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RCRA PART B PERMIT APPLICATION SECTION E: GROUNDWATER MONITORING APPENDIX E-I WELL LOGS , SAMPLING AND ANALYSIS PLAN VOLUME 4 OF 11 SEPTEMBER 22, 1990

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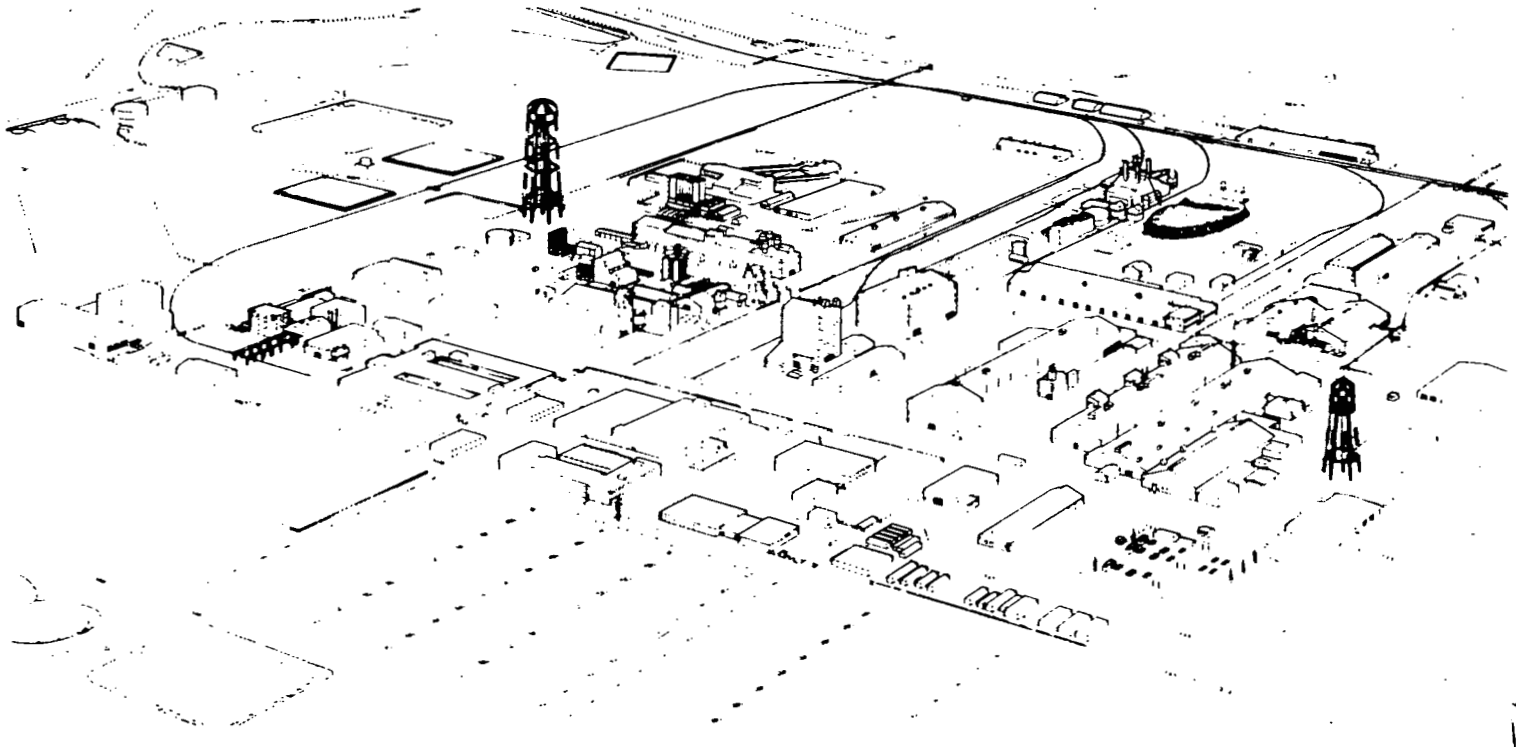

SEPTEMBER 22, 1989

SECTION E: GROUNDWATER MONITORING
APPENDIX E-I WELL LOGS,
SAMPLING AND ANALYSIS PLAN
(Volume 4 of 11)

FEED MATERIALS PRODUCTION CENTER
U.S. DEPARTMENT OF ENERGY
CINCINNATI, OHIO 45239-8705

U.S. EPA IDENTIFICATION NO. 0H6890008976
OHIO EPA PERMIT NO. 05-31-0681

RCRA PART B
PERMIT APPLICATION

SECTION E - GROUNDWATER MONITORING

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Part B Permit Application
Feed Materials Production Center
Fernald, Ohio

Section E of this Resource Conservation and Recovery Act (RCRA) Part B Permit Application provides all required information on the groundwater monitoring program at the Feed Materials Production Center (FMPC) in accordance with the OAC 3745-54-90 through 99 and Code of Federal Regulations 40 CFR 270.14(c)(1) and 40 CFR 264 Subpart E. Described herein is the interim status groundwater monitoring program and the proposed groundwater monitoring program to be implemented at the FMPC in order to fulfill RCRA permit status requirements for monitoring the groundwater in the entire uppermost aquifer underlying the hazardous waste area.

E-1 EXEMPTION FROM GROUNDWATER PROTECTION REQUIREMENTS

The FMPC is not requesting a waiver from the Subpart E groundwater monitoring requirements because one regulated landfill unit (Waste Pit 4) has been identified at the property. Waste Pit 4 is located near to five other waste pits (Pits 1, 2, 3, 5, and 6) and one clear well.

E-2 INTERIM STATUS PERIOD GROUNDWATER MONITORING DATA

E-2-1 Interim Status Detection Monitoring Program

In accordance with the requirements of 40 CFR 265.90 and OAC 3745-65-90, a Detection Monitoring Program was initiated at Waste Pit No. 4 at the FMPC in August 1985. The Detection Monitoring Program included the quarterly monitoring for one year of wells upgradient and downgradient of the regulated unit for general water quality, drinking water suitability and indicator parameters specifically

defined in 40 CFR 265.92 and OAC 3745-65-92. In addition to satisfying regulatory requirements, the Detection Monitoring Program was expanded to focus on a number of additional wells on and off the FMPC site, and it included an extended list of site-specific parameters. The program was expanded to address identified environmental concerns and provide additional insight into the potential impacts the facility may be having on regional groundwater quality. The additional site-specific parameters included target organic and inorganic compounds and radionuclides. Many of these site specific parameters, including radionuclides are not regulated under RCRA or Ohio Hazardous Waste Regulations.

Six rounds of groundwater sampling were completed as part of the Detection Monitoring Program. Table E-1 lists the dates of each of the rounds of sampling under the program. (Note: Tables and figures are shown on the end of Section E). The Detection Monitoring Program involved the sampling of 41 groundwater monitoring wells located on and adjacent to the FMPC as identified in Table E-2. For consistency, Table E-2 also provides a cross reference to well numbering systems previously employed on the Detection Monitoring program at the FMPC since 1985. Figure E-1 provides a map showing the locations of wells sampled as part of this program.

The well numbering system generally describes the geologic unit being monitored by each of the Detection Monitoring Program wells. A 1000 series well monitors the glacial till, while the 2000, 3000 and 4000 series wells monitor the sand and gravel aquifer. Figure E-2 presents a generalized description of the relative positions of these monitoring wells within the geologic framework present at the FMPC. A detailed description of the geologic and hydrogeologic conditions present at the FMPC can be found in Section E-3.

Table E-2 and Figure E-2 present those wells selected to monitor each of the major geologic units present at the FMPC. Six wells of the

total 41 monitor the till, while the remaining 35 monitor the sand and gravel aquifer. As defined in Section E-3, the glacial till unit does not represent a significant or continuous source of groundwater and does not constitute an aquifer as defined in 40 CFR 260.10 and OAC 3745-50-10. The glacial till unit does represent an important geologic unit relative to the potential vertical and horizontal movement of contaminants to the underlying aquifer. Glacial till wells were monitored during the Detection Monitoring Program to support a 3-dimensional understanding of the potential movement of contaminants and provide valuable insight into the connection of this unit with the underlying sand and gravel aquifer.

The sand and gravel aquifer monitoring wells are completed at various depths (i.e. 2000, 3000, and 4000 series) in order to provide information on the potential vertical movement of target constituents through the sand and gravel aquifer. Table E-3 provides a brief summary of the critical construction details associated with each of the 41 monitoring wells. Detailed lithologic logs and well completion logs are provided in Appendix E-I, where available, for each of the Detection Monitoring Program wells.

Representative water quality samples were withdrawn from the 41 wells during each of the six rounds and analyzed for the parameters listed in 40 CFR 265.92 and shown in Table E-4. A summary listing of the analytical methods and detection limits employed during the Detection Monitoring Program is provided in Table E-5.

Monitoring well 1012 was selected as the background well for monitoring the glacial till unit. Well 1012, which is screened in the glacial till and weathered bedrock, is located hydraulically upgradient of the FMPC Waste Storage Area and is approximately 500 feet north of the FMPC Production Area. The water level in this upgradient well is more than 20 feet higher than the downgradient till (1000 series) wells.

A nearby water supply well, SW-2, was selected to characterize background groundwater quality in the uppermost aquifer (sand and gravel aquifer) beneath Waste Pit No. 4. This well, which is located approximately one mile to the east of the site, was selected because it was determined, at that time, that the water from SW-2 would be more representative of natural water quality beneath the FMPC than a geographically closer well.

Detection Monitoring program samples were collected and analyzed in accordance with U.S. EPA protocols and procedures. A copy of the FMPC RCRA Sampling and Analysis Plan For Waste Pit No. 4 is provided in Appendix E-I. The Sampling and Analysis Plan describes the procedures and protocols employed for sample collection, preservation, shipment, laboratory analysis and chain of custody for the Detection Monitoring program.

Water level elevations were measured at most well locations during each sampling round. At wells 4101, 4102, 4103, 3001, 3003, 3005, SW-2, 2061 and 3062 the depth of the water could not be measured due to presence of permanently installed pumps in the wells. Water table elevations from the six rounds of Detection Monitoring are presented in Appendix E-II. These water table elevations are in general agreement with the water level contour map presented in Section B, Figure B-7. As identified in this contour map, groundwater flow in the uppermost aquifer (sand and gravel aquifer) in the vicinity of Waste Pit No. 4 is to the east toward the FMPC Production area.

A complete listing of the water quality data collected during the six rounds of Detection Monitoring at Waste Pit No. 4 is provided in Appendix E-II. These data were progressively reported to U.S. EPA and OEPA as it was generated. In general, the water quality data collected under this program indicated the following:

- Water quality of the sand and gravel aquifer within the FMPC Waste Storage Area appears to indicate degradation of water quality with respect to sulfate and nitrates.

- Water quality in the plant production wells appears to have remained constant throughout the program and apparently unaffected by Waste Pit No. 4 operation.

- The quality of the sand and gravel aquifer east of the FMPC remained relatively constant and apparently unaffected throughout the program.

- No pesticides/herbicides were detected in any of the wells within the program.

- No significant or prevalent concentrations of organic compounds were detected during the program. Concentrations of select organic compounds ranging from less than 1 part(s) per billion (ppb) to approximately 30 ppb were identified randomly during the program. The origin of these organic compounds could not be specifically traced to any individual unit.

The detailed findings and conclusions of the FMPC RCRA Detection Monitoring Program can be found in the reports generated by the FMPC for each of the six rounds of sampling. These groundwater monitoring reports, which are listed in Appendix E-III, have been previously transmitted to U.S. EPA and OEPA.

A statistical analysis was completed following Round 5 on the groundwater indicator parameters comparing upgradient and downgradient monitoring wells at Waste Pit No. 4. These analyses were done in accordance with procedures defined within Appendix IV of 40 CFR 264, the Technical Enforcement Guidance Document, and as required by 40 CFR 265.93 and OAC 3745-65-93. Consistent with these

requirements, the Cochran's Approximation to the Behrens-Fisher Student's T-Test was employed to compare background and downgradient monitoring data for select Detection Program wells. Statistical analysis was completed comparing background till well 1012 to downgradient wells 1019, 1021 and 1022. Similarly, statistical analysis was completed comparing background well SW-2 to downgradient wells 2019, 3019, 2021, and 2022. These downgradient wells were selected for comparison because of their close proximity to Waste Pit No. 4.

The results of the statistical analysis completed on the first four rounds of RCRA Detection Monitoring appear in Appendix E-II. In general, the statistical evaluation indicated the following for the glacial till unit:

- There was no indication of a statistically significant increase in Total Organic Halogen (TOX) between the upgradient and downgradient well locations.

- Total Organic Carbon (TOC) concentrations significantly increased in all downgradient wells.

- In all downgradient wells pH significantly decreased in comparison to the upgradient well.

- Specific conductance significantly increased in two of the three downgradient wells (Wells 1019 and 1022) as compared to the upgradient well.

The statistical evaluation of the data collected from the background and downgradient wells in the sand and gravel aquifer indicated the following:

- There was no statistically significant change in TOC or TOX in the downgradient wells as compared to the background well.

- Specific conductance significantly increased in all downgradient wells as compared to the background well.

- PH significantly decreased in one downgradient well (Well 3019) as compared to the background well.

In summary, the comparisons completed on the five rounds of Detection Monitoring indicated that statistically significant changes in two of four indicator parameters had occurred in the uppermost aquifer in the vicinity of Waste Pit No. 4. Required confirmatory sampling was conducted as Round 6 of Detection Monitoring in December, 1987. Round 6 data showed similar trends to Round 5 data.

E-2-2 Assessment Monitoring

In accordance with OAC 3745-65-93 and 40 CFR 265.93, the U.S. EPA and the OEPA were notified on November 13, 1987 that Waste Pit No. 4 may be affecting groundwater quality. This notification was based upon the statistical comparisons completed as part of the Interim Status Detection Monitoring Program implemented in the vicinity of Waste Pit No. 4. On November 25, 1987 a RCRA Groundwater Quality Assessment Program Plan (GQAPP) for Waste Pit No. 4 was submitted to U.S. EPA and OEPA. A copy of the November 25, 1987 Groundwater Quality Assessment Program Plan and the notification letter are provided in Appendix E-III.

A Groundwater Quality Assessment Program Outline was prepared in August, 1986 in response to Item A.7 of the RCRA section of the Federal Facilities Compliance Agreement (FFCA). This outline was prepared in conformance with 40 CFR 265.93 (a) and OAC 3745-65-93 (a) and was revised in January 1987 to reflect comments by U.S. EPA and

OEPA on the original submittal. A copy of the revised outline is provided in Appendix E-III. As defined in the outline and applicable sections of the Ohio Administrative Code and RCRA, the objectives of the Groundwater Quality Assessment Program are to determine:

(a) Whether hazardous waste or hazardous waste constituents have entered the groundwater;

(b) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater; and

(c) The concentrations of the hazardous waste and hazardous waste constituents in the groundwater.

To fulfill these objectives, as stated in the November 25, 1987 GQAPP, the initial phases of the Assessment Program could be most efficiently accomplished as part of the on-going site-wide Remedial Investigation/Feasibility Study (RI/FS) at the FMPC. The consolidation of the RCRA and CERCLA groundwater programs was proposed because of the similarity of objectives between the Assessment Program and the RI/FS.

In excess of 100 additional groundwater monitoring wells were installed at the FMPC to support the Assessment Monitoring and RI/FS programs. These wells were installed consistent with the guidance provided by the RCRA Technical Enforcement Guidance Document and in strict accordance with the procedures defined in the FMPC RI/FS Quality Assurance Program Plan (QAPP). A specific reference for the FMPC RI/FS QAPP can be found in Appendix E-III.

The assessment groundwater sampling program, as defined in the November 25, 1987 GWQAPP, included the 100 newly installed wells in addition to 106 existing onsite and offsite wells. Assessment Program sampling was initiated in May 1988. Each well was sampled

Program sampling was initiated in May 1988. Each well was sampled quarterly for one year in order to assess any seasonal fluctuations in groundwater flow and quality. The fourth round of groundwater sampling was completed in February 1989. The dates of each of the Assessment Program sampling rounds are listed in Table E-6.

All groundwater quality samples collected during the first four rounds of Assessment Monitoring were analyzed for a full suite of general water quality parameters. It should be noted that radiological parameters monitored during the first four rounds of the Assessment program are specific to the FMPC RI/FS and are not part of the RCRA groundwater program.

RCRA parameters were included in the FMPC RI/FS parameters for Round 1 sampling of 31 wells. These parameters included the Hazardous Substance List (HSL), including inorganics, semi-volatile and volatile organics, and pesticides/PCBs. On the basis of the results of a parallel investigation in the FMPC Waste Storage Area (Characterization Investigation Study), the HSL was extended, for purposes of the Assessment Monitoring program, to include organo-phosphorus pesticides. Selected wells in the Waste Storage Area were also sampled for dioxins once during Round 1.

Water level measurements were collected monthly from all wells. A water table map completed following the fourth round of Assessment Monitoring is provided in Section B, Figure B-7. Water level data collected to date as part of the Assessment Program is provided in Appendix E-II.

In order to provide additional insight into the direction and rate of groundwater, a three dimensional groundwater flow and solute transport model is being utilized to support the RI/FS and Assessment Monitoring program.

Technical review comments were received from U.S. EPA and OEPA on the November 25, 1987 GQAPP on February 3, 1989. In response to these review comments and to the progressive activities and findings under the Assessment Program, a revised GQAPP was submitted to U.S. EPA and OEPA on March 23, 1989. A copy of the Groundwater Quality Assessment Program Plan, Revision 1 is provided in Appendix E-III.

The revised GQAPP provides a brief summary of the results of the first two rounds of sampling under the Assessment Program and presents a framework for continuing assessment monitoring following the completion of the fourth round groundwater sampling. On the basis of a detailed evaluation of the available water quality and flow information, the revised GQAPP identifies 43 specific wells for continuation of the RCRA Groundwater Quality Assessment Program, following the fourth round of Assessment sampling. These wells, which are listed in Table E-7, are proposed to be sampled quarterly until final closure of Waste Pit No.4 or until Permitted Status groundwater monitoring (Detection or Compliance Monitoring) is initiated.

Figures E-3 to E-6 indicate the locations of the 43 wells selected as part of the ongoing Groundwater Quality Assessment Program at the FMPC. The rationale for selection of these wells is discussed in the revised GQAPP, as provided in Appendix E-III. Well completion logs and boring logs for each of the 43 selected wells are provided in Appendix E-I, where available. Critical construction details of the 43 wells are listed in Table E-8.

Monitoring wells 1024, 1052, 2066, 3066, 2043, and 3043 were installed to serve as background wells for the Assessment Monitoring Program. Monitoring well 1012, which was employed as the background glacial till well for the Detection Monitoring Program, was not used during the Assessment Program because the location of the screened interval within the geologic unit would not likely yield water

quality samples representative of groundwater in the vicinity of the regulated unit. Wells 1024 and 1052, which were installed to service as the background glacial till wells, were located based upon water level and geologic information obtained during the Detection Monitoring Program.

Local supply well SW-2, which was employed as the background sand and gravel aquifer well for the Detection Monitoring Program, was not employed during the Assessment Monitoring Program as a result of additional insight gained during the Detection Program and other related groundwater investigations on the hydrogeologic conditions present in the vicinity of the FMPC. As a result of concern as to the influence of recharge from the Great Miami River on the water quality in SW-2 and the inability to withdraw samples representative of the conditions present in the vicinity of the regulated unit, two clusters of wells (2043, 3043 and 2066, 3066) were installed hydraulically upgradient of the Waste Storage Area at the FMPC.

Based upon a review of the available characterization data from Waste Pit No. 4 and the results of the Detection Monitoring and RI/FS groundwater sampling programs, select parameters were identified for analysis from samples collected from the 43 target Assessment program wells. These analytical parameters are identified in Table E-9. The rationale for the selection of the identified parameters is provided in the revised GQAPP.

Sampling and analytical procedures for the Assessment program are consistent with U.S. EPA and OEPA approved procedures. A summary of these procedures can be found in the revised GQAPP, as provided in Appendix E-III. Additionally, water table elevations are collected from each of the 43 Assessment program wells during each quarterly sampling.

A summary of the analytical results collected during the first four rounds of the Assessment groundwater program for the identified 43 monitoring wells is provided in Appendix E-II. These results are considered preliminary as the final data validation process is ongoing. Statistical analysis of the collected groundwater data is currently underway.

The fifth round of Assessment monitoring (initial round following completion of the four rounds of Assessment - RI/FS sampling) was completed in June 1989. This sampling round was focused specifically upon the completion of sampling and analysis on the 43 targeted Assessment Program wells. Analytical results from the fifth round are expected in September 1989. The sixth round of sampling under the Assessment program is scheduled for August-September 1989 timeframe.

As previously stated, the statistical analysis of the data collected to date for the Assessment program is ongoing. Following completion of this analysis and subsequent analysis of the fifth round of sampling, an evaluation will be performed to determine whether sufficient data are available to complete the determinations required under 40 CFR 265.93 (a) and OAC 3745-65-93 (A). If data gaps are identified, necessary modifications will be made to the ongoing Assessment program sampling to satisfy these deficiencies. If the necessary determinations can be completed, a summary report will be prepared and submitted to the U.S. EPA and the OEPA as required in 40 CFR 265.93 (d) 5 and OAC 3745-65-93 (D) 5.

The FMPC is scheduled to perform Appendix IX sampling during Round 6 of Assessment Monitoring on wells 1052, 1025, 1079, 1080, 1082, 1031, 2043, 3043, 2019, 3019, 2027, 2084, 3084, 2037, and 3037. The results of the Appendix IX analysis will be reported after final validation of the raw analytical data.

E-3 AQUIFER IDENTIFICATION

E-3-1 Geologic and Hydrogeologic Setting

The FMPC is located within a two-to-three-mile wide valley, entitled the New Haven Trough, which has formed as a result of Pleistocene glaciation and, subsequently, filled with glacial outwash materials and till. Figure E-7 shows the approximate location of the New Haven Trough with respect to the FMPC. Figure E-8 provides a schematic geologic cross section of the New Haven Trough. The geological history of the FMPC area is briefly summarized below:

- In Late Ordovician time (approximately 450 million years ago) sediments which would become a predominantly flat-lying shale with thin interbedded limestone were deposited in a shallow sea. This shale (a part of the Cincinnatian Series) is the relatively impermeable bedrock which now underlies the FMPC site area.

- Sometime prior to, or perhaps during Pleistocene glaciation, a large watercourse (larger than the present-day Great Miami River) cut its channel into this shale bedrock to a level of more than 200 feet below that of the present-day Great Miami River. This approximately two-mile wide channel (called the New Haven Trough) may be an abandoned course of the ancestral Ohio River.

- During subsequent Pleistocene glacial advances and retreats across the site (Illinoisan--approximately 30,000 years to 40,000 years ago and Wisconsian--approximately 10,000 years ago) the New Haven Trough was filled with about 200 feet of glacial sediments. These sediments were deposited by water running from the margins of the glaciers and consisted mainly of well sorted sand and gravel. Deposited on top of these sediments was a blanket of clay-rich relatively impermeable glacial till from a more recent glacial event.

- Erosion by the Great Miami River and its tributaries then removed significant portions of the glacial till and left terrace remnants which stand topographically higher than surrounding bottom lands. The FMPC site lies on top of one of these terrace remnants.

Bedrock underlying the FMPC is comprised of flat lying olive gray shale with thin interbedded limestone. This shale forms the floor and valley of the New Haven Trough and is generally between 60 to more than 200 feet below the land surface in the vicinity of the FMPC. Elevation of the bedrock surface varies from 327 feet south of the Production Area to 400 feet just north of the FMPC (GeoTrans, 1985).

Unconformably overlying the shale bedrock is a sequence of sand and gravel glacial outwash material up to 200 feet thick. Underneath parts of the FMPC, these gravels are separated by a 10 to 20 feet thick greenish-black silty clay ("blue-clay") at a depth of about 100 to 125 feet below the surface (Spieker, 1968; GeoTrans, 1985). This clay layer, which appears to be discontinuous, is located in the vicinity of the Waste Storage Area and production wells. Progressive data collected under the ongoing sitewide Remedial Investigation/Feasibility Study (RI/FS) suggests that this clay layer extends from east of Paddy's Run to the center of the FMPC Production Areas. The clay layer does not appear to the east or south of the Production Area. Planned RI/FS drilling activities in the Production area will provide clearer definition of this layer.

Near the surface of the FMPC, overlying the outwash materials is a dense, silty clay, glacial till that varies in composition vertically and laterally. The silty clay till contains lenses of poorly sorted fine- to medium-grained sand and gravel, silty sand and silt with layers of silty clay to the west and south of the

FMPC. The till varies in thickness from 20 to 50 feet having an average base of approximately 540 feet above MSL (Dames & Moore, 1985; GeoTrans, 1985; Spieker, 1968).

To the west and south of the site, the silty clay till laterally grades into a sequence of silty sand and silt with some layers of silty clay. The silty clay till remains continuous to the north and east of the site and directly overlies the bedrock in these areas. In the lower reach of Paddy's Run and the Storm Sewer Outfall Ditch, the silty clay till has been eroded away and the underlying sand and gravel are exposed.

E-3-2 Hydrology

The FMPC is located within the Great Miami River Basin drainage above the river's present day flood plain. Natural drainage from the FMPC to the Great Miami River is primarily from Paddy's Run and trends eastward. Paddy's Run is a stream originating north of the plant and draining southward along the west side of the Waste Storage Area (Figure E-9) which loses flow to the ground water near Willey Road. Paddy's Run is an ungaged stream that flows primarily between January and May with an estimated discharge ranging between 0.2 and 4.0 cubic feet per second (cfs) (Dames & Moore, 1985).

Surface water drainage from the FMPC facility is channeled through the Storm Sewer Outfall Ditch which flows south of the Production Area and eventually drains into Paddy's Run at the facility's southwest corner. Surface runoff from the Waste Storage Area and fly ash piles flows generally westward either directly toward Paddy's Run or some of its numerous tributaries.

E-3-3 Groundwater Hydrology

Regional hydrogeologic environments of the buried channel aquifer have been investigated and reported extensively by the USGS. Spieker (1968a) has classified and mapped five major hydrogeologic environments in the Great Miami River Valley. A hydrogeologic environment describes a portion of an aquifer possessing hydrologic and geologic properties that differ from the properties of aquifers in adjacent areas. Of the five hydrogeologic environments in the Great Miami River Valley, four are relevant to a description of hydrogeologic conditions in the vicinity of the FMPC facility (Figure E-10). Using the notation of Spieker (1968a), these environments are:

- Type I: Sand and Gravel Aquifer. No continuous clay layers are present. Potential for induced stream infiltration exists. The Type I aquifer environment is further divided into a Type I-A-1 aquifer which is 150 to 200 feet or more thick and a Type I-A-2 aquifer which is less than 150 feet thick.

- Type II: Sand and Gravel Aquifer. Types II-A-1, II-A-2, II-B-1, and II-B-2 have been described; however, only Type II-A-2 has been determined to exist in the study area. This environment is less than 150 feet thick and recharge by induced stream infiltration does not occur.

- Type III: Sand and Gravel Aquifer Overlain by Clay. The potential for induced stream infiltration does not exist. The transmissivity and storage properties are highly variable.

- Type V: Shale and Limestone Bedrock Overlain by Till. Relatively impermeable shale and limestone bedrock. Small water supplies are available.

Type I aquifer environment is found along the floodplain of the Great Miami River to the south and east of the FMPC facility. The lithology of the aquifer consists principally of sand and gravel. Scattered lenses of clay or fine-grained material may exist anywhere in the environment; however, these lenses are not of sufficient thickness or areal extent to act as semiconfining layers or otherwise affect groundwater movement. The Type I aquifer may be classed as unconfined with a storage coefficient in the range of 0.2 to 0.25.

The Type II aquifer environment is characterized by 150 to 200 or more feet of sands and gravels with no interstratified clay layers present between soil strata over extensive areas. Recharge by induced stream infiltration does not occur. The coefficient of storage is about 0.2. Large groundwater supplies are not generally available from the Type II-A-2 aquifer because of its limited areal extent and proximity to bedrock valley walls.

The Type III aquifer environment is characterized by 50 feet or more of clayey till overlying the main buried channel aquifer. In the region of the FMPC, the buried channel aquifer is divided into an upper and lower part by a semipervious clay layer approximately 10 to 20 feet thick occurring approximately 140 feet below land surface. Hence, the lower aquifer is classed as a semiconfined or leaky confined aquifer. Spieker and Norris (1962) have estimated a coefficient of storage of 0.001 for the lower sand and gravel aquifer.

The Type V hydrogeologic environment includes all of the area outside of the buried channel. These areas are uplands which consist of shale with interbedded limestone bedrock overlain by 50 feet or less of clay-rich till. Large quantities of groundwater are not generally transported through this material. Well yields vary widely, generally ranging from zero to ten gallons per minute. Sand and gravel lenses, however, are erratically distributed throughout this

material and, in some cases, wells completed in these units may yield up to 50 gallons per minute.

The buried channel aquifer includes numerous interbedded clay or fine-grained lenses. These lenses result in very large variations of aquifer properties on a localized scale. The aquifer may be regarded, however, as homogeneous since the hydrogeologic properties of interest occur on a much larger scale than these local variations. On the scale appropriate for characterizing groundwater movement in the vicinity of the FMPC, aquifer properties have been previously established by aquifer pumping tests (Spieker, 1968a; Spieker and Norris, 1962; Dove, 1961).

Transmissivity values within the Type I-A-1 aquifer have been reported in the range of 300,000 to 500,000 gallons per day per foot (Spieker, 1968a). Based on an average saturated thickness of 150 feet, the range of horizontal hydraulic conductivity is approximately 270 to 450 feet per day. The Type I-A-2 aquifer would be expected to have similar hydraulic conductivity.

From an aquifer test, Spieker and Norris (1962) estimated the transmissivity of the lower sand and gravel aquifer below the FMPC to be about 140,000 gallons per day per foot. Using a thickness of 70 feet, the estimated horizontal hydraulic conductivity of the lower sand and gravel aquifer is approximately 270 feet per day.

