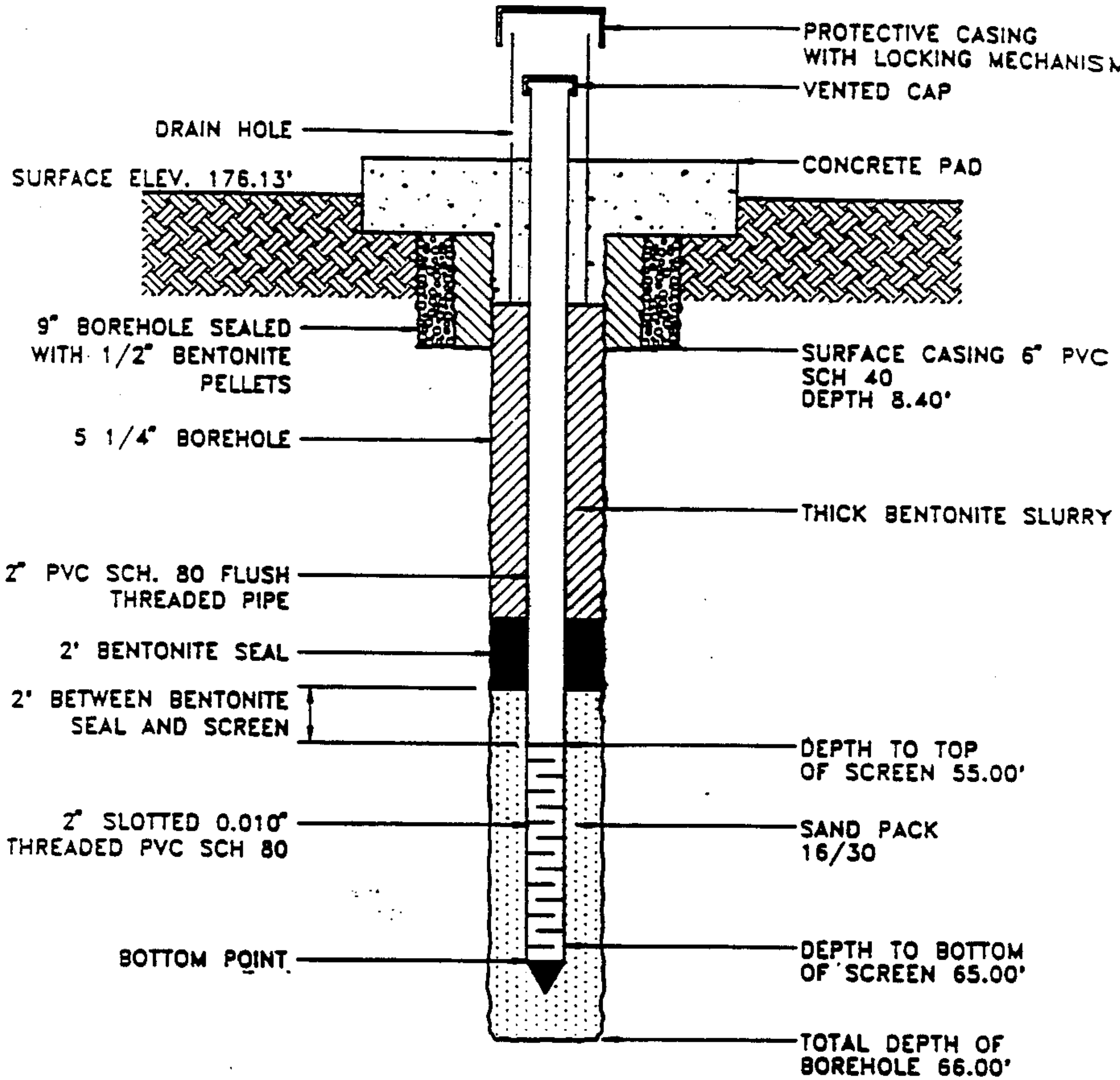
Drilling Method: Mud Rotary

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-20

Woodward-Clyde

NOT TO SCALE

FIGURE: 4

LOG of BORING No. SM-20

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 176.1 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–5				**WEATHERED CHALK** Yellowish, tan-gray weathered chalk.		
5–65.3				**UNWEATHERED CHALK** Bluish-gray, hard unweathered chalk.		Bottom of adjacent trench T-7 is 34.94 feet below land surface.

Completion Depth: 65.3 Ft.

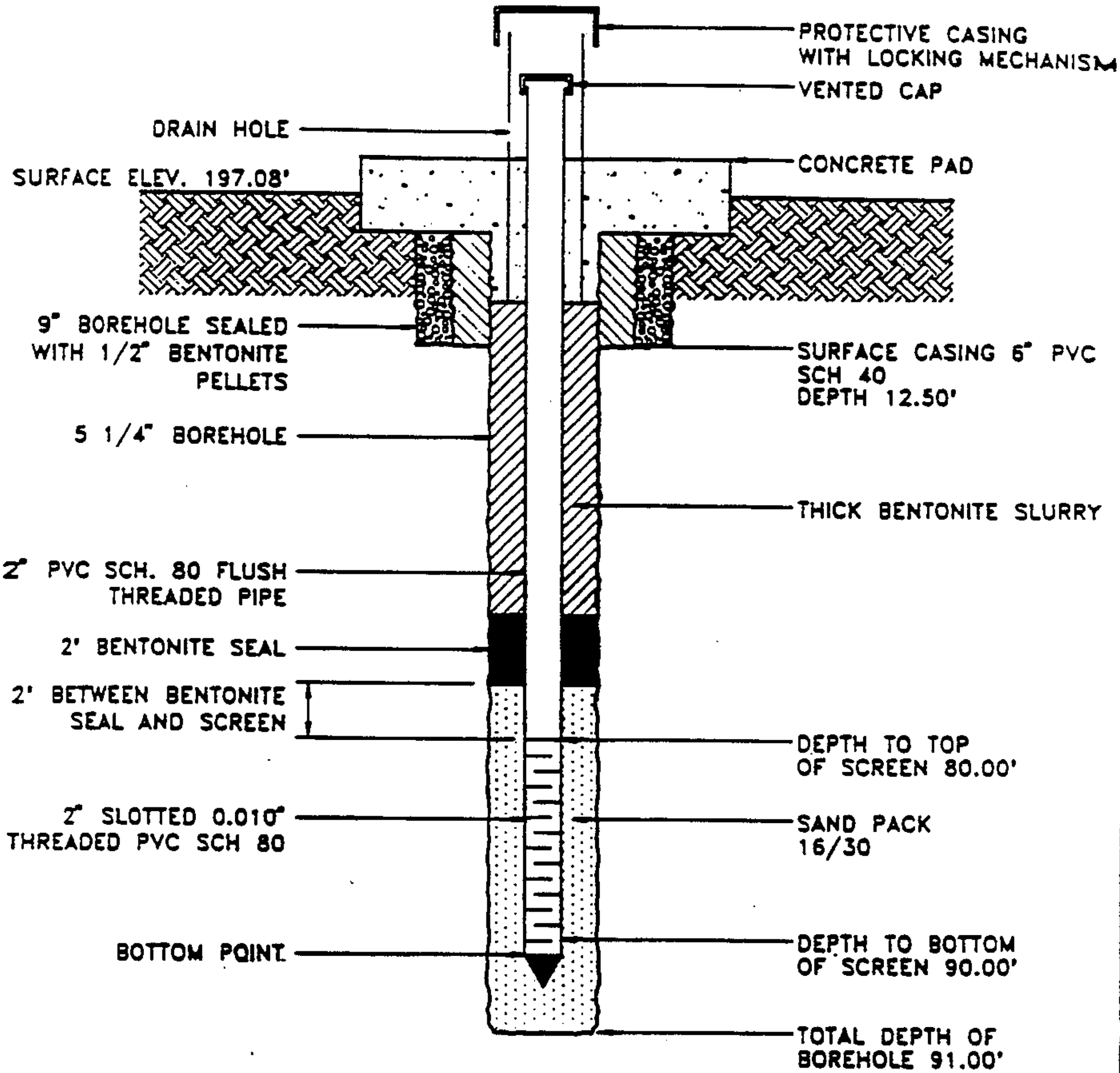
Drilling Method: Mud Rotary

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-21

Woodward-Clyde

Drawn by: B.T. | Checked by: T.K.

Scale: NOT TO SCALE

FIGURE: 5

LOG of BORING No. SM-21

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 197.1 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–21				**WEATHERED CHALK** Yellowish, tan-gray weathered chalk.		
21–90.2				**UNWEATHERED CHALK** Bluish-gray, hard unweathered chalk.		Bottom of adjacent trench T-6 is 57.55 feet below land surface.

Completion Depth: 90.2 Ft.

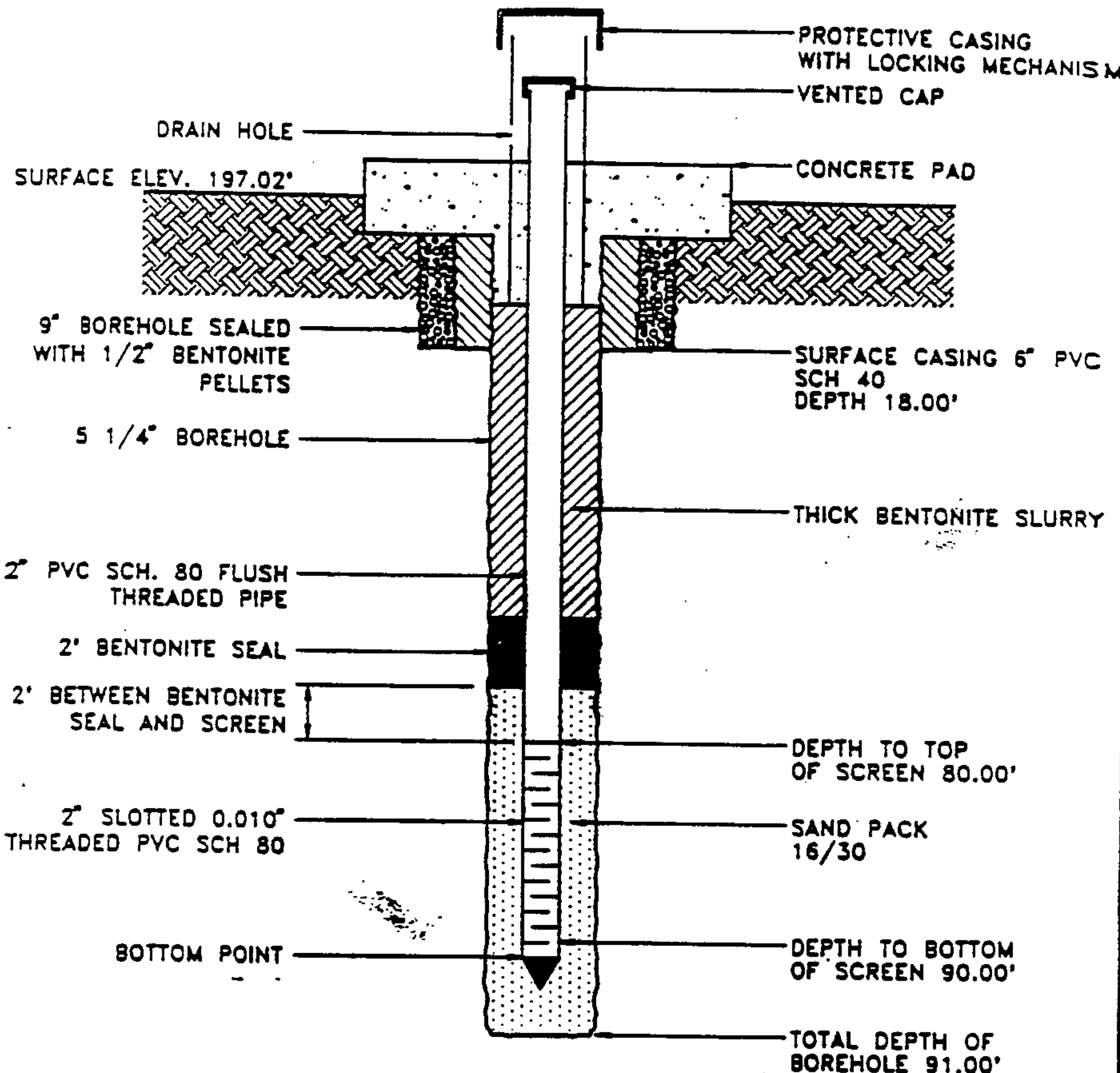
Drilling Method: Mud Rotary

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA

MONITORING WELL
SM-22

Woodward-Clyde

Drawn by: S.T. | Checked by: T.K.

NOT TO SCALE

FIGURE: 6

LOG of BORING No. SM-22

DATE September 1986 SURFACE ELEVATION 197.0 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–28				**WEATHERED CHALK** Yellowish, tan-gray weathered chalk.		
28–90				**UNWEATHERED CHALK** Bluish-gray, hard unweathered chalk.		Bottom of adjacent trench T-7 is 55.83 feet below land surface.

Completion Depth: 90.0 Ft.

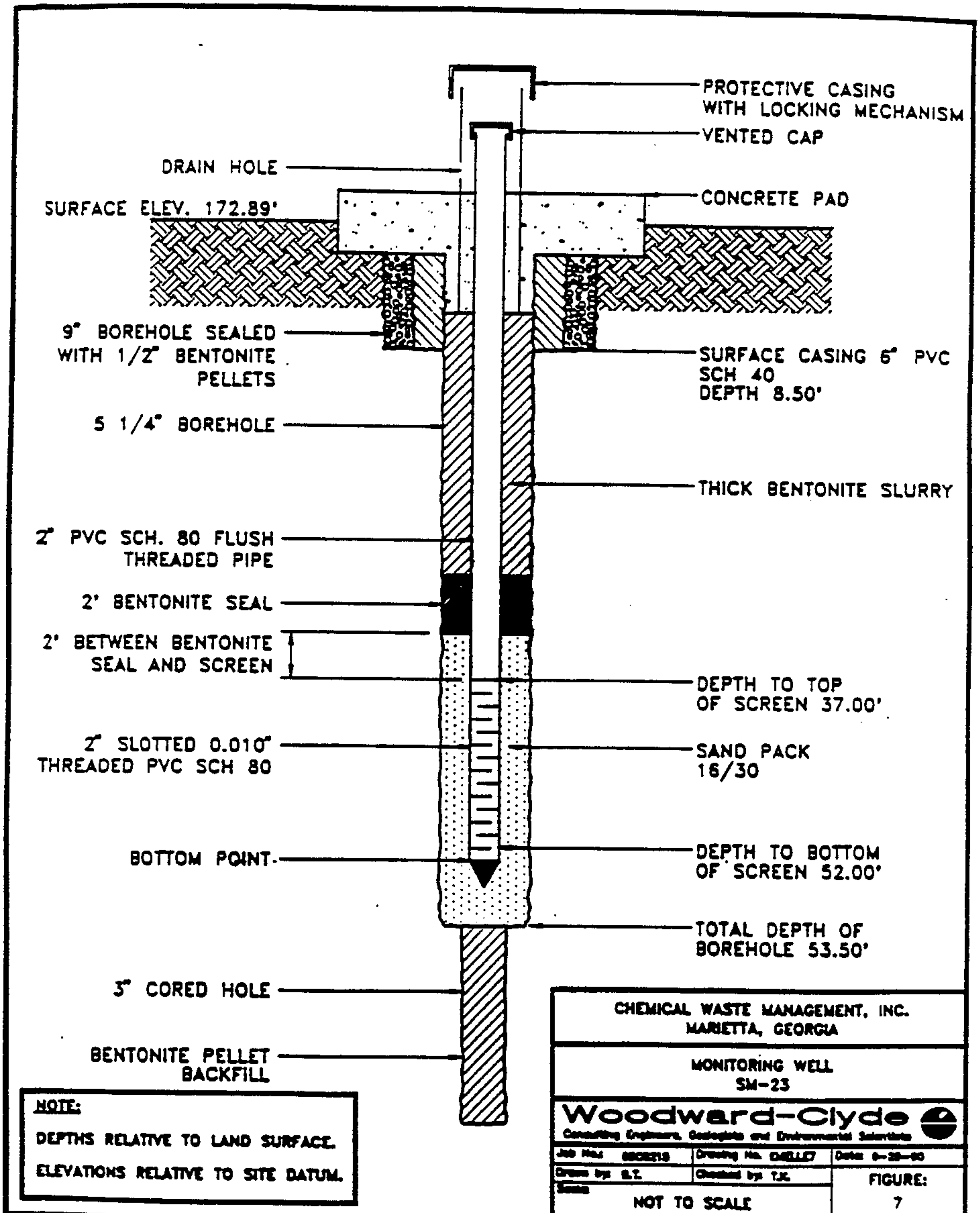
Drilling Method: Mud Rotary

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants


PROTECTIVE CASING
WITH LOCKING MECHANISM
VENTED CAP
DRAIN HOLE
CONCRETE PAD
SURFACE ELEV. 172.89'
9" BOREHOLE SEALED
WITH 1/2" BENTONITE
PELLETS
SURFACE CASING 6" PVC
SCH 40
DEPTH 8.50'
5 1/4" BOREHOLE
THICK BENTONITE SLURRY
2" PVC SCH. 80 FLUSH
THREADED PIPE
2' BENTONITE SEAL
2' BETWEEN BENTONITE
SEAL AND SCREEN
DEPTH TO TOP
OF SCREEN 37.00'
2" SLOTTED 0.010"
THREADED PVC SCH 80
SAND PACK
16/30
BOTTOM POINT
DEPTH TO BOTTOM
OF SCREEN 52.00'
TOTAL DEPTH OF
BOREHOLE 53.50'
3" CORED HOLE
BENTONITE PELLET
BACKFILL
NOTE:
DEPTHS RELATIVE TO LAND SURFACE.
ELEVATIONS RELATIVE TO SITE DATUM.
CHEMICAL WASTE MANAGEMENT, INC.
MARIETTA, GEORGIA
MONITORING WELL
SM-23
Woodward-Clyde
FIGURE:
7
NOT TO SCALE

A-13

LOG of BORING No. SM-23

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 172.9 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–18				**WEATHERED CHALK** Yellowish, tan-gray weathered chalk.		
18–65				**UNWEATHERED CHALK** Bluish-gray, hard unweathered chalk.		Bottom of adjacent trench T-7 is 31.70 feet below land surface. Fractures encountered at 39.5, 47.5, 48.3, 49.7 and 50.8 feet below land surface.

Completion Depth: 65.0 Ft.

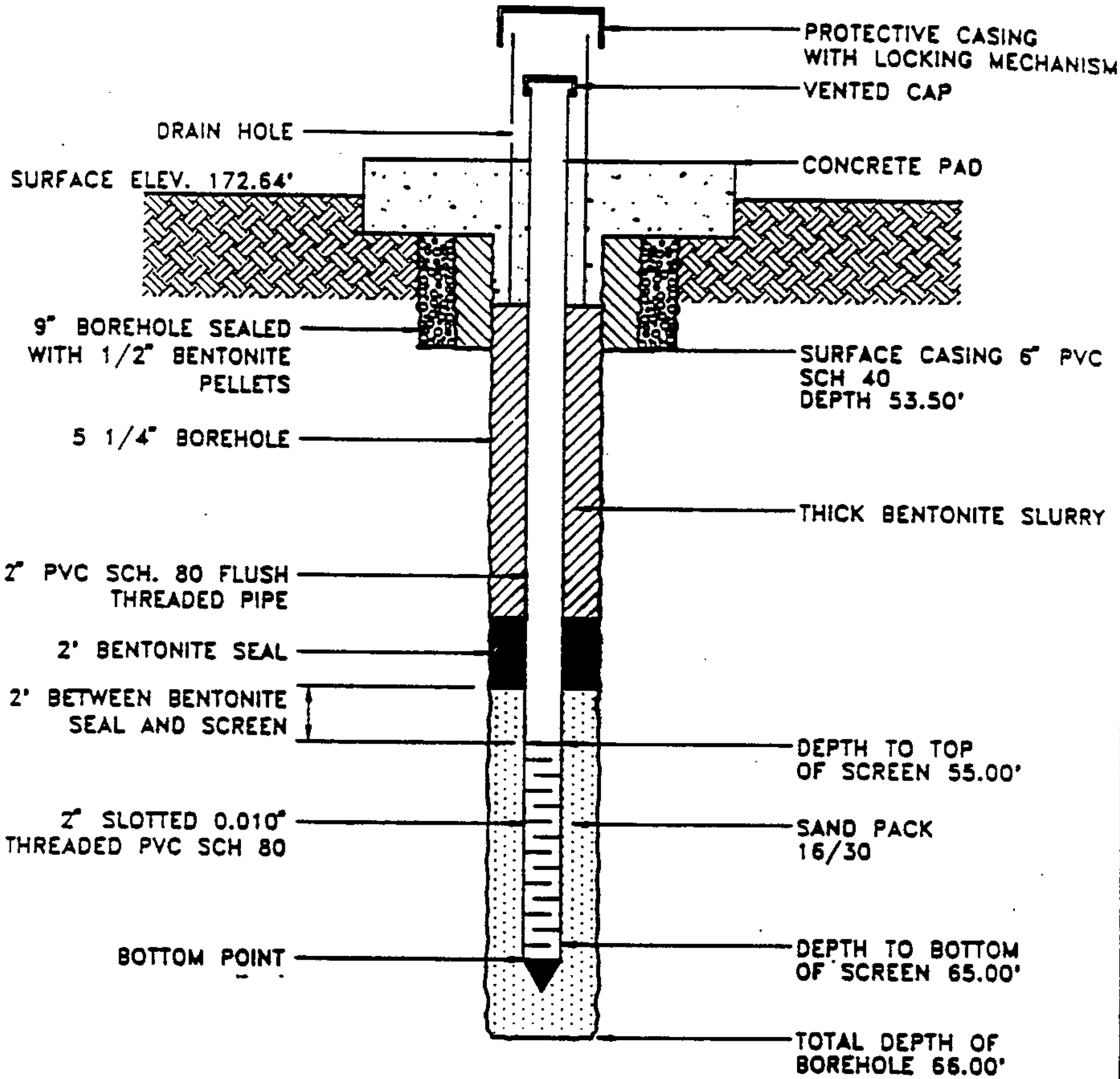
Drilling Method: Mud Rotary

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary DrillRig

Woodward-Clyde Consultants



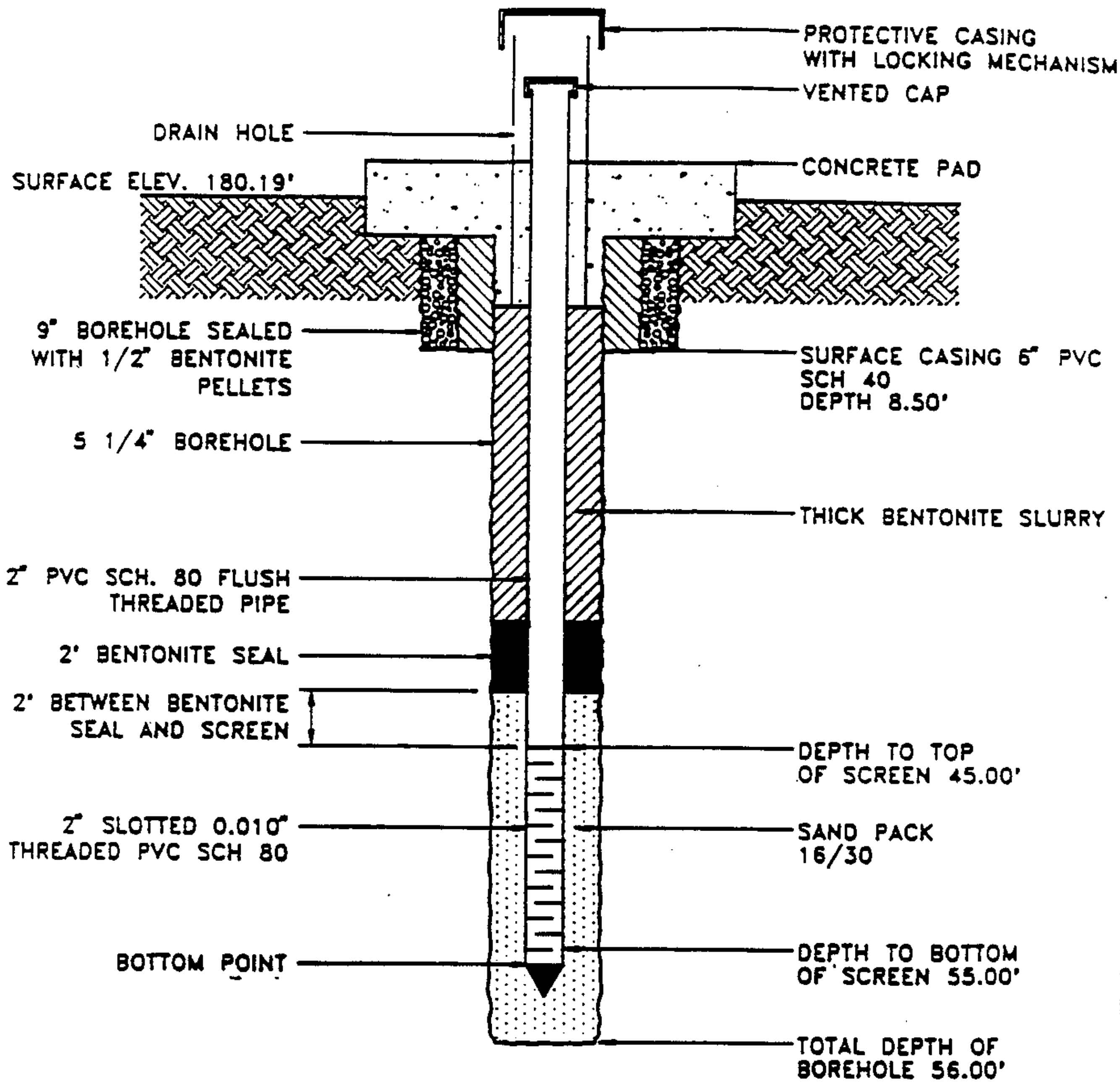
NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC. MARIETTA, GEORGIA
MONITORING WELL SM-23A
Woodward-Clyde Consulting Engineers, Geologists and Environmental Scientists

Job No.:	Drawing No.	Date:
Drawn by:	Checked by: T.K.	FIGURE: 8
Scale: NOT TO SCALE		



NOTE:

DEPTHS RELATIVE TO LAND SURFACE.

ELEVATIONS RELATIVE TO SITE DATUM.

CHEMICAL WASTE MANAGEMENT, INC. MARIETTA, GEORGIA		
MONITORING WELL SM-24		
Woodward-Clyde Consulting Engineers, Geologists and Environmental Scientists		
Job No.: [illegible]	Drawing No. [illegible]	Date: [illegible]
Drawn by: [illegible]	Checked by: T.K.	FIGURE:
Scale: NOT TO SCALE		9

A-14

LOG of BORING No. SM-24

Sheet 1 of 1

DATE September 1986 SURFACE ELEVATION 180.2 LOCATION Emelle, Alabama

DEPTH, ft.	SAMPLES	RECOVERY (inches)	SAMPLE TYPE	DESCRIPTION	LITHOLOGIC SYMBOL	SPECIAL NOTES AND FIELD OBSERVATIONS
0–28				**WEATHERED CHALK** Yellowish, tan-gray weathered chalk.		Bottom of adjacent trench T-3 is 25.19 feet below land surface.
28–55.1				**UNWEATHERED CHALK** Bluish-gray, hard unweathered chalk.		

Completion Depth: 55.1 Ft.

Drilling Method: Mud Rotary

Project No.: 85C6215

Project Name: Chemical Waste Management, Inc.

Drilling Equipment: Rotary Drill Rig

Woodward-Clyde Consultants

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle Facility	Inspector	H. Caudill	Boring No.	SM-27
Project Number	1186.009	Weather	Cloudy	Sheet	1 of 2
Drilling Company	AT&E	Temperature	62 F	Surface Elev.	~254
Drill Rig	CME 750	Depth Hole	106.0 ft	Datum	msl
Wt Hammer	140 lb Drop 30 "	Hole Diam.	10 ¼", 6"	Started	10/28/97 9:15 am
Driller	Scott Towe	Drilling Mud	NA	Completed	11/4/97 10:50 am
Sampling Method	Split Spoon, Triple Barrel Core	No. Dist. S.A.	9	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

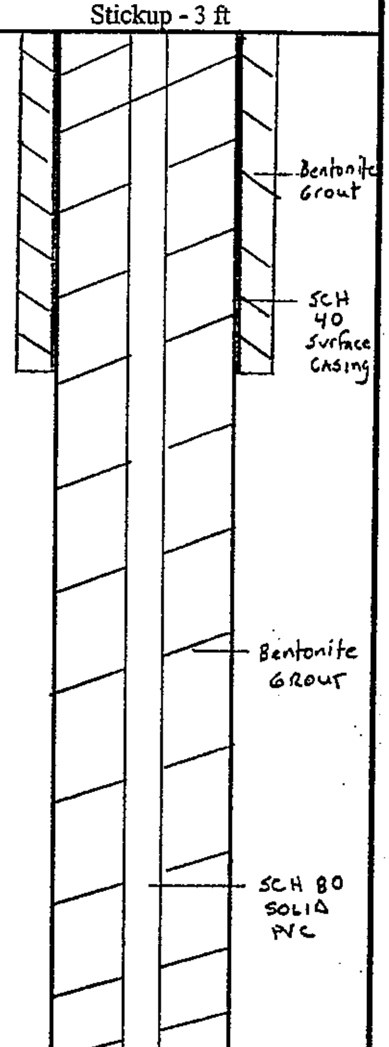
Well Materials Inventory

Well I.D.	SM-27	Filter Pack Qty	3.36 cu ft	Grout Install	Tremie
Well Casing Dia.	2 L.F. 92.5	Pack Type & Size	DSI #1 - Filter Pack	End Cap/Sump	0.5 ft
Casing Type	SCH 80 PVC	Install Method	Tremie	Prot. Casing: Y	X N
Joint Type	Flush Threaded, Teflon Taped, 'O'ring Removed	Seal Type	Cetco Bentonite 3/8" Pellets	Well Pad Size	3 ft x 3 ft x 4 in
Well Screen Dia.	2 L.F. 15	Qty/Install Method	2.5 cu ft, pour / tap	TOC Elevation	NA
Screen Type	Factory Slotted	Grout Type & Qty	Pure Gold Bentonite / 11 cu ft	Water Level	76.14
Slot Size	0.010 in	Mix Ratio	1 50 lb Bentonite/.14 gal H_2O	Date	11/5/97 Time 3:45 pm

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
1.0	SS-1	7-8-9-13	100		
3.0	SS-2	3-5-8-9	100		Yellow Brown Weathered
5.0	SS-3	4-4-7-8	100		CHALK with shell fragments
7.0	SS-4	3-3-5-7	100		
9.0	SS-5	3-3-7-9	100		
11.0	SS-6	4-5-7-8	100		
13.0	SS-7	4-5-11-13	100		
15.0	SS-8	7-10-14-20	100		
17.0	SS-9	7-8-16-23	100		
19.0					
	Run 1	20.0 - 25.0	100		Unweathered Blue Gray
					Fossiliferous CHALK
	Run 2	25.0 - 36.0	100		
30					
	Run 3	36.0 - 46.0	100		
40					
				f - 42.2 ft	55°
				f - 42.5 ft	54°, Slickensides, Calcite coated
				f - 46.1 ft	54°, Slickensides
	Run 4	46.0 - 56.0	100		
50					
	Run 5	56.0 - 66.0	100		
60					

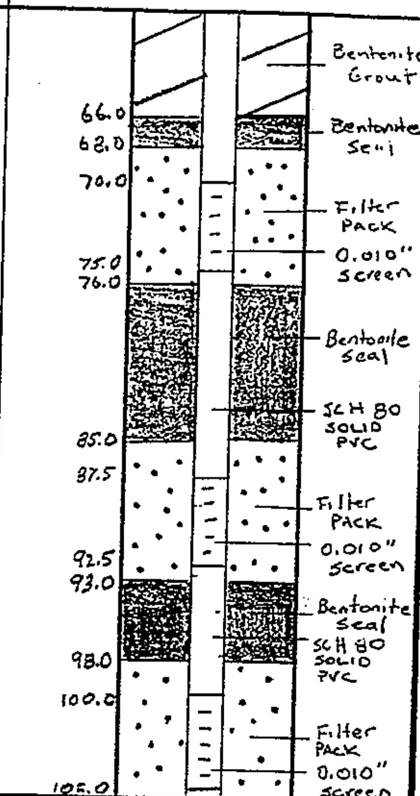
Well Diagram / Comments
Stickup - 3 ft



Notes:
1. Continuous split spoon sampling through HSA Augers to 20.0 ft. Set 6" SCH 40 surface casing and grouted in place.
2. Cored through surface casing from 20.0 ft to 106.0 ft with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5 cont.	56.0 - 66.0	100		
	Run 6	66.0 - 76.0	100		
70					
				f - 72.3 ft	42°, Slickensides, Pyrite, Calcite coated
				f- 73.9 ft	64°, Slickensides, Calcite coated
	Run 7	76.0 - 86.0	100		
80					
	Run 8	86.0 - 96.0	100		
90					
				f- 90.2 ft	40°, Slickensides, Calcite coated
	Run 9	96.0 - 106.0	100		
100					
				f-105.0 ft	57°, Slickensides, Calcite coated

Well Diagram / Comments



Coring Terminated at 106.0 ft

NOTES CONTINUED:

4. f - fracture
5. Recorded fracture dip is the apparent dip.
6. Breaks in the core other than those noted above were drilling induced, often along shell planes (approx. horizontal), or broken by the geologist during logging.
7. Survey data including the horizontal coordinates, surface elevation, and top of casing elevation will be submitted separately.

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle Facility	Inspector	H. Caudill	Boring No.	SM-28
Project Number	1186.009	Weather	Clear	Sheet	1 of 2
Drilling Company	AT&E	Temperature	58 F	Surface Elev.	~238.90
Drill Rig	CME 750	Depth Hole	94.0 ft	Datum	msl
Wt Hammer	140 lb Drop 30 "	Hole Diam.	10 ¼ ", 6 "	Started	11/4/97 1:45 pm
Driller	Scott Towe	Drilling Mud	NA	Completed	11/11/97 1:50 pm
Sampling Method	Split Spoon, Triple Barrel Core	No. Dist. S.A.	8	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

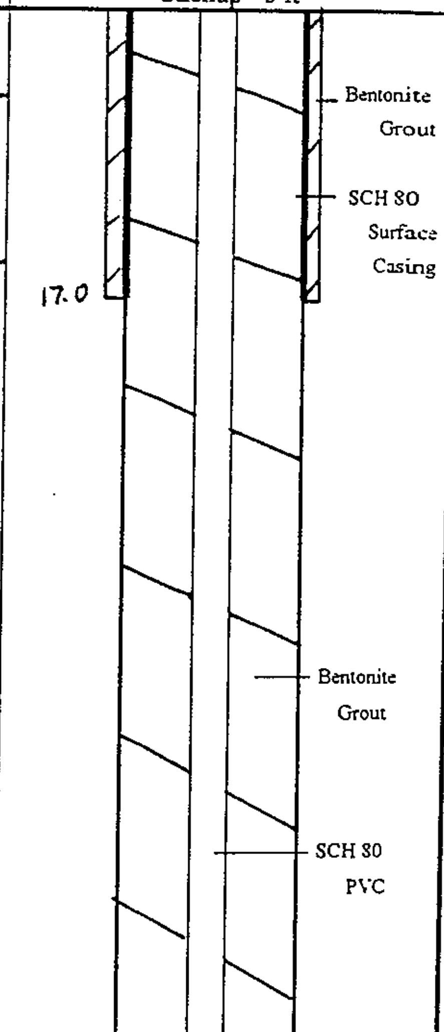
Well Materials Inventory

Well I.D.	SM-28	Filter Pack Qty	3.20 cu ft	Grout Install	Tremie
Well Casing Dia.	2 L.F. 82.0	Pack Type & Size	DSI #1 - Filter Pack	End Cap/Sump	0.5 ft
Casing Type	SCH 80 PVC	Install Method	Tremie	Prot. Casing: Y	X N
Joint Type	Flush Threaded, Teflon Taped. 'O'ring Removed	Seal Type	Cetco Bentonite 3/8" Pellets	Well Pad Size	3 ft x 3 ft x 4 in
Well Screen Dia.	2 L.F. 15	Qty/Install Method	2.3 cu ft, pour / tap	TOC Elevation	NA
Screen Type	Factory Slotted	Grout Type & Qty	Pure Gold Bent. / 10.4 cu ft	Water Level	NA
Slot Size	0.010 in	Mix Ratio	1 50 lb Bentonite/ 14 gal H_2O	Date	Time

Boring and Well Diagram

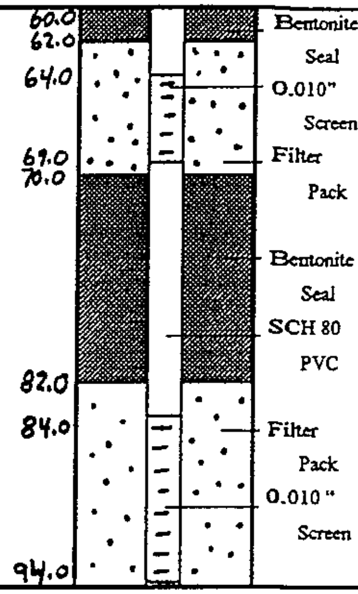
Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
1.0	SS-1	1-3-3-6	100		Fill Material
3.0	SS-2	4-5-7-8	100		
5.0	SS-3	3-4-5-5	75		
7.0	SS-4	3-3-5-6	100		Yellow Brown Weathered CHALK with Shell Fragments
9.0	SS-5	3-5-5-6	100		
11.0	SS-6	5-7-10-10	100		
13.0	SS-7	7-10-14-23	100		
15.0	SS-8	6-13-17-25	100		
17.0					
20	Run 1	17.0 - 27.0	93		Unweathered Blue Gray Fossiliferous CHALK
30	Run 2	27.0 - 36.7	100		
40	Run 3	36.7 - 47.2	100		
				f - 43.5 ft	52°, Slickensides, Calcite coated
				f - 43.8 ft	47°, Slickensides, Calcite coated
				f - 45.3 ft	50°
50	Run 4	47.2 - 57.2	100		
60	Run 5	57.2 - 67.0	100		

Well Diagram / Comments
Stickup - 3 ft



Notes:
1. Continuous split spoon sampling through HSA Augers to 17.0 ft. Set 6" SCH 40 surface casing and grouted in place.
2. Cored through surface casing from 17.0 ft to 94.0 ft with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Well Diagram / Comments
	Run 5 cont.	57.2 - 67.0	100			
				f - 66.4 ft	67°, Slickensides	
70	Run 6	67.0 - 77.0	100			
80	Run 7	77.0 - 87.0	100			
90	Run 8	87.0 - 94.0	100			



Coring Terminated at 94.0 ft

NOTES CONTINUED:

4. f - fracture
5. Recorded fracture dip is the apparent dip.
6. Breaks in the core other than those noted above were drilling induced, often along shell planes (approx. horizontal), or broken by the inspector during logging.
7. Survey data including the horizontal coordinates, surface elevation, and top of casing elevation will be submitted separately.

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle Facility	Inspector	H. Caudill	Boring No.	SM-29
Project Number	1186.009	Weather	Clear	Sheet	1 of 2
Drilling Company	AT&E	Temperature	53 F	Surface Elev.	~244.37
Drill Rig	CME 750	Depth Hole	94.0 ft	Datum	msl
Wt Hammer	140 lb Drop 30 "	Hole Diam.	10 ¼ ", 6 "	Started	11/5/97 4:10 pm
Driller	Scott Towe	Drilling Mud	NA	Completed	11/10/97 3:45 pm
Sampling Method	Split Spoon, Triple Barrel Core	No. Dist. S.A.	10	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

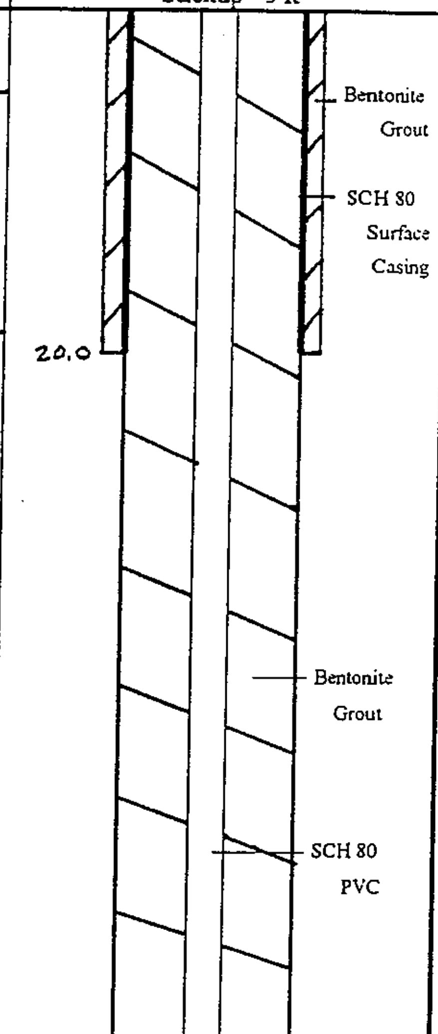
Well Materials Inventory

Well I.D.	SM-29	Filter Pack Qty	3.36 cu ft	Grout Install	Tremie
Well Casing Dia.	2 L.F. 88.0	Pack Type & Size	DSI #1 - Filter Pack	End Cap/Sump	0.5 ft
Casing Type	SCH 80 PVC	Install Method	Tremie	Prot. Casing: Y	X N
Joint Type	Flush Threaded, Teflon Taped, 'O'ring Removed	Seal Type	Cetco Bentonite 3/8" Pellets	Well Pad Size	3 ft x 3 ft x 4 in
Well Screen Dia.	2 L.F. 15	Qty/Install Method	1.7 cu ft, pour / tap	TOC Elevation	NA
Screen Type	Factory Slotted	Grout Type & Qty	Pure Gold Bent. / 11.6 cu ft	Water Level	NA
Slot Size	0.010 in	Mix Ratio	1 50 lb Bentonite/ 14 gal H_2O	Date	Time

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
1.0	SS-1	3-3-4-5	100		Fill Material
3.0	SS-2	4-5-5-5	100		
5.0	SS-3	4-5-5-7	100		
7.0	SS-4	3-4-5-7	100		Yellow Brown Weathered CHALK with Shell Fragments
9.0	SS-5	4-6-10-12	100		
11.0	SS-6	6-9-11-14	100		
13.0	SS-7	5-6-8-12	100		
15.0	SS-8	7-11-14-23	100		
17.0	SS-9	6-18-10-13	100		
19.0	SS-10	10-13-24-30	100		
21.0					
	Run 1	20.0 - 26.0	92		Unweathered Blue Gray Fossiliferous CHALK
30					
	Run 2	26.0 - 36.2	100	f - 32.8 ft	50°, Slickensides
				f - 33.8 ft	39°, Slickensides
40					
	Run 3	36.2 - 46.2	100		
50					
	Run 4	46.2 - 56.1	100		
60					

Well Diagram / Comments
Stickup - 3 ft

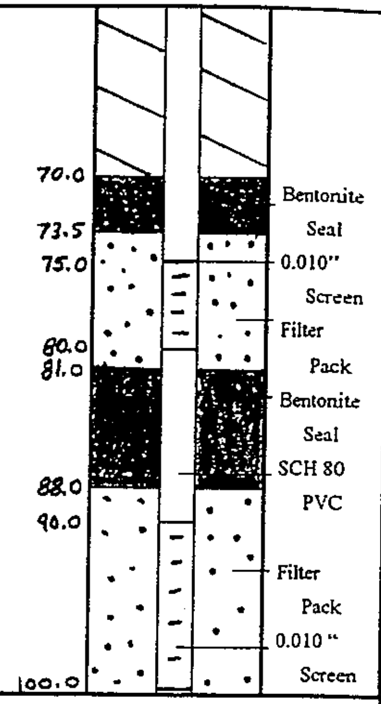


Notes:
1. Continuous split spoon sampling through HSA Augers to 20.0 ft. Set 6" SCH 40 surface casing and grouted in place.
2. Cored through surface casing from 20.0 ft to 100.0 ft with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.

Boring / Monitoring Well Installation Log

Boring No. / Well ID: SM-29

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Well Diagram / Comments
	Run 5	56.1 - 66.0	100			
70						
	Run 6	66.0 - 76.0	100			
80				f - 78.5 ft	25°	
	Run 7	76.0 - 86.0	100			
90						
	Run 8	86.0 - 96.0	100			
				f - 98.1 ft	80°, Slickensides	
				f - 99.3 ft	57°, Slickensides, Wavy	
100	Run 9	96.0 - 100.0	100	f - 99.7 ft	73°, Slickensides	



Coring Terminated at 100.0 ft

NOTES CONTINUED:

4. f - fracture
5. Recorded fracture dip is the apparent dip.
6. Breaks in the core other than those noted above were drilling induced, often along shell planes (approx. horizontal), or broken by the inspector during logging.
7. Survey data including the horizontal coordinates, surface elevation, and top of casing elevation will be submitted separately.

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	Inspector	R. Patterson (initials)	Boring No.	SM-30
Project Number	1186.018	Weather	Cloudy, Rainy	Sheet	1 of 2
Drilling Company	AT&E	Temperature	45 F	Surface Elev.	192.4'
Drill Rig	CME-750	Depth Hole	120.0' bgs	Datum	msl
Wt Hammer	140 lb. Drop 30"	Hole Diam.	10 ¼" / 6"	Started	12-8-98 / 10:00 am
Driller	Pat Bergman	Drilling Mud	NA	Completed	12-15-98 / 12:45pm
Sampling Method	S.S. / NQWL Core	No. Dist. S.A.	11	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

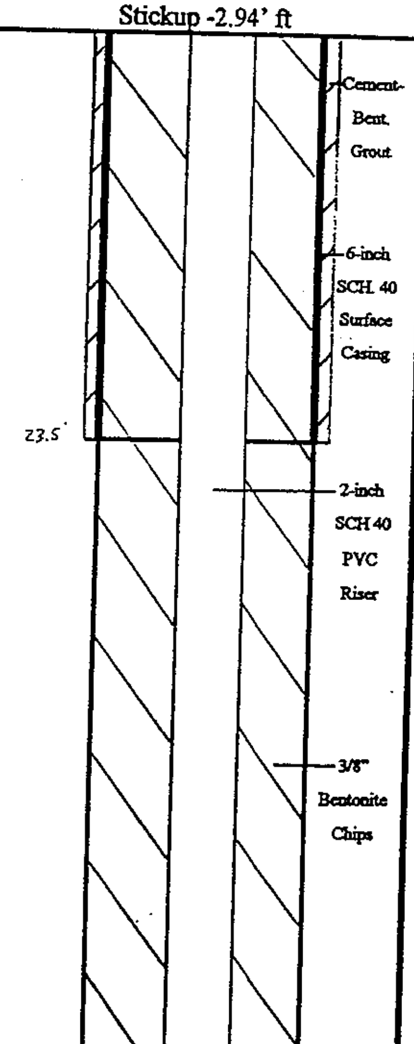
Well Materials Inventory

Well I.D.	SM-30	Filter Pack Qty	2.0 cu. ft.	Grout Install	Tremie around surface casing
Well Casing Dia.	2" L.F. 110'	Pack Type & Size	DSI #1 - Filter Sand	End Cap/Sump	0.5'
Casing Type	Sch. 40 PVC	Install Method	Pour	Prot. Casing: Y	X N
Joint Type	Flush Threaded, O-Rings Removed	Seal Type	3/8" Pure Gold Medium Bentonite Chips (Well annulus)	Well Pad Size	4' X 4' X 4"
Well Screen Dia.	2" L.F. 10'	Qty/Install Method	17.0 cu. ft. / Pour (To surface)	TOC Elevation	195.34'
Screen Type	Factory Slotted	Grout Type & Qty	Cement-Bentonite / 8.9 cu. ft.	Water Level	NA
Slot Size	0.010"	Mix Ratio	564 lbs cement/ 13 lbs bentonite/ 60 gal. H20	Date WL NA	Time NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	2-5-7-9	100		Soft to compact, tan, brown, and gray chalk fill
	S.S. 2	3-4-6-7	100		
	S.S. 3	3-4-4-5	100		
	S.S. 4	4-6-9-8	50		
10	S.S. 5	2-4-5-6	75		
	S.S. 6	2-3-4-5	80		
	S.S. 7	2-3-2-3	75		
	S.S. 8	2-4-5-5	80		
	S.S. 9	2-4-4-7	100		
20	S.S. 10	4-14-31-50	90		19.0' Tan to light brown
	S.S. 11	14-29-48-50	100		21.0' weathered CHALK
	Run 1	23.0-25.0	75		Gray, unweathered, fossiliferous CHALK
30					
	Run 2	25.0-35.0	98		
40					
	Run 3	35.0-45.0	73		
50					
	Run 4	45.0-55.0	99		
60					

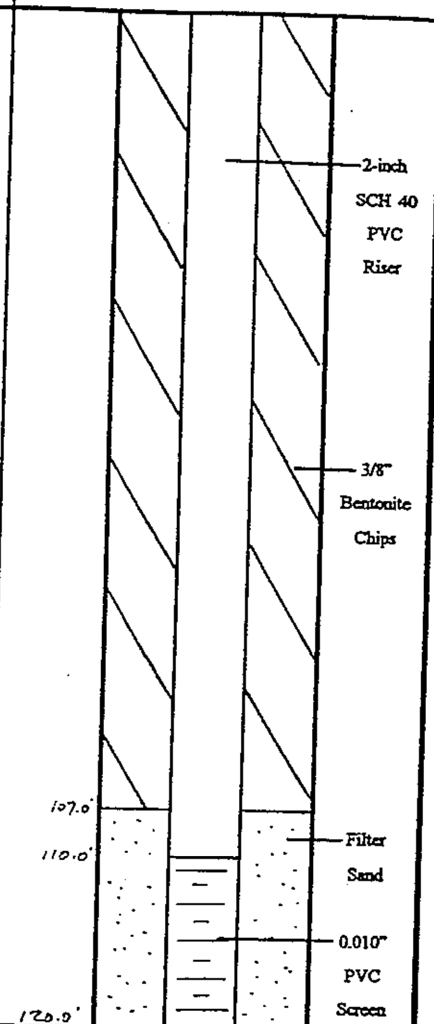
Well Diagram / Comments
Stickup -2.94' ft



Notes:
1. Continuous split spoon sampling to 22.0'. Set 6" Sch. 40 surface casing to 23.5' and grouted in place.
2. Cored through surface casing from 23.0' to 120.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	55.0-65.0	98		
70					
	Run 6	65.0-75.0	98		
80					Gray, unweathered, fossiliferous CHALK
	Run 7	75.0-85.0	87		
90					
	Run 8	85.0-95.0	99		
100					
	Run 9	95.0-105.0	57		
110					
	Run 10	105.0-115.0	79		
120	Run 11	115.0-120.0	100		

Well Diagram / Comments



Coring terminated at 120.0'

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	Inspector	R. Patterson ✓ mB	Boring No.	SM-31
Project Number	1186.018	Weather	Clear, Cool	Sheet	1 of 2
Drilling Company	AT&E	Temperature	50 F	Surface Elev.	207.8'
Drill Rig	CME-750	Depth Hole	122.0' bgs	Datum	msl
Wt Hammer	140 lb. Drop 30"	Hole Diam.	10 ¼" / 6"	Started	12-9-98 / 10:05 am
Driller	Pat Bergman	Drilling Mud	NA	Completed	12-17-98 / 2:30 pm
Sampling Method	S.S. / NQWL Core	No. Dist. S.A.	5	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

Well Materials Inventory

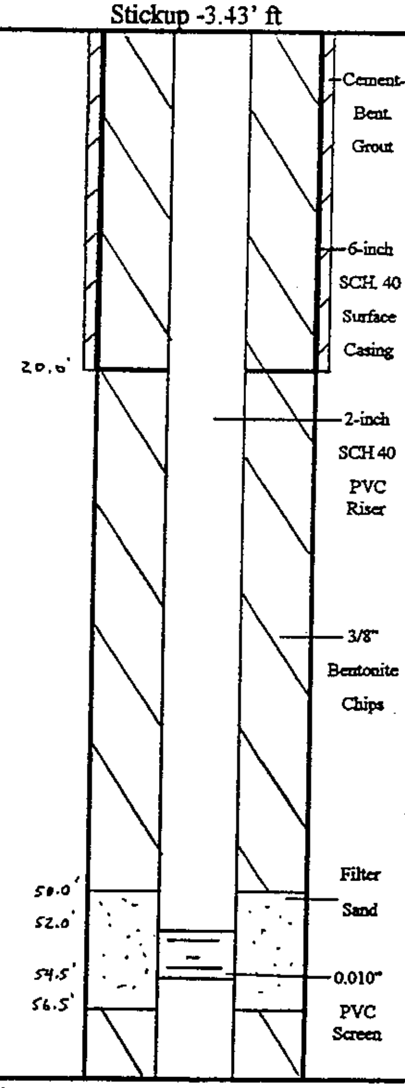
Well I.D.	SM-31	Filter Pack Qty	4.4 cu. ft.	Grout Install	Tremie around surface casing
Well Casing Dia.	2" L.F. 104.5'	Pack Type & Size	DSI #1 - Filter Sand	End Cap/Sump	0.5'
Casing Type	Sch. 40 PVC	Install Method	Tremie / Pour	Prot. Casing: Y	X N
Joint Type	Flush Threaded, O-Rings Removed	Seal Type	3/8" Pure Gold Medium Bentonite Chips(Well annulus)	Well Pad Size	4' X 4' X 4"
Well Screen Dia.	2" L.F. 17.5'	Qty/Install Method	15.0 cu. ft. / Pour(To surface)	TOC Elevation	211.23'
Screen Type	Factory Slotted	Grout Type & Qty	Cement-Bentonite/7.6 cu. ft.	Water Level	NA
Slot Size	0.010"	Mix Ratio	564 lbs. Cement/ 12 lbs. Bentonite/ 55 gal. H20	Date WL NA	Time NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	3-3-5-5	60		Fill material
	S.S. 2	4-4-7-7	100		4.5' Tan to light brown, weathered CHALK
	S.S. 3	3-8-24-34	100		
	S.S. 4	6-21-27-33	100		Gray, unweathered,
10	S.S. 5	7-21-27-37	100		fossiliferous CHALK
20				f - 20.6'	42°, Slickensides
				f - 20.8'	60°, Slickensides
	Run 1	20.0-25.0	90	f - 24.7'	60°, Slickensides
30				f - 28.5'	52°, Slickensides
				f - 30.2'	30°, Slickensides
	Run 2	25.0-35.0	89		
40					
	Run 3	35.0-45.0	97		
50					
				f - 53.0'	54°, Slickensides
				f - 54.3'	41° Slickensides
	Run 4	45.0-55.0	98		
60					

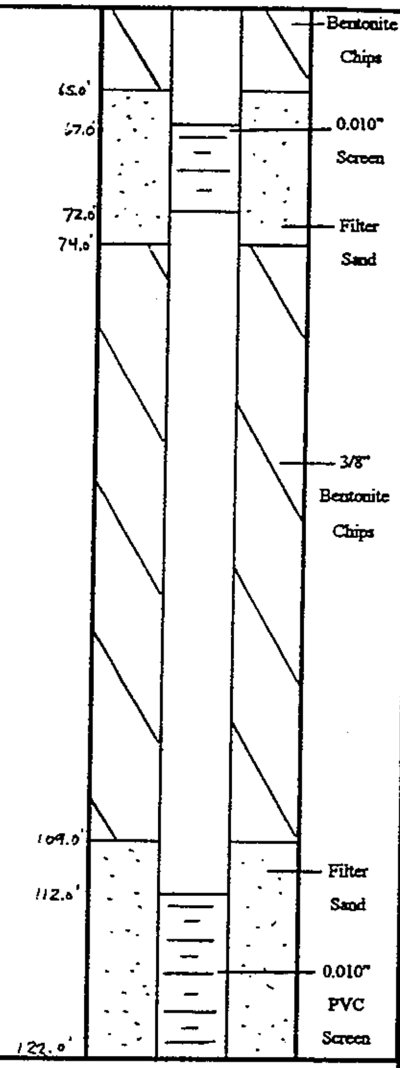
Well Diagram / Comments

Stickup -3.43' ft



Notes: 1. Continuous split spoon sampling to 10.0'. Set 6" Sch. 40 surface casing to 20.0' and grouted in place.
2. Cored through surface casing from 20.0' to 122.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Well Diagram / Comments
	Run 5	55.0-65.0	98			
				f-68.4'	58°, Slickensides	
70				f-69.25'	40°, Slickensides	
				f-70.5'	45°, Slickensides	
	Run 6	65.0-75.0	97			
80						
					Gray, unweathered, fossiliferous CHALK	
	Run 7	75.0-85.0	100			
90						
	Run 8	85.0-95.0	98			
100						
	Run 9	95.0-105.0	100			
110						
	Run 10	105.0-115.0	98			
120						
	Run 11	115.0-122.0	99			



Coring terminated at 122.0' bgs

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	Inspector	R. Patterson	Boring No.	SM-32
Project Number	1186.018	Weather	Cloudy, Cool	Sheet	1 of 2
Drilling Company	AT&E	Temperature	55 F	Surface Elev.	209.7'
Drill Rig	CME-750	Depth Hole	117.0' bgs	Datum	msl
Wt Hammer	140 lb. Drop 30"	Hole Diam.	10 ¼" / 6"	Started	12-9-98 / 2:45 pm
Driller	Pat Bergman	Drilling Mud	NA	Completed	12-21-98 / 3:45 pm
Sampling Method	S.S. / NQWL Core	No. Dist. S.A.	10	No. UD. S.A.	NA
Depth W.L.	NA	Time W.L.	NA	Date W.L.	NA

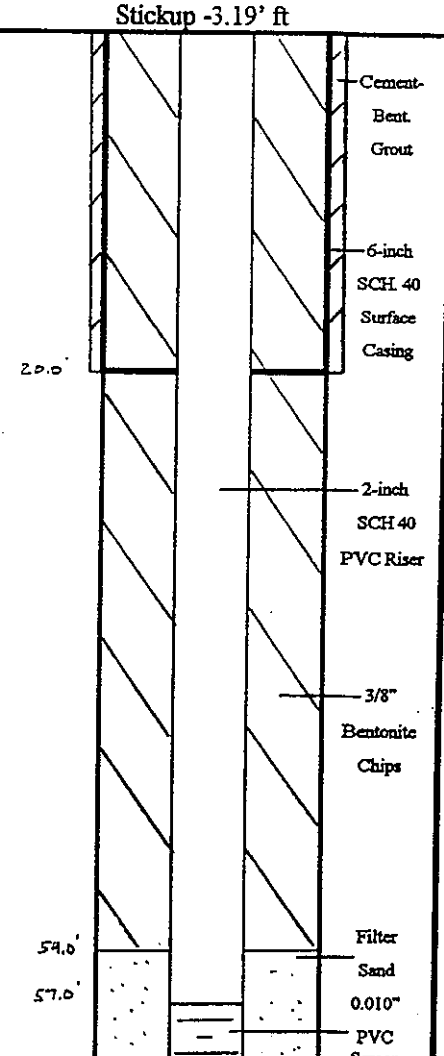
Well Materials Inventory

Well I.D.	SM-32	Filter Pack Qty	3.5 cu. ft.	Grout Install	Tremie around surface casing
Well Casing Dia.	2" L.F. 112'	Pack Type & Size	DSI #1 - Filter Sand	End Cap/Sump	0.5'
Casing Type	Sch. 40 PVC	Install Method	Pour	Prot. Casing: Y X N	
Joint Type	Flush Threaded, O-Rings Removed	Seal Type	3/8" Pure Gold Medium Bentonite Chips(Well annulus)	Well Pad Size	4' X 4' 4"
Well Screen Dia.	2" L.F. 15'	Qty/Install Method	15.3 cu. ft. / Pour (To Surface)	TOC Elevation	212.89'
Screen Type	Factory Slotted	Grout Type & Qty	Cement-Bentonite/7.6 cu. ft.	Water Level	NA
Slot Size	0.010"	Mix Ratio	564 lbs cement/12 lbs Bentonite/ 60 gal H20	Date WL NA	Time NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	9-14-14-21	100		Soft to compact, tan, brown, and gray chalk fill
	S.S. 2	8-8-18-24	100		
	S.S. 3	7-7-8-9	100		
	S.S. 4	5-5-6-12	100		
10	S.S. 5	5-5-5-8	100		
	S.S. 6	5-8-19-18	100		
	S.S. 7	2-3-4-5	80		
	S.S. 8	4-5-10-19	100		15.0' Tan to light brown, weathered
	S.S. 9	8-19-22-31	100		17.5' CHALK
20	S.S. 10	5-23-29-56	100		Gray, unweathered, fossiliferous CHALK
	Run 1	20.0-25.0	84		
30					
				f-32.6'	35°
	Run 2	25.0-35.0	98		
40					
	Run 3	35.0-45.0	97		
50					
	Run 4	45.0-55.0	98		
60				f-59.4'	28°, Slickensides

Well Diagram / Comments
Stickup -3.19' ft



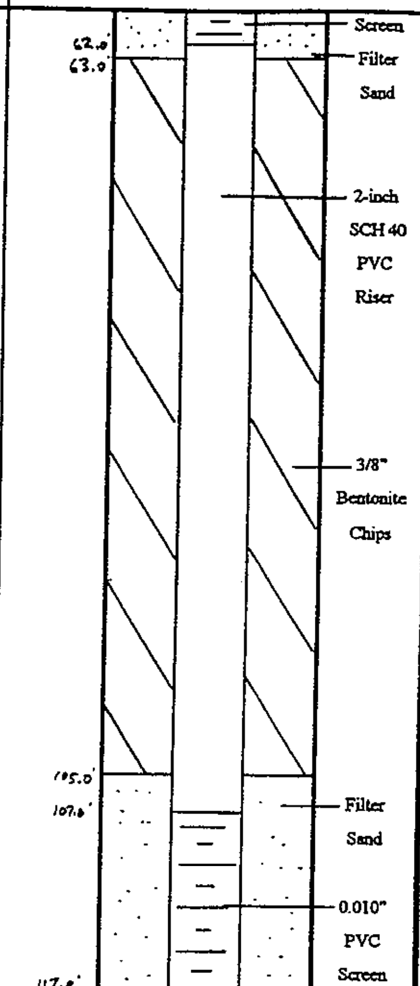
Notes:
1. Continuous split spoon sampling to 20.0'. Set 6" Sch. 40 surface casing to 20.0' and grouted in place.
2. Cored through surface casing from 20.0' to 117.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Boring / Monitoring Well Installation Log — Page 2 of 2

Boring No. / Well ID SM-32

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	55.0-65.0	98		
70					
	Run 6	65.0-75.0	97		
80					Gray, unweathered, fossiliferous CHALK
	Run 7	75.0-85.0	85		
90					
	Run 8	85.0-95.0	98		
100					
	Run 9	95.0-105.0	96		
110					
	Run 10	105.0-115.0	95		
	Run 11	115.0-117.0	100		

Well Diagram / Comments



Coring terminated at 117.0' bgs

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

Boring / Monitoring Well Installation Log

Project Name	CWM-Emelle	**Inspector**	R. Patterson	**Boring No.**	SM-33
Project Number	1186.018	**Weather**	Clear, Cool	**Sheet**	1 of 2
Drilling Company	AT&E	**Temperature**	50 F	**Surface Elev.**	204.43'
Drill Rig	CME-750	**Depth Hole**	109.0' bgs	**Datum**	msl
Wt Hammer	140 lb. **Drop** 30"	**Hole Diam.**	10 ¼" / 6"	**Started**	12-17-98 / 3:25 pm
Driller	Pat Bergman	**Drilling Mud**	NA	**Completed**	12-23-98 / 1:15 pm
Sampling Method	S.S. / NQWL Core	**No. Dist. S.A.**	10	**No. UD. S.A.**	NA
Depth W.L.	NA	**Time W.L.**	NA	**Date W.L.**	NA

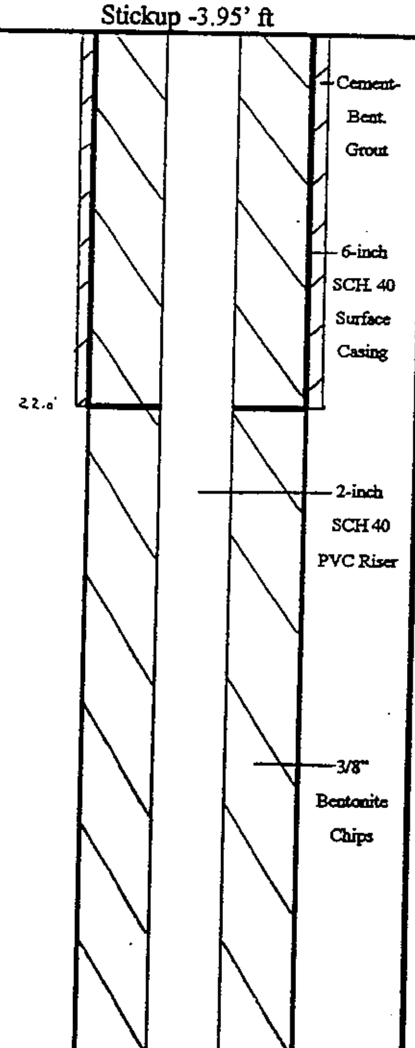
Well Materials Inventory

Well I.D.	SM-33	**Filter Pack Qty**	2.0 cu. ft.	**Grout Install**	Tremie around surface casing
Well Casing Dia.	2" **L.F.** 99'	**Pack Type & Size**	DSI #1 - Filter Sand	**End Cap/Sump**	0.5'
Casing Type	Sch. 40 PVC	**Install Method**	Pour	**Prot. Casing: Y**	X **N**
Joint Type	Flush Threaded, O-Rings Removed	**Seal Type**	3/8" Pure Gold Medium Bentonite Chips(Well annulus)	**Well Pad Size**	4' X 4' X 4"
Well Screen Dia.	2" **L.F.** 10'	**Qty/Install Method**	15.0 cu. ft. / Pour (To Surface)	**TOC Elevation**	208.38'
Screen Type	Factory Slotted	**Grout Type & Qty**	Cement-Bentonite / 8.4 cu. ft.	**Water Level**	NA
Slot Size	0.010"	**Mix Ratio**	564 lbs cement / 13 lbs bentonite / 60 gal. H20	**Date WL** NA	**Time** NA

Boring and Well Diagram

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	S.S. 1	2-4-5-7	80		Soft to compact, tan, brown, and gray chalk fill
	S.S. 2	3-6-9-13	100		
	S.S. 3	6-11-19-18	100		
	S.S. 4	11-14-17-18	100		
10	S.S. 5	7-12-13-14	100		
	S.S. 6	4-6-7-10	70		
	S.S. 7	4-5-5-8	80		
	S.S. 8	4-5-5-7	100		
	S.S. 9	5-11-14-16	100		17.0' Tan to light brown weathered
20	S.S. 10	5-10-17-29	100		19.5' CHALK
					Gray, unweathered, fossiliferous CHALK
	Run 1	22.0-25.0	53		
30					
	Run 2	25.0-35.0	98		
40					
	Run 3	35.0-45.0	93		
50					
	Run 4	45.0-55.0	99		
60					

Well Diagram / Comments
Stickup -3.95' ft

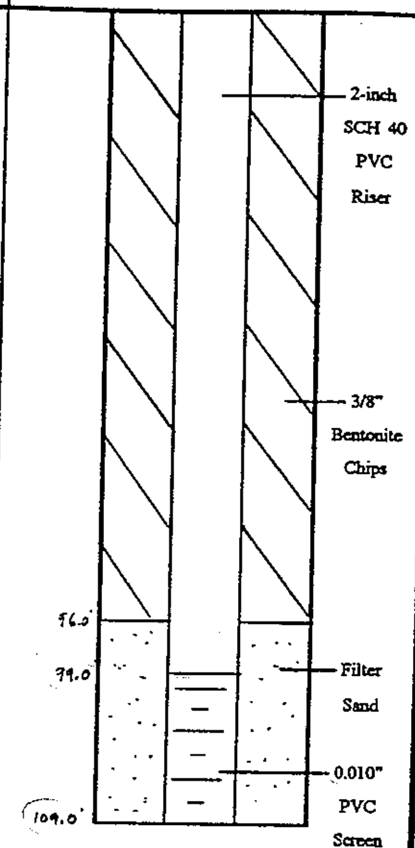


Notes:
1. Continuous split spoon sampling to 20.0'. Set 6" Sch. 40 surface casing to 22.0' and grouted in place.
2. Cored through surface casing from 22.0' to 109.0' with NQ sized triple core barrel.
3. Reamed hole to 6" diameter using 5 7/8" drag bit and wash rotary drilling techniques.
4. f = fracture

Boring / Monitoring Well Installation Log
Boring No. / Well ID – SM-33 Page 2 of 2

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description
	Run 5	55.0-65.0	98		
70					
	Run 6	65.0-75.0	98		
80					
					Gray, unweathered, fossiliferous CHALK
	Run 7	75.0-85.0	99		
90					
	Run 8	85.0-95.0	99		
100					
	Run 9	95.0-105.0	98		
110	Run 10	105.0-109.0	98		

Well Diagram / Comments



Coring terminated at 109.0' bgs

Notes (cont.)

5. **Recorded fracture dip is apparent dip.**
6. **Breaks in the core other than those noted above were drilling induced, often along shell planes or broken by the geologist during logging (approximately horizontal).**

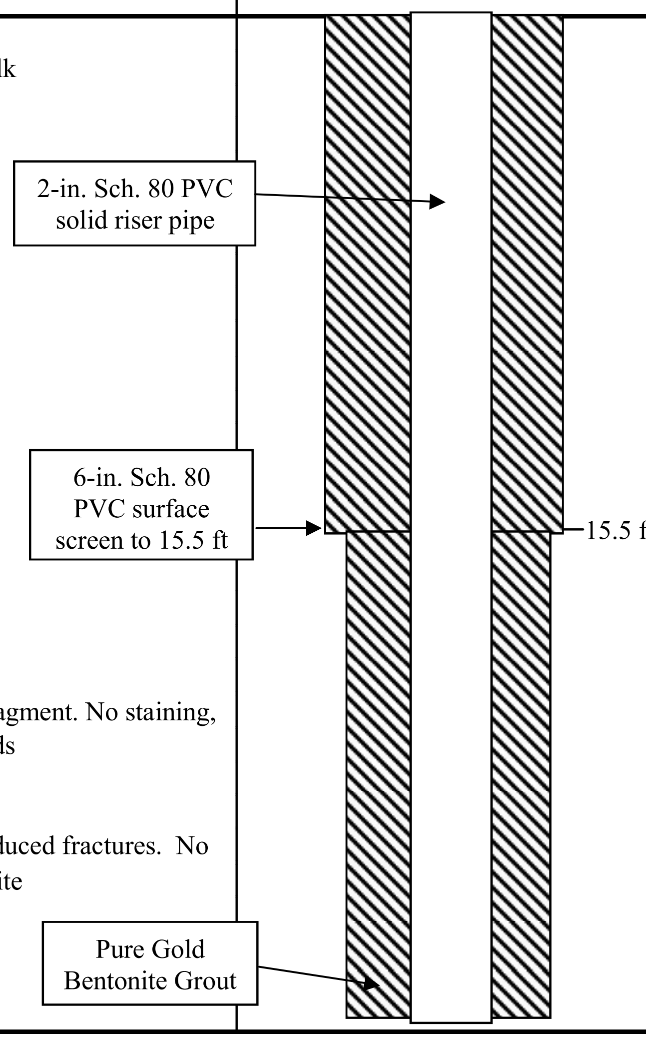
Boring Log

Project Name	CWM-Emelle SM-34	**Logger**	CHF	**Reviewer**	SBL
Boring No.	SM-34				
Project Number	01186035.01	**Weather**	Clear - Warm	**Sheet**	1 of 3
Drilling Company	QORE	**Temperature**	~75 degrees F	**Surface Elev.**	249.1 ft (note 3)
Drill Rig	CME 550	**Depth of Hole**	93.5 ft bgs	**Location**	North – 8988.06 East – 7307.31
Hammer Data	140-lb – 30 inches	**Hole Diam.**	5 5/8 inches		
Driller	Dan Bergman	**Drilling Mud**	N/A	**Started**	3 May 2005
Sampling Method	Split spoon / NQ3	**Disturbed Samples**	12	**Completed**	6 May 2005
Depth to Water	N/A (note 1)	**Time Water Meas.**	N/A (note 1)	**Undisturbed Samples**	None

Boring Diagram

	Depth (ft)		**Blow Count**	**N-Value**	**% Rec**	**Stratigraphic Description**
0						
	0	1.5	2-3-5	8	100	Orange-brown weathered chalk
	1.5	3	2-5-6	11	100	Grey-green weathered chalk
5	3	4.5	4-7-11	18	100	
	4.5	6	4-6-7	13	100	
	6	7.5	4-6-7	13	100	
	7.5	9	3-8-11	19	100	Light-brown weathered chalk
10						
	9	10.5	2-9-10	19	100	Dark-grey unweathered chalk
	10.5	12	6-14-16	30	100	
	12	13.5	6-16-24	40	100	
15	13.5	15	6-12-16	28	100	Dark-grey unweathered chalk
	15	16.5	8-12-16	28	100	
	16.5	18	8-14-13	27	100	Dark-grey unweathered chalk
			RUN 1	**RQD**		
20						Dark-grey fossiliferous chalk
						20.5 ft: fracture along shell fragment. No staining,
						Mineral infilling, or slickensids
25				6.22	100	25.5 ft and 26.3 ft: drilling induced fractures. No
			Run 2			Staining, slickensides, or calcite
30						

Well Diagram

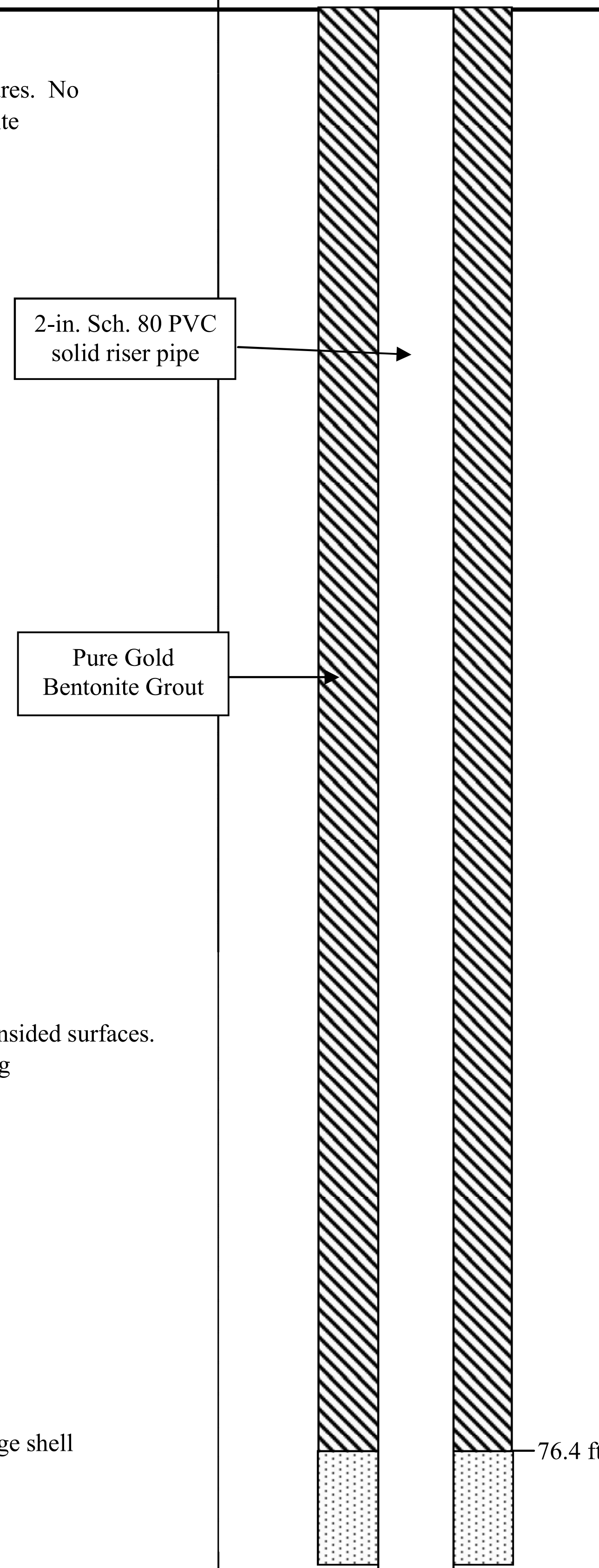


Notes:

1) Due to slow recovery in chalk, static water levels will be collected by CWM-Emelle staff during next sampling event.
2) Low recovery and RQD due to drilling problems. Core slipped out of barrel while pulling barrel. Attempts to recover core unsuccessful.
3) Ground Elevation = 249.1 ft MSL
   Top of PVC Casing Elevation = 252.26 ft MSL

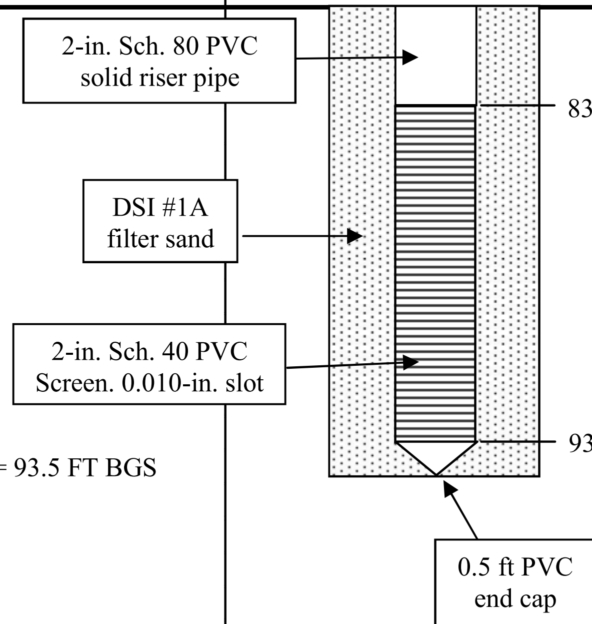
Depth (ft)	Sample Number	RQD	% Rec	Stratigraphic Description
30				
				33.1 ft: drilling induced fractures. No Staining, slickensides, or calcite
		10.3	100	
35	Run 3			
				Dark-grey fossiliferous chalk
40				
		10	100	
45	Run 4			
50				
		9.7	100	
55	Run 5			
		3.2	100	
		58.1 ft		
	Run 6			
60				
				63.0 ft: Tight fracture. Slickensided surfaces. No staining or mineral infilling
		6.8	99	
65	Run 7			
				Dark-grey fossiliferous chalk
70				
		5.9	77	See note 2
75	Run 8			76.0 ft: core broken along large shell
80				

Well Diagram



Depth (ft)	Sample Number	RQD	% Rec	Stratigraphic Description
80				
				Dark-grey fossiliferous chalk
		10	100	
85	Run 9			
				Dark-grey fossiliferous chalk
90				
		8.5	100	
		93.5 ft		BOTTOM OF BORING = 93.5 FT BGS
95				

Well Diagram



RECORD OF BOREHOLE SM-35

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: February 12, 2012 / 9:20:00 AM
DRILLING END: February 12, 2012 / 12:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,778

SHEET 1 of 3
GS ELEVATION: 256.6
TOC ELEVATION: 259.9

DEPTH (ft)	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 22.5 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}	0.0	1	DO	5-7-7-11	14	24/24	
				2	DO	8-7-11-13	18	24/24	
5				3	DO	6-5-3-6	8	24/24	
				4	DO	5-6-7-8	13	24/24	
				5	DO	3-5-5-6	10	24/24	
10				6	DO	3-5-3-7	8	24/24	
				7	DO	3-5-5-5	10	13/24	
15				8	DO	2-2-2-1	4	15/24	
				9	DO	2-2-5-7	7	24/24	
				10	DO	2-2-4-6	6	24/24	
20				11	DO	2-2-4-6	6	24/24	
		22.5 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.	234.1 22.5	12	DO	5-18-21-38	39	24/24	
25				13	DO	9-14-25-50/5"	39	24/24	
				14	DO	8-16-19-33	35	24/24	
				15	DO	5-13-18-24	31	24/24	
30	HQ Wire Line, Water Rotary	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	226.6 30.0						
35				1	RC			100	
40									
45				2	RC			100	
50									

PENETRATION RESISTANCE BLOWS / ft ■ — RQD (%) — WATER CONTENT (PERCENT) W_p ⊢—O—W—⊣ W_l (20, 40, 60, 80)

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-35

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: February 12, 2012 / 9:20:00 AM
DRILLING END: February 12, 2012 / 12:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,778

GS ELEVATION: 256.6
TOC ELEVATION: 259.9

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in (ASTM D1586, 140 lb hammer, 30 inch drop (Cathead))	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft; RQD (%); WATER CONTENT (PERCENT) Wp — W — Wl (20, 40, 60, 80)	NOTES WATER LEVELS
50	HQ Wire Line, Water Rotary	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*									
55					3	RC			100		
60		61.2 - 61.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.									
65					4	RC			100		
70											
75					5	RC			100		
80		83.2 - 83.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.									
85					6	RC			100		
90											
95					7	RC			100		
100											

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-35

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: February 12, 2012 / 9:20:00 AM
DRILLING END: February 12, 2012 / 12:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,778

GS ELEVATION: 256.6
TOC ELEVATION: 259.9

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp ⊢—O—⊣ Wl (20 40 60 80)	NOTES WATER LEVELS
100		30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*			8	RC			100		
105				150.6							
		Drilling terminated at 106 ft. BGS									
110											
115											
120											
125											
130											
135											
140											
145											
150											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

WELL SM-35

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	February 12, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	256.6 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	259.89 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface 0.0 - 22.5 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}		For material quantities see Tables 1,1A.
15		(0' to 86' bgs) Pure Gold Portand cement grout	
22.5	22.5 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		DEVELOPMENT NOTES For well development details see Table 3.
30	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		
40			

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

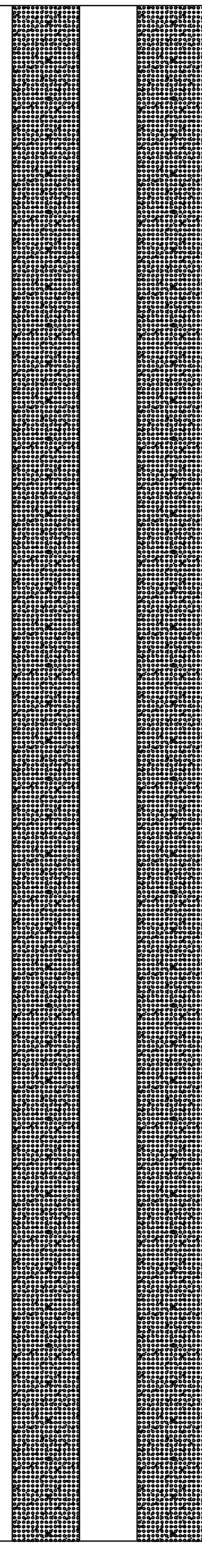
WELL SM-35

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** February 12, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
45			
50			
55			
60	61.2 - 61.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		
65			**DEVELOPMENT NOTES** For well development details see Table 3.
70			
75			
80			
85	83.2 - 83.8 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		

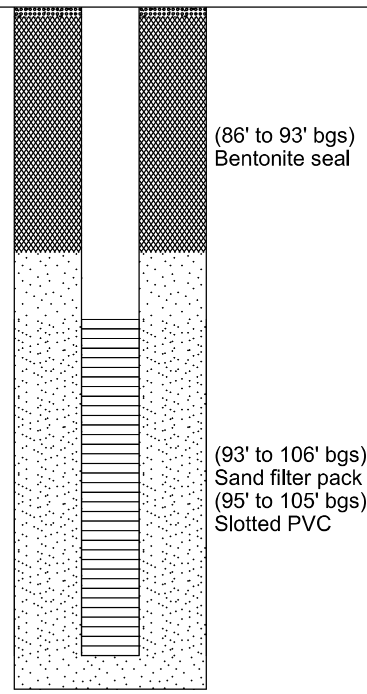
WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** February 12, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	30.0 - 106.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
90			
95			
100			
105			
	Bottom of borehole at 106.0 feet.		
110			
115			DEVELOPMENT NOTES For well development details see Table 3.
120			
125			
130			



RECORD OF BOREHOLE SM-35B

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: April 24, 2012 / 10:00:00 AM
DRILLING END: April 24, 2012 / 4:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,783

GS ELEVATION: 256.6
TOC ELEVATION: 259.8

SOIL PROFILE

DEPTH (ft)	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)
0.0 - 22.0	Hollow Stem Auger	Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}	0.0
22.0 - 30.0	Hollow Stem Auger	Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.	234.6 / 22.0
30.0 - 88.8	HQ Wire Line, Water Rotary	Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	226.6 / 30.0

SAMPLE / RUN

NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)
1	DO	3-3-4-5	7	22/24
2	DO	2-4-5-7	9	17/24
3	DO	5-4-5-5	9	24/24
4	DO	3-3-5-7	8	24/24
5	DO	2-1-3-4	4	19/24
6	DO	2-3-5-7	8	24/24
7	DO	2-2-4-5	6	20/24
8	DO	2-3-3-5	6	24/24
9	DO	3-3-5-6	8	22/24
10	DO	2-3-4-5	7	23/24
11	DO	2-4-9-19	13	24/24
12	DO	5-15-23-26	38	24/24
13	DO	4-15-25-50/5"	40	24/24
14	DO	10-16-20-40	36	24/24
15	DO	7-15-23-44	38	24/24
1	RC			100
2	RC			100
3	RC			100

PENETRATION RESISTANCE BLOWS / ft ■
RQD (%)
WATER CONTENT (PERCENT) W_p — W — W_l
20 40 60 80

NOTES
WATER LEVELS

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-35B

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: April 24, 2012 / 10:00:00 AM
DRILLING END: April 24, 2012 / 4:00:00 PM
DRILL RIG: CME 75

COORDS: N: 8,938
E: 6,783

GS ELEVATION: 256.6
TOC ELEVATION: 259.8

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) W_p — O — W_l 20 40 60 80	NOTES WATER LEVELS
50	HQ Wire Line, Water Rotary	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*		3	RC			100		
55										
60		60.0 - 60.5 Slickensided (K), Polished (P), discontinuity at a 50 degree angle with respect to the core axis.		4	RC			100		
65										
70				5	RC			100		
75										
80				6	RC			100		
85		85.6 - 86.2 Slickensided (K), Polished (P), discontinuity at a 55 degree angle with respect to the core axis.	167.8							
90		Drilling terminated at 88.8 ft. BGS								
95										
100										

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

WELL SM-35B

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	April 24, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	256.6 ft MSL	**GROUT TYPE/QUANTITY**	Aquagard / See Tables 1,1A
TOP OF CASING	259.78 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	Ground Surface		
0	0.0 - 22.0 Firm, dry, gray, CLAY, [Fill], {Compacted Chalk}		For material quantities see Tables 1,1A.
15		(0' to 43' bgs) Aquagard Portand cement grout	
22	22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		**DEVELOPMENT NOTES** For well development details see Table 3.
30	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		
40			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL SM-35B

Golder Associates

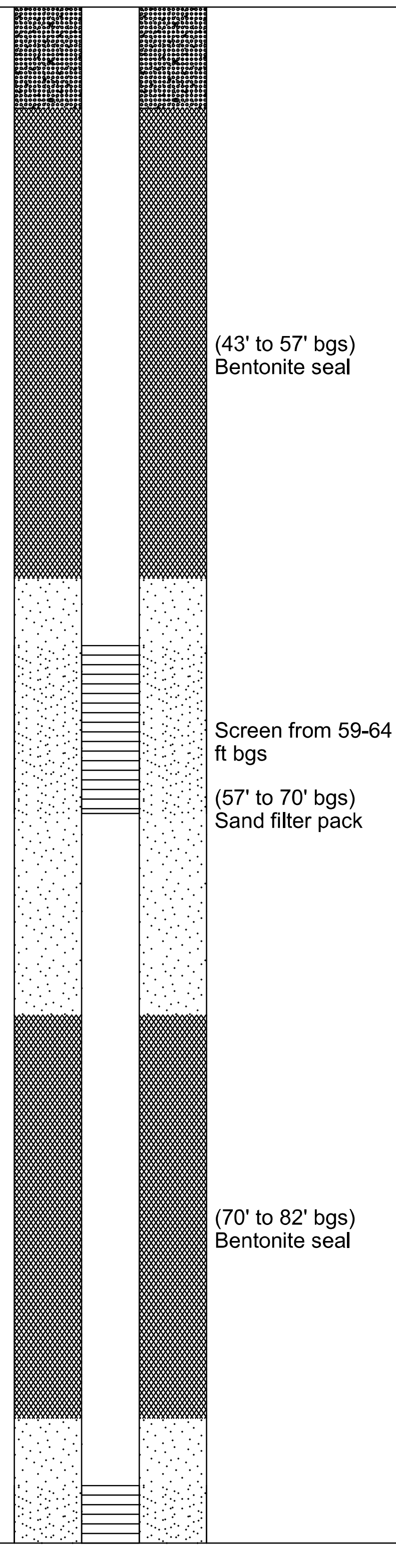
PROJECT NUMBER 11390080 **DATE STARTED** April 24, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
60	60.0 - 60.5 Slickensided (K), Polished (P), discontinuity at a 50 degree angle with respect to the core axis.		

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75, 80, 85



DEVELOPMENT NOTES

For well development details see Table 3.

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

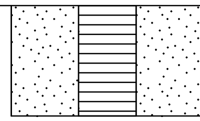
WELL SM-35B

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** April 24, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	30.0 - 88.8 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)* 85.6 - 86.2 Slickensided (K), Polished (P), discontinuity at a 55 degree angle with respect to the core axis. *(continued)*	 (82' to 89' bgs) Sand filter pack Screen from 84-89 ft bgs	For material quantities see Tables 1,1A.
90	Bottom of borehole at 88.8 feet.		
95			
100			
105			
110			
115			
120			
125			
130			

DEVELOPMENT NOTES

For well development details see Table 3.

RECORD OF BOREHOLE SM-36

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 12, 2012 / 3:45:00 PM
DRILLING END: January 12, 2012 / 3:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,847
E: 7,519

GS ELEVATION: 192.4
TOC ELEVATION: 195.1

DEPTH (ft)	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	NOTES WATER LEVELS
0	Hollow Stem Auger / Water Rotary	0.0 - 10.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]	0.0	1	DO	2-4-7-19	11	18/24	
				2	DO	23-30-50/4"	100	16/16	
5				3	DO	14-18-25-35	43	24/24	
				4	DO	7-16-18-32	34	24/24	
			182.4	5	DO	2-6-14-18	20	24/24	
10		10.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.	10.0	6	DO	9-16-24-50/2"	25	20/20	
				7	DO	4-8-24-24	32	24/24	
15				8	DO	3-17-23-39	40	24/24	
				9	DO	11-20-30-50/2'	50	24/24	
				10	DO	12-26-43-50/3'	69	24/24	
20				11	DO	7-24-28-50/4"	53	22/22	
				12	DO	9-23-30-50/5"	53	23/23	
25				13	DO	6-29-34-50/4"	63	23/23	
				14	DO	12-29-43-50/2'	72	20/20	
			162.4	15	DO	11-28-40-50/2'	67	20/20	
30	HQ Wire Line, Water Rotary	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	30.0						
35				1	RC			100	
40									
45				2	RC			100	
50				3	RC			100	

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-36

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 12, 2012 / 3:45:00 PM
DRILLING END: January 12, 2012 / 3:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,847
E: 7,519

GS ELEVATION: 192.4
TOC ELEVATION: 195.1

DEPTH (ft)	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) / CORE REC (%)	RQD (%)	NOTES WATER LEVELS
50	HQ Wire Line, Water Rotary	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*								
55				3	RC			100		
60				4	RC			100		
65										
70										
75		74.0 - 74.4 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		5	RC			100		
		75.3 - 75.7 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.								
80										
85				6	RC			100		
87.3		Drilling terminated at 87.3 ft. BGS	105.1							
90										
95										
100										

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

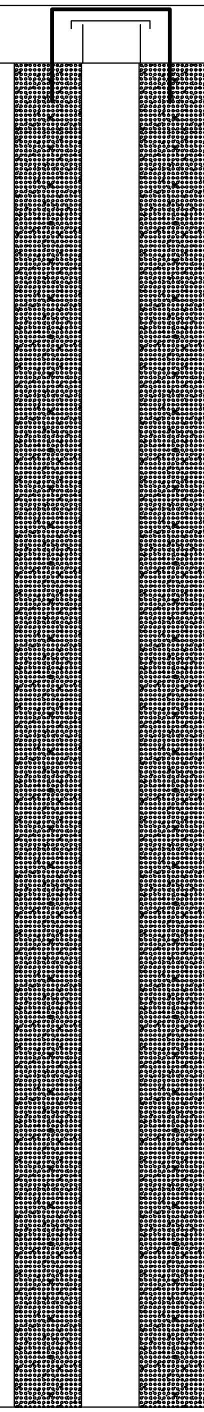
Golder Associates

WELL SM-36

PROJECT NUMBER	11390080	**DATE STARTED**	January 12, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	192.4 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	195.08 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	INSTALLATION NOTES
0	Ground Surface 0.0 - 10.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]	For material quantities see Tables 1,1A.
10	10.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.	
30	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	

WELL DIAGRAM



(0' - 66' bgs) pure gold cement bentonite grout

DEVELOPMENT NOTES

For well development details see Table 3.

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL SM-36

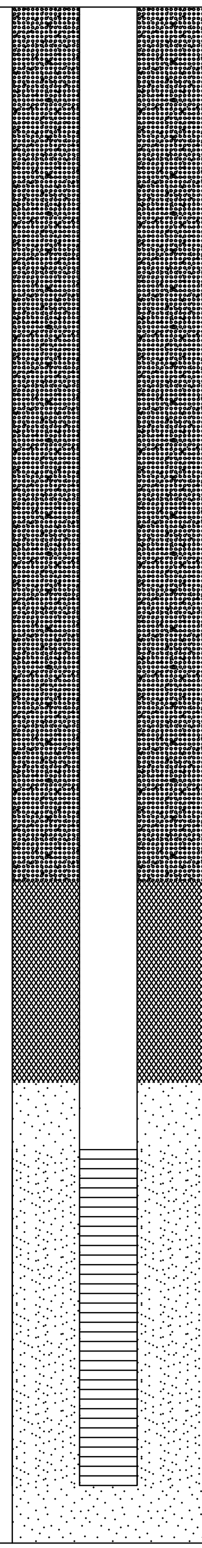
Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** January 12, 2012

PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.0 - 87.3 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
45			
50			
55			
60			
65			
70			**DEVELOPMENT NOTES** For well development details see Table 3.
75	74.0 - 74.4 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis. 75.3 - 75.7 Slickensided (K), Polished (P), discontinuity at a 65 degree angle with respect to the core axis.		
80			
85			



WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL SM-36

Golder Associates

PROJECT NUMBER 11390080
DATE STARTED January 12, 2012
PROJECT NAME Chemical Waste Management
BOREHOLE DIAMETER 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	Bottom of borehole at 87.3 feet.		For material quantities see Tables 1,1A.
90			
95			
100			
105			
110			
			DEVELOPMENT NOTES
115			For well development details see Table 3.
120			
125			
130			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-37

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,121
E: 7,674

GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC / ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp —o— Wl (20, 40, 60, 80)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 5.0 Stiff, moist, gray tan, CLAY, trace medium to coarse sand, trace fine gravel (rock fragments). [Soft Weathered Chalk] {FILL}	0.0	1	DO	WH-2-4-10	6	18/24		
				2	DO	29-30-49-50/5"	79	24/24		
5		5.0 - 22.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]	189.9 / 5.0	3	DO	5-19-17-50	36	24/24		
				4	DO	12-30-45-50/3"	75	24/24		
				5	DO	12-37-27-50/3"	64	24/24		
10				6	DO	10-12-23-50/4"	35	24/24		
				7	DO	4-38-48-50/4"	86	24/24		
15				8	DO	6-20-30-50/3"	50	24/24		
				9	DO	9-21-28-50/4"	49	24/24		
				10	DO	7-23-31-50/3"	54	24/24		
20			172.9	11	DO	4-16-25-50/5"	41	24/24		
		22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		12	DO	14-28-43-50/3"	71	24/24		
25				13	DO	7-27-38-50/3"	65	24/24		
				14	DO	8-26-46-50/2"	72	24/24		
			164.9	15	DO	7-24-48-50/3"	72	24/24		
30	HQ Wireline, Air Rotary	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	30.4							
35				1	RC			100		
40										
45				2	RC			100		
50				3	RC			100		

Log continued on next page

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

RECORD OF BOREHOLE SM-37

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama
DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75
COORDS: N: 14,121 E: 7,674
GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) / CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp ⊢—O—⊣ Wl 20 40 60 80	NOTES WATER LEVELS
50	HQ Wireline, Air Rotary	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*									
55					3	RC			100		
60											
65					4	RC			100		
70		70.8 - 71.2 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.									
		71.3 - 71.7 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.									
75		73.3 - 73.7 Calcite fused discontinuity at a 15 degree angle with respect to the core axis. Only apparent when mechanically broken.			5	RC			100		
80											
		83.0 - 83.4 Calcite fused discontinuity at a 18 degree angle with respect to the core axis. Only apparent when mechanically broken.									
85		83.8 - 84.2 Calcite fused discontinuity at a 30 degree angle with respect to the core axis. Only apparent when mechanically broken.			6	RC			100		
90											
95					7	RC			100		
100											

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee
LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-37

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,121
E: 7,674

GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) W_p — W_l (20 40 60 80)	NOTES WATER LEVELS
100	HQ Wireline, Air Rotary	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*			8	RC			100		
105					8	RC			100		
115					9	RC			100		
120					10	RC			100		
125					11	RC			99		
135					12	RC			100		
145					13	RC			100		
150					14	RC			100		

Log continued on next page

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE SM-37

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 9, 2012 / 10:25:00 AM
DRILLING END: January 9, 2012 / 2:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,121
E: 7,674

SHEET 4 of 4
GS ELEVATION: 194.9
TOC ELEVATION: 198.1

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT) Wp ⊢—○—⊣ Wl 20 40 60 80	NOTES WATER LEVELS
150		30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(Continued)*		41.3	14	RC			100		
155		Drilling terminated at 156 ft. BGS									
160											
165											
170											
175											
180											
185											
190											
195											
200											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

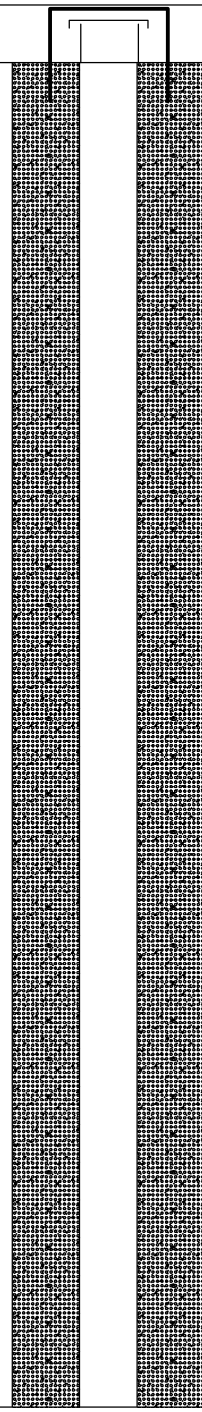
Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL SM-37

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	January 9, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	194.9 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	198.08 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface		
0–5	0.0 - 5.0 Stiff, moist, gray tan, CLAY, trace medium to coarse sand, trace fine gravel (rock fragments). [Soft Weathered Chalk] {FILL}		For material quantities see Tables 1,1A.
5–22	5.0 - 22.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		
22–30	22.0 - 30.0 Fresh, massive - mottled, gray, very weak CHALK [SELMA CHALK], fossiliferous.		**DEVELOPMENT NOTES** For well development details see Table 3.
30–40	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

PROJECT NUMBER 11390080 **DATE STARTED** January 9, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

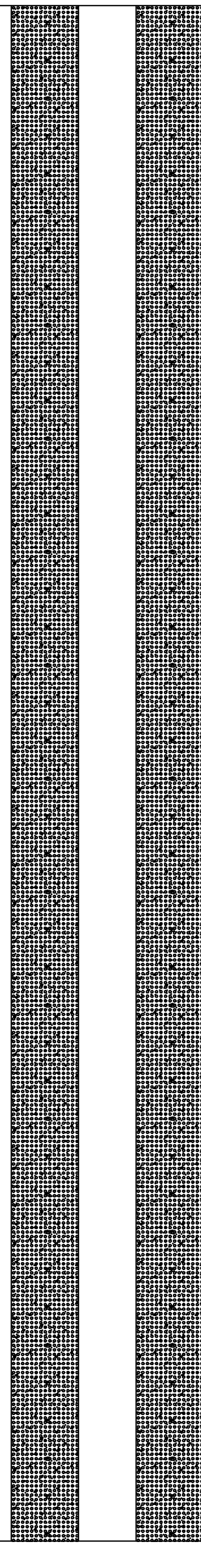
Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
40	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
45			
50			
55			
60			
65			DEVELOPMENT NOTES For well development details see Table 3.
70	70.8 - 71.2 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken. 71.3 - 71.7 Calcite fused discontinuity at a 65 degree angle with respect to the core axis. Only apparent when mechanically broken.		
75	73.3 - 73.7 Calcite fused discontinuity at a 15 degree angle with respect to the core axis. Only apparent when mechanically broken.	(0-140.5' bgs) Pure Gold cement bentonite grout	
80			
85	83.0 - 83.4 Calcite fused discontinuity at a 18 degree angle with respect to the core axis. Only apparent when mechanically broken.		

Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** January 9, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	83.8 - 84.2 Calcite fused discontinuity at a 30 degree angle with respect to the core axis. Only apparent when mechanically broken.		For material quantities see Tables 1,1A.
90	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		
95			
100			
105			
110			
115			**DEVELOPMENT NOTES** For well development details see Table 3.
120			
125			
130			

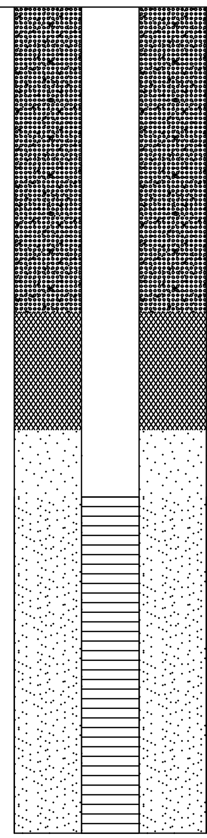


Golder Associates

PROJECT NUMBER 11390080 **DATE STARTED** January 9, 2012
PROJECT NAME Chemical Waste Management **BOREHOLE DIAMETER** 10.25 inches

Continued from Previous Page

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
135	30.4 - 153.6 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous. *(continued)*		For material quantities see Tables 1,1A.
140			
145			
150			
155	Bottom of borehole at 156.0 feet.		
160			DEVELOPMENT NOTES For well development details see Table 3.
165			
170			
175			



WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE CMI-1

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama

DRILLING START: January 16, 2012 / 4:15:00 PM
DRILLING END: January 16, 2012 / 4:00:00 PM
DRILL RIG: CME 75

COORDS: N: 14,420
E: 5,222

GS ELEVATION: 194.4
TOC ELEVATION: 197.8

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE / RUN: NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC / ATT (inch), CORE REC (%)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 18.0 Firm, moist, dark gray and tan, mottled, CLAY, trace fine to medium sand.	0.0	1	D.O.	1-1-3-5	4	16.8/24	
				2	D.O.	3-6-8-10	14	21.6/24	
5				3	D.O.	2-2-4-7	6	21.6/24	
				4	D.O.	2-4-4-6	8	24/24	
				5	D.O.	3-3-6-7	9	24/24	
10				6	D.O.	2-3-4-5	7	24/24	
				7	D.O.	1-2-4-4	6	21.6/24	
15				8	D.O.	2-3-3-3	6	15.6/24	
			176.4	9	D.O.	1-2-2-3	4	22.8/24	
		18.0 - 36.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]	18.0	10	D.O.	WH-3-4-5	7	21.6/24	
20				11	D.O.	2-4-6-8	10	24/24	
				12	D.O.	1-2-2-3	4	24/24	
25				13	D.O.	1-1-5-8	6	24/24	
				14	D.O.	4-4-7-10	11	24/24	
				15	D.O.	3-4-6-8	10	24/24	
30				16	D.O.	3-5-7-8	12	24/24	
				17	D.O.	3-5-7-8	12	24/24	
35			158.4	18	D.O.	2-4-5-6	9	19.2/24	
		36.0 - 40.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.	36.0	19	D.O.	1-19-36-48	55	24/24	
			154.4	20	D.O.	13-30-50/3"	80	15/15	
40		Drilling terminated at 40 ft. BGS							
45									
50									

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee

LOGGED: MJS
CHECKED: TPC

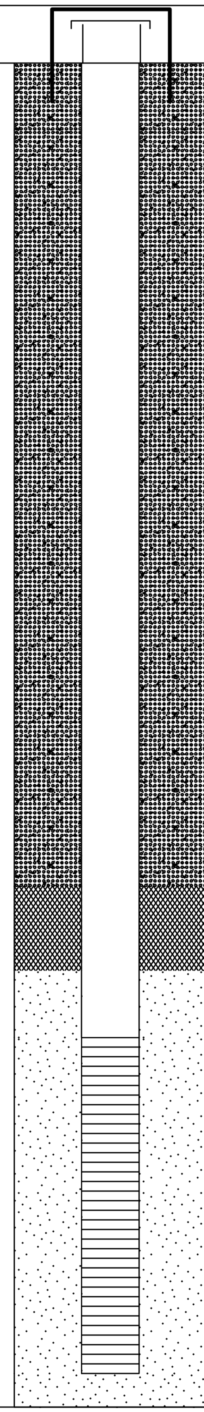
Golder Associates

WELL CMI-1

Golder Associates

PROJECT NUMBER	11390080	DATE STARTED	January 16, 2012
PROJECT NAME	Chemical Waste Management	BOREHOLE DIAMETER	10.25 inches
LOCATION	Emelle, Alabama	CASING TYPE/DIAMETER	PVC / 2""
DRILLING METHOD	HSA	SCREEN TYPE/SLOT	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	FILTER PACK TYPE /QUANTITY	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	194.4 ft MSL	GROUT TYPE/QUANTITY	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	197.77 ft MSL	DEPTH TO WATER	No Stable Water Level Recorded
LOGGED BY	MJS	GROUND WATER ELEVATION	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
0	Ground Surface		
0	0.0 - 18.0 Firm, moist, dark gray and tan, mottled, CLAY, trace fine to medium sand.		For material quantities see Tables 1,1A.
18	18.0 - 36.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]		
36	36.0 - 40.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		



DEVELOPMENT NOTES

For well development details see Table 3.

Bottom of borehole at 40.0 feet.

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

RECORD OF BOREHOLE CMI-2

SHEET 1 of 1

PROJECT: Chemical Waste Management
PROJECT NUMBER: 11390080
LOCATION: Emelle, Alabama
DRILLING START: January 18, 2012 / 8:20:00 AM
DRILLING END: January 18, 2012 / 1:00:00 PM
DRILL RIG: CME 75
COORDS: N: 14,560 E: 6,829
GS ELEVATION: 173.8
TOC ELEVATION: 176.8

DEPTH (ft)	BORING METHOD	DESCRIPTION	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in ASTM D1586 140 lb hammer 30 inch drop (Cathead)	SPT N (bpf) (uncorr)	REC/ATT (inch) CORE REC (%)	PENETRATION RESISTANCE BLOWS / ft ■ / RQD (%) / WATER CONTENT (PERCENT)	NOTES WATER LEVELS
0	Hollow Stem Auger	0.0 - 8.0 Soft, tan-gray mottled, silty CLAY, trace fine to medium sand. No odor. Moist [Weathered Chalk].		0.0	1	D.O.	1-3-4-2	7	21/24		
					2	D.O.	2-3-4-7	7	24/24		
5					3	D.O.	3-4-7-7	11	21/24		
				165.8	4	D.O.	2-2-4-4	6	12/24		
		8.0 - 18.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		8.0	5	D.O.	8-20-22-18	42	21/24		
10					6	D.O.	5-8-9-13	17	24/24		
					7	D.O.	10-29-25-50/3'	54	24/24		
15					8	D.O.	16-35-47-50/4'	82	24/24		
				155.8	9	D.O.	9-25-33-50/4"	58	24/24		
		Drilling terminated at 18 ft. BGS									
20											
25											
30											
35											
40											
45											
50											

DRILLING CONTRACTOR: Technical Drilling Services
DRILLER: Curtis Lee
LOGGED: MJS
CHECKED: TPC

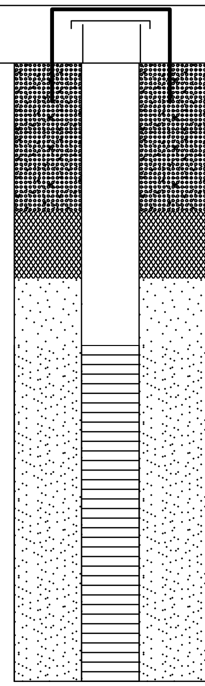
Golder Associates

BOREHOLE AND CORING LOG - JUNE 2007 EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL CMI-2

Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	January 18, 2012
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2""
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40 / 0.01 mils
SAMPLING METHOD	Split-Spoon Sampler / HQ Wire-line	**FILTER PACK TYPE /QUANTITY**	Filter Sil Sand / See Tables 1,1A
GROUND ELEVATION	173.8 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / See Tables 1,1A
TOP OF CASING	176.75 ft MSL	**DEPTH TO WATER**	No Stable Water Level Recorded
LOGGED BY	MJS	**GROUND WATER ELEVATION**	"No Stable Water Level Recorded"
REMARKS			

Depth	LITHOLOGIC DESCRIPTION	WELL DIAGRAM	INSTALLATION NOTES
	Ground Surface		
0	0.0 - 8.0 Soft, tan-gray mottled, silty CLAY, trace fine to medium sand. No odor. Moist [Weathered Chalk].		For material quantities see Tables 1,1A.
5			
	8.0 - 18.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.		
10			
15			
	Bottom of borehole at 18.0 feet.		
20			
25			**DEVELOPMENT NOTES** For well development details see Table 3.
30			
35			
40			

WELL INSTALLATION EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 5/29/12

WELL CMI-3

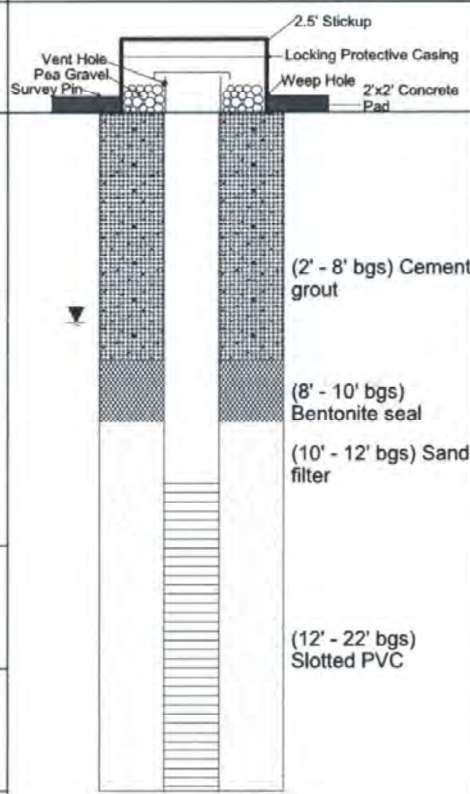
Golder Associates

PROJECT NUMBER	11390080	**DATE STARTED**	June 26, 2013
PROJECT NAME	Chemical Waste Management	**BOREHOLE DIAMETER**	10.25 inches
LOCATION	Emelle, Alabama	**CASING TYPE/DIAMETER**	PVC / 2"
DRILLING METHOD	HSA	**SCREEN TYPE/SLOT**	#10 Slot Schedule 40
SAMPLING METHOD	Split-Spoon Sampler	**FILTER PACK TYPE /QUANTITY**	DSI Filter Sand / 5.5 cubic feet
GROUND ELEVATION	173.96 ft MSL	**GROUT TYPE/QUANTITY**	Pure Gold cement bentonite / 3 cubic feet
TOP OF CASING	176.41 ft MSL	**DEPTH TO WATER**	6.81 ft BTOC
LOGGED BY	MJS	**GROUND WATER ELEVATION**	169.60 ft MSL
REMARKS			

Depth	LITHOLOGIC DESCRIPTION
0	Ground Surface
0	0.0 - 14.0 Firm, moist, dark gray and tan, mottled, CLAY, trace fine to medium sand.
14	14.0 - 18.0 Stiff, moist, gray and tan, CLAY, trace fine to coarse sand. [Weathered Chalk]
18	18.0 - 22.0 Fresh, massive - mottled, gray, weak to very weak CHALK [SELMA CHALK], fossiliferous.
22	Bottom of borehole at 22.0 feet.

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

WELL DIAGRAM



INSTALLATION NOTES

Well installed following drilling on 6/27/2013. Well constructed with schedule 2" diameter 40 PVC screen and riser. DSI filter sand to 2' above screen. 1 bag pelletized bentonite installed 2' above sand and hydrated. Cement-bentonite grout tremied to two feet below ground surface. Well completed with 2x2' concrete pad and locking protective casing. Three protective bollards were placed around the well.

DEVELOPMENT NOTES

CMI-3 developed on 6/28/2013 after grout dried. Depth to water prior to development was 6.81 feet below top of casing. Total well depth prior to development was 22.0 feet below top of casing. Approximately 180 gallons were removed during development. Final turbidity was 17.0 NTU.

JENN'S LOG EMELLE_WELL_LOGS.GPJ GINT PLOG_03_2010.GDT 7/22/13

APPENDIX E-2-1

DESCRIPTION OF INTERIM STATUS GROUNDWATER MONITORING WELLS EMELLE FACILITY

Well 1	Located on private property east of the intersection of Highway 17 and 116. A free-flowing artesian well reportedly drilled 940 feet below land surface prior to October 1964. Depth of screening and other construction details are unknown.
Well 2	Located east of office-laboratory building. Drilled 1,085 feet below land surface during first quarter, 1978. Well is cased with PVC pipe for upper 25 feet, with annular space sealed with cement. Well is uncased below 25 feet.
Well 3	Located approximately 3,700 feet south of the office building and west of Highway 17. The well was reportedly drilled to a depth of 670 feet below ground surface in 1960. No record of construction is available.
Well 4	Located approximately 3,900 feet west of Well 3. A free-flowing artesian well drilled approximately 700 feet below land surface in 1960. No record of construction is available.

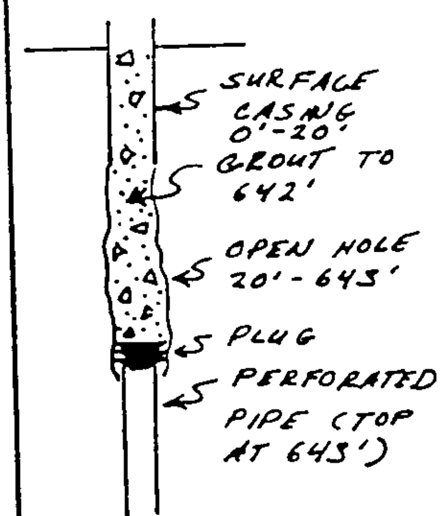
WELL SEALING FORM

PROJECT: CWM/RCRA WELLS/EMELLE
WELL: RCRA 4
JOB NUMBER: 853-3107
DATE: 9-18-85
GOLDER INSPECTOR: AES
GROUTER: GRAVES/HALLIBURTON

WELL INFORMATION

DESIGNED WELL DEPTH: UNKNOWN ft.
MEASURED DEPTH (H): SEE NOTES ft.
DEPTH TO WATER: FLOWING
CASING STICKUP: 0 ft.
CASING TYPE: SEE NOTES
INSIDE CASING DIA. (D): 4" in.

GROUT VOLUME



COMPUTED VOLUME

REQUIRED VOLUME = $\frac{D^2 \text{ (in.)} \times H \text{ (ft.)}}{183.4}$ = — ft.^{3}

ACTUAL VOLUME

BAGS OF CEMENT: 37.5
~~BAGS OF~~ BENTONITE: 150 #
GALLONS OF WATER: 430
GROUT VOLUME: 84 ft.^{3}
GROUT SETTLEMENT: 0 in.
ADDED GROUT VOLUME: — ft.^{3}
FLY ASH: 37.5 ft^3
CALCIUM CHLORIDE: 150 #

COMMENTS

The well was constructed with 4" surface casing to about 20', open hole through the Selma Group, and perforated pipe in the Eutaw Aquifer. The top of the perforated pipe was at 643'; the screened interval and total depth of the well are unknown. Set a top-hole plug at 642' before grouting.

Golder Associates

New Page
February 24, 1986

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 5 Date Installed: reworked 9-13-85

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/Water Rotary Total Depth: 937' Boring Dia: 6"/4"

Ground El.: 211 Standpipe El.: 211.63

Casing: Diameter: 4" Length: 672 Material: steel

Screen: Diameter: 2" Length: 41' Slot Size: 0.008"

Water Level: Initial: ---- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: This well has been reworked and the open interval below the screen grouted. The well is not suitable for water quality assessment.

Description of Screened Interval

From*	To*	Soil Description
691	732	Tombigbee Sand Member, Eutaw Formation. See drillers log for detailed description of strata.
		*See drawing 107 for well completion details

*Values are: x depth from ground surface or ____ elevation msl.

New Page
February 24, 1986

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 6 Date Installed: 5-24-83

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/Water Rotary Total Depth: 650 Boring Dia: 6"/4"

Ground El.: 164 Standpipe El.: 162.94

Casing: Diameter: 4" Length: 650 Material: steel

Screen: Diameter: 2" Length: 40' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Downgradient well

Description of Screened Interval

From*	To*	Soil Description
606	646	Tombigbee Sand Member, Eutaw Formation. See drillers log for detailed description of strata.
		*See Drawing 107 for well completion details

*Values are: x depth from ground surface or ____ elevation msl.

New Page
February 24, 1986

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 7 Date Installed: 5-30-83

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/Water Rotary Total Depth: 708 Boring Dia: 6"/4"

Ground El.: 206 Standpipe El.: 207.62

Casing: Diameter: 4" Length: ______ Material: steel

Screen: Diameter: 2" Length: 40' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Downgradient well

Description of Screened Interval

From*	To*	Soil Description
682	722	Tombigbee Sand Member, Eutaw Formation. See drillers log for detailed description of strata.
		*See drawing 107 for well completion details

*Values are: x depth from ground surface or ______ elevation msl.

New Page
February 24, 1986

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 8 Date Installed: 5-13-83

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/water Rotary Total Depth: 692 Boring Dia: 6"/4"

Ground El.: 131 Standpipe El.: 140.93

Casing: Diameter: 4" Length: ____ Material: ____

Screen: Diameter: 2" Length: 40' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Upgradient well

Description of Screened Interval

From*	To*	Soil Description
668	708	Tombigbee Sand Member, Eutaw Formation. See Driller's log for detailed description of strata.
		*See Drawing 107 for well completion details

*Values are: x depth from ground surface or ____ elevation msl.