Average annual precipitation at the FMPC for the years 1941 through 1970 was approximately 39 inches (NLO, 1977). Of the total annual precipitation, approximately 57 percent occurs during the spring and summer months. Most precipitation is lost through evapotranspiration during the summer. The remainder is lost through surface runoff or infiltrates to the groundwater.

Groundwater recharge is low in summer months when evapotranspiration is high. Freezing of the ground also lowers recharge during a portion of the winter. For these reasons, most groundwater recharge generally occurs during the months of October, November, March, and April. Average annual recharge has been reported by various authors in the range of 6 inches per year to as high as 21 inches per year for areas not overlain by clay. Average annual recharge within the Type I and Type III hydrogeologic environments has been estimated to be 15 and 6 inches per year, respectively (GeoTrans, 1985; Spieker, 1968a and 1968b). Groundwater recharge by induced infiltration is significant along the Great Miami River near the Cincinnati and Southwestern Ohio Water Company (SOWC) well fields. Dove (1961) estimated the average rate of infiltration along the Great Miami River near the SOWC well field to be 240,000 gallons per day per acre of stream bottom.

E-3-4 Groundwater Flow

Groundwater flow in the buried channel aquifer near the FMPC has been described by various authors. Spieker and Norris (1962) constructed a groundwater level elevation contour map using data from 48 wells. They determined that a groundwater divide existed along the eastern boundary of the FMPC. From their analyses, they concluded that groundwater west of the divide moves from northwest of the facility near Shandon southeastward through the FMPC towards the Great Miami River between New Baltimore and Paddy's Run. These authors did not feel that pumping on-site production wells influenced regional groundwater movement.

Sedam (1985) completed a well inventory and water level measurement survey in August 1982. From these measurements, he constructed a water table map of the area surrounding the FMPC. He also showed the north-south groundwater divide along the eastern boundary of the FMPC and concluded that groundwater moves from north to south across the

facility and discharges to the Great Miami River between the New Baltimore and Paddy's Run. Sedam shows a cone of depression in the groundwater table caused from pumping the plant wells. This pumping cone, as described, would capture a portion of the flow moving across the FMPC.

Dames and Moore (1985) produced a groundwater contour map within the FMPC which shows west to east groundwater movement which is influenced by the production wells at the plant. For their off-site groundwater quality impact assessment, however, they used Sedam's (1985) evaluation of groundwater flow.

GeoTrans (1985) questioned the USGS groundwater divide location stating that water level elevations were determined by using surface elevations from topographic maps and not determined by an actual ground truth elevation survey and also that more wells were needed along the eastern site boundary. Through a groundwater modeling study of the buried channel aquifer near the FMPC, GeoTrans concluded that:

- A groundwater divide exists which trends from southeast to northwest across the south-central portion of the facility;

- Water in the buried channel aquifer near the waste pits will travel east towards the Great Miami River; and

- Water south of the waste pits will travel south and southeasterly towards the Great Miami River.

Progressive data collection and modeling runs under the FMPC RI/FS generally support the conclusions reached by GeoTrans in their 1985 investigation of regional groundwater in the vicinity of the facility. Efforts continue under the RI/FS to refine the current understanding of the relative location of the groundwater divide and

its impact on local groundwater flow and quality. A generalized groundwater flow map compiled using available RI/FS data appears as Figure E-11.

E-3-5 Surface Water/Groundwater Interaction

The main surface water drainage channel for the western portion of the site is Paddy's Run, a stream with losing and gaining reaches, which empties into the Great Miami River (Figure E-9). In addition to drainage to Paddy's Run, a portion of the runoff from the Production Area has been collected and allowed to discharge to the Storm Sewer Outflow Ditch (SSOD). The SSOD is a natural gully that is channelled through the southcentral to southwest portion of the site. The SSOD empties into Paddy's Run near Willey Road at the southwestern corner of the FMPC. Additionally, the surface waters infiltrate into the sandy soils and probably recharge the local sand and gravel groundwater system.

North of Willey Road, water in Paddy's Run is elevated above the regional water table (GeoTrans, 1985). Somewhere between Willey and New Haven roads, water in Paddy's Run lies below the water table and groundwater discharges to Paddy's Run. The exact location where Paddy's Run lies below the water table is seasonal. The location is probably farther south during months when groundwater levels are lowest (GeoTrans, 1985).

E-3-6 Groundwater Usage

Groundwater is a major source of water supply in the area. Major groundwater users have been identified in the study area. The estimated total pumping from these well fields averages more than 37 million gallons per day. Additionally, there are many other smaller industrial, commercial, agricultural, and private groundwater users in the area. On the basis of the region's social and economic

dependence on regional groundwater, the Great Miami Buried Valley Aquifer has been designated a Sole Source Aquifer under the provisions of Section 1424(e) of the Safe Drinking Water Act of 1974 (53 FR 25670).

E-3-7 Uppermost Aquifer

In accordance with 40 CFR 265.90(a) and OAC 3745-65-90(A), a facility must maintain a groundwater monitoring program capable of determining the impact of a facility on the quality of groundwater in the uppermost aquifer underlying the facility. An aquifer, as defined in 40 CFR 260.10 and OAC 3745-50-10, is a geologic formation, group of formations, or part of a formation capable of yielding significant quantities of water to wells or springs. In accordance with this definition, the sand and gravel aquifer underlying the FMPC is considered the uppermost aquifer and specifically subject to the monitoring provisions within RCRA and the OAC. This designation is supported by the following:

- Significant perched water zones have not been identified in the FMPC Waste Storage area at elevations at or below the bottom elevation of the regulated facility (~ 560 ft. MSL).

- Perched water zones that have been encountered in the FMPC Waste Storage Area appear to be fairly discontinuous yielding limited quantities of water. The discontinuity of the water bearing lenses in the till is supported by the inconsistent occurrence of water in the till wells in the vicinity of Waste Pit No. 4.

- Local residential and commercial wells in the vicinity of the FMPC are principally located in the sand and gravel aquifer as a result of poor yields in the glacial till unit.

While the glacial till unit at the FMPC does not represent a continuous flow system, it is an important unit for developing a 3-dimensional understanding of the hydrogeology of the FMPC Waste Storage Area. The glacial till represents an early detection system capable of providing valuable insight into potential future impacts on the sand and gravel aquifer. For this reason significant focus was applied during the Detection, Assessment and RI/FS programs to monitor this important geologic unit.

E-3-8 BIBLIOGRAPHY

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E-4 CONTAMINANT PLUME DESCRIPTION

As stated in Section E-2, Interim Status Period Assessment Monitoring Program, final validation and statistical analysis of the four rounds of Assessment Program sampling is currently underway. Round 5 of Assessment Monitoring was completed in June, 1989 with samples currently undergoing analyses. Following completion of statistical analyses of the five rounds of Assessment Monitoring, the FMPC will assess the adequacy of the available data to complete the determination of whether hazardous waste or hazardous waste constituents have entered the uppermost aquifer in the vicinity of Waste Pit No. 4. If additional data deficiencies are identified, the necessary modifications will be made to the ongoing Assessment Monitoring Program. If the necessary determinations can be completed, a written report will be prepared summarizing the findings and submitted to OEPA, as required in OAC 3745-65-93 (D) 5 and 40 CFR 265.93 (d) 5. Concentrations of methylene chloride (1-22 ppb), toluene (5-10 ppb), acetone(13-37 ppb) and carbon disulfide (1-8 ppb) have been inconsistently detected in scattered wells in the sand and gravel aquifer in the Waste Storage Area. As stated above, sufficient data are presently not available to determine statistical significance of these constitute readings.

As required under 40 CFR 270.14 (c) 4, the FMPC is completing Appendix IX sampling in 16 wells upgradient and downgradient of the Waste Storage Area as part of Round 6 of the Assessment Program monitoring. This sampling is being performed to establish the presence or absence of these constituents in the uppermost aquifer underlying the Waste Storage Area.

E-5 DETECTION MONITORING PROGRAM

Currently, the facility is continuing with the Assessment Monitoring Program in accordance with the Groundwater Quality Assessment Program Plan (GQAPP) Revision 1, that was submitted to the OEPA and the U.S. EPA on March 23, 1989.

The fifth round of sampling under the GQAPP was completed in June 1989. The sixth round of sampling is scheduled to be conducted during August and September 1989. The analytical results of both rounds of sampling will be prepared and submitted to the OEPA once they are received and reviewed by the facility in accordance with the GQAPP.

The Detection Monitoring Program is herein outlined so that it can be implemented under the facility's permitted status if Assessment Monitoring Program data indicate that hazardous constituents have not entered the uppermost aquifer downgradient of the regulated facility.

Data and information gathered to support the Detection Monitoring Program outline was, in part, compiled as part of the RI/FS program presently being conducted at the facility concurrently with the RCRA program being conducted for Waste Pit 4.

E-5(a) Constituents to be Monitored

The groundwater upgradient and downgradient of the waste storage area will be monitored for hazardous waste and hazardous waste constituents that are specific to the FMPC regulated unit. As required by 40 CFR 264.98 the constituents to be monitored at the point of compliance include indicator parameters, waste constituents or reaction products which provide a reliable indication of the presence of hazardous constituents in the groundwater. Selection of these constituents is based on groundwater sampling data obtained from interim status detection and assessment monitoring and 40 CFR

261 Appendix VIII sampling conducted on Waste Pit No. 4 as part of the Characterization Investigation Study. Table E-10 provides the complete list of hazardous constituents and groundwater indicator parameters to be monitored at the point of compliance as part of the Detection Monitoring Program.

The FMPC is scheduled to perform 40 CFR 264 Appendix IX sampling on compliance well numbers 2043, 3043, 2019, 3019 and 2027 in the Waste Storage Area during the sixth round of Assessment Monitoring in the month of August 1989. As part of the ongoing assessment monitoring program, 40 CFR 264 Appendix IX sampling will also be done on till wells 1052, 1025, 1079, 1074, 1080, 1082 and 1031, and sand and gravel wells 2084, 3084, 2037 and 3037. This sampling will be conducted at wells located both upgradient and downgradient of the Waste Storage Area. The analytical results will be reported after receipt of validated data by this facility. Table E-10 may be amended following receipt of this Appendix IX analytical data.

E-5a(1) Hazardous Waste Characterization

A wide variety of chemical and metallurgical processes are employed at the FMPC facility to produce the finished products. These manufacturing processes have historically generated a large quantity of derived waste materials. These waste materials were principally neutralized, low-level radioactive byproduct and off-specification materials. These materials were transferred, from start up of the facility in 1952 until 1986, to the FMPC Waste Storage Area. The Waste Storage Area, as shown in Figure E-12 and Section B, Figure B-2, is comprised of six waste storage pits and other miscellaneous waste management facilities. Waste Pit No. 4, the facility regulated under RCRA, is located immediately adjacent to the other waste management units in the FMPC Waste Storage Area.

Waste Pit No. 4 was constructed in 1960 and utilized until May, 1986. The pit was constructed by excavating into the underlying clay till. A layer of clay was placed on the sides and bottom of the facility to serve as a liner. Waste Pit No. 4 primarily received process residues (i.e. magnesium fluoride slag, off-specification compounds, etc.), filter pressed sump sludges, neutralized raffinate sludges, graphite, noncombustible trash (i.e. construction rubble), and asbestos. From May 1981 to April 1983, Pit No. 4 received 23,500 pounds of barium chloride.

In February 1986 the FMPC, as part of the RI/FS, initiated a comprehensive investigation of the Waste Storage Area. This investigation, entitled the Characterization Investigation Study (CIS), was initiated to satisfy the data needs of a CERCLA action in the Waste Storage Area. The results of this investigation have been integrated into the ongoing sitewide RI/FS at the FMPC. References for the procedures and findings of the CIS can be found in Appendix E-III.

Sampling and analysis under the CIS was conducted in strict accordance with EPA SW-846 protocols. Representative samples were collected from four full depth boreholes in Waste Pit No. 4. Also, one sample of run-on water was collected from Pit No. 4 for analysis. The boreholes were completed using a 3 inch diameter hollow stem auger. Samples were obtained using a 24-inch drive split spoon sampler in accordance with ASTM D1586-84. All boring locations were sampled continuously with discrete samples collected at 2 foot intervals. Sampling continued until reaching a depth at which the on-site geologist identified the waste/clay liner interface. With the exception of the samples designated for volatile organic analysis, all samples were composited from

given borehole prior to analysis. Strict sample preparation, labeling, packaging and chain of custody procedures were employed throughout the program.

All Pit No.4 samples were analyzed for the full Appendix VIII parameters following Contracts Laboratory Program (CLP) protocols. In addition, collected samples were analyzed for the characteristics of a hazardous waste (i.e. ignitability, etc.).

A summary of the inorganic and organic compounds from Appendix VIII that were identified in each borehole sample is presented in Appendix E-II. Also provided is analytical results of the metals detected in the EP Toxicity leachate from the borehole samples.

In summary, the analytical results of the samples collected from Pit No. 4 indicated that all samples were within the established limits for corrosivity, ignitability, and reactivity. The concentrations of the primary RCRA metals in the EP Toxicity leachate on all of the borehole samples were less than the maximum allowable concentration under 40 CFR 261.

Appendix VIII analyses indicated that the pit contained high concentrations of aluminum, calcium, iron, and magnesium. Fluoride was found in large concentrations in all borehole samples ranging from 47,812 to 124,567 ppm. Barium was detected in all the borehole samples ranging from 444 to 6,668 ppm. Barium was not, however, found in a leachable form (exceeding EP Toxicity Limit) in any of the borehole samples.

PCB's were detected in all the borehole samples at concentrations ranging from 99 to 1,034 ppb. Organophosphorus pesticides, including ethyl parathion and methyl parathion, were detected at concentrations ranging from 82 to 2,100 ppb. Tetrachloroethane was detected in one borehole sample at a concentration of 30,000 ppb. Semivolatile compounds were detected in two of the samples at concentrations up to 2,000 ppb.

On the basis of a review of the analytical results of the CIS and knowledge of the generating processes of the wastes placed at Pit No. 4, the primary RCRA constituent of concern in the uppermost aquifer relative to the regulated unit is tetrachloroethane. Concentrations of tetrachloroethane above 12 ppb have not been detected in the uppermost aquifer underlying the regulated unit.

E-5a(2) Behavior of Constituents

Each of the hazardous waste constituents identified on Table E-10 have specific solubilities, vapor pressures, specific gravities, and half lives in groundwater which affect, to a degree, their individual mobility, stability, and persistence in the environment. Specific values for each of these physical properties can be found in U.S. EPA 540/1-86/060, Superfund Public Health Evaluation Manual, October, 1986. In general, of key concern to the Detection Monitoring Program are the listed volatile organic compounds (Tetrachloroethane, Methylene Chloride, Dichloroethane, Acetone, Tricholorethane and Toluene). Each of these compounds are soluble, to some degree, in groundwater, are relatively stable and are extremely persistent in the environment. Each of these compounds can be expected to be attenuated to some degree on the silts and clays in the

glacial till and on the fines in the unsaturated zone.

E-5a(3) Detectability

Each of the indicator parameters and hazardous constituents have specific analytical methods and associated detection limits. A complete listing of these methods and detection limits can be found in U.S. EPA SW-846 3rd Edition. Detection limits as identified in Table 2-15 of SW-846 for each of the listed constituents is provided in Table E-11.

E-5b Groundwater Monitoring Program

The groundwater monitoring system that is to be used during the Detection Monitoring Program is discussed in detail in the following subsections. The detection monitoring system comprises upgradient and background wells and downgradient wells that are located at the point of compliance to allow detection of hazardous constituents that may migrate from the regulated unit into the uppermost aquifer. The point of compliance is defined here as the vertical plane located at the downgradient limits of the regulated unit and positioned in the uppermost aquifer underlying that regulated unit. (See Section B, Figure B-7). The sand and gravel aquifer, as described in Section E-3.7, underlying the regulated unit.

Monitoring wells screened in the sand and gravel are monitored as part of the Compliance Monitoring Program. These wells are 2000, 3000, and 4000 series wells, which are screened at increasingly deeper collection points in the sand and gravel aquifer. Hydrogeologic data on the sand and gravel aquifer is discussed in Section E-3.

E-5b(1) Description of Wells

Table E-12 provides a list of the monitoring wells in the detection monitoring network. The monitoring system includes background wells and downgradient wells located at the point of compliance. At the FMPC, the Detection Monitoring Program study area is defined to be the area comprising the six waste pits and the clearwell, designated the Waste Pit Area. The Waste Pit Area was selected as the study area for detection monitoring due to the inability to hydraulically separate the individual waste pits from each other for purposes of groundwater monitoring.

A total of nine wells installed within the sand and gravel aquifer comprise the detection well monitoring program in the uppermost aquifer underlying the Waste Pit Area. Four of these wells (2043, 2066, 3043 and 3066) are located hydraulically upgradient of the Waste Pit Area and serve as the background monitoring wells. The downgradient wells installed at the point of compliance are 3001, 4001, 2019, 3019, and 2027.

Well clusters 2043/3043 and 2066/3066 are located west and upgradient of the Waste Pit Area and serve to determine background groundwater quality of the sand and gravel aquifer.

Downgradient wells 3001, 4001, 2019, 3019, and 2027 are located at the point of compliance downgradient of the Waste Pit Area. Well locations in relation to the piezometric contours of the sand and gravel aquifer are depicted on the potentiometric map provided in Section B, Figure B-7.

Wells in the sand and gravel aquifer detection monitoring program were installed at various times and are constructed of different materials. All of these sand and gravel wells,

however, are those that partially constitute the Interim Status assessment monitoring program wells and have been previously sampled over several years.

Wells 2043, 3043, 2066, 3066, 2027, and 3027 are constructed with 4-inch I.D. stainless steel screen and riser pipe materials. Wells 3001 and 4001 are constructed of 8-inch diameter steel casing. Wells 2019 and 3019 are constructed of 4-inch I.D. schedule 40 PVC screen and riser materials. The base of the screens in the 2000 series wells range from 66.8 to 74 feet deep. Depths to the base of the screen range from 134 to 117.6 feet below the ground surface in the 3000 series wells. (Detailed well logs for each of these sand and gravel wells describing the lithologic and well construction information are provided in Appendix E-I).

E-5b(2) Representative Samples

Groundwater samples collected from the designated detection monitoring wells in the sand and gravel aquifer are representative of the quality of groundwater that passes through the wells. As discussed in Section E-3, transmissivity values in the sand and gravel aquifer have been recorded up to 270 feet per day. The high transmissivity values and a quarterly sampling frequency indicate that representative samples will be collected from each well during each sampling event.

Water level data are proposed to be collected from Detection Program monitoring wells each time the wells are sampled on a quarterly basis. Piezometric contour maps will continue to be prepared from the water level data to characterize the groundwater gradient and direction of flow. The contour maps

will aid in determining any fluctuations in groundwater flow direction throughout the monitoring program.

Background Monitoring Points

Well clusters 2066/3066 and 2043/3043 are located upgradient of the Waste Pit Area so that the samples collected from the wells are not impacted from the waste pits within the area. The groundwater gradient in the sand and gravel aquifer trends eastward, toward the Great Miami River (Figure B-7). Data collected from these upgradient wells are sufficient to characterize background groundwater quality at two depths within the sand and gravel aquifer.

Compliance Monitoring Points

The compliance point wells in the sand and gravel aquifer represent three downgradient locations. Two wells at each location are representative of two depth intervals. These nested wells (3001 and 4001, 2019 and 3019, and 2027 and 3027) are located east of and downgradient of the hazardous waste management area. The wells are located on the point of compliance and are capable of characterizing the groundwater at various depths within the sand and gravel aquifer that potentially may be impacted by the Waste Storage Area.

E-5b(3) Locations of Background Groundwater Monitoring Wells that are not Upgradient

Extensive groundwater gradient characterization across the site indicates that all wells used to determine background groundwater quality in the sand and gravel aquifer are

upgradient wells and, therefore, this section is not applicable to this Part B Permit Application.

E-5c Background Values

This section provides details on the FMPC plans for establishing background values for the hazardous constituents proposed for monitoring under this Detection Monitoring Program.

E-5c(1) Data Currently Available

The FMPC is currently in the process of establishing background values for the all the hazardous constituents proposed for monitoring under this Detection Monitoring Program. Data used to determine background levels will include those collected during the Assessment Monitoring Program and the Appendix IX sampling effort currently undergoing laboratory analysis. The plan for establishing these values is discussed in Section E-5 (c)(2) below.

E-5c(2) Plan for Establishing Groundwater Quality Data

The monitoring constituents identified for this Detection Monitoring Program are also included in the list of constituents currently being monitored under the revised 40 CFR 265 Groundwater Quality Assessment Program Plan (GQAPP). (A copy of the GQAPP is provided in Appendix E-III). Site specific constituents were identified for monitoring in the March 1989 revision of the GQAPP. The proposed detection monitoring constituents provided in Table E-10 are a subset of the revised GQAPP constituents. At the time of submission of this permit application one round (Round 5) of sampling has been completed under the revised Groundwater Quality Assessment Program. Analytical results are not yet available

from this round of sampling. As a consequence background values have not been established for the detection monitoring constituents. Background values, at the upgradient wells identified in Section E-5b, will be established for all proposed detection monitoring constituents as described below.

E-5c(2)(a) Well Locations

The wells being used to establish background data are well clusters 2043/3043 and 2066/3066 which are screened in the upper and lower sand and gravel aquifer. Groundwater data collected during the RI/FS (Rounds 1 through 4) indicate that these wells are all upgradient of the waste storage area within their respective hydrogeologic units and therefore should provide samples which are representative of the background groundwater quality in the uppermost aquifer. The relative location of these wells to the waste storage area along with the groundwater potentiometric configuration is shown on groundwater potentiometric maps which are included in Section B, Figure B-7.

E-5c(2)(b) Sampling Frequency

As detailed in the Groundwater Quality Assessment Program Plan, quarterly sampling will be done on all wells being used to acquire the data necessary for determining the background groundwater quality of all monitoring constituents. Sampling will be conducted on a quarterly basis. All samples will be analyzed for all of the constituents, listed

in Table E-10, being proposed for monitoring under the detection monitoring program.

E-5c(2)(c) Sampling Quantity

A minimum of one sample from each well will be taken each time the wells being used to establish background are sampled. There will be a minimum of four sampling rounds conducted for the Detection Monitoring Program background determination. This requirement will be fulfilled as part of the quarterly sampling being done for 40 CFR 265 Groundwater Quality Assessment Program.

E-5c(2)(d) Background Values

Background values established for the detection monitoring program will be used as compliance limits against which downgradient hazardous constituent concentrations will be compared to determine if there has been a statistically significant increase of these hazardous constituents at the compliance point wells. Background groundwater quality data will be expressed in the appropriate form to allow these statistical comparisons. The form of the data will be dictated by the statistical procedure being utilized. Section E-5 (d)(7) provides descriptions of the statistical procedures which will be employed in this monitoring program.

E-5d Sampling, Analysis, and Statistical Procedures

E-5d(1) Sample Collection

Sample collection procedures are included in Appendix E-I.

E-5d(2) Sample Preservation and Shipment

All sample preservation and shipment procedures are included in Appendix E-I.

E-5d(3) Analytical Procedures

All analytical procedures are included in Appendix E-I.

E-5d(4) Chain of Custody

All chain of custody procedures are included in Appendix E-I.

E-5d(5) Additional Requirements for Compliance Point Monitoring

Additional requirements for detection monitoring are described in the following sections.

E-5d(5)(a) Sampling Frequency

All wells in the detection monitoring system will be monitored quarterly throughout the compliance period. The compliance period will normally continue until completion of the post closure care period of the regulated unit.

E-5d(5)(b) Compliance Point Groundwater Quality Values

All groundwater data collected from this detection monitoring program will be expressed in a form which will allow the statistical procedures described in section E-5d(7) to be utilized in the determination of whether there has been a statistically significant increase in the concentrations of hazardous constituents measured at the compliance point wells.

E-5d(6) Annual Determination of Aquifer Flow Rate and Direction

The regional groundwater flow rate and direction will be determined annually using the SWIFT III three dimensional groundwater flow and solute transport computer model being utilized in parallel investigations under the RI/FS program. Groundwater surface elevations, measured each time the wells are sampled, will be entered into the most recently calibrated version of the flow model. The groundwater flow model will then be recalibrated if necessary to permit a determination of the regional groundwater flow rates and directions. In addition to the determinations on the flow model, potentiometric maps will be updated at least annually to graphically document changes in the groundwater surface elevation.

E-5d(7) Statistical Determinations

All analytical results obtained from groundwater sampling at each compliance point well will be examined to determine whether there has been a statistically significant increase

in the concentration of hazardous constituents over the background values. Several statistical procedures are being specified to allow the flexibility to respond to changes in monitoring conditions. The statistical procedures specified here cover several anticipated conditions. However, should these procedures prove inadequate for a currently unforseen situation, an appropriate procedure, as determined by a statistician, which satisfies the performance requirements of 40 CFR 264.98(g), will be used to determine statistically significant differences.

E-5d(7)(a) Statistical Procedure

Figure E-13 shows the decision steps that will be followed when the data being evaluated involves comparisons between background wells and compliance point wells. An analysis of variance will be the primary statistical procedure used for data comparisons between background wells and compliance wells. Two other statistical procedures, tolerance intervals and prediction intervals, will be utilized as alternate procedures to the analysis of variance procedure if deemed necessary. The specific conditions under which each procedure may be used to determine whether there is statistically significant evidence of contamination are discussed below.

Analysis of variance:

If the proportion of detected values is 50% or more, then an analysis of variance procedure

pH, compliance concentrations which do not fall within the tolerance interval, would indicate statistically significant evidence of contamination. A coverage and a tolerance coefficient of 95% will be employed providing a 95% confidence level that the upper 9 5 % tolerance limit will contain at least 95% of the distribution of observations from background well data.

Prediction intervals:

Prediction intervals is also an alternate procedure which may be employed for determining statistically significant differences between data gathered from background wells and compliance point wells. The concentrations of a hazardous constituent in background wells will be used to establish an interval within which future observations from the same population will be expected to lie with a specified confidence. Statistical evidence of contamination is provided when a future observation exceeds the prediction interval. The number of future observations will be specified and the prediction interval will be constructed for a specified period of at least one year. The prediction interval will be constructed, within a 95% probability, either to contain all individual observations or to contain the means observed at the sampling periods.

E-5d(7)(b) Results

Statistical Analyses have been previously completed as part of Interim Status Detection Monitoring. As a result of these statistical analyses, the facility is currently engaged in Interim Status Assessment Monitoring. In the event that a permitted status detection monitoring program is initiated at the facility the necessary statistical analyses under 40 CFR 264.98 (g) (2) will be completed at the first opportunity and in no event longer than the receipt and analyses of the fourth round of permitted status detection monitoring data.

E-6 COMPLIANCE MONITORING PROGRAM

In accordance with 40 CFR 270.14(c)(7), if the presence of hazardous constituents has been identified in the groundwater at the point of compliance at the time the Part B Permit Application is submitted, the owner/operator of the facility must provide sufficient information to establish a compliance monitoring program which meets the requirements of 40 CFR 264.99.

Currently, the facility is continuing with the assessment monitoring program in accordance with the Groundwater Quality Assessment Program Plan (GQAPP) Revision 1, that was submitted to the OEPA and the U.S. EPA on March 23, 1989.

The fifth round of sampling under the GQAPP was completed in June 1989. The sixth round of sampling is scheduled to be conducted during August and September 1989. The analytical results of both rounds of sampling will be prepared and submitted to the OEPA once they are received and reviewed by the facility in accordance with the GQAPP.

The Compliance Monitoring Program is herein outlined and defined so that it can be implemented under the facility's permitted status if Assessment Monitoring Program data indicate that hazardous constituents have been detected in the uppermost aquifer downgradient of the regulated facility.

Data and information gathered to support the Compliance Monitoring Program outline was, in part, compiled as part of the RI/FS program presently being conducted at the facility concurrently with the RCRA program being conducted for Waste Pit 4.

Upon implementation of this Compliance Monitoring Program the following procedure will be carried out in the event that the groundwater protection standards, as defined in the permit, are exceeded:

(1) Written notification will be sent to the Director of the Ohio EPA within seven days of making a determination that the groundwater protection standards have been exceeded. This notification will indicate what concentration limits have been exceeded.

(2) The FMPC will then submit an application for a permit modification to establish a corrective action program within 100 days meeting the requirements of 40 CFR 264.100. Details of the actions to be undertaken in order to bring the groundwater into compliance will also be provided at this time along with a description of the monitoring program that will be implemented to demonstrate the effectiveness of the corrective action.

(3) In the event it is determined that the permit concentration limits were exceeded as a result of a source other than the FMPC or an error in sampling or sample analysis, a demonstration will be made to the OEPA to substantiate this determination.

E-6a Waste Description

For a complete waste description, please refer to Section E-5a(1).

E-6b Characterization of Contaminated Groundwater

As discussed in Section E-2, the FMPC is currently executing a Groundwater Quality Assessment Monitoring Program. The Assessment Program was initiated as a combined effort with the Remedial Investigation/Feasibility Study (RI/FS) groundwater investigation due to the consistency in objectives of the two programs. Samples collected during RI/FS Round 1 monitoring identified low concentrations of dichloroethane, methylene chloride, toluene and acetone in scattered wells in waste storage area. The groundwater was resampled in June 1989 for these substances at both upgradient and downgradient locations to determine if the constituents are actually present in the groundwater or the result of sampling or analytical error. The results of this sampling event have not been reported to this facility at the time of this writing. If these substances are discovered to be present in the groundwater the data will be evaluated to determine if they are present in statistically significant quantities compared to background values. Data collected to date on the Assessment Program wells can be found in Appendix E-II.

E-6c Hazardous Waste Constituents to be Monitored

The groundwater upgradient and downgradient of the waste storage area will be monitored for hazardous waste and hazardous waste constituents that are specific to the FMPC. As required by 40 CFR 264.93 the constituents to be monitored at the point of compliance include hazardous constituents identified in Appendix IX of 40 CFR 264 that have been detected in the groundwater in the uppermost aquifer underlying the waste storage area. Selection of these

constituents is based on groundwater sampling data obtained from interim status detection and assessment monitoring and 40 CFR 261 Appendix VIII sampling conducted on Waste Pit No. 4 as part of the Characterization Investigation Study. Table E-13 provides the complete list of hazardous constituents and groundwater indicator parameters to be monitored at the point of compliance.