New Page
February 24, 1996

MONITORING WELL INFORMATION FORM

Site: Emelle Facility, Sumter County, Alabama

Well Number: RCRA 9 Date Installed: 10-15-85

Location: See Drawing 00-150-21

Drilling Co./Driller: Graves Well Drilling

Supervising Co.: Golder Associates Log By: Driller

Drilling Method: Air/water Rotary Total Depth: 725' Boring Dia: 6"/4"

Ground El.: 209 Standpipe El.: 211.37

Casing: Diameter: 4" Length: 673' Material: steel

Screen: Diameter: 2" Length: 41' Slot Size: 0.008"

Water Level: Initial: --- 24-hour: --- Other: ---

(Water levels are: --- depth from ground surface or --- elevation msl)

Comments: Downgradient well

Description of Screened Interval

From*	To*	Soil Description
684	725	Tombigbee Sand Member, Etuaw Formation. See Driller's log for detailed description of strata.

*Values are: x depth from ground surface or ____ elevation msl.

New Page
February 24, 1986

Boring Log

Project Name	CWM-Emelle	**Inspector**	H. Caudill / K. Fleck	**Boring No.**	RCRA-10
Project Number	1186 - 010	**Weather**	Variable - Rainy to Clear, 40-65°F	**Sheet** 1	**of** 4 (Plus 3A & 3b)
Drilling Company	Layne Christensen	**Drill Bit**	8-inch roller cone	**Surface Elev.**	237.56 feet
Drill Rig	Schramm	**Depth Hole**	725 feet	**Datum**	MSL (Top of Concrete)
Wt Hammer NA	**Drop** NA	**Hole Diam.**	8-inch	**Started**	1/3/98
Driller	James Bull	**Drilling Mud**	NA	**Completed**	1/20/98
Sampling Method	NQ-Size Core	**Coring Interval**	350 - 431 feet BGS		Boring abandoned 3/98
Depth W.L.	--	**Time W.L.**	--	**Date W.L.**	--

Boring Log

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
Ground Surface						
					Yellow Brown Weathered CHALK	
20					Blue Gray Unweathered CHALK	
40						
60						
80						
100						
120						
140						

Notes:

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
160						
180						
200						
220						
240						
260						
280						
300						
320						
340						

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK	
				350'	See Attached Coring Log Sheets 3A and 3B	
360						
380						
400						
420						
				431'	Blue Gray Unweathered CHALK (Continued)	
440						
460						
480						
500						
520						
540						

Depth (ft)	Sample No.	% Rec	% RQD	Frac. Log	Lithologic Description	Comments
	Run 1	94	100		Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Occasional Pyrite Nodules	
355						
360						
	Run 2	100	100			
365						
	Run 3	64	100			
370						
	Run 4	90	100	f-372.2' (ss, 66°)		
380						
	Run 5	112	100			
386						
	Run 6	88	100			
395						
	Run 7	98	100			

Coring Log Boring No.					Page 3B of 4 RCRA-10	
Depth (ft)	**Sample No.**	**% Rec**	**% RQD**	**Frac. Log**	**Lithologic Description**	**Comments**
	Run 7 (cont)	98	100		Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Occasional Pyrite Nodules	
403						
	Run 8	93	100			
					Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Black Sand "Peppered Appearance"	
410						
	Run 9	96	100			
					White to Light Gray, Dense LIMESTONE with Washed Layers of Higher Clay Content	
415						
	Run 10	127	100	f-416' (ss, 60°)	Gray, Fossiliferous CHALK	
					White to Pale Gray LIMESTONE (<2")	
					Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Black Sand, "Peppered Appearance"	
421						
	Run 11	104	100		Blue Gray to Gray, Unweathered, Fossiliferous CHALK	
431						

End of Coring Interval

Depth (ft)	Sample No.	Blows / Foot	% Rec		Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
560						
580						
600						
620						
640						
660						
				668'	Green, Fine Sandy Clay Grading to Clayey Fine SAND (Salt and Pepper)	
680				677'	Rock Seam, Hard Green Clayey Fine SAND ("Peppered Appearance")	
				682'	Green, Medium SAND with Clay (Loose to Tight) (Salt and Pepper Appearance)	
700						
725					Hard Gray Chalk	

Boring Terminated at 725 feet BGS

Boring Log

Project Name	CWM-Emelle	**Inspector**	H. Caudill / K. Fleck	**Boring No.**	RCRA-10R
Project Number	1186 - 010	**Weather**	Variable - Cloudy to Clear, 40-80F	**Sheet**	1 **of** 4 (plus 3A)
Drilling Company	Layne Christensen	**Drill Bit**	8-inch wing bit	**Surface Elev.**	Approx. 229.8 feet
Drill Rig	Schramm	**Depth Hole**	725.0	**Datum**	MSL
Wt Hammer NA **Drop** NA		**Hole Diam.**	8-inch	**Started**	3/16/98
Driller	Rick Bilgry	**Drilling Mud**	NA	**Completed**	Boring completed 3/22/98
Sampling Method	NQ-Size Core	**Coring Interval**	380 - 430 feet BGS		
Depth W.L.	--	**Time W.L.**	--	**Date W.L.**	--

Boring Log

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Ground Surface	
					Tan Brown Weathered CHALK	
					Blue Gray Unweathered CHALK	
20						
40						
60						
80						
100						
120						
140						

Notes:

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
160						
180						
200						
220						
240						
260						
280						
300						
320						
340						

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
360					Blue Gray Unweathered CHALK (Continued)	
380				380'		
400					See Attached Coring Log Sheet 3A	
420				430'		
440						
460						
480						
500						
520						
540						

Depth (ft)	Run No.	% Rec	% RQD	Frac. Log	Lithologic Description	Comments
380	Run 1	90	90		Blue Gray to Gray, Unweathered Fossiliferous CHALK with Occasional Pyrite Nodules	
390	Run 2	100	100			
400	Run 3	100	100		Blue Gray to Gray CHALK with some Shell Fragments and Black Sand "Peppered Appearance"	
					White to Light Gray, Dense LIMESTONE	
					Blue Gray to Gray CHALK with some Shell Fragments and Black Sand "Peppered Appearance"	
					White to Light Gray, Dense LIMESTONE (6"thick)	
410					Blue Gray to Gray CHALK with some Shell Fragments and Black Sand	
	Run 4	100	100			
					Blue Gray to Gray, Unweathered Fossiliferous CHALK	
420	Run 5	100	100			
430					End of Coring Interval	

Boring Log Boring No.					Page 4 of 4 RCRA-10R	
Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
560						
580						
600						
620						
640						
660						
				675'	Rock Seam-Hard Clayey Fine Sand	
680						
				680'	Green Medium SAND with Little Clay, Salt and Pepper Appearance	
700						
720						
Boring Terminated at 725 feet BGS						

Boring / Monitoring Well Installation Log

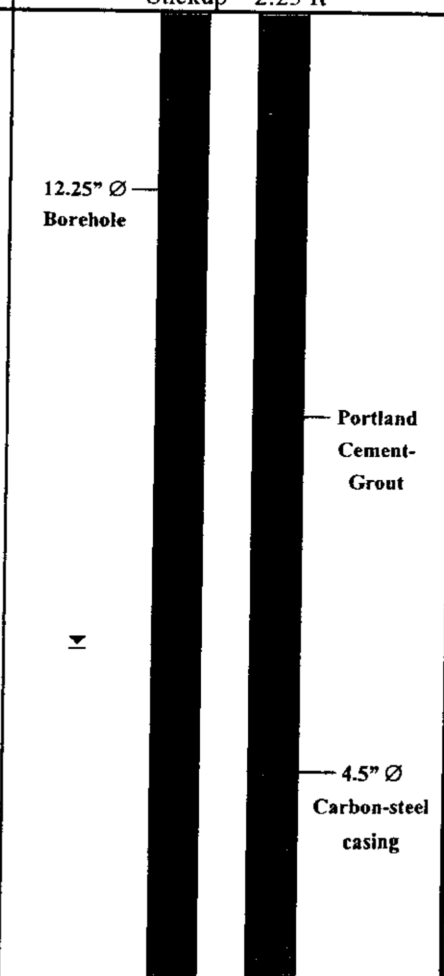
Project Name	WM-Emelle, Al.	**Inspector**	Russ Patterson	**Boring No.**	RCRA-10A
Project Number	1186.010.08	**Weather**	Clear to P. Cloudy	**Sheet**	1 **of** 4
Drilling Company	Graves Services Corp.	**Temperature**	65-85 F	**Surface Elev.**	219.06'
Drill Rig	Schramm T450W	**Depth Hole**	726.0' BGS	**Datum**	msl
Wt Hammer	NA **Drop** NA	**Hole Diam.**	12.25 inches	**Started**	4-20-99
Driller	John Mitchell	**Drilling Mud**	Water + Chalk	**Completed**	5-4-99
Sampling Method	Air Hammer Cuttings	**No. Dist. S.A.**	7	**No. UD. S.A.**	0
Depth W.L.	99.02' BTOC	**Time W.L.**	0935	**Date W.L.**	5-27-99

Well Materials Inventory

Well I.D.	RCRA-10A	**Filter Pack Qty**	4150 lbs. (41.5 cu. ft.)	**Grout Install**	Tremie
Well Casing Dia.	4.5" **L.F.** 683.85	**Pack Type & Size**	PMC-16/30 Silica Sand	**End Cap/Sump**	.82'
Casing Type	Carbon Steel	**Install Method**	Tremie	**Prot. Casing: Y**	X **N**
Joint Type	Threaded	**Seal Type**	Holeplug 3/8" Bentonite	**Well Pad Size**	3'x3'x4"
Well Screen Dia.	4.5" **L.F.** 40.78	**Qty/Install Method**	150 lbs. (2.1 cu. ft.)/Tremie	**TOC Elevation**	221.31'
Screen Type	Stainless Steel	**Grout Type**	Type-1 Portland Cement	**Water Level**	99.02' BTOC
Slot Size	0.012"	**Grout Qty.**	315 96-lb bags/2205 gal. H2O	**Date WL**	5/27 **Time** 0935

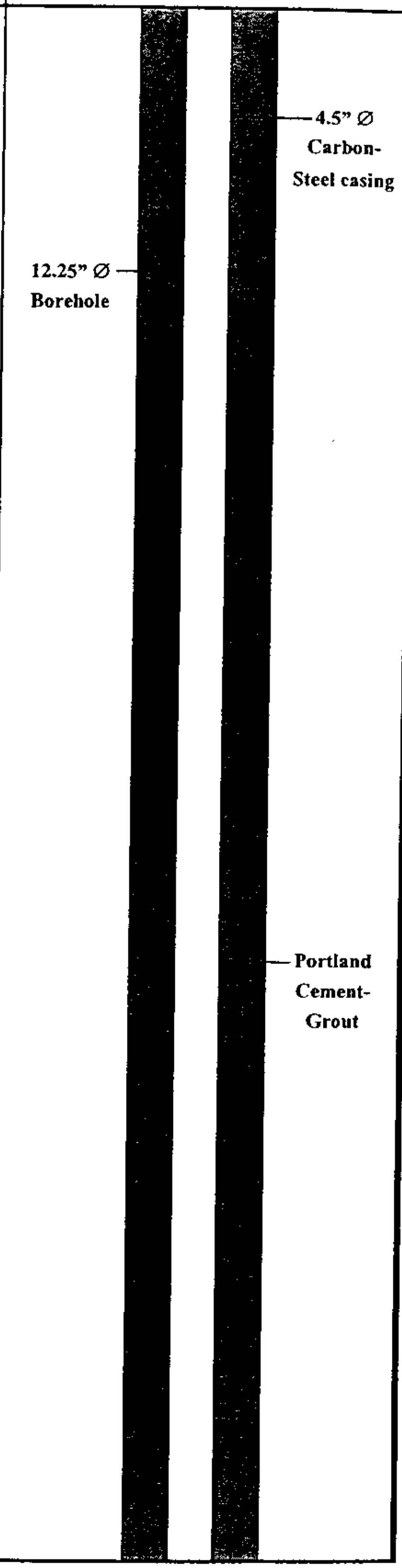
Boring and Well Diagram

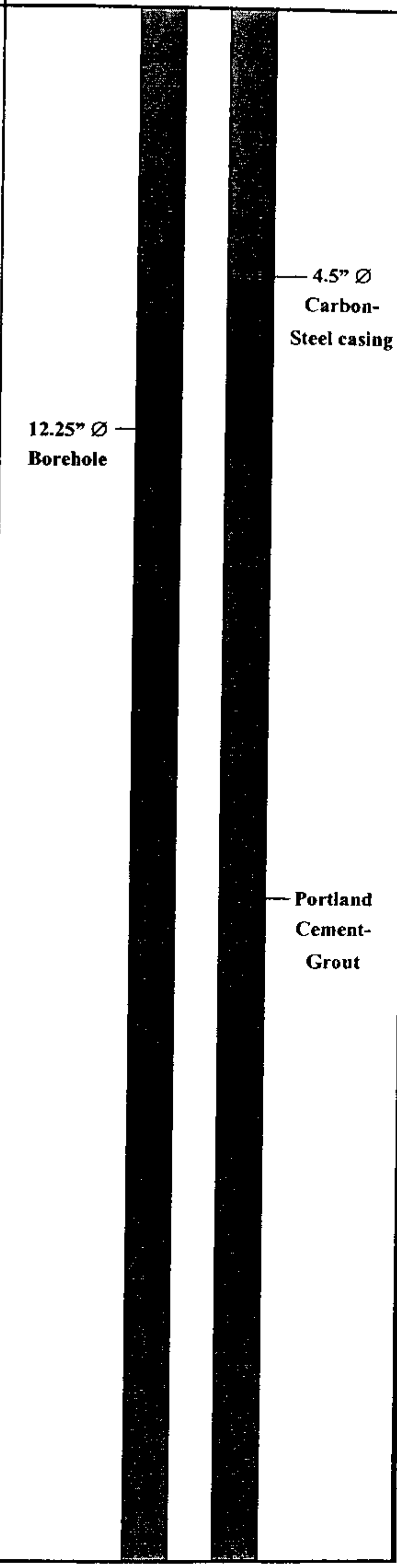
Depth (ft)	Lithologic Description	Remarks	Well Diagram Stickup – 2.25 ft
0–5	**Tan, Weathered Chalk**	**Top of unweathered chalk 5.0' BGS**	
25			
50			
75	**Blue-Gray, Unweathered Fossiliferrous Chalk**		
100		**Stable Water Level At 99.02' BTOC (5-27-99)**	
125			
150			



Notes:

Depth (ft)	Lithologic Description	Remarks	Well Diagram
175			
200			
225			
250			
	Blue-Gray, Unweathered Fossiliferrous Chalk		
275			
300			
325			
350			
375			
		Top of Arcola Limestone 397.7' BGS	
400	Arcola Limestone		

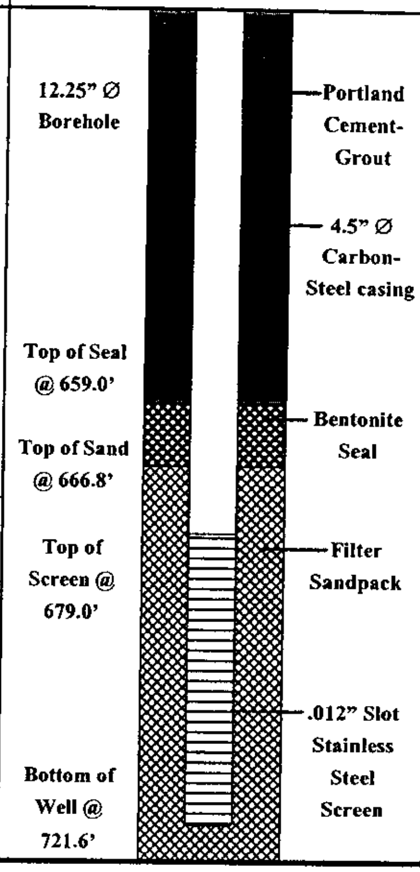


Boring / Monitoring Well Installation Log Boring No. / Well ID RCRA-10A	Page __3_ of _4_		
Depth (ft)	**Lithologic Description**	**Remarks**	**Well Diagram**
425 450 475 450 475 500 525 550 575 600	**Arcola Limestone** **Blue-Gray, Unweathered Fossiliferrous Chalk**	**Bottom of Arcola Limestone 403.0' BGS**	

Boring / Monitoring Well Installation Log
Boring No. / Well ID RCRA-10A

Depth (ft)	Lithologic Description	Remarks
625 650 675	Blue-Gray, Unweathered Fossiliferrous Chalk	
	Clayey Fine Sand	
700 725	Gray-Green, Fine to Medium Sand (Pepper-like appearance-Black Sand Grains)	Top of Eutaw Formation 672.0' BGS Boring Terminated at 726.0' BGS

Well Diagram



APPENDIX E-13

SECTION E

ARCOLA LIMESTONE EVALUATION REPORT AND RCRA-10, RCRA-10R, AND RCRA-10A INSTALLATION AND ABANDONMENT REPORTS

Revision No.
5.0

APPENDIX E-13

SECTION E

LIST OF DOCUMENTS

Document 1: Arcola Limestone Evaluation Report, prepared by Jordan, Jones & Goulding, Inc., dated November 2, 1998.

Document 2: Installation of Groundwater Monitoring Well/RCRA-10A, Waste Management, Inc., Emelle, Alabama Facility, prepared by Jordan, Jones & Goulding, Inc., dated June 14, 1999.

Document 3: Waste Management (WM) Emelle, Alabama Facility, AHWMMA Permit Number ALD 000 622 464, Permit Condition X.B.1.e. and X.B.1.j. (RCRA-10A), prepared by Waste Management, dated January 18, 1999.

Document 4: Abandonment Plan of Boring RCRA-10, prepared by Jordan, Jones & Goulding, Inc., dated March 2, 1998.

APPENDIX E-13

DOCUMENT 1

Feeney

REPORT

ARCOLA LIMESTONE EVALUATION REPORT

Prepared for:

Chemical Waste Management
Emelle, Alabama

By:

Jordan, Jones & Goulding, Inc.
Project No. 1186.016

Jordan Jones & Goulding
INCORPORATED

Jordan Jones & Goulding
INCORPORATED

6001 RIVER ROAD, SUITE 408
COLUMBUS, GEORGIA 31904
PHONE: (706) 324-3213 □ FAX: (706) 322-4562

ATLANTA
ATHENS
COLUMBUS
COLUMBIA
CHARLESTON
KNOXVILLE
LEXINGTON
LOUISVILLE
MIAMI
PUERTO RICO

November 2, 1998

Ms. Teresa Williams
Chemical Waste Management, Inc.
Route 17 @ Milepost 63
Emelle, Alabama 35459

RE: Arcola Limestone Evaluation Report
Chemical Waste Management
Emelle, Alabama

Dear Ms. Williams:

Jordan, Jones & Goulding, Inc. (JJ&G) is pleased to present this Arcola Limestone Evaluation Report. The report was prepared at the request of Chemical Waste Management, Inc. (CWM) to fulfill certain requirements of the Alabama Department of Environmental Management (ADEM) Hazardous Waste Treatment, Storage, and Disposal Permit (Permit) for the CWM Emelle, Alabama Disposal Facility (Permit Number ALD000622464).

Background

The report has been prepared in accordance with the requirements of Condition X.B.1. j of the ADEM permit issued to the Chemical Waste Management, Inc. facility in Emelle, Alabama (CWM-Emelle), on September 26, 1997. Specifically, the requirements of the permit addressed in this report include:

- Reviewing and summarizing existing information and data on the Arcola Limestone from available technical literature;
- Providing documentation of continuous rock coring and geophysical logging of the Arcola Limestone acquired during drilling and installation of boring RCRA-10 and monitoring well RCRA-10R;
- Presenting the results of an evaluation of the Arcola Limestone as a potential monitoring unit for the CWM-Emelle facility; and
- Providing a recommendation regarding the need to monitor groundwater potentially present in the Arcola Limestone.

Monitoring well RCRA-10 is being installed at the CWM-Emelle facility to comply with Condition X.B.1.e of the Permit. JJ&G was retained by Chemical Waste Management, Inc. to monitor the installation of monitoring well RCRA-10. CWM-Emelle retained Layne Christensen Company (Layne) to provide drilling and well installation services for well RCRA-10. The first attempt to construct monitoring well RCRA-10 failed; the borehole was plugged and abandoned. A replacement well, RCRA-10R, was constructed approximately 250 feet to the northwest of the abandoned RCRA-10 boring.

As required by the Permit, the interval containing the Arcola Limestone was continuously cored and geophysically logged following completion of drilling. The results of coring and geophysical logging of both boreholes were used in the evaluation presented in this report.

Summary of Existing Literature on the Arcola Limestone

Two of the major geologic units present beneath the CWM-Emelle facility are the Eutaw Formation, which is the uppermost aquifer at the site, and the Selma Group which overlies the Eutaw Formation. The Arcola Limestone is the uppermost unit of the Mooreville Chalk of the Selma Group. The following provides a brief summary of the stratigraphy and hydrogeology of the Eutaw Formation and the Selma Group and a summary of existing literature on the Arcola Limestone.

Eutaw Formation

The Eutaw Formation is of late Cretaceous age and consists of sands and clay approximately 400 feet thick (References 1 and 2). The Eutaw Formation comprises three units which include from oldest to youngest the basal unit, the middle unit, and the Tombigbee Sand Member. These units also comprise the three principal hydrogeologic zones in the Eutaw Formation. In terms of groundwater resources potential, the basal sand is considered the most important, because wells producing from this sand are reportedly capable of yielding more than a million gallons of water per day in many areas of the state (Reference 1).

Wells producing water from the upper hydrogeologic zone of the Eutaw Aquifer, the Tombigbee Sand Member, commonly yield less than 0.15 million gallons per day in western and central Alabama. The Mooreville Chalk and Demopolis Chalk of the Selma Group overlie the Tombigbee zone and form the upper confining layer for the Eutaw Aquifer in west and central Alabama. The groundwater in the Eutaw Aquifer is considered as confined by the overlying and characteristically low permeability chalk (Reference 1).

The Eutaw Formation is a monitored hydrostratigraphic unit at the CWM-Emelle facility.

Selma Group

The Selma Group is a deposit of semiconsolidated chalk and marl of late Cretaceous age which is estimated to be approximately 600 to 750 feet thick at the Emelle facility (References 3, 4, and 5). The Selma Group has been subdivided into formations based on fossil assemblages, marker horizons, and minor variations in lithology. The Selma Group comprises four units which include from oldest to youngest:

- Mooreville Chalk,
- Demopolis Chalk,
- Ripley Formation, and
- Prairie Bluff Chalk.

The general stratigraphy of the Selma Group is shown in Table 1. The Selma Group is primarily a dense, fine grained, semiconsolidated chalk or marl that is preserved throughout the sequence with little variation either laterally or with depth (Reference 3). The Selma Group chalks, including the Mooreville and Demopolis Chalks, consist of relatively impermeable chalk and clay beds that do not yield water to wells; however, they have a significant influence on groundwater conditions, because they confine water in underlying aquifers and retard downward percolation of water from the land surface and from overlying aquifers (Reference 2).

The CWM-Emelle facility is located on the Demopolis Chalk of the Selma Group (Reference 9). The Demopolis Chalk and the Mooreville Chalk, which includes the Arcola Limestone Member, are the only two formations of the Selma Group present at the CWM-Emelle facility (References 3, 8, and 9). An evaluation of the results of hydrogeologic investigations previously conducted at the CWM-Emelle facility (References 3, 4 and 5) indicate that groundwater water levels in the Selma Chalk at the site range from 120 feet MSL to 240 feet MSL. These investigations also indicate that the groundwater potentiometric surface typically follows surface topography. The vertical and horizontal flow occurring in the chalk was estimated to be at very low gradients. Hydraulic conductivity for the Selma Group chalks at the site have been estimated to range from 10^{-8} centimeters per second (cm/sec) to 10^{-7} cm/sec (References 3, 4, and 5).

Shallow monitoring wells at the CWM-Emelle facility are screened in the Demopolis Chalk.

Arcola Limestone

The Arcola Limestone Member occurs at the top of the Mooreville Chalk and consists of two or more dense limestone beds separated by beds of chalky clay. The Arcola Limestone is described in general terms as approximately 10 feet thick and consisting of very light colored beds of alternating hard (brittle) limestone and soft chalk or clay (References 3, 6, 7, and 10). The dense limestone beds may be one to two feet thick and fossiliferous (References 3, 6, and 10). Visually, the Arcola Limestone may be difficult to distinguish from the underlying or overlying chalk because of subtle color and lithologic contrasts. However, the dense limestone beds have a lower clay content and are relatively higher permeability than the adjacent chalk which is distinguishable on certain geophysical logs.

The Arcola Limestone Member (commonly termed "bored rock") of the Selma Chalk appears to have been identified as early as 1850 (Reference 5). Where exposed in outcrops, this stratigraphic unit consists of limestone infilled with small pockets of marl, which, upon weathering, were washed out leaving a somewhat perforated structure. This appearance led to the common description of "bored rock". The Arcola Limestone Member is slightly more resistant to erosion than the remainder of Mooreville Chalk and typically forms a cuesta in southwestern Alabama (Reference 11).

In *Environmental Geology of An Area in West-Central Alabama* (Reference 7), the Arcola is described as averaging 10 feet thick and consisting of two or more beds of light gray, soft, fossiliferous limestone with a coarse granular texture. The limestone layers are separated by beds of gray to pale olive chalky clay. The cuesta supported by the resistant Arcola Limestone Member (Arcola cuesta) is prominent near Boligee in Greene County and can be traced northwestward into Mississippi. The Arcola is a key indicator for differentiating the Mooreville from the overlying Demopolis Chalk; however, it is not shown on geologic maps because of its limited outcrop pattern.

Lithologically, the Arcola consists of from one to four thin beds of indurated calcisphere packstone to wackestone alternating with interbeds of chalky marl, both possessing burrows and borings (Reference 12). In exposed outcrops, the clayey marl filling individual borings weathers out resulting in the characteristic perforated appearance referred to as the "bored rock". As summarized in Reference 12, few studies focusing on the origin and depositional history of the Arcola have been performed. However, the indurated beds consist of calcispheres which many believed have resulted from periodic blooms of algal cysts.

The Arcola Limestone extends geographically from near Tupelo, Mississippi about 225 miles southeastward to near Downing, Alabama in east-central Montgomery County (Reference 12). The Arcola varies in thickness from a few centimeters at its western and eastern termini to a maximum known thickness of about 14 feet in Dallas County, Alabama. In northern Sumter County, Alabama (Noxubee River section), the Arcola outcrop was observed to be about eight feet thick and consist of two limestone beds (a lower bored indurated bed about two feet thick, an intervening marl two feet thick, and an upper bored indurated bed about four feet thick). In east-central Sumter County, outcrops of the Arcola Limestone was observed to consist of three indurated limestone beds.

In the shallow subsurface, the Arcola Limestone generally varies from 10 to 16 feet in thickness and can be identified and mapped by its thin yet distinctive electric-log character that can be traced downdip for distances over 125 miles (Reference 12). Further downdip, the electric-log marker and characteristic light color and indurated nature is no longer recognizable within the massive chalky marl of the Selma Group. Investigations of calcareous nannofossils from upper Mooreville, Arcola, and basal Demopolis sediments have established the Arcola Limestone as the most widespread time-synchronous lithostratigraphic unity within the eastern Gulf Coastal Plain area (Reference 12).

Site Stratigraphy

Site specific stratigraphic information was examined prior to beginning drilling of well RCRA-10. Boring logs from the installation of previous monitoring wells completed in the Eutaw, in conjunction with available geophysical logs, were evaluated to identify the elevations of the top of the Arcola Limestone. The boring logs and geophysical logs obtained during the installation of monitoring well RCRA-9 and the deep boring DB-1 installed in 1982, as well as geologic cross sections obtained from Section E of the Facility's Part B Permit Application, were used to estimate the elevation of the top of the Arcola Limestone.

Figure 1 presents the geophysical logs obtained from well RCRA-9 and boring DB-1. The geophysical signature of the Arcola Limestone is identified on the geophysical logs for well RCRA-9 and boring DB-1. As shown in Figure 1, the Arcola Limestone is characterized by a relative increase in the resistivity and a decrease in the self-potential (SP) logs compared to the marl/chalk. The other log shown on Figure 1 is for deep boring DB-3 which was cored to a depth of 489 feet, apparently without encountering the Arcola Limestone. However, by correlating marker beds between the three wells shown on Figure 1, the depth of the Arcola Limestone was inferred to be at approximately 520 feet in DB-3.

Although no core was collected in drilling well RCRA-9, the drillers's log indicates the presence of a sea (marine) shale at approximately the same elevation as the Arcola Limestone signature on the geophysical log. The geophysical signature in boring DB-1 is similar to that on the log for well RCRA-9, but the geologic observations made on the core log obtained for boring DB-1 do not indicate the presence of the Arcola Limestone. However, the log of boring DB-1 indicated that a lower Rock Quality Designation (RQD) measurement was recorded for the same elevation at which the Arcola geophysical signature was noted. The Arcola is characterized as thin layers of limestone with interbedded clays or chalks. If the clays or chalks were partially or completely washed out during coring, a lower RQD through the Arcola Limestone would be anticipated. The lower RQD encountered in boring DB-1 at the approximate elevation of the Arcola geophysical signature provides additional evidence of the presence of this limestone member. Since the color of the Arcola Limestone Member is similar to that of the chalk, and because the unit is not very thick, the Arcola can be difficult to identify. In 1982, when boring DB-1 was completed, the Arcola Limestone was not a focus of interest and could have been overlooked by the core logger.

Core Description for RCRA-10 and RCRA-10R

As discussed above, prior to drilling well RCRA-10, geologic literature and boring and geophysical logs from the installation of previous deep borings at the facility were reviewed. In the *Work Plan for the Installation of RCRA-10 Monitoring Well* dated November 4, 1997, the depth of the Arcola Limestone was estimated to be approximately 380 to 400 feet below ground surface (BGS) in the vicinity of RCRA-10, and the depth to initiate coring was established at 350 feet BGS. This estimate of the location of the Arcola Limestone was based upon the geophysical logging performed on well RCRA-9 and upon cross sections obtained from Section E of the facility's Part B Permit Application. At the time the Work Plan was prepared, the exact location and ground surface elevation of RCRA-10 was not known. After obtaining this information from CWM-Emelle and prior to drilling, the original predicted depths were reevaluated and estimated to be 410 feet BGS. This estimate was within about two feet of the actual depth the Arcola was observed in the core samples. Because the strata present in this portion of the facility are considered relatively consistent and predictable, the depth to initiate coring in RCRA-10R was revised to 380 feet BGS.

Coring was performed in both the RCRA-10 and RCRA-10R locations using a NQ-size core (2.98-inch hole diameter). The coring intervals in each of the locations included the Arcola Limestone, as required by Condition X.B.1.j of the Permit. All cores samples were placed into appropriately labeled core sample boxes and stored by CWM-Emelle personnel. The logs for the boreholes are included as Attachment A.

RCRA-10 Core Description

In January 1998, coring was initiated at 350 feet BGS in RCRA-10 and continued until 431 feet BGS. Eleven core runs were attempted in this boring. Based on the examination of rock core, the Arcola Limestone was encountered from approximately 412 to 417 feet BGS. Two naturally occurring fractures were observed in the core; one at approximately 372.2 feet BGS in chalk and one at approximately 416 feet BGS in chalk. Slickensides were observed on the faces of each fracture. The fracture surfaces were inclined approximately at 60° to 66° from horizontal. A blue gray to gray, unweathered, fossiliferous chalk with occasional pyrite nodules was observed from approximately 350 feet to 407 feet BGS. The percentage content of clay, fossils, and pyrite nodules in the chalk, as well as the overall gray color of the chalk, varied within this interval. From approximately 407 feet BGS to several inches before 412 feet BGS, a gray, fossiliferous chalk with black sand ("peppered appearance") was encountered. A white to pale gray, dense limestone, slightly fossiliferous, with washed layers of higher clay content (chalk) was observed from approximately 412 to 415 feet BGS. Gray chalk, possibly mixed with some of the lighter colored limestone, was observed from approximately 415 to 417 feet BGS. Another thin (less than two inches), white to light gray, dense limestone layer was located at approximately 417 feet BGS. From approximately 418 to 420.5 feet BGS, gray, fossiliferous chalk with a "peppered appearance" is observed. The remainder of the core samples, from approximately 420.5 feet BGS to the end of the core at 431 feet BGS, are blue gray to gray, unweathered, fossiliferous chalk.

RCRA-10R Core Description

In March 1998, coring was initiated at 380 feet BGS in RCRA-10R and continued until 430 feet BGS. Five runs of core were attempted in this boring. Based on the examination of rock core, the Arcola Limestone was encountered from approximately 401 to 409 feet BGS. No naturally occurring fractures were observed in the core samples from RCRA-10R. A blue gray to gray, unweathered, fossiliferous chalk with occasional pyrite nodules is located from approximately 380 to 400 feet BGS. The percentage content of clay, fossils, and pyrite nodules in the chalk, as well as the overall gray color of the chalk, varied within this interval. From approximately 400 feet BGS to several inches before 401 feet BGS, gray chalk, fossiliferous, with black sand (peppered appearance) was encountered. A white to pale gray, dense limestone, slightly fossiliferous, was observed from approximately 401 to 403.5 feet BGS. Gray chalk, possibly mixed with some of the lighter colored limestone, was located from approximately 404 to 408 feet BGS. Another thin (approximately six inches), light gray, dense limestone layer was located at approximately 408.5 feet BGS. From approximately 409 to 410.5 feet BGS, gray, fossiliferous chalk with a "peppered appearance" is located. The chalk loses its peppered appearance after approximately 410.5 to 411 feet BGS. The remainder of the core samples, from approximately 411 feet BGS to the end of the core at 430 feet BGS, are blue gray to gray, unweathered, fossiliferous chalk.

Photographs of the core samples containing the Arcola Limestone are included as Attachment B. The visual differentiation between the chalk and the limestone is subtle in the core from each boring. The Arcola Limestone is more distinguishable in the core samples from RCRA-10 because of its very light color. No voids or fractures were observed in the limestone beds.

Another indicator used to assist to identify the location of the Arcola Limestone during field activities was the drill rig response. The drill rig response (i.e. chattering) during the drilling of RCRA-10 proved evidence of the depth of the dense Arcola. The driller's log in RCRA-9 indicated a change in hardness during drilling at the approximate depth of the Arcola.

Geophysical Logging in RCRA-10 and RCRA-10R

Geophysical logging was performed in each of the boreholes prior to undertaking well installation procedures. Layne Geosciences, Inc. of Mission Woods, Kansas performed spontaneous potential (SP) logging, gamma logging, and resistivity logging in each borehole. The geophysical logs for RCRA-10 and RCRA-10R are included as Attachment C.

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As is illustrated in the geophysical logs shown in Figure 2, the Arcola Limestone is characterized by an increase in the resistivity log and a decrease in the SP log. The geophysical logs for RCRA-10 shows an increase in resistivity at approximately 409 feet BGS and again at approximately 414 feet BGS. The concurrent decrease in the SP log which is characteristic of the Arcola Limestone is not observed in the SP log of RCRA-10. An increase in the gamma log of RCRA-10 is observed at approximately 407 feet BGS which is followed by a decrease in the gamma log at approximately 410 feet BGS. The decrease in the gamma log indicates a decrease in the formation natural radioactivity, and indirectly, a decrease in clay content (or other potentially naturally radioactive minerals).

The depths at which the resistivity log showed an increase do not exactly match with visual observations and depth measurements logged for the Arcola Limestone for this borehole, but are within three feet of the depths observed in the core. Visual observations of the core samples indicate the first limestone layer was encountered at approximately 412 feet BGS. These apparent depth discrepancies between core logs and geophysical logs may have resulted from such causes as a different datum used for depth determination or mislabeling of the depth of the core samples.

The geophysical logs for RCRA-10R shows an increase in resistivity and decrease in SP logs at approximately 407 feet BGS. A decrease in the gamma log, indirectly indicating a decrease in clay content, was also indicated in this interval. Similarly to RCRA-10, the depth of the Arcola Limestone shown on the geophysical log does not exactly match with visual observations and depth measurement logged for the borehole. Visual observations of the core samples indicate the first limestone layer was encountered at approximately 401 feet BGS and a second thin layer (approximately six inches) was encountered at about 408.5 feet BGS.

Evaluation of the Arcola Limestone as a Potential Monitoring Horizon

Condition X.B.1.j of the Permit states that the Arcola Limestone shall be re-evaluated as a potential monitoring horizon based on the information obtained during the installation of RCRA-10. Consistent with the descriptions from the available technical literature, the Arcola Limestone encountered in each of the boreholes consists of two beds of limestone interbedded with chalk or chalky marl. In both boreholes, the upper limestone layer was the larger of the two beds with a thickness of 2 ½ to 3 feet. The total thickness of the Arcola Limestone including the marl separating the upper limestone bed from lower limestone bed was approximately 5 feet in RCRA-10 and approximately 8 feet in RCRA-10R.

Outcrops of the Arcola Limestone have been described as "bored rock" because of the characteristically perforated appearance. This perforated appearance is caused by the weathering out of the chalky marl infilling. The limestone beds observed in the core samples collected from both RCRA-10 and RCRA-10R were dense with no visible voids or cavities. The limestone beds did not visually appear significantly different than the overlying and underlying chalky beds. A significant percentage of the Arcola Limestone zone in both borings is chalk or chalky marl. The approximate percentage of chalk or chalky marl within the Arcola Limestone zone (between the top of the first limestone bed and the bottom of second limestone bed) was 40% in RCRA-10 and 62% in RCRA-10R. No fractures were observed in the limestone beds in either boring. A fracture was observed in the chalk located between the two limestone beds in RCRA-10.

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In general terms, the SP log measures relative permeability of the formation. The slight deflection in the SP log observed in RCRA-10R in the Arcola Limestone zone indicates a relatively slightly higher permeability in this area, as does the slight increase on the resistivity log. The decrease in gamma log, indirectly indicating a decrease in clay content, was also observed in the Arcola Limestone zone. Unlike that observed in RCRA-10R, a deflection in the SP log in RCRA-10 was not observed in the Arcola Limestone zone in this boring. Increases in the resistivity log in RCRA-10, suggesting a relatively slightly higher permeability in these areas, were observed in two areas. Decreases in the gamma logs were also seen at approximately the same locations as the deflections observed on the resistivity log in RCRA-10.

Based on these observations, the Arcola Limestone is a distinct lithologic unit beneath the CWM-Emelle facility. These observations do not suggest that the Arcola Limestone represents a distinct hydrostratigraphic unit, but that hydrogeologically it is appropriately incorporated into the Selma Group Chalks.

Conclusion and Recommendation

In summary, based on the information presented in this report, we have concluded the following:

- The limestone beds and interbedded chalk of the Arcola Limestone at this site are visually very similar to the overlying and underlying chalk.
- No voids, cavities, or fractures were observed in the limestone beds in either of the borings.
- Although geophysical logging indicates that there may be a slight increase in permeability within several small areas of the Arcola Limestone zone, the Arcola Limestone and the chalks of the Selma Group form a single hydrostratigraphic unit.

It is our recommendation, for the reasons indicated above, that the Arcola Limestone not be monitored.

JJ&G is pleased to support CWM-Emelle on this project. If you have any questions or need additional information, please call me at (770) 455-8555.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Sherri H. Clark

Sherri H. Clark, P.G.
Project Geologist

Sherri H. Clark for:

Michael T. Feeney, P.E.
Manager, Geosciences

Attachments

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Table

System	Series	Group	Stratigraphic units	Thickness (ft)	Description
Cretaceous	Upper Cretaceous	Selma	Prairie Bluff Chalk	0-70	Chalk, Firm, Brittle, fossiliferous, sandy.
			Ripley Formation	100±	Sand, micaceous, fine-grained; clay, calcareous, light-gray to pale-olive, with thin indurated beds of fossiliferous sandstone; and chalk, light gray.
			Bluffport Marl Member	60±	Marl, massive, chalky; chalk, very clayer; and clay, calcareous, dark olive-gray, fossiliferous.
			Demopolis Chalk	460±	Chalk, light-to medium-light gray, fossiliferous.
			Arcola Limestone Member	10±	Limestone, brittle beds, light gray, impure, dense, fossiliferous; separated by calcareous clay beds.
			Mooreville Chalk	0-360	Clay and marl, compact, calcareous, locally glauconitic; and chalk, clayey.

Table 1 - Generalized litholigic descriptions of the Selma Group in west-central Alabama (adapted from Reference 10).

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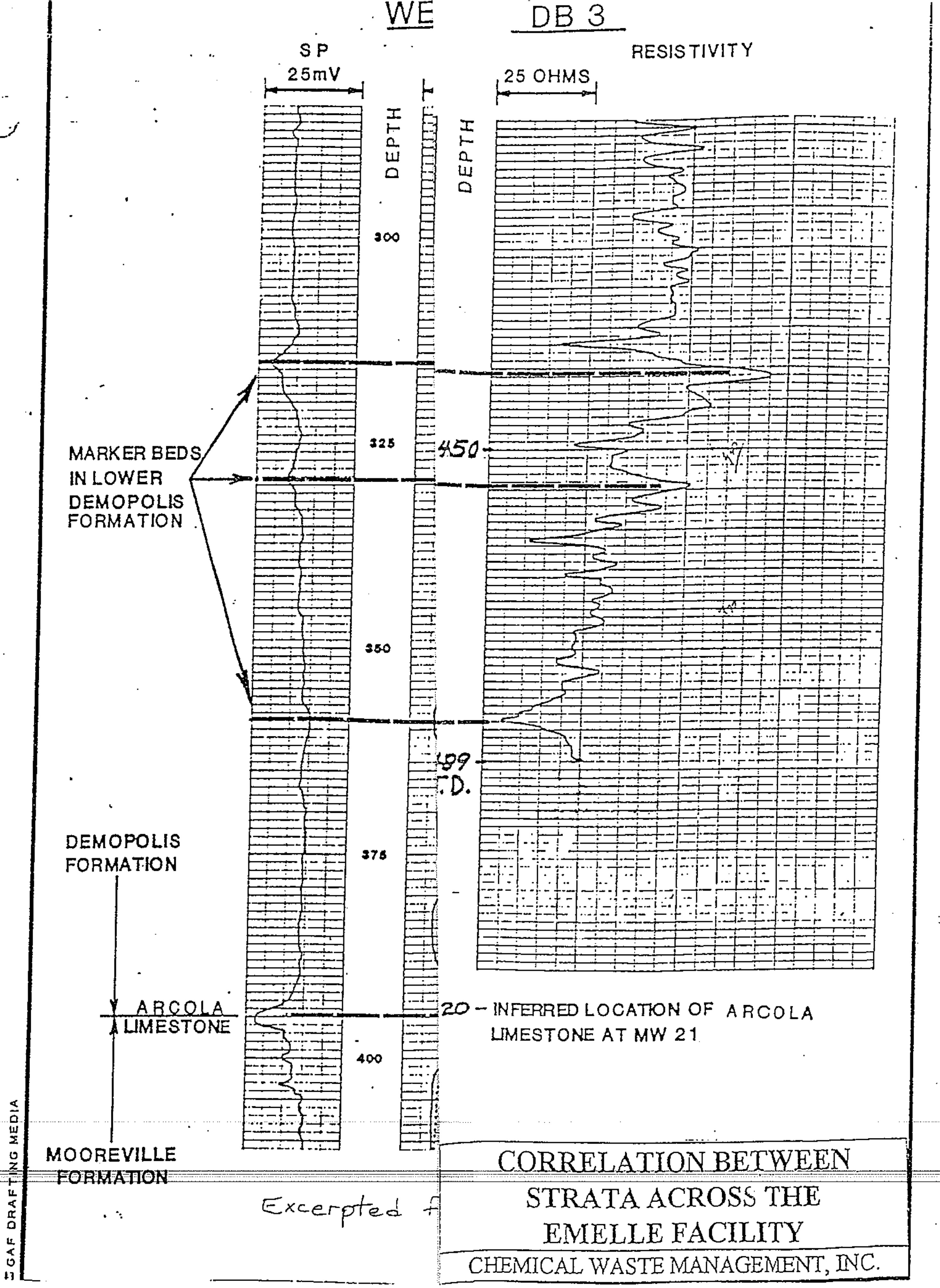
Figure



CORRELATION BETWEEN STRATA ACROSS THE EMELLE FACILITY

CHEMICAL WASTE MANAGEMENT, INC.

Figure 1

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Attachment A

Boring Log

Project Name	CWM-Emelle	**Inspector**	H. Caudill / K. Fleck	**Boring No.**	RCRA-10
Project Number	1186 - 010	**Weather**	Variable - Rainy to Clear, 40-65°F	**Sheet**	1 of 4 (Plus 3A & 3b)
Drilling Company	Layne Christensen	**Drill Bit**	8-inch roller cone	**Surface Elev.**	237.56 feet
Drill Rig	Schramm	**Depth Hole**	725 feet	**Datum**	MSL (Top of Concrete)
Wt Hammer NA **Drop** NA		**Hole Diam.**	8-inch	**Started**	1/3/98
Driller	James Bull	**Drilling Mud**	NA	**Completed**	1/20/98
Sampling Method	NQ-Size Core	**Coring Interval**	350 - 431 feet BGS		Boring abandoned 3/98
Depth W.L.	--	**Time W.L.**	--	**Date W.L.**	--

Boring Log

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
Ground Surface						
					Yellow Brown Weathered CHALK	
20					Blue Gray Unweathered CHALK	
40						
60						
80						
100						
120						
140						

Notes:

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
160						
180						
200						
220						
240						
260						
280						
300						
320						
340						

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK	
				350'		
360						
380					See Attached Coring Log Sheets 3A and 3B	
400						
420						
				431'		
440					Blue Gray Unweathered CHALK (Continued)	
460						
480						
500						
520						
540						

Depth (ft)	Sample No.	% Rec	% RQD	Frac. Log	Lithologic Description	Comments
	Run 1	94	100		Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Occasional Pyrite Nodules	
355						
360						
	Run 2	100	100			
365						
	Run 3	64	100			
370						
	Run 4	90	100			
				f-372.2' (ss, 66°)		
380						
	Run 5	112	100			
386						
	Run 6	88	100			
395						
	Run 7	98	100			

Depth (ft)	Sample No.	% Rec	% RQD	Frac. Log	Lithologic Description	Comments
	Run 7 (cont)	98	100		Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Occasional Pyrite Nodules	
403						
	Run 8	93	100			
					Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Black Sand "Peppered Appearance"	
410						
	Run 9	96	100			
					White to Light Gray, Dense LIMESTONE with Washed Layers of Higher Clay Content	
415						
	Run 10	127	100	f-416' (ss, 60°)	Gray, Fossiliferous CHALK	
					White to Pale Gray LIMESTONE (<2")	
					Blue Gray to Gray, Unweathered, Fossiliferous CHALK with Black Sand, "Peppered Appearance"	
421						
	Run 11	104	100		Blue Gray to Gray, Unweathered, Fossiliferous CHALK	
431						

End of Coring Interval

Depth (ft)	Sample No.	Blows / Foot	% Rec		Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
560						
580						
600						
620						
640						
660						
				668'	Green, Fine Sandy Clay Grading to Clayey Fine SAND (Salt and Pepper)	
680				677'	Rock Seam, Hard Green Clayey Fine SAND ("Peppered Appearance")	
				682'	Green, Medium SAND with Clay (Loose to Tight) (Salt and Pepper Appearance)	
700						
725					Hard Gray Chalk	

Boring Terminated at 725 feet BGS

Boring Log

Project Name	CWM-Emelle	**Inspector**	H. Caudill / K. Fleck	**Boring No.**	RCRA-10R
Project Number	1186 - 010	**Weather**	Variable - Cloudy to Clear, 40-80F	**Sheet**	1 of 4 (plus 3A)
Drilling Company	Layne Christensen	**Drill Bit**	8-inch wing bit	**Surface Elev.**	Approx. 229.8 feet
Drill Rig	Schramm	**Depth Hole**	725.0	**Datum**	MSL
Wt Hammer	NA **Drop** NA	**Hole Diam.**	8-inch	**Started**	3/16/98
Driller	Rick Bilgry	**Drilling Mud**	NA	**Completed**	Boring completed 3/22/98
Sampling Method	NQ-Size Core	**Coring Interval**	380 - 430 feet BGS		
Depth W.L.	--	**Time W.L.**	--	**Date W.L.**	--

Boring Log

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Ground Surface	
					Tan Brown Weathered CHALK	
					Blue Gray Unweathered CHALK	
20						
40						
60						
80						
100						
120						
140						

Notes:

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
160						
180						
200						
220						
240						
260						
280						
300						
320						
340						

Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
360					Blue Gray Unweathered CHALK (Continued)	
380				380'		
400					See Attached Coring Log Sheet 3A	
420						
				430'		
440						
460						
480						
500						
520						
540						

Depth (ft)	Run No.	% Rec	% RQD	Frac. Log	Lithologic Description	Comments
380	Run 1	90	90		Blue Gray to Gray, Unweathered Fossiliferous CHALK with Occasional Pyrite Nodules	
390						
	Run 2	100	100			
400						
	Run 3	100	100		Blue Gray to Gray CHALK with some Shell Fragments and Black Sand "Peppered Appearance"	
					White to Light Gray, Dense LIMESTONE	
					Blue Gray to Gray CHALK with some Shell Fragments and Black Sand "Peppered Appearance"	
					White to Light Gray, Dense LIMESTONE (6"thick)	
410					Blue Gray to Gray CHALK with some Shell Fragments and Black Sand	
	Run 4	100	100			
					Blue Gray to Gray, Unweathered Fossiliferous CHALK	
420						
	Run 5	100	100			
430					End of Coring Interval	

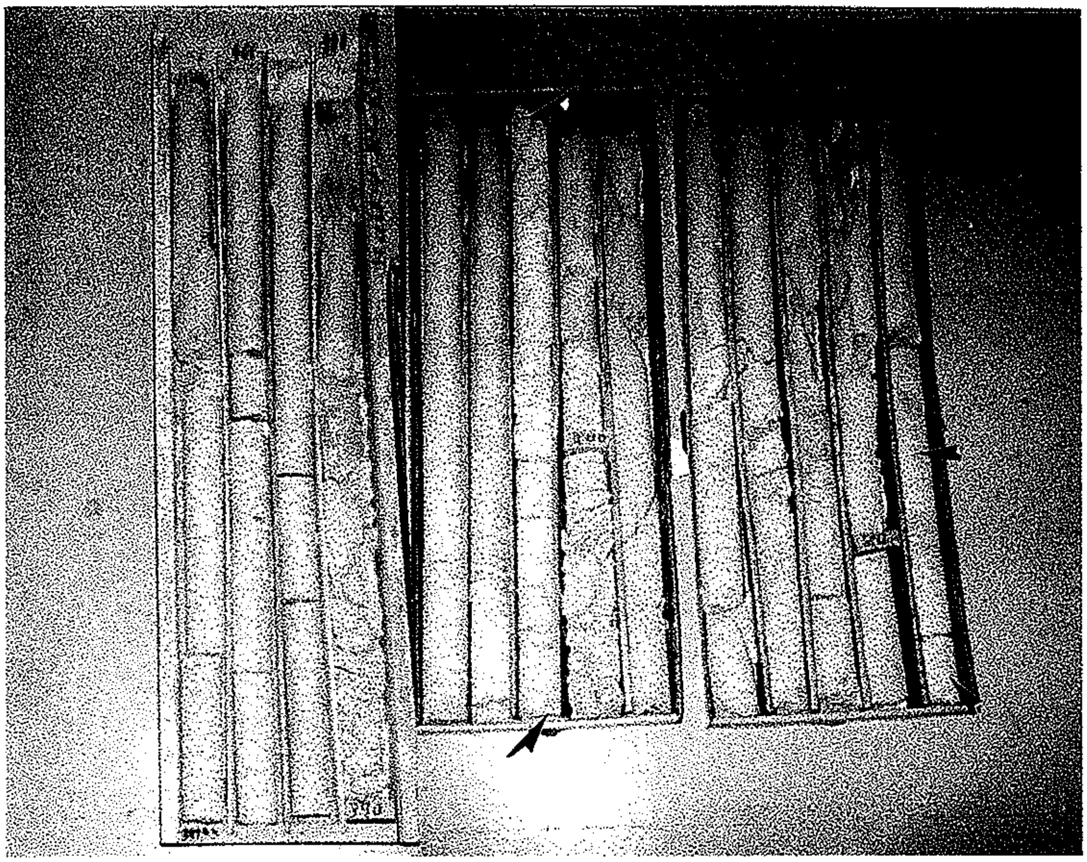
Depth (ft)	Sample No.	Blows / Foot	% Rec	Frac. Log	Lithologic Description	Comments
					Blue Gray Unweathered CHALK (Continued)	
560						
580						
600						
620						
640						
660						
				675'	Rock Seam-Hard Clayey Fine Sand	
680				680'	Green Medium SAND with Little Clay, Salt and Pepper Appearance	
700						
720						

Boring Terminated at 725 feet BGS

Jordan Jones & Goulding Incorporated

Attachment B

Photograph 1 - Core from RCRA-10. All boxes are 2.5 feet in length and start at the top right corner. Box 1 (394.5 feet BGS - 404.5 feet BGS); Box 2 (404.5 feet BGS - 414.5 feet BGS); Box 3 (414.5 feet BGS - 422.5 feet BGS). White to pale gray limestone layers are located approximately 412 - 415 feet BGS and at 417 feet BGS (see red arrows). A fracture with slicken sides is located at approximately 416 feet BGS.



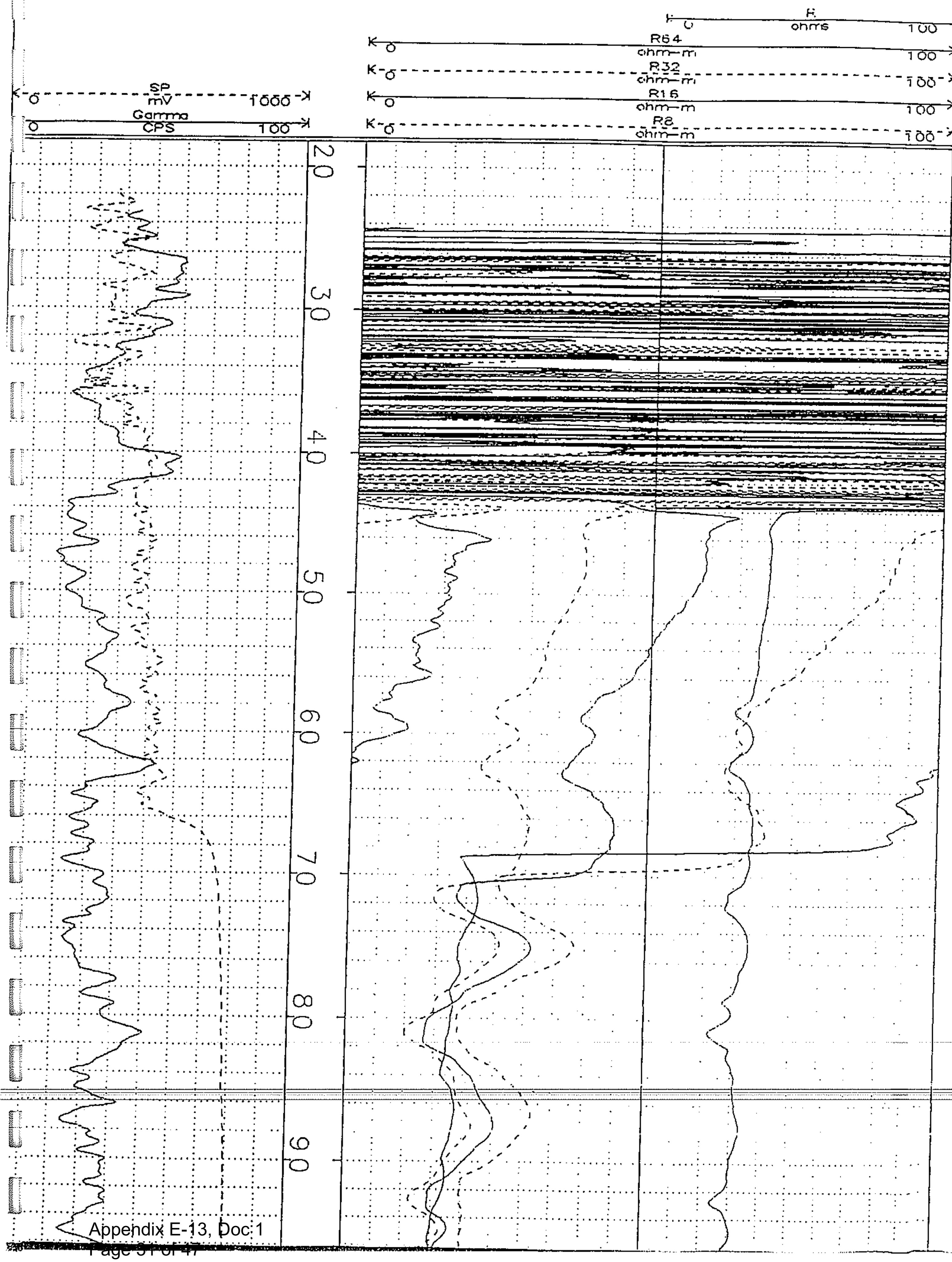
Photograph 2 - Core from RCRA-10R. Box (388 feet BGS - 397.5 feet BGS); Box 2 (397.5 feet- BGS - 407.5 feet BGS); Box 3 (407.5 feet BGS - 417 feet BGS). White to pale gray dense limestone layers are located at approximately 401 - 403 feet BGS and from 408.5 - 409 feet GBS (see red arrows). A mixed chalk and limestone layer is located from approximately 403- 404 feet BGS.

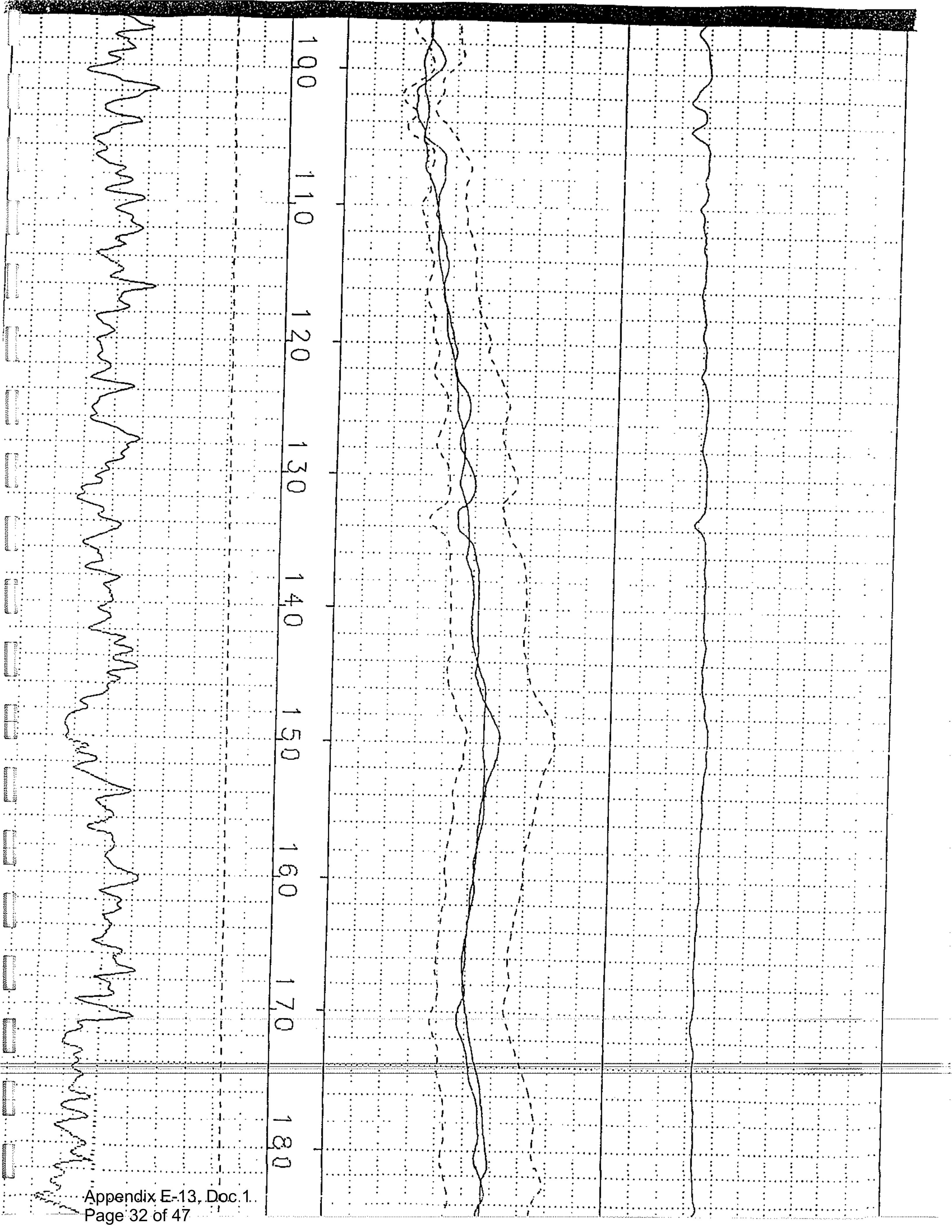
Jordan Jones & Goulding Incorporated

Attachment C

(C:\TEMP\RCRA10.AA1)

Monitoring Well RCRA-10

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170
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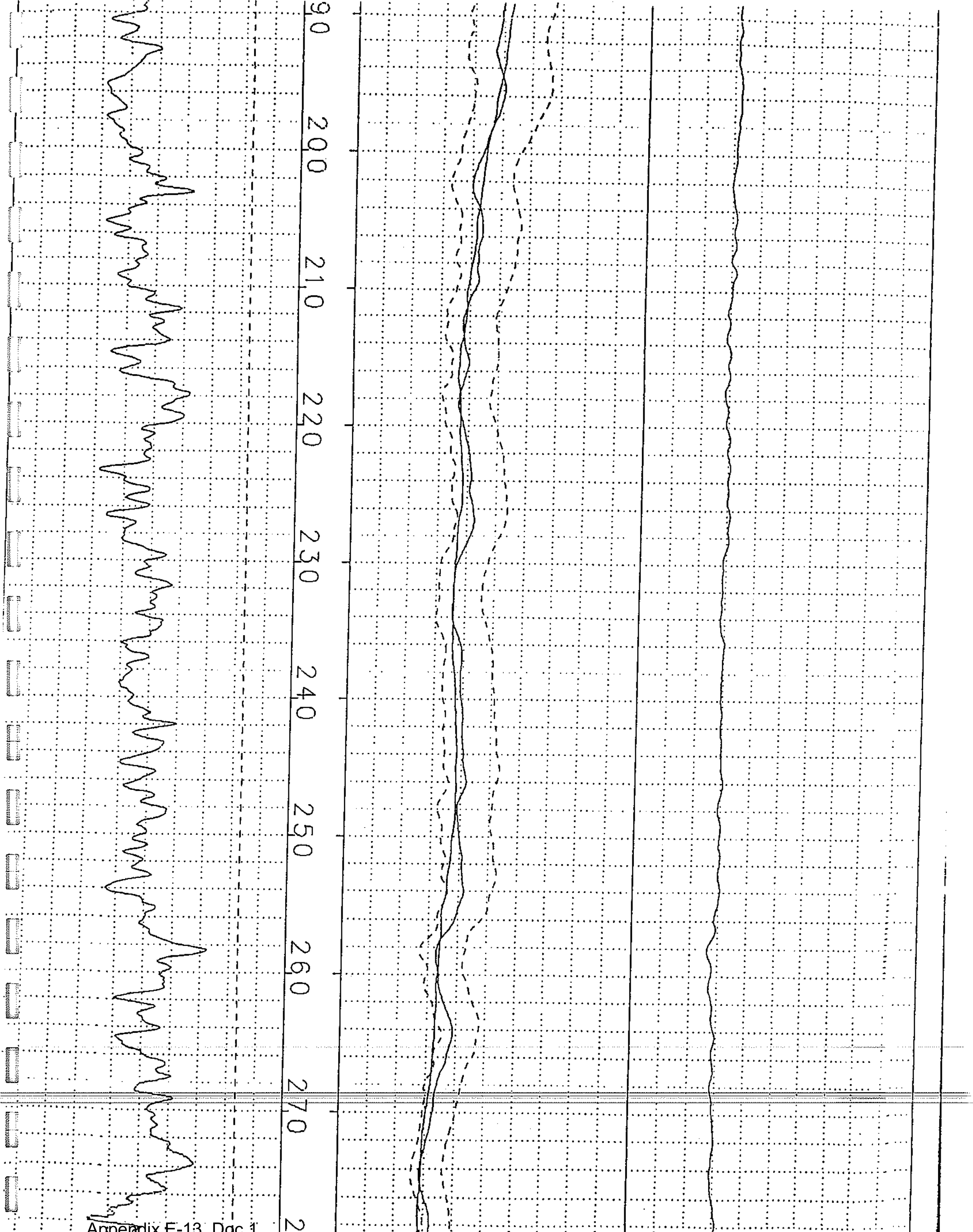
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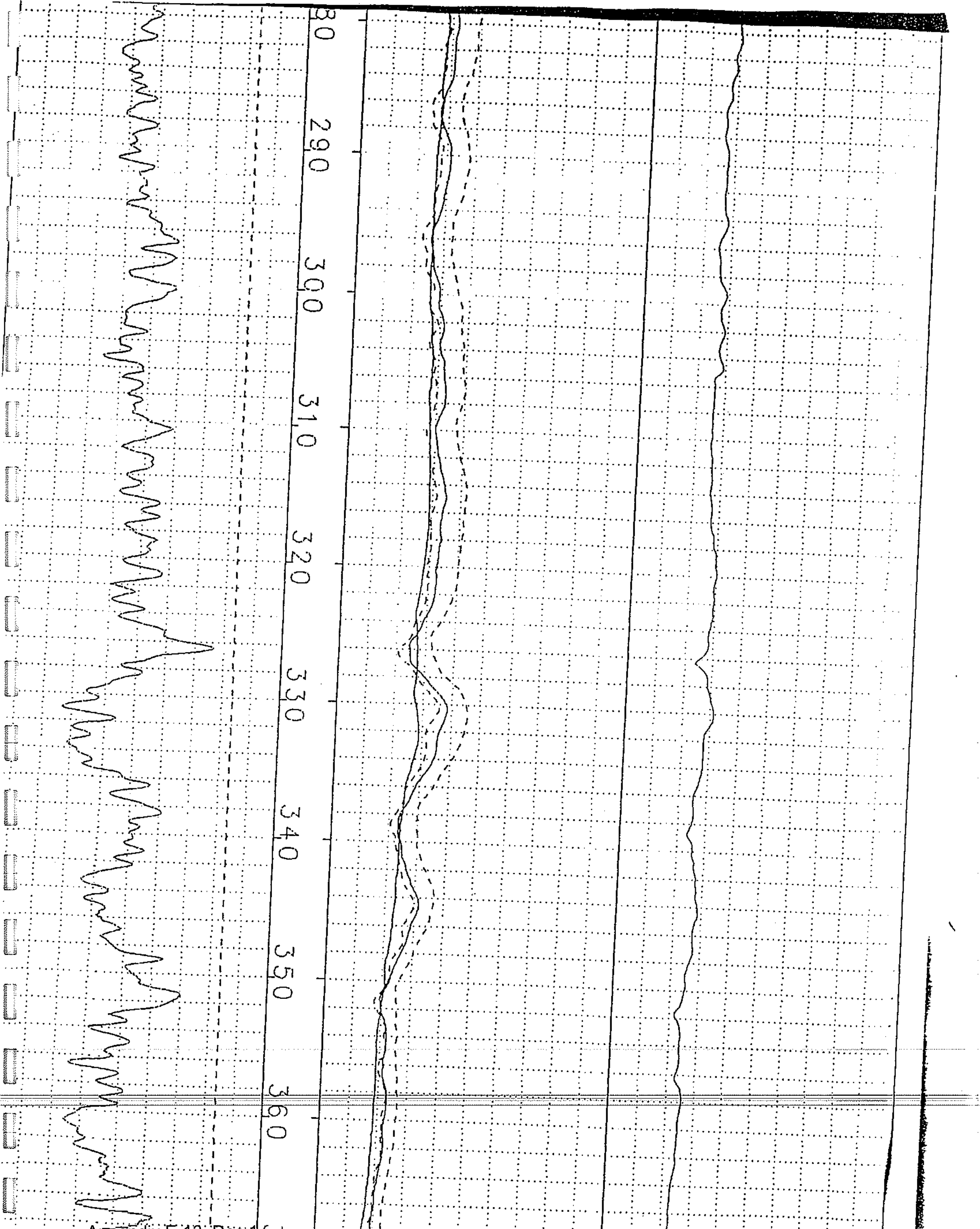
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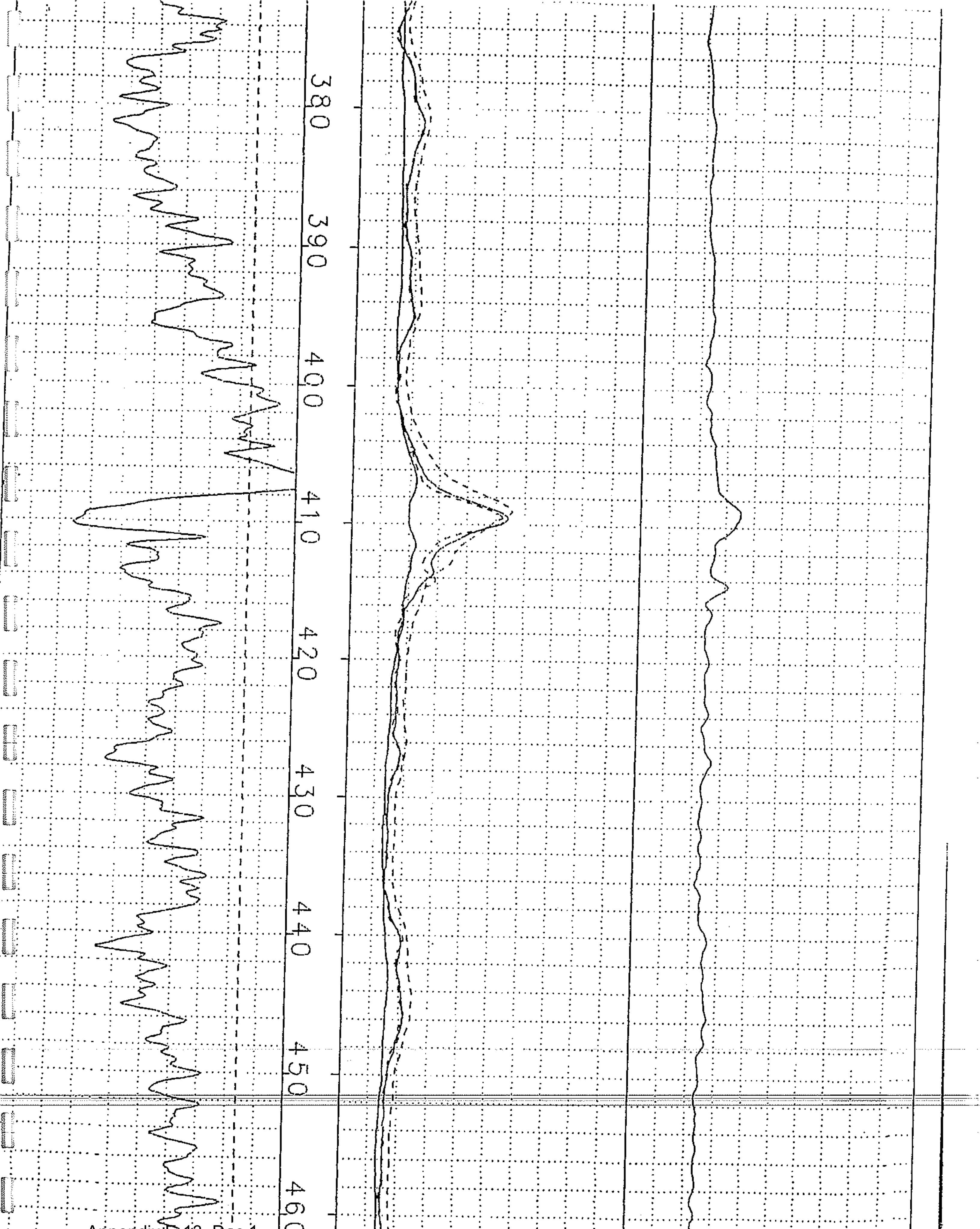
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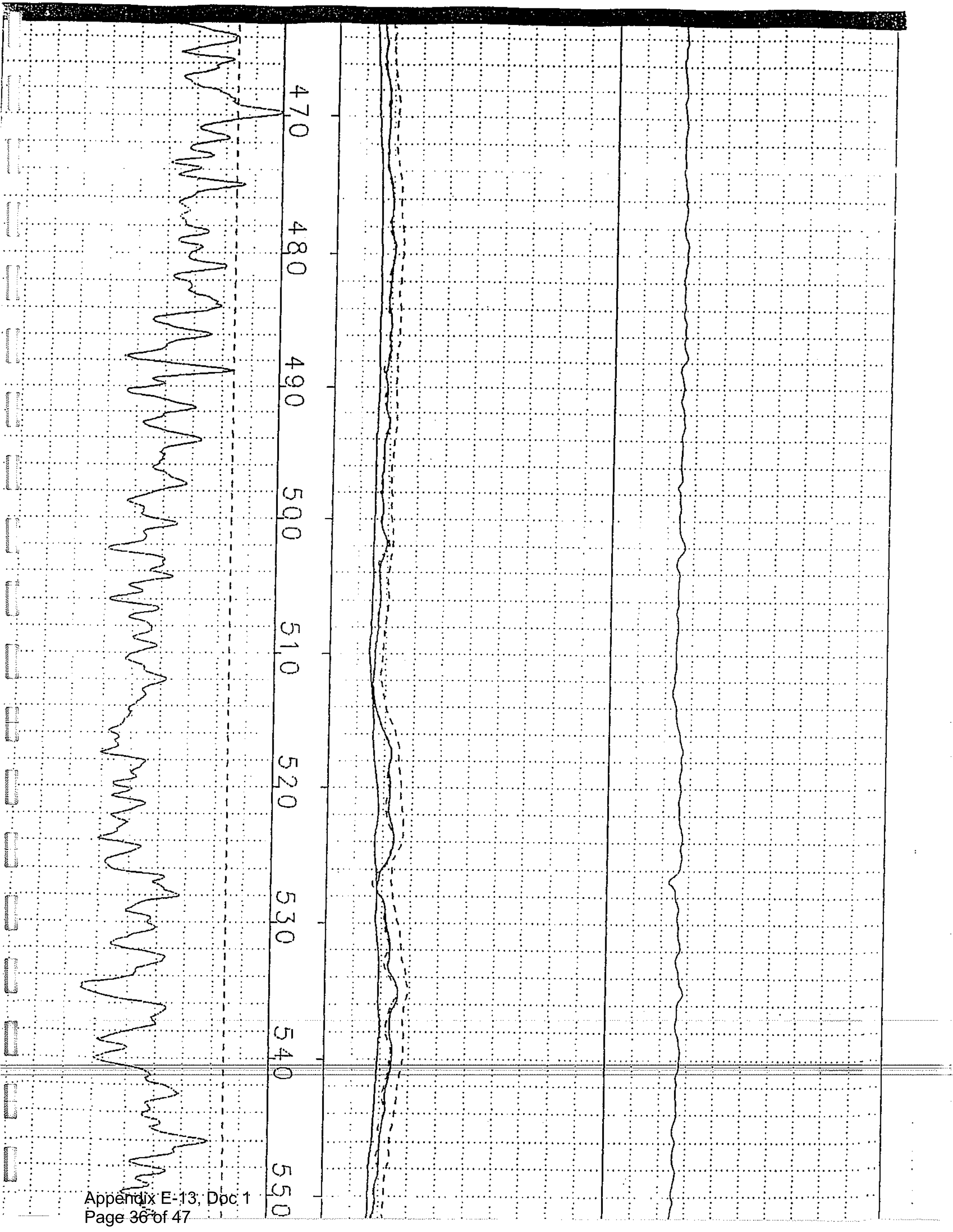
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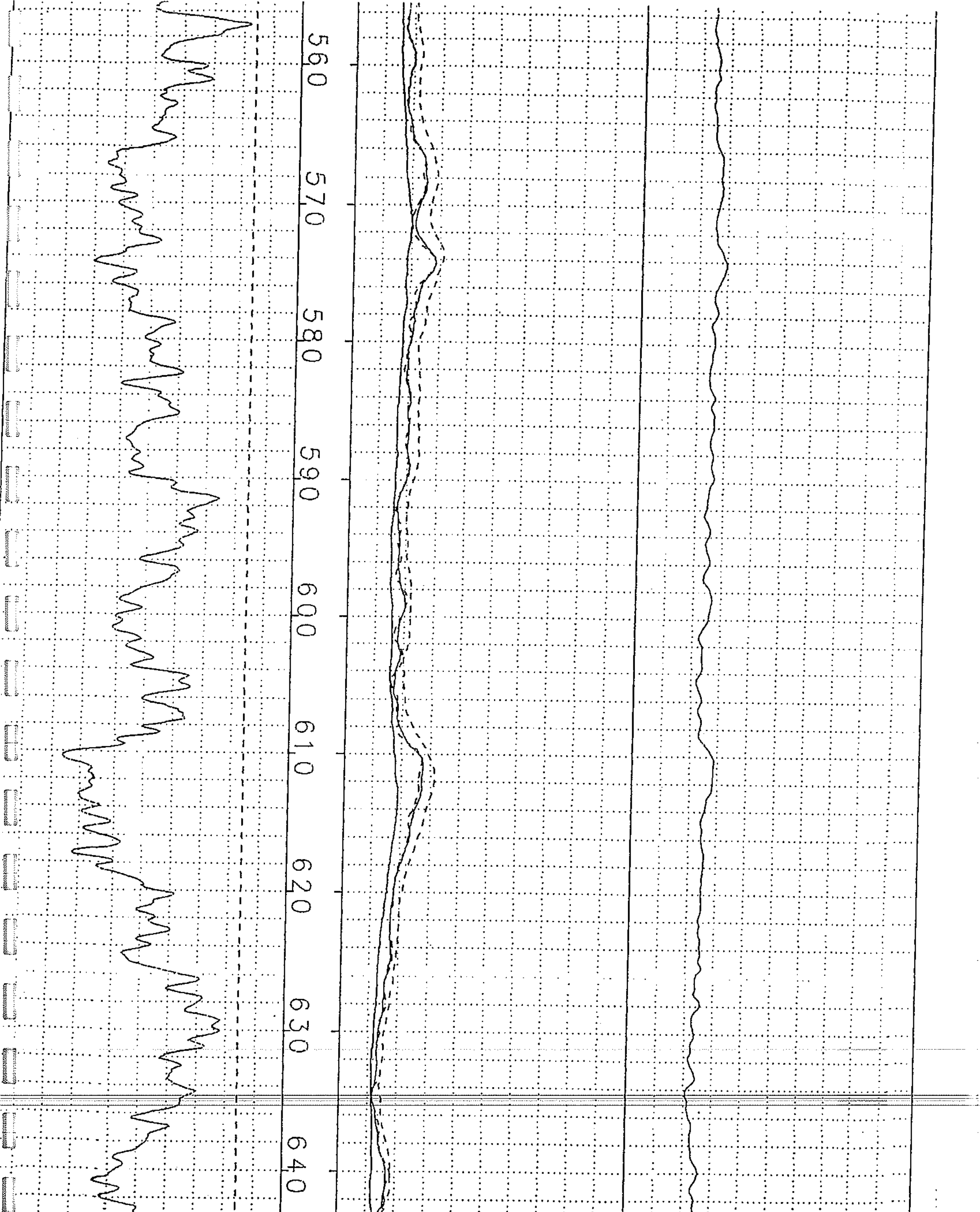
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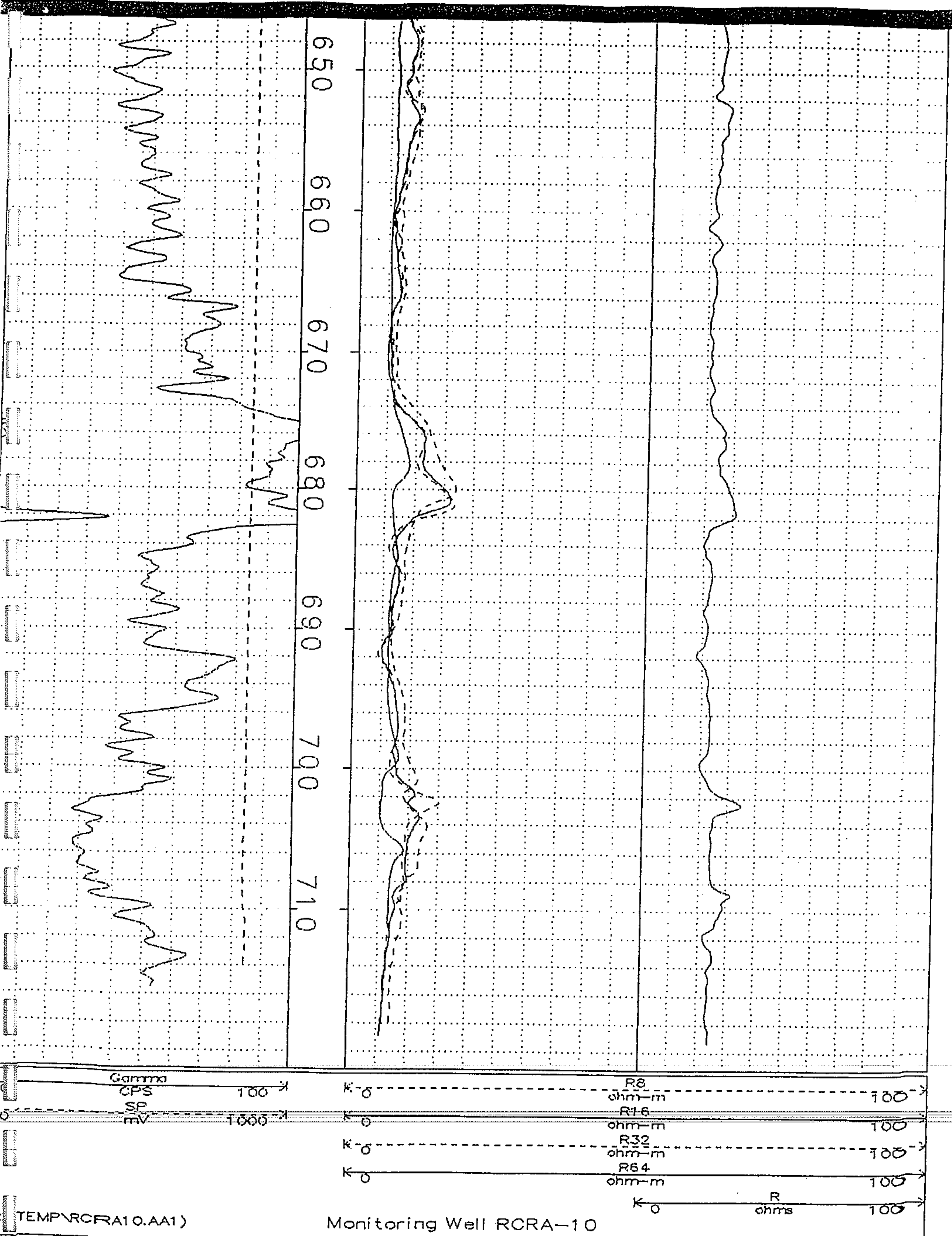

650
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670
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700
710
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CPS
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mV
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0
R8
ohm-m
100
0
R16
ohm-m
100
0
R32
ohm-m
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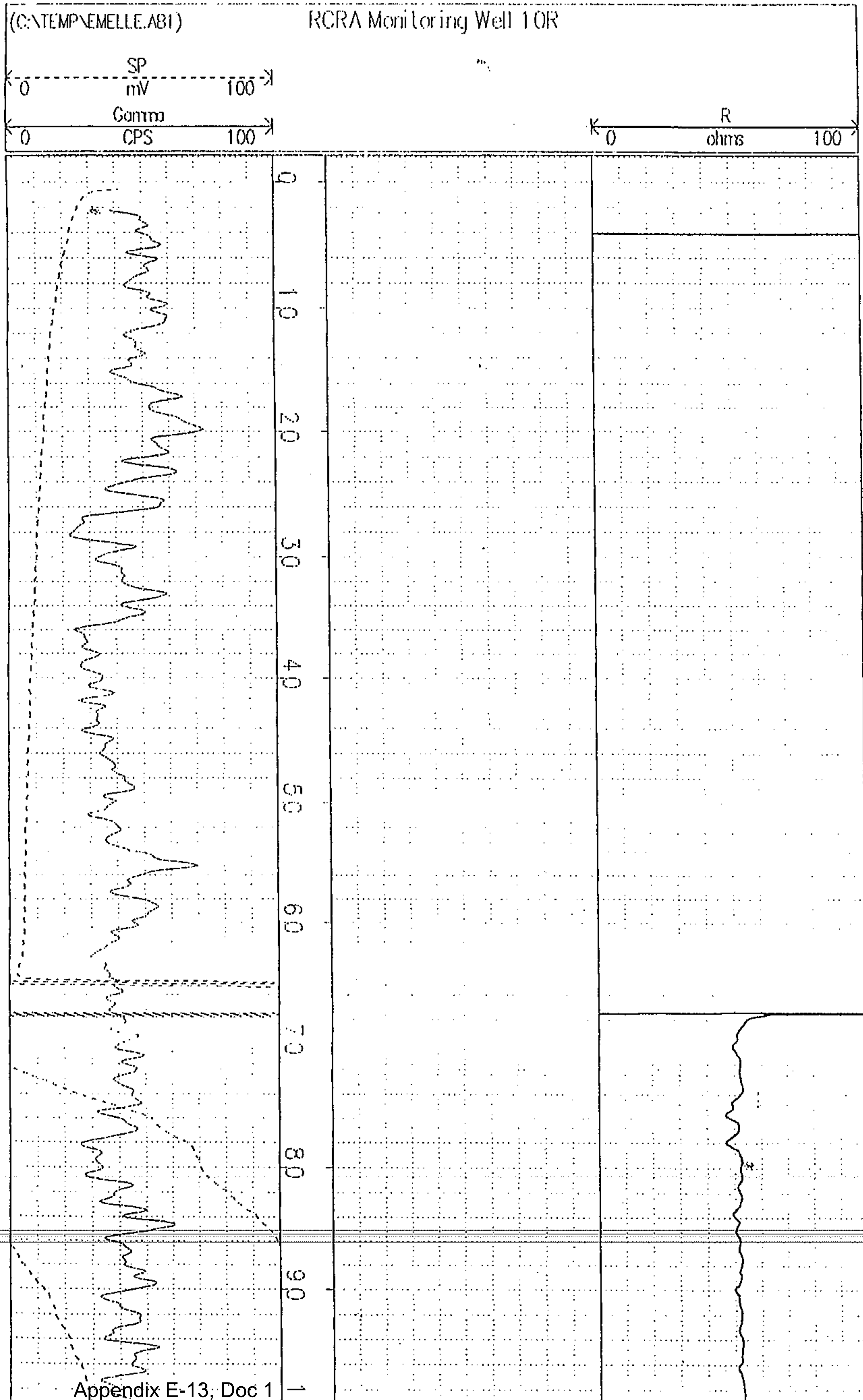
0
R64
ohm-m
100
0
R
ohms
100
TEMP\RCRA10.AA1)
Monitoring Well RCRA-10


(C:\TEMP\EMELLE.A81)
RCRA Monitoring Well 10R
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Gamma
0 CPS 100
R
0 ohms 100
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30
40
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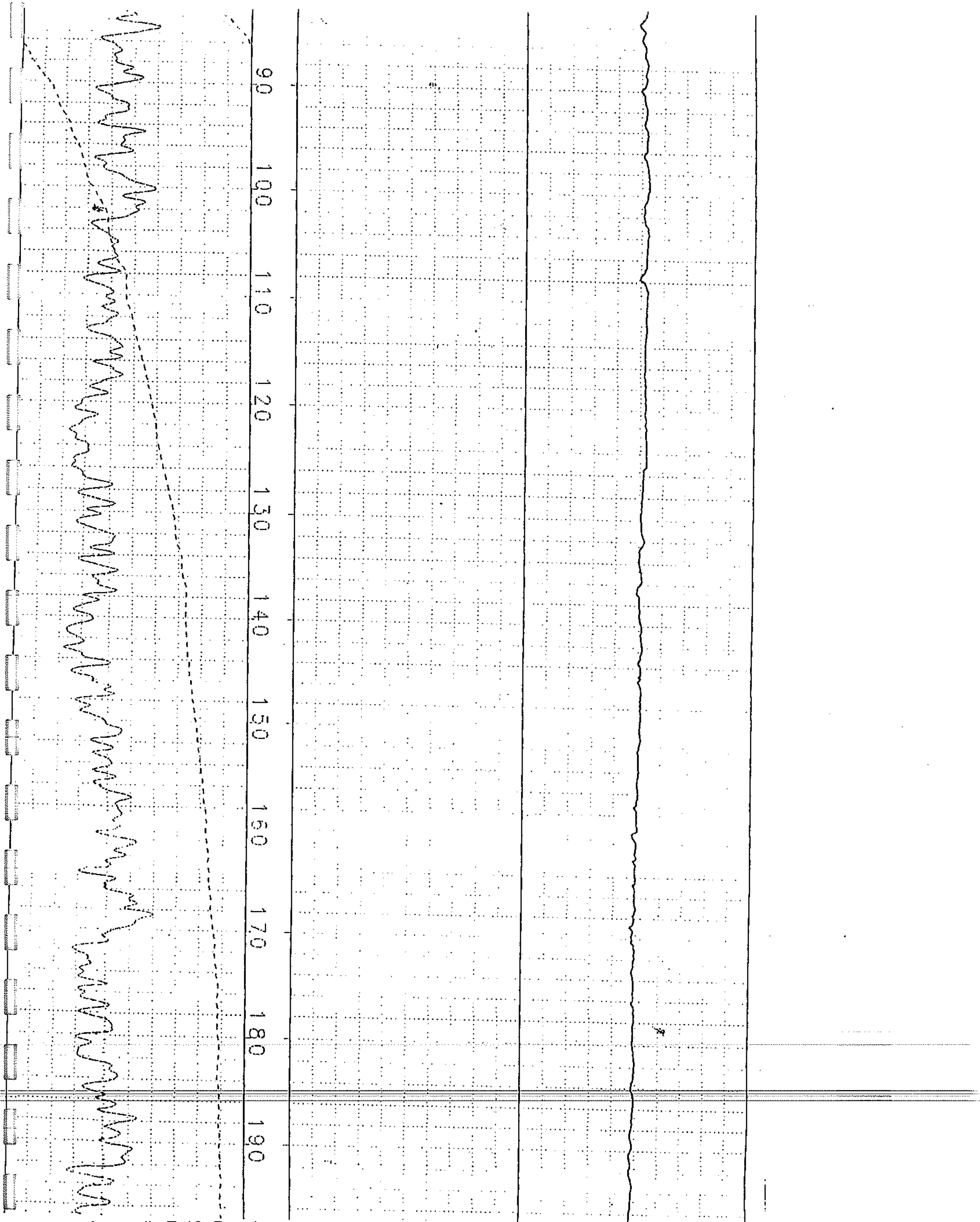
70
80
90
1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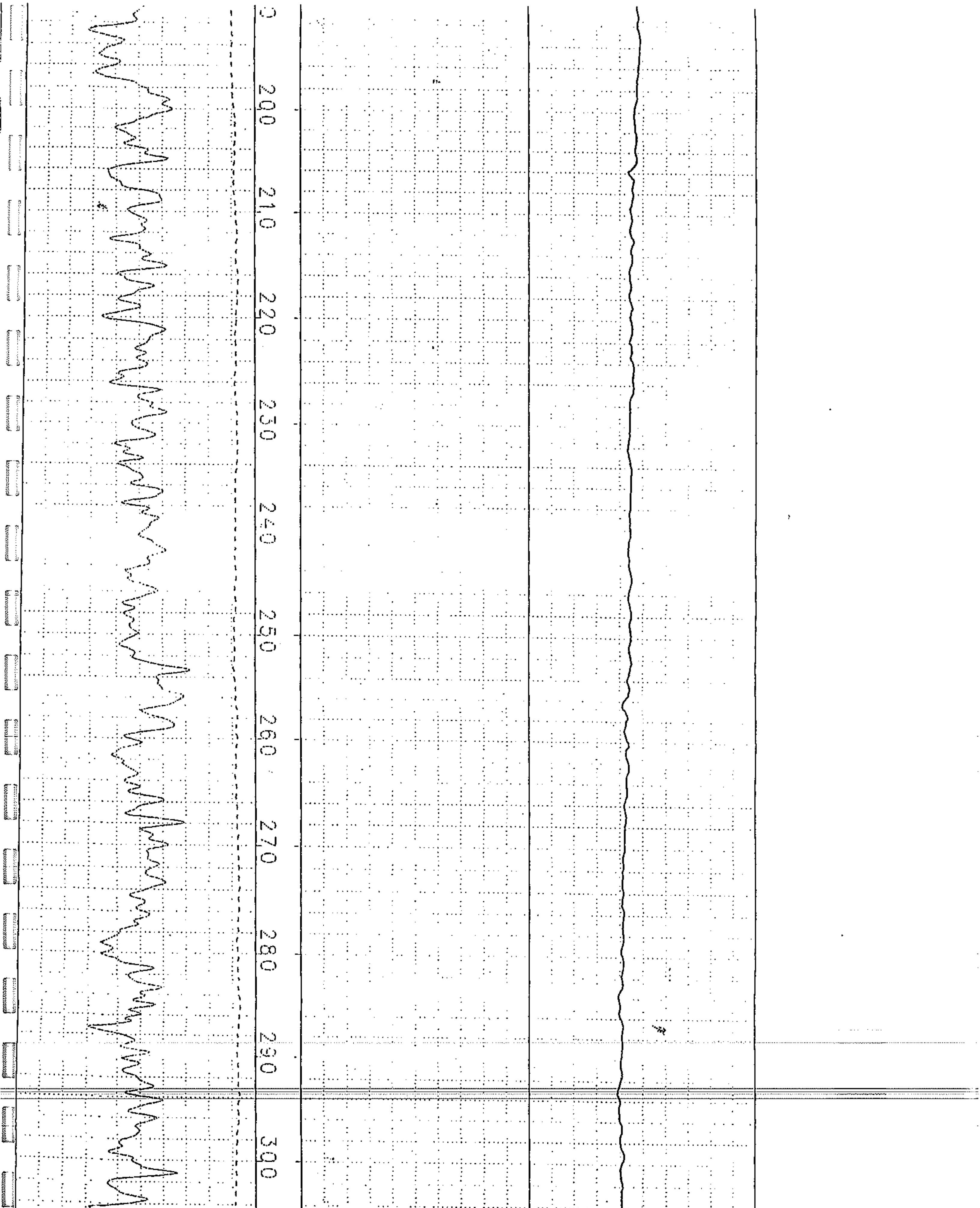
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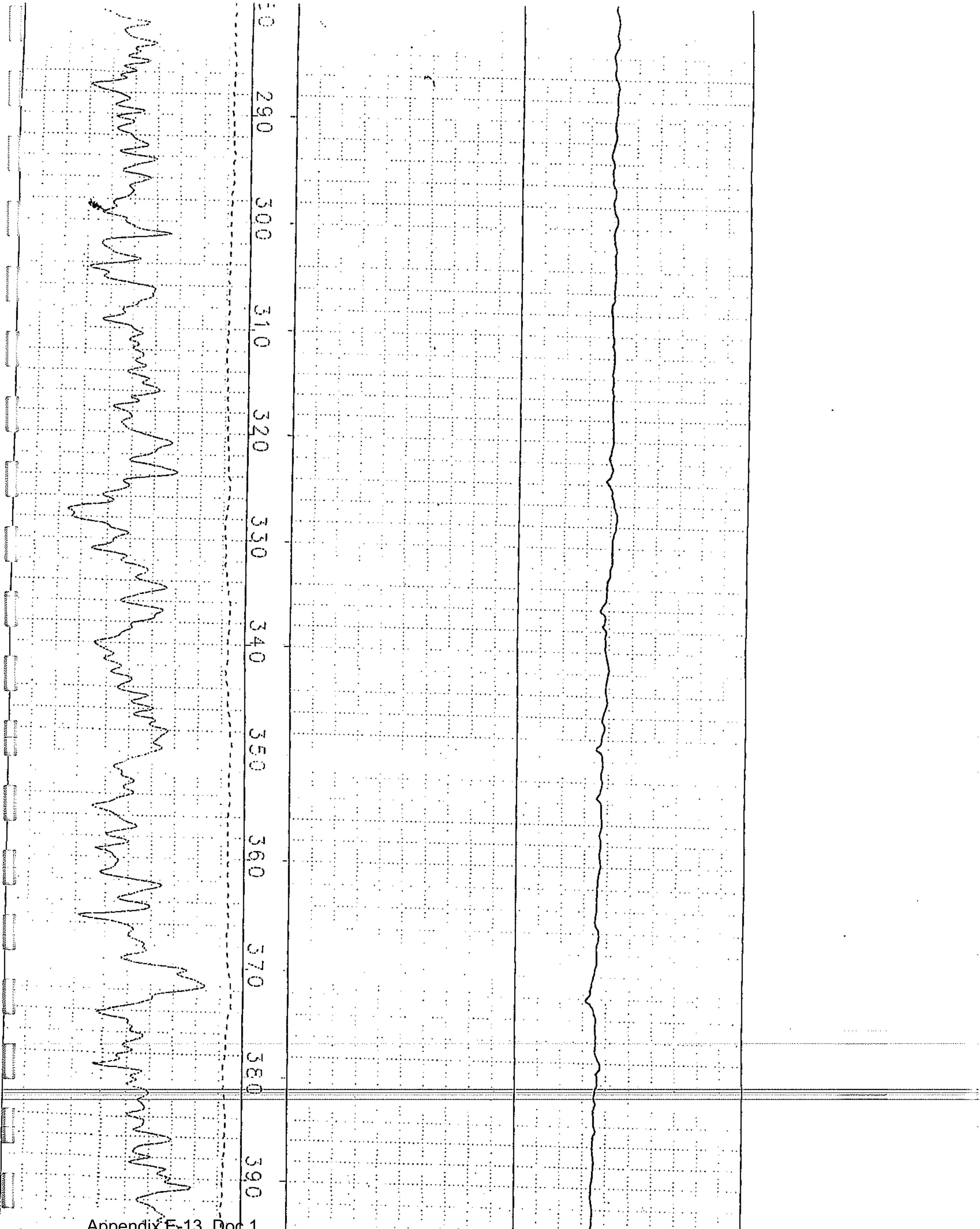
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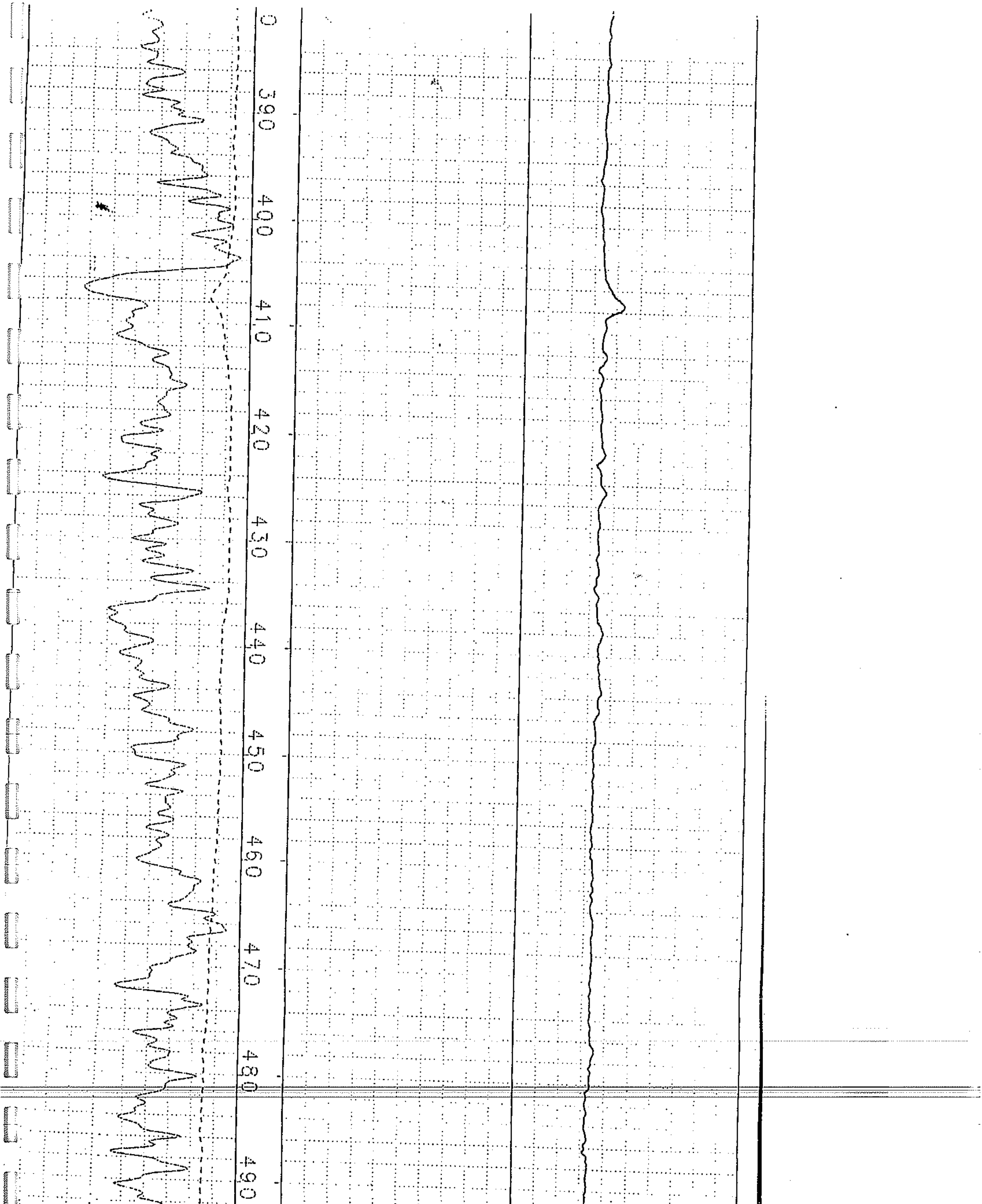
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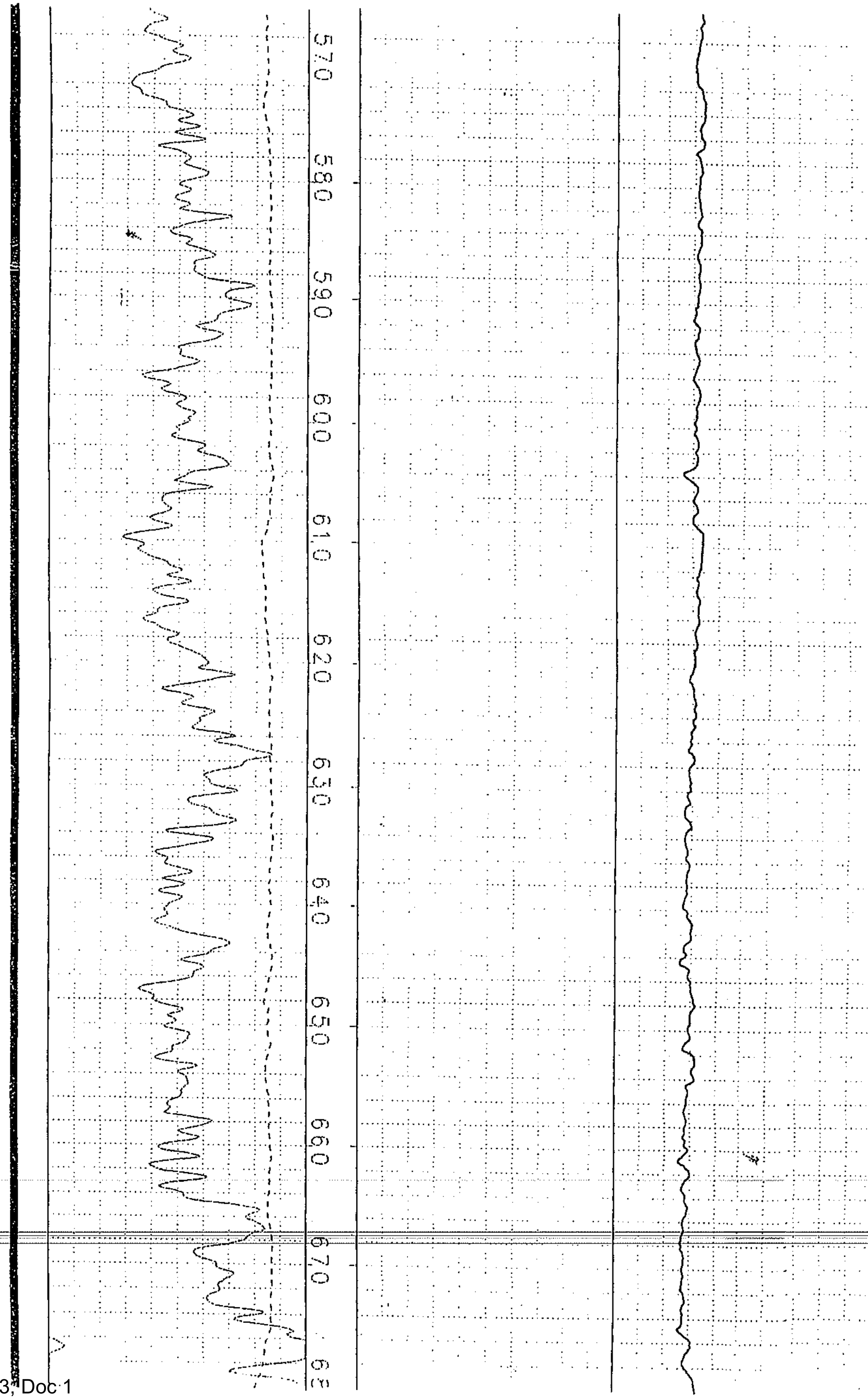
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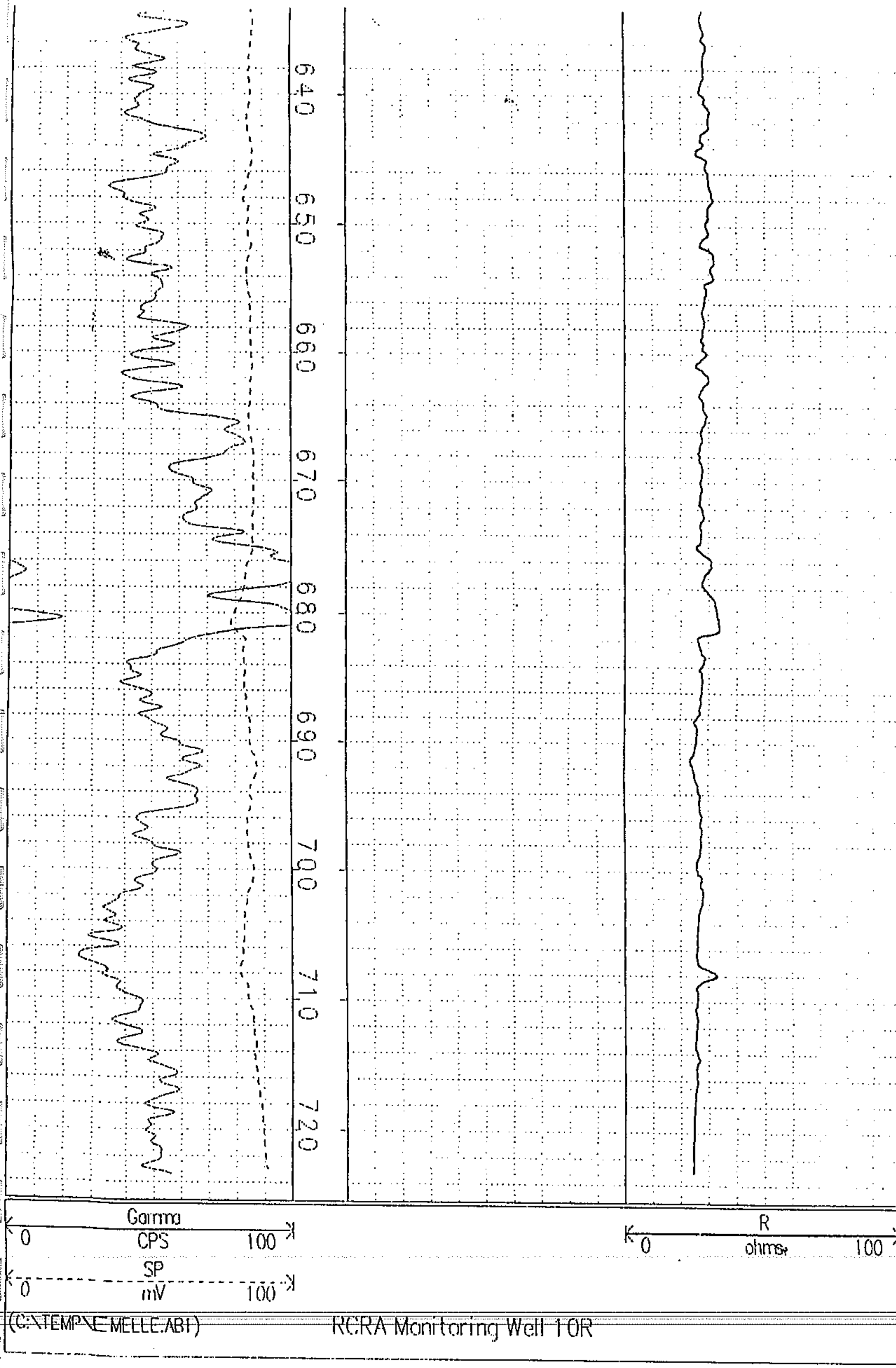
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650
660
670
680
690
700
710
720
Gamma
0 CPS 100
SP
0 mV 100
R
0 ohms 100
(C:\TEMP\EMELLE.ABI)
RCRA Monitoring Well 10R

ADEM

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
POST OFFICE BOX 301463 • 1751 CONG. W. L. DICKINSON DRIVE 36109-2608
MONTGOMERY, ALABAMA 36130-1463
WWW.ADEM.STATE.AL.US
(334) 271-7700

JAMES W. WARR
DIRECTOR

DON SIEGELMAN
GOVERNOR

Facsimiles: (334)
Administration: 271-7950
Air: 279-3044
Land: 279-3050
Water: 279-3051
Groundwater: 270-5631
Field Operations: 272-8131
Laboratory: 277-6718
Education/Outreach: 213-4399

January 29, 1999

CERTIFIED MAIL # Z 385 765 774
RETURN RECEIPT REQUESTED

FEB 02 1999

Rodger Henson, Ph.D.
Division President
Chemical Waste Management, Inc.
P.O. Box 55
Emelle, AL 35459-0055

RE: Arcola Limestone Evaluation Report
Monitoring Wells SM-27, SM-28, and SM-29
SM-18 Well Cluster Study
EPA ID No. ALD 000 622 464

Dear Mr. Henson:

The Department has completed its review of the Arcola Limestone Evaluation Report, dated November 2, 1998 and has determined it to be complete and technically adequate. Based on the findings of the report, no additional monitoring of the Arcola Limestone is required at this time. However, the cores from wells RCRA-10 and RCRA-10R should be archived in the onsite repository.

Regarding CWM's letter of November 11, 1998, concerning surface seep sampling associated with the SM-18 Well Cluster Study, additional tracer tests are not required at this time. However, the Department remains concerned about the possibility of contamination from unlined trenches migrating to the surface in areas previously observed as seeps. Therefore, the Department has determined that the issue of the surface seeps should be addressed in the Leachate Removal Investigation required by Condition IX.B.11. of CWM's AHWMMA Permit. This requirement is in addition to those requirements described in the Department's 11/30/98 comments regarding the Leachate Removal Evaluation (LRE) Workplan. In order to facilitate an investigation of the previously identified surface seeps in the areas of the unlined trenches, a series of spring boxes or similar devices should be installed. The LRE Workplan should provide for the location, installation and sampling of such devices throughout the investigation period, and should also provide for Department notification prior to the installation or removal of the devices.

Birmingham
110 Vulcan Road
Birmingham, Alabama 35209-4702
(205) 942-6168
(205) 941-1603 (Fax)

Decatur
2708 8th Avenue, SE, Suite B
Decatur, Alabama 35603-1508
(256) 353-1713
(256) 340-9359 (Fax)

Mobile
2204 Perimeter Road
Mobile, Alabama 36615-1131
(334) 450-3400
(334) 479-2593 (Fax)

Mobile – Coastal
4171 Commanders Drive
Mobile, Alabama 36615-1421
(334) 432-6533
(334) 432-6598 (Fax)

Regarding CWM's letter of November 4, 1998 submitted in response to the Department's comments concerning the results of the initial sampling of wells SM-27, SM-28, and SM-29, the Department has no additional comments on this matter at this time.

Should you have any questions concerning these matters, please contact Mr. Chip Crockett, of the Hazardous Waste Branch at (334) 271-7747.

Sincerely,

Wm. Gerald Hardy, Chief
Land Division

WGH/VHC/sem:L::CWM 990111

cc: Michael Champion/ADEM
Wayne Payton/ADEM

File: CWM/ALD000622464

APPENDIX E-13

DOCUMENT 2

Jordan
Jones &
Goulding
INCORPORATED

2000 CLEARVIEW AVE., N.E.
ATLANTA, GEORGIA 30340
PHONE: (770) 455-8555 □ FAX: (770) 455-7391

ATLANTA
ATHENS
CHARLESTON
COLUMBIA
COLUMBUS
KNOXVILLE
LEXINGTON
MACON
MIAMI
PUERTO RICO

RCRA 10 File

June 14, 1999

Ms. Teresa Williams
Waste Management, Inc.
Route 17 at Milepost 163
Emelle, Alabama 35459

RE: INSTALLATION OF GROUNDWATER
MONITORING WELL/RCRA-10A
WASTE MANAGEMENT, INC.
EMELLE, ALABAMA FACILITY

Dear Ms. Williams:

Jordan, Jones & Goulding, Inc. (JJ&G) was retained by Waste Management, Inc. Emelle, Alabama, facility (WM-Emelle) to install one groundwater monitoring well, designated as Resource Conservation and Recovery Act (RCRA)-10A, adjacent to the northwest corner of the facility's Compliance Boundary/Waste Management area. This well was installed in accordance with Condition X.B.1.e.i. of the facility's Part B Permit and the Groundwater Monitoring Section (Section E) of the Part B Permit Application.

This well installation report summarizes drilling and well installation procedures utilized in the construction of RCRA-10A and the abandonment of RCRA-10R, which was deemed unusable in October 1998 due to foreign material plugging RCRA-10R at a depth of approximately 520 feet.

Drilling Operations

Drilling services were provided by Graves Services Corporation (Graves) to drill and install RCRA-10A at the WM-Emelle facility. Graves mobilized a Schramm T450W drill-rig to the facility on April 19, 1999. A member of JJ&G's environmental staff provided oversight for the drilling operations and collected data. The boring and well installation logs for RCRA-10A are enclosed with this report.

Upon arriving at the site on April 19, mudpits were constructed by WM-Emelle personnel by excavating two five-foot deep depressions, approximately fifty feet by twenty feet. The drill-rig, all drill-rods, bits, tools and well materials were steam-cleaned prior to drilling and well installation of RCRA-10A.

Drilling at the RCRA-10A location was initiated on April 20, 1999. Water used in the construction of the borehole was obtained from monitoring well RCRA-5. A 6.75-inch diameter pilot hole was drilled using air-rotary drilling techniques to a depth of approximately 600 feet below ground surface (BGS). Soil cuttings were collected approximately every 100 feet. The pilot hole was then overdrilled with a 12.25-inch diameter mud-rotary roller-cone bit. On April 20, 1999, shaking of the drill-rig was observed at a depth of 397.7 feet BGS, which was estimated to be the top of the Arcola Limestone. This depth is consistent with data collected at prior drilling operations in this area. The Arcola Limestone was calculated to be 5.3 feet thick. The top of the Eutaw Formation was encountered on April 25, 1999 at a depth of 672 feet BGS. Drilling was completed at a depth of 726 feet BGS. Cuttings generated during the borehole construction were spread on the ground surface. Once final depth was encountered, well installation proceeded.

Well Installation

On April 25, 1999, the 12.25-inch diameter bore-hole was converted to a groundwater monitoring well through the installation of four ten-foot sections of nominal four-inch diameter stainless steel well screen, set at the base of the assembly to ensure placement of the screen in the underlying Eutaw Formation. A total of 683.85 feet of four-inch diameter carbon-steel casing in (about 32-1/2 sections of 21.1 feet each) were installed above the screen. Rubber "O-rings" were removed from the well sections prior to placement in the borehole.

Upon completion of the placement of the wall screen and casings within the borehole, 83 bags (approximately 4150 pounds) of Pontchartrain Materials Corporation (PMC) 16/30 silica-sand filter media were tremied into the annulus surrounding the well screen. Following the placement of the filter-pack, three bags (150 pounds) of "Holeplug" 3/8-inch bentonite pellets were pumped through a tremie pipe to the top of the sandpack and allowed to set overnight. The following day, April 28, 1999, Graves installed a 1/2 horsepower Grundfos pump at a depth of 160 feet BGS and approximately 920 gallons of water were pumped from the well in order to measure pH and conductivity and evaluate well performance before placing grout.

On April 29, 1999, 15 bags of Portland Cement were mixed with 105 gallons of water and tremied into the annular space above the bentonite seal. This first lift of grout was allowed to set overnight. The following day, April 30, 1999, the second lift of grout was tremied into place. The second lift was a mixture of 25 bags of cement and 175 gallons of water. This second lift was allowed to set overnight.

Additional pumping was performed on May 1, 1999, in order to compare to groundwater conditions observed on April 28, 1999, prior to grout placement. Approximately 1650 gallons of water were pumped following the second lift installation. Conductivity (range 1500 to 3000 microhms) and pH (range 7.0 to 9.0) parameters were observed to be

Jordan
Jones &
Goulding

similar to those noted on April 28, 1999 and were in the expected ranges observed in other Eutaw wells at the site.

On May 3, 1999 the remaining annular space was filled with grout to grade using a tremie pipe. Bama Concrete Company arrived on site and unloaded 2.75 truckloads of cement-grout (approximately 275 bags of cement and 1925 gallons of water), which was also tremied into place. Approximately 2475 additional gallons of water were pumped from the well on May 4, 1999 to evaluate well performance. The values of water quality parameters including pH, electrical conductivity and temperature were within ranges of values observed in other Eutaw monitoring wells at the Emelle site. A boring log, well diagram and development information is attached with this report.

Installation of the well cover, concrete bollards and construction of the well pad were performed by WM-Emelle personnel. The well has now been included in the WM-Emelle Eutaw monitoring network.

RCRA-10R Abandonment

Upon the completion of RCRA-10A, RCRA-10R was plugged by grouting in place and abandoned. On May 4, 1999, Graves filled the well casing with grout consisting of 50 bags of cement and 350 gallons of water within the well casing of RCRA –10R. The grout was placed in the well using a tremie lowered to depth of about 500 ft. The existing well cover and concrete bollards were cut off at ground surface. The concrete bollards from RCRA-10R will be used around the well pad for RCRA-10A.