The FMPC is scheduled to perform 40 CFR 264 Appendix IX sampling on compliance well numbers 2043, 3043, 2019, 3019 and 2027 in the Waste Storage Area during the sixth round of Assessment Monitoring in the month of August 1989. As part of the ongoing assessment monitoring program, 40 CFR 264 Appendix IX sampling will also be done on till wells 1052, 1025, 1079, 1074, 1080, 1082 and 1031, and sand and gravel wells 2084, 3084, 2037 and 3037. This sampling will be conducted at wells located both upgradient and downgradient of the Waste Storage Area. The analytical results will be reported after receipt of validated data by this facility. Appendix IX constituents identified in the groundwater which are not already included in the list of proposed monitoring constituents given in Table E-13 will be provided in a revised list at that time.

As required by 40 CFR 264.99 (f) compliance point wells will be monitored annually for all 40 CFR 264 Appendix IX constituents in addition to the substances listed in Table E-13.

E-6d <u>Concentration Limits</u>

Concentration limits for the hazardous constituents included in the Compliance Monitoring Program are established according to guidance provided in 40 CFR 264.94. Concentration limits for specific inorganic constituents are listed in 40 CFR 264.94 (a)(2), Table 1, Maximum Concentration Limits of Constituents for Groundwater Protection. From Table 1 in 40 CFR 264.94 (a) 2, the FMPC proposes to monitor barium, chromium, lead, and silver for statistically

significant increases over the concentration limits provided in that table. Concentration limits for the other constituents identified in Table E-13 will be statistically determined from background values of those constituents. Background values are currently being established for these remaining constituents. These background values will be established from the statistical analysis of data gathered through sampling currently being conducted for the Assessment Monitoring Program. The plan for establishing these concentration limits is discussed in Section E-6 (g)(2).

E-6e Alternate Concentration Limits

Groundwater data gathered from the uppermost aquifer indicate that low concentrations of select constituents have been sporadically identified. Because of the low concentrations recorded, the facility is not requesting that Alternate Concentration Limits (ACLs) be established at the time of this Part B Application submittal.

E-6f Groundwater Monitoring System

For a complete description of the groundwater monitoring system, please refer to Section E-5b.

E-6f(1) Description of Wells

For a complete description of wells, please refer to Section E-5b(1).

E-6(f)(2) Representative Samples

For a complete discussion of representative samples, please refer to Section E-5b(2).

E-6f(3) Locations of Background Groundwater Monitoring Wells that are not Upgradient

Please refer to Section 5b(3).

E-6g Background Levels

This section provides details on the FMPC plans for establishing background values for the hazardous constituents proposed for monitoring under this compliance monitoring program.

E-6g(1) Data Currently Available

The FMPC is currently in the process of establishing background values for the all the hazardous constituents proposed for monitoring under this compliance monitoring program. Data used to determine background levels will include those collected during the Assessment Monitoring Program and the Appendix IX sampling effort currently undergoing laboratory analysis. The plan for establishing these values is discussed in section E-6 (g)(2) below.

E-6g(2) Plan for Establishing Groundwater Quality Data

The monitoring constituents identified for this compliance monitoring program are also included in the list of constituents currently being monitored under the revised 40 CFR 265 Groundwater Quality Assessment Program Plan (GQAPP). A copy of the GQAPP is provided in Appendix E-III. Site specific constituents were identified for monitoring in the March 1989 revision of the GQAPP. The proposed compliance monitoring constituents provided in Table E-13 are a subset of the revised GQAPP constituents. At the time of submission of this permit application one round (Round 5) of sampling

has been completed under the revised Groundwater Quality Assessment Program. Analytical results are not yet available from this round of sampling. As a consequence background values have not been established for the compliance monitoring constituents. Background values, at the upgradient wells identified in section E-6 (f), will be established for all proposed compliance monitoring constituents as described below.

E-6g(2)(a) Background Data

Upgradient wells 2066, 3066, 2043 and 3043 were sampled during the month of June 1989 (Round 5) as part of the 40 CFR 265 assessment monitoring program which was revised in March 1989. Round 6 of sampling will be conducted during the month of August 1989. Samples taken during both of these rounds are to be analyzed for all of the monitoring constituents identified for this compliance monitoring program. The data collected will be statistically evaluated to establish representative background values for each constituent. In accordance with the requirements of 40 CFR 264.97(g)(2), all data used for establishing background values for the proposed monitoring constituents will be examined thoroughly for measurement errors in sampling and analysis. Where appropriate, adjustments will be made for any seasonal fluctuations in the background quality if such fluctuations are expected to affect the concentration of the hazardous constituent.

E-6g(2)(b) Well Location

The wells being used to establish background data are well clusters 2043/3043 and 2066/3066 which are screened in the upper and lower sand and gravel aquifer. Groundwater data collected during the RI/FS (Rounds 1 through 4) indicate that these wells are all upgradient of the waste storage area within their respective hydrogeologic units and therefore should provide samples which are representative of the background groundwater quality in the uppermost aquifer. The relative location of these wells to the waste storage area along with the groundwater potentiometric configuration is shown on groundwater potentiometric maps which are included as Figure B-7.

E-6g(2)(c) Sampling Frequency and Quantity

As detailed in the Groundwater Quality Assessment Program Plan (see Appendix E-III, quarterly sampling will be done on all wells being used to acquire the data necessary for determining the background groundwater quality of all monitoring constituents. Sampling will be conducted on a quarterly basis. All samples will be analyzed for all of the constituents, listed in Table E-13, being proposed for monitoring under the compliance monitoring program.

E-6g(2)(d) Sampling Quantity

In accordance with the requirements of 40 CFR 264.97(g)(4) for establishing groundwater quality data a minimum of one sample from each well will be taken each time the wells being used to establish background are sampled. There will be a minimum of four sampling rounds conducted for the Compliance Monitoring Program background determination. This requirement will be fulfilled as part of the quarterly sampling being done for 40 CFR 265 Groundwater Quality Assessment Program.

E-6g(2)(e) Background Values

Background values established for the compliance monitoring program will be used as compliance limits against which downgradient hazardous constituent concentrations will be compared to determine whether there has been a statistically significant increase of these hazardous constituents at the compliance point wells. Background groundwater quality data will be expressed in the appropriate form to allow these statistical comparisons per 40 CFR 264.99(c)(3)(ii). The form of the data will be dictated by the statistical procedure being utilized. Section E-6h(7) provides descriptions of the statistical procedures which will be employed in this monitoring program.

E-6h Sampling, Analysis, and Statistical Procedures

E-6h(1) Sample Collection

All sample collection procedures are included in Appendix E-I.

E-6h(2) Sample Preservation and Shipment

All sample preservation and shipment procedures are included in Appendix E-I.

E-6h(3) Analytical Procedures

All analytical procedures are included in Appendix E-I.

E-6h(4) Chain of Custody

All chain of custody procedures are included in Appendix E-I.

E-6h(5) Additional Requirements for Compliance Monitoring

Additional requirements for compliance monitoring are described in the following sections.

E-6h(5)(a) Sampling Frequency

All wells in the compliance monitoring system will be monitored quarterly throughout the compliance period in accordance with the requirements of 40 CFR 264.99(d). The compliance period will normally continue until final closure of the waste management area at which time an application will

be submitted for the reinstatement of a detection monitoring program.

E-6h(5)(b) Testing for Appendix IX Constituents

According to 40 CFR 264.99(f), samples from all monitoring wells at the compliance point will be analyzed annually to determine whether constituents identified in the list in Appendix IX to 40 CFR 264 are present in the groundwater and if so at what concentration.

E-6h(5)(c) Compliance Point Groundwater Quality Values

According to 40 CFR 264.99(d), all groundwater data collected from this compliance monitoring system will be expressed in a form which will allow the statistical procedures described in section E-6 (h)(7) to be utilized in the determination of whether there has been a statistically significant increase, over the concentration limits, in the concentrations of hazardous constituents measured at the compliance wells.

E-6h(6) Annual Determination of Aquifer Flow Rate and Direction

In accordance with the requirements of 40 CFR 264.99(e) the regional groundwater flow rate and direction will be determined annually using the SWIFT III three dimensional groundwater flow and solute transport computer model being utilized in parallel investigations under the RI/FS program.

Groundwater surface elevations, measured each time the wells are sampled in accordance 40 CFR 264.97(f) requirements, will be entered into the most recently calibrated version of the flow model. The groundwater flow model will then be recalibrated if necessary to permit a determination of the regional groundwater flow rates and directions. In addition to the determinations on the flow model, potentiometric maps will be updated at least annually to graphically document changes in the groundwater surface elevation.

E-6h(7) Statistical Determinations

All analytical results obtained from groundwater sampling at each compliance point well will be examined to determine whether there has been a statistically significant increase in the concentration of hazardous constituents over the concentration limits specified in the permit. Several statistical procedures are being specified to allow the flexibility to respond to changes in monitoring conditions. The statistical procedures specified here cover several anticipated conditions. However, should these procedures prove inadequate for a currently unforseen situation, an appropriate procedure, as determined by a statistician, which satisfies the performance requirements of 40 CFR 264.97(i), will be used to determine statistically significant differences.

E-6h(7)(a) Background Well to Compliance Well Comparisons

Figure E-13 shows the decision steps that will be followed when the data being evaluated involves comparisons between background wells and compliance point wells. An analysis of variance

will be the primary statistical procedure used for data comparisons between background wells and compliance wells. Two other statistical procedures, tolerance intervals and prediction intervals, will be utilized as alternate procedures to the analysis of variance procedure if deemed necessary. The specific conditions under which each procedure may be used to determine whether there is statistically significant evidence of contamination are discussed below.

Analysis of variance:

If the proportion of detected values is 50% or more, then an analysis of variance procedure (ANOVA) will be the first choice for the determination of statistical significance.

One-way analysis of variance statistical procedures will be used to determine whether differences in mean concentrations among wells or groups of wells are statistically significant. A one-way parametric analysis of variance procedure will be used for situations where data for a water quality parameter or hazardous constituent are available from several wells but only for one time period, or when data, which do not exhibit seasonality, are available from several wells for several time periods. A one-way non-parametric analysis of variance procedure will be used for interwell comparisons when the data or the residuals from a parametric ANOVA have been found to be significantly different from

normal and when a log transformation fails to adequately normalize the data.

Tolerance intervals based on the normal distribution:

The homogeneous nature of the geology between the background wells and compliance wells in the waste storage area lends itself to an alternate approach, such as a tolerance intervals procedure, to an analysis of variance. Tolerance intervals will be constructed from data on background wells. The concentrations from compliance wells will then be compared with the tolerance interval. With the exception of pH, compliance concentrations which do not fall within the tolerance interval, would indicate statistically significant evidence of contamination. A coverage and a tolerance coefficient of 95% will be employed providing a 95% confidence level that the upper 95% tolerance limit will contain at least 95% of the distribution of observations from background well data.

Prediction intervals:

Prediction intervals is also an alternate procedure which may be employed for determining statistically significant differences between data gathered from background wells and compliance point wells. The concentrations of a hazardous constituent in background wells will be used to establish an interval within which future observations from the same population will be

expected to lie with a specified confidence. Statistical evidence of contamination is provided when a future observation exceeds the prediction interval. The number of future observations will be specified and the prediction interval will be constructed for a specified period of at least one year. The prediction interval will be constructed, within a 95% probability, either to contain all individual observations or to contain the means observed at the sampling periods.

E-6h(7)(b) Comparisons with Maximum Concentration Limits or Alternate Concentration Limits

The statistical procedures described here will be utilized when comparisons are being made between concentrations of hazardous constituents in compliance point wells and prespecified fixed concentration limits. The mean compliance well concentration will be compared against the compliance limit through the construction of a confidence level. Figure E-14 shows the decision process which will be employed for compliance well comparisons with MCL's or ACL's.

Confidence intervals:

Confidence intervals, using the 99th percentile of the t-distribution, for the mean concentration will be constructed from the compliance well data. Once constructed the interval will be compared with the Maximum Concentration Limit (MCL) or the Alternate Concentration Limit (ACL) to determine

whether the mean concentration significantly exceeds the MCL or ACL. This statistical procedure will be used for both normal and log-normal data. Log-normal data will be compared to the log-normal of the compliance limit. If the compliance well data do not adequately follow the normal distribution even after logarithm transformation, a nonparametric confidence interval will be constructed using a minimum of seven observations in order to obtain a one-sided significance level of 1% (confidence of 99%). This may require pooling of data from two or more wells or sampling periods.

E-6h(7)(c) Optional Intra-well Comparisons

Upon the establishment of enough data for each well (eight or more independent samples), the FMPC may elect to construct control charts by plotting each data point against time to allow detection of possible trends or drifts in the data. This is an optional statistical procedure, which the FMPC may or may not choose to implement, that will complement the statistical procedures specified above. Corrections for seasonal variations of the data will be done to preclude the chance of mistaking seasonal effect for evidence of well contamination. A procedure such as the combined Shewhart-Cusum control charts may be used for each well and constituent.

E-6h(7)(d) Test of Proportions

In situations where more than 50% of the data but at least 10% of the observations are quantified, a test of proportions may be used to compare the background well data with the compliance well data. A higher proportion of quantitated values in the compliance wells may indicate the presence of contamination. If only a small portion of the observations are not detected, these will be replaced with either the Method Detection Limit or the Practical Quantitation Limit divided by two (MDL/2 or PQL/2). The PQL will be taken from Appendix IX of 40 CFR 264.

E-6h(7)(e) Handling Outlying Data

An "outlier" or groundwater constituent value which is much different from most other values may indicate one of the following situations:

- A catastrophic unnatural occurrence such as a spill;
- Inconsistent sampling or analytical chemistry methodology that may result in laboratory contamination or other anomalies;
- Errors in the transcription of data values or decimal points; and
- True but extreme groundwater constituent concentration measurements.

When such suspect data is encountered a test for outliers which determines whether there is statistical evidence that particular observation does not fit the distribution of the rest of the data will be performed. If determined to be an outlier the value in question will not be dropped or replaced unless it is determined that an error has occurred.

E-7 CORRECTIVE ACTION PROGRAM

At the time of submittal of this permit application, a determination of the presence hazardous waste constituents in the uppermost aquifer underlying the regulated unit had not been completed as a result of insufficient data. Upon identification and confirmation of the presence of hazardous waste or hazardous waste constituents in the uppermost aquifer at the point of compliance an engineering feasibility plan for a corrective action program necessary to meet the requirements of 40 CFR 264.100 will be developed and submitted in accordance with 40 CFR 270.14 (c) (7).

Table E-1.
RCRA Detection Monitoring Program
Sampling Dates

Round 1	August, 1985
Round 2	May, 1986
Round 3	August, 1986
Round 4	November, 1986
Round 5	May, 1987
Round 6	December, 1987

Table E-2
RCRA Detection Monitoring
Wells and Name Equivalents
1986-1989

1989 Well Identification	1987 Well Identification	1986 Well Identification
3001	301	1s
4001	401	1d
3003	303	3
2004	204	4
3005	305	5
3008	308	8s
4008	408	8d
3009	309	9
3010	310	10
2011	211	11
1012	112	12
2013	213	13s
3013	313	13d
2014	214	14s
3014	314	14d
2015	215	15s
4015	415	15d
2016	216	16s
3016	316	16d
2017	217	17s
3017	317	17d
2018	218	18s
3018	318	18d
1019	119	19TP
2019	219	19s
3019	319	19d
1020	120	20TP
2020	220	20s
3020	320	20d
1021	121	21TP
2021	221	21s
1022	122	22TP
2022	222	22s
2060	OS-1	OS-1
1060	OS-1A	OS-1A
2061	OS-2	OS-2
3062	OS-3	OS-3
SW-2	SW-2	SW-2
4101	P1	P1
4102	P2	P2
4103	P3	P3

TABLE E-3

RCRA DETECTION MONITORING PROGRAM
WELL CONSTRUCTION DATA

WELL NUMBER	DEPTH (FT.)	CASING	DIAMETER (IN.)	SCREEN ELEV. (MSL)	SCREEN LENGTH (ft)
3001	130	ST	8	510 - 490	20
4001	180	ST	4	410 - 405	5
3003	105	ST	8	474 - 454	20
2004	43	ST	6	544 - 524	20
3005	95	ST	8	480 - 460	20
3008	116	ST	4	464 - 459	5
4008	180	ST	4	400 - 395	5
3009	103	ST	4	457 - 452	5
)10	130	GVST	6	480 - 460	20
2011	130	GVST	6	510 - 490	20
1012	61	ST	4	593 - 577	26
2013	78	PVC	4	516 - 511	5
3013	117	PVC	4	482 - 472	10
2014	19	PVC	4	520 - 515	5
3014	48	PVC	4	491 - 486	5
2015	85	PVC	4	498 - 493	5
4015	185	GVST	6	402 - 392	10
2016	34	PVC	4	510 - 503	7
3016	66	PVC	4	480 - 475	5
2017	27	PVC	4	512 - 507	5
3017	70	PVC	4	407 - 465	5

WELL NUMBER	DEPTH (FT.)	CASING	DIAMETER (IN.)	SCREEN ELEV.	SCREEN LENGTH (ft)
2018	60	PVC	4	517 - 512	5
3018	108	PVC	4	470 - 465	5
1019	10	PVC	4	573 - 578	5
2019	74	PVC	4	514 - 509	5
3019	124	PVC	4	465 - 460	5
1020	10	PVC	4	568 - 563	5
2020	64	PVC	4	514 - 519	5
3020	116	PVC	4	455 - 450	5
1021	11	PVC	4	579 - 574	5
2021	74	PVC	4	515 - 510	5
1022	11	PVC	4	582 - 577	5
2022	90	PVC	4	504 - 499	5
2060	NOT AVAILABLE				
1060	NOT AVAILABLE				
2061	74	PVC	4	515 - 510	5
3062	NOT AVAILABLE				
SW-2	NOT AVAILABLE				
4101	210	ST	26	393 - 368	25
4102	210	ST	26	393 - 368	25
4103	210	ST	26	390 - 369	21

Note: PVC - Polyvinyl Chloride
ST - Steel
GVST- Galvanized Steel

TABLE E-4
RCRA INTERIM STATUS DETECTION MONITORING PROGRAM
ANALYTICAL PARAMETERS(1)

A. For General Water Quality

1. Chloride
2. Iron
3. Manganese
4. Phenols
5. Sodium
6. Sulfate

B. For Indicators of Contamination (Quadruplicate Analysis)

1. pH
2. Specific Conductance
3. Total Organic Carbon (TOC)
4. Total Organ Halogen (TOX)

C. For Drinking Water Suitability

1. Arsenic
2. Barium
3. Cadmium
4. Chromium - Hexavalent
   - Total
5. Fluoride
6. Lead
7. Mercury
8. Nitrate
9. Selenium
10. Silver
11. Gross Alpha
12. Gross Beta
13. Radium
14. Endrin
15. Lindane
16. Methoxychlor
17. Toxaphene
18. 2, 4-D
19. 2, 4, 5-TP Silvex
20. Coliform Bacteria

(1) Other parameters which are not part of the interim status detection monitoring program, were sampled as part of the FMPC RI/FS.

Table E-5
Interim Status
RCRA DETECTION MONITORING PROGRAM
ANALYTICAL METHODS AND DETECTION LIMITS FOR GROUNDWATER SAMPLES
WATER QUALITY INDICATORS

PARAMETER	DETECTION LIMIT	ANALYTICAL METHOD *
Chloride	1 ppm	9250
Iron	50 ppb	7380
Manganese	20 ppb	7460
Phenols (total)	5 ppb	8040
Sodium	50 ppb	7770
Sulfate	1.0 ppb	9035
pH	0.1 std./units	9040
Specific Conductance	1 umho/cm	9050
Total Organic Carbon (TOC)	1 ppb	9060
Total Organic Halogen (TOX)	10 ppb	9020
Arsenic	5 ppb	7060
Barium	200 ppb	7080
Cadmium	2 ppb	7090
Chromium-Hexavalent	5 ppb	7195, 7196, 7197
Chromium-Total	5 ppb	7190
Fluoride	10 ppb	
Lead	5 ppb	7420
Mercury	2 ppb	7470
Nitrate (as N)	20 ppb	9200
Selenium	2.5 ppb	7740
Silver	30 ppb	7760
Gross alpha	15 pCi/l	9310
Gross beta	5 pCi/l	9310
Radium	5 pCi/l	9320
Endrin	0.2 ppb	8150
Lindane	0.2 ppb	8150
Methoxychlor	0.2 ppb	8150
Toxaphene	0.5 ppb	8150
2, 4-D	0.2 ppb	8150
2, 4, 5-TP Silvex	0.2 ppb	8150
Coliform Bacteria	2/100 ml	9132
Nickel	5 ppb	7520
Cyanide	5 ppb	9010
Copper	25 ppb	7210
Zinc	25 ppb	7950
Magnesium	10 ppb	7450
Calcium	50 ppb	7140
Phosphorus	20 ppb	415[1]
Total Dissolved Solids (TDS)	10 ppb	2090[1]
Total Potassium	50 ppb	7610

* SW-846 Third Edition, September, 1986

Table E-5 (cont'd)
Interim Status
RCRA DETECTION MONITORING PROGRAM
ANALYTICAL METHODS AND DETECTION LIMITS FOR GROUNDWATER SAMPLES
VOLATILES

PARAMETER	DETECTION LIMIT	ANALYTICAL METHOD *
Chlorobenzene	2.0 ppb	8240
Chlorodibromomethane	2.0 ppb	8240
Chloroethane	2.0 ppb	8240
2-Chloroethlvinyl Ether	2.0 ppb	8240
Chloroform	2.0 ppb	8240
Dichlorobromoethane	2.0 ppb	8240
Dichlorodifluoromethane	2.0 ppb	8240
Chemical Oxygen Demand (COD)	10 ppb	508A[1]
cis 1,2 Dichloroethylene	2.0 ppb	8240
Tributylphosphate	2.0 ppb	8240
Acrolein	2.0 ppb	8240
Acrylonitrille	2.0 ppb	8240
Benzene	2.0 ppb	8240
bis (Chloromethyl) Ether	2.0 ppb	8240
Bromoform	2.0 ppb	8240
Bromodichloromethane	2.0 ppb	8240
Bromoethane	2.0 ppb	8240
Carbon tetrachloride	2.0 ppb	8240
Chloromethane	2.0 ppb	8240
1, 2 Dichlorobenzene	2.0 ppb	8250
1, 3 Dichlorobenzene	2.0 ppb	8250
1, 4 Dichlorobenzene	2.0 ppb	8250
1, 1 Dichloroethane	2.0 ppb	8240
1, 2 Dichloroethane	2.0 ppb	8240
1, 1 Dichloroethylene	2.0 ppb	8240
1, 2 Dichloropropane	2.0 ppb	8250
1, 2 Dichloropropylene	2.0 ppb	8250
Ethylbenzene	2.0 ppb	8240
Methylbromide	2.0 ppb	8240
Methylchloride	2.0 ppb	8240
Trans 1, 2 Dichloroethylene	2.0 ppb	8240
1, 3 Dichloropropene	2.0 ppb	8250
1, 1, 2, 2 Tetrachloroethane	2.0 ppb	8240
Tetrachloroethylene	2.0 ppb	8240
1, 1, 1 Trichloroethane	2.0 ppb	8240
1, 1, 2 Trichloroethane	2.0 ppb	8240
Trichloroethylene	2.0 ppb	8240
Trichlorofluoromethane	2.0 ppb	8240
Vinyl Chloride	2.0 ppb	8240

* SW-846, Third Edition, September 1986, unless otherwise noted
(1) Standard Methods for the Examination of water and wastewater; America Public Health Assoc. and America Waterworks Assoc.; 15th Ed., 1981

Table E-6
RCRA Assessment Monitoring Program
Sampling Dates

Round 1	May, 1988
Round 2	August, 1988
Round 3	November, 1988
Round 4	February, 1989
Round 5	June, 1989
Round 6	August, 1989

Table E-7
RCRA ASSESSMENT PROGRAM WELLS

Well	Description
1024	Upgradient Till Well
1052	Upgradient Till Well
1027	Downgradient Till Well
1080	Downgradient Till Well
1079	Downgradient Till Well
1004	Downgradient Till Well
1074	Downgradient Till Well
1031	Downgradient Till Well
1028	Downgradient Till Well
1072	Downgradient Till Well
1030	Downgradient Till Well
1038	Downgradient Till Well
1081	Downgradient Till Well
1083	Downgradient Till Well
1082	Downgradient Till Well
1025	Downgradient Till Well
2066/3066	Upgradient Sand and Gravel Cluster
2043/3043	Upgradient Sand and Gravel Cluster
3001/4001	Downgradient Sand & Gravel Cluster
2084/3084	Downgradient Sand & Gravel Cluster
2019/3019	Downgradient Sand & Gravel Cluster
2010/3010/4010	Downgradient Sand & Gravel Cluster
2013/3013/4013	Downgradient Sand & Gravel Cluster
2051/3051	Downgradient Sand & Gravel Cluster
2055/3055	Downgradient Sand & Gravel Cluster
3008/4008	Downgradient Sand & Gravel Cluster
2037/3037	Downgradient Sand & Gravel Cluster
2021	Downgradient Sand & Gravel
2027	Downgradient Sand & Gravel
3024	Downgradient Sand & Gravel

TABLE E-8

RCRA ASSESSMENT MONITORING PROGRAM

WELL CONSTRUCTION DATA

WELL NUMBER	DEPTH (FT.)	CASING	DIAMETER (IN.)	SCREEN ELEV. (MSL)	SCREEN LENGTH (ft)
1052	28.9	STS	4	554 - 556	2
1024	27	STS	4	553 - 551	2
1027	31	STS	4	554 - 552	2
1080	30.9	STS	4	553 - 551	2
1079	31	STS	4	554 - 552	2
1028	29	STS	4	560 - 558	2
1004	31	STS	4	550 - 548	2
1031	26	STS	4	552 - 550	2
1072	31	STS	4	547 - 545	2
1074	23.5	STS	4	557 - 555	2
1030	30	STS	4	548 - 546	2
1038	28.5	STS	4	556 - 554	2
1081	33	STS	4	559 - 557	2
1083	21.5	STS	4	563 - 561	2
1082	23	STS	4	562 - 560	2
1025	21	STS	4	562 - 560	2
2066	62.4	STS	4	531 - 516	15
2043	66.8	STS	4	527 - 512	15
2084	76	STS	4	522 - 507	15
2019	74	PVC	4	514 - 509	5

WELL NUMBER	DEPTH (FT.)	CASING	DIAMETER (IN.)	SCREEN ELEV.	SCREEN
2027	76	STS	4	522 - 507	15
2021	74	PVC	4	515 - 510	5
2037	82.5	STS	4	521 - 506	15
2010	75.5	STS	4	522 - 507	15
2055	81.5	STS	4	526 - 511	15
2013	78	PVC	4	516 - 511	5
2051	102.4	STS	4	520 - 505	15
3066	137.5	STS	4	451 - 441	10
3043	120	STS	4	470 - 460	10
3084	102.4	STS	4	491 - 481	10
3019	142	PVC	4	465 - 460	5
3024	110	STS	4	480 - 470	10
3037	135.5	STS	4	463 - 453	10
3001	130	ST	8	510 - 490	20
3008	116	ST	4	464 - 459	5
3010	130	GVST	6	480 - 460	20
3055	120.8	STS	4	476 - 466	10
3013	117	PVC	4	482 - 472	10
3051	145.9	STS	4	471 - 461	10
4001	180	ST	4	410 - 405	5
4008	180	ST	4	400 - 395	5
4010	210.6	STS	4	392 - 382	10
4013	222.5	STS	4	387 - 377	10

Note: PVC - Polyvinyl Chloride
ST - Steel
GVST- Galvanized Steel
STS - Stainless Steel

Table E-9
RCRA ASSESSMENT MONITORING PROGRAM
ANALYTICAL PARAMETERS

Cobalt
Beryllium
Zinc
Vanadium
Nickel
Copper
Magnesium
Calcium
Aluminum
Barium
Chromium
Lead
Silver
Iron
Fluoride
Nitrate
Chloride
Sulfate
pH
Conductivity
TOC
TOX
Tetrachloroethene
Methylene chloride
Dichloroethane
Toluene

Table E-10
DETECTION MONITORING PROGRAM
CONSTITUENTS TO BE MONITORED

MONITORING CONSTITUENT
Cobalt
Beryllium
Zinc
Vanadium
Nickel
Copper
Barium
Chromium
Lead
Silver
pH
Specific Conductance
TOC
TOX
Tetrachloroethene
Methylene Chloride
Dichlorethane
Acetone
Trichloroethene
Toluene

Table E-11
DETECTION MONITORING PROGRAM
DETECTION LIMITS

MONITORING CONSTITUENT	DETECTION LIMIT *
Cobalt	50
Beryllium	5
Zinc	20
Vanadium	50
Nickel	40
Copper	25
Barium	200
Chromium	10
Lead	5
Silver	10
pH	0.1 units
Specific Conductance	1 umho/cm
TOC	1000
TOX	5
Tetrachloroethene	10
Methylene Chloride	10
Dichlorethane	10
Acetone	10
Trichloroethene	10
Toluene	10

* All detection limits are in parts per billion (PPB) except as noted in table.