JJ&G appreciates the opportunity to provide environmental consulting services to WM. If you have comments or need additional information, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Russell A. Patterson

Russell A. Patterson

Leo F. Gentile, P.G.

cc: Mr. Michael Feeney, P.E.
Ms. Sherri Clark, P.G.

Boring / Monitoring Well Installation Log

Project Name	WM-Emelle, Al.	Inspector	Russ Patterson ckd	Boring No.	RCRA-10A
Project Number	1186.010.08	Weather	Clear to P. Cloudy	Sheet	1 of 4
Drilling Company	Graves Services Corp.	Temperature	65-85 F	Surface Elev.	219.06'
Drill Rig	Schramm T450W	Depth Hole	726.0' BGS	Datum	msl
Wt Hammer NA	Drop NA	Hole Diam.	12.25 inches	Started	4-20-99
Driller	John Mitchell	Drilling Mud	Water + Chalk	Completed	5-4-99
Sampling Method	Air Hammer Cuttings	No. Dist. S.A.	7	No. UD. S.A.	0
Depth W.L.	99.02' BTOC	Time W.L.	0935	Date W.L.	5-27-99

Well Materials Inventory

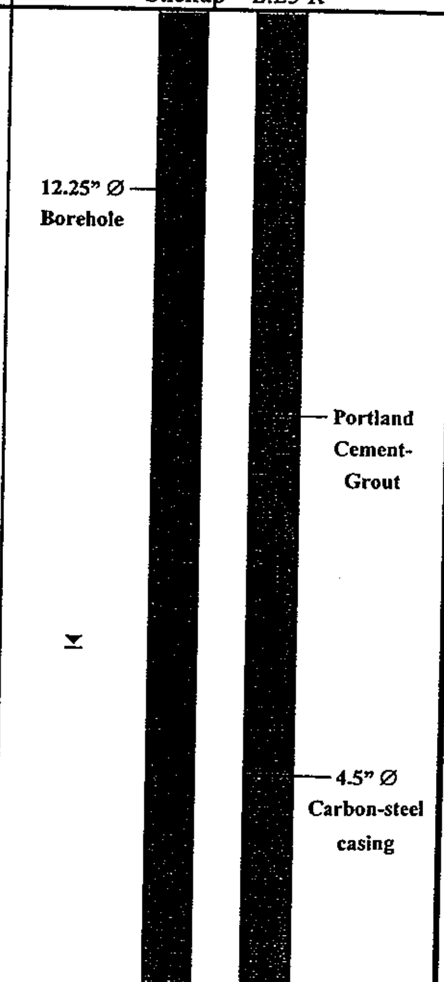
Well I.D.	RCRA-10A	Filter Pack Qty	4150 lbs. (41.5 cu. ft.)	Grout Install	Tremie
Well Casing Dia.	4.5" L.F. 683.85	Pack Type & Size	PMC-16/30 Silica Sand	End Cap/Sump	.82'
Casing Type	Carbon Steel	Install Method	Tremie	Prot. Casing: Y N	X
Joint Type	Threaded	Seal Type	Holeplug 3/8" Bentonite	Well Pad Size	3'x3'x4"
Well Screen Dia.	4.5" L.F. 40.78	Qty/Install Method	150 lbs. (2.1 cu. ft.)/Tremie	TOC Elevation	221.31'
Screen Type	Stainless Steel	Grout Type	Type-1 Portland Cement	Water Level	99.02' BTOC
Slot Size	0.012"	Grout Qty.	315 96-lb bags/2205 gal. H2O	Date WL 5/27	Time 0935

Boring and Well Diagram

Depth (ft)	Lithologic Description	Remarks
0	Tan, Weathered Chalk	Top of unweathered chalk 5.0' BGS
25		
50		
75	Blue-Gray, Unweathered Fossiliferrous Chalk	
100		Stable Water Level At 99.02' BTOC (5-27-99)
125		
150		

Well Diagram

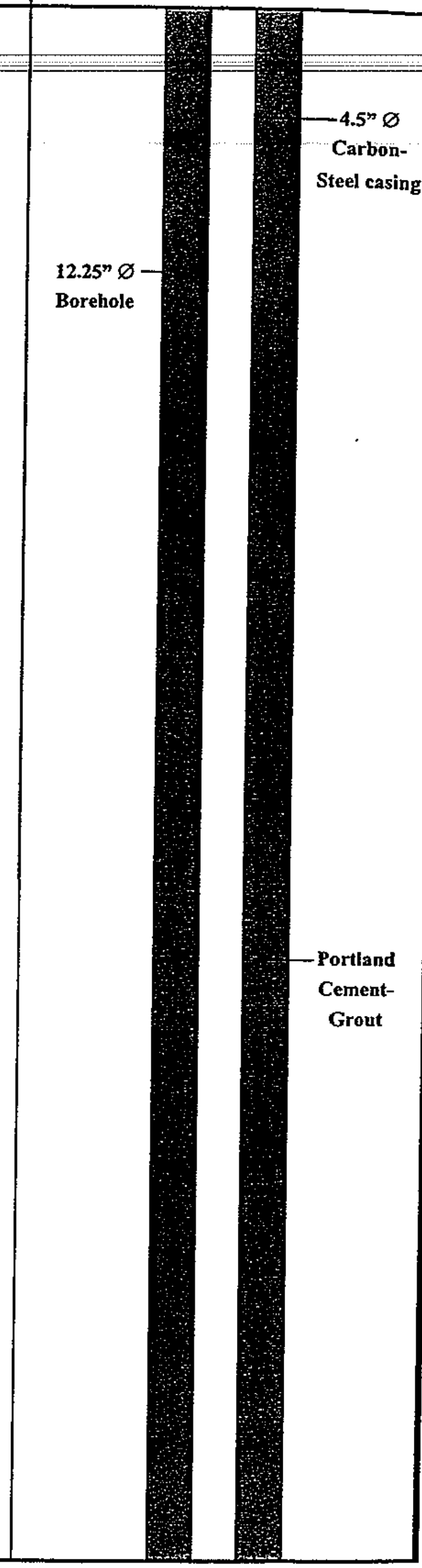
Stickup – 2.25 ft



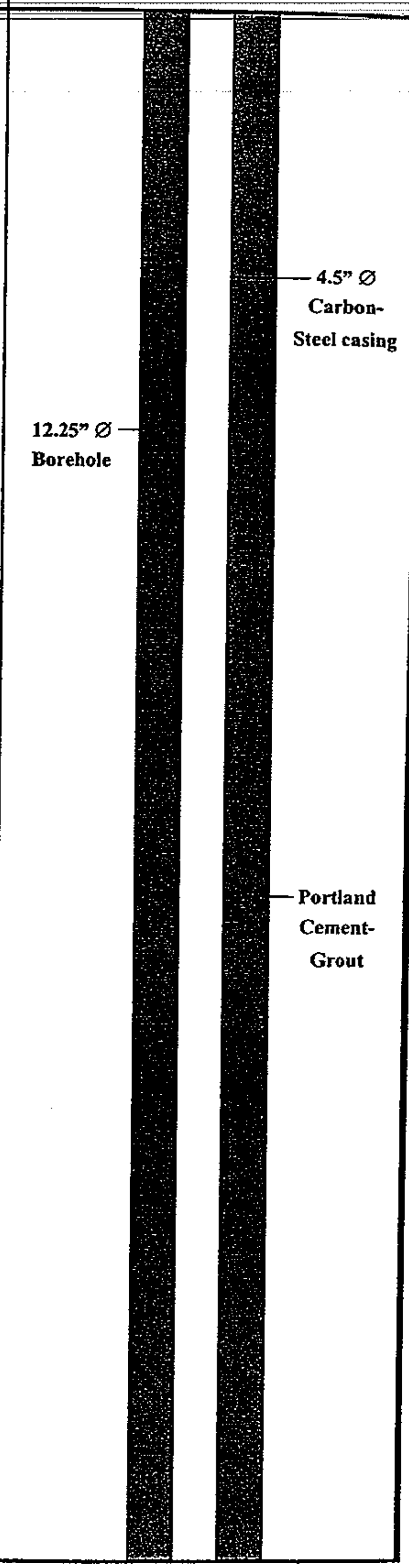
Notes:

Boring / Monitoring Well Installation Log
Boring No. / Well ID RCRA-10A

Depth (ft)	Lithologic Description	Remarks	Well Diagram
175			
200			
225			
250			
	Blue-Gray, Unweathered Fossiliferrous Chalk		
275			
300			
325			
350			
375			
		Top of Arcola Limestone 397.7' BGS	
400	Arcola Limestone		

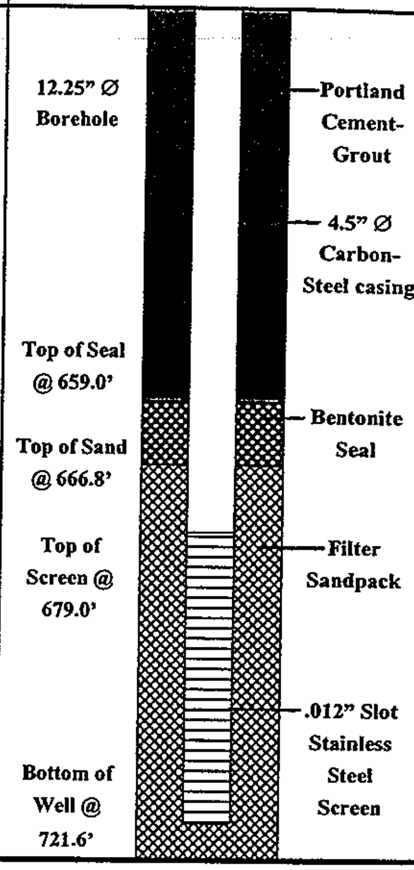


Depth (ft)	Lithologic Description	Remarks	Well Diagram
	Arcola Limestone	Bottom of Arcola Limestone 403.0' BGS	
425			
450			
475	Blue-Gray, Unweathered Fossiliferrous Chalk		
450			
475			
500			
525			
550			
575			
600			



Boring / Monitoring Well Installation Log
Boring No. / Well ID RCRA-10A

Depth (ft)	Lithologic Description	Remarks	Well Diagram
625 650 675	Blue-Gray, Unweathered Fossiliferrous Chalk		
	Clayey Fine Sand		
700 725	Gray-Green, Fine to Medium Sand (Pepper-like appearance-Black Sand Grains)	Top of Eutaw Formation 672.0' BGS Boring Terminated at 726.0' BGS	



APPENDIX E-13

DOCUMENT 3

WM

WASTE MANAGEMENT

~~Highway 17, Milemarker 163~~
P.O. Box 55
Emelle, AL 35459
(800) 652-5755
(205) 652-8289 Fax

RECEIVED
JAN 21 1999
Project #

January 18, 1999

Mr. John A. Poole, Jr., Chief
Land Division
Alabama Department of Environmental Management
1751 Congressman W. L. Dickinson Drive
Montgomery, Alabama 36109

RE: Waste Management (WM) Emelle, Alabama Facility
AHWMMA Permit Number ALD 000 622 464
Permit Condition X.B.1.e. and X.B.1.j. (RCRA - 10A)

Dear Mr. Poole:

Pursuant to the WM AHWMMA Permit Condition X.B.1.e. and j., WM is requesting concurrence by the Alabama Department of Environmental Management (ADEM) with the proposed location of RCRA - 10A Eutaw Monitoring Well and exception to the required coring and borehole geophysical logging requirements contained in these permit conditions, within thirty (30) days of receipt of this letter.

In a letter, to the Agency dated December 15, 1998, WM presented: a description of the condition of Eutaw Formation monitoring well RCRA -10R, which has been found unusable; a recommendation for filling, sealing, and plugging the well; and a proposal that a replacement well, RCRA - 10A, be drilled and installed. WM has retained a qualified drilling contractor to drill and install the new well RCRA - 10A to the specifications required by the above referenced permit. However, WM requests that the coring and borehole geophysical logging requirements, which are directed toward characterizing the Arcola Limestone in this area, be excepted for this well. The Arcola Limestone report submitted to ADEM on November 9, 1998, contained detailed information on Arcola Limestone obtained from coring and borehole geophysical logging performed in the boreholes drilled for RCRA - 10 and RCRA- 10R. It is the opinion of WM and its consultant, Jordan, Jones and Goulding, that the characterization of the Arcola Limestone required by the above referenced permit conditions has been complete, and therefore no additional coring or logging is required.

The proposed location for the new well RCRA -10A is approximately 180 feet southwest of the existing will RCRA - 10R. The new well location selection is hydraulically upgradient of wells RCRA - 10 and RCRA - 10 R to minimize potential interference in the effectiveness of the new well from possible changes in aquifer characteristics from the filling, plugging and sealing of the previously drilled wells. A tentative date has been established with the contractor for drilling the new well, but it is contingent upon drilling equipment availability and potential schedule daily due to weather. WM will notify ADEM as soon as possible once the actual start date has been confirmed.

If you have any questions please call Teresa Williams at (205) 652-8140.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to be the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,
Waste Management

Rodger Henson, Ph.D.
Division President

cc: Teresa Williams
Michael Feeney
Correspondence File
Repository
Permit File

APPENDIX E-13

DOCUMENT 4

MTF

Jordan
Jones &
Goulding
INCORPORATED

2000 CLEARVIEW AVE., N.E.
ATLANTA, GEORGIA 30340
PHONE: (770) 455-8555 ☐ FAX: (770) 455-7391

ATLANTA
ATHENS
COLUMBUS
COLUMBIA
CHARLESTON
KNOXVILLE
LEXINGTON
LOUISVILLE
MIAMI
PUERTO RICO

March 2, 1998

Mr. Steve Pekera
Chemical Waste Management, Inc.
Route 17 at Milepost 163
Emelle, Alabama 35459

RE: Abandonment Plan of Boring RCRA-10

Dear Mr. Pekera:

Jordan, Jones & Goulding, Inc. (JJ&G) is providing this abandonment plan for the boring installed in the original location of well RCRA-10. This abandonment plan should be submitted to the Alabama Department of Environmental Management (ADEM) for approval prior to initiating abandonment activities.

Background

JJ&G was retained by the Chemical Waste Management, Inc. Emelle, Alabama, facility (CWM-Emelle) to inspect the installation of monitoring well RCRA-10. CWM-Emelle contracted with the Layne Christensen Company (Layne) to provide drilling and well installation services for well RCRA-10. During the installation of the well casing and screen, a pipe clamp failed and the well material fell 140 feet to the bottom of the hole. Layne was able to remove the well casing from the borehole, but the 40-foot section of 2-inch stainless steel screen was damaged and lodged in the lower portion of the boring. Layne attempted to remove the stainless steel screen from the boring, but in the process lost a carbon steel fishing bit downhole. Several attempts were made to retrieve the material from the boring without success.

Given the presence of the carbon steel bit in the borehole, it has been recommended that this boring be abandoned and a new boring be installed approximately 250 feet to the northwest of the abandoned boring.

Jordan
Jones &
Goulding

Abandonment Plan

JJ&G obtained a copy of the *Guidelines for Well Abandonment* from the ADEM Ground Water Branch. The guideline stipulates for hazardous waste management sites that the preferred method of abandonment is to completely remove the well casing and screen from the borehole, including the grout and filter pack materials. The boring should be backfilled from the bottom to the top by pressure grouting with the positive displacement method (tremie method).

In the case of the original location of well RCRA-10, a monitoring well was never installed because of the lost materials downhole. Thus, filter pack and grout materials were never installed into the borehole. However, the approximate 40 feet of 2-inch stainless steel screen and the carbon steel fishing bit remain in the hole. As mentioned above, several attempts were made to retrieve the material from the boring without success.

This abandonment plan proposes following the abandonment guidelines of the Ground Water Branch of ADEM with the exception of completely removing all of the material downhole. The boring will be backfilled with a pure bentonite grout. The bentonite grout will be placed into the borehole from the bottom to the top using a tremie method as stipulated in the *Guidelines for Well Abandonment*. The top 2 feet of the borehole will be backfilled with concrete and a concrete pad will be formed at the surface to ensure a secure seal.

JJ&G is pleased to support CWM-Emelle on this project. If you have any questions or comments, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

for Michael T. Feeney

Sherri H. Clark, P.G.
Project Geologist

Michael T. Feeney

Michael T. Feeney, P.E.
Manager, Geosciences

1186.010(5B1)
P:\1186-010\RCRA10ABANDONMENTPLAN.DOC

APPENDIX E-14

SECTION E

SELMA CHALK WELL ABANDONMENT DOCUMENTATION

Revision No.

5.0

APPENDIX E-14

SECTION E

LIST OF DOCUMENTS

Document 1: Abandonment of Wells SM-25 and SM-26, prepared by Jordan, Jones & Goulding, Inc., dated February 7, 1995.

Document 2: M-Series Monitoring Well Abandonment, prepared by Terracon Consultants, Inc., dated August 9, 2017.

APPENDIX E-14

DOCUMENT 1

Jordan Jones & Goulding
INCORPORATED

ATLANTA
ATHENS
COLUMBUS
COLUMBIA
CHARLESTON
KNOXVILLE
PUERTO RICO

2000 CLEARVIEW AVE., N.E.
ATLANTA, GEORGIA 30340
PHONE: (404) 455-8555 ☐ FAX: (404) 455-7391

February 7, 1995

Ms. Teresa Williams
Chemical Waste Management, Inc.
Route 17 at Milepost 163
Emelle, Alabama 35459

RE: Abandonment of Wells SM-25 and SM-26

Dear Teresa:

Jordan, Jones & Goulding, Inc. (JJ&G) was retained by the Chemical Waste Management, Inc. Emelle, Alabama, facility (CWM-Emelle) to abandon two monitoring wells at CWM-Emelle, SM-25 and SM-26. SM-25 and SM-26 were installed to monitor surface impoundment L-3 which was clean closed in 1989. JJ&G contracted Atlanta Testing & Engineering, Inc. (AT&E) to abandon SM-25 and SM-26 in conjunction with the installation of four monitoring wells near SM-18. A JJ&G geologist observed and documented the well abandonment procedures.

SM-25 and SM-26 were abandoned on December 9, 1994, by AT&E personnel by placing a tremie pipe inside each well and grouting, from the bottom of the well upward, with a cement/bentonite grout. Grout was pumped into each well until grout returned from the top of the well. The grout mixture consisted of 94-pound bags of Portland Type I cement, and 5-percent bentonite powder, by dry weight, mixed to approximately 7 1/2 gallons of water. Prior to grouting, the protective well covers and well pads had been removed by CWM-Emelle staff.

JJ&G trusts that this information meets your needs. If you have further comments or need additional information, please call us.

Sincerely,

JORDAN, JONES & GOULDING, INC.

Michael T. Feeney

Michael T. Feeney, P.E.
Manager, Geotechnology

/mtf
1186.004(5B1)
P:\CWM004\WL-ABND.W51

APPENDIX E-14

DOCUMENT 2

August 9, 2017

Mr. Clay Messer
Alabama Department of Environmental Management
Industrial Hazardous Waste Branch
Engineering Services Division
1400 Coliseum Boulevard
Montgomery, Alabama 36110-2400

RE: M-Series Monitoring Well Abandonment
Chemical Waste Management, Inc.
36964 AL Hwy 17
Emelle, Sumter County, Alabama
ADEM Permit ALD 000 622 464
Terracon Project No. E1177090

Dear Mr. Messer:

On behalf of Chemical Waste Management, Inc. (CWM), Terracon Consultants, Inc. (Terracon) is pleased to submit this letter report to you summarizing the abandonment of the M-series monitoring wells, including PM-17 and PM-18, and the over-drilling and abandonment of background monitoring well SMBG-01 located at the above-referenced site. The monitoring well abandonment plan was submitted by Golder and Associates, Inc. (Golder) on February 8, 2016 and July, 18, 2017. The Chemical Waste Management Inc. (CWM) abandonment activities were approved by ADEM's M-Series Well Abandonment Plan letter, dated March 15, 2016, and its Addendum to Revised M-Series Well Abandonment Plan letter, dated July 24, 2017. The Golder and ADEM Correspondence is included as an attachment.

M-Series, PM-17, and PM-18 Well Abandonment

On July 18-20, 2017, a Terracon geologist supervised the abandonment of M-series wells M-3, M-54 through M-59, M-61, M-62, M-64, M-65, M-66, M-68, and M-69, as well as piezometers PM-17 and PM-18 by Terracon Drilling Services of Chattanooga, Tennessee. Prior to abandonment activities, the total well depths and depths to water were measured in all M-series wells. Abandonment of the monitoring wells were achieved by:

- Removal of the protective steel covers or concrete vaults, poly-vinyl chloride (pvc) well casings to 2-feet below grade surface (ft bgs), concrete pads, and protective bollards with a backhoe on all M-series wells and PM-17 and PM-18;
- Removal of dedicated pumps and associated tubing;
- Installation of grout into the boring to within two feet of the surface via the tremie method on all M-series wells, including PM-17 and PM-18;
- Allowing the grout time to settle;
- Installation of cement in the top two feet of the boring; and
- Topping off of the boring with topsoil to match the surrounding surface on all M-series wells, including PM-17 and PM-18.

Concrete, manhole covers and lids, and pvc casings were transported by backhoe to a centralized location on site for used construction materials. Boring logs for the abandoned wells as wells as photos depicting each well's completed abandonment are included as an attachment

SMBG-01 Abandonment

On July 26-27, 2017, a Terracon geologist supervised the abandonment of background well SMBG-01 by Terracon Drilling Services of Chattanooga, Tennessee. Prior to any abandonment activities, the total well depth and depth to water was measured. Abandonment of the monitoring wells was achieved by:

- Removal of the protective steel cover, concrete pad, and protective bollards with a backhoe;
- Over-drilling through the center of the casing via solid stem auger;
- Excavating (via trackhoe) immediately adjacent to the outer 6-inch casing of the well after the inner 2-inch casing broke approximately 10 ft bgs;
- Locating and grabbing the broken casing in the excavated trench;
- Pulling out the entirety of the 2-inch well casing;
- Over-drilling the remaining well materials (sand, bentonite slurry) down to 100 ft bgs;
- Installation of grout into the boring to within two feet of the surface via the tremie method;
- Allowing the grout time to settle;
- Installation of cement in the top two feet of the boring; and
- Topping off of the boring with topsoil to match the surrounding surface.

Concrete, protective steel cover, protective bollards and pvc casings were transported by backhoe to a centralized location on site for used construction materials. The boring log for SMBG-01, as wells as photos depicting its abandonment are attached.

Terracon

If you have any questions concerning this, please call us at (205) 942-1289.

Sincerely,
Terracon Consultants, Inc.

Brian B. Brown
Staff Geologist

Chris Gillentine
Senior Project Geologist

Terrell W. Rippstein
Principal Geologist

cc: Brian Espy, ADEM
Robert Stanley, ADEM
Mike Davis, CWM
Robert Kronable, CWM
Michael Smiley, Golder
Scott Terrell, Jacobs

Attachments: Golder and ADEM Correspondence
Figure 1 – Site Map
Table 1 – M-Series Well Data
Photographs of Site Activities
Boring Logs for Abandoned Wells

Attachment

Golder and ADEM Correspondence

February 8, 2016 1417910

Mr. Robert Stanley
Alabama Department of Environmental Management
Industrial Hazardous Waste Branch
Land Division
1400 Coliseum Boulevard
Montgomery, AL 36110-2400

**RE: M-SERIES WELL ABANDONMENT PLAN
CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA**

Dear Mr. Stanley:

At the request of Chemical Waste Management (CWM), Golder Associates Inc. (Golder) has prepared this monitoring well abandonment plan for fourteen (14) M-series groundwater monitoring wells, shown in Figure 1. These monitoring wells are utilized for water level collection purposes, only. Historically, these wells pre-date the current surveillance groundwater monitoring system and were components of trench closure activities, PCB monitoring evaluations, and water level studies. Additional Selma Chalk monitoring wells have been installed as new trenches were installed and the facility expanded, making the M-series wells unnecessary for groundwater flow evaluations. As a result, the M-series wells are proposed for abandonment. The abandonment of the M-series wells will be performed in accordance with Alabama Environmental Investigation and Remediation Guidance (AEIRG) as described in Appendix A.

To comply with AEIRG guidance, Golder and CWM understand that this plan requires ADEM concurrence. Golder, on behalf of CWM, requests that ADEM provide comment or concurrence following receipt of this correspondence, so that the monitoring well abandonment plan may be appropriately executed. Please contact Mr. Robert Kronable at (205) 652-8179 or Mr. Mike Smilley at (248) 295-0135, if you have any questions regarding the proposed well abandonment activities. We look forward to your review of this abandonment plan.

Sincerely,

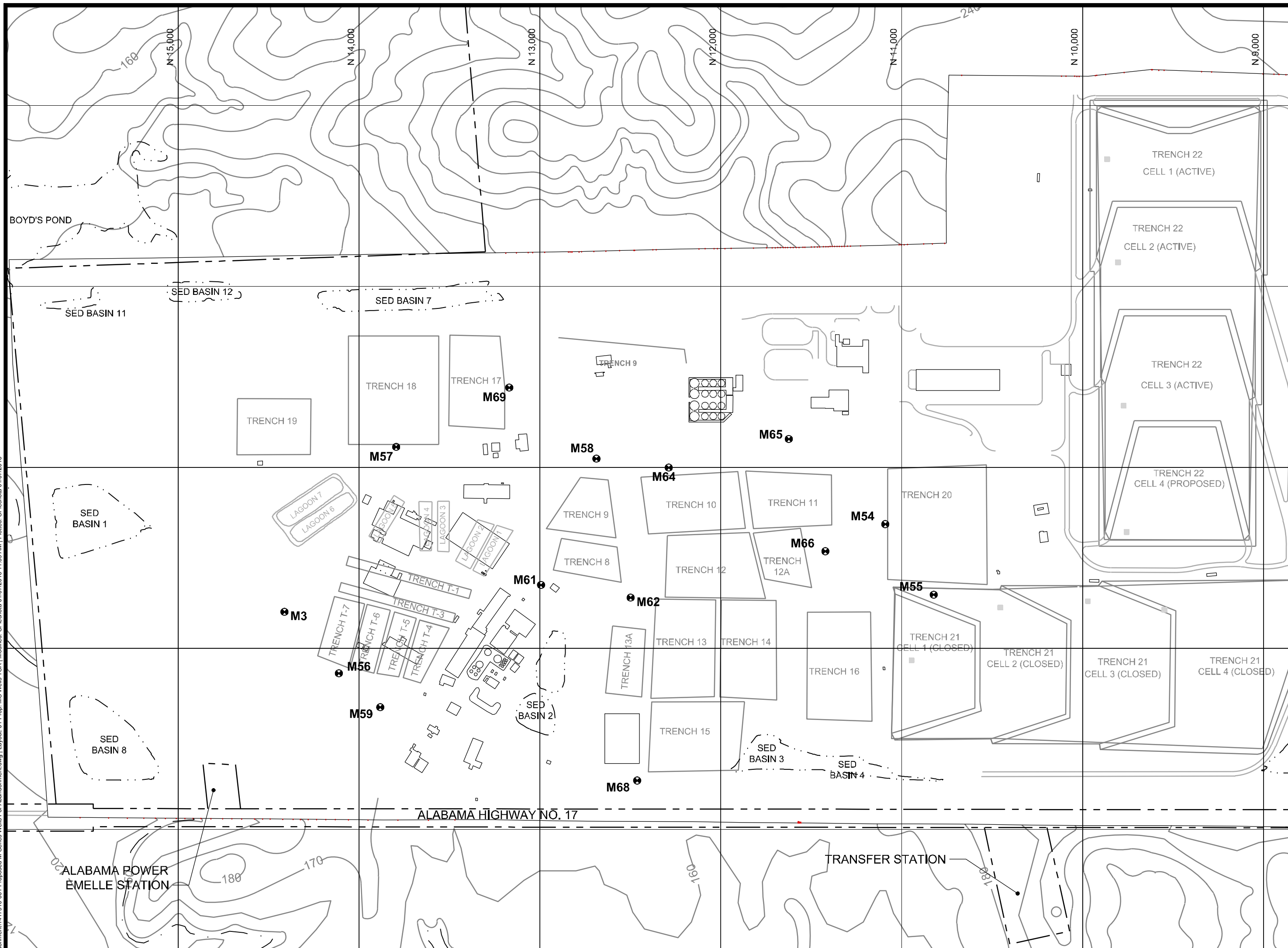
GOLDER ASSOCIATES INC.

Michael Jay Smilley, P.G.
Senior Project Geologist

Jeffery C. Paul, P.G.
Principal and Senior Practice Leader

cc: Robert W. Kronable, CWM
Clay Messer, ADEM

Attachments: Figure 1
Appendix A: Well Decommissioning Procedures



WELL ID	WELL DEPTH	SCREENED INTERVAL	MONITORED ZONE
M-3	61.66	55.00 - 65.00	SELMA CHALK
M-54	154.80	79.69 - 89.54	SELMA CHALK
M-55	170.25	79.64 - 89.54	SELMA CHALK
M-56	96.48	55.00 - 65.00	SELMA CHALK
M-57	156.59	48.75 - 58.60	SELMA CHALK
M-58	110.50	148.58 - 158.43	SELMA CHALK
M-59	102.40	80.00 - 90.00	SELMA CHALK
M-61	104.47	148.58 - 158.43	SELMA CHALK
M-62	158.60	148.58 - 158.43	SELMA CHALK
M-64	151.20	148.58 - 158.43	SELMA CHALK
M-65	130.24	153.76 - 163.61	SELMA CHALK
M-66	118.62	149.80 - 159.60	SELMA CHALK
M-68	117.60	129.88 - 134.78	SELMA CHALK
M-69	143.30	120.00 - 129.85	SELMA CHALK

LEGEND

PROPERTY LINE

M3 — M - SERIES WELLS (TO BE ABANDONED)

REFERENCES

1. BASE MAP (emellewrk.dwg) PROVIDED BY WASTE MANAGEMENT INC. VIA E-MAIL DATED MAY 31, 2011.

2. GRID IS BASED ON SITE COORDINATE SYSTEM.

SCALE 0 300 600 900 FEET

PROJECT: WASTE MANAGEMENT EMELLE FACILITY / ALABAMA

TITLE: PROPOSED M - SERIES WELLS TO BE ABANDONED

Golder Associates

PROJECT No.		1417910	FILE No. 1417910-001 Proposed M-Series Wells For Abandonment
DESIGN	-	-	SCALE AS SHOWN
CADD	SEP	2016-01	FIGURE
CHECK	MJS	2016-01	1
REVIEW	JJCP	2016-01	

G:\Waste Management\1417910 Emelle\Production\M-Series Well Abandonment\1417910-001 Proposed M-Series Wells For Abandonment.dwg | Layout: 01 Prop. MS Wells TOA | Modified: SPiechota 01/07/2016 11:39 AM | Plotted: SPiechota 01/07/2016

1.0 INTRODUCTION

The following sections provide general decommissioning procedures for M-Series monitoring wells along with specific abandonment methods.

2.0 GENERAL DECOMMISION PROCEDURES

The proposed wells will be abandoned in accordance with ADEM well construction standards (Code R. 335-9-1-.06(g)), ADEM Ground Water Branch guidelines, and United States Environmental Protection Agency Region 4 procedures for well abandonment. The well will be sealed to prevent migration of contaminants from the ground surface to the water table or between aquifers. The drilling rig and associated down-hole tools to be used for abandonment will be cleaned and decontaminated prior to commencing work.

Field personnel will provide oversight of all abandonment activities and will record pertinent information related to the abandonment including well location, date and time on site, equipment present, and materials used.

First, the well will be over-drilled to the original boring depth using hollow stem augers (HSA), or similar method, with a nominal inner diameter (ID) two inches larger than the well casing. The well casing will serve as a guide for the HSA. After the original boring termination depth is reached, the well casing will be removed from inside the augers. The augers will then be removed from the borehole along with original backfill (where applicable) and construction materials. The borehole will be pressure grouted to the surface via tremie method with grout slurry consisting of 5 percent bentonite powder and 95 percent Portland cement. Boreholes will be checked 24 to 48 hours after grout/bentonite emplacement to determine whether the grout cured properly. If settling has occurred, a sufficient amount of mud/solid bentonite will be added to fill the hole to the ground surface. Curing checks and addition of mud/solid bentonite will be recorded in the field log.

3.0 REPORTING

Once abandonment is complete, a report will be submitted to ADEM summarizing abandonment activities. The report will include the following information:

- Site name and address;
- Type of well abandoned;
- Justification for abandonment;
- Well identification;
- Well abandonment date and supervisor;
- Latitude and longitude of well;
- Site map showing abandoned well location;
- Description of abandonment methods (e.g. total depth, type of sealant, etc.); and
- Photographs of abandoned well.

Lance R. LeFleur
Director

ADEM

Robert J. Bentley
Governor

Alabama Department of Environmental Management
adem.alabama.gov
1400 Coliseum Blvd. 36110-2400 ▪ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ▪ FAX (334) 271-7950

March 15, 2016

Mr. Mike Davis
District Manager
Chemical Waste Management
P.O. Box 55
Emelle, AL 35459-0055

Re: M-Series Wells Abandonment Plan
Chemical Waste Management, Inc. (CWM)
Emelle, Alabama Facility
USEPA I.D. Number: ALD 000 622 464

Dear Mr. Davis:

The Department has reviewed the abandonment plan for the M-series wells dated February 8, 2016, and has determined that the plan appears to be adequate and complies with the facility's Hazardous Waste Permit. The abandonment of the M-series wells should proceed in compliance with Section IX.B.1.a. of the facility's Hazardous Waste Permit.

If questions should arise concerning this matter, please contact Mr. Clay Messer of the Engineering Services Section at (334) 394-4330.

Sincerely,

Brian Espy, Chief
Engineering Services Section
Industrial Hazardous Waste Branch
Land Division

BE/CM/nbf

cc/via email: ADEM: Robert Stanley, Clethes Stallworth, Austin Pierce
Chemical Waste Management: Robert Kronable
Golder Associates: Michael Smilley

July 18, 2016 1653953

Mr. Robert Stanley
Alabama Department of Environmental Management
Industrial Hazardous Waste Branch
Land Division
1400 Coliseum Boulevard
Montgomery, AL 36110-2400

RE: ADDENDUM TO REVISED M-SERIES WELL ABANDONMENT PLAN
CHEMICAL WASTE MANAGEMENT FACILITY
EMELLE, ALABAMA

Dear Mr. Stanley:

At the request of Chemical Waste Management (CWM), Golder Associates Inc. (Golder) has prepared this addendum to the Revised Well Abandonment Plan, dated September 8, 2016. This addendum is submitted to include the abandonment of two additional monitoring wells (PM-17 and PM-18), overlooked when preparing the original submittal, at the Chemical Waste Management Facility, Emelle, Alabama. These wells pre-date the current surveillance groundwater monitoring system and were historically components of trench closure activities, PCB monitoring evaluations, and water level studies. These wells are proposed for abandonment using in-place abandonment methods. Concurrence on in-place abandonment was received from ADEM in an email dated August 26, 2016. Abandonment will be performed in accordance with Alabama Environmental Investigation and Remediation Guidance (AEIRG).

To comply with AEIRG guidance, Golder and CWM understand that this plan requires ADEM concurrence. We request that ADEM provide comment or concurrence following receipt of this correspondence so that the well abandonment may be appropriately coordinated. Please contact Mr. Rob Kronable at (313) 322-9834 or Mr. Mike Smilley at (203) 947-9360 if you have any questions regarding the proposed well abandonment activities. We look forward to your review of the abandonment plan.

Sincerely,

GOLDER ASSOCIATES INC.

Michael Jay Smilley, P.G.
Senior Project Geologist

cc: Clay Messer, ADEM

LANCE R. LEFLEUR
DIRECTOR

ADEM

Alabama Department of Environmental Management
adem.alabama.gov

1400 Coliseum Blvd. 36110-2400 ■ Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 ■ FAX (334) 271-7950

KAY IVEY
GOVERNOR

RECEIVED
JUL 27 2017
W... TE MANAGEMENT
EMELLE, ALABAMA

July 24, 2017

Mr. Mike Davis
District Manager
Chemical Waste Management
P.O. Box 55
Emelle, AL 35459-0055

Re: Addendum to Revised M-Series Wells Abandonment Plan
Chemical Waste Management, Inc. (CWM)
Emelle, Alabama Facility
USEPA I.D. Number: ALD 000 622 464

Dear Mr. Davis:

The Department has reviewed the addendum to the revised abandonment plan for the M-series wells dated July 18, 2016, and has determined that the plan appears to be adequate and complies with the facility's Hazardous Waste Permit. The abandonment of the M-series wells should proceed in compliance with Section XI.B.1.a. of the facility's Hazardous Waste Permit.

If questions should arise concerning this matter, please contact Mr. Clay Messer of the Engineering Services Section at (334) 394-4330.

Sincerely,

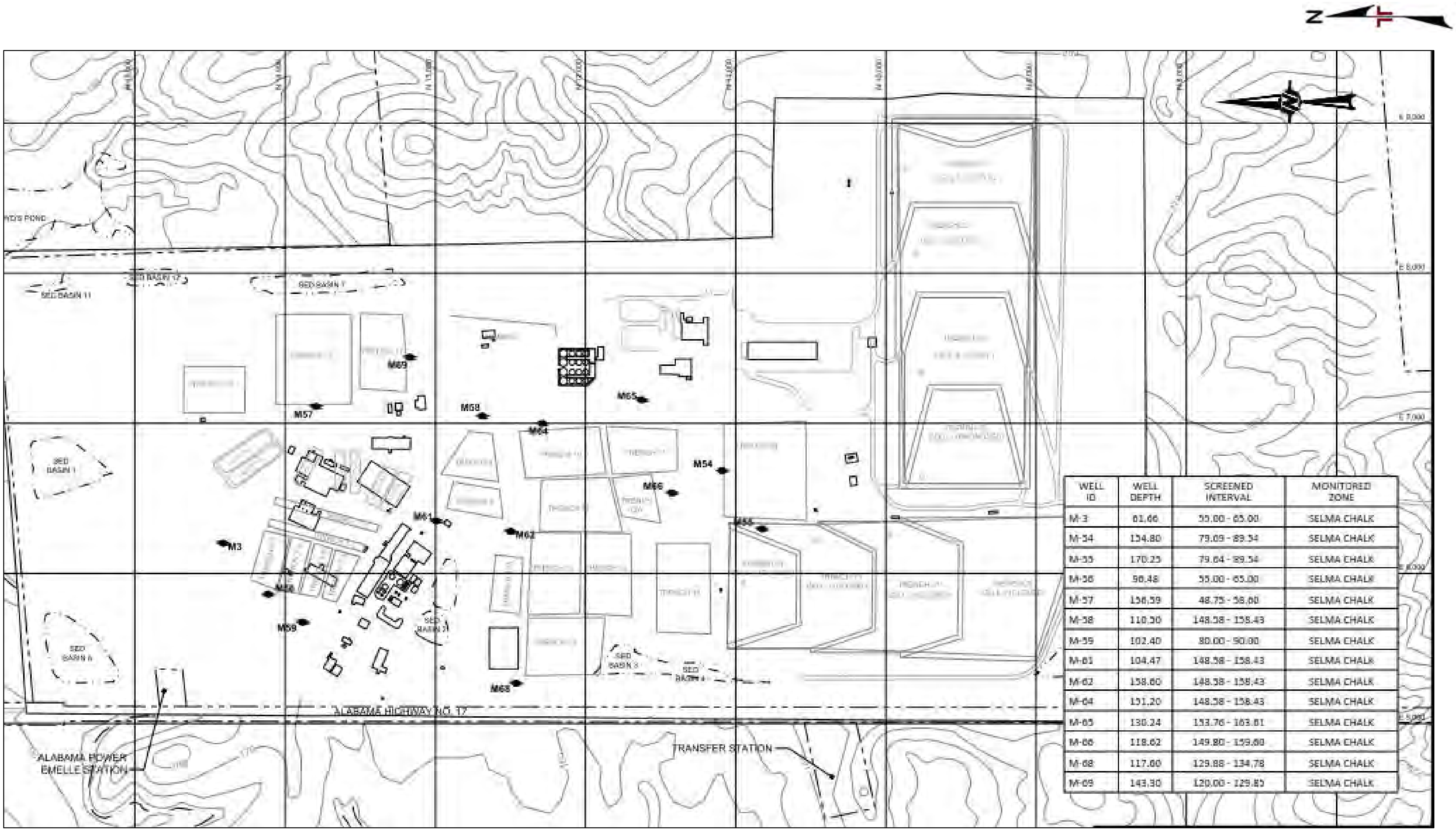
Brian Espy, Chief
Engineering Services Section
Industrial Hazardous Waste Branch
Land Division

BE/CM/nbf

cc/via email: ADEM: Robert Stanley, Brent Watson, Austin Pierce
Chemical Waste Management: Robert Kronable
Golder Associates: Michael Smilley

Attachment

Figure 1 – Site Map



WELL ID	WELL DEPTH	SCREENED INTERVAL	MONITORED ZONE
M-3	61.66	55.00 - 65.00	SELMA CHALK
M-54	154.80	79.09 - 89.34	SELMA CHALK
M-55	170.25	79.64 - 89.34	SELMA CHALK
M-56	98.48	55.00 - 65.00	SELMA CHALK
M-57	156.59	48.75 - 58.60	SELMA CHALK
M-58	110.30	148.58 - 158.43	SELMA CHALK
M-59	102.40	80.00 - 90.00	SELMA CHALK
M-61	104.47	148.58 - 158.43	SELMA CHALK
M-62	158.60	148.58 - 158.43	SELMA CHALK
M-64	151.20	148.58 - 158.43	SELMA CHALK
M-65	130.24	153.76 - 163.81	SELMA CHALK
M-66	118.62	149.80 - 159.60	SELMA CHALK
M-68	117.60	129.88 - 134.78	SELMA CHALK
M-69	143.30	120.00 - 129.85	SELMA CHALK

Project Manager: CJG	Project No. E1177090		
Drawn By: CWM	Scale: As Shown		
Checked By: CJG	File Name: E1177090		
Approved By: TWR	Date: July 2017		

Terracon
Consulting Engineers & Scientists
110 12th Street North Birmingham, Alabama 35203
PH. (205) 942-1289 www.terracon.com

Site Map

M-Series Well Abandonment
Chemical Waste Management
Emelle, Sumter County, Alabama

Figure 1

Attachment

Table 1 – M-Series Well Data

Table 1
M-Series Well Abandonment
Chemical Waste Management, Emelle Facility
Emelle, Sumter County, Alabama
ADEM Permit ALD 000 522 464
July 18-19, 2017
Project No.: E1177090

Well Number	Well Type	Well Latitude (State Plane E)	Well Longitude (State Plane N)	Well Depth (ft BTOC)	Depth to Water (ft BTOC)	Ground Elevation (ft. MSL)	TOC Elevation (ft. MSL)	Screened Interval (ft MSL)	Monitored Zone/Aquifer*
M-3	PGM	14413.07	6200.02	61.66	2.01	173.71	176.71	55.00 - 65.00	Selma Chalk
M-54	PGM	11091.35	6684.71	154.80	33.58	242.06	245.06	79.69 - 89.54	Selma Chalk
M-55	PGM	10823.63	6295.65	170.25	42.42	245.85	248.85	79.64 - 89.54	Selma Chalk
M-56	PGM	14112.86	5860.67	96.48	21.40	201.88	204.88	55.00 - 65.00	Selma Chalk
M-57	PGM	13795.75	7112.00	156.59	17.49	204.28	207.28	48.75 - 58.60	Selma Chalk
M-58	PGM	12688.55	7047.96	110.50	18.44	249.95	251.95	148.58 - 158.43	Selma Chalk
M-59	PGM	13883.75	5673.26	102.40	13.84	196.87	199.87	80.00 - 90.00	Selma Chalk
M-61	PGM	12994.73	6349.21	104.47	7.38	215.02	218.02	148.58 - 158.43	Selma Chalk
M-62	PGM	12499.47	6279.17	158.60	44.76	257.97	260.97	148.58 - 158.43	Selma Chalk
M-64	PGM	12288.77	6997.77	151.20	49.43	271.60	274.60	148.58 - 158.43	Selma Chalk
M-65	PGM	11624.82	7156.02	130.24	43.11	275.66	278.66	153.76 - 163.61	Selma Chalk
M-66	PGM	11422.69	6535.25	118.62	28.33	249.99	251.99	149.80 - 159.60	Selma Chalk
M-68	PGM	12463.18	5267.95	117.60	23.09	198.93	201.93	129.88 - 134.78	Selma Chalk
M-69	PGM	13711.44	7441.22	143.30	31.59	230.69	233.69	120.00 - 129.85	Selma Chalk
PM-17	PGM	11388.82	5509.26	112.02	22.09	201.82	204.82	97.00 - 107.56	Selma Chalk
PM-18	PGM	11104.51	5837.66	163.58	37.43	222.62	225.62	97.00 - 107.00	Selma Chalk
BG-1	CSM, BKG	11030.32	7976,10	100.70	72.31	293.40	297.12	206.14 - 196.24	Selma Chalk

PGM =Piezometer and/or General Monitoring
BKG = Background Wells
MSL = Mean Sea Level

BTOC = Below Top of Casing
BLS = Below Land Surface

Attachment

Photographs of Site Activities

Photo #1 Method of grouting the M-series wells.

Photo #2 (Continued)

Photo #3 (Continued)

Photo #4 Method of removing concrete pad, well bollards, well vault, etc.

Photo #5 (Continued)

Photo #6 (Continued)

Photo #7 M-56 completed abandonment

Photo #8 M-59 completed abandonment

Photo #9 M-3 completed abandonment

Photo #10 M-57 completed abandonment

Photo #11 M-69 completed abandonment

Photo #12 M-58 completed abandonment

Photo #13 M-64 completed abandonment

Photo #14 M-65 completed abandonment

Photo #15 M-54 completed abandonment

Photo #16 M-55 completed abandonment

Photo #17 PM-18 completed abandonment

Photo #18 M-66 completed abandonment

Photo #19 PM-17 completed abandonment

Photo #20 M-62 completed abandonment

Photo #21 M-61 completed abandonment

Photo #22 M-68 completed abandonment

Photo #23 Removing concrete pad, well bollards, well vault, etc.

Photo #24 (Continued)

Photo #25 Overdrilling of BG-1 before inner well casing broke about ten feet below grade.

Photo #26 Excavating immediately adjacent to outer well casing to locate broken inner well casing.

Photo #27 (Continued)

Photo #28 Located the break and removed the well casing.

Photo #29 Overdrilling of the bentonite slurry after well casing was removed.

Photo #30 BG-1 completed abandonment.

Attachment

Boring Logs for Abandoned Wells

Abandoned on 7/27/17

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3098.3 PROJECT CWM/CONSENT WELLS/EMELLE WELL NO. BG-1 SHEET 1 OF 1

GA INSP RDD DRILLING METHOD ROTARY WASH GROUND ELEV 293.94' WATER DEPTH –

WEATHER SUNNY DRILLING COMPANY TRI-STATE 2" PVC COLLAR ELEV. 296.94' DATE/TIME –

TEMP 35° F DRILL RIG MOBILE B-61 DRILLER DT/WG STARTED 8:25AM/12-16-85 COMPLETED 3:15PM/2-4-86 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 90.85 LF

CASING TYPE PVC SCHEDULE 80

JOINT TYPE THREADED (TEFLON WRAPPED)

GROUT QUANTITY APPROX. 12.0 FT. ABOVE PELLET SEAL

GROUT TYPE APPROX 1:1 RATIO OF AQUAGEL GOLD SEAL BENTONITE BINDER W/WATER

WELL SCREEN 2 in. dia. 9.85 LF

SCREEN TYPE PVC SCHEDULE 80

SLOT SIZE .010 INCH

CENTRALIZERS –

DRILLING MUD TYPE –

BENTONITE SEAL 2.7' THICK 1/2" Ø PELLETS, ABOVE SCREEN

INSTALLATION METHOD BY HAND

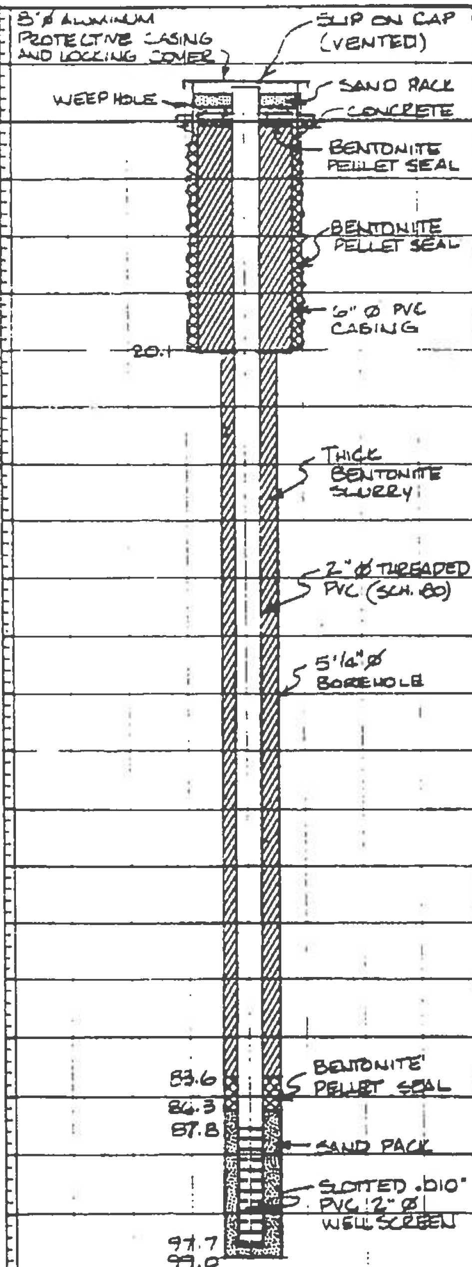
FILTER PACK QTY 3 BAGS (50LB. BAGS)

FILTER PACK TYPE #30 GRADE BLASTING SAND

INSTALLATION METHOD BY HAND

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
293.94'	GROUND SURFACE
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	IN SITU CHALK (NO FRACTURES)
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	
105.0	

WELL SKETCH



INSTALLATION NOTES

2" Ø PVC STANDPIPE "STICKUP" = 3.0'

ALUMINUM PROTECTIVE CASING STICKUP = 3.6'

WELL SCREEN INTERVAL SET AT DEPTHS BETWEEN 87.8' AND 97.7' AND NOT THE SPECIFIED DEPTH INTERVAL OF 89.0' TO 99.0' BECAUSE OF THE PIPE LENGTHS BEING CUT TOO SHORT. THE PIPE LENGTH DISCREPANCY WAS NOT NOTED UNTIL AFTER THE WELL WAS SET. THE DECISION WAS MADE TO LEAVE THE WELL SET AS SHOWN ON THE SKETCH.

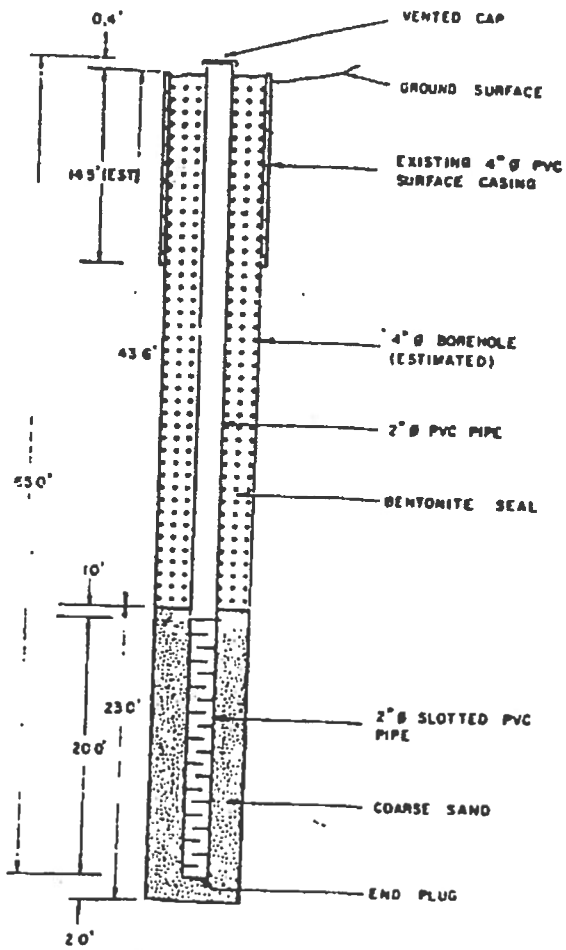
WELL DEVELOPMENT NOTES

Golder Associates

New Page
May 19, 1986

Abandoned on 720/17

WELL M-3



NOTES

1. THREADED 2" ø PVC PIPE USED THROUGHOUT.
2. SLOT SIZE OF 2" ø PVC IS 0.010 "
3. ADDITIONAL 4.1' UNATTACHED 6" ø PVC SURFACE CASING ON WELL PM-15 NOT SHOWN.
4. A 1.5' LENGTH OF 4" ø PVC SURFACE REMOVED FROM WELL M-3.

JOB NO. 824-1308.27	SCALE NOT TO SCALE	RECOMPLETION DETAIL
DRAWN CAB	DATE 11-15-83	
CHECKED EB	DWG. NO. —	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC

Abandoned on 7/20/17

JOB NO. ______ PROJECT *Closure Trench 16 Well raised* WELL NO. *PM 17* APR - 1 198[illegible] SHEET ______

QA INSP. ______ DRILLING METHOD ______ GROUND ELEV. *247.2* WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ COLLAR ELEV. *250.94* DATE/TIME ______

TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED *3/18/86* TIME / DATE COMPLETED ______

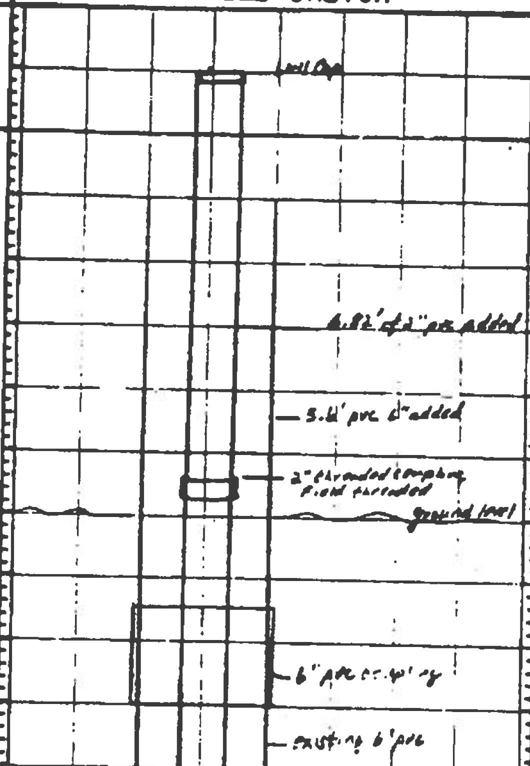
MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ LF
CASING TYPE ______
JOINT TYPE ______
GROUT QUANTITY ______
GROUT TYPE ______

WELL SCREEN ______ in. dia. ______ LF
SCREEN TYPE ______
SLOT SIZE ______
CENTRALIZERS ______
DRILLING MUD TYPE ______

BENTONITE SEAL ______
INSTALLATION METHOD ______
FILTER PACK QTY. ______
FILTER PACK TYPE ______
INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION N[...]
	GROUND SURFACE		
0.0			



INSTALLATION N[...]

Well raised in sh[...]
Two 2'x4' barrier[...]
Shown. Well had [...]
been raised before[...]

pvc totally stem[...]
well fill threaded[...]
added. Threads [...]
6" pvc added to [...]
6" pvc from previous[...]
5 gal. bentonite pelle[...]
6" annulus.
well barrier 6" s[...]
with locking cap se[...]
new elev. are 2[...]

WELL DEVELOPMENT

taken from Closure report 8-18 + 20 1986 pages 1-9

(1)

Abandoned on 7/20/17

WELL INSTALLATION LOG

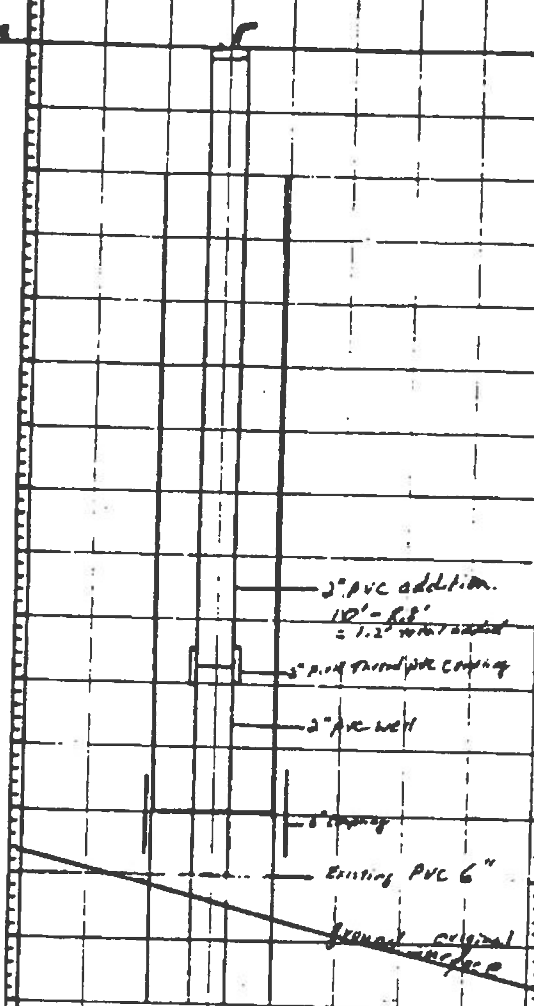
JOB NO. ______ PROJECT Tinach 16 Placeme Well raised WELL NO. AN 18 SHEET 1
GA ENGR. ______ DRILLING METHOD ______
WEATHER ______ DRILLING COMPANY ______ GROUND ELEV. 198.6 WATER DEPTH
TEMP. ______ DRILL RIG ______ DRILLER ______ Top of Casing / COLLAR ELEV. 201.02 DATE/TIME
STARTED 5/ TIME / 5/16/96 DATE COMPLETED

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ LF
CASING TYPE ______
JOINT TYPE ______
GROUT QUANTITY ______
GROUT TYPE ______

WELL SCREEN ______ in. dia. ______ LF
SCREEN TYPE ______
SLOT SIZE ______
CENTRALIZERS ______
DRILLING MUD TYPE ______

BENTONITE SEAL ______
INSTALLATION METHOD ______
FILTER PACK QTY. ______
FILTER PACK TYPE ______
INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION
0.0	GROUND SURFACE		5-16-96 Well rai[sed] 10.0' section add[ed] 6" pvc connected to PVC. Well cap replac[ed] placed over well. Final Grade deter[mined] Changed. Addition to Cut off so that on[ly] of 1.2' added to Well 2'x4' Concrete bu[...] Steel well locking Bentonite pellets in Steel annulus. NAD msl elev. 2[...] Well depth 198[...]

WELL DEVELOPMENT

Abandoned on 7/20/17

WELL INSTALLATION LOG

PROJECT *T20 Closure — Well raising* WELL NO. *MS4* SHEET *1*

G.E. ENGR. ______ DRILLING METHOD [redacted] GROUND ELEV. *0* WATER DEPTH

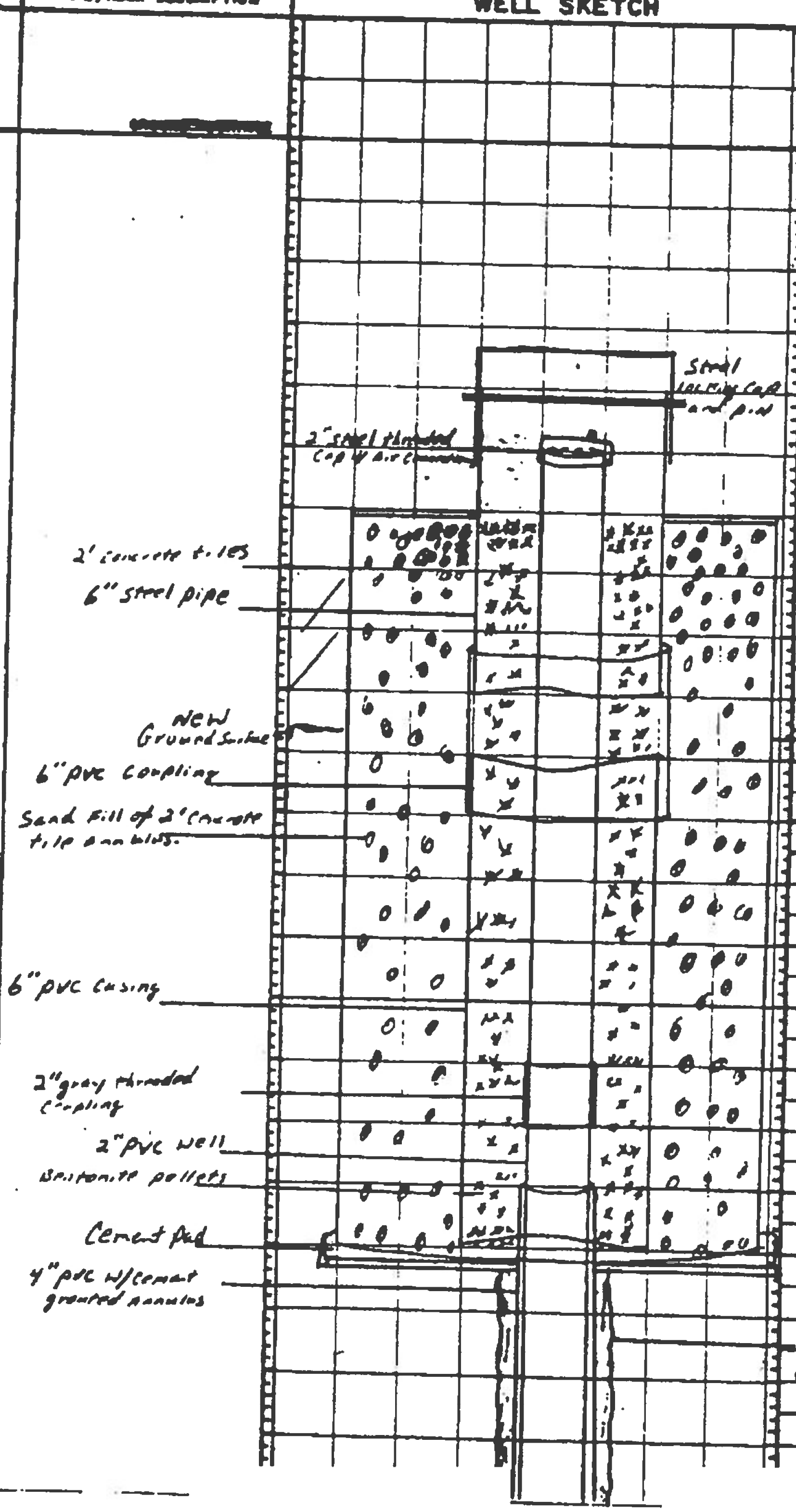
WORKER ______ DRILLING COMPANY [redacted] COLLAR ELEV. *246.13* DATE/TIME

TEAM ______ STARTED ______ TIME / DATE COMPLETED ______

MATERIALS INVENTORY

WELL CASING *2* [redacted]	WELL SCREEN ______ in. dia. ______ ft	BENTONITE SEAL ______
CASING TYPE *4" and 6"*	SCREEN TYPE ______	INSTALLATION METHOD ______
JOINT TYPE *threaded*	SLOT SIZE ______	FILTER PACK QTY. ______
GROUT QUANTITY ______	CENTRALIZERS ______	FILTER PACK TYPE ______
GROUT TYPE ______	DRILLING MUD TYPE ______	INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION N...
0.0			



INSTALLATION N...

2" pvc cut off ...
backhoe 2" below ...
joint attached 6-20 ...
2" pvc rethreaded ...
field threader; ...
teflon tape and ...
a threaded 2" pvc ...
All tools and ...
steam cleaned and ...
Well in plastic 2' ...
concrete tiles placed ...
raised well to ...
fill. 10' section ...
to well ...
... water level ...
Plastic bag ...
... 11/81?? ...
off and well protection ...
7.75' total added ...
Pipe elev. 246.13
Bentonite pellets poured ...
... ground surface

WELL DEVELOPMENT

6" borehole w/ ...
Cement grout

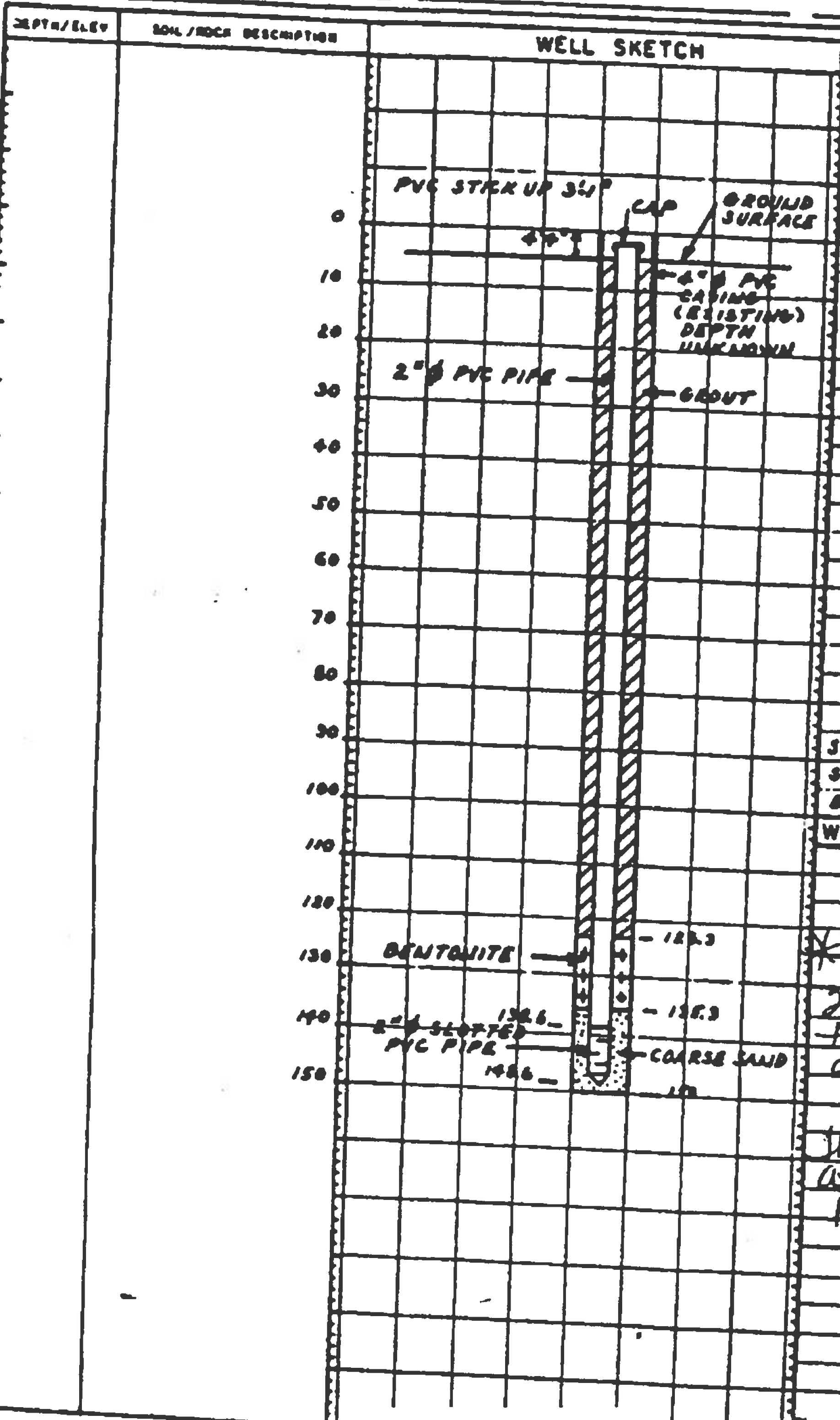
Abandoned on 7/20/17

MONITORING WELL INSTALLATION LOG

Job No. 229-1348	Project SWM/EMELLE/AL.	Well No. MEE	Sheet 1 of 1
QA Rep CSN/JVK	Drilling Method HAND COMPLETED	Ground Elev.	Depth of
Weather SUNNY	Drilling Contract	PVC Top Elev. 232.45 *	Date/Time 10-17-93
Temp WARM	Drill Rig	Driller	Started / Completed

MATERIALS INVENTORY

Well Casing 2 in. dia. 140 ft	Well Screen 2 in. dia. 10 ft	Bentonite Seal ✓
Casing Type BK TRILOCK SCH 40 PVC	Screen Type SLOTTED PVC TRILOCK	Installation Method HAND POURED
Joint Type FLUSH THREADED	Slot Size 0.010	Filter Pack Qty
Grout Quantity	Centralizers NONE	Filter Pack Type COARSE SAND
Grout Type PORTLAND CEMENT		Installation Method HAND POURED



INSTALLATION NOTES

WELL WAS PREVIOUSLY DRILLED

INSERT PVC
ADD SAND
135.3' TOP OF SAND
ADD BENTONITE
123.3' TOP OF BENTONITE

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

*approximately 25' was added to the well after damage in 1991.

the elevation at the top of PVC is 248.95

Abandoned on 7/20/17

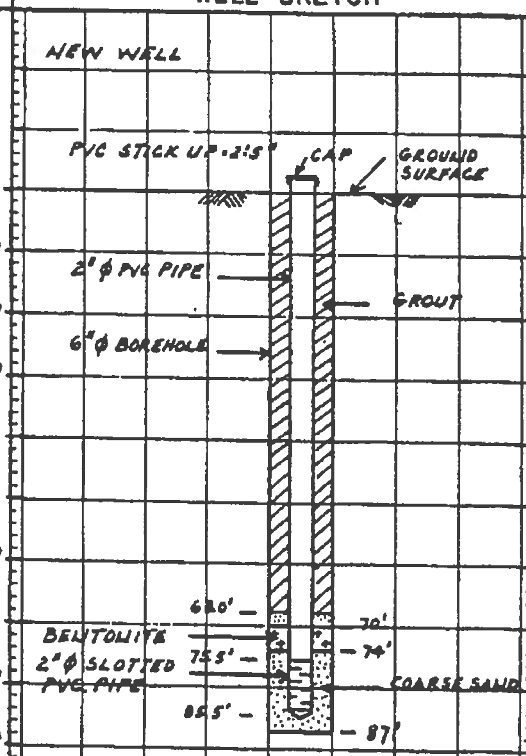
MONITORING WELL INSTALLATION LOG

JOB NO. BCY 1100	PROJECT CWM/EMELLE/ALA	WELL NO 83M30	SHEET 1 OF 1
GA MGR J E B.	DRILLING METHOD MUD ROTARY	GROUND ELEV	DEPTH WL
WEATHER SUNNY	DRILLING COMPANY GRAVES	(PVC TOP) ELEV 193.18	DATE/TIME
TEMP MILD	DRILL RIG MAYHEW 1000 / DRILLER A. CAUSEY	STARTED 10:00 AM / 10-15-83 (TIME / DATE)	COMPLETED 5:00 PM / 10-15-83 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 IN DIA 80 FT	WELL SCREEN 2 IN. DIA. 10 FT	BENTONITE SEAL ✓
CASING TYPE BK TRILOCK SCH. 40 PVC	SCREEN TYPE SLOTTED PVC TRILOCK	INSTALLATION METHOD HAND POURED
JOINT TYPE FLUSH THREADED	SLOT SIZE 0.010 in.	FILTER PACK QTY 3½ BAGS
GROUT QUANTITY 3 BAGS	CENTRALIZERS NONE	FILTER PACK TYPE COARSE SAND
GROUT TYPE PORTLAND CEMENT		INSTALLATION METHOD HAND POURED

DEPTH/ELEV.	SOIL/ROCK DESCRIPTION	WELL SKETCH



INSTALLATION NOTES

SECOND TRY - MOVED 10' WEST OF FIRST HOLE WHICH WAS ABANDONED DUE TO CAVING

74' TOP OF SAND

70' TOP OF BENTONITE

68' TOP OF SAND

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

REDRAWN BY SAP

Abandoned
on 7/20/17

WELL INSTALLATION LOG

JOB NO.: PROJECT: *[illegible] Trenche 18417 [illegible]* WELL NO. *M 57* SHEET

QA ENGR. GROUND ELEV. *203.6* WATER DEP

WEATHER DRILLING COMPANY COLLAR ELEV. *207.40* DATE/TIME

TEMP. DRILL RIG DRILLER STARTED *[illegible] 5-19-86* COMPLETED

TIME / DATE

MATERIALS INVENTORY

WELL CASING ___ in. dia. ___ lf

CASING TYPE

JOINT TYPE

GROUT QUANTITY

GROUT TYPE

WELL SCREEN ___ in. dia. ___ lf

SCREEN TYPE

SLOT SIZE

CENTRALIZERS

DRILLING MUD TYPE

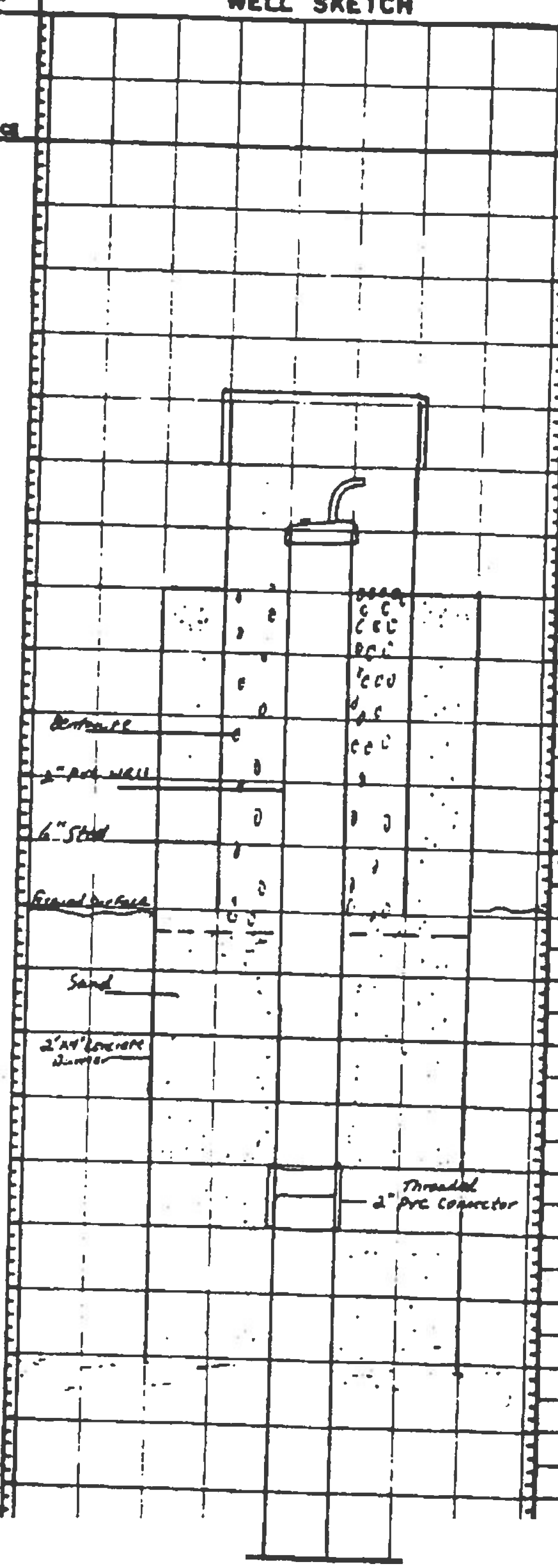
BENTONITE SEAL

INSTALLATION METHOD

FILTER PACK QTY.

FILTER PACK TYPE

INSTALLATION METHOD

ELEV/DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION
	GROUND SURFACE		*6" Steel protectiv[...] and cap removed [...] [illegible] broken [...] Steel.*
0.0			*2" well [illegible] [...] [illegible] 6.2' [...] (Two) 2'x4' Concrete [...] tiles placed around [...] bentonite pellets [...] annulus.*
			WELL DEVELOPMEN[T]

Abandoned on 7/20/17

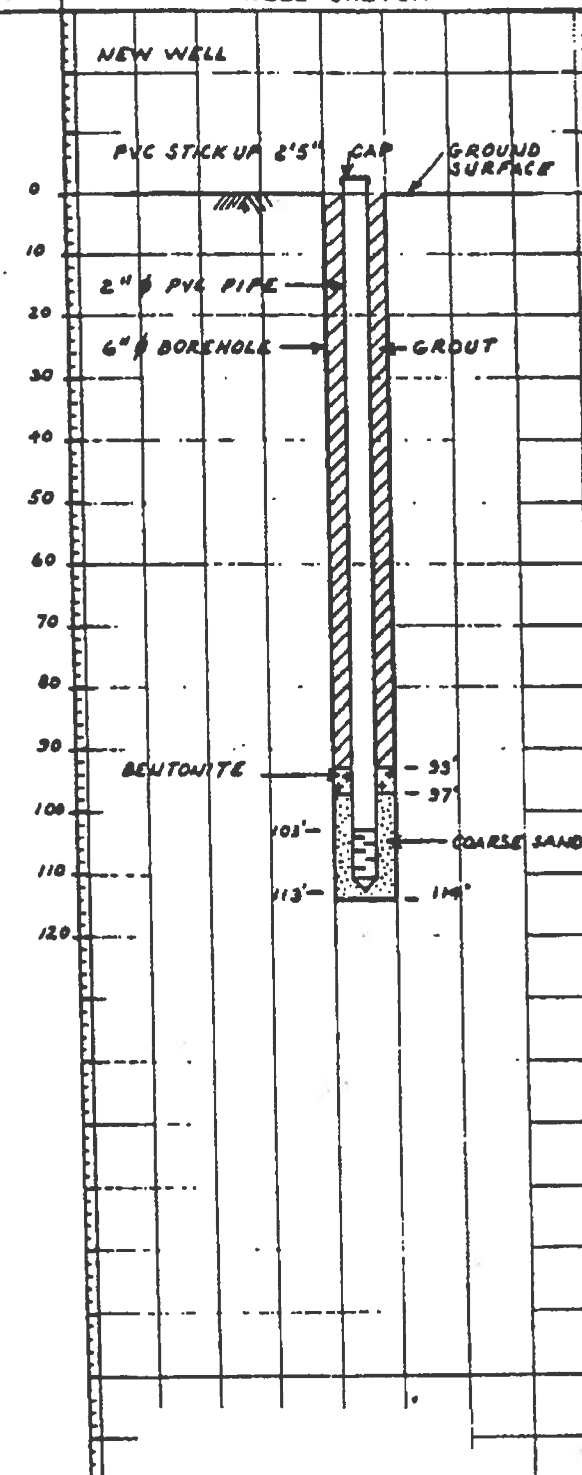
MONITORING WELL INSTALLATION LOG 58

JOB NO. 867 1308	PROJECT LWM/BAILEY/ALA	WELL NO. 83MB	SHEET 1 OF 1
GA REP SAR	DRILLING METHOD MUD ROTARY	GROUND ELEV	DEPTH WL
WEATHER SUNNY	DRILLING COMPANY GRAVES	(PVC TOP) ELEV 251.64	DATE/TIME
TEMP WARM	DRILL RIG MAYHEW 1000	DRILLER A CAUSEY	STARTED 12 30 PM / 10-16-83 (TIME / DATE) — COMPLETED 4:15 PM / 10-16-83 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 IN DIA. 110 FT	WELL SCREEN 2 IN DIA. 10 FT	BENTONITE SEAL ✓
CASING TYPE BK TRILOCK SCH 40 PVC	SCREEN TYPE SLOTTED PVC TRILOCK	INSTALLATION METHOD HAND POURED
JOINT TYPE FLUSH THREADED	SLOT SIZE 0.010 in.	FILTER PACK QTY. 2 1/2 BAGS
GROUT QUANTITY 9 BAGS	CENTRALIZERS NONE	FILTER PACK TYPE COARSE SAND
GROUT TYPE PORTLAND CEMENT		INSTALLATION METHOD HAND POURED

DEPTH/ELEV	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES



INSTALLATION NOTES

- ADD 1/2 BAG OF SAND TO 113'
- INSERTED PVC
- ADD 2 BAGS OF SAND BRIDGED AT 83' - FLUSHED WITH TREMIE PIPE TO UNBLOCK

97.0' TOP OF SAND

- ADD ONE BUCKET OF BENTONITE

93.0' TOP OF BENTONITE

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

Abandoned on 7/20/17

MONITORING WELL INSTALLATION LOG

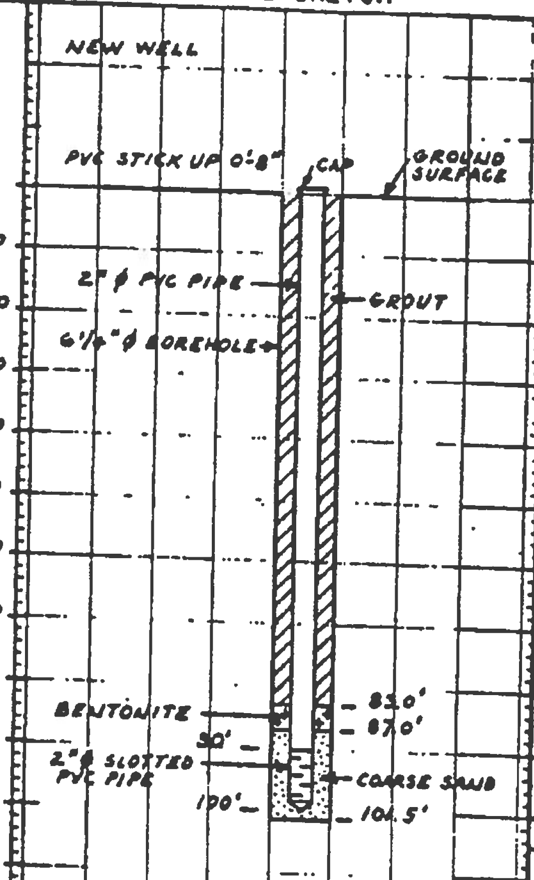
JOB NO. 824-1308	PROJECT LWM/EMALLE/ALA	WELL NO. 83 MS9	SHEET 1 OF 1
GA INSP SAR	DRILLING METHOD AIR ROTARY	GROUND ELEV	DEPTH WL
WEATHER SUNNY	DRILLING COMPANY GRAVES	(PVC TOP) ELEV 136.10	DATE/TIME
TEMP WARM	DRILL RIG INGERSOLL RAND	DRILLER DICK WOOD	STARTED 8:25 AM/10-17-83 (TIME / DATE)
			COMPLETED 8:45 AM/10-?-83 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 IN DIA 90 FT	WELL SCREEN 2 IN DIA 10 FT	BENTONITE SEAL ✓
CASING TYPE BK TRILOCK SCH 40 PVC	SCREEN TYPE SLOTTED PVC TRILOCK	INSTALLATION METHOD HAND POURED
JOINT TYPE FLUSH THREADED	SLOT SIZE 0.010 in.	FILTER PACK QTY 3 BAGS
GROUT QUANTITY	CENTRALIZERS NONE	FILTER PACK TYPE COARSE SAND
GROUT TYPE PORTLAND CEMENT		INSTALLATION METHOD HAND POURED

DEPTH/ELEV	SOIL/ROCK DESCRIPTION

WELL SKETCH



INSTALLATION NOTES

4' OF BROWN CLAY NOTED AT 1' DEPTH
- ADD 1/2 BAG OF SAND TO 100'
- INSERT PVC
- ADD 2 1/2 BAGS OF SAND
87.0' TOP OF SAND
- ADD ONE BUCKET OF BENTONITE
83.0' TOP OF BENTONITE

NOTE: DRY HOLE - ADDED WATER TO SET BENTONITE

DRILLED HOLE TO 102'
MEASURED T.D. TO 101.5'

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

RED

Abandoned on 7/20/17

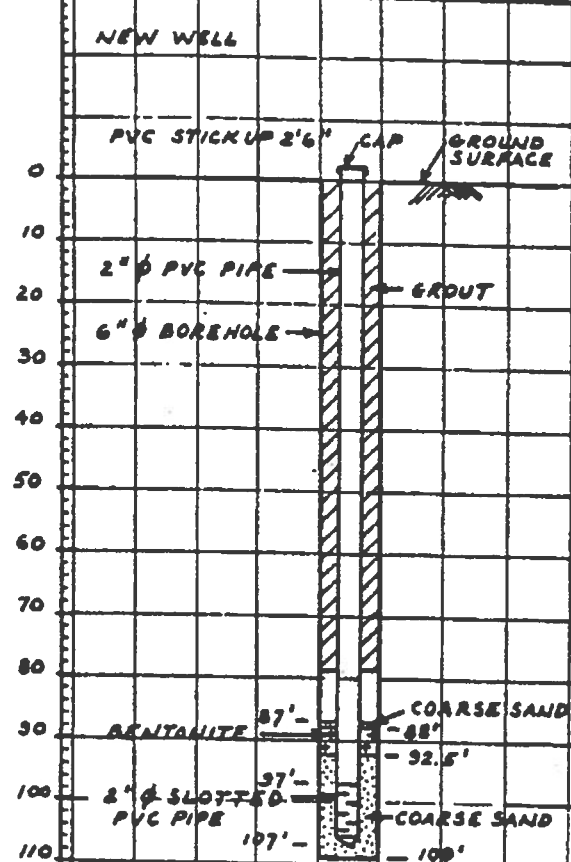
MONITORING WELL INSTALLATION LOG

JOB NO. 864 1318	PROJECT LWM/AMELLA/ALA	WELL NO. 83M61	SHEET 1 OF 1
QA INSP. JEB/SAR	DRILLING METHOD MUD ROTARY	GROUND ELEV	DEPTH WL
WEATHER SUNNY	DRILLING COMPANY GRAVES	(PVC TOP) ELEV 818.39	DATE/TIME
TEMP WARM	DRILL RIG MAYHEW 1000 / DRILLER A CAUSEY	STARTED 6:00 PM/10-15-83 (TIME / DATE)	COMPLETED 2:45 AM/10-16-83 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 IN DIA. 100 FT	WELL SCREEN 2 IN DIA 10 FT	BENTONITE SEAL ✓
CASING TYPE BK TRILOCK SCH. 40 PVC	SCREEN TYPE SLOTTED PVC TRILOCK	INSTALLATION METHOD HAND POURED
JOINT TYPE FLUSH THREADED	SLOT SIZE 0.010	FILTER PACK QTY. 3 BAGS
GROUT QUANTITY	CENTRALIZERS NONE	FILTER PACK TYPE COARSE SAND
GROUT TYPE PORTLAND CEMENT		INSTALLATION METHOD HAND POURED

DEPTH/ELEV	SOIL/ROCK DESCRIPTION	WELL SKETCH



INSTALLATION NOTES

- DRILLED TO 113'
  MEASURED T.D. TO 109'
  (FALL IN AT BOTTOM)
- ADD 1/2 BAG OF SAND TO 107'
- INSERT PVC
- ADD 2 1/2 BAGS OF SAND
  92.5' TOP OF SAND
- ADD ONE BUCKET OF BENTONITE
  88.0' TOP OF BENTONITE
- ADD 1/2 BAG OF SAND TO 87'

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

10-17-83 - 11:00 AM
MEASURED DEPTH OF 79' - SOME CAVING OCCURRED ABOVE BENTONITE BEFORE GROUTING

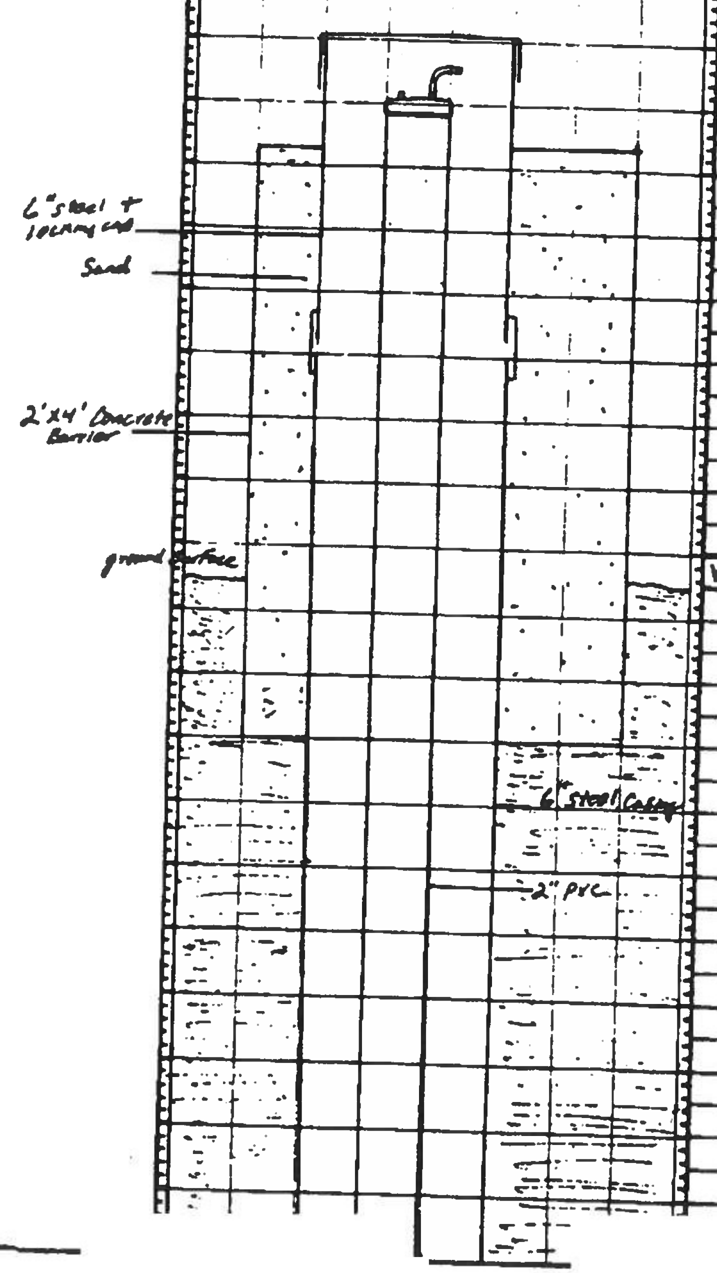
MONITORING WELL INSTALLATION LOG

JOB NO.: ____ PROJECT: ____ WELL NO. M62 SHEET 1
GA MGR. ____ DRAWING NO. ____ GROUND ELEV. 2526 WATER DEPTH ____
WEATHER ____ DRILLING COMPANY ____ TOC/Csg COLLAR ELEV. 260.03 DATE/TIME ____
TEMP. ____ DRILL RIG ____ DRILLER ____ STARTED 4-2-86 TIME / DATE COMPLETED ____

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ ft. | WELL SCREEN ____ in. dia. ____ ft. | BENTONITE SEAL ____
CASING TYPE ____ | SCREEN TYPE ____ | INSTALLATION METHOD ____
JOINT TYPE ____ | SLOT SIZE ____ | FILTER PACK QTY. ____
GROUT QUANTITY ____ | CENTRALIZERS ____ | FILTER PACK TYPE ____
GROUT TYPE ____ | DRILLING MUD TYPE ____ | INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION N[otes]
	GROUND SURFACE		
0.0			



INSTALLATION N[OTES]

4-2-86 removed ba[...]
well. Cut away[...]
6' of 6" steel ba[...]
well. Some Sand [...]
6" annulus no grou[...]
at top. 2" pvc [...]
threaded for resetting[...]
cap. thing. Total [...]
cut from well. [...]
New elev shot 2[...]
New well depth 16[...]
2'x4' Concrete barr[...]
6" steel with lock[...]
set over well. [...]
final grade. [...]
(5 gal) poured in 6"[...]

WELL DEVELOPMENT

Abandoned on 7/20/17

Abandoned
on 7/20/17

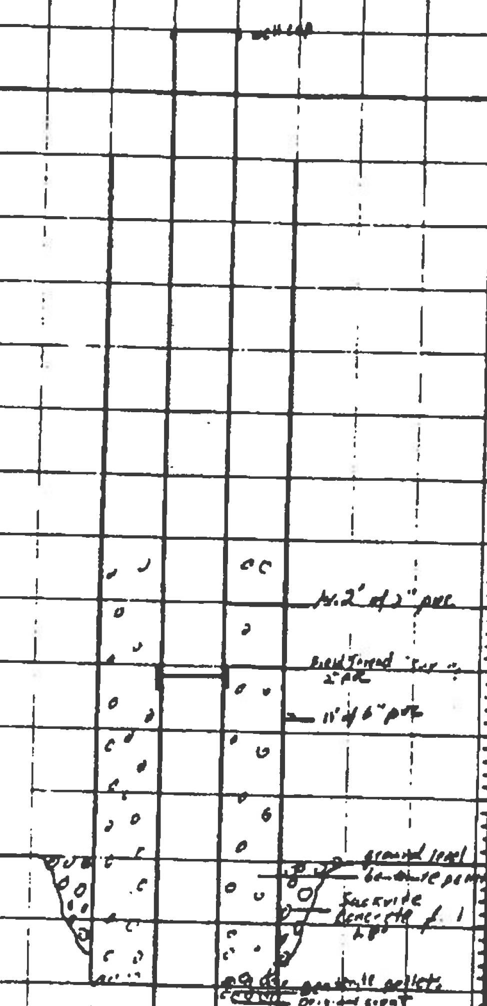
MONITORING WELL INSTALLATION LOG

JOB NO.	PROJECT *Trend Phase Well raised*	WELL NO. *MW-64*	SHEET
EQ. INSP.	DRILLING METHOD	GROUND ELEV. *270.7*	WATER DEPTH
WEATHER	DRILLING COMPANY	COLLAR ELEV. *274.60*	DATE/TIME
TEMP.	DRILL RIG	DRILLER	STARTED *5/16/[illegible]* TIME *1 [illegible]*	COMPLETED

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ LF	WELL SCREEN ____ in. dia. ____ LF	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY.
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION
	GROUND SURFACE		
0.0			



INSTALLATION

pvc + tools steam [illegible]
threaded joints [illegible]
6" pvc added to [illegible]
Well from fill [illegible]
pellets and [illegible]
in annulus. 14.2' [illegible]
well total.

Concrete pad 6" [illegible]
and locking cap [illegible]
around Well. [illegible]
New cll elev. 27[illegible]
Depth of well 153.[illegible]

WELL DEVELOPMENT

(6)

Abandoned on 7/20/17

MONITORING WELL INSTALLATION LOG

JOB NO. 889-1309 PROJECT SWM/EMELLE/ALA. WELL NO. 83MG5 SHEET 1 OF 1

SA MSP SAR DRILLING METHOD AIR/MIST ROTARY GROUND ELEV DEPTH WL

WEATHER SUNNY DRILLING COMPANY GRAVES (PM/MP) ELEV 278.17 DATE/TIME

TEMP WARM DRILL RIG INGERSOLL RAND DRILLER DICK WOOD STARTED 4:15 PM/10-16-89 (TIME / DATE) COMPLETED 5:10 AM/10-16-89 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 IN DIA 130 FT — WELL SCREEN 2 IN DIA 10 FT — BENTONITE SEAL ✓

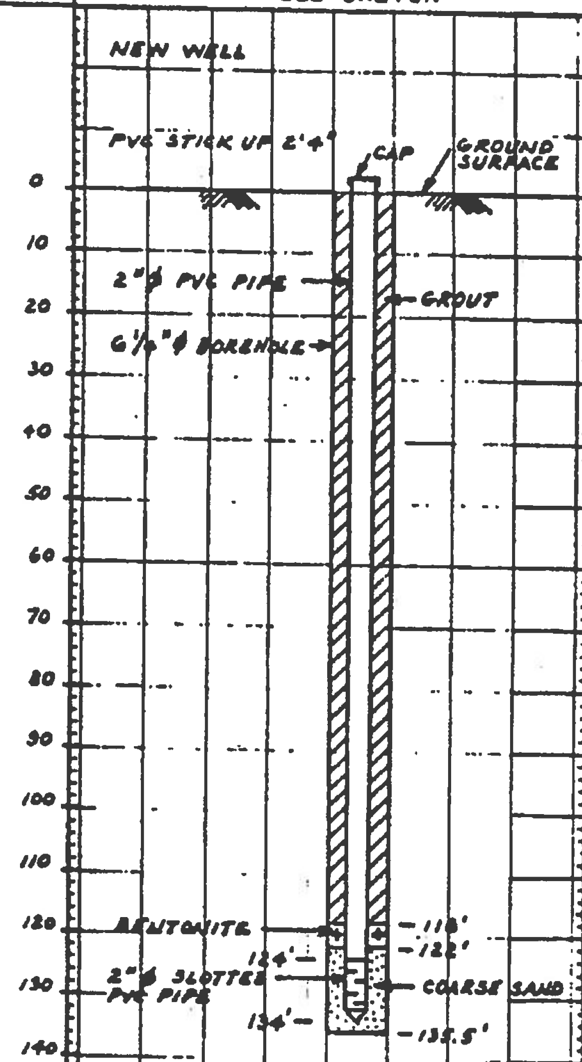
CASING TYPE BK TRILOCK SCH.40 PVC — SCREEN TYPE SLOTTED PVC — INSTALLATION METHOD HAND POURED

JOINT TYPE FLUSH THREADED — SLOT SIZE 0.010 — FILTER PACK QTY 3 BAGS

GROUT QUANTITY — CENTRALIZERS NONE — FILTER PACK TYPE COARSE SAND

GROUT TYPE PORTLAND CEMENT — INSTALLATION METHOD HAND POURED

DEPTH/ELEV	SOIL/ROCK DESCRIPTION	WELL SKETCH



INSTALLATION NOTES

DRILLED TO 137'
MEASURED T.D. TO 135.5'

122' TOP OF SAND
118' TOP OF BENTONITE

NOTE: CLAY FROM 8'-11'

VENTED WELL

STEEL PROTECTIVE COVER SUPPLIED - TO BE INSTALLED BY SITE PERSONNEL

WELL DEVELOPMENT NOTES

RE

Abandoned on 7/20/17

JOB NO. ______ PROJECT Trench Closure Well raised ______ WELL NO. M66 ______ SHEET 1

GA INSP. ______ DRILLING METHOD ______ GROUND ELEV. 249.97 ______ WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ Top of Casing COLLAR ELEV. 251.99 ______ DATE/TIME ______

TEMP. ______ DRILL RIG ______ DRILLER ______ STARTED ______ TIME / DATE ______ COMPLETED ______

MATERIALS INVENTORY

WELL CASING ______ in. dia. ______ l.f.

CASING TYPE ______

JOINT TYPE ______

GROUT QUANTITY ______

GROUT TYPE ______

WELL SCREEN ______ in. dia. ______ l.f.

SCREEN TYPE ______

SLOT SIZE ______

CENTRALIZERS ______

DRILLING MUD TYPE ______

BENTONITE SEAL ______

INSTALLATION METHOD ______

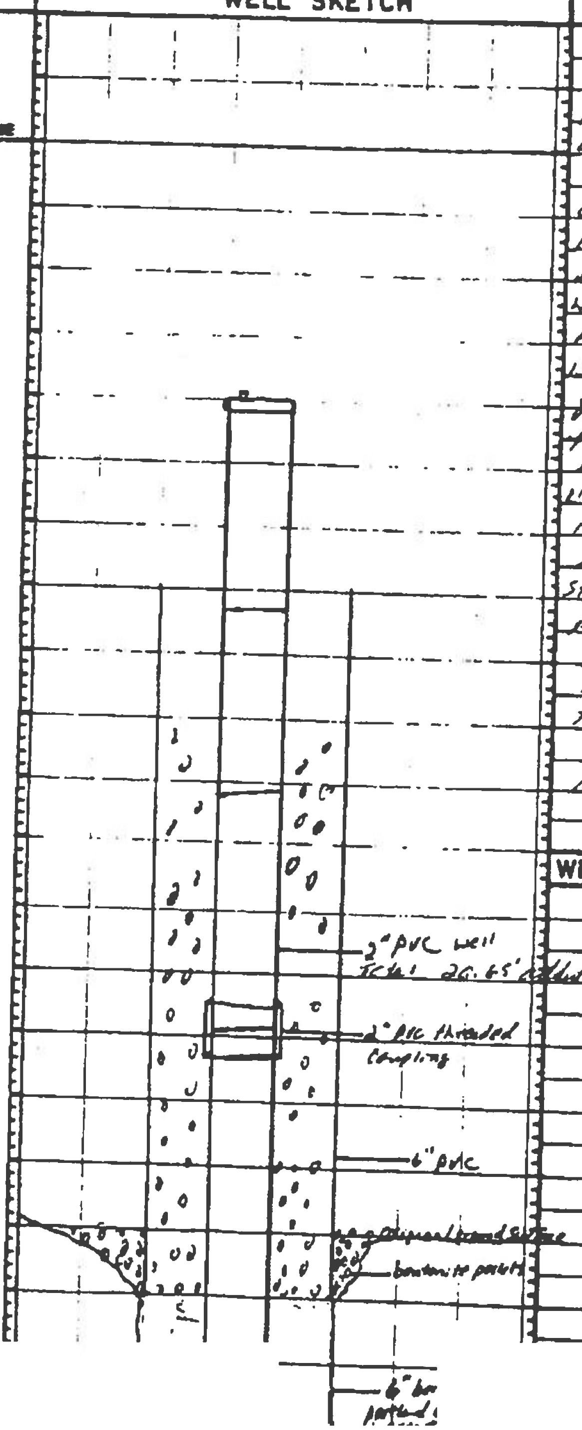
FILTER PACK QTY. ______

FILTER PACK TYPE ______

INSTALLATION METHOD ______

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	

WELL SKETCH



INSTALLATION NO...

Well raised in sta...
as fill was placed...
PVC 2" TK" stream...
Carried to well and...
wrapped in plasti...
2" PVC fill threaded...
wrapped w/ teflon ta...
6" PVC placed on top...
what looked like 6"...
grout. 6" PVC wel...
fill placed around...
bag placed over wel...
while stream ...
Fill allowed to settle...
2'x4' concrete ...
Steel with locking ...
placed around well...
New elev. 251.99
New depth 122.0'
Top of Casing.
Bentonite pellets ...
down 6" steel ...

WELL DEVELOPMENT ...

Abandoned on 7/20/17

JOB NO. ____ PROJECT Trench Closure Well raised for roads WELL NO. M 68 SHEET 1

GA INSP. ____ DRILLING METHOD ____ GROUND ELEV. 198.3 WATER DEPTH ____

WEATHER ____ DRILLING COMPANY ____ Top of Casing COLLAR ELEV. 202.08 DATE/TIME ____

TEMP. ____ DRILL RIG ____ DRILLER ____ STARTED ____ (TIME / DATE) COMPLETED ____

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f.

CASING TYPE ____

JOINT TYPE ____

GROUT QUANTITY ____

GROUT TYPE ____

WELL SCREEN ____ in. dia. ____ l.f.

SCREEN TYPE ____

SLOT SIZE ____

CENTRALIZERS ____

DRILLING MUD TYPE ____

BENTONITE SEAL ____

INSTALLATION METHOD ____

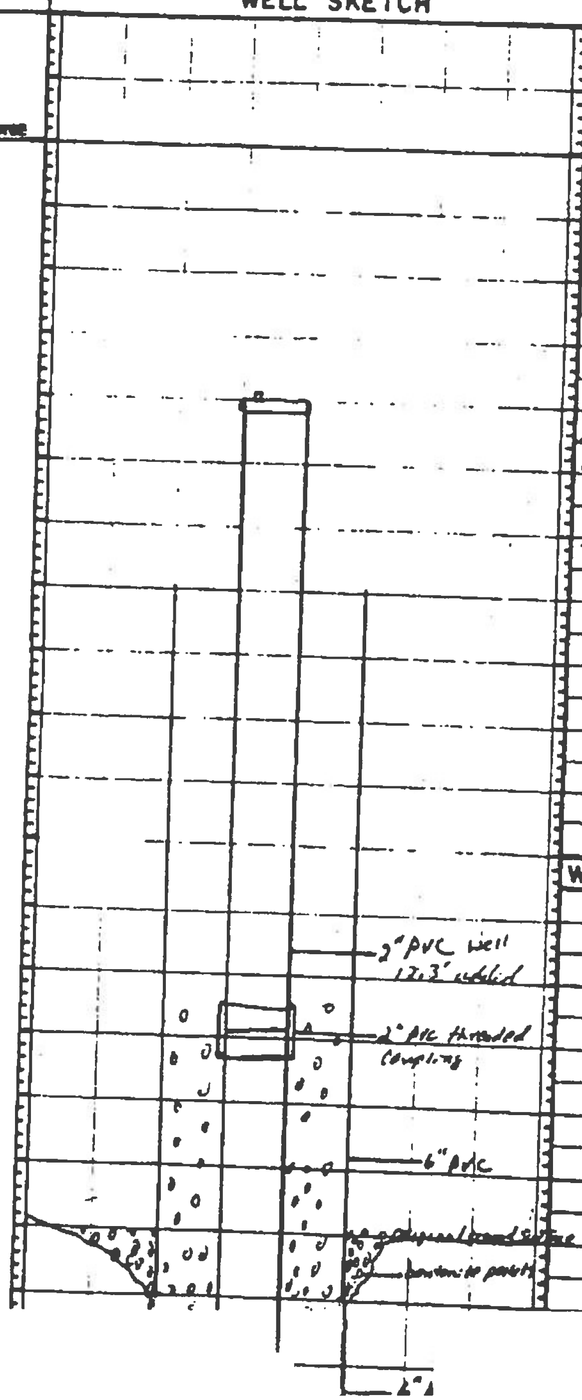
FILTER PACK QTY ____

FILTER PACK TYPE ____

INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	

WELL SKETCH



INSTALLATION N

Well protection re[illegible]
2" PVC field [illegible]
12.3' added to wel[illegible]
Teflon taped thre[illegible]
joints. 6" PVC
riser well with [illegible]
bentonite pellets [illegible]
at bottom. 6" [illegible]
held while fill[illegible]
2'x2' concrete [illegible]
with 6" steel [illegible]
Cap placed 2 [illegible]
[illegible] Fill [illegible]
final grade.
Bentonite pellets [illegible]
annulus.
[illegible] elev. msl 2[illegible]
Well depth 122.[illegible]

WELL DEVELOPMENT

Abandoned on 7/20/17

JOB NO. ____ PROJECT Trench Closure Well raised ____ WELL NO. M69 ____ SHEET 1

GA INSP. ____ DRILLING METHOD ____ GROUND ELEV. 232.4 ____ WATER DEPTH ____

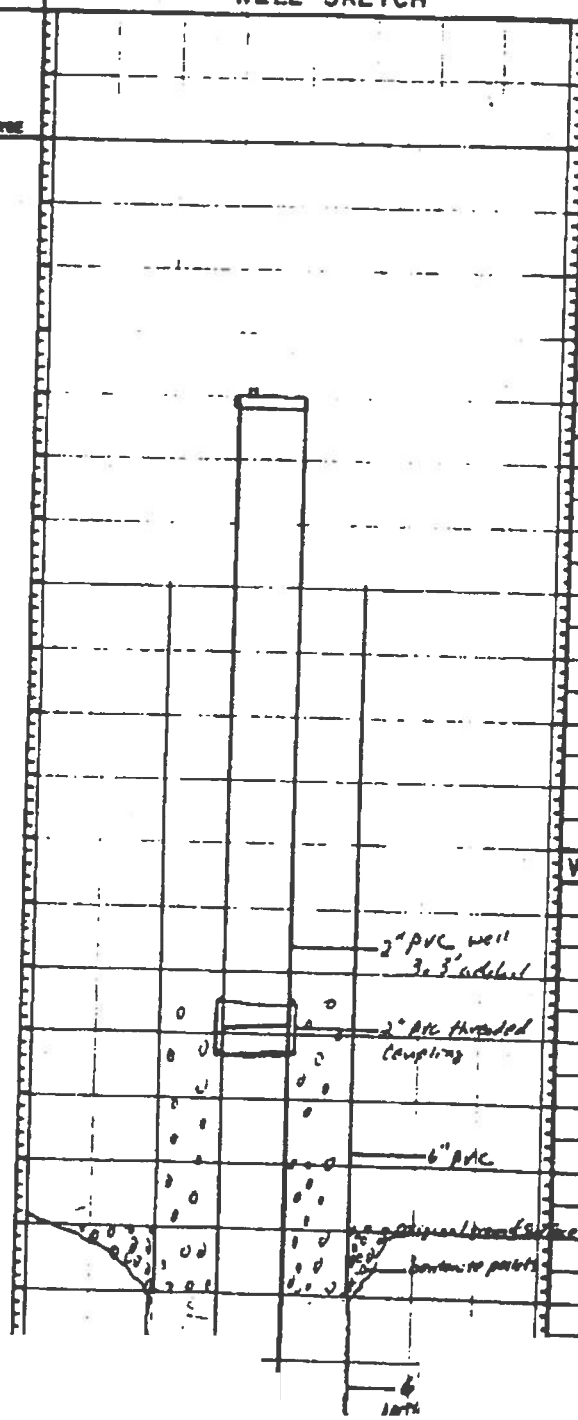
WEATHER ____ DRILLING COMPANY ____ Top of casing COLLAR ELEV. 234.62 ____ DATE/TIME ____

TEMP. ____ DRILL RIG ____ DRILLER ____ STARTED ____ TIME / DATE ____ COMPLETED ____

MATERIALS INVENTORY

WELL CASING ____ in. dia. ____ l.f.	WELL SCREEN ____ in. dia. ____ l.f.	BENTONITE SEAL ____
CASING TYPE ____	SCREEN TYPE ____	INSTALLATION METHOD ____
JOINT TYPE ____	SLOT SIZE ____	FILTER PACK QTY. ____
GROUT QUANTITY ____	CENTRALIZERS ____	FILTER PACK TYPE ____
GROUT TYPE ____	DRILLING MUD TYPE ____	INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION
	GROUND SURFACE		
0.0			



INSTALLATION

Well barrier re...
2" PVC full threa...
6" and 2" PVC ...
steam cleaned.
added ... the...
teflon threads ...
cap ... 6" ...
lowered over we...
pellets placed at bo...
2'x4' concrete ba...
set. Fill place...
well. Another ...
barrier placed on...
Annular ... w...
Bentonite in 6"...
6" ... cap ...
concrete top ...
New elev. ...
... 147. ...

WELL DEVELOPMENT

APPENDIX E-15

SECTION E

FRACTURE AND LINEAMENT STUDY

EMELLE FACILITY

<u>Revision No.</u>
5.0

APPENDIX E-15

SECTION E

LIST OF DOCUMENTS

Document 1: Fracture and Lineament Study, Emelle Facility, prepared by Jordan, Jones & Goulding, Inc., dated May 2005.

May 2005

Fracture and Lineament Study
Emelle Facility

Prepared for

WASTE MANAGEMENT

Emelle Facility,
Emelle, Alabama

Prepared by

JORDAN
JONES &
GOULDING

working to better our communities and environment

Table of Contents

\\TEMP\Archives\01\01186\035\Historical fracture information\fracture_study2005.Final.doc

List of Figures

List of Appendices

Jordan
Jones &
Goulding

SECTION 1
Introduction

SECTION 1
Introduction

As part of an Alabama Department of Environmental Management (ADEM) approved work plan dated January 1996, Chemical Waste Management, Inc. (CWM-Emelle) conducted a hydrogeologic study in the vicinity of shallow monitoring well SM-18. The work plan required the preparation of a site fracture map to be submitted to ADEM. The fracture map was to include the items listed below in a single document.

- A compilation of location and, to the extent available, the strike and dip of fractures previously mapped in trench excavations by consultants to CWM-Emelle;
- The results of a previous lineament study conducted in the site vicinity by Woodward-Clyde Consultants;
- The location, strike and dip of any fractures recorded in the field notes of Mr. Paul Moser (deceased) of the Alabama Geologic Survey, should such notes be available from the Survey;
- The results of a new lineament study conducted in the site vicinity using aerial photographs, topographic maps, and false imagery (infrared, etc.) to interpret lineaments.

The final report was submitted in June 1997 and included an analysis of fracture direction trends in the chalk.

CWM-Emelle renewed the facility's RCRA Part B Permit Application in 2001 and received an updated and renewed Facility Operating Permit from ADEM (ALD 000 622 464) on November 8, 2004. As required in Section IX.B.1.i of the Facility Permit, the site fracture map and rose diagram is to be updated within 180 days of Permit issuance (by May 9, 2005), and annually thereafter as part of the annual groundwater monitoring report. This report updates June 1997 report and site fracture map and rose diagram based upon information gathered during fracture mapping of Trench 22, Cell 3. Details of the Trench 22, Cell 3 fracture mapping are discussed in Section 3 – Fracture Studies.

Jordan Jones & Goulding

SECTION 2
Local and Regional Geology

SECTION 2
Local and Regional Geology

Chemical Waste Management, Inc. (CWM) has owned and operated the hazardous waste disposal facility in Emelle, Alabama since the mid to late 1970's. This site is located in Sumter County, Alabama on Highway 17 between the towns of Geiger and Emelle.

This facility is topographically located in the Black Belt portion of the Coastal Plain. This region is characterized as a low valley which is underlain by a massive sequence of Cretaceous Chalk. Elevations in the vicinity of the site range from 140 feet MSL to 290 feet MSL.

Regional Geologic Setting

The Emelle hazardous waste disposal facility is located on a sequence of gulfward dipping Late Cretaceous, Tertiary, and Quaternary sediments exposed in successively younger outcrop belts toward the coast. Most of the sediments are clastic wedges that thicken and grade seaward from deltaic to marine facies (Reference 1). During the Cretaceous period, worldwide marine transgression was fueled by the increased rate of sea floor spreading. The sediments which accumulated in the gulf basin were predominately shallow-water marine or deltaic sediments that accumulated near sea level. The sedimentary rocks of the Coast Plain exhibit a general east-west strike in central Alabama, gradually changing to northwest-southeast towards the west, and dip approximately 30 to 40 feet per mile to the south and southwest (Reference 1).

Stratigraphically, this facility is situated in the Selma Group. The Selma Group was deposited approximately 75 million years ago during the Upper Cretaceous period. These Upper Cretaceous sediments outcrop in a crescent-shaped pattern approximately 40 to 75 miles wide and are oriented westward in the eastern portion of the state and northwestward in the western portion of the state. This belt is approximately 275 miles long. The Upper Cretaceous sediments are estimated to be 2,300 feet thick. The Selma Group extends across the state of Alabama into northeastern Mississippi. These sediments were deposited predominately in a shallow marine environment, with some sediments deposited by transversing streams on low floodplains bordering the paleo-coast.

The Selma Group rests disconformably on the Eutaw formation and is subdivided into four formations: the Mooreville chalk, the Demopolis chalk, the Ripley formation and the Prairie Bluff Chalk. The Emelle site is specifically located in the Demopolis chalk, which is described as a clayey chalk. The location of this facility within the geologic framework is depicted in Figure 1. The Demopolis formation has higher calcium carbonate content and is more indurated than the underlying Mooreville chalk. This formation exhibits more faults than the Mooreville chalk because of its brittle character (Reference 1). The upper member of the Demopolis chalk is known as the Bluffport Marl member. This member is described as a chalky marl. The contact between the marl and the underlying clayey chalk has been exposed in some of the trenches at the Emelle facility. The thickness of the Demopolis chalk is estimated to be 450 feet.

Faults in the Selma Group

The Livingston fault zone (Lfz) is located to the southeast of the Emelle facility. The strata are broken into a series of horsts and grabens that strike generally N 70 W and are bounded by high angle reverse faults. Displacement along these faults may be greater than 90 feet, although in most places it averages 40 feet. The reverse faults of the Lfz are considered to have formed after the deposition of the Prairie Bluff chalk and prior to the deposition of the Quaternary high-terrace deposits of the Tombigbee River.

There are two types of faults found in the Selma Group (Reference 1). The first type is normal faults found outside of the Lfz. The second type is normal and reverse faults (horsts and grabens) of varying magnitude restricted to the Lfz.

The normal faults outside the Lfz are more visible in the western portion of the Demopolis chalk particularly along the Tombigbee River. Several of these faults are parallel to the outcrop pattern of the Selma Group. Others seem to show no discernible pattern of orientations. Dips in these faults range from 70 to 90 degrees. Slickensides along the fault plane show a dip slip movement. The faults are curved and tend to die out in the bedding planes. These faults are generally filled with calcite encrustations.

Many of the normal faults found in the Selma Group originate and terminate within the confines of the chalk. These are characteristic of slump structures resulting from settlement and sediment loading. Previous investigations have suggested that these fault zones do not appear to be tectonic in origin, but are depositional (Reference 2). Normal faults outside the Lfz generally do not show large openings along the fault planes. Although there are many explanations for the origin of the Livingston fault zone, the most pliable is offered by Schneeflock. He suggested that the reverse faults formed as a result of localized horizontal compression in the trough of the northwest-southeast trending syncline produced by movement along a flexure in the Paleozoic basement; but, it is important to note, no movement has occurred along these faults within the last 35,000 years (Reference 1).

Jordan Jones & Goulding

SECTION 3
Previous Fracture Studies

SECTION 3
Previous Fracture Studies

1979 Lineament Study

In 1979, Woodward-Clyde Consultants (WCC) were retained by Resource Industries of Alabama, Inc. (then a subsidiary of Chemical Waste Management) to collect literature, maps, photographs, and imagery of the facility and to analyze this material to identify linear features which may represent faults and/or joints.

Review of Maps, Photographs, and Imagery

The 1979 work studied the lineaments in the subject site area using Landsat image, high and low altitude photographs, and topographic maps of varying scales. The following summarizes the finds of the 1979 lineament study.

- Lineaments identified on the Landsat image revealed a prominent northwest trending lineament pattern. A second, less prominent, northeast trending set was also identified near the facility.

- High altitude aerial photography revealed that the majority of the lineaments trended northwest and were concentrated on the northeast side of the site and a short distance southwest of the site. The second most dominant set identified were those which trend to the northeast. In general, this set is shorter than the first, more dominant set.

- Low altitude photographic lineaments were predominantly north, northwest, and northeast trending. Although a second east-west trend was identified.

- Review of the large scale topographic map (1:250,000) resulted in the identification of pronounced northwest trending lineaments. These lineaments followed the long stream or drainage stretches.

- Review of the 1:24,000 topographic map revealed longer lineaments trending in the northwest to west - northwest direction. The most prominent lineament trended from the southeast corner of the site then trended westward.

- Lineaments identified on the 1:1,200 scale topographic map trended to the northwest. Many of the features were man-made or reflected property lines.

Groundtruthing of Lineaments

Field observations performed as part of the 1979 study determined that none of the lineaments identified during the analysis represented surface manifestations of faulting. In addition, several test pits were excavated along two identified lineaments. These excavations were advanced into the unweathered chalk. No joints, fractures, or faults along these lineaments were identified in the backhoe excavations.

Literature Review on Faulting

WCC reviewed a study performed by Scheenflock in 1972. In this study, Scheenflock stated that the Lfz did not pass through the Emelle site. One fault was identified by seismic reflection several miles to the northeast of the site. This fault was detected a few 1,000 feet below the ground.