TABLE E-12

RCRA DETECTION AND COMPLIANCE MONITORING PROGRAM

WELL CONSTRUCTION DATA

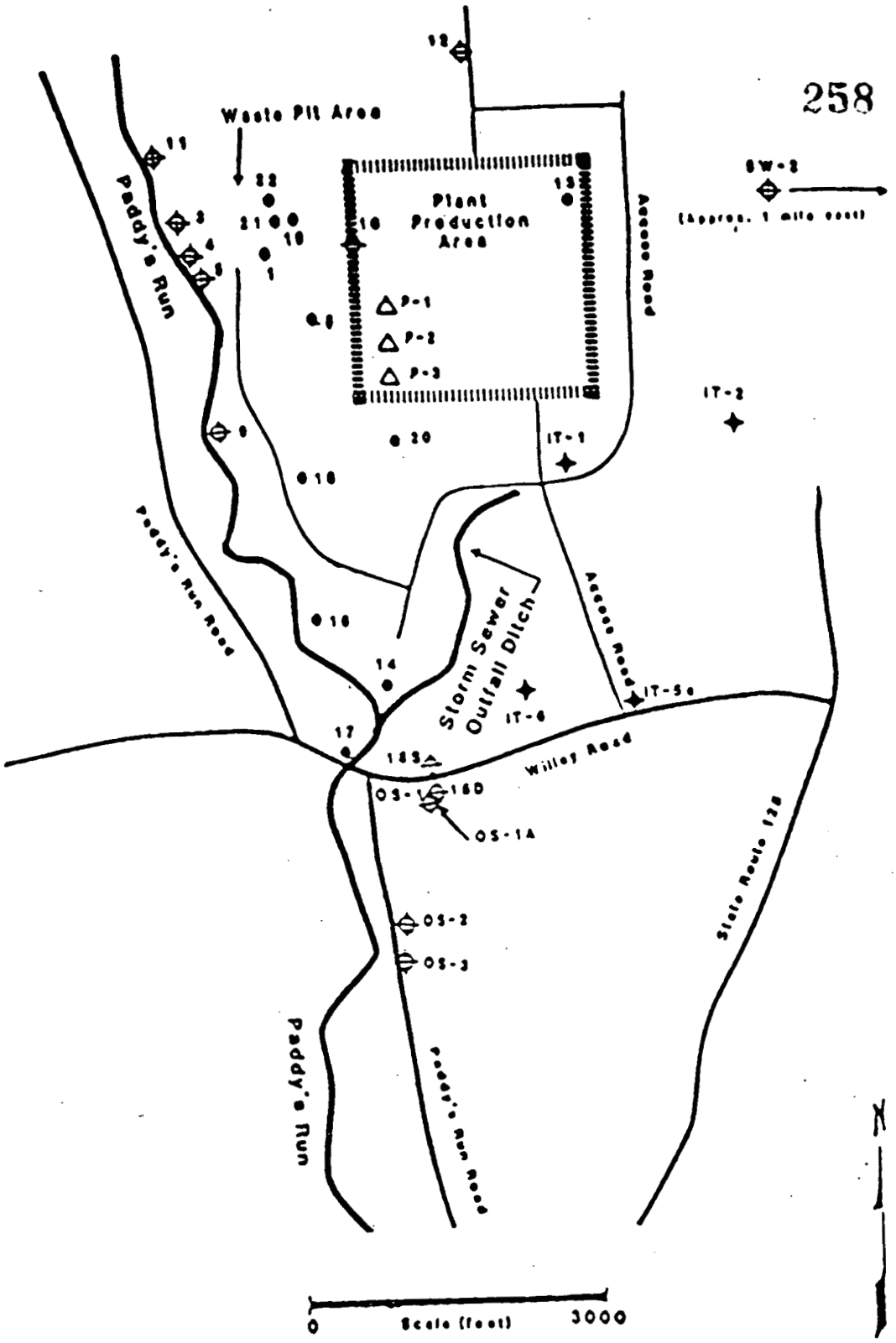
WELL NUMBER	DEPTH (FT.)	CASING	DIAMETER (IN.)	SCREEN ELEV. (MSL)	SCREEN LENGTH (ft)
2043	66.8	STS	4	527 - 512	15
2019	74	PVC	4	514 - 509	5
2027	76	STS	4	522 - 507	15
3043	120	STS	4	470 - 460	10
3019	142	PVC	4	465 - 460	5
3001	130	ST	8	510 - 490	20
4001	180	ST	4	410 - 405	5
2066	62.4	STS	4	531 - 516	15
3066	137.5	STS	4	451 - 441	10

Note: PVC - Polyvinyl Chloride
ST - Steel
GVST- Galvanized Steel
STS - Stainless Steel

Table E-13
COMPLIANCE MONITORING PROGRAM
HAZARDOUS WASTE CONSTITUENTS TO BE MONITORED

MONITORING CONSTITUENT	COMPLIANCE LIMIT	BACKGROUND VALUE
Cobalt	*	*
Beryllium	*	*
Zinc	*	*
Vanadium	*	*
Nickel	*	*
Copper	*	*
Barium	1.0 mg/l	*
Chromium	0.05 mg/l	*
Lead	0.05 mg/l	*
Silver	0.05 mg/l	*
pH	*	*
Conductivity	*	*
TOC	*	*
TOX	*	*
Tetrachloroethene	*	*
Methylene Chloride	*	*
Dichlorethane	*	*
Acetone	*	*
Trichloroethene	*	*
Toluene	*	*

* TBD - To be Determined upon evaluation of Assessment Monitoring data.



Explanation:

- Single Well Location
- Cluster Well Location
- Production Well Locatio
- IT Well Location

NOTE: Figure uses 1986 Well Numbers (See Table E – 2)

WELL LOCATIONS

FIGURE E – 1

General Monitoring Well Depths and Screen Locations

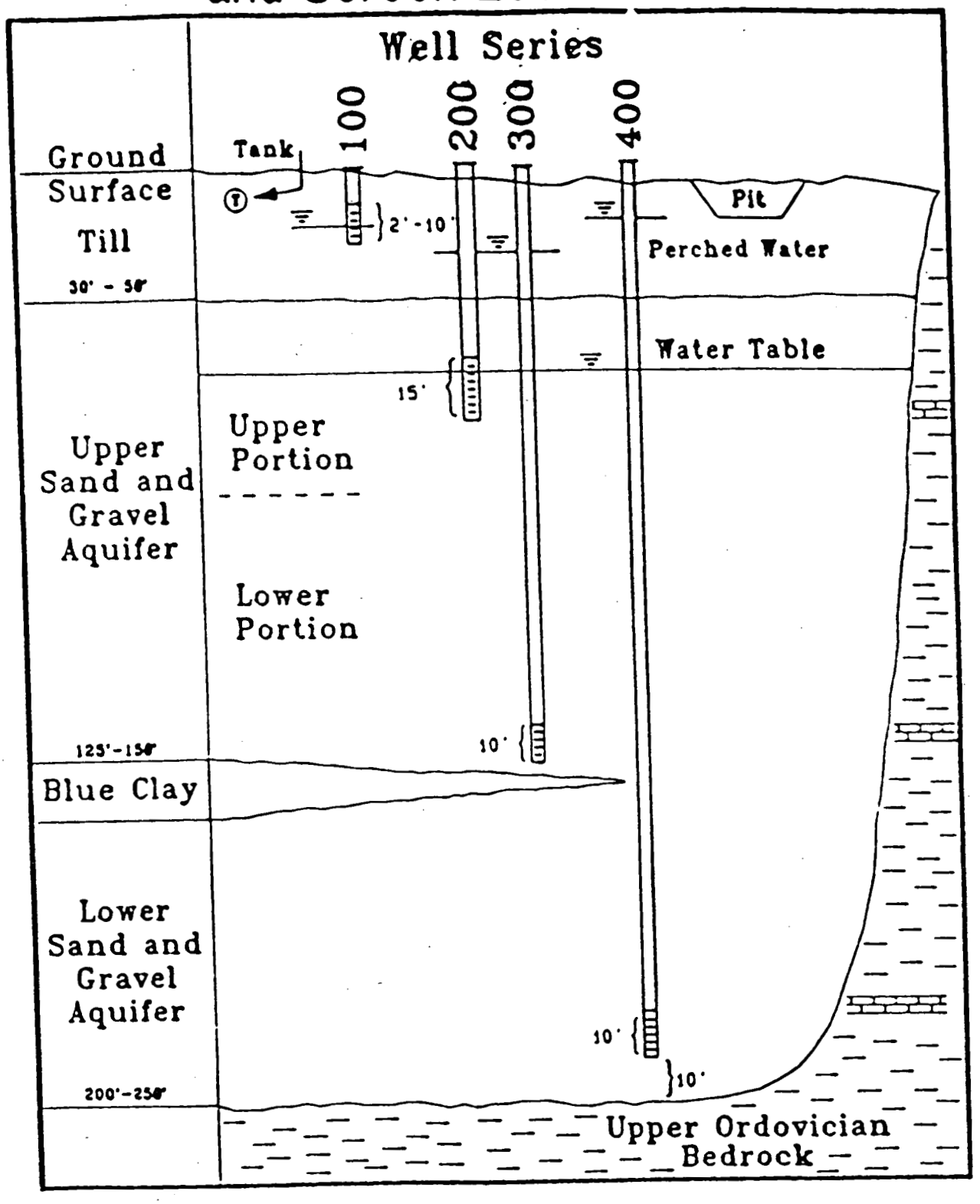
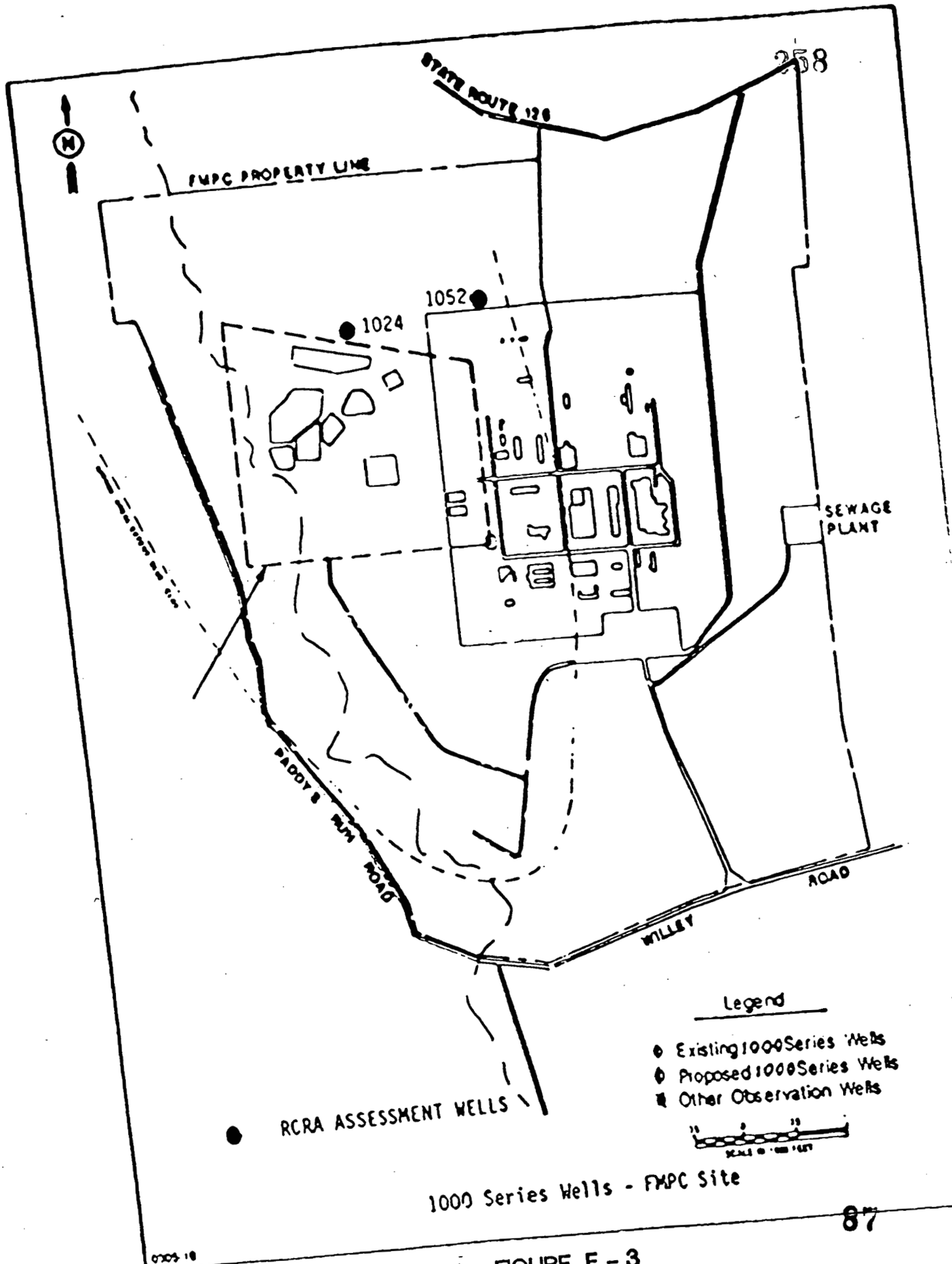
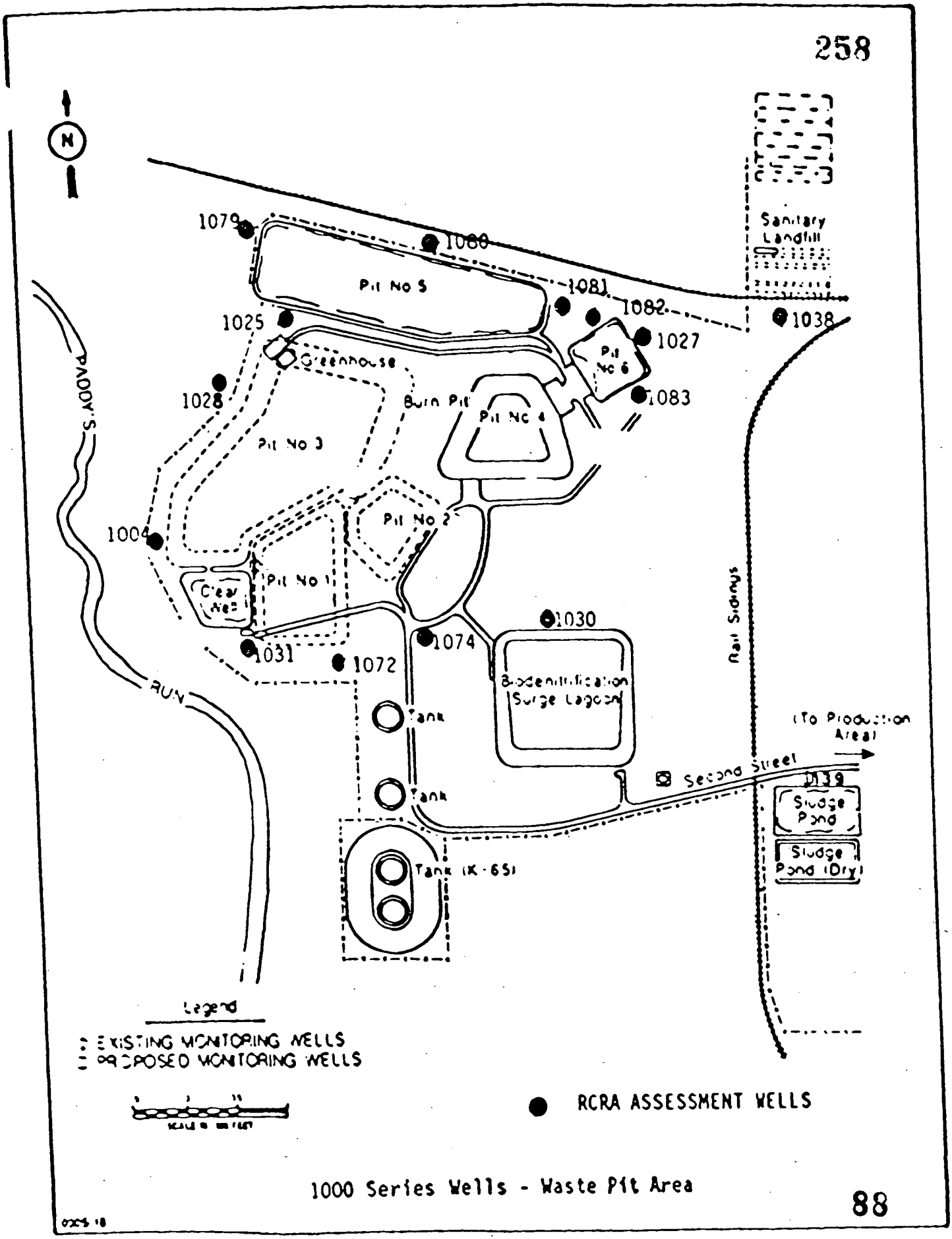


FIGURE E - 2



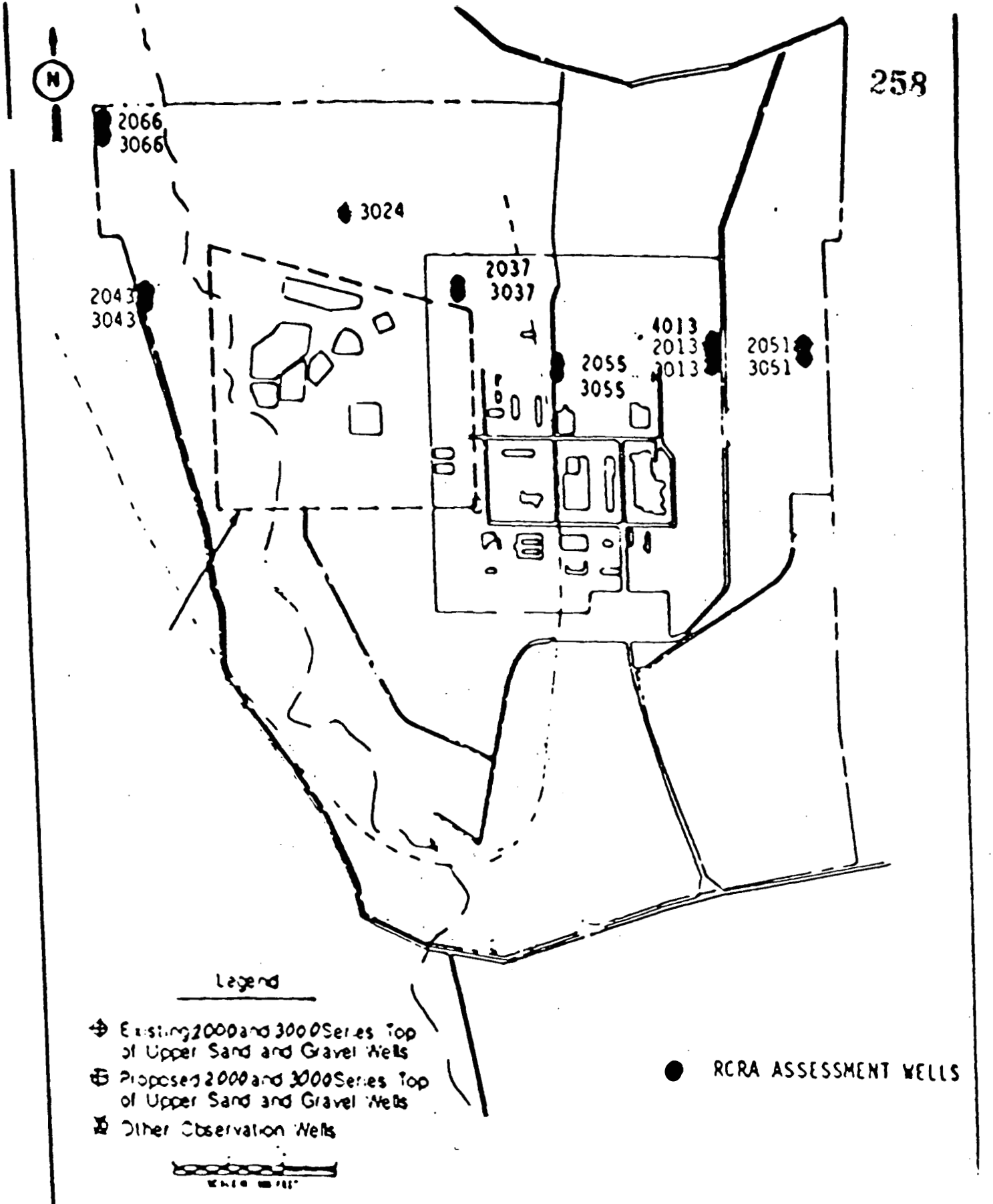
1000 Series Wells - FMPC Site

FIGURE E - 3



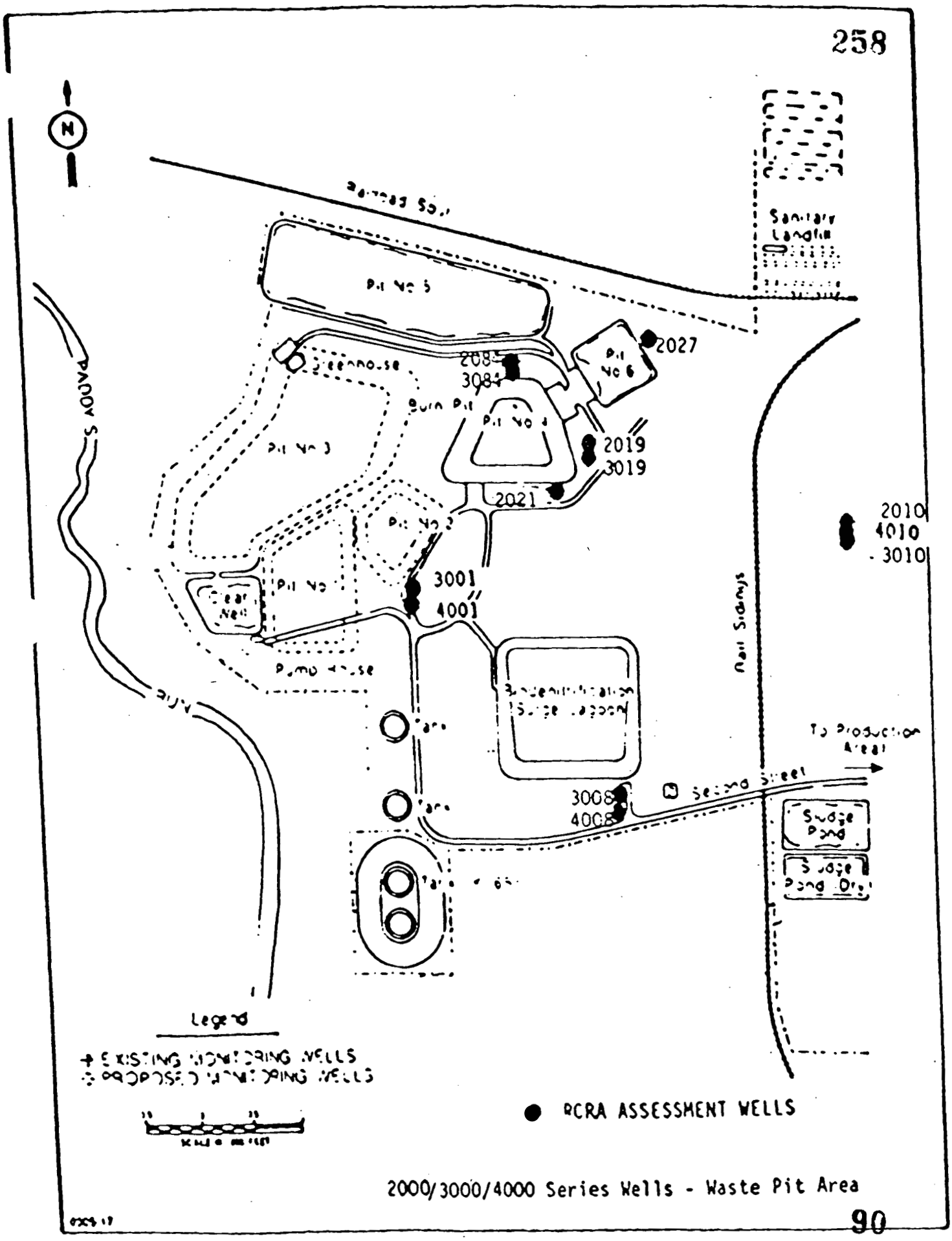
1000 Series Wells - Waste Pit Area

FIGURE E - 4



2000, 3000 and 4000 Series Wells - FMPC Site

FIGURE E - 5



2000/3000/4000 Series Wells - Waste Pit Area

FIGURE E - 6

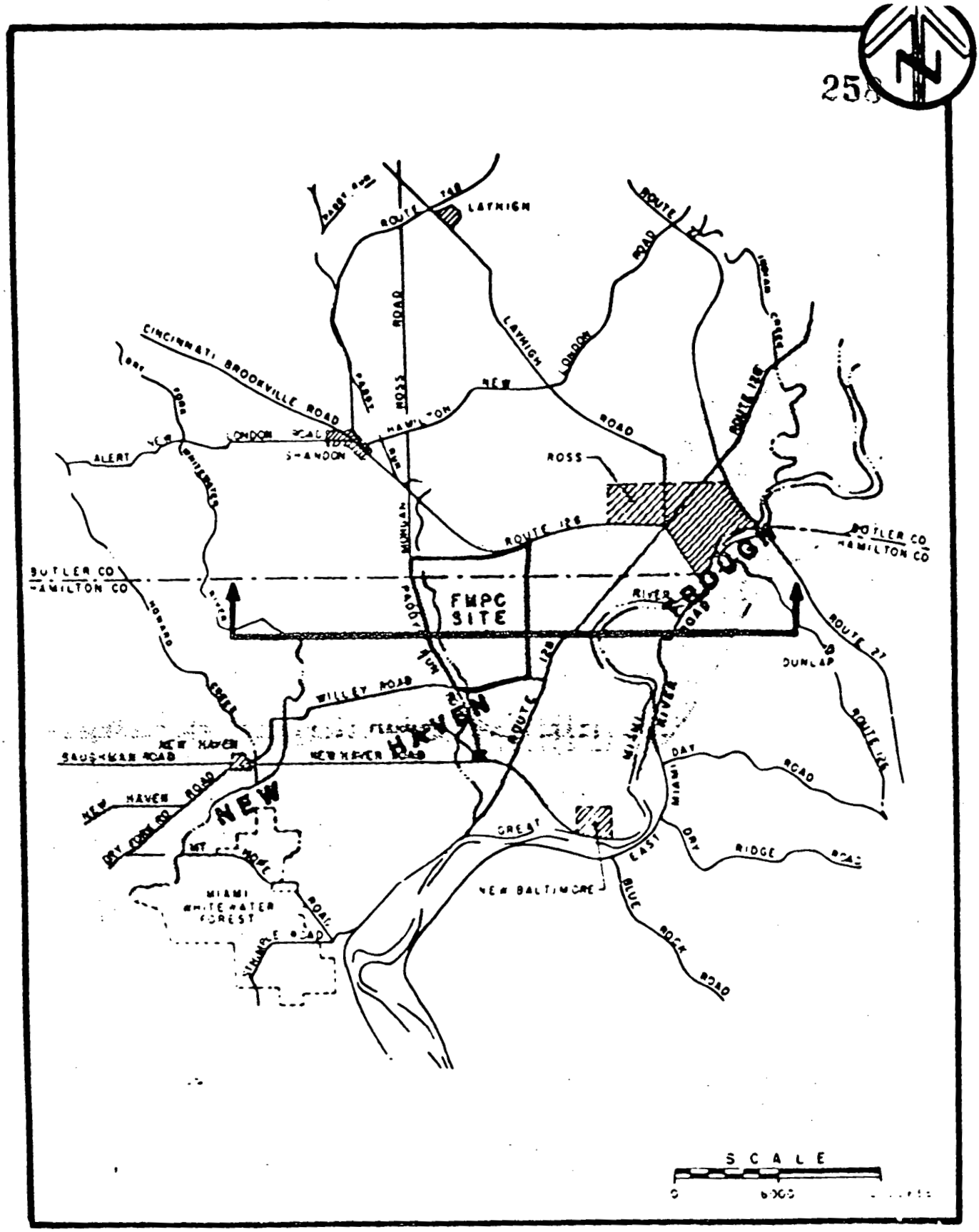
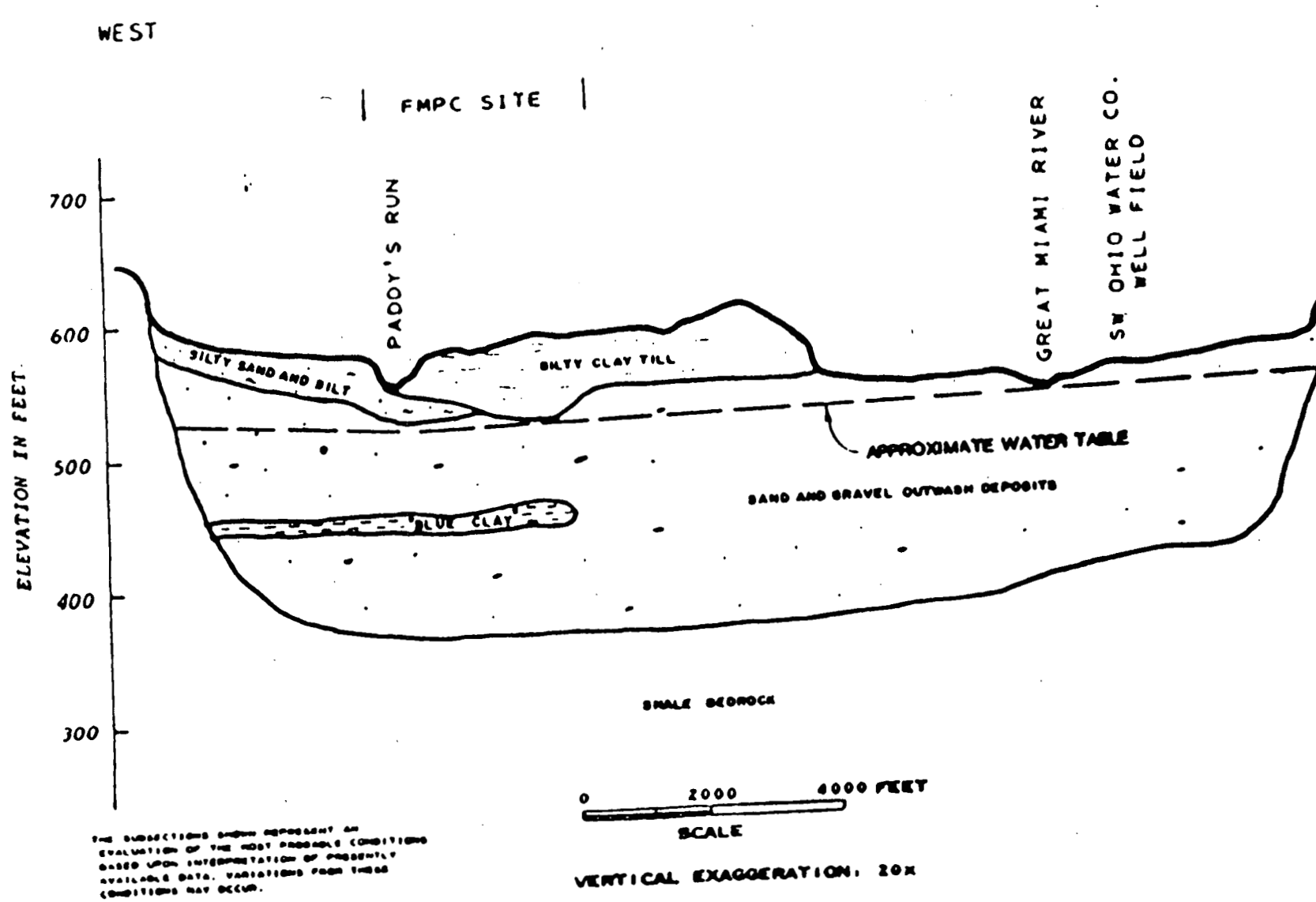


FIGURE E - 7

APPROXIMATE LOCATION OF NEW HAVEN TROUGH



GENERALIZED GEOLOGIC CROSS SECTION OF NEW HAVEN TROUGH

(See Figure E – 7 for location section)

FIGURE E - 8

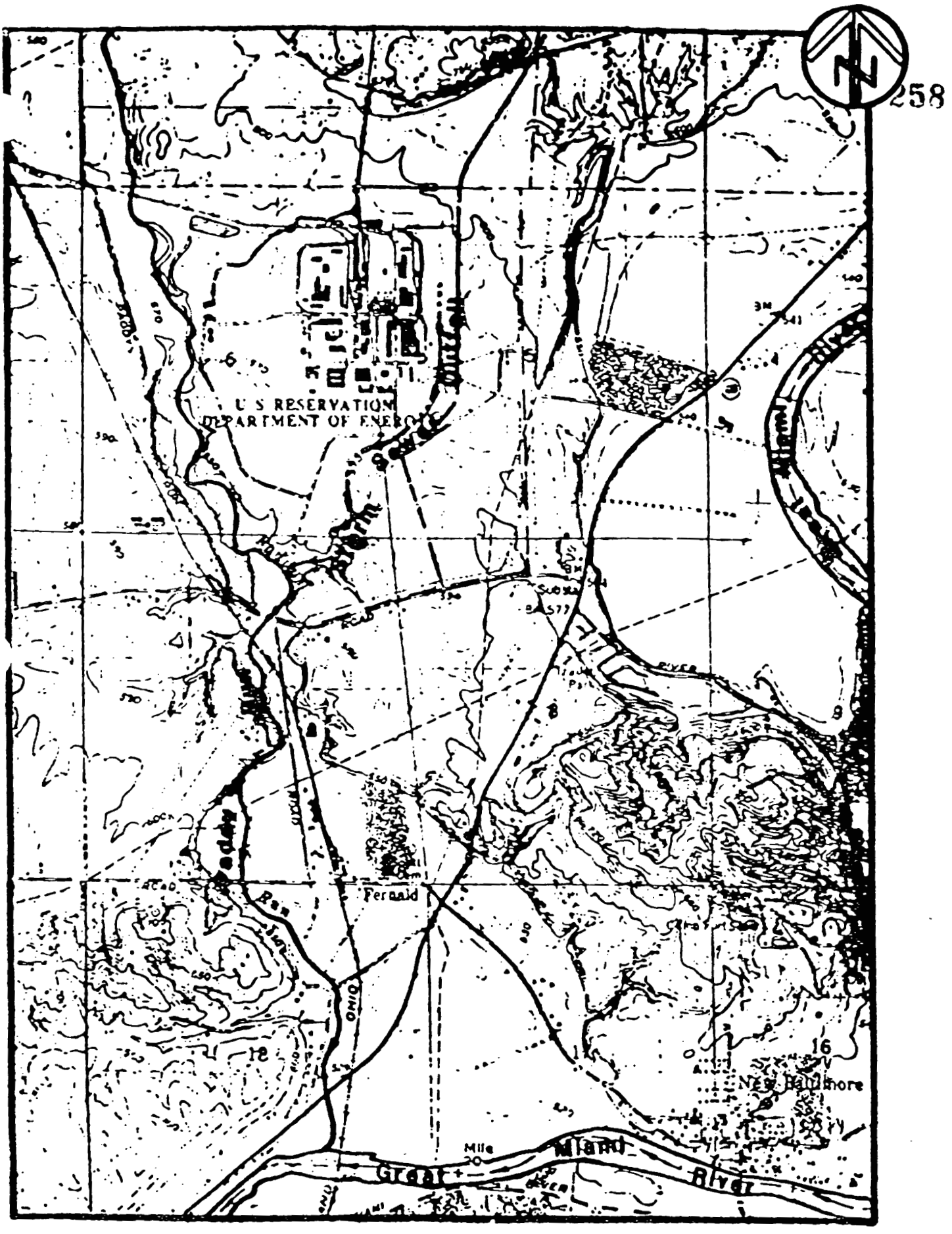
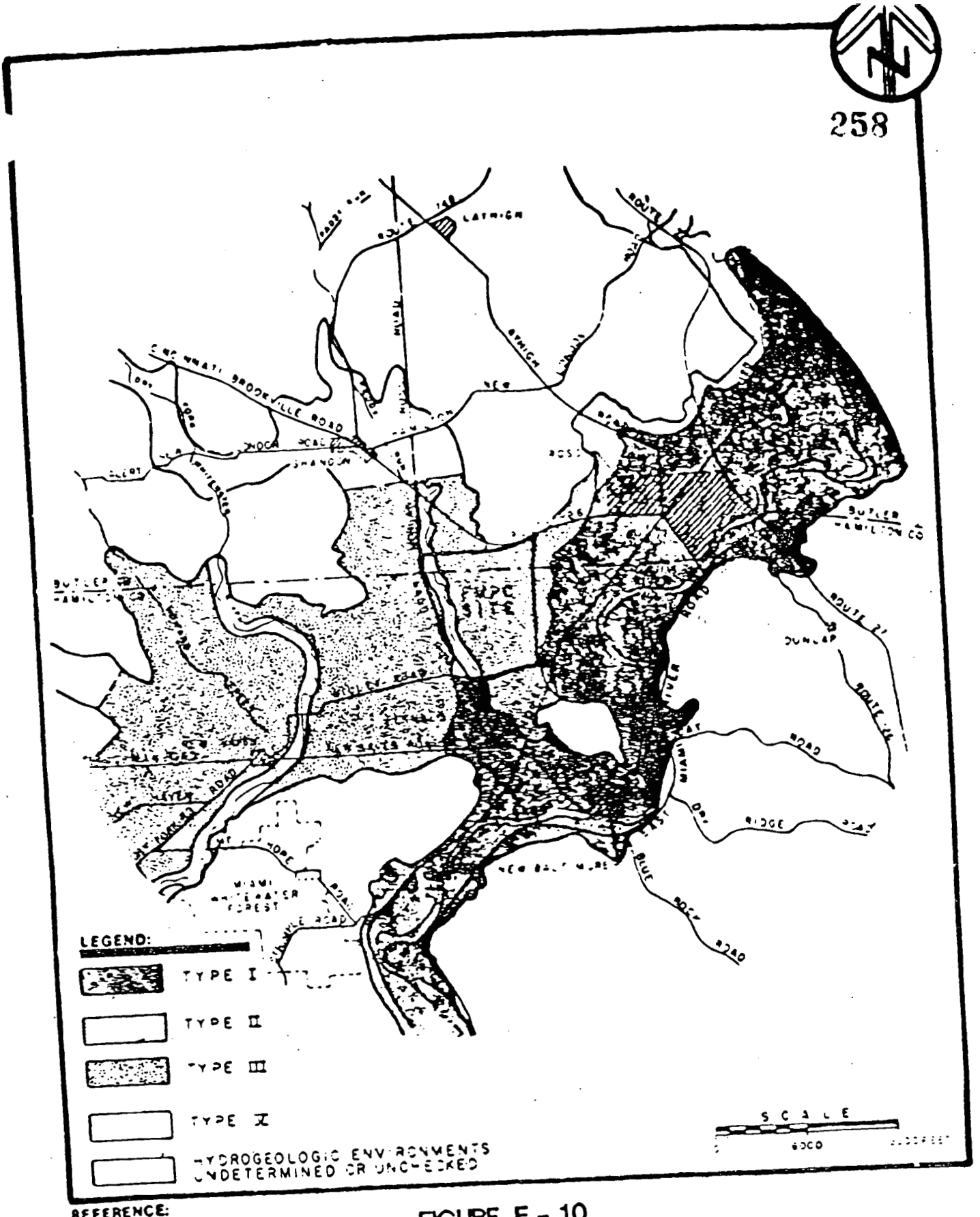


FIGURE E - 9

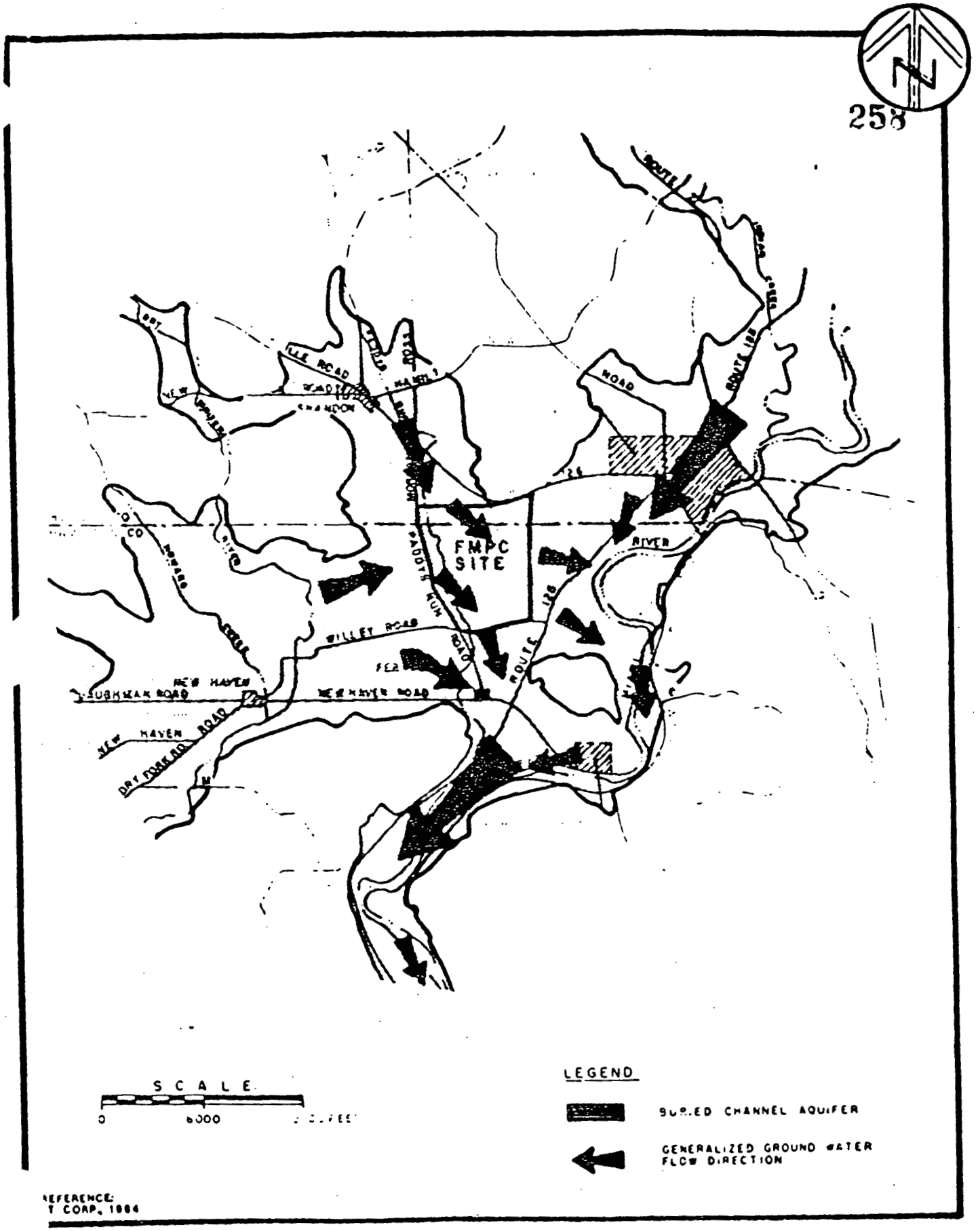
SURFACE STREAMS- FMPC ENVIRONS



REFERENCE:
LT. CORP., 1984

FIGURE E - 10

HYDROGEOLOGIC ENVIRONMENTS



REFERENCE:
T CORP. 1984

FIGURE E - 11
GENERALIZED GROUNDWATER FLOW IN BURIED CHANNEL AQUIFER

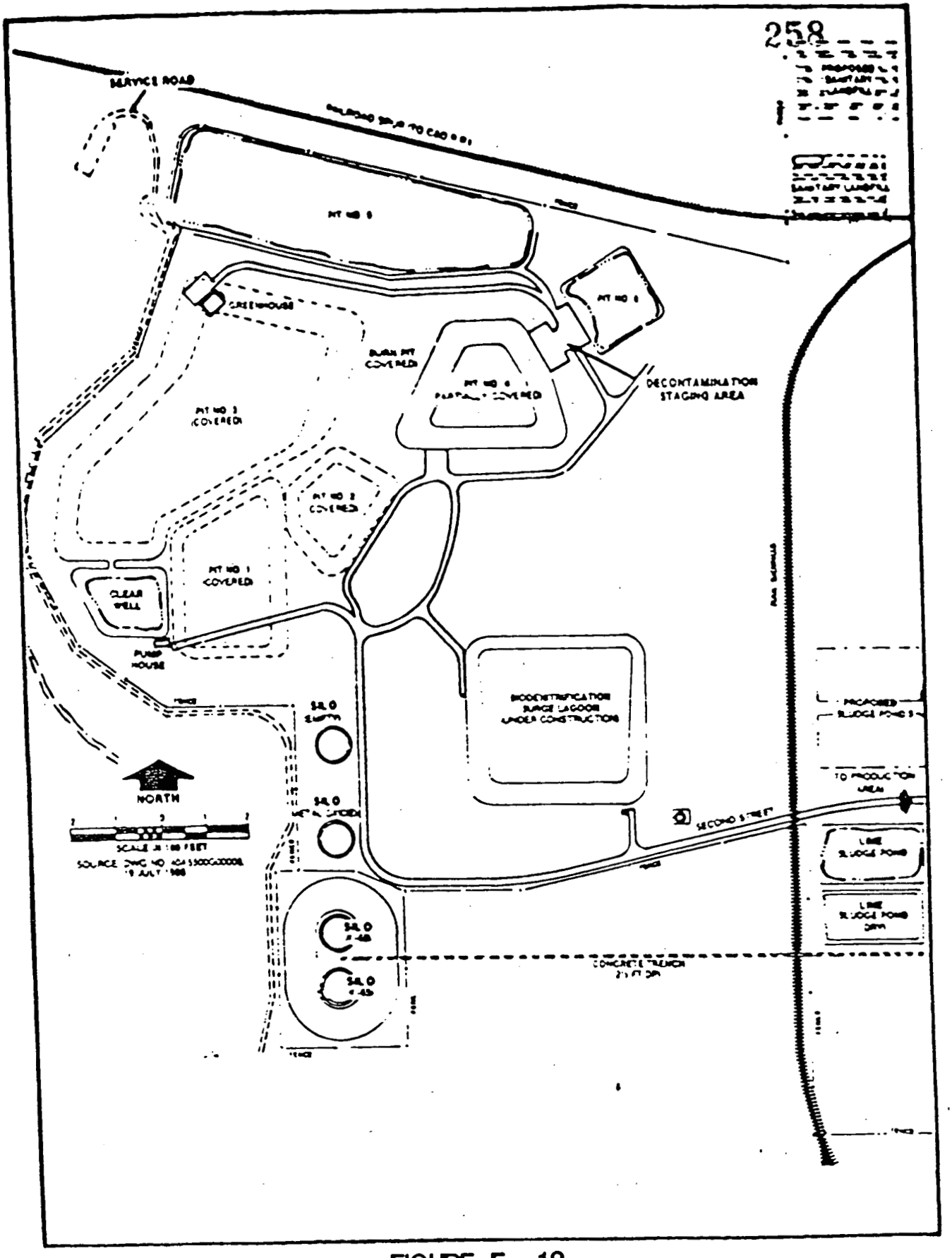


FIGURE E - 12
FMPC WASTE STORAGE AREA

BACKGROUND WELL TO CO IANCE WELL COMPARISONS

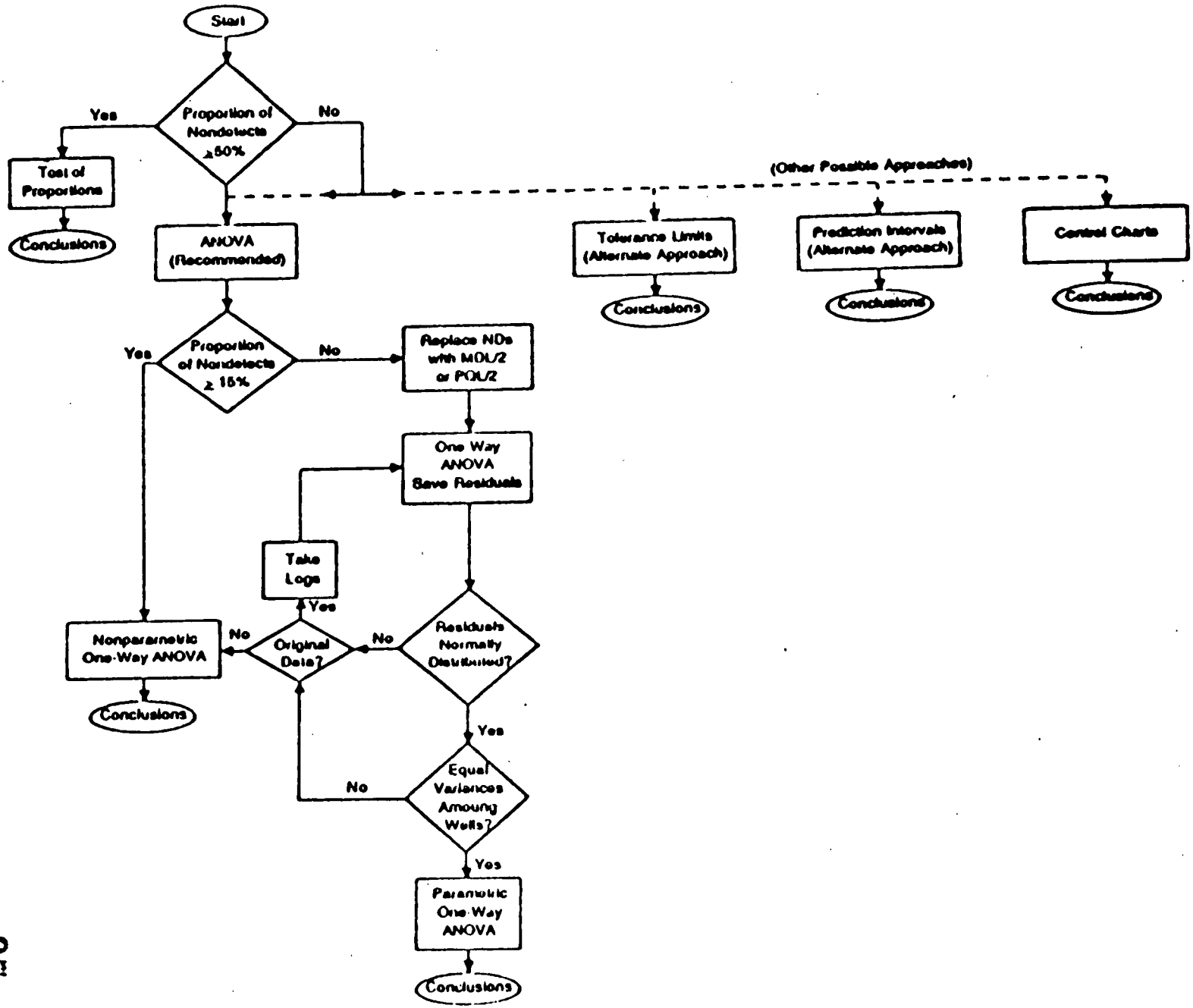


Figure E- 13 Background well to compliance well comparisons.

Comparisons with MCL/ACLs

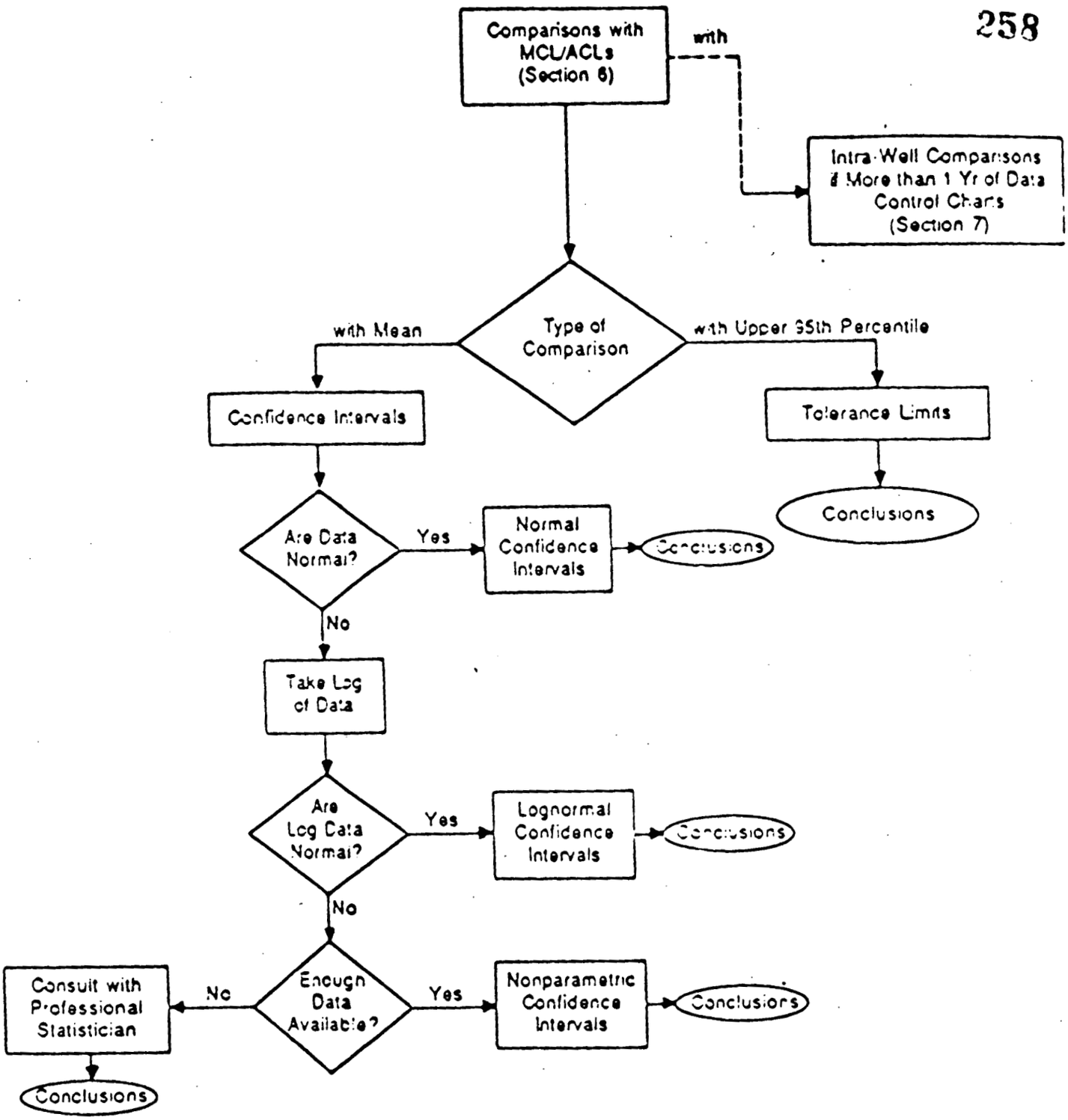


Figure E-14 Comparisons with MCLs/ACLs.

APPENDIX

E-I

Well and Soil Boring Logs and Sampling and Analysis Plan

RCRA Detection Monitoring
Wells and Name Equivalents
1986-1989

1989 Well Name	1987 Well Name	1986 Well Name
3001	301	1s
4001	401	1d
3003	303	3
2004	204	4
3005	305	5
3008	308	8s
4008	408	8d
3009	309	9
3010	310	10
2011	211	11
1012	112	12
2013	213	13s
3013	313	13d
2014	214	14s
3014	314	14d
2015	215	15s
4015	415	15d
2016	216	16s
3016	316	16d
2017	217	17s
3017	317	17d
2018	218	18s
3018	318	18d
1019	119	19TP
2019	219	19s
3019	319	19d
1020	120	20TP
2020	220	20s
3020	320	20d
1021	121	21TP
2021	221	21s
1022	122	22TP
2022	222	22s
2060	OS-1	OS-1
1060	OS-1A	OS-1A
2061	OS-2	OS-2
3062	OS-3	OS-3
SW-2	SW-2	SW-2
4101	P1	P1
4102	P2	P2
4103	P3	P3

RCRA Detection Monitoring
Well Boring and Completion Logs
List of Contents

1989 Well Name	Boring Log	Completion Log
3001	X	NA
4001	X	NA
3003	X	NA
2004	X	NA
3005	X	NA
3008	X	NA
4008	X	NA
3009	X	NA
3010	X	NA
2011	X	NA
1012	X	X
2013	X	X
3013	X	X
2014	X	X
3014	X	X
2015	X	X
4015	X	X
2016	X	X
3016	X	X
2017	X	X
3017	X	X
2018	X	X
3018	X	X
1019	X	X
2019	X	X
3019	X	X
1020	X	X
2020	X	X
3020	X	X
1021	X	X
2021	X	X
1022	X	X
2022	NA	X
2060	NA	NA
1060	NA	NA
2061	NA	NA
3062	NA	NA
SW-2	NA	NA
4101	X	X
4102	X	X
4103	X	X

RCRA Assessment Program
Well Name Equivalency Table

1989 WELL NUMBER	1987 WELL NUMBER
1024	124
1052	152
1027	127
1080	180
1079	179
1004	104
1074	174
1031	131
1028	128
1072	172
1030	130
1038	138
1081	181
1083	183
1082	182
1025	125
2066	266
3066	366
2043	243
3043	343
3001	301
4001	401
2084	284
3084	384
2021	221
2019	219
3019	319
2027	227
2010	210
3010	310
4010	410
2013	213
3013	313
4013	413
2051	251
3051	351
2055	255
3055	355
3008	308
4008	408
3024	324
2037	237
3037	337

WM. CRANE, WELL DRILLING CONTRACTOR, SHANDON, OHIO

Log of Well for — National Lead Co of Ohio

Well No. : 3001 1 Location: Fernald, Ohio

258

Size : 8"

Type : Test

This is the information that we have on the well known as Shallow Test Well # 1

Dia 8"
Depth 129'10" from concrete base
Static level 63'7" " "
Screen Length total 21'2" Slot size unknown
Make of pump Universal (Jacuzzi)
Setting 100 ft 4" X 1¼" X 7/8" oil lub.

Pump was pulled Aug 30,1976 and found to be nearly full of iron oxide, column pipe and oil tube was cleaned at Nat Lead shop and pump was taken to machine shop and disassembled and cleaned with muriatic acid. Bowl assembly was found to be in fair condition and was reinstalled. Column pipe was found to be badly pitted and was replaced with new.

Well was found to be stopped up with iron and producing very little water. Treated well with 60 gal inhibited muriatic acid and the following day was surged with air, well was greatly improved so the same treatment was made the following day with 5 gal of hydroxy acetic acid added to kill any iron bacteria that might be present. Well responded very well so pump was then installed.

Well was pumped at 230 g.p.m. with 26'2" of drawdown. This pump test was made 9/2/1976.

Bowl assembly 8" 6 stage # 8KCA6 Jacuzzi
W O K 9
Spec # T 494

Driller

THE LAYNE OHIO COMPANY

COLUMBUS, OHIO

8-in. LOG OF/TEST WELL No. 1 S

For National Lead Co. of Ohio City Fernald State Ohio

Location On bank between plant and dump

Date Started 8-3-59 Date Finished 8-6-59

FORMATIONS

DEPTH TO TOP OF STRATUM	DEPTH TO BOTTOM OF STRATUM	THICKNESS OF STRATUM	STATIC WATER LEVEL	1-HOUR BAILING TEST		HOW FAR DID FORMATION HEAVE	FORMATION FOUND	REMARKS
				AVERAGE G. P. M.	DRAWDOWN FEET			
0'	16'	16'					Yellow clay	
16	36	20					Blue clay	
36	40	4					Clay and gravel	
40	55	15					Sandy clay	
55	60	5	59'				Brown sand	
60	79	19					Sand and gravel	

DRILLER N. R. Morris

S-G T-610

(SKETCH OF LOCATION ON BACK OF THIS LOG SHEET)

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WELL LOG AND DRILLING REPORT

CUSTOMER'S COPY

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

PLEASE USE PENCIL OR TYPEWRITER DO NOT USE INK.

No. 291500
258

County Butler Township Ross Section of Township 31

Owner National Lime & Stone Address Box 34158 Cincinnati, O.