1982 Geologic and Geotechnical Evaluation

In 1982, Golder Associates performed a geologic and geotechnical evaluation of the Emelle facility. As a part of this investigation, discontinuities were mapped in the Selma chalk. Discontinuities were mapped in Trenches 15, 16, and outcrops throughout the site. Field mapping of these discontinuities lead to the identification of several joint sets. The dominant joint set orientations were:

Strike (degrees)	Dip (degrees)
N 62 W	44 to NE
N 60 W	86 to NE
N 52 E	85 to NW
N58 E	42 to NW
N 14 E	82 to NW
N 58 E	58 to SE

The discontinuities identified during this evaluation were typically tightly closed and infilled with calcite. Golder Associates also concluded that the integrity of the calcite infilled discontinuities were verified by the low permeabilities determined by packer testing performed by WCC during a previous investigation. Fracture permeabilities were estimated by WCC to be 3 x 10^{-7} (Reference 2). Furthermore, cores recovered during the 1982 Golder investigation could not be broken across the calcite infilled joints. Many of the discontinuous surfaces also displayed waviness, which lead to scattered orientations within single joint sets.

Golder Associates also undertook a Deep Boring program to ascertain the thickness and character of the Selma Chalk. Three borings were advanced 500 feet. In two of the three borings, discontinuities were identified. In general, joints encountered greater than 10 feet below the ground surface were infilled with calcite. In addition, cores recovered during this investigation had a rock quality designation that was consistently greater than 95 percent indicating that these discontinuities were not significant conduits for flow (Reference 2).

Field Notes from Paul Moser of the Alabama Geologic Survey

Mr. Paul Moser (now deceased) of the Alabama Geologic Survey made several site visits to inspect the discontinuities encountered during trenching activities. Inspections were made in Trenches 15, 16, and 20 by Mr. Moser or other members of the Alabama Geologic Survey. The discontinuities identified in these trenches were typically infilled with calcite and did not pose a significant conduit for fluid flow. The only exception was in Trench 15.

On March 17, 1982, Mr. Moser visited the Emelle facility at the request of Mr. Don Hunter of the Environmental Protection Agency (EPA). They arranged a site visit to inspect Trench 15 as outlined in a memorandum written by Mr. Moser on March 22, 1982. According to the Mr. Moser's documentation (Reference 4), water had been observed draining into the trench from two faults that extended from the top of the fresh chalk into a recompacted chalk barrier at approximately 0.5 gallons per minute.

Following his site visit, Mr. Moser concluded that water was surface water which was diverted to drain along the recompacted chalk blanket contact into the two faults. CWM-Emelle decided to fill, compact, and abandon the trench in the area within about 100 feet of the observed drainage. In addition to Mr. Moser's field notes, a copy of an aerial photograph with several lineaments indicated has been included in Appendix A of this report. Mr. Moser did not record strike or dip measurements for joints identified in Trench 15 during his field visit.

1996 Lineament and Fracture Analysis

Jordan, Jones & Goulding (JJG) performed a fracture and lineament study as a part of the January 1996 study plan for shallow monitoring well SM-18. The fracture and lineament study was divided into two parts – a lineament analysis and a discrete fracture analysis, as discussed in the sections below.

Lineament Analysis Results

<u>Aerial Photographs</u>

Aerial photographs were examined at two scales: black and white 1:19,066 scale (low altitude) and color infrared 1:58, 000 scale (high altitude). The lineaments are identified on the aerial photographs in Figures 2, 3, and 4. Results of the lineament analyses on the low altitude aerial photographs were plotted a Rose diagram (Figure 5). The dominant lineament sets, identified on the Rose diagram are 320 to 330 and 300 to 310. Two minor sets are present: 270 to 290 and 040 to 050. Lineament orientations for the high altitude, color inferred photographs are depicted in Figure 6. Major sets identified during the lineament analysis of the high altitude photographs include: 270 to 280 and 310 to 330. There are two minor sets: 290 to 300 and 070 to 080.

Topographic Maps

In addition to examining aerial photographs, topographic maps were examined at two scales (1:24,000 and 1:100,000). Lineament analysis of the large scale (1:24,000) map resulted in the identification of lineaments as depicted in Figure 7. Two major sets have been identified on a Rose diagram (Figure 8): 010 to 040 and 320 to 340. The minor sets include: 300 to 310 and 270 to 280. A review of the lineaments found on the 1:100,000 scale topographic map (Figure 9) have produced similar northwest and northeast trending major sets: 310 to 350 and 000 to 030. Two minor sets trending slightly northwest (270 to 280) and slightly northeast (070 to 080) were also identified. A Rose diagram summarizing lineament orientation on the 1:100,000 topographic map is included as Figure 10.

Discrete Fracture Analysis

Discontinuities were mapped at the Emelle facility in Trench 22, Cell 2 on October 16 and 17, 1996, by JJG staff. This field analysis was performed during the initial phases of cell construction. In this cell, the uppermost zone of the Selma Chalk is weathered to an orange and yellow color. This weathered zone extends down to approximately 10 to 15 feet below the original ground surface around Cell 2. The slopes of Cell 2 were graded to approximately 22 degrees during the cell construction. It was difficult to identify fractures in the graded chalk slope, particularly on the south slope. Therefore, quantitative data was collected from the nearly vertical walls cut at the base of the north and west slopes of the Cell 2 excavation. The scanline technique, described in Section 4, was utilized in order to map fractures encountered on these walls. The origin of the scanline was the northwest corner of Trench 22, Cell 2. The first scanline extended 146 feet from the northwest corner to the northeast corner and intersected ten fractures. Of these fractures, six did not intersect other fractures in the visible scanplane. The apertures of these fractures varied from 0.25 millimeter (mm) to 1 mm. The second scanline extended from the northwest corner 450 feet to the southwest corner. This scanline was perpendicular to the first and intersected only five fractures. A summary of the collected fracture data is included in Appendix B of this report.

There are two dominant fracture sets that are apparent from the scanline analysis in Trench 22, Cell 2. One set trends northwest/southeast while the other trends north/south. Fracture trends are plotted on a Rose diagram in Figure 11. The strike and dip for each fracture is also plotted on a stereonet in Figure 12. The fractures encountered in the trench were typically infilled with calcite. In addition, slickensides were noted on many surfaces. In all but three cases, the fractures did not terminate within the visible scanplane; i.e., their observed length is a minimum length. It was noted that one of the fractures identified on the north wall was wavy. This fracture extended approximately 50 feet in the visible scanplane and the termination point could not be identified on the graded chalk slope. This fracture was wavy and therefore the orientation of this fracture was variable.

In addition to the scanline analysis in Trench 22, a less detailed survey of fractures was performed at other small exposures of the Selma Chalk near the Emelle facility. Fracture orientation and length measurements were collected from pavement and vertical exposures. A Rose diagram summarizing the orientations of fractures from the Trench 22 study and those collected from nearby outcrops is included as Figure 15. Five mean fracture sets were identified from this data. These mean sets are summarized below and are shown in Figure 15.

Strike (degrees)	Dip (degrees)
295 (N 65 W)	67 to SW
008 (N 08 E)	84 to W
064 (N 64 E)	82 to N
124 (S 54 E)	43 to NE
234 (S 54 W)	61 to SE

For comparison purposes, the mean fracture data collected during work performed in 1982 are depicted in Figure 16 and Figure 17. The fracture sets identified in 1982 were similar to those collected during the field mapping in Trench 22 and adjacent outcrops (Reference 3).

Conclusions of 1996 Lineament and Fracture Analysis

The result of this study indicates a strong correlation between the various scales of data. These mean fracture sets collected at the outcrop scale correlated with the fracture sets identified during the lineament analysis portion of the study.

The trends of the fracture sets identified during the field study, when plotted on a Rose diagram, produce the following dominant sets: 290 to 320, 350 to 020, and 050 to 080. These sets were identifiable on all scales of analysis performed during this investigation. Field analysis in Trench 22 and on the eastern portion of the facility indicated that the majority of fractures are tightly closed or infilled with calcite and therefore do not pose as a significant conduit for flow.

Furthermore, lineament data collected during this investigation correlates with lineament trends identified by WCC in 1979. Similar results were also obtained by Golder Associates during work performed in 1982. Fracture analysis in Trenches 15 and 16 produced fracture set orientations similar to those obtained during the 1996 JJG study. In addition, Golder reported that most joints encountered in the unweathered chalk during coring were filled with calcite or were tightly closed.

Jordan
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Goulding

SECTION 4

Trench 22, Cell 3 - Fracture Methodology

SECTION 4
Trench 22, Cell 3 - Fracture Methodology

The Trench 22, Cell 3 fracture mapping study involved detailed field measurement and analysis of discrete fractures on the outcrop scale. Fracture characteristics examined in real space were then compared to data collected during the 1996 JJG lineament study.

The scanline analysis was used to assess the characteristics of the localized fracture sets and to map fractures in real space. There are two different types of scanline set-up: pavement and wall. JJG relied solely on the second type of scanlines due to poor pavement (floor surface) exposures in the chalk. The first step in discrete fracture measurement was to set up a scanline, using a measuring tape, across the fractures. Once the tape measure was in place, and the site had been characterized in terms of location; outcrop orientation, height, and width; scanline type; scanline orientation; and length, the characteristics of individual fractures were measured as they intersected the scanline. For each fracture that intersected the scanline, frequency, intersection distance, fracture orientation, fracture trace length, aperture, mineral infilling, fracture type, termination style, and fracture surface morphology were all recorded. Fracture intersection distance was based on the location of the midpoint of the fracture with regard to the tape measure.

Fracture orientations collected during the outcrop scale analysis are plotted on stereonets and rose diagrams. A stereonet, or stereoplot, is a spherical plot depicting the dip of a plane. Stereographic analysis is used to illustrate three-dimensional data on a graphic diagram. Planar orientations collected during the field portion of this study were plotted on a lower hemisphere Schmidt net. The angular relationships between fracture sets can lend some insight to the anisotropic transmissivity and permeability created by the intersection of some of these sets. For purposes of comparison with the lineament data collected from the topographic maps and aerial photographs, the strike direction for the outcrop data was plotted on rose diagrams.

Jordan Jones & Goulding

SECTION 5

Trench 22, Cell 3 - Fracture Analysis Results

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SECTION 5

Trench 22, Cell 3 - Fracture Analysis Results

Fractures in Trench 22, Cell 3 were mapped by JJG staff on November 17 and 18, 2004 during the early stages of cell construction. Two scanlines were performed on the south trench wall, and visual fracture logging was performed for the remainder of the trench walls. During fracture mapping, orange-tan weathered chalk was observed to extend approximately 30 feet below the original ground surface in the northeast corner of the cell. The thickness of the weathered chalk layer diminished midway along the north wall of the cell to a layer extending approximately 5-10 feet below original ground surface. Weathered chalk was also visible in the southwest corner of the cell extending approximately 10 feet below the original ground surface.

The north, east, and south cell walls were graded to approximately 20 degrees. The west wall was graded to 48 degrees. See Table 1 for wall orientations. Due to limited accessibility and accumulation of graded material on portions of the cell walls, scanline fracture mapping was performed on the south cell wall. Visual fracture mapping was performed for the remaining cell walls, where accessible. The graded chalk made fracture identification difficult in some areas. Two scanlines were performed along the south wall in an area exhibiting the best exposure of ungraded chalk. Both scanlines originated at the same point in the southwest corner of Cell 3. The first scanline extended 100 feet up the south slope and intercepted two fractures. The second scanline extended 300 feet along the base of the slope and intercepted eight fractures. Scanline data is presented in Appendix B.

Table 1. Trench 22, Cell 3 wall orientations.

North Wall	East Wall	South Wall	West Wall*
N85W, 21S	N04W, 20W	N85W, 18N	N05E, 48E

*Face of west wall was inaccessible due to steep slope and water at foot of slope. Orientations were taken by sighting along slope.

The scanline data shows two dominant fracture sets in Trench 22, Cell 3: one set trends northwest/southeast and the other trends north/south (Figures 13 and 14). The typical fracture along either scanline had an aperture of less than 5 millimeters, had no mineral infillings, and was limited in length to less than 4 feet on either side of the scanline. One notable exception to this was fracture 1 of scanline 1 that had slickensides and calcite infillings along its 30 foot trace. The amount of offset could not be determined due to poor bedding structures (on the scale of the trench wall) and graded chalk covering portions of the fracture. Staining was not present on any scanline analysis fractures.

Three fractures were visually observed along the western side of the cell.

- The first fracture was near the original ground surface in the north wall of the driveway cut at the southwest corner of Trench 22, Cell 3. This fracture was oriented N53W, 50N, had an aperture of ~2 millimeters, and iron staining extending out ~10 millimeters on either side of the fracture. No slickensides were observed.

- The second fracture was visible on the west wall of the cell. Although access prevented direct measurement, the fracture had an apparent dip of ~60° south with offset of 2 feet visible in bedding. Apparent dip of the bedding changed across the fracture plane from ~10° north on the southern side of the fracture to 0° on the northern side of the fracture. Fracture aperture was less than 50 millimeters.
- The third fracture was on the southern end of the west wall with an apparent dip of 45° north. Offset was not visible and the aperture was less than 50 millimeters.

Jordan Jones & Goulding

SECTION 6
Conclusions

SECTION 6
Conclusions

Discrete fracture mapping was performed in Trench 22, Cell 3 using a combination of scanline and visual methods. The fracture sets identified in Cell 3 (Appendix B) are similar to those identified in previous work at the Emelle facility. The data collected during this investigation correlates with fracture data collected previously by JJG, Golder and Associates, and Woodward-Clyde Consultants.

The relationship between the discrete fracture sets and those lineaments previously identified on the topographic maps and aerial photographs was examined using rose diagrams. The orientation of the fracture sets described during the 1996 and 2004 discrete fracture analysis were plotted on a rose diagram (Figure 15). In this method the fracture dip for each set is ignored, and it is assumed that the fracture sets have intersected at horizontal surface. This assumption creates a condition where the fracture plane strike is equivalent to its fracture trace manifested on a theoretical surface. Although this assumption does not necessarily hold true in real space, this is a reasonable way to correlate fractures mapped in the study area with those linears (possible structural features) identified on maps and images.

The major sets identified on the rose diagram summarizing discrete fracture data include: 290 to 320, 350 to 020, and 050 to 080. The orientations of these fracture sets are similar to those lineament sets present on the topographic maps and aerial photographs with one notable exception - the 270 to 290 set does not appear to be strongly represented in the field. The 270 to 290 set identified on the topographic maps and aerial photographs does not appear to be a significant set compared to the 290 to 320 and 050 to 080 set. Therefore, this east-west set may not be identifiable on the outcrop scale possibly due to the presence of low angle variably oriented (undulating) fracture sets. The fracture orientations measured in the field would potentially produce variable sets on a stereonet or Rose diagram thereby possibly skewing the data.

SECTION 7
References

SECTION 7
References

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2. Woodward-Clyde Consultants, *Lineament Study Emelle Alabama Waste Disposal Site*, 1980.

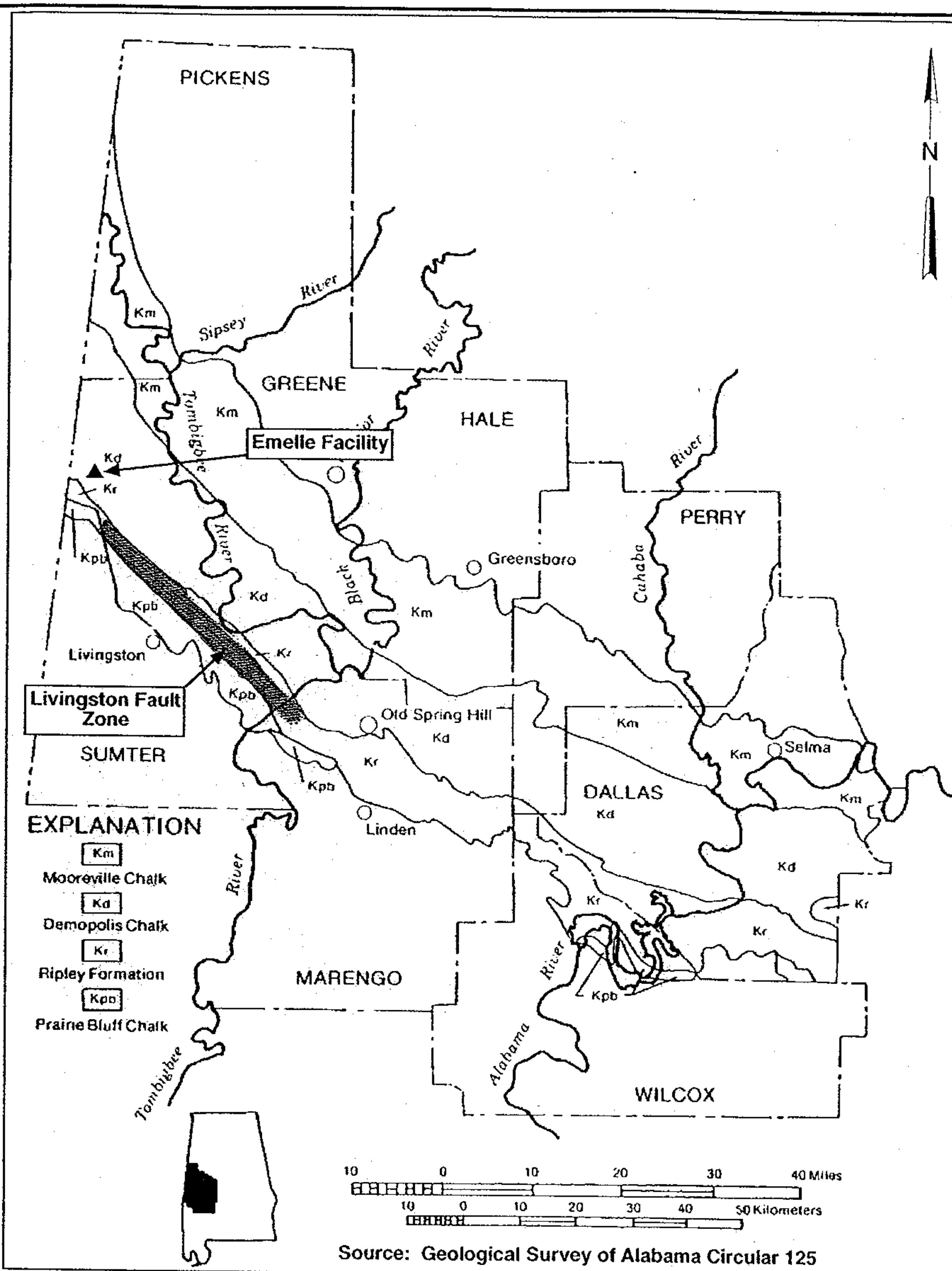
3. Golder Associates, *Geologic and Geotechnical Evaluation of the Emelle Facility*, 1983.

4. Moser, Paul, *Field Notes,* Geologic Survey of Alabama, 1982.

5. Marshak, S. and Mitra, G., *Basic Methods of Structural Geology*. Prentice-Hall, Inc. 446 pp, 1988.

Jordan
Jones &
Goulding

FIGURES



Jordan Jones & Goulding INCORPORATED

Chemical Waste Management
Emelle, Alabama

Distribution of the Selma Group in West-Central Alabama

Date: July 1997
Scale: As Shown
Job No.: 1186.002.00

Figure 1

chem waste survey map

Source: USGS Black and White February 1967
Photograph 1-102

Jordan Jones & Goulding INCORPORATED

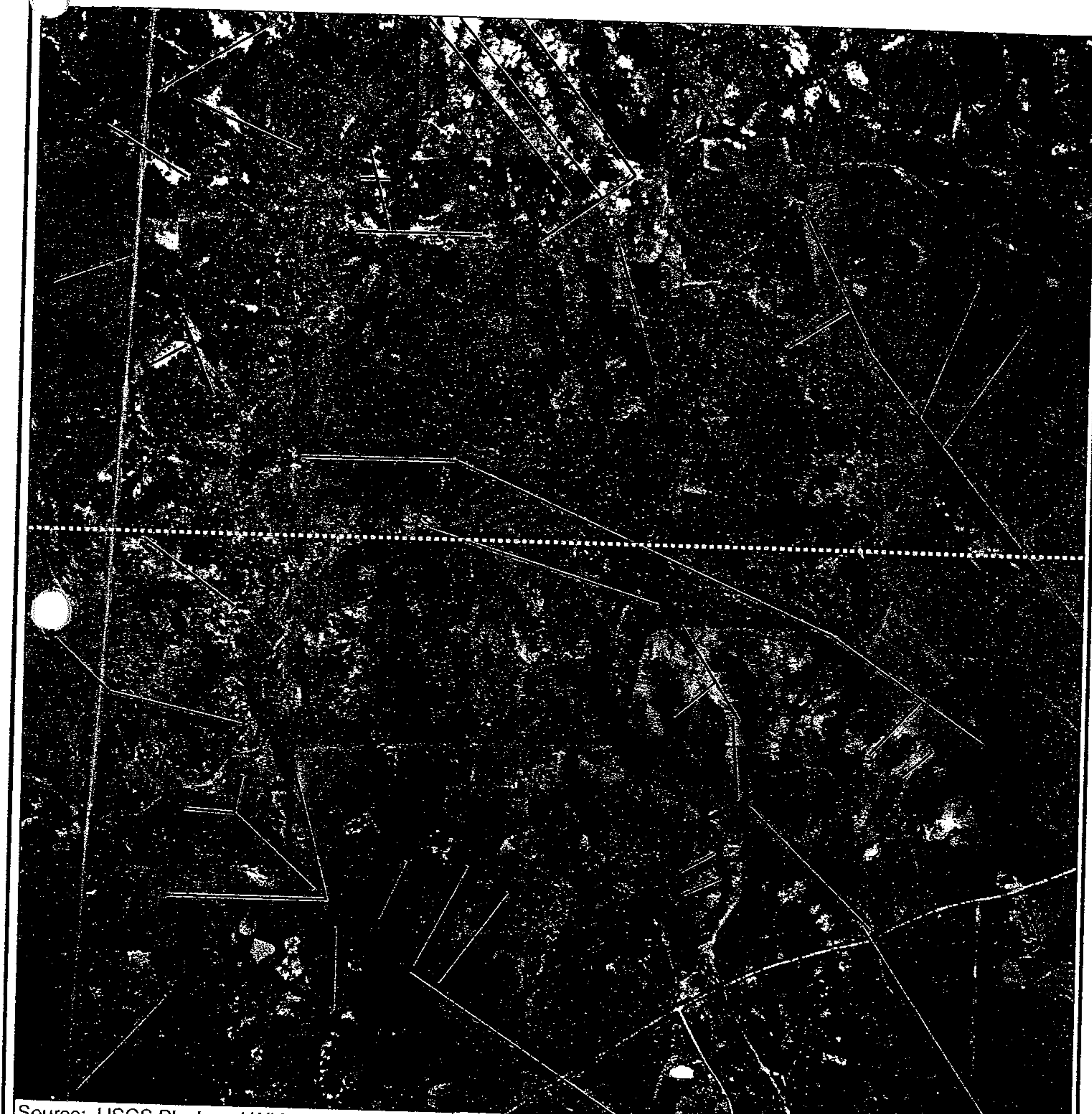
Chemical Waste Management, Inc.

Photographic Lineaments

Date:	July 1997
Scale:	1:19066
Job No.:	1186.004.07

Figure 2

chem waste aerial maps Zip 50 p4



Source: USGS Black and White February 1967
Photograph 1-103

NOTE: Lineaments noted above dashes line are depicted on photograph 1-102.

Jordan Jones & Goulding INCORPORATED	Chemical Waste Management, Inc.	Date: July 1997
		Scale: 1:19066
	Photographic Lineaments	Job No.: 1186.004.07
		Figure 3

chem waste aerial maps Zip 50 p5

Source: USGS Color Infrared March 1981
Photograph 39150

Jordan Jones & Goulding INCORPORATED

Chemical Waste Management, Inc.

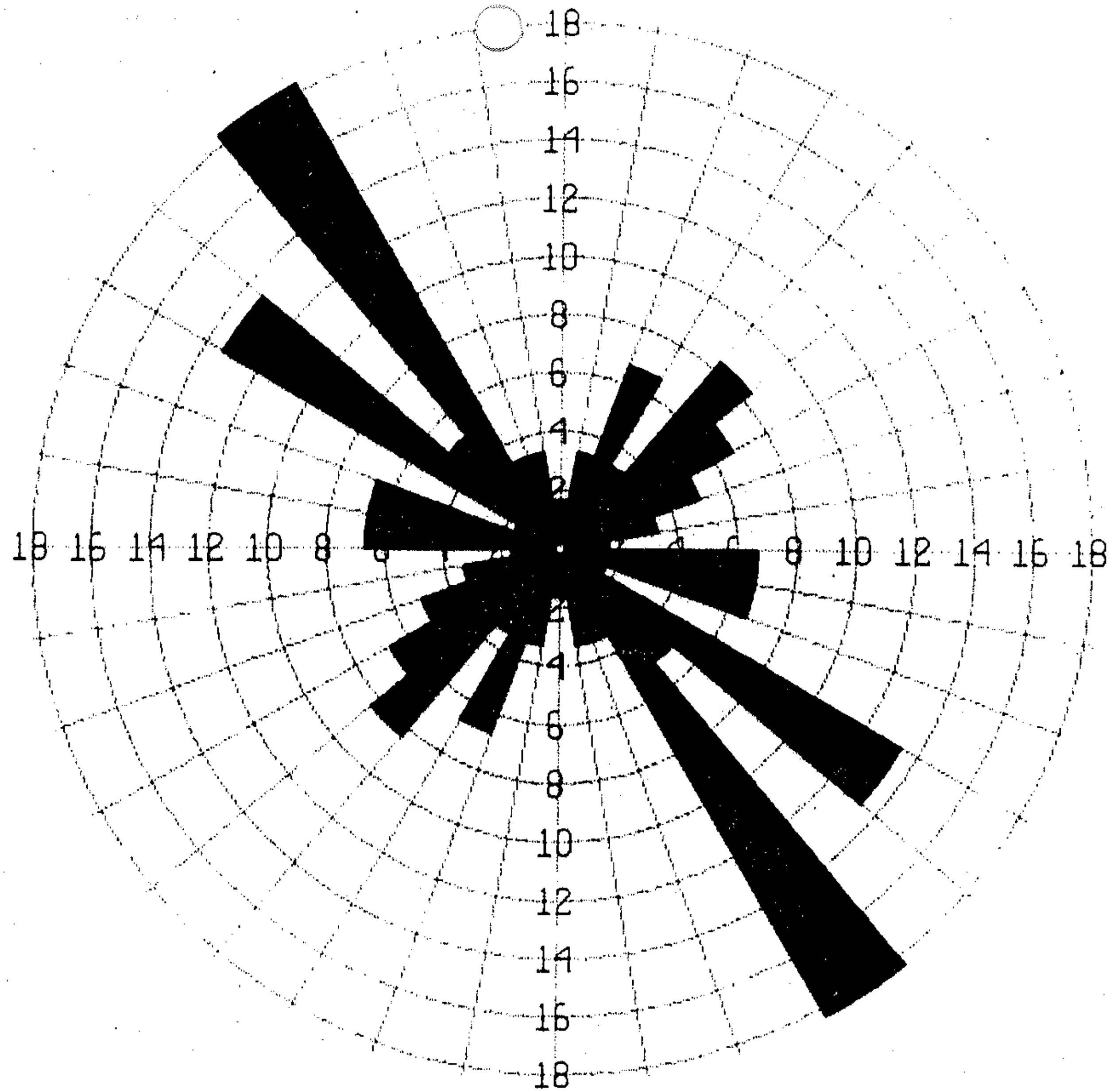
Photographic Lineaments

Date:	July 1997
Scale:	1:58000
Job No.:	1186.004.07

Figure 4

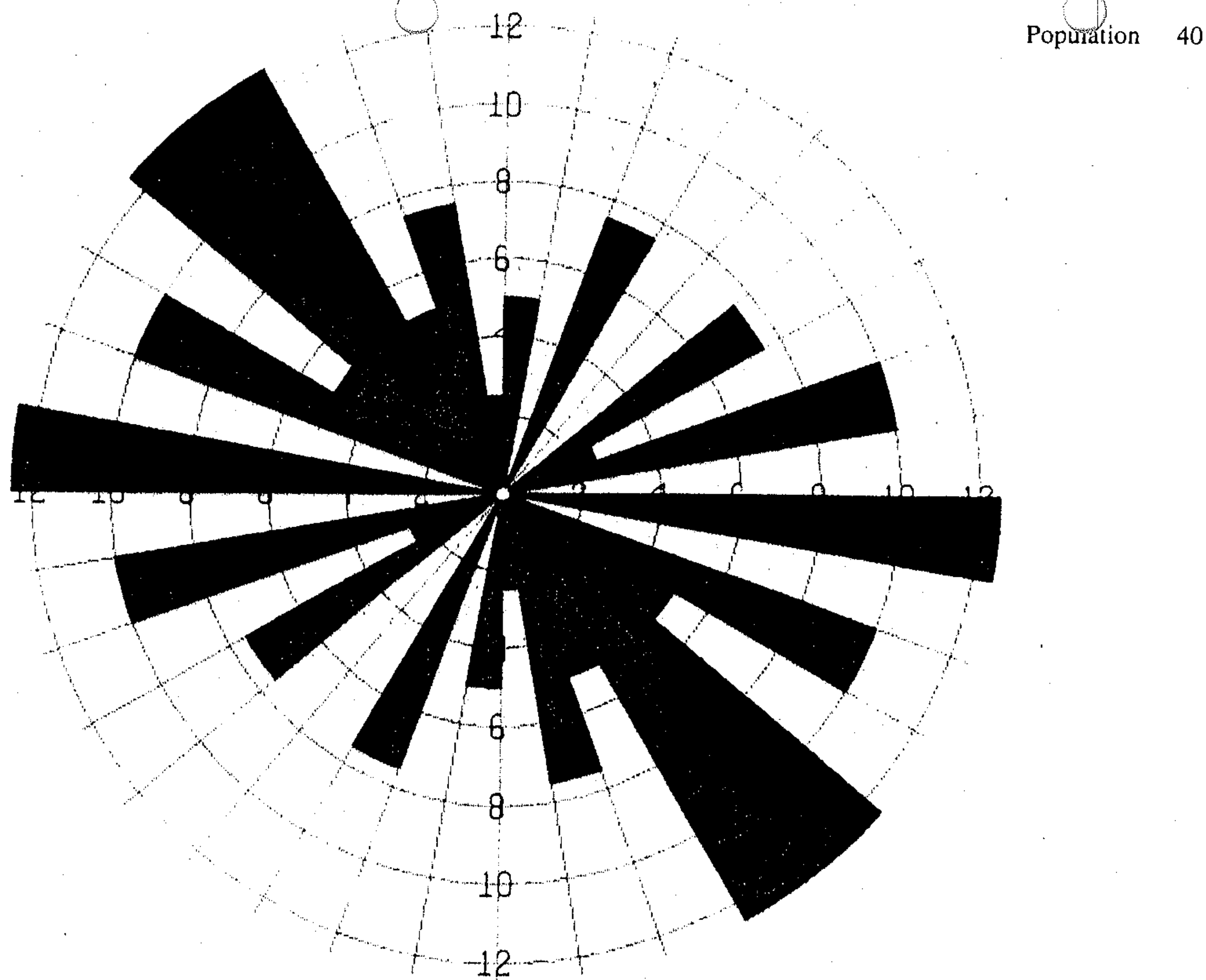
chem waste aerial maps Zip 50 p2

Population 60



Jordan Jones & Goulding INCORPORATED	Chemical Waste Management, Inc.	Date: July 1997
		Scale: N.T.S.
	Lineament Trends Identified on the Black and White 1:19,066 Scale Photographs	Job No.: 1186.004.07
		Figure 5

chem waste trench 22.fh Æ pg 6



Chemical Waste Management, Inc.

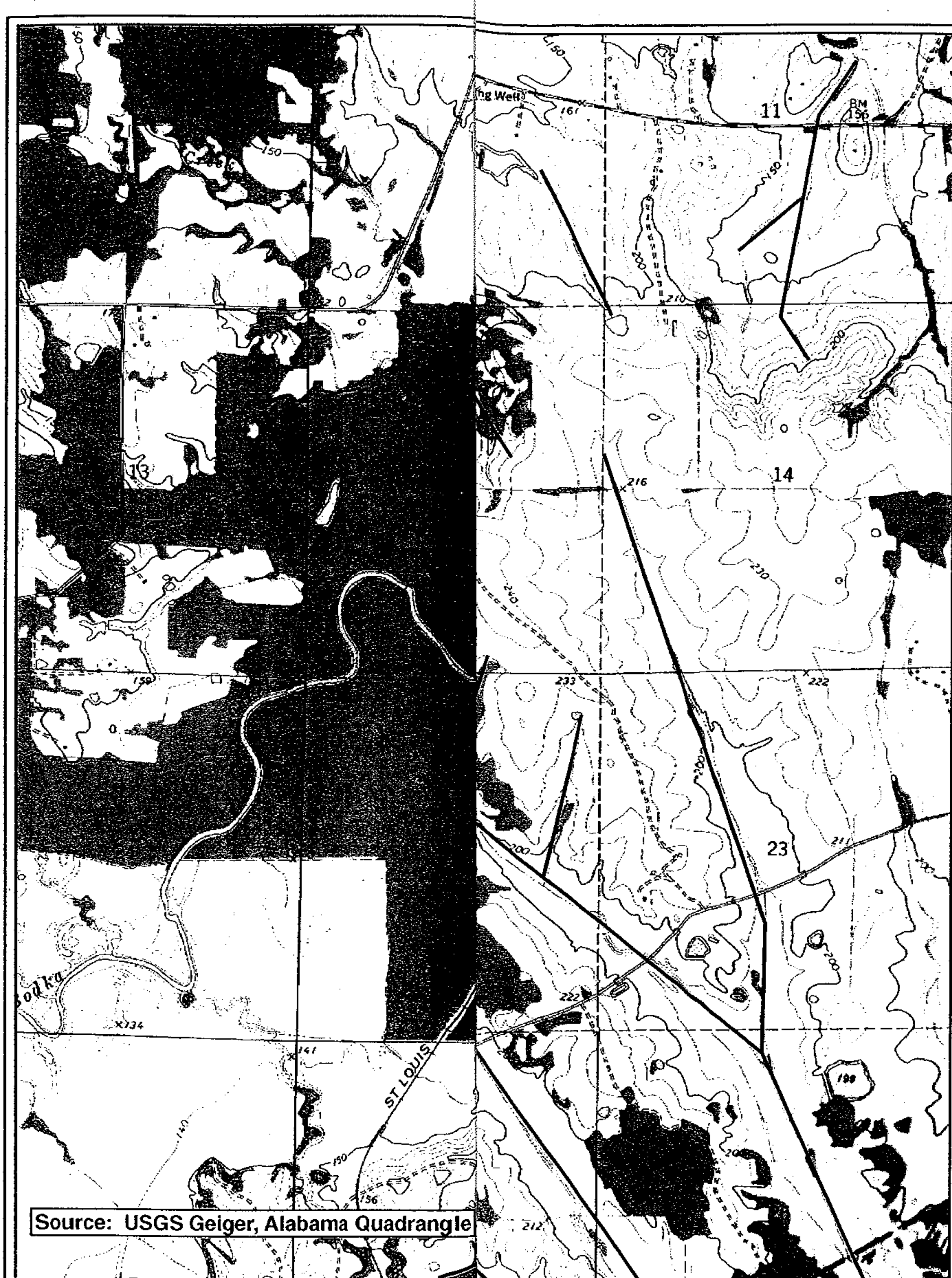
Lineament Trends Identified on the Color Infrared 1:58,000 Scale Photograph

Date: July 1997
Scale: N.T.S.
Job No.: 1186.004.07

Figure 6

Jordan Jones & Goulding INCORPORATED

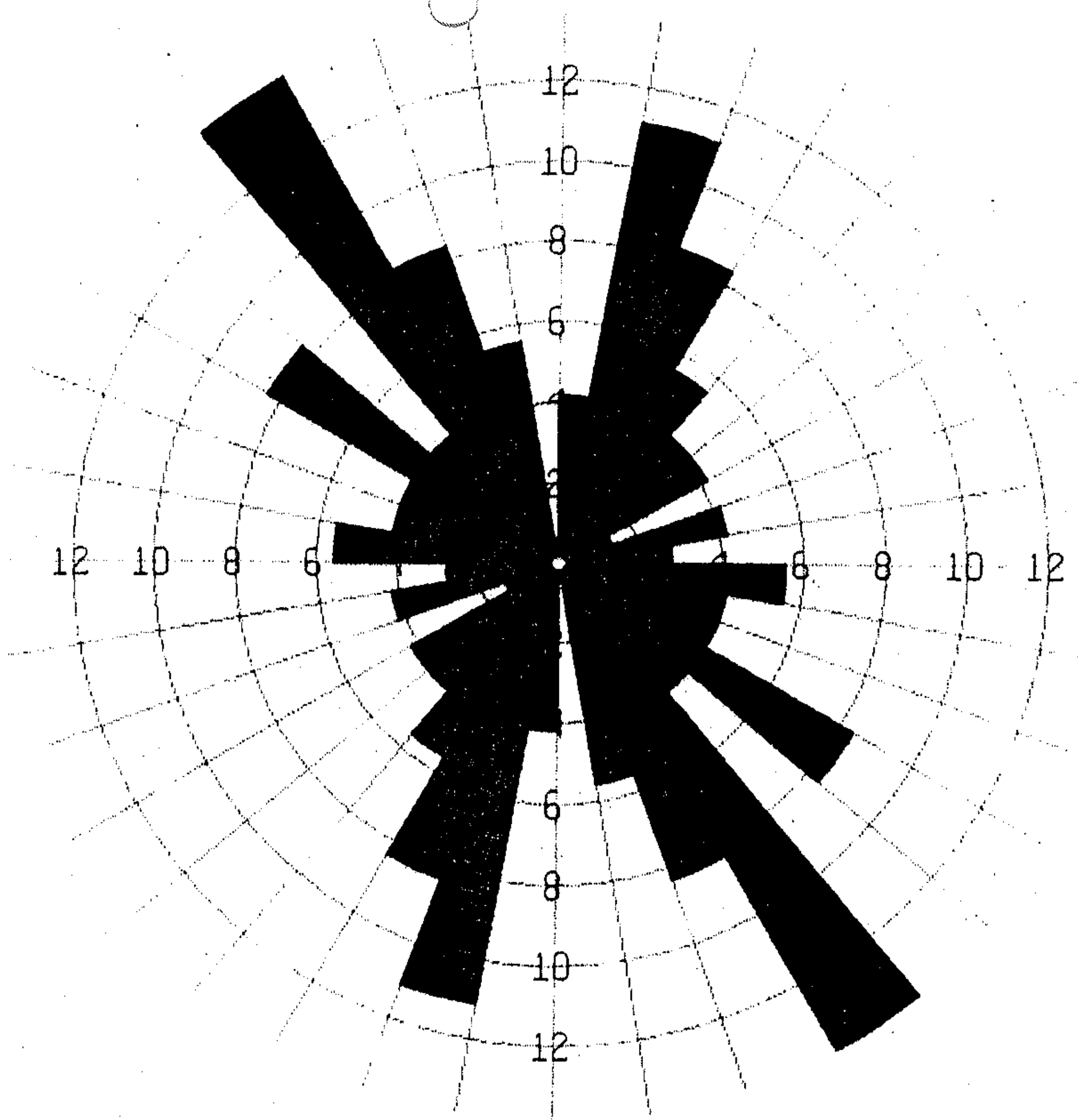
chem waste trench 22.fh Æ pg 5



		Date:	July 1997
		Scale:	1:24,000
		Job No.	1186.004.07
		Figure 7	

chem waste lineaments map Zip 50 p1

Population 72



Jordan Jones & Goulding INCORPORATED

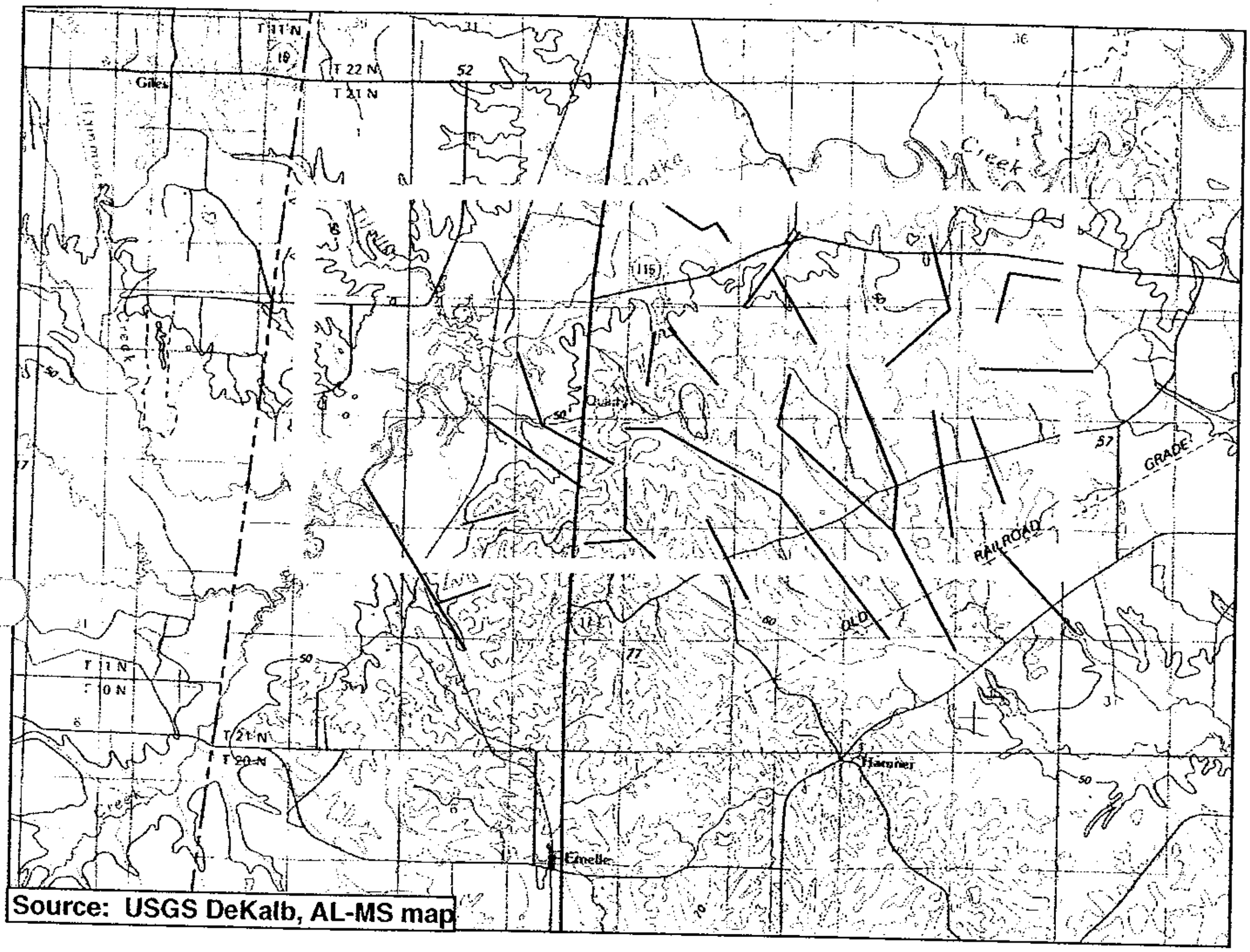
Chemical Waste Management, Inc.

Lineaments Trends Identified on the Geiger, Alabama 1:24,000 Scale Topographic Map

Date:	July 1997
Scale:	N.T.S.
Job No.:	1186.004.07

Figure 8

chem waste trench 22.th Æ pg 10

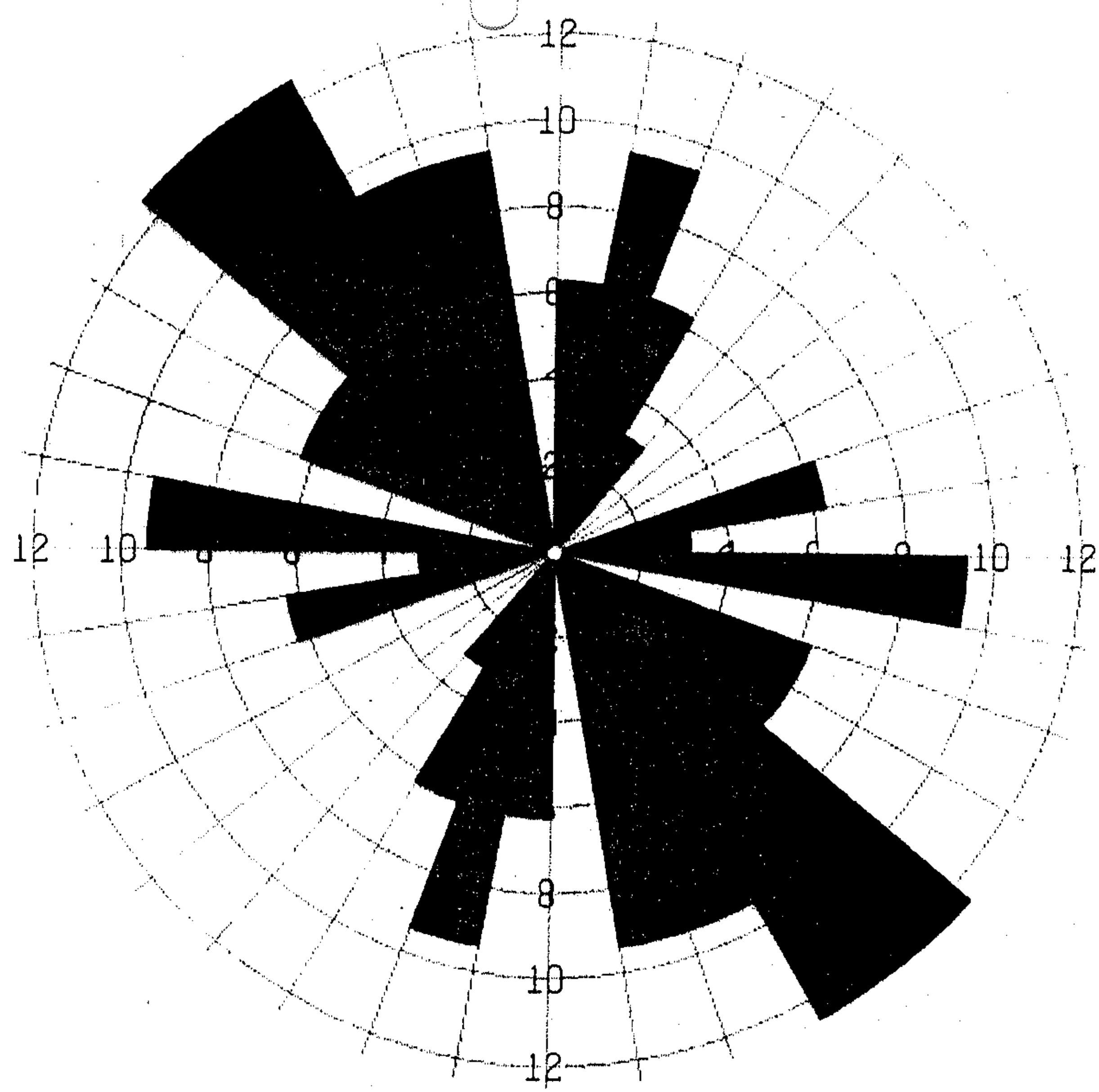


Source: USGS DeKalb, AL-MS map

Jordan Jones & Goulding INCORPORATED

Chemical Waste Management, Inc.	Date: July 1997
	Scale: 1:100000
	Job No.: 1186.004.07
Topographic Lineaments	Figure 9

chem waste lineament maps Zip50 p2



Chemical Waste Management, Inc.

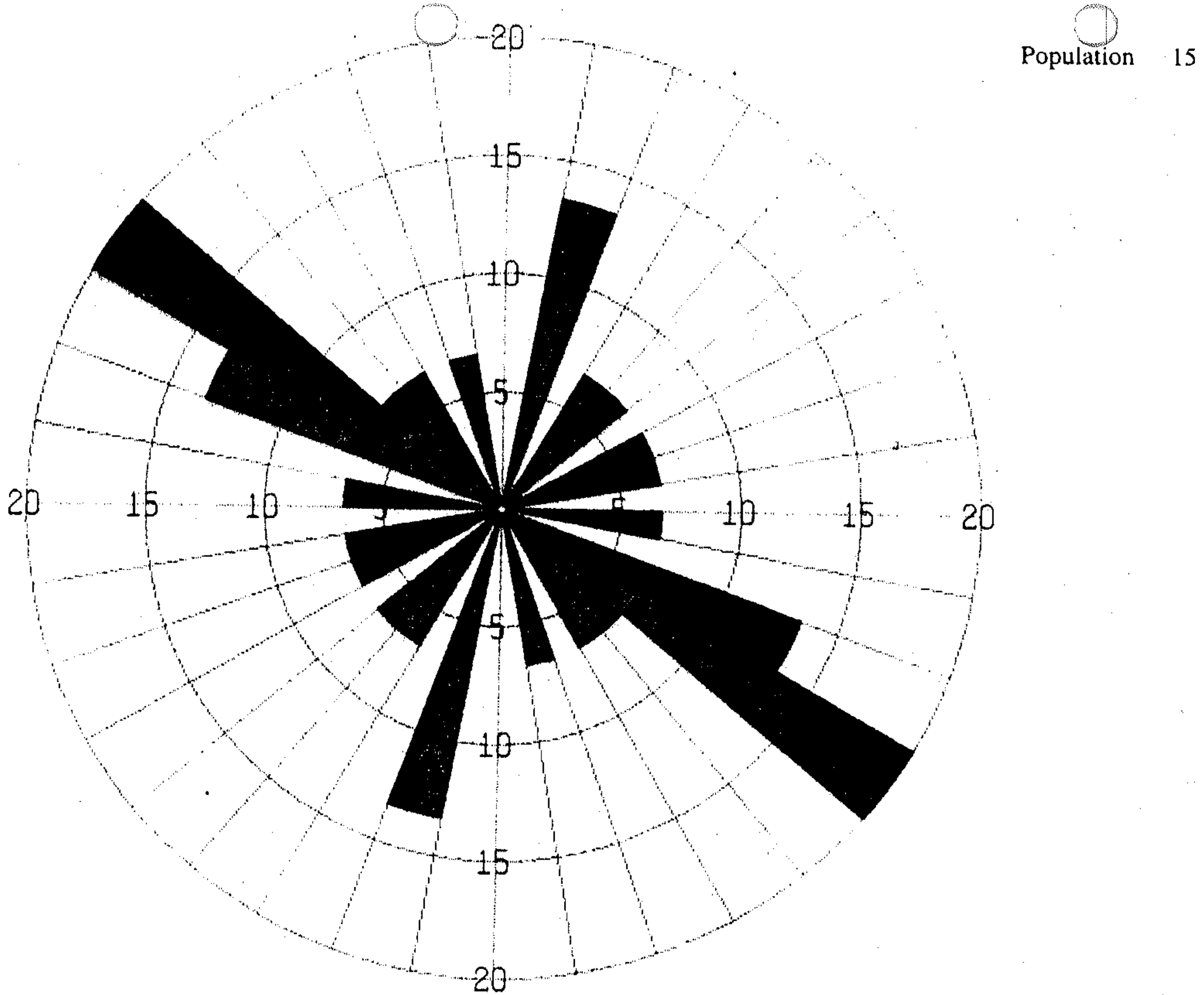
Lineament Trends Identified on the DeKalb, AL-MS 1:100,000 Scale Topographic Map

Date:	July 1997
Scale:	N.T.S.
Job No.:	1186.004.07

Figure 10

Jordan Jones & Goulding INCORPORATED

chem waste trench 22.jh Æ pg 7



Jordan Jones & Goulding INCORPORATED

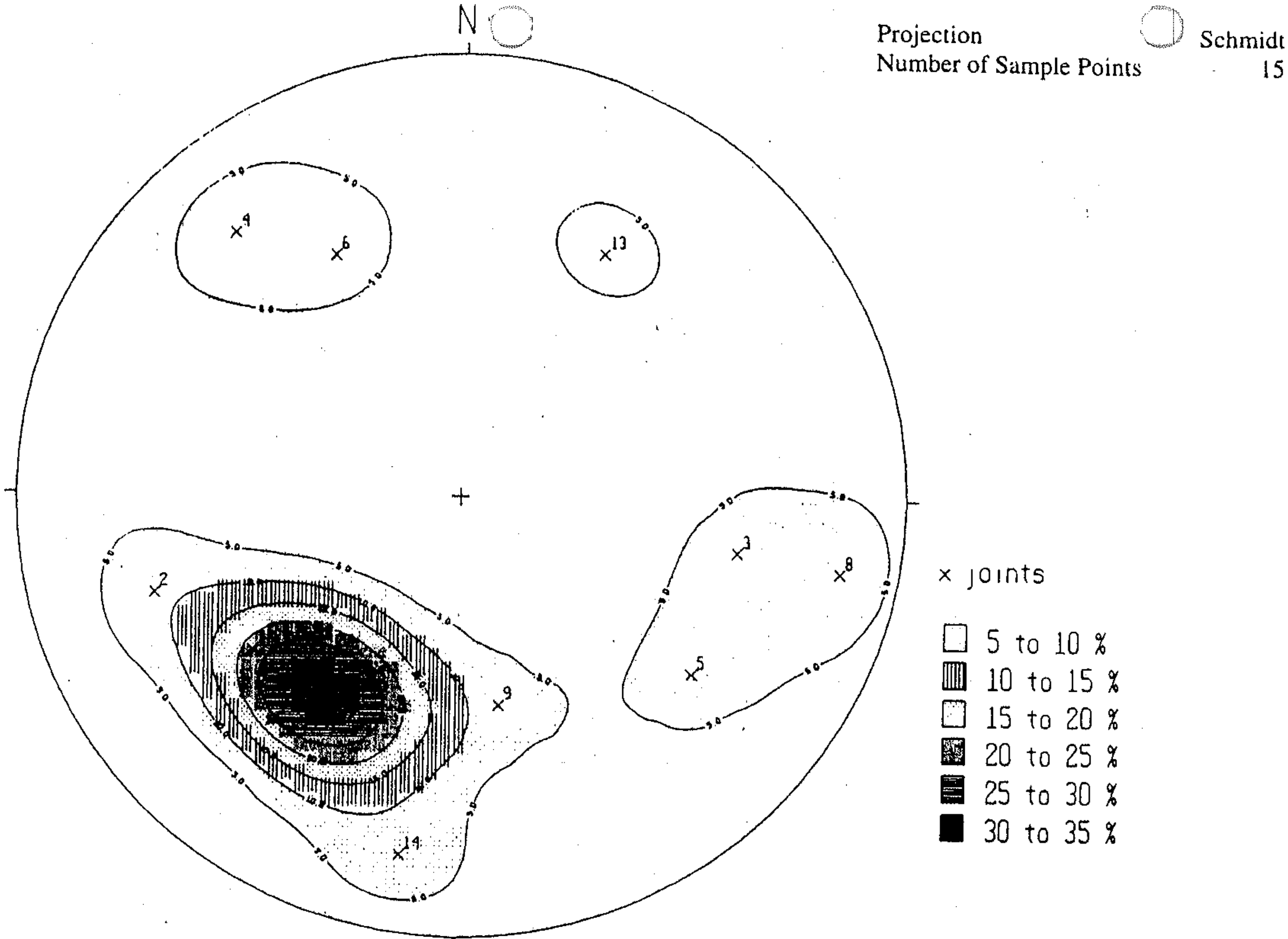
Chemical Waste Management, Inc.

Fracture Trends - Trench 22, Cell 2

Date:	July 1997
Scale:	N.T.S.
Job No.:	1186.004.07

Figure 11

chem waste trench 22.th Æ pg 11



Jordan Jones & Goulding INCORPORATED

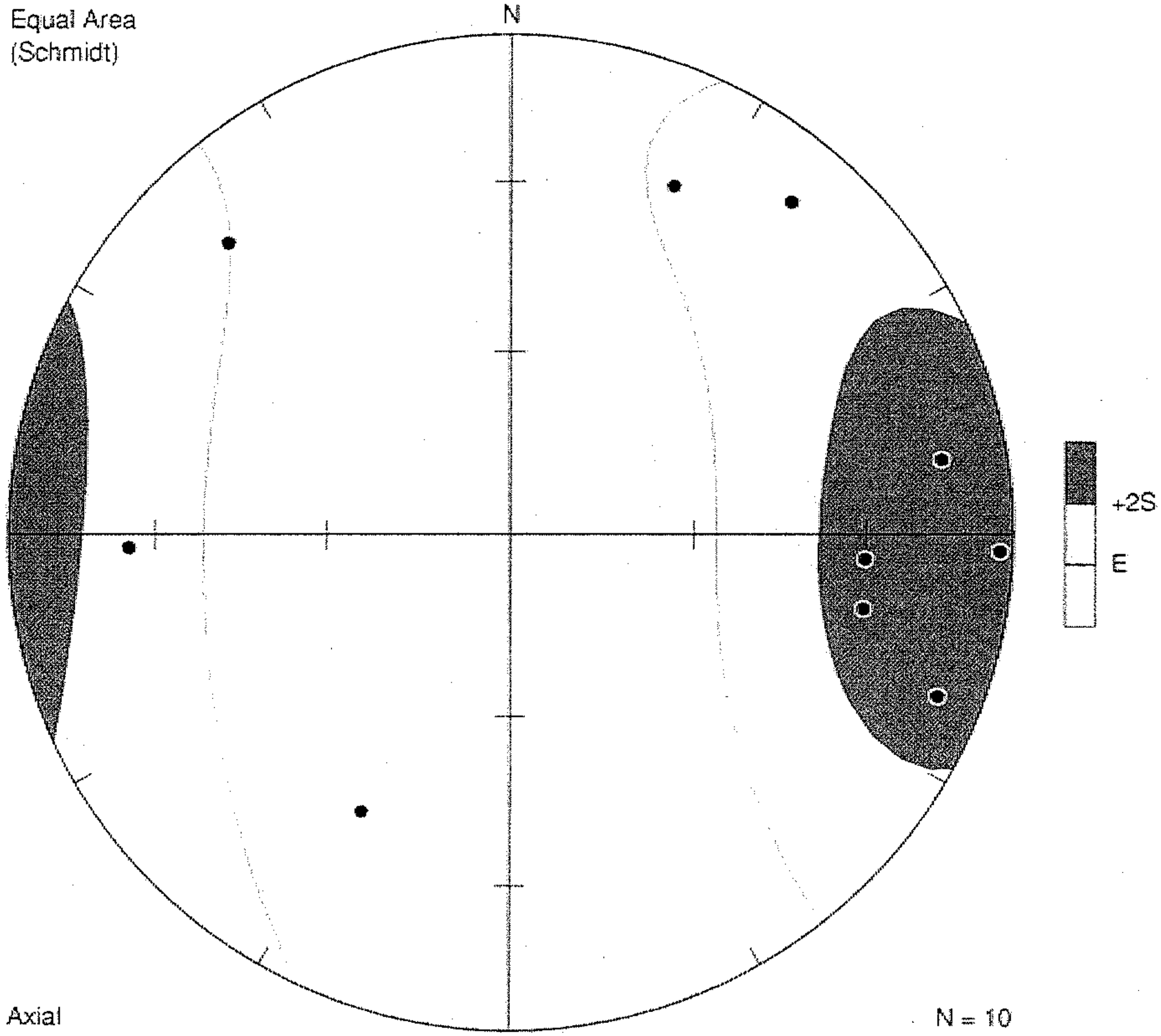
Chemical Waste Management, Inc.