Location of ~~property~~ Well # 1-D 4001

CONSTRUCTION DETAILS

Casing diameter 4" Length of casing 17'6"

Type of screen Gravel Length of screen

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST

Pumping Rate 70 G.P.M. Duration of test 4 hrs.

Drawdown ft. Date 7/12/55

Static level-depth to water 44 ft.

Quality (clear, cloudy, taste, odor)

Pump installed by

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From 0 Feet	To Ft.
Yellow clay	0	12
Gravel & yellow clay	12	19
Blue clay some gravel	19	40
Sandy yellow clay	40	45
Gravel some gravel	45	151'6"
Blue clay	151'6"	155'
[illegible]	[illegible]	[illegible]
Gravel & gravel	155'	152'
[illegible] sand	152'	170'
[illegible] sand	170'	180'

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

Check with Nat'l Lime for well location

W. E.

S.

See reverse side for instructions

Drilling Firm [illegible] Cincinnati, O.

Date [illegible]

Signed [illegible]

105

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER. DO NOT USE INK.

#3

No. 258889
258

unty Hamilton Township Crosby Section of Township North

Owner National Lead Co. of Ohio Address Box 39158 Cinti. Ohio Zone 39

Location of property S.R. 128 Fernald Ohio

CONSTRUCTION DETAILS

Casing diameter 8" Length of casing 85'

Type of screen Red Brass Length of screen 30'

Type of pump Vertical turbine

Capacity of pump 300 G.P.M.

Depth of pump setting 79'4"

Date of completion 9/27/63

BAILING OR PUMPING TEST

Pumping rate 380 G.P.M. Duration of test 24 hrs.

Drawdown ft. Date

Developed capacity

Static level—depth to water ft.

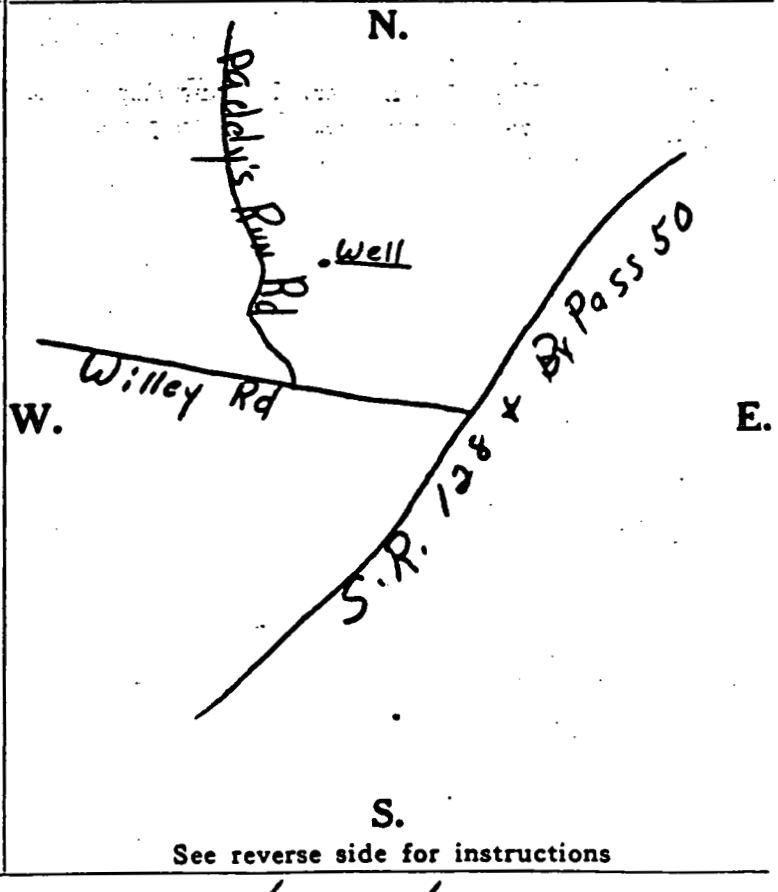
Pump installed by Hyden Bro's Drilling Co

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay + Sand	0 Feet	40 Ft.
Sand + Gravel	40'	105'

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

illing Firm Hyden Bro's Drilling Co Date 9/27/63

Address 6105 Wooster Rd. Signed Ralph W. Hyden

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THE LAYNE (.IO COMPANY

COLUMBUS, OHIO

8-in.

LOG OF/TEST WELL No. 3

For National Lead Co. of Ohio City Fernald State Ohio

Location 200 ft. downstream from well No. 2

Date Started 8-11-59 Date Finished 8-12-59

FORMATIONS

DEPTH TO TOP OF STRATUM	DEPTH TO BOTTOM OF STRATUM	THICKNESS OF STRATUM	STATIC WATER LEVEL	1-HOUR BAILING TEST		HOW FAR DID FORMATION HEAVE	FORMATION FOUND	REMARKS
				AVERAGE G. P. M.	DRAWDOWN FEET			
0'	2'	2'					Top soil	
2	8	6					Yellow clay	
8	18	10					Blue clay	
18	40	22	33'10"				Brown sand	
40	51	11					Sand and gravel	

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DRILLER N-'1 R. Morris

S-G T-61C

(SKETCH OF LOCATION ON BACK OF THIS LOG SHEET)

RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2		
BORING NUMBER: ~~104~~ DB 1-3-88 1004	COORDINATES:	DATE: 2-20-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 02/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 02/21/88	
DRILLING METHODS: Cable Tool		PAGE 1 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1				See Well Boring No. 304 For soil Lithology			
2							
3							
4							
5							
6							
7							02/20/88
8	OB 1 2 4	N/A	12"	Shelby Tube	N/A	N/A	Pushed 2.3 Ft Recovery 1.0 Ft 1445
9							
10							
11							
12							
13							
14							
15							

NOTES: I) Drilling contractor: Pennsylvania Drilling
Driller: Tim Harris
Helper: Craig Coulter

II Background Measurements:

A) Hnu = 0 B) α = 0 C) γB = 140cpm

III) Water used = 75 gallons

IV Samples via Muncell Color chart 108

N/A = not applicable

402-U-86

RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 002	PROJECT NAME: FMPC RI/FS T3.2		
BORING NUMBER: ~~104~~ 1004	COORDINATES:	DATE: 2-20-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 02/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 02/21/88	
DRILLING METHODS: Cable Tool		PAGE 2 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16				See Well Boring			
17				No. ~~304~~ 3004 RMG 2/6/89			
18				FOR			
19				Soil Lithology			
20							
21							
22							
23							
24							
25							02/21/88
26	C 85	N/A	12"	SHELBY Tube	N/A	N/A	Pushed Tube 2.0 Ft Recovery 1.0 Ft 1000
27							
28							
29							
30							
NOTES: 31							

Bottom of Hole 31 FT

RI/FS

PIEZOMETER INSTALLATION SHEET

258

PROJECT NAME Fernald RI/FS
PROJECT NO. 602
BORING NO. ~~109~~ 88 1-5-88 1004
PIEZOMETER NO. N/A

FIELD ENG./GEO. M. Goldberg DATE 02/21/88
CHECKED BY R M Zollweit DATE 2/6/89
DATE OF INSTALLATION 02/21/88

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 30 TO 31 Ft
FLUID _____ FROM _____ TO _____

TYPE OF BIT Flat Head
CASING SIZE (S) USED:
SIZE 10" FROM 0 TO 31 Ft
SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE Monitoring
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010" inches
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 Ft

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4 inches
LENGTH OF PIPE SECTIONS 10 Ft
JOINING METHOD Thread and couple

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Ft
PROTECTIVE PIPE Ø.D. 10" inches

OTHER PROTECTION Lockable cap

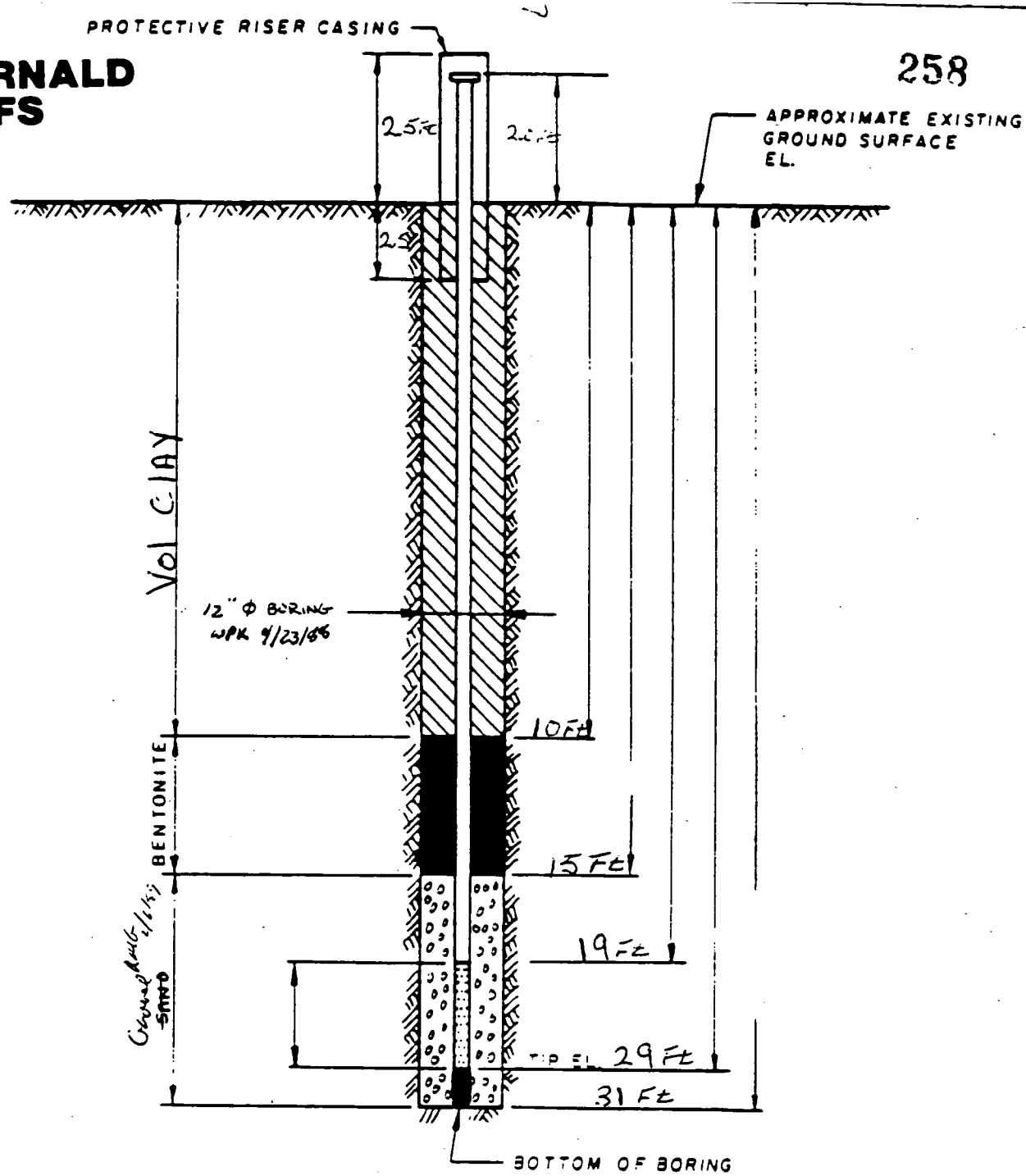
ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 Ft			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 10 Ft	TOP	BOTTOM
BENTONITE	TOP 10 Ft	BOTTOM 15 Ft	TOP	BOTTOM
[redacted]	TOP N/A	BOTTOM N/A	TOP	BOTTOM
GRAVEL	TOP 15 Ft	BOTTOM 31 Ft	TOP	BOTTOM
PERFORATED SECTION	TOP 19 ft	BOTTOM 29 ft	TOP	BOTTOM
PIEZOMETER TIP	31 ft			
BOTTOM OF BOREHOLE	31 ft			
GWL AFTER INSTALLATION	N/A			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS

110

409-11-86

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED ~~FLUSH~~ - JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 104

PREPARED FOR
FMPC

RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~304~~ OB FS-39 3004	COORDINATES:	DATE: 1-20-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED 02/18/88	
DRILLING METHODS: Cable Tool		PAGE 1 OF 10	

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 ft)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07 9 10	1 3 4	10"	Very STIFF yellowish Brown clay (10YR 5/4) Dry	ML	3.0	Hnu = 0 ∝ = 0 ∂B = 140 cpm 1005
2 3	07 9 11	2 2 5	8"	STIFF very dark grayish Brown (10YR 3/2) Dry 3.0 ft	CL	2.0	Hnu = 0 ∝ = 0 ∂B = 120 1010
4	07 9 12	3 5 7	10"	Very STIFF yellowish Brown clay (10YR 5/4) Dry. Trace gravel 4.5 ft	CL	2.5	Hnu = 0 ∝ = 0 ∂B = 100 1015
5 6	07 9 13	4 8 9	10"	Very STIFF Dark Brown clay (10YR 4/3) Dry Trace of gravel	CL	3.0	Hnu = 0 ∝ = 0 ∂B = 120 1022
7	07 9 14	15 19 21	18"	Hard Dark Brown clay (10YR 4/3) Dry. Trace of gravel 7.5 ft		4.0	Hnu = 0 ∝ = 0 ∂B = 140 1026
8 9	07 9 15	28 29 33	14"	Hard Dark grayish Brown clay (10YR 3/2) Dry. Trace of gravel	CL	4.0	Hnu = 0 ∝ = 0 ∂B = 140 1032
10	07 9 16	6 14 17	16"	Hard Dark grayish Brown clay (10YR 3/2) Dry. Trace of gravel 10.5			Hnu = 0 ∝ = 0 ∂B = 140 cpm 0909
11 12	07 9 17	15 16 23	18"	Hard Dark Brown clay (10YR 4/3) Trace of gravel. Dry 12.0 ft	CL	4.0	Hnu = 0 ∝ = 0 ∂B = 140 cpm 0923
13	07 9 18	6 11 10	12"	Hard Dark grayish Brown clay (10YR 3/2) Trace of gravel Dry.		4.0	Hnu = 0 ∝ = 0 ∂B = 100 0952
14 15	07 9 19	10 13 16	8"	Hard Dark grayish Brown clay (10YR 3/2) Trace gravel. Dry		4.0	Hnu = 0 ∝ = 0 ∂B = 100 0957

NOTES:

I) Drilling contractor: Pennsylvania Drilling
Driller: Tim Harris
Helper: Craig Coulter

II) Background Measurements

A) Hnu 0 B) ∝ = 0 C) ∂B = 140 cpm

III Water used - 150 + 80 + 3000

IV Samples via Munsell, colors ASTM II?

V ASTM Followed for SPT

402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~304~~ 1-5-88 OB 3004	COORDINATES:	DATE: 1-21-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 2 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	0 7 9 20	8 10 11	10"	Hard yellowish Brown clay (10YR5/6) Trace gravel. Dry	CL	4.0	Hnu = 0 α = 0 δB = 120 1045
17 18	0 7 9 21	5 9 13	10"	Hard yellowish Brown clay (10YR5/6) Trace gravel. Dry	CL	4.0	Hnu = 0 α = 0 δB = 120 1440
19	0 7 9 22	4 7 11	14"	Very STIFF yellowish Brown clay (10YR 5/6) Trace gravel. Dry 19.5	CL	3.5	Hnu = 0 α = 0 δB = 100 1505
20 21	0 7 9 23	8 14 17	14"	Very STIFF Dark Brown clay (10YR4/3) Trace gravel - DRY 21.5	CL	3.5	Hnu = 0 α = 0 δB = 100 1542
22	0 7 9 24	13 11 18	10"	Very STIFF yellowish Brown clay (10YR5/6) Dry. 22.5	CL	2.5	Hnu = 0 α = 0 δB = 140cpm 1630
23 24	0 7 9 25	9 11 17	14"	Very STIFF Dark grey clay (5Y 4/1) Dry. 24.7	CL	2.5	Hnu = 0 α = 0 δB = 180cpm Lense of Yellow Brown clay. 1645
25	0 7 9 26	8 12 17	14"	Very STIFF Dark Brown clay (10YR 4/3) w/ lenses of Dark grey clay (5Y 4/1) Trace gravel. Dry 25.5	CL	3.5	Hnu = 0 α = 0 δB = 100 0850
26 27	0 7 9 27	8 12 16	16"	Very STIFF Dark Brown clay (10YR 4/3) Trace gravel Dry 27	CL	2.5	Hnu = 0 α = 0 δB = 120 0920
28	0 7 9 28	18 23 25	8"	Very STIFF Dark Brown clay (10YR4/3) w/ trace of sand. Moist 28.5	CL	3.0	Hnu = 0 α = 0 δB = 100 0940
29 30	0 7 9 29	0 11 23	8"	Very STIFF Dark grey clay (2.5Y 4/0) Trace gravel Dry	CL	3.5	Hnu = 0 α = 0 δB = 100 1045

NOTES:

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS T3.2		
BORING NUMBER: ~~304~~ 815 3004	COORDINATES:	DATE: 1-22-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 3 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	07 6 3 0	21 24 50-3	8"	31 Ft Very STIFF olive yellow clay (2.5Y 6/6) Trace gravel Dry 31.5	CL	3.0	Hnu = 0 α = 0 γB = 120 1345
32 33	07 9 3 1	24 34 38	16"	Very Dense olive yellow sand (2.5Y 5/6) Dry	SW	1.0	Hnu = 0 α = 0 γB = 100 1428
34 35	07 9 3 2	22 24 18 33	24"	Very Dense olive yellow sand (2.5Y 5/6) Dry	SP	1.0	Hnu = 0 α = 0 γB = 100 1450
36 37 38 39							
40 41	07 9 3 3	16 16 24	18"	Dense yellowish Brown sand (10YR 5/6) Trace gravel. Dry	SP	1.0	Hnu = 0 α = 0 γB = 110 1015
42 43 44 45							

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.1		
BORING NUMBER: ~~304~~ 88 1-5-89 3004	COORDINATES:	DATE: 1-24-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 4 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45							
46	07 9 3 4	20 20 28	18"	Very Dense yellowish Brown sand (10YR 5/6) DRY	SP	1.0	Hnu = 0 α = 0 γB = 140 1340
47							
48							
49							
50	07 9 3 5	5 11 23	16"	Dense yellowish Brown sand (10YR 5/4) DRY		<1	Hnu = 0 α = 0 γB = 100 1440
51							
52							
53							
54							
55	07 9 3 6	9 13 23	18"	Dense yellowish Brown sand 10YR 5/4) MOIST	SM	<1	Hnu = 0 α = 0 γB = 100 1600
56							
57							
58							
59							
60							

NOTES:

FERNALD
RI/FS

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Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~304~~ BB 1-7-89 3004	COORDINATES:	DATE: 1-26-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 5 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60							
61	07 9 3 7	11 13 23	18"	Dense Yellowish Brown sand (10YR 5/4) Moist	SM	<1	Hna = 0 α = 0 βB = 100 1653
62							
63							
64				≈ WaTeR ≈			
65	07 9 3 8	9 21 23	16"	Dense Dark yellowish Brown (10yr 4/6) Trace gravel. WeT	SW	<1	Hna = 0 α = 0 βB = 100 1030
66							
67							
68							
69							
70	07 9 3 9	7 16 21	18"	Dense Dark yellowish Brown (10YR 4/6) Trace gravel. WeT	SW	<1	Hna = 0 α = 0 βB = 100 1105
71							
72							
73							
74							
75							

NOTES:

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~304~~ 3004	COORDINATES:	DATE: 1-28-88	
ELEVATION:	GWL: Depth 71.7 Date/Time 01/27/88 1720	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M Goldberg	Depth 67.2 Date/Time 01/28/88 0840	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 6 OF 10	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75							
76	07 9 40	22 24 32	18"	Very dense DARK Yellowish Brown (10YR 4/4) very coarse. Wet. Gravel.	sand SW	<1	Hnu=0 α=0 BB=100 cpm 1605
77							
78							
79							
80	07 9 41	5 3 5	18"	Loose DARK Yellowish Brown sand (10YR 4/6) poorly sorted. Trace gravel wet	SW	<1	Hnu=0 α=0 BB=80 1655
81							
82							
83							
84							
85	07 9 42	19 29 50	18"	Very Dense DARK yellowish Brown Sand (10YR 4/6) poorly sorted. Wet	SW	<1	Hnu=0 α=0 BB=140 cpm 0910
86							
87							
88							
89							
90							

NOTES:

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RI/FS

VISUAL CLASSIFICATION OF SOILS

2nd Key In	
Hard Copy Verification	

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PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2	
BORING NUMBER: ~~304~~ BB 1-5-88 3004	COORDINATES:	DATE: 2-5-88
ELEVATION:	GWL: Depth 58.1 FT Date/Time 02/03/88 0835	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88
DRILLING METHODS: Cable Tool		PAGE 7 OF 10

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
90				900			
91	07 9 4 3	22 19 24	16"	Dense grayish Brown gravel (10YR 5/2) w/sand wet	GW	<1	Hnu = 0 α = 0 [redacted] ΣB = 100 1440
92							
93							
94				≈ 94 FT			
95	07 9 4 4	19 24 37	12"	Very Dense Dark grey sand (10YR 4/1) very Fine	SM	<1	Hnu = 0 α = 0 Blowsand ΣB = 100 1515
96							
97							
98							
99							
100	08 1 7 5	40 49 50/3	NR	Blow sand Very Dense Dark grey sand (10YR 4/1)			Hnu = no Recovery α = after 2 attempt ΣB = 1450
101							
102							
103							
104							
105							

NOTES: NR = no Recovery

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RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2		
BORING NUMBER: 304 88 1-5-88 3004	COORDINATES:	DATE: 2-8-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 8 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1/2 FT	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
105							
106	08176	50/3 50/3 50/3	6"	Very Dense Dark Brown sand (10 YR 4/3) wet			Hna = 0 α = 0 BB = 80 Blowsand 1505
107	08177		2#	Shelby Tube Blue clay contact ??? 107.5			No. 08177 1700
108							
109							
110							
111	08178	22 5/1	4"	very dense, dark gray, well graded sand, gravelly (5 y 4/1) wet	SW		Hna = 0 α = 0 BB = 160 1015
112							
113							
114							
115							
116	08179	32 5/3	9"	Very dense, very dark grayish brown poorly graded sand, wet (10 yr 3/2)	SP		Hna = 0 α = 0 BB = 120 1425
117							
118							
119							
120							

NOTES

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RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2		
BORING NUMBER: ~~304~~ BB 1-5-88 3004	COORDINATES:	DATE: 2-16-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 2-18-88	
DRILLING METHODS: Cable Tool		PAGE 9 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
120				120.5			
121	CB 1 8 0	50/3	6"	Very Dense ~~Dark~~ very dark gray gravely sand (10YR 3/1) no Fines poorly sorted. wet	GW	<1	Hna = 0 α = 0 BB = 100 1320
122							
123							
124							
125							
126	CB 1 8 1	50/5	6"	Very Dense Very dark gray gravely sand (10YR 3/1) no Fines poorly sorted wet	GW	<1	Hna = 0 α = 0 BB = 100 1555
127							
128							
129							
130							
131	CB 1 8 2	6 8 12	8"	Medium dense Very dark grey gravel (10YR 3/1) no Fines, wet large Fragments.	GW	<1	Hna = 0 α = 0 BB = 100 0935
132							
133							
134							
135							

NOTES:

402-11-86

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2		
BORING NUMBER: ~~304~~	COORDINATES:	DATE: 2-18-88	
ELEVATION:	GWL: Depth 58.7 Date/Time 02/18/88	DATE STARTED: 01/20/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 02/18/88	
DRILLING METHODS: Cable Tool		PAGE 10 OF 10	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
135							
136	8 1 8 3	22 16 12		Dense Dark grey gravel (10YR3/1) Trace clay. wet Poorly sorted			Hnu = 0 α = 0 OB = 100 1110
				Bottom of Borehole 135 ft			

NOTES:

THE LAYNE OHIO COMPANY

COLUMBUS, OHIO

8-in.

LOG OF/TEST WELL No. 4

For National Lead Co. of Ohio City Fernald State Ohio

Location 300 ft. downstream from well No. 3

Date Started 8-13-59 Date Finished 8-17-59

FORMATIONS

DEPTH TO TOP OF STRATUM	DEPTH TO BOTTOM OF STRATUM	THICKNESS OF STRATUM	STATIC WATER LEVEL	1-HOUR BAILING TEST		HOW FAR DID FORMATION HEAVE	FORMATION FOUND	REMARKS
				AVERAGE G. P. M.	DRAWDOWN FEET			
0'	6'	6'					Blue clay	
6	16	10					Yellow clay	
16	40	24	30'10"				Brown sand	
40	43	3					Sand and gravel	

DRILLER N. 1 R. Morris

(SKETCH OF LOCATION ON BACK OF THIS LOG SHEET)

2-G T-419

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WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER. DO NOT USE INK.

CUSTOMER'S COPY

258 (45)

No. 258890

County Hamilton Township Crosby Section of Township North

Owner National Lead Co. of Ohio Address Box 31958 Cinti. Ohio Zone 39

Location of property S. R. 128 Fernald Ohio

CONSTRUCTION DETAILS

Casing diameter 8" Length of casing 75'

Type of screen Red Brass Length of screen 20'

Type of pump Vertical Turbine

Capacity of pump 200 G.P.M.

Depth of pump setting 19' 4"

Date of completion 10/3/63

BAILING OR PUMPING TEST

Pumping rate ..... G.P.M. Duration of test ..... hrs.

Drawdown ..... ft. Date .....

Developed capacity .....

Static level—depth to water ..... ft.

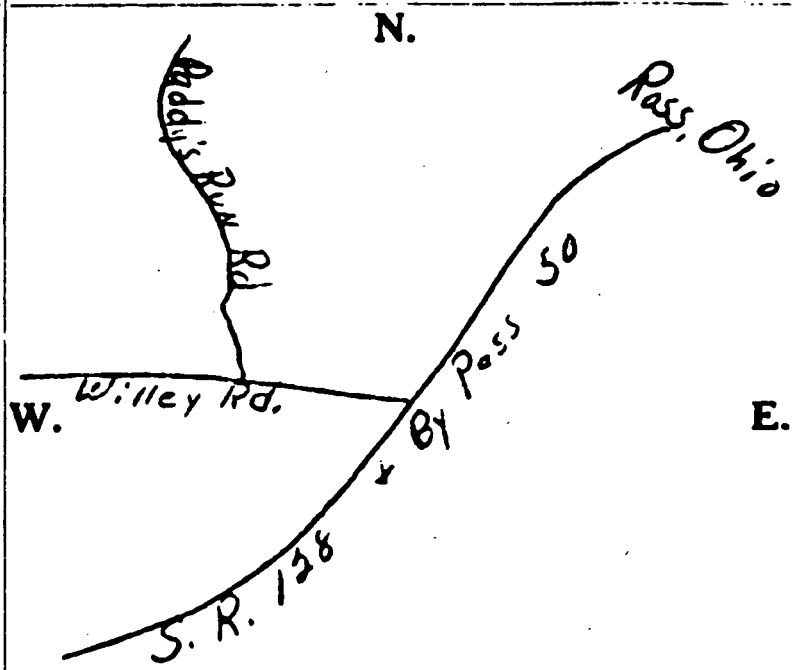
Pump installed by Hyden Bro's Drilling

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay + Sand	0 Feet	40 Ft.
Sand + Gravel	40	95 ft.

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Hyden Bro's Drilling Co Date 10/3/63 123

Address 6105 Wooster Rd Signed Ralph W. Hyden

(ALSO H J LOG)
TO DEPTH OF
95'
25889 ODNR WELL #

THE LAYNE OHIO COMPANY

COLUMBUS, OHIO

8-in.

LOG OF TEST WELL No. 5

For National Lead Co. of Ohio City Fernald State Ohio

Location 200 ft. downstream from well No. 4

Date Started 8-18-59 Date Finished 8-18-59

FORMATIONS

DEPTH TO TOP OF STRATUM	DEPTH TO BOTTOM OF STRATUM	THICKNESS OF STRATUM	STATIC WATER LEVEL	1-HOUR BAILING TEST AVERAGE G. P. M.	1-HOUR BAILING TEST DRAWDOWN FEET	HOW FAR DID FORMATION HEAVE	FORMATION FOUND	REMARKS
0'	3'	3'					Top soil	
3	16	13					Yellow clay	
16	40'6"	24'6"	30'3"				Brown sand	

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DRILLER Neil R. Morris

(SKETCH OF LOCATION ON BACK OF THIS LOG SHEET)

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

ASE USE PENCIL
R TYPEWRITER
O NOT USE INK

№ 327201
258

nty Butler Township Russ Section of Township 31

wner National Lead Co of Ohio Address Box 39158 Cincinnati, O.

cation of ~~property~~ Well # 8 S 3008

CONSTRUCTION DETAILS

ng diameter 4" Length of casing 112'8"

of screen Cook brass #14 Length of screen 5"

of pump

city of pump

h of pump setting

of completion

BAILING OR PUMPING TEST

Pumping Rate 50 G.P.M. Duration of test 4 hrs.

Drawdown — ft. Date 4/15/65

Static level-depth to water 52" ft.

Quality (clear, cloudy, taste, odor)

Pump installed by

WELL LOG*

Formations andstone, shale, limestone, gravel and clay	From	To
	0 Feet	Ft.
op soil	0	2
Blue muck	2	8
Blue clay	8	37
and & some clay	37	38
Sand	38	60
Blue clay	60	61
Sand & some gravel	61	85"
Fine gray sand	85"	116
Blue clay	116	120
Pulled back to	116'	

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

Check with Natl Lead for well location

W. AEC Fernald Plant E.

S.

See reverse side for instructions

k Firm Wm Crane Date 4/15/65

Address Shandon, O Signed Wm Crane

125

If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

CUSTOMER'S COPY

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER

DO NOT USE INK.

No 327202

County Butler Township Ross Section of Township 31

Owner National Lead Co of Ohio Address Box 39158 Cincinnati, O

Location of ~~property~~ Well # 8-D Deep 4008

CONSTRUCTION DETAILS

Casing diameter _____ Length of casing _____

Type of screen Cook brass #14 Length of screen 5'

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST

Pumping Rate 20 G.P.M. Duration of test 4 hr hrs.

Drawdown — ft. Date 4/22/65

Static level-depth to water 52' ft.

Quality (clear, cloudy, taste, odor) _____

Pump installed by _____

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From 0 Feet	To Ft.
Top soil	0	2
Blue muck	2	8
Blue clay	8	36'6"
Sand & some blue clay	36'6"	38'
Sand	38'	60'
Streak blue clay (6" to 8")	60'	61'
Sand & some fine gravel	61	116'
Blue clay	116'	122'
Sand & gravel	122'	150'
Med & fine sand	150'	165'
Fine sand	165'	180'

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

Check with Natl Lead for well location

W. A.E.C. Fernald Plant E.

S.

See reverse side for instructions

Drilling Firm Wm Crane Date 4/22/65 126

Address Shandon, O Signed Wm Crane

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

258 CUSTOMER'S COPY

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK.

№ 327203

County Butler Township Ross Section of Township 6

Owner National Lead Co of Ohio Address Box 139 155 Cincinnati, Ohio

Location of ~~property~~ Well # (9) Test well

CONSTRUCTION DETAILS

Casing diameter 4" Length of casing 99'6"
Type of screen Cook brass #20 Length of screen 5'
Type of pump
Capacity of pump
Depth of pump setting
Date of completion

BAILING OR PUMPING TEST

Pumping Rate 90 G.P.M. Duration of test 4 hrs.
Drawdown — ft. Date 4/23/65
Static level-depth to water 28' ft.
Quality (clear, cloudy, taste, odor)

Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From 0 Feet	To Ft.
Top soil	0	1'
Yellow clay	1'	15'
Sandy yellow clay	15'	20'6"
Sand	20'6"	55'
Sand & some gravel	55'	70'
Sand	70'	98'
Sand & gravel	98'	103'
Blue clay	103'	—

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

Check with Natl Lead for well location

W. A.E.C. Fernald Plant E.

S.

See reverse side for instructions

Firm Wm Crane Date 4/23/65

Address Hamilton, O. Signed Wm Crane

127

If additional space is needed to complete well log, use next consecutive numbered form.

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

RIG # 2

PROJECT NUMBER: [illegible]	PROJECT NAME: [illegible] RI/FS		
BORING NUMBER: ~~[illegible]~~ 2010 OB [illegible]	COORDINATES:	DATE: [illegible]	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: [illegible]	
ENGINEER/GEOLOGIST: H. Schwarzel	Depth Date/Time	DATE COMPLETED: [illegible]	
DRILLING METHODS: Cable tool		PAGE 1 OF [illegible]	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	[illegible] 0850 [illegible]	1 5 6	8	SOFT, BROWN (10YR 4/2) CLAY, SOME FINE GRAVEL, ROOTLETS, DAMP	CL	.5	HNU: 0 ∝: — BS: 100 CPM
2	[illegible] 0852 [illegible]	5 6 8	12	STIFF, BROWN (10YR 4/2) CLAY, SOME SILT AND FINE GRAVEL, DRY	CL	1.5	HNU: 0 ∝: — BS: 100 CPM
4	[illegible] 0856 [illegible]	6 5 9	12	STIFF, BROWN (10YR 4/4) CLAY, SOME SILT AND FINE GRAVEL, DRY 4.5	CL	1.5	HNU: 0 ∝: — BS: 100 CPM
5 6	[illegible] 0859 [illegible]	9 9 9	14	MEDIUM STIFF, GREY-OLIVE (5Y 4/1) CLAY SOME SILT, DRY	CL	1.0	HNU: 0 ∝: — BS: 100 CPM
7	[illegible] 0901 [illegible]	7 9 10	18	MEDIUM STIFF, GREY-OLIVE (5Y 5/1) CLAY SOME SILT, DRY 7.0	CL	1.0	HNU: 0 ∝: — BS: 100 CPM
8 9	[illegible] 0905 [illegible]	7 13 14	18	MEDIUM STIFF, GREY-OLIVE (5Y 5/2) CLAY SOME SILT, DRY	CL	1.0	HNU: 0 ∝: — BS: 80 CPM
10	[illegible] 1032 [illegible]	2 2 4	14	MEDIUM STIFF, GREY-OLIVE (5Y 5/2) CLAY SOME SILT, DRY	CL	1.0	HNU: 0 ∝: — BS: 80 CPM
11 12	08400 1038 [illegible]	4 4 4	14	SOFT, GREY-OLIVE (5Y 5/2) CLAY, SOME SILT, DAMP 12.5	CL	.25	HNU: 0 ∝: — BS: 80 CPM
13	08401 1050 [illegible]	4 5 6	12	STIFF, BROWN-GREY (2.5Y 5/4) CLAY SOME SILT, DAMP 14.0	CL	1.0	HNU: 0 ∝: — BS: 80 CPM
14	08402 1056 [illegible]	8 7 8	18	VERY STIFF, GREY (5Y 5/1) CLAY, SOME SILT, DAMP	CL	2.5	HNU: 0 ∝: — BS: 80 CPM

NOTES: CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR
ASSISTANT: JOHN JARDINE

SAMPLES COLLECTED AS PER ASTM STANDARD PENETRATION TEST
COLORS: IDENTIFIED USING MUNSELL COLOR CHART
BACKGROUND LEVELS: HNU = 0
H_2LO_2: 0 PPM LEL ∝: —
21.9% O_2 BS = 100

WATER ADDED TO BOREHOLE: 750 GAL.

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402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 210 3010 BB 1-2-89	COORDINATES:		DATE: 03-30-88
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 03-23-88
ENGINEER/GEOLOGIST: M. SLOWINSKI	Depth	Date/Time	DATE COMPLETED: 03-30-88
DRILLING METHODS: Cable tool			PAGE 2 OF 6

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	08402 1112 03-23	10 9 10	14	MEDIUM DENSE GREY (5Y 5/1) CLAYEY FINE SAND, SOME SILT, DAMP	ML		HNU 0 α — BG 80 CPM
17 18	08404 1310 03-23	12 16 12	14	MEDIUM DENSE GREY (5Y 5/1) CLAYEY FINE SAND, SOME SILT, ~~DAMP~~ WET	ML		HNU 0 α — BG 80 CPM
19	08405 1316 03-23	5 6 6	12	MEDIUM DENSE GREY (5Y 5/1) CLAYEY FINE SAND, SOME SILT, WET 19.5	ML		HNU 0 α — BG 80 CPM
20 21	08406 1330 03-23	11 10 9	12	MEDIUM DENSE GREY (5Y 5/1) CLAYEY GRAVEL, SOME SAND WET 20.0	GC		HNU 0 α — BG 80 CPM
22	08407 1339 03-23	8 8 10	12	MEDIUM DENSE GREY (5Y 5/1) SILTY FINE SAND, WET MEDIUM DENSE GREY (5Y 5/1) SILTY FINE SAND, TRACE FINE GRAVEL, WET	SM SM		HNU 0 α — BG 80 CPM
23 24	08408 1456 03-23	13 10 15	9	HARD GREY (5Y 4/1) CLAY TRACE FINE GRAVEL, DRY	CL	>4.0	HNU 0 α — BG 80 CPM
25	08409 1510 03-23	7 7 10	10	VERY STIFF GREY (5Y 4/1) CLAY TRACE SILT, DRY	CL	2.5	HNU 0 α — BG 80 CPM
26 27	08410 1520 03-23	3 5 7	14	STIFF GREY (5Y 4/1) CLAY TRACE SILT, DRY	CL	2.5	HNU 0 α — BG 80 CPM
28	08411 1532 03-23	2 5 7	9	STIFF GREY (5Y 4/1) CLAY SOME FINE GRAVEL DAMP	CL	2.5	HNU 0 α — BG 80 CPM
29	08412 1605 03-23	2 4 9	14	STIFF GREY (5Y 4/1) CLAY SOME FINE GRAVEL, DAMP	CL	2.5	HNU 0 α — BG 80 CPM

NOTES:

402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 [illegible]	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~210~~ 3010 [illegible]	COORDINATES:	DATE: [illegible]
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03-23-88
ENGINEER/GEOLOGIST: M. [illegible]	Depth Date/Time	DATE COMPLETED: 03-30-88
DRILLING METHODS: [illegible]		PAGE 2 OF [illegible]

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	0848 13 1617 03-22	3 7 12	12	STIFF GREY (5Y 4/1) CLAY, SOME SAND AND FINE GRAVEL DAMP 32.0	CL	2.0	HNU = 0 α = — BG = 80 CPM
32	0848 14 1627 03-22	10 20 30	14	VERY DENSE GREY (5Y 4/1) CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE TRACE COARSE GRAVEL, DAMP 33.5	GC		HNU = 0 α = — BG = 80 CPM
33 34	0848 15 1637 03-22	[illegible] 4" [illegible]	4	VERY DENSE GREY (5Y 5/1) SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURE TRACE SAND, DRY	GM		HNU = 0 α = — BG = 80 CPM
35 36	0848 16 1704 03-22	[illegible] 50 [illegible]	7	VERY DENSE GREY (5Y 5/1) SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURE TRACE SAND, DAMP 36.0	GM		HNU = 0 α = — BG = 80 CPM
37	0848 17 1030 03-28	16 43 50	14	VERY DENSE GREY (5Y 5/1) CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE TRACE COARSE GRAVEL DAMP	GC		HNU = 0 α = — BG = 80 CPM
38 39	0848 18 1048 03-28	15 29 33	2	VERY DENSE GREY (5Y 5/1) CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURE TRACE COARSE GRAVEL DAMP 39.0	GC		HNU = 0 α = — BG = 80 CPM
40	0848 19 1115 03-28	9 20 28	14	VERY STIFF GREY (5Y 4/1) CLAY WITH SOME FINE TO MEDIUM GRAVEL DAMP 41.0	CL	2.0	HNU = 0 α = — BG = 80 CPM
41 42	0848 20 1330 03-28	9 22 36	18	HARD, BROWN (10YR 4/3) CLAY, SOME FINE GRAVEL & SAND DRY 41.5	CL	4.0	HNU = 0 α = — BG = 80 CPM ⊥ BASE OF TILL @ 41.5 FT.
43 44				VERY DENSE YELLOW-BROWN (10YR 5/4) SAND TRACE FINE GRAVEL, DRY			

NOTES:

402-11-86

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: [illegible]	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 210 3010 BB	COORDINATES:	DATE: 03-30-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 3-23-88
ENGINEER/GEOLOGIST: M. [illegible]	Depth Date/Time	DATE COMPLETED: 03-30-88
DRILLING METHODS: Cable tool		PAGE 4 OF 5

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (ft)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	08421 1422 03-28	40 95 —	10	VERY DENSE YELLOW-BROWN (10YR 5/4) WELL GRADED GRAVELLY SAND DRY	SW		HNU 0 X — BG 80 CPM
47							
48							
49							
50							
51	08422 1555 03-28	75 50 —	8	VERY DENSE YELLOW-BROWN (10YR 5/4) WELL GRADED GRAVELLY SAND DAMP	SW		HNU 0 X — BG 80 CPM
52							
53							
54							
55							
56	08423 1707 03-28	90 — —	10	VERY DENSE YELLOW BROWN (10YR 5/4) WELL GRADED GRAVELLY SAND DAMP	SW		HNU 0 X — BG 80 CPM
57							
58							
59							

NOTES:

402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: [illegible]	PROJECT NAME: [illegible]	
BORING NUMBER: ~~[illegible]~~ 3010 1013 1-4-59	COORDINATES:	DATE: [illegible]
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03-23-88
ENGINEER/GEOLOGIST: [illegible]	Depth Date/Time	DATE COMPLETED: 03-30-88
DRILLING METHODS: Cable tool		PAGE 5 OF 6

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	08424 0851 03-29	26 48 28	12	VERY DENSE YELLOW-BROWN (10YR 5/4) WELL GRADED GRAVELLY SAND DAMP 61.0	SW		HNU: 0 ∝: — BS: 90 CPM
62				VERY DENSE GREY (10YR 4/1) SAND TRACE FINE GRAVEL DAMP	SP		
63							* ESTIMATED WATER TABLE 03-29-88: 63.0 FT
64							
65	08427 0938 03-29	13 23 [illegible]	10	VERY DENSE GREY (10YR 4/1) SAND TRACE FINE GRAVEL, WET 66.0	SP		HNU: 0 ∝: — BS: 90 CPM
66				STIFF GREY (5Y 4/1) SILTY CLAY, WET	CL		
67							
68							
69							
70	08430 1102 03-29	28 60 [illegible]	14	VERY DENSE, GREY (10YR 4/1) POORLY GRADED GRAVELLY SAND WET	SP		HNU: 0 ∝: — BS: 90 CPM
71							
72							
73							
74							

NOTES:

WATER TABLE ON 03-29-88 ESTIMATED @ 63.0 FT.

402-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

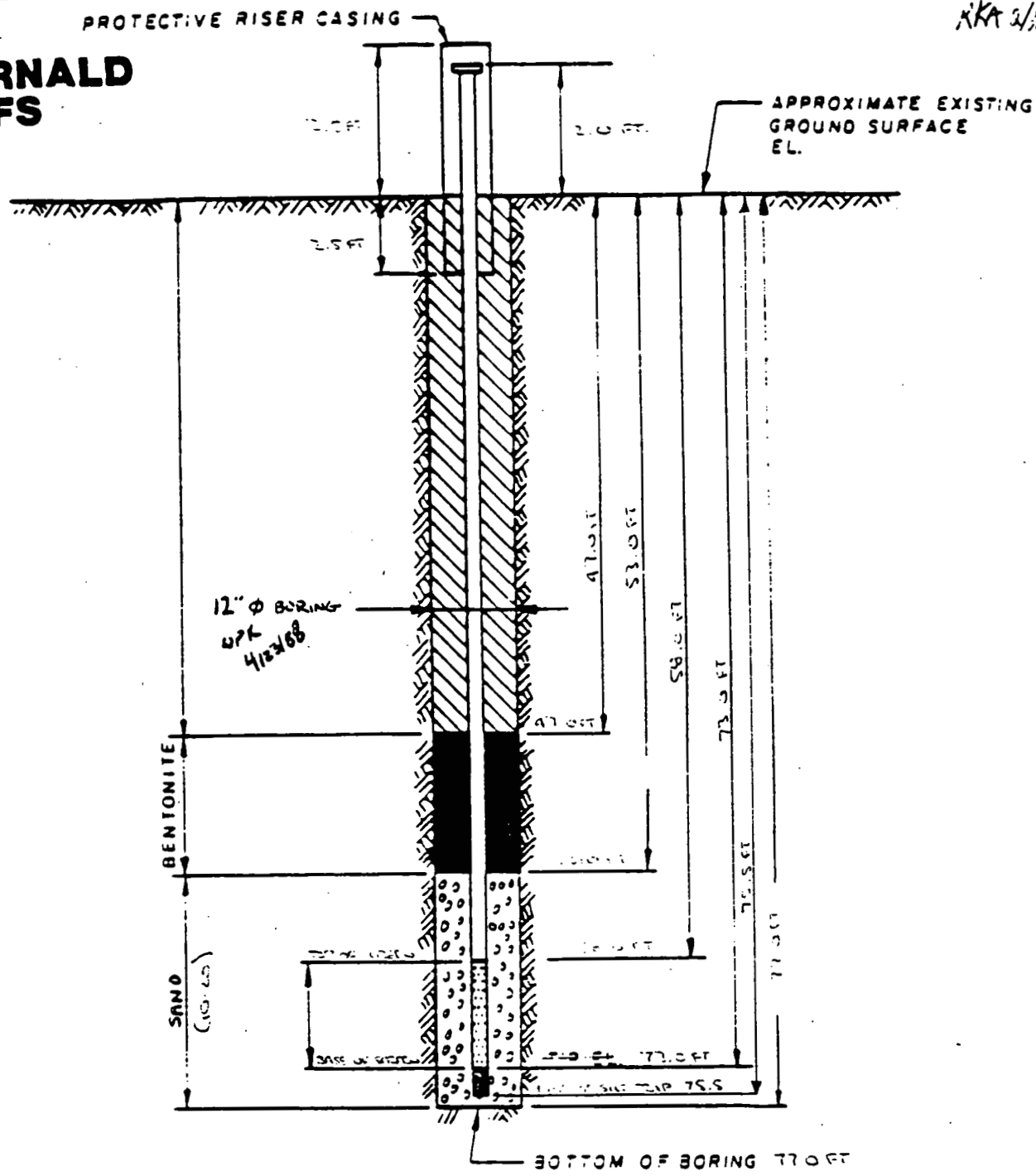
PROJECT NUMBER: 60232	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~210~~ 2010 GM 1-22-89	COORDINATES:	DATE: 03-30-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03-23-88
ENGINEER/GEOLOGIST: H. [illegible]	Depth Date/Time	DATE COMPLETED: 03-30-88
DRILLING METHODS: Cable tool		PAGE 6 OF 6

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (FT)	RECOVERY (FT)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	0827 1358 0829	9 65 35	10	VERY DENSE GRAY (10YR 4/1) WELL GRADED GRAVELLY SAND WET	SW		H2O: 0 X: -- BT: 80 CPM
77				BOTTOM OF BORING 77 ft WPK 4/24/88			
78							
79							
80							

NOTES:

402-11-86

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL
03-30-98
PREPARED FOR

BORING # 2010

FERNALD RI/FS

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME [illegible] FIELD ENG./GEO. [illegible] DATE [illegible]
PROJECT NO. [illegible] CHECKED BY [illegible] DATE 2/6/89
BORING NO. ~~210~~ 2016 PIO 17-5-39
PIEZOMETER NO. ~~210~~ WELL 2016 DATE OF INSTALLATION 03-20-89

BOREHOLE DRILLING

DRILLING METHOD [illegible]	TYPE OF BIT HAMMER
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID WATER FROM 0.0 FT TO 77.0 FT	SIZE 10" ID FROM 0.0 FT TO 27.0 FT
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE MONITORING WELL	RISER PIPE MATERIAL STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4" ID	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 IN I.D. 4 IN
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS _____
AVERAGE SIZE OF PERFORATIONS 0.010 IN	JOINING METHOD SCREW TYPE FLUSH
TOTAL ~~PERFORATED~~ SCREEN LENGTH AREA 15.0 FT	JOINT THREADS

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 7 FT	OTHER PROTECTION LOCKING CAP
PROTECTIVE PIPE ~~Ø~~ I.D. 10 3/4 IN	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT.)		ELEVATION ( )	
TOP OF RISER PIPE	~~2.5~~ 2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 FT	BOTTOM 47.0 FT	TOP	BOTTOM
BENTONITE	TOP 47.0 FT	BOTTOM 53.0 FT	TOP	BOTTOM
SAND (10-20)	TOP 53.0 FT	BOTTOM 77.0 FT	TOP	BOTTOM
GRAVEL	TOP	BOTTOM	TOP	BOTTOM
PERFORATED SECTION	TOP 59.0 FT	BOTTOM 73.0 FT	TOP	BOTTOM
PIEZOMETER TIP	75.5 FT.			
BOTTOM OF BOREHOLE	77.0 FT			
GWL AFTER INSTALLATION				

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS _____

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409-11-85

Reynolds Supply, Inc.

COMPLETE MUNICIPAL & INDUSTRIAL WATER SYSTEMS

258

FORMATION LOG OF WELL

3010

Starting Date _____ Finished _____ Well Number Well #10

Owner NIO Location Whitewater, Ohio

TOTAL DEPTH	THICKNESS EACH STRATUM	FORMATION
0	8	Yellow Clay
8	18	Blue clay
18	19	Muddy gravel
19	48	Blue clay
48	52	Blue gravel
52	63	Yellow coarse sand & gravel
63	70	Gray sand and clay balls
70	85	Gray sand and gravel
85	110	Gray sand and fine gravel
110	125	Gray sand and gravel
125	130	Gray sand and gravel

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Static Water Level 60' Draw Down _____

Driller Steve Reynolds

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald		
BORING NUMBER: 4010	COORDINATES:	DATE: 1-20-89	
ELEVATION: 582.2 G.S.	GWL: Depth Date/Time	DATE STARTED: 1-18-89	
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2-25-89	
DRILLING METHODS: Cable Tool		PAGE 4 OF 16 17	

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46				For description of samples over interval 0-80 ft. See descriptions for boring & well 210.			
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							

NOTES:

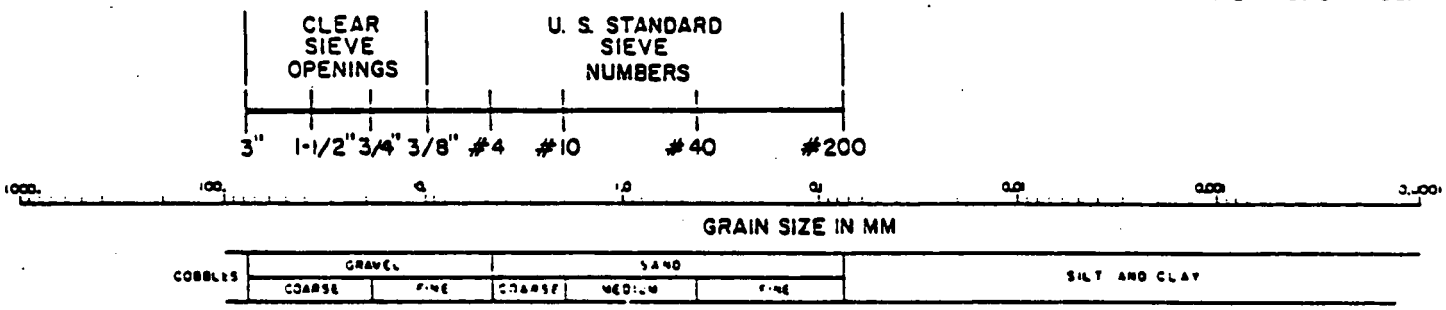
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

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FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald RI FS	
BORING NUMBER: 4010	COORDINATES:	DATE: 1-19-89
ELEVATION: 582.2	GWL: Depth Date/Time	DATE STARTED: 1-18-89
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2-25-81
DRILLING METHODS: Cable Tool		PAGE 5 OF 16

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61				For descriptions of samples over interval 0-80 ft. See descriptions for boring & well 210.			
62							
63							
64							
65							
66							
67							
68							
69							
70							
71							
72							
73							
74							

NOTES:

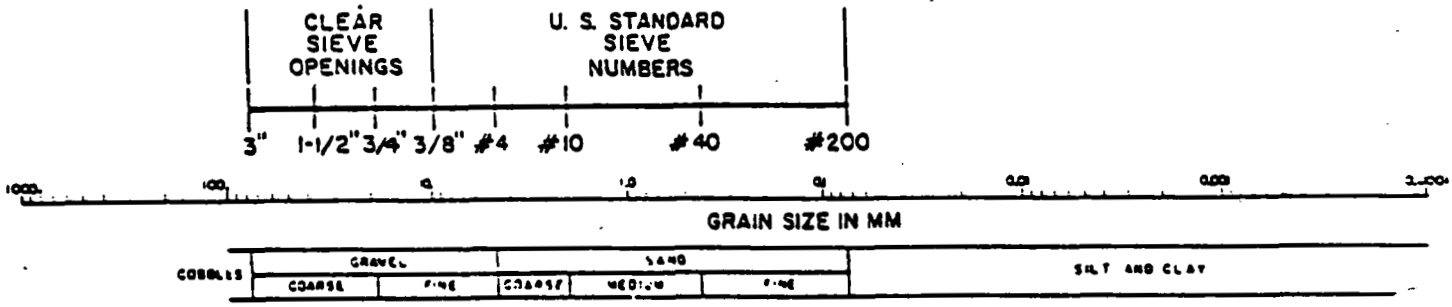
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

140

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald		
BORING NUMBER: 4010	COORDINATES:	DATE: 1/20/89	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1/18/89	
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2/25/89	
DRILLING METHODS: Cable Tool		PAGE 6 OF 16	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (ISF)	REMARKS
76							
77							
78							
79	WAH 2-23-89 08968						
80	~~1070~~ 1005 1-20-89	23 38 24	7	Very dense, gray brown (10 yr 4/3) well graded gravelly sand. Wet. Gravel size to 1 in.	SW	N/A	Hnu = 0 ppm α = — β = 80 cpm (bkg.)
81							
82							
83							
84	WAH 2-23-89 08969	89					
85	~~1077~~ 1400 1-20-89	14 15 23		Dense, gray brown (10 yr 4/1) med-well sorted gravelly sand. Damp. Gravel size to 3/4 in.	SW	N/A	Hnu = 0 ppm α = — β = 100 ppm
86							
87							
88							
89							

NOTES: Drillers: Craig Coulter, Chris Coulter

Instrument Backgrounds: Hnu = 0 ppm, α = 0 cpm, β = 80 cpm

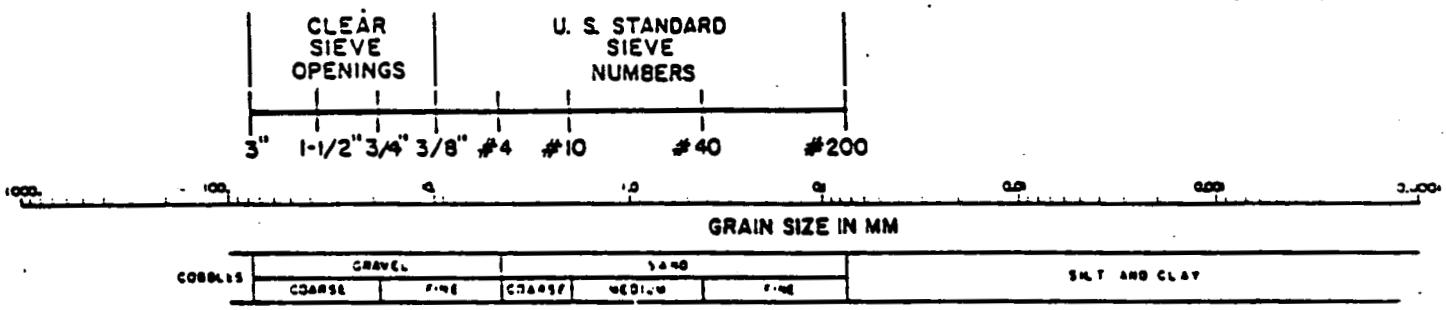
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

142

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald RIFS		
BORING NUMBER: 4010	COORDINATES:		DATE: 1-19-89
ELEVATION: 582.2 G.S.	GWL: Depth	Date/Time	DATE STARTED: 1-18-89
ENGINEER/GEOLOGIST: L. Adams	Depth	Date/Time	DATE COMPLETED: 2-25-89
DRILLING METHODS: Cable Tool			PAGE 3 OF 16 17

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31				For description of samples over interval 0-80 ft. See descriptions for boring & well 210.			
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							

NOTES:

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
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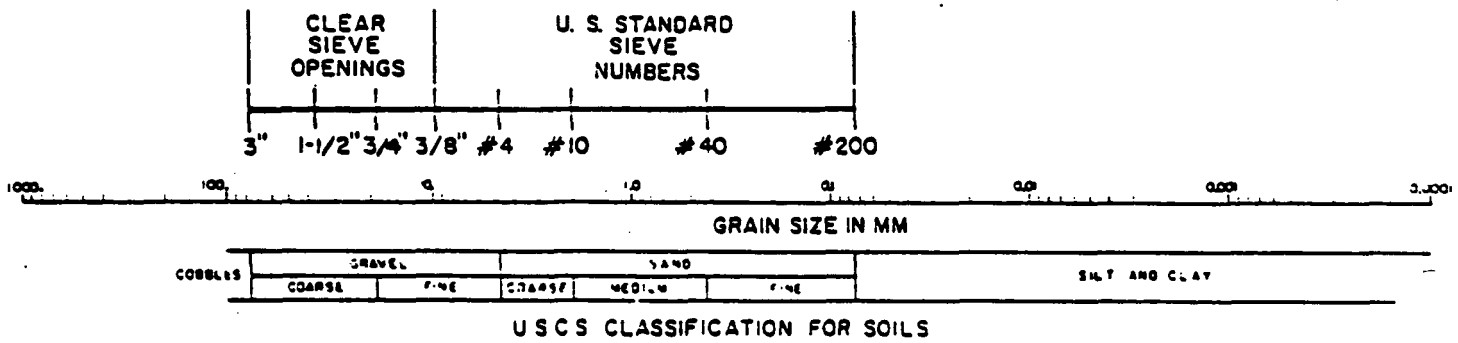
(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



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SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
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FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
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HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald RIFS	
BORING NUMBER: 4010	COORDINATES:	DATE: 11-19-89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1-18-89
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2/25/89
DRILLING METHODS: Cable Tool		PAGE 2 OF 16

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16				For classification of samples in interval 0-80 ft, refer to descriptions on boring + well no. 210.			
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							

NOTES:

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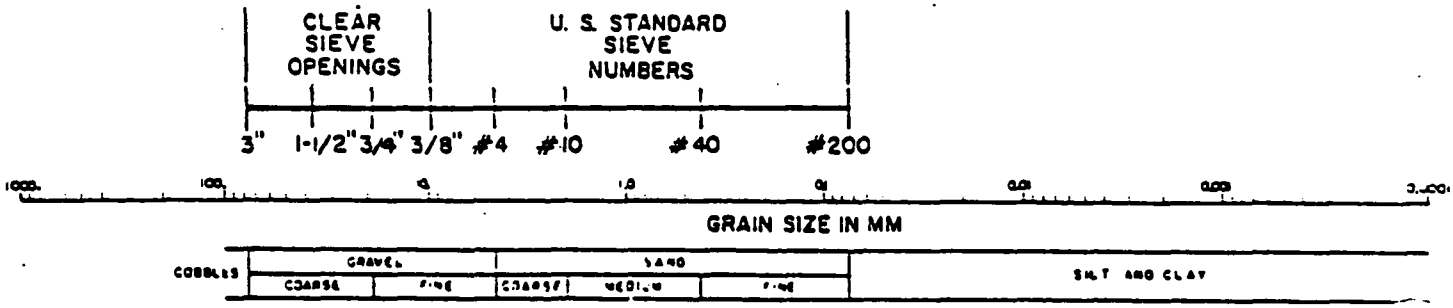