Fracture Orientations - Trench 22, Cell 2

Date:	July 1997
Scale:	N.T.S.
Job No.:	1186.004.07

Figure 12

chem waste trench 22.fh Æ pg 4



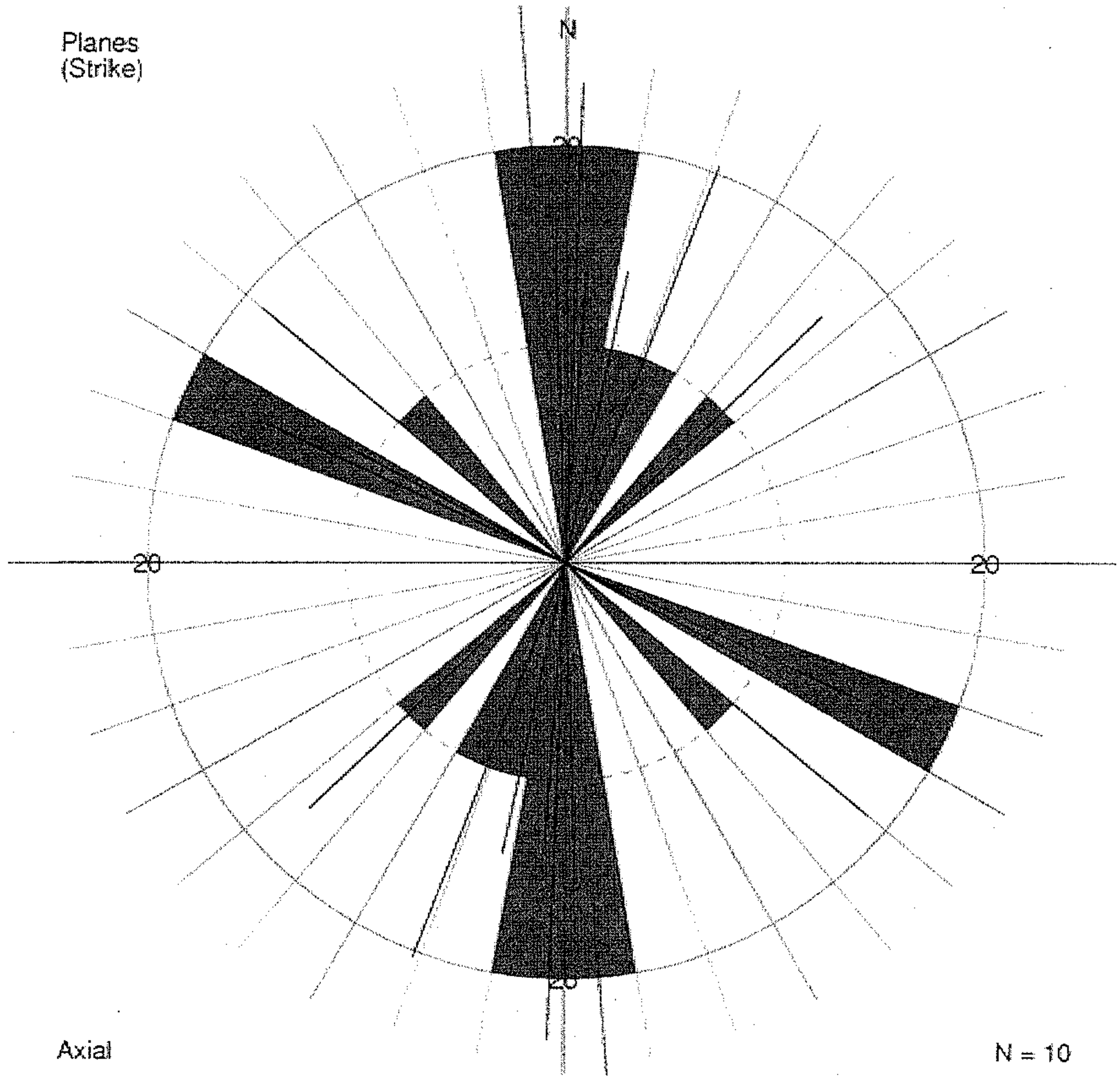
Jordan Jones & Goulding

Chemical Waste Management, Inc.

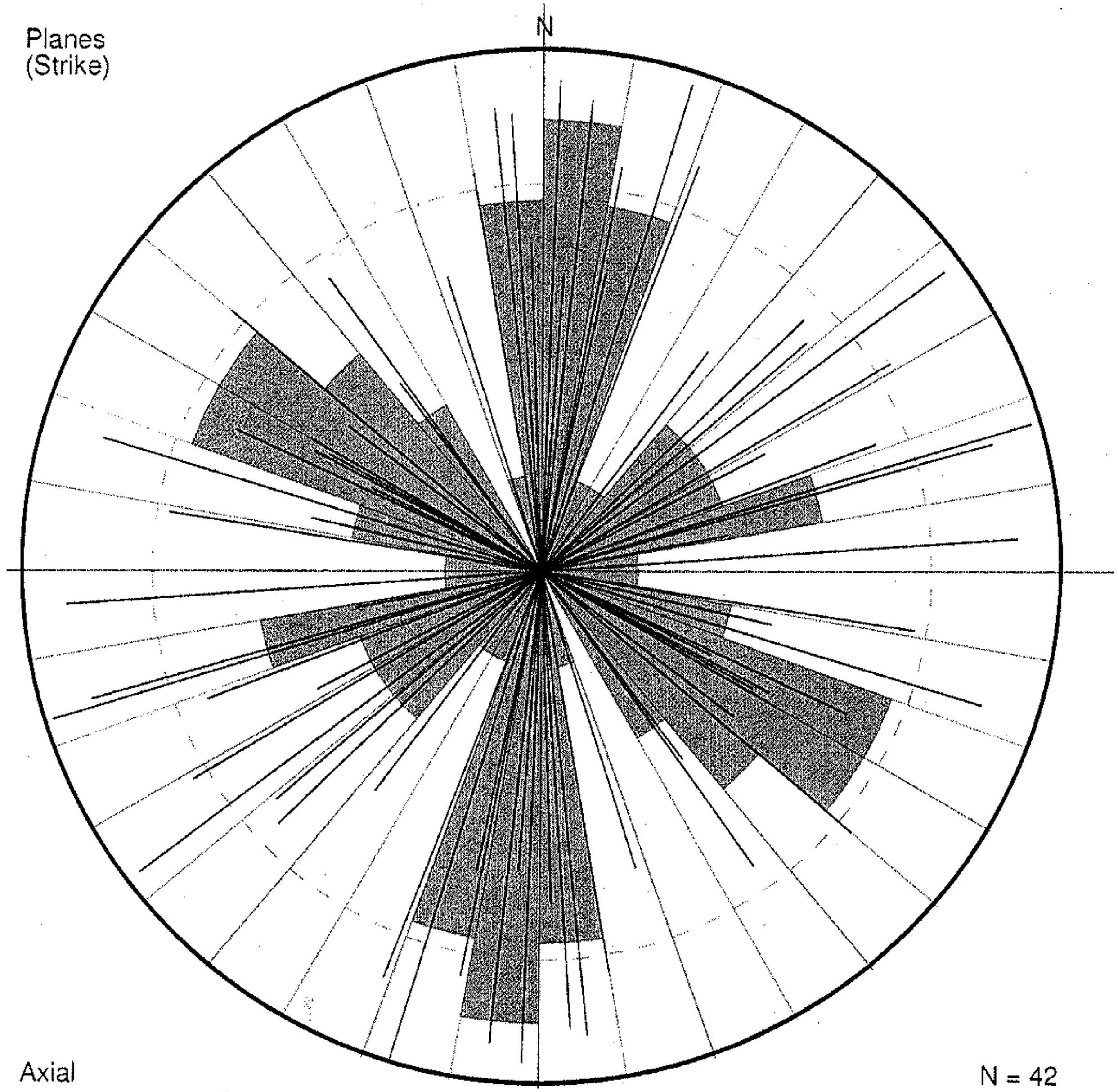
Fracture Orientations – Trench 22, Cell 3

DATE: December 2004
SCALE: NTS
JOB No.:

FIGURE 13



Jordan Jones & Goulding	Chemical Waste Management, Inc.	DATE: December 2004 SCALE: NTS JOB No.:
	Fracture Trends – Trench 22, Cell 3	**FIGURE 14**



Jordan Jones & Goulding

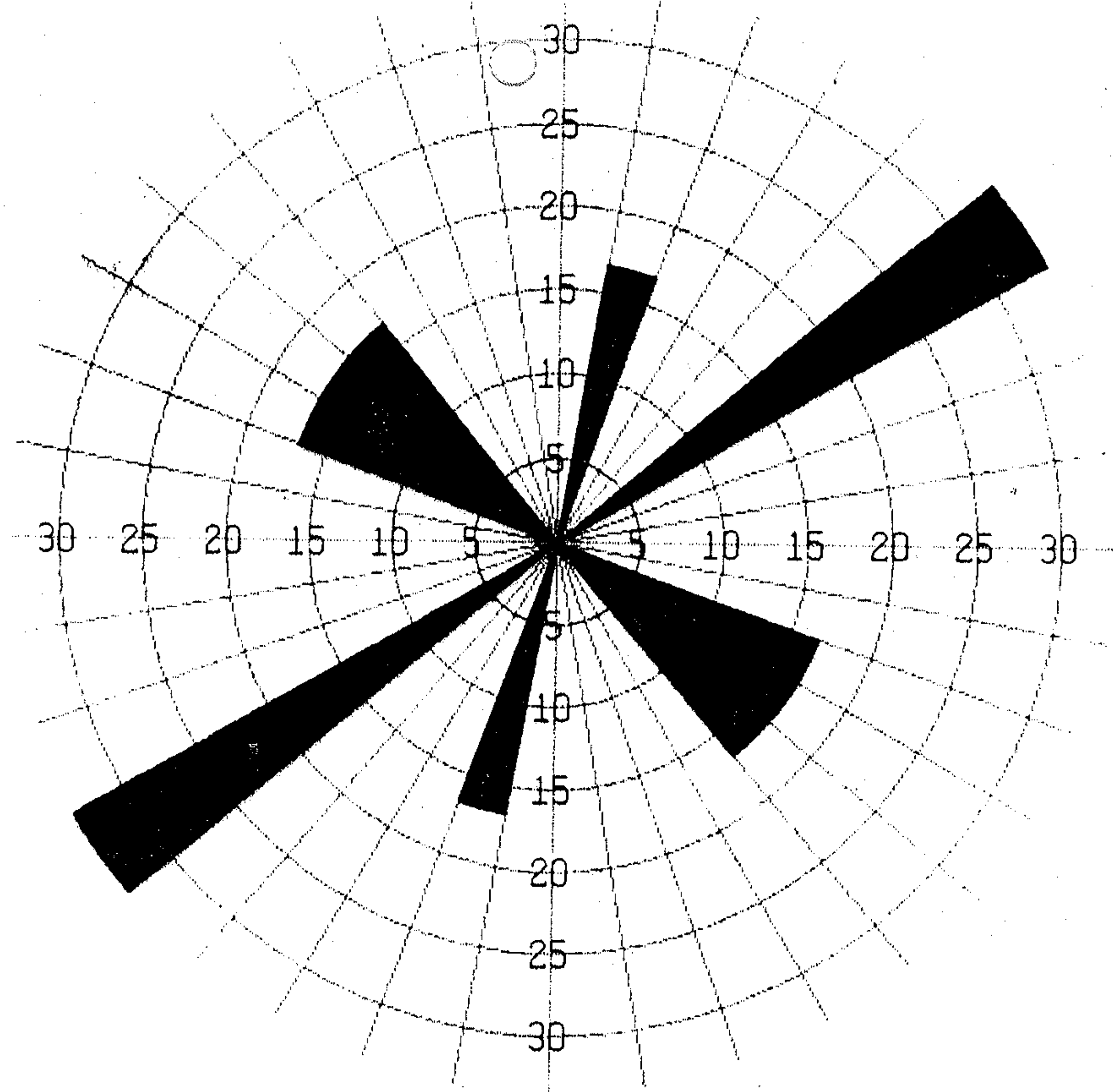
Chemical Waste Management, Inc.

All fracture data collected by JJG at Emelle, AL site

DATE:	December 2004
SCALE:	NTS
JOB No.:	

FIGURE 15

Popu[illegible]n 6



Jordan Jones & Goulding INCORPORATED

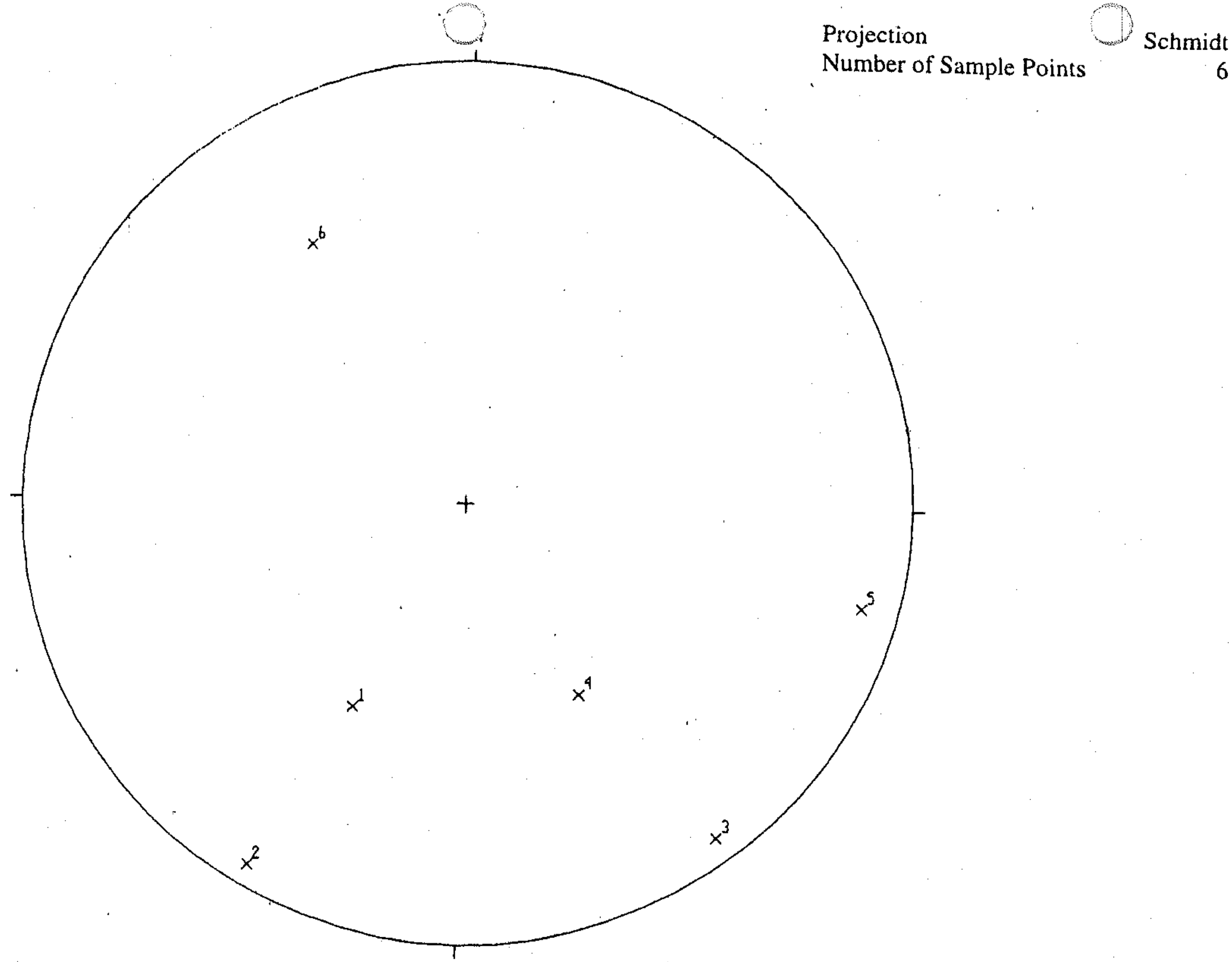
Chemical Waste Management, Inc.

Mean Fracture Set Trends Identified by Golder Associates

Date:	July 1997
Scale:	N.T.S.
Job No.:	1186.004.07

Figure 16

chem waste trench 22.th Æ pg 9



Jordan Jones & Goulding INCORPORATED	Chemical Waste Management, Inc.
	Mean Fracture Set Orientations Identified by Golder Associates

Date:	July 1997
Scale:	N.T.S.
Job No.:	1186.004.07

Figure 17

chem waste trench 22.th Æ pg 2

Jordan
Jones &
Goulding

APPENDIX A

Paul Moser's Field Notes and Alabama Geologic Survey Correspondence

GEOLOGICAL SURVEY OF ALABAMA

A. CHARLES FREEMAN
Attorney
JAMES H. GRIGGS
Attorney
GEORGE W. SWINDEL, JR.
Director,
Administrative Services
THORNTON L. NEATHERY
Director,
Budget & Program Development
RICHARD N. RAYMOND
Director,
Technical Operations
W. EVERETT SMITH
Director,
Program Review & Quality Control

THOMAS J. JOINER
State Geologist and Oil and Gas Supervisor

TECHNICAL DIVISION
Water Resources
J. D. MOORE, ACTING CHIEF
Mineral Resources
M. W. SZABO, CHIEF
Geology
C. W. COPELAND, JR., CHIEF
Energy Resources
T. W. DANIEL, JR., CHIEF
Environmental
M. F. METTEE, CHIEF
Publications
T. V. STONE, CHIEF
Geochemistry—
Water Quality Research
A. M. MALATINO, CHIEF

December 11, 1980

Mr. Alfred S. Chipley, Director
Division of Solid & Hazardous Wastes
Department of Public Health
State Office Building
Montgomery, AL 36104

RECEIVED
DEC 16 1980
STATE ... DEPARTMENT
DIVISION OF ... WASTE
& VECTOR CONTROL

Dear Chip:

Re: Project No. 81-9010
Contract No. 81-3005
Inspection of Pit No. 15
Hazardous Waste Disposal Site
Emelle, Sumter County, Alabama

On December 5, 1980, a visual inspection of Pit No. 15 at the Hazardous Waste Disposal Site in Emelle was conducted in the accompaniment of Mr. Maurice Oxner of Waste Management of Alabama, Inc.

At the time of the inspection, Pit No. 15 had been excavated to the maximum projected depth of about 100 feet. The floor of the pit will be constructed so that leachate can collect in a trench. A 2-foot layer of in situ material will be placed along the bottom of the pit and compacted in 4- to 6-inch lifts.

A visual inspection of the vertical walls of Pit No. 15 revealed the presence of 4 to 6 faults. The plane of most of the faults exhibited slickensides and appeared to dip at an angle of from about 40 to 80 degrees. Some of the faults were at a much lower angle and some smaller faults terminated against the larger faults.

One fault exhibited calcite-filled openings and calcite crystals. These depositional features are commonly indicative of circulating ground water sometime in the past. The linear extent of this calcite deposition, however, was no more than about 1 to 2 feet. It is anticipated that these depositional calcite features should not be of any major concern in regard to the overall rock integrity.

AN EQUAL OPPORTUNITY EMPLOYER
P. O. Drawer O University, Alabama 35486

The faults observed in Pit No. 15 appear to be similar in nature to those that have previously been uncovered in other pits, and it is probable that these faults would react hydrologically in a similar manner as those uncovered in previous pits. We recommend, therefore, that Pit No. 15 be utilized for the purpose of hazardous waste disposal.

We continue to recommmend the placement of a 2-foot thick impermeable layer along the bottom of the pit compacted in 4- to 6-inch lifts and the placement of a leachate collection trench. We also recommend the continued surveillance and, where and when necessary, the packer-testing of fault zones that appear to have the potential for water movement.

If we may be of further assistance to you, please do not hesitate to contact us.

Sincerely,

Paul H. Moser

Paul H. Moser
Environmental Geologist

iet

State of Alabama

DEPARTMENT OF PUBLIC HEALTH

State Office Building
Montgomery, Alabama 36130

IRA L. MYERS, M.D.
STATE HEALTH OFFICER

March 5, 1982

Mr. Rodger Henson
Chemical Waste Management
P. O. Box 55
Emelle, Alabama 35459

Dear Mr. Henson:

Enclosed you will find a copy of a letter from Mr. Paul Moser regarding slumping and sloughing of the south wall of Pit No. 16. This office contacted Mr. Moser after a visit we made to your facility on February 9, 1982, at which time the problem with Pit 16 was noted.

As you can see, Mr. Moser has stated that the failure is due to fault activity and slippage in the area in which the pit is located. In order to avoid future problems of the nature now occurring at Pit 16, Mr. Moser has recommended that a study be conducted to isolate areas where faulting is likely to occur. We agree with Mr. Moser's comment and therefore are going to require that you do a thorough geotechnical evaluation of the area now under permit to determine where, if any, future faulting is likely to occur. Then based upon this information and other pertinent engineering factors, you are to submit to this office by July 1, 1982, a facility plan showing the proposed layout for trenches to be constructed under the existing permit.

We are extremely concerned over the last paragraph of Mr. Moser's letter which deals with possible groundwater movement into Pit 15. As stated to you during previous conversations, the periphery wall used in the trenches must be properly constructed in order to insure that contaminants do not migrate from the cell. All periphery walls must be constructed and compacted prior to waste being placed in the trench. The walls must be compacted to at least 95% Proctor with a permeability coefficient of at least 10^{-9} cm/sec.

Should you have questions, please feel free to contact this office.

Sincerely,

B.E. Cox

Bernard E. Cox, Jr., Chief
Industrial and Hazardous Waste Section
Division of Solid and Hazardous Waste

BEC:rc

Enclosure

cc: Paul Moser
Jim Scarbrough

GEOLOGICAL SURVEY OF ALABAMA

P. O. Drawer O
University, Alabama 35486
(205) 349-2852

ERNEST A. MANCINI
State Geologist
and
Oil and Gas Supervisor

ADMINISTRATIVE DIRECTO
J. A. Carey, Attorney
T. L. Neathery, Budget and Program
W. E. Smith, Technical Operations
G. W. Swindel, Jr., Services

DIVISIONS
C. W. Copeland, Jr., Geology
T. W. Daniel, Jr., Energy Resources
A. M. Malatino, Geochemistry–Water Laboratory
M. F. Mettee, Environmental
J. D. Moore, Water Resources
T. V. Stone, Publications
M. W. Szabo, Mineral Resources

February 26, 1982

Mr. Bernard Cox
Department of Public Health
Division of Solid & Hazardous Wastes
434 Monroe Street
Montgomery, AL 36130-1701

Dear Buddy:

Re: Pit No. 16
Chemical Waste Management
Sumter County

On February 23, 1982, I visited the Chemical Waste Management site located in Emelle, Sumter County. At your request, I inspected the rather massive slumping and sloughing that has occurred on the south wall of Pit No. 16.

Many of the recently excavated pits at the Emelle site have exposed numerous faults on the walls, and Pit No. 16 is no exception. The south wall of Pit No. 16 in particular has some classic textbook examples of faulting. These include faulting with or without relative displacement, arcuate faulting, curved and discontinuous fault planes, en-echelon faulting, antiphetic faulting, slickensides, calcite deposition in the fault zone with one surface demonstrating slickensides, and grabens.

The slide scar surface area located above the sloughed material is almost entirely covered by a slickenside surface. This would indicate a zone of weakness that apparently caused the sudden release of a large segment of material during a particularly severe freeze in January. This release was obviously aggravated by the removal of large amounts of rock mass in the partially excavated pit; and it was, I believe, a certain amount of "bad luck" that the open pit was located so close to this faulted and slickenside zone of weakness.

I could not speculate on any method whereby this sloughing could have been avoided, save locating the areas of highest fault concentration and avoiding these areas in the future.

Re: Pit No. 16, Sumter County

Mr. Maurice Oxner, the Operations Manager of Chemical Waste Management, plans to cut back the south wall and place it on a more gentle slope to prevent such sloughing in the future. This probably would be as practical a solution as any other. There is no assurance that this same type of arcuate faulting and large slickenside surfaces would not occur further back into the wall.

Another contributing factor to the massive sloughing is probably the fact that Pit No. 16 was started in November 1981 and thus has been open and exposed for about three months. This has allowed the release of pressure due to excavation of the pit which aggravated the slickenside zone of weakness.

In light of the demonstrated relative impermeability of the faulted and slickensided surfaces in other pits, I would not expect the south side of Pit No. 16 to be any less permeable than the other pits. However, I would recommend that, if practical, a study should be conducted to isolate the areas where abundant faulting occurs and then avoid these areas when future pits are located. *

At the time of my visit, Chemical Waste Management had just begun disposal in Pit No. 15. The requested 5-foot barrier back-filled layer was being placed around the periphery of the fill area as the pit was being filled. Unless very thorough mechanical compaction is attained, it is my opinion that this periphery barrier is not effective in isolating the liquid waste material in the disposal area of the pit. I am far more concerned about the ground water leaking into the southwest corner of Pit No. 15 than I am about the periphery barrier. If ground water can leak into the pit, leachate can just as easily leak out, and this would lead to the potential for contamination of the ground water and surface water. *

If I can be of further assistance, please do not hesitate to call me.

Sincerely,

Paul H. Moser

Paul H. Moser
Environmental Geologist

iet

State of Alabama

DEPARTMENT OF PUBLIC HEALTH

State Office Building
Montgomery, Alabama 36130

IRA L. MYERS, M.D.
STATE HEALTH OFFICER

August 16, 1982

Rodger Henson, Ph. D.
Chemical Waste Management, Incorporated
P. O. Box 55
Emelle, Alabama 35459

Dear Dr. Henson:

As you are aware, representatives of this office and the Alabama Geological Survey recently visited your facility to determine the status of Trench No. 16. A copy of the Survey's letter is enclosed.

By examining the Survey's letter, you can see that even though fractures exist in the trench wall, it is their opinion that the fractures are unconsolidated and are not interconnecting. They further state that the chance for migration of pollutants from the trench via the fractures is minimal.

In view of the Survey's findings, we are approving Trench 16 for burial of waste material. However, in order to insure that no pollutants leave the site, you are reminded that all liners must be in place prior to waste being placed in the trench. Further, no waste can be placed on a lift until such time as the sidewall liner for that lift has been entirely completed.

Should you have questions, please feel free to contact Mr. Cox or me.

Sincerely,

Alfred S. Chipley

Alfred S. Chipley, Director
Division of Solid and Hazardous Waste

ASC:rc

Enclosure

cc: Jim Scarbrough

GEOLOGICAL SURVEY OF ALABAMA
P. O. Drawer O
University, Alabama 35486
(205) 349-2852

ERNEST A. MANCINI
State Geologist
and
Oil and Gas Supervisor

ADMINISTRATIVE DIRECT[ORS]
J. A. Carey, Attorney
T. L. Neathery, Budget and Progra[m]
W. E. Smith, Technical Operations
G. W. Swindel, Jr., Services

DIVISIONS
C. W. Copeland, Jr., Geology
T. W. Daniel, Jr., Energy Resources
A. M. Malatino, Geochemistry–Water Laboratory
M. F. Mettee, Environmental
J. D. Moore, Water Resources
T. V. Stone, Publications
M. W. Szabo, Mineral Resources

August 6, 1982

AUG 1982
RECEIVED
Health Dept.
Solid Waste

Mr. Alfred Chipley
Department of Public Health
Division of Solid and Hazardous Waste
434 Monroe Street
Montgomery, Alabama 36130

Dear Mr. Chipley:

This is to report results of my inspection on August 5 of Pit No. 16 at the Hazardous Waste Disposal Facility in Sumter County, Alabama. Paul Moser of our staff, who normally carries out our inspections at this facility, is currently on out-of-state leave.

Inspection of the pit showed several fractures exposed on the west wall, no factures on the south wall, and 4 fractures on the east wall. Clay liner construction was underway on the north wall. This along with the access ramps to the pit, limited exposure of the excavated north wall, therefore, limiting the opportunity to view this wall in its entirety. However, evidence was not seen in the limited exposures of this wall to suggest that significant fractures or other structural features occur on this wall. Continuity or interconnection of fractures observed on the pit walls could not be seen in the pit floor.

Fractures observed on pit walls are related to vertical displacement of the chalk beds ranging from very slight to 3 to 4 feet. No ground water was observed entering the pit from any of the fractures. The fractures show calcite mineralization and gouge development, indicating that their permeabilities are very low and probably as low as the undisturbed chalk. These fractures, therefore, will not serve as significant conduits to allow liquid waste to escape from the pit.

In view of the good structural integrity of the chalk in Pit 16, and the relatively impermeable nature of the several fractures exposed in the pit, it is my recommendation that Pit No. 16 be approved for use in disposal of hazardous wastes. I will be happy to answer any questions or otherwise dicuss this matter further should you so wish.

Sincerely,

Everett Smith

Everett W. Smith
Assistant State Geologist
for Technical Operations

sar

GEOLOGICAL SURVEY OF ALABAMA

P. O. Drawer O
University, Alabama 35486
(205) 349-2852

ERNEST A. MANCINI
State Geologist
and
Oil and Gas Supervisor

ADMINISTRATIVE DIRECT
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W. E. Smith, Technical Operations
G. W. Swindel, Jr., Services

DIVISIONS
T. W. Daniel, Jr., Energy Resources
N. A. Lloyd, Geochemistry – Water Laboratory
M. F. Mettee, Environmental
J. D. Moore, Water Resources
T. V. Stone, Publications
M. W. Szabo, Mineral Resources

April 1, 1983

1983 APR

Mr. Buddy Cox
Dept. of Environmental Management
State Capitol
Montgomery, AL 36130

Dear Buddy:

Re: Geologic inspection of pit no. 20,
Emelle, Sumter County

On March 29, 1983, pit no. 20 was inspected at the hazardous waste disposal site at Emelle, Sumter County, Alabama. The pit is located south of pit no. 16 that is now almost filled, and in the northeast corner of the 60-acre plot recently investigated by Golder and Associates. This pit is deeper (140 feet deep) and larger (about 500 feet wide x 600 feet long) than previous pits. At the time of the inspection, final grade had been reached and compaction was taking place at the maximum projected depth.

Faults were observed in all four walls, and calcite deposits were noted in several of the fault zones. Neither one of these conditions, however, should prove detrimental in the proposed disposal of hazardous waste in pit no. 20.

If prescribed operational procedures are adhered to and if the site is operated according to the guidelines, it is anticipated that no detrimental environmental effects will occur.

Sincerely yours,

Paul H. Moser

Paul H. Moser
Environmental Geologist
Water Resources Division

GEOLOGICAL SURVEY OF ALABAMA

420 Hackberry Lane
P. O. Box O
Tuscaloosa, Alabama 35486 - 9780
(205) 349-2852
FAX (205) 349-2861

August 19, 1996

Mr. Randall L. Meadows
2000 Clearview Ave., N.E.
Atlanta, GA 30340

Dear Randy:

This letter is in response to your request for information pertaining to any fracture or structure work which Paul Moser may have done on the chalks in the Emelle, Alabama area.

A review of Mr. Moser's personal files has turned up only a modest amount of informtion on fractures and structure. Most of his attention seems to have been focused on surface water drainage in and around the site; in particular, he was concerned about pit #15. However, I have located an aerial photogragh on which linaments were spotted. The photograph is of an area to the north of the Emelle facility near the town of Emelle. As the photocpying of the photograph is not very clear, I have enclosed 3 copies, at various levels of contrast. On the lightest one, I have highlighted the linament picks. How reliable these linaments are will have to be left up to you as we have no information except the photograph itself. I have also enclosed a memorandum written by Mr. Moser regarding his site inspection.

I hope this information is helpful. If I can be of further assistance, please feel free to contact us again.

Sincerely,

Blakeney Gillett
Geologist
Hydrogeology Division

OFFICE MEMORANDUM

GEOLOGICAL SURVEY OF ALABAMA
AND
STATE OIL AND GAS BOARD

To : File

Date: 3/22/82

From : Paul Moser

Subject: Pit #15, Emelle Site, Sumter County

At the request of Buddy Cox, Division of Solid and Hazardous Waste, Don Hunter of EPA contacted me and arranged an inspection of Pit #15 of the Chemical Waste Management site in Emelle. On March 17, 1982, an inspection was conducted on Pit #15. The following people were present during the inspection and/or the followup conference:

Maurice Oxner, Chemical Waste Management, Operations Manager
Rodger Hinson, Chemical Waste Management (did not complete inpsection with group)
Don Hunter, EPA, Atlanta, Geohydrologist with the Hazardous Waste Section
Paul Moser, GSA
Mark Gregory, Chemical Waste Management, General Manager (did not inspect site but was involved in conference).

In my letter of February 26, 1982, to the Division of Solid and Hazardous Waste, I expressed concern about the leaking of water into the SW corner of Pit #15. At that time, the filling of Pit #15 had just been started and the leaking was indicated by wet spots on the wall by the southwest corner.

On March 17, 1982, a more thorough inspection was conducted of Pit #15 by Oxner, Hunter and me.

At locations 1 and 2 (see attached sketches), water was flowing (not dripping or seeping) into the recompacted chalk barrier in the SW corner of the pit. I would estimate a total of 0.5 gpm for both sources. Sources of flow from locations 1 and 2 were from faults that extended from the top of the fresh chalk to the recompacted barrier in the SW corner. At location 3, no flow was evident, but only seepage was coming from the contact of the fresh chalk below and the overlying recompacted chalk blanket.

The recompacted 20- to 30-foot thick barrier being built along the SW corner was absorbing all the water soaking onto it from above. A wet spot on top of the barrier was the only indication that moisture was entering this barrier.

At location 4, seepage was coming out of the chalk-recompacted blanket contact.

MEMO

TO: File
From: P. H. Moser

3/22/82

My analysis is that water is coming in from the drain, probably flowing along the chalk-recompacted blanket contact, thus into the two faults, and into the pit. The entire horizontal interval from the drain to pit #15 has been replaced and the drain has been moved. The SW corner of Pit #15 is at about the location of the old drain. It is unknown at this time what the channel of transport is--whether direct or circuitous--but I would suspect fairly direct along the shortest route of travel.

During construction of the pit, a V-shaped ditch was dug and compacted with chalk up the west side and along the south side of the SW corner because of some initial seepage in the pit. Apparently, this was not sufficient to retard the movement of water, as actual flow was noted at this time.

Oxner and Gregory are willing to open up the berm around this SW corner again, progress not along the west wall, dig all the way down to fresh rock, proceed along the entire south wall and north along the east wall. This would --theoretically--intercept any flow of water from the drainage ditch flowing north into the pit. I suggested using a bentonite slurry mixture, as apparently the recompacted chalk is not working. I also suggested going the last 20+ feet with a backhoe to keep from getting the V-shaped ditch so large and that the backhoe dig till they were sure they were on fresh chalk. This bentonite slurry (or other suitable material) should be more effective than the recompacted chalk in effectively blocking the entrance of water into the pit.

Gregory also said they would be willing to go north 50 feet from the northernmost seep (#2) along the west wall and fill, compact, and abandon in the vicinity of 100 feet of the southern part of Pit #15.

I allowed as how these two remedial actions would be good, prudent and advisable. The bentonite slurry barrier should be installed first to ascertain that it is being effective in blocking the entrance of water along the southern part of the pit. The abandonment, filling and compacting of the southern 100+ feet of Pit #15 would insure(?) that toxic leachate would not escape southward into the surface-water system.

iet

Attachment

March 18 82

Called Buddy Cox & Al Chipley DSHW in Montgomery, and reported on the visit, the evaluation, remedial action etc. No formal written report was asked for nor was it volunteered. Chemical Waste will proceed with remedial action forthwith

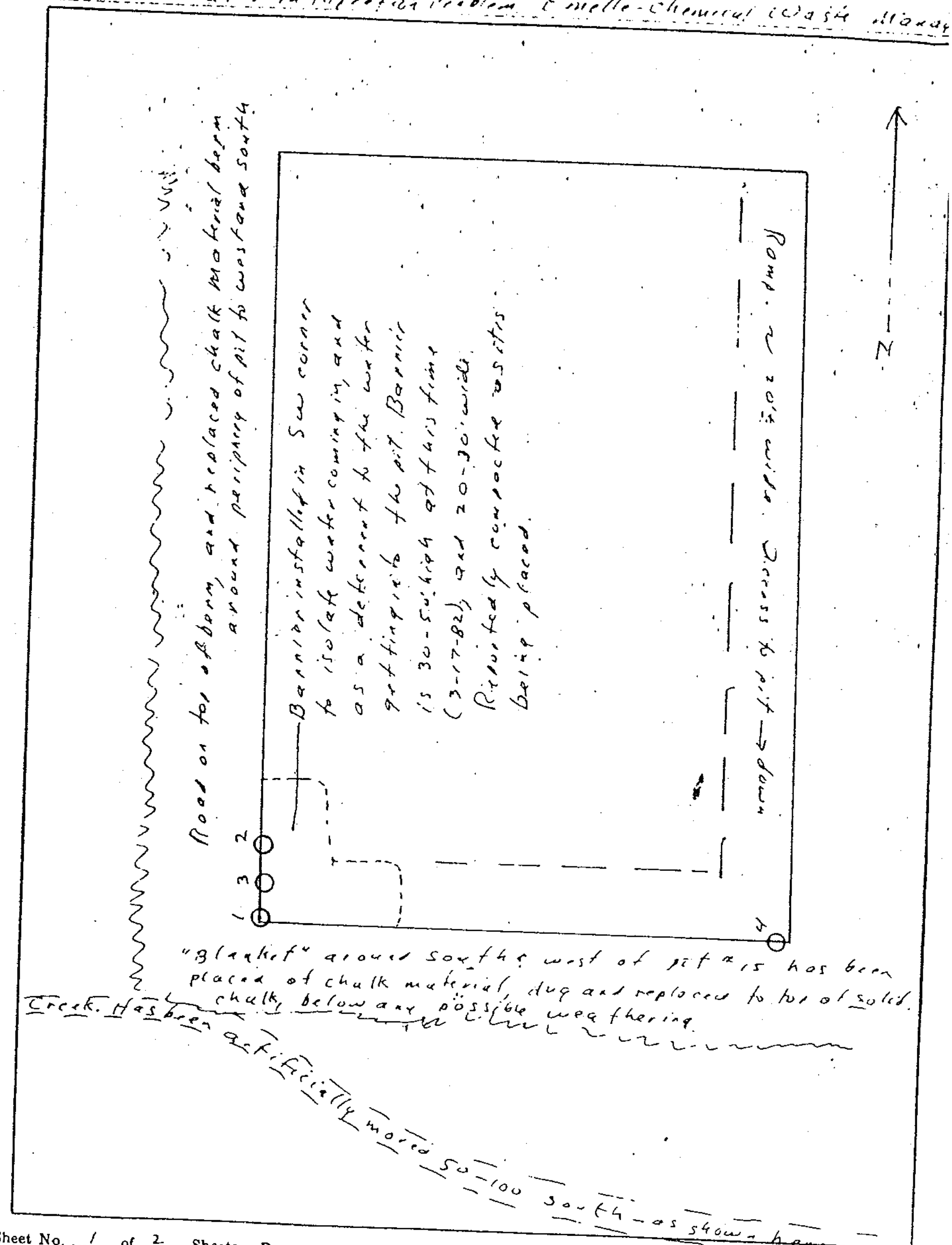
PHM.

9-331 ?

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File March 17

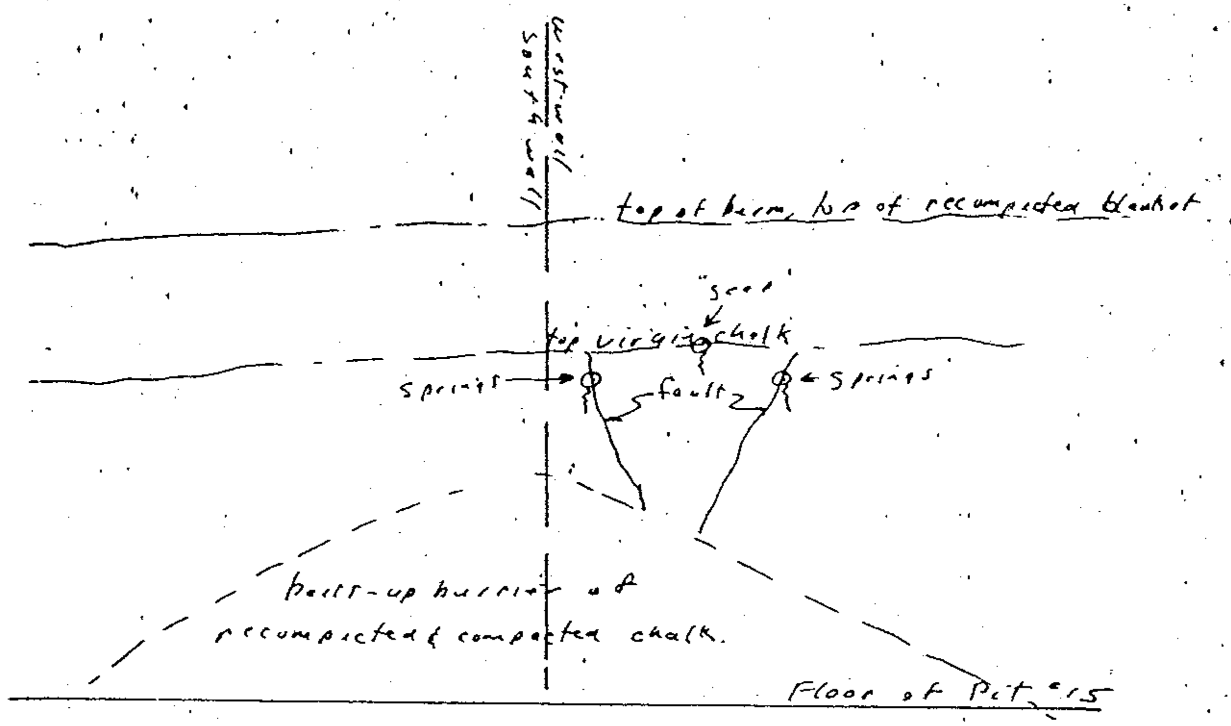
Pit #15: Water infiltration Problem Emelle-chemical waste manag



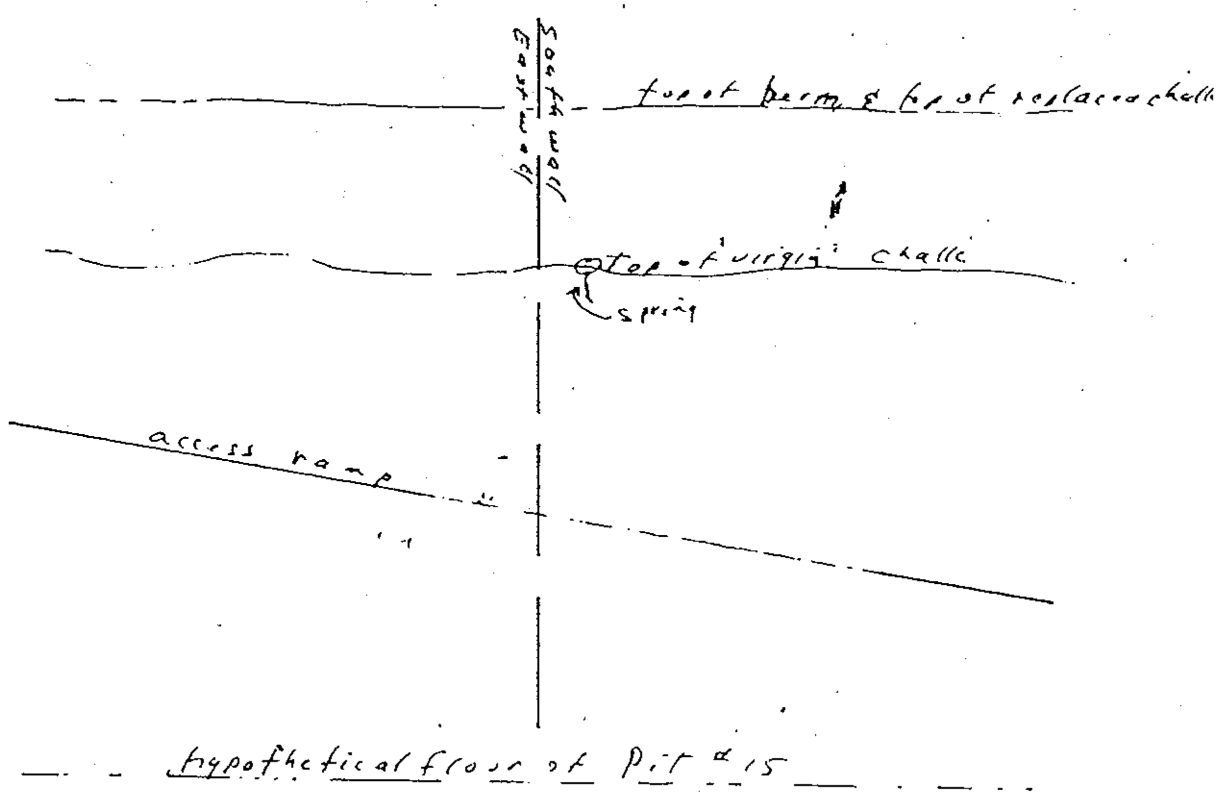
Sheet No. 1 of 2 Sheets. Prepared by .... Date .... Checked by .... Date ......

U.S. GOVERNMENT PRINTING OFFICE : 1960 O - 564019

Cross section - looking SW @ SW corner of pit #15



Cross Section looking SE @ SE Corner - Pit 15




4-10-80 28-100 328814 HAP 80


4-10-80 28-100 328814 HAP 80


4-10-80 28-100 328814 HAP 80

Jordan
Jones &
Goulding

APPENDIX B

Fracture and Lineament Data Forms

SCANLINE FRACTURE DATA LOGGING FORM

Page of

General Information		Details of Scanline		Details of rock		Attitude of all Fabrics	
Project name:	WM - Emelle, AL facility	Scanline ID:	1	Stratigraphic unit:	Selma Chalk	Bedding/layer:	
Domain ID:	South wall	Attitude of Slope:	N85E, 18N	Lithology:	Chalk	Foliation:	
Station #:	Trench 22, Cell 3	Nature of rock face:		Bed/mechanical layer thickness:(T=[m])		Lineation:	
Map/photo ID:		Scanline's trend, plunge:	N81W, 4°N	If scanline is across bedding, give all T's below:		Fold ax. plane:	
Logged by:	c. fortner	Origin of Scanline:	SW corner	T =		Fold hingeline:	
Date logged:	18-Nov-04	Trimming level: (ft)		Comments		Sketch	
Film roll/shot #:		Total length, (L =[ft])	100				
Location:	Emelle, AL at	Exposed Length, (L=[ft])	100	The distance was measured based on midpoint of fracture			
	WM Hazardous	Height [ft]					
	Waste Facility	Width [m]					

Fracture Count: i = 1, n	Intersection distance, d (ft)	Fracture strike (degrees)	Fracture dip (degrees)	Termination code	Trace length, (ft)	Aperture (mm)	Infilling mineral or rock codes	Fracture type codes	Intersection style codes	Fracture roughness codes	Planarity codes	Remarks
1	8.24	n12e	61w	X	30	15	c, g	s	N/A	s	p	No staining. Slickenlines: n54w, 64n (trend, plunge). No visible offset.
2	30.75	n65w	66s	I	3	1	t	j	N/A	s	u	No staining

codes:
infilling minerals: a = anhydrite: br = breccia; g = gouge; c = calcite; ch=chlorite; t = tight (no infill)
fracture type: h = hybrid; j = joint; s = shear; st = stylolite; v = vein
intersection style: e = echelon; h = hooked; H = H-shaped; L = L-shaped; K = K-shaped; X = X-shaped
planarity: c = curved; p = planar; s = stepped; st = stylolitic; u = undulating
roughness: r = rough; s = smooth
termination: p = pinches out; I = intersects other fracture; X = termination obscured
N/A = not applicable

SCANLINE FRACTURE DATA LOGGING FOR

Page of

General Information		Details of Scanline		Details of rock		Attitude of all Fabrics
Project name:	WM - Emelle, AL facility	Scanline ID:	2	Stratigraphic unit:	Selma Chalk	Bedding/layer:
Domain ID:	South wall	Attitude of Slope:	N85E, 18N	Lithology:	Chalk	Foliation:
Station #:	Trench 22, Cell 3	Nature of rock face:		Bed/mechanical layer thickness:(T=[m])		Lineation:
Map/photo ID:		Scanline's trend, plunge:	N81W, 4°N	If scanline is across bedding, give all T's below:		Fold ax. plane:
Logged by:	c. fortner	Origin of Scanline:	SW corner	T =		Fold hingeline:
Date logged:	18-Nov-04	Trimming level: (ft)		Comments		Sketch
Film roll/shot #:		Total length, (L =[ft])	300			
Location:	Emelle, AL at	Exposed Length, (Le=[ft])	300	The distance was measured based on midpoint of fracture		
	WM Hazardous	Height [ft]				
	Waste Facility	Width [m]				

Fracture Count: i = 1, n	Intersection distance, d. (ft)	Fracture strike (degrees)	Fracture dip (degrees)	Termination code	Trace length, (ft)	Aperture (mm)	Infilling mineral or rock codes	Fracture type codes	Intersection style codes	Fracture surface morphol. codes	Planarity codes	Remarks
1	7.66	n62w	53n	X	12	10	c	s	N/A	s	p	No staining. Slickenlines: n17e, 49n (trend, plunge)
2	25.57	n02e	65n	p	3.5	1	t	j	N/A	s	p	No staining
3	30.7	n04e	60n	X	11	2	t	j	N/A	s	p	No staining
4	33.81	n10w	76w	p	2	1	t	j	N/A	s	u	No staining
5	34.32	n50w	76w	p	1	1	t	j	N/A	s	u	No staining
6	38.91	n21e	80w	p	4	1	t	j	N/A	s	p	No staining
7	41.71	n02e	87w	p	8	1	t	j	N/A	s	c	No staining
8	63.6	n46e	70e	p	1	1	t	j	N/A	s	u	No staining

codes:
infilling minerals: a = anhydrite: br = breccia; c = calcite; ch=chlorite; t = tight (no infill)
fracture type: h = hybrid; j = joint; s = shear; st = stylolite; v = vein
intersection style: e = echelon; h = hooked; H = H-shaped; L = L-shaped; K = K-shaped; X = X-shaped
planarity: c = curved; p = planar; s = stepped; st = stylolitic; u = undulating
roughness: r = rough; s = smooth
termination: p = pinches out; I = intersects other fracture; X = termination obscured
N/A = not applicable

Fracture Analysis
Chemical Waste Management, Inc.
Project No. 1186.004.07

Fracture Data
Property east of Emelle Facility

Number	Orientation
1	130, 70W
2	103, 49N
3	006, 84S
4	006, 85E
5	324, 70E
6	086, 85S
7	107, 83S
8	197, 89W
9	233, 88N
10	239, 76N
11	354, 84E
12	176, 83W
13	249, 69N
14	186, 63W
15	253, 89N
16	254, 84N

SCANLINE FRACTURE DATA LOGGING FORM

Page of

General Information		Details of Scanline		Details of Rock		Attitude of all Fabrics		
Project name:	Chemwaste - Emelle	Scanline ID:	D	Stratigraphic unit:	Selma Chalk	Bedding/layer:		
Domain ID:		Attitude of Scanplane:	095, 80S	Lithology:	Chalk	Foliation:		
Station #:	T22_Cell2_North_Wall	Nature of rock face:	Vertical	Bed/mechanical layer thickness:(T=[m])		Lineation:	038, 43	320, 37
Map/photo ID:		Scanline's trend, plunge:	089, 02	If scanline is across bedding, give all T's below:		Fold ax. plane:		
Logged by:	HLC	Origin of Scanline:	NW Corner	T =		Fold hingeline:		
Date logged:	10/15/1996	Trimming level: (ft)	3	Comments		Sketch		
Film roll/shot #:		Total length, (L =[ft])	146	Slickenside orientations are indicated to the right.				
Location:	Emelle, AL at	Exposed Length, (L_e=[ft])	146	The distance was measured based on midpoint of fracture				
	Chemwaste Hazardous	Height [ft]	14 to 4					
	Waste Facility	Width [m]						

Fracture Count: i = 1, n	Intersection distance, d_i (ft)	Fracture plane strike, dip (degrees)	Fracture trace trend, plunge (degrees)	Termination I=1, A=2 O=3 code	Semi-trace length, l_a above or left (ft)	Semi-trace length, l_b below or right (ft)	Aperture b_i (mm)	Infilling mineral or rock codes	Fracture type codes	Intersection style codes	Fracture surface morphol. codes	Planarity codes	Roughness codes	Fracture set assignment using net
1	2.5	307, 45 E	NA	3	17'	9 ' 11"	1	NE	j	Y	S	P	SM	
2	5	342, 62E	NA	3	0	5'	0.5	C	j	Y	NE	P	SM	
3	5.7	191, 54W	NA	1	5'4"	0	0.5	NE	j	I	NE	W	SM	
4	62.5	049, 68W	NA	3	10'	0	0.5	NE	j	I	S	W	R	
5	78.7	217, 56W	NA	3	0	4'4"	0.5	C	j	I	S	W	SM	
6	84	062, 52S	NA	1	3'	0	0.25	NE	j	I	S	P	R	
7	86.9	323, 49E	NA	1	6'	0	0.5	C	j	I	NE	W	SM	
8	91.2	191, 77W	NA	3	4'3"	2'10"	0.5	C	j	T	S	W	SM	
9	96	259, 40N	NA	3	9'	0	0.5	C	j	T	NE	S	SM	
10	121.1	310, 42N	NA	3	32'	17'6"	0.5	C	j	I	S	W	SM	
1														
2														
3														
4														
5														
6														
7														
8														
9														
0														

Do the following calculations after all columns in the logging form are filled for one scanline, and after the sets are identified on a stereonet.

SET, i	semi-trace total l_a	semi-trace total l_b	Full length total l_i	average l_i	minimum l_i	maximum l_i	average aperature	count for each type of fracture per set: h	j	s	st	v	set total, n_i	$n_i/n_A/n_o$
1														
2														
3														
4														
5														
6														
7														

SCANLINE FRACTURE DATA LOGGING FORM

Page of

General Information		Details of Scanline		Details of rock		Attitude of all Fabrics
Project name:	Chemwaste - Emelle	Scanline ID:	D	Stratigraphic unit:	Selma Chalk	Bedding/layer:
Domain ID:		Attitude of Scanplane:	005, 38E	Lithology:	Chalk	Foliation:
Station #:	T22_Cell2_WEST_Wall	Nature of rock face:	Vertical	Bed/mechanical layer thickness:(T=[m])		Lineation:
Map/photo ID:		Scanline's trend, plunge:	005, 06	If scanline is across bedding, give all T's below:		Fold ax. plane:
Logged by:	HLC	Origin of Scanline:	NW Corner	T =		Fold hingeline:
Date logged:	10/16/1996	Trimming level: (ft)	0	Comments		Sketch
Film roll/shot #:		Total length, (L =[ft])	450			
Location:	Emelle, AL at	Exposed Length, (Le=[ft])	450	The distance was measured based on midpoint of fracture		
	Chemwaste Hazardous	Height [ft]		The scanline was at the cell floor, so all fractures were above.		
	Waste Facility	Width [m]				

Fracture Count: i = 1, n	Intersection distance, d_i (ft)	Fracture plane strike, dip (degrees)	Fracture trace trend, plunge (degrees)	Termination I=1, A=2 O=3 code	Semi-trace length, l_a above or left (ft)	Semi-trace length, l_b below or right (ft)	Aperture b_i (mm)	Infilling mineral or rock codes	Fracture type codes	Intersection style codes	Fracture surface morphol. codes	Planarity codes	Roughness codes	Fracture set assignment using net
1	233	300, 46 N	NA	3	6'4"	0	<0.25	NE	j	I	S	P	SM	
2	272	299, 50N	NA	3	5'3"	0	<0.25	NE	j	I	S	C	SM	
3	298	120, 54W	NA	3	11'10"	0	0.5	C	j	I	S	P	SM	
4	451.2	279, 72N	NA	3	9'9"	0	0.5	NE	j	I	S	P	SM	
5	442	296, 40N	NA	3	13'4"	0	<0.25	C	j	I	S	P	SM	
6														
7														
8														
9														
10														
1														
2														
3														
4														
5														
6														
7														
8														
9														
0														

Do the following calculations after all columns in the logging form are filled for one scanline, and after the sets are identified on a stereonet.

SET, i
1
2
3
4
5
6
7

Lineament Analysis
Chemical Waste Management, Inc.
Project No. 1186.004.07

Photo/Map ID USGS Dekalb, AL-MS
Photo/Map Scale 1:100,000

Lineament Number	Lineament Orientation	Lineament Number	Lineament Orientation
1	302	31	333
2	070	32	011
3	324	33	
4	036	34	
5	329	35	
6	345	36	
7	029	37	
8	016	38	
9	276	39	
10	270	40	
11	022	41	
12	316	42	
13	349	43	
14	337	44	
15	004	45	
16	331	46	
17	311	47	
18	321	48	
19	298	49	
20	270	50	
21	297	51	
22	304	52	
23	075	53	
24	329	54	
25	010	55	
26	318	56	
27	341	57	
28	084	58	
29	000	59	
30	310	60	

Lineament Analysis
Chemical Waste Management, Inc.
Project No. 1186.004.07

Photo/Map ID USGS B&W February 1967 1-102
Photo/Map Scale 1:19,066

Lineament Number	Lineament Orientation	Lineament Number	Lineament Orientation
1	301	31	321
2	308	32	013
3	320	33	344
4	074	34	271
5	075	35	080
6	045	36	
7	035	37	
8	305	38	
9	040	39	
10	322	40	
11	329	41	
12	332	42	
13	065	43	
14	021	44	
15	023	45	
16	318	46	
17	337	47	
18	283	48	
19	279	49	
20	325	50	
21	053	51	
22	066	52	
23	288	53	
24	294	54	
25	057	55	
26	305	56	
27	329	57	
28	326	58	
29	321	59	
30	321	60	

Lineament Analysis
Chemical Waste Management, Inc.
Project No. 1186.004.07

Photo/Map ID USGS B&W February 1967 1-103
Photo/Map Scale 1:19,066

Lineament Number	Lineament Orientation	Lineament Number	Lineament Orientation
1	306	31	
2	287	32	
3	328	33	
4	051	34	
5	043	35	
6	049	36	
7	313	37	
8	325	38	
9	057	39	
10	066	40	
11	024	41	
12	027	42	
13	035	43	
14	303	44	
15	000	45	
16	345	46	
17	271	47	
18	312	48	
19	011	49	
20	272	50	
21	041	51	
22	283	52	
23	304	53	
24	355	54	
25	303	55	
26		56	
27		57	
28		58	
29		59	
30		60	

Lineament Analysis
Chemical Waste Management, Inc.
Project No. 1186.004.07

Photo/Map ID USGS Color Infared March 1981 39150
Photo/Map Scale 1:58,000

Lineament Number	Lineament Orientation	Lineament Number	Lineament Orientation
1	295	31	069
2	324	32	296
3	304	33	056
4	076	34	058
5	324	35	327
6	314	36	070
7	313	37	279
8	328	38	270
9	340	39	313
10	336	40	342
11	077	41	
12	050	42	
13	001	43	
14	312	44	
15	028	45	
16	027	46	
17	079	47	
18	297	48	
19	349	49	
20	270	50	
21	353	51	
22	308	52	
23	299	53	
24	023	54	
25	330	55	
26	000	56	
27	270	57	
28	270	58	
29	317	59	
30	327	60	

Lineament Analysis
Chemical Waste Management, Inc.
Project No. 1186.004.07

Photo/Map ID USGS Geiger, AL Quadrangle
Photo/Map Scale 1:24,000

Lineament Number	Lineament Orientation	Lineament Number	Lineament Orientation	Lineament Number	Lineament Orientation
1	301	31	015	61	285
2	279	32	024	62	348
3	323	33	312	63	296
4	346	34	334	64	080
5	318	35	308	65	311
6	012	36	330	66	324
7	324	37	280	67	270
8	020	38	301	68	044
9	334	39	032	69	303
10	018	40	031	70	281
11	059	41	021	71	072
12	342	42	017	72	320
13	036	43	013	73	
14	326	44	270	74	
15	333	45	338	75	
16	051	46	040	76	
17	035	47	089	77	
18	011	48	022	78	
19	324	49	326	79	
20	341	50	071	80	
21	000	51	073	81	
22	335	52	050	82	
23	309	53	293	83	
24	014	54	270	84	
25	018	55	328	85	
26	027	56	303	86	
27	020	57	326	87	
28	323	58	000	88	
29	298	59	064	89	
30	005	60	045	90	