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HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

FERNALD RI/FS

6/29/89

	Initial	Date
Field Check		
1st Key In		
2nd Key In		
Final Check/Validation		

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: 4010	COORDINATES: N491,460.53/E1,379,691.07	DATE: 1/19/89
ELEVATION: 582.2 G.S.	GWL: Depth Date/Time	DATE STARTED: 1/18/89
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2/25/89
DRILLING METHODS: Cable Tool		PAGE 1 OF 16/17

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1				For information on samples for interval 0-80 ft from ground surface, please refer to Visual Class of Soils on Boring + Well No. 210 dated 3-30-88. Samples for this boring begin at 80.0-81.5'.			
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

NOTES: Contractor: Penn Drill
Rig: 4
Driller: Craig Coulter
Assistant: Chris Coulter

Samples collected as per ASTM Standard Penetration Test
Colors identified using Munsell Color Chart
Background Levels: H_m = 0 ppm
α = 0-1 cpm
β = 80 cpm

147

LEL O_2 = 0 ppm lel
21.9% O_2

Total pages = 17 including diagram and installation sheet

Water added to Borehole 1,820 gallons

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
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HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
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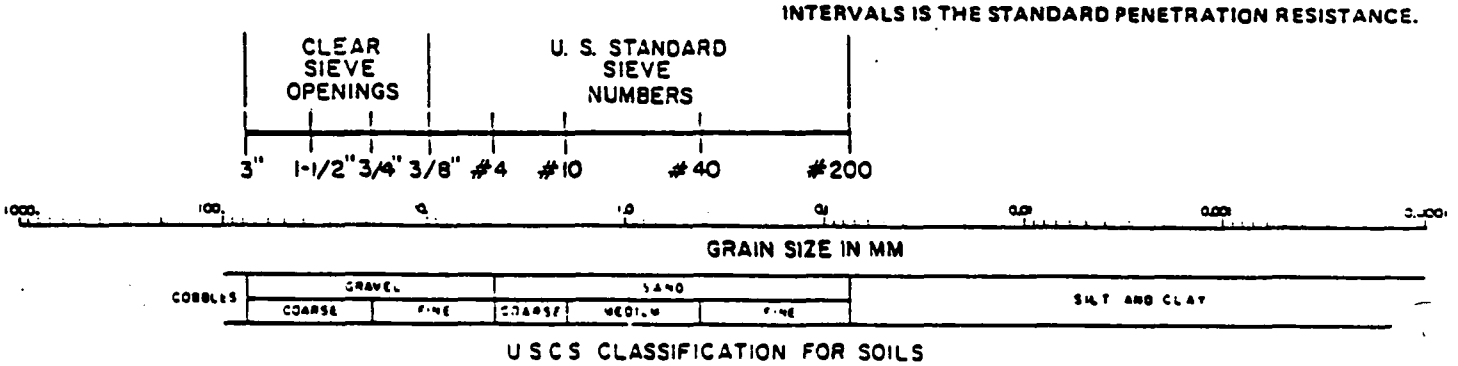

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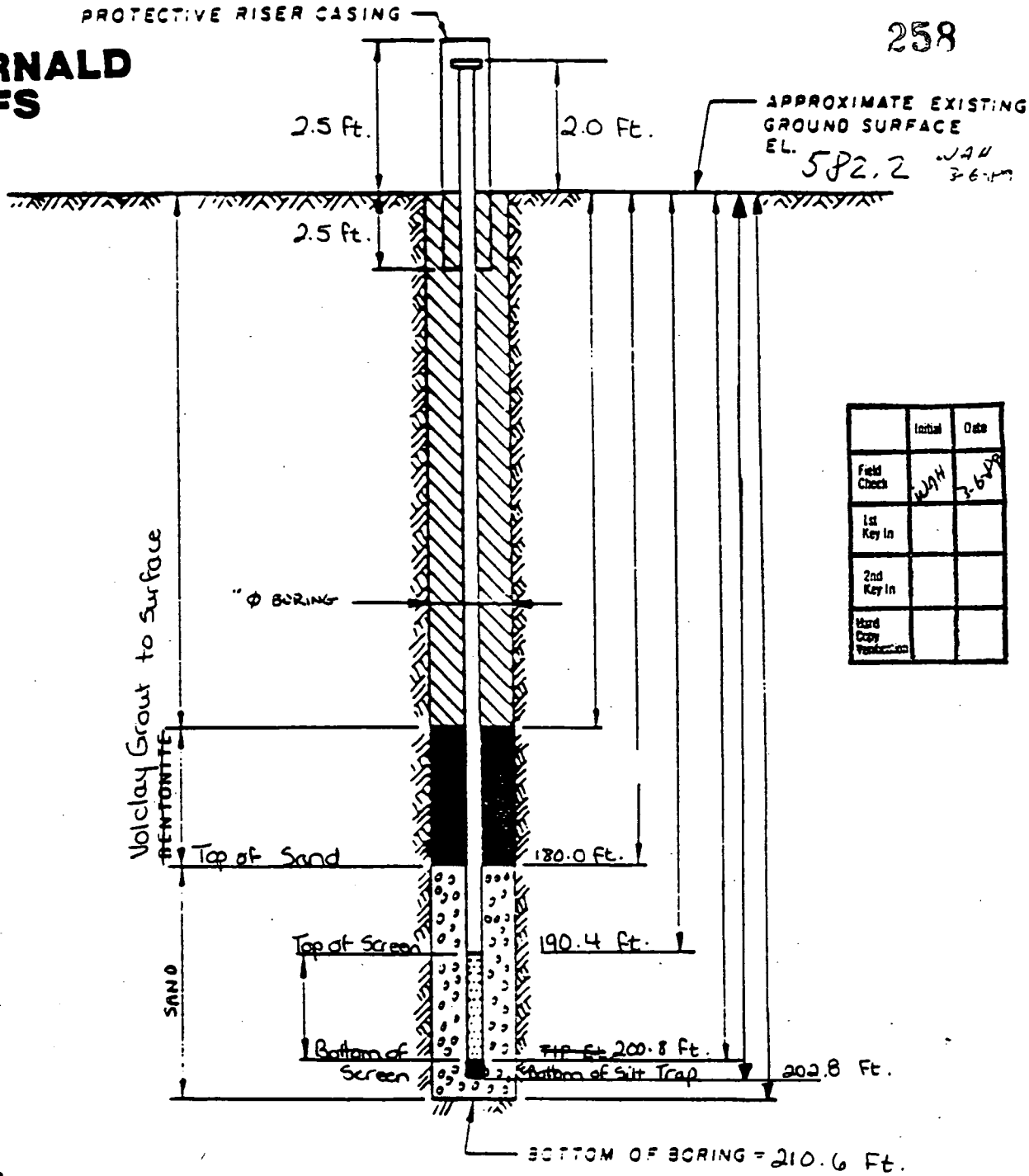
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

Well 4010

258

FERNALD RI/FS



	Initial	Date
Field Check	WJH	3-6-89
1st Key In		
2nd Key In		
Hard Copy Verification		

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
WAH 2/27/89	WJH 3-6-89		

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.0 0 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED. 3-30-~~89~~ 88 (from 2010 log)
4. ELEVATION OF WATER LEVEL 63.0 Ft. from 2010.
5. WATER LEVEL READING ON

Materials used:
19 Bags 10-20 sand
51 Bags volclay grout.
3 Bags 4-30 Sand

Total Water added to hole: 1820 gal.

INSTALLATION DETAILS
MONITORING WELL 4010

PREPARED FOR
Boring # 4010 2/27/89

149

Water Used:
During Drilling: Approx. 800 gal
During Grouting: 1020 gal.

FERNALD RI/FS

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI\FS
FIELD ENG./GEO. L. Adams DATE 2/27/89
PROJECT NO. 602 3.2
CHECKED BY W.A. Liertzi DATE 3-6-89
BORING NO. 4010
PIEZOMETER NO. 4010
DATE OF INSTALLATION 2/8/89 - 2/25/89

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0.0 ft. TO 210.6 ft.
FLUID — FROM — TO —

TYPE OF BIT Hammer
CASING SIZE (S) USED:
SIZE 10 in. ID FROM 0.0 ft TO 210.0 ft.
SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE Monitoring well
DIAMETER OF PERFORATED SECTION 4 in. I.D.
PERFORATION TYPE:
SLOTS ☒ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010 in.
TOTAL PERFORATED AREA 10.0 ft.

RISER PIPE MATERIAL Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8 in. I.D. 4 in.
LENGTH OF PIPE SECTIONS 10 ft., 2 ft.
JOINING METHOD screw, type, flush joint threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 ft.
PROTECTIVE PIPE O.D. 10 3/4 in.

OTHER PROTECTION locking cap with padlock WAH 3-6-89

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft)		ELEVATION (Ft.)	
TOP OF RISER PIPE	2.0		584.2	
GROUND SURFACE	0.0		582.2	
BOTTOM OF PROTECTIVE PIPE	2.5		579.7 ft.	
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0	BOTTOM 180.0	TOP	BOTTOM
BENTONITE	TOP N/A	BOTTOM N/A	TOP	BOTTOM
SAND (10x20) WAH 3-6-89	TOP 180.0	BOTTOM 202.8	TOP	BOTTOM
~~GRAVEL~~ (4x30)	TOP 202.8	BOTTOM 205 ft	TOP	BOTTOM
PERFORATED SECTION	TOP 190.4	BOTTOM 200.8	TOP	BOTTOM
PIEZOMETER TIP	202.8 ft.			
BOTTOM OF BOREHOLE	210.6 ft.			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

150

REMARKS Hole was allowed to collapse in on itself to 205.0 ft, where the gravel pack was started.
Drilling procedures began on 1-18-89, Stainless steel riser placed in well on 2-8-89, Hole cover emplaced on 2-25-89 (WAH 3-6-89)

409-...8

TEST EQUIPMENT LIST

TEST _____

EQUIPMENT NUMBER	EQUIPMENT NAME

NOTE:

THIS LIST SHALL BE COMPLETED FOR ALL TESTS, ONLY EQUIPMENT SUBJECT TO CALIBRATION NEED BE LISTED.

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4010	COORDINATES:		DATE: 2-7-89
ELEVATION: 582.2 FT	GWL: Depth	Date/Time	DATE STARTED: 1-18-89
ENGINEER/GEOLOGIST: TESORIERO	Depth	Date/Time	DATE COMPLETED: 2-25-89
DRILLING METHODS: CABLE TOOL			PAGE ~~14~~ 15 OF ~~16~~ 17

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION 210.5 FT	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
211	1061C 1530 2-7-89	40 50/1	7	VERY DENSE DARK GRAYISH BROWN (10YR 4/2) WELL GRADED FINE TO MEDIUM SAND, WET	SW	NA	Hnu = 0 ppm α = 0 cpm β γ = 80-120 cpm
				VERY DENSE, DARK GRAY (5Y 4/1) WEATHERED SHALE	N/A	NA	
				BOTTOM OF BORING = 210.6 FT			
212							
213							
214							
215							
216							
217							
218							
219							
220							
221							
222							
223							
224							

NOTES:

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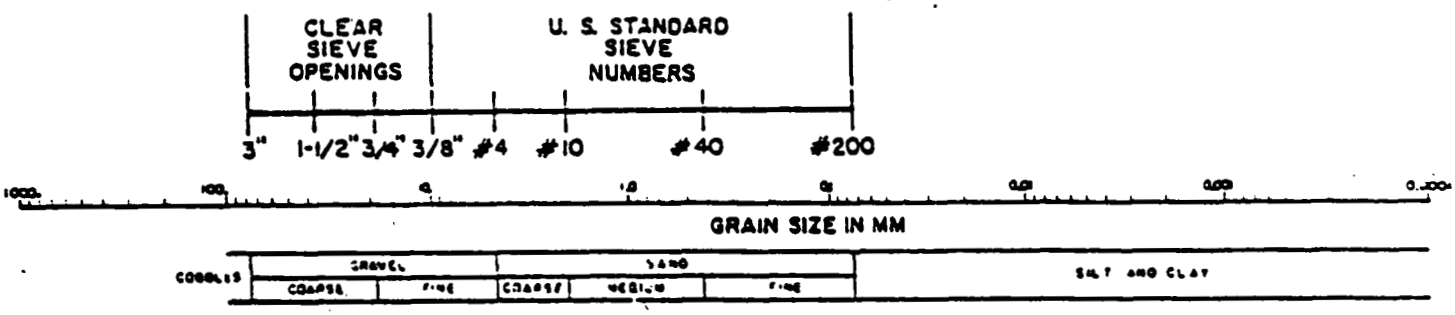
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE[1]
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

153

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTI

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4010	COORDINATES:	DATE: 2-7-89
ELEVATION: 582.2	GWL: Depth Date/Time	DATE STARTED: 1-18-89
ENGINEER/GEOLOGIST: TESORIERO	Depth Date/Time	DATE COMPLETED: 2-25-89
DRILLING METHODS: CABLE TOOL		PAGE ~~13~~ 14 OF ~~16~~

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
196	10607 1000 2-7-89	40 43 50/2	14	VERY DENSE, DARK GRAYISH BROWN (10YR 4/2) POORLY GRADED MEDIUM SAND, WET	SP	N/A	HNU = 0 ppm α = 0 cpm βγ = 60-80 cpm
197							
198							
199							
200	10608 1050 2-7-89	5 8 12	7	MEDIUM DENSE, DARK GRAYISH BROWN (10YR 4/2) POORLY GRADED SAND, WET	SP	N/A	HNU = 0 ppm α = 0 cpm βγ = 80-120 cpm
201							
202							
203							
204							
205	10609 1350 2-7-89	25 50 100/4*	10	VERY DENSE, DARK GRAYISH BROWN (10YR 4/2) WELL GRADED SAND, TRACE GRAVEL (0.25-0.75 IN), WET	SW	N/A	HNU = 0 ppm α = 0 cpm βγ = 60-110 cpm
206							
207							
208							
209							

NOTES:
* MORE THAN 50 BLOWS WERE ALLOWED TO TRY TO RECOVER BEDROCK, IF PRESENT

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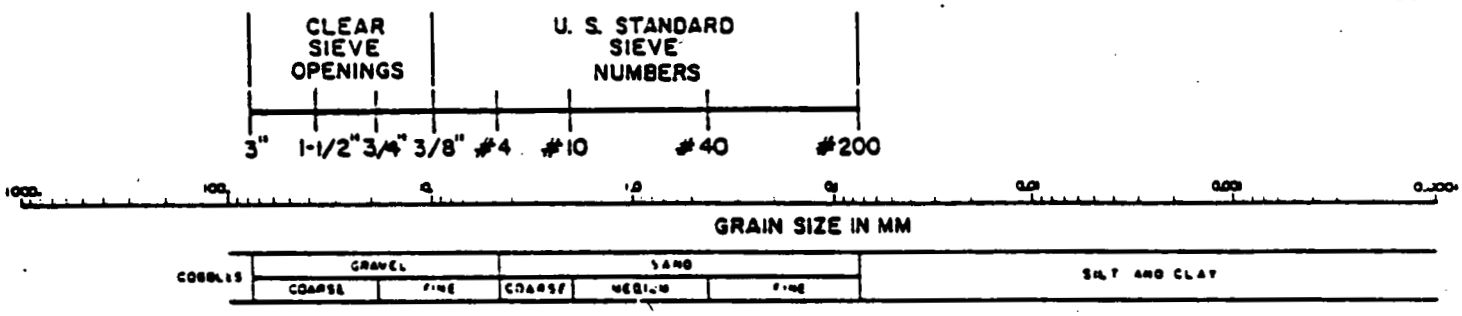
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE (1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

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FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTEN

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4010	COORDINATES:	DATE: 2-6-89	
ELEVATION: 582.2	GWL: Depth Date/Time	DATE STARTED: 1-18-89	
ENGINEER/GEOLOGIST: TESORIERO	Depth Date/Time	DATE COMPLETED: 2-25-89	
DRILLING METHODS: CABLE TOOL		PAGE 13 OF 16	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
181	10604 1340 2-6-89	8 10 14	4	MEDIUM DENSE, GRAY BROWN (10YR 5/2) WELL GRADED MEDIUM SAND, TRACE GRAVEL, WET	SW	NA	HNU = 0 ppm α = 0 cpm βγ = 60-80 cpm
182							
183							
184							
185	10605 1510 2-6-89	16 30 25	17	VERY DENSE, DARK GRAYISH BROWN (10YR 4/2) FINE TO MEDIUM SAND, WELL GRADED, TRACE GRAVEL, WET	SW	N/A	HNU = 0 ppm α = 0 cpm βγ = 40-80 cpm
186							
187							
188							
189							
190	10606 1600 2-6-89	20 50 50/2	7	VERY DENSE, DARK GRAYISH BROWN (10YR 4/2) POORLY GRADED MEDIUM SAND, WET	SP	N/A	HNU = 0 ppm α = 0 cpm βγ = 60-80 cpm
191							
192							
193							
194							

NOTES:

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402-11-86

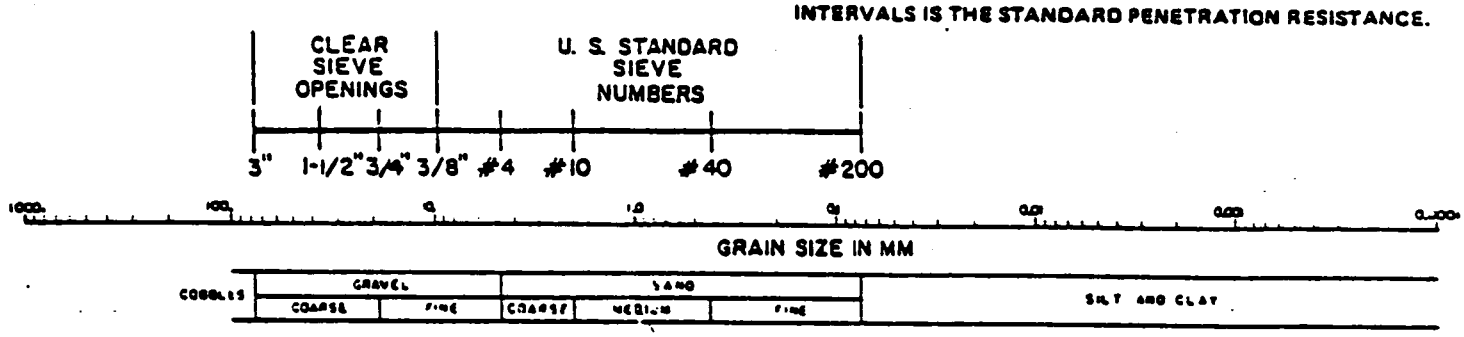
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE (1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

157

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTEN

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3, 2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4010	COORDINATES:	DATE: 2-4-89, 2-6-89	
ELEVATION: 582.2 FT	GWL: Depth Date/Time	DATE STARTED: 1-18-89	
ENGINEER/GEOLOGIST: TESORIERO	Depth Date/Time	DATE COMPLETED: 2-25-89	
DRILLING METHODS: CABLE TOOL		PAGE 12 OF 16	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
166	10601 1530 2-4-89	18 24 13	9	DENSE, BROWN (10YR 5/2), WELL GRADED MEDIUM SAND, TRACE GRAVEL, WET (0.25-0.50 IN)	SW	NA	HNu = 1 ppm α = 0 cpm βγ = 60-100 cpm
167							
168							
169							
170	10602 1610 2-4-89	6 13 14	9	MEDIUM DENSE, BROWN (10YR 5/2) WELL GRADED MEDIUM SAND, TRACE GRAVEL (0.25IN-0.50IN), WET	SW	NA	HNu = 1 ppm α = 0 cpm βγ = 60-100 cpm
171							
172							
173							
174							
175	10603 1050 2-6-89	13 36 62	8	VERY DENSE, GRAY BROWN (10YR 5/2) WELL GRADED MEDIUM SAND, TRACE GRAVEL (0.25-0.50 IN), WET	SW	N/A	HNu = 0 ppm α = 0 cpm βγ = 60-80 cpm
176							
177							
178							
179							

NOTES:

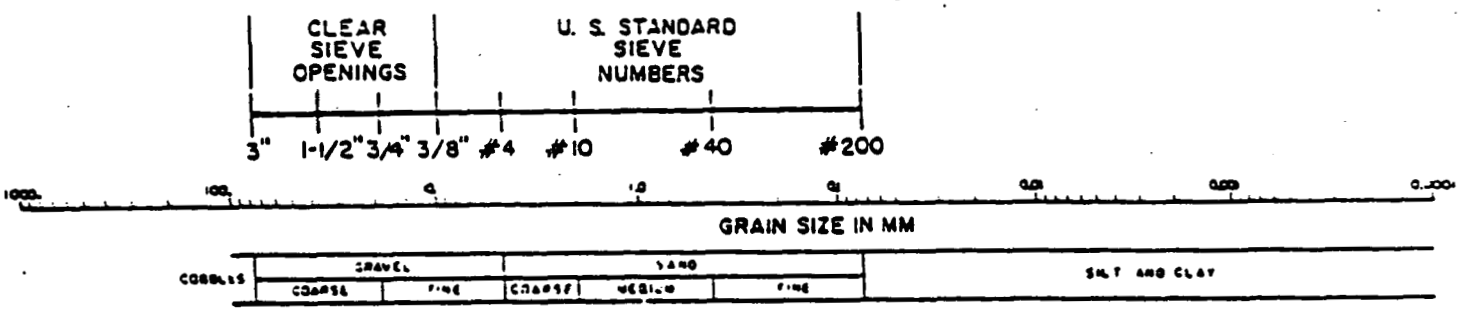
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONT

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4010	COORDINATES:	DATE: 2-2-89, 2-4-89	
ELEVATION: 582.2 FT	GWL: Depth / Date/Time	DATE STARTED: 1-18-89	
ENGINEER/GEOLOGIST: TESORIERO	Depth / Date/Time	DATE COMPLETED: 2-25-89	
DRILLING METHODS: CABLE TOOL		PAGE 10 OF 16	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
151	10598 1120 2-2-89	47 25 38	5	VERY DENSE, BROWN ~~GRAVELLY SAND~~ AJT (10YR 5/2) GRAVELLY SAND, WET WELL GRADED	SW	NA	HNU = 0 ppm α = 0 cpm βγ = 60-80 cpm
152							
153							
154							
155	10599 1520 2-2-89	40 45 50	8	VERY DENSE, BROWN (10YR 5/2) WELL GRADED FINE SAND WITH SOME GRAVEL, WET	SW	NA	HNU = 0 ppm α = 0 cpm βγ = 80-100 cpm
156							
157							
158							
159							
160	10600 1400 2-4-89	10 15 15	6	MEDIUM DENSE, BROWN (10YR 5/2) WELL GRADED, SILTY MEDIUM TO COARSE SAND WITH SOME GRAVEL WET	SM	NA	HNU = 0 ppm α = 0 cpm βγ = 50-100 cpm
161							
162							
163							
164							

NOTES:

LA 2/27/89

402-11-8

258

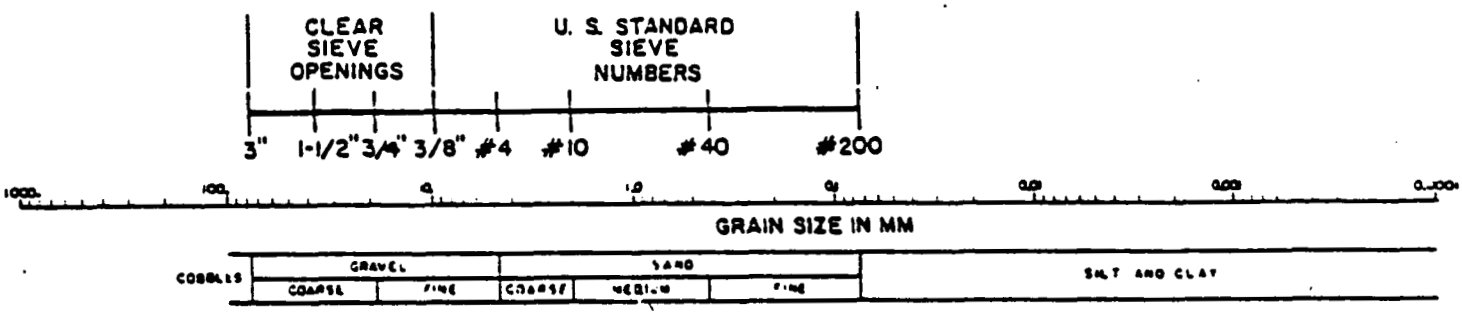
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE (1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

161

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTE

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 4010	COORDINATES:	DATE: 2-1-89, 2-2-89
ELEVATION: 582.2 FT	GWL: Depth Date/Time	DATE STARTED: 1-18-89 17
ENGINEER/GEOLOGIST: TESORIERO	Depth Date/Time	DATE COMPLETED: 2-25-89
DRILLING METHODS: CABLE TOOL		PAGE 90 OF 167

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136	10595 1600 2-1-89	NA	24	VERY STIFF, DARK GRAY (7.5YR 3/2) CLAY, DAMP	CL	2.5	HNU = 0 ppm SEE NOTE α = 0 cpm βγ = 80-100 cpm ~~2-1-89~~ ATT
137							
138							
139							
140	10596 0900 2-2-89	5 10 12	14	VERY STIFF, OLIVE GRAY (5Y 4/2) CLAY, WET	CL	2.3	HNU = 0 ppm α = 0 cpm βγ = 80-100 cpm
141							
142							
143							
144							
145	10597 1040 2-2-89	3 5 10	12	STIFF, OLIVE ~~GREEN~~ GRAY (5Y 4/2) ATT 2-2-89 CLAY, TRACE SAND AND GRAVEL WET	CL	2.0	HNU = 1 ppm α = 0 cpm βγ = 60-50 cpm
146							
147							
148							
149							

NOTES: SAMPLE 10595 IS A SHELBY TUBE.

162

402-11-8

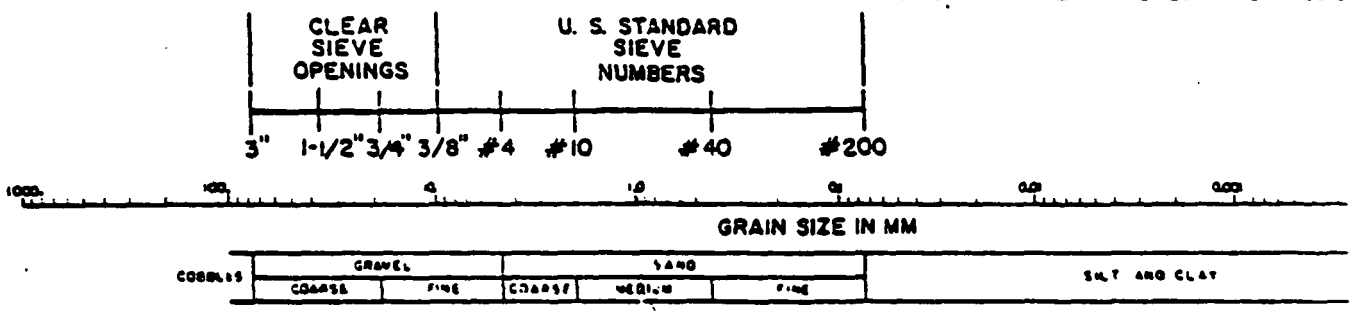
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR S

DENSITY	STANDAR PENETRATI RESIST^NC
VERY LOOSE	
LOOSE	5
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUM BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BA SAMPLER 12 INCHES USING A 140-POUND HAMMER F FREELY THROUGH 30 INCHES. THE SAMPLER IS DRI INCHES AND THE NUMBER OF BLOWS RECORDED FC 6-INCH INTERVAL. THE SUMMATION OF THE FINAL INTERVALS IS THE STANDARD PENETRATION RESIS



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

FINE-GRAINED/HIGHLY ORGAN

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILT AND VERY FINE S ROCK FLOUR, SILTY OR CLAYEY FINE OR CLAYEY SILT WITH SLIGHT PLAST
	CL	INORGANIC CLAY OF LOW TO MEDIUM PL GRAVELLY CLAY SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY OF LOW PLASTIC
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILT MICACEOUS OR DIATOM FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLA OF HIGH PLASTIC FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PL ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HU SWA WITH HIGH O.

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald RIFS		
BORING NUMBER: 4010	COORDINATES:	DATE: 1-24-89	
ELEVATION: 582.2 G.S.	GWL: Depth Date/Time	DATE STARTED: 1-18-89	
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2-25-89	
DRILLING METHODS: Cable Tool		PAGE 9 OF 16	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
WAH 2-23-89 08976							
121	~~11078~~ ~~1445~~ 1-24	*	12	Loose, poorly graded brown gray sand with some gravel. Wet. (10 yr 4/1) (Gravel to .5 in.)	SP	N/A	Hnu = Bkg α = Bkg β = Bkg
122							
123							
124	WAH 2-23-89 08977			* When sample rod was put in hole, it sunk as soon as weight was placed on it. The rod was pounded about 3 times and sunk 2 ft.			
125	~~11079~~ 1605 1-24	6 22 26	10	Dense, brown gray (10 yr 4/2) well graded gravelly sand. (Gravel to .25 in.)	SW	N/A	Hnu = Bkg α = Bkg β = Bkg
126							
127							
128							
129	WAH 2-23-89 08978						
130	~~11080~~ 0935 1-26	8 12 16	8	Med. Dense gray brown (10 yr 4/2) well graded gravelly sand (gravel to .25 in.)	SP	2.5	Hnu = Bkg α = Bkg β = Bkg
131				Very stiff blue clay			
132	~~11081~~ ~~1550~~ 2-1-89 10611	NA	6	VERY STIFF, DARK GRAY (7.5 YR 3/0) CLAY, SAND	CL	2.5	SEE NOTE
133							Blue clay layer contact!
134							

NOTES: Blow sand has been causing quite a few problems in stabilizing borehole depth. It has also been possible to make progress from 110-120.0 ft in borehole using only sand pump (not using drill bit.)

SAMPLE 10611 IS A SHELBY TUBE

164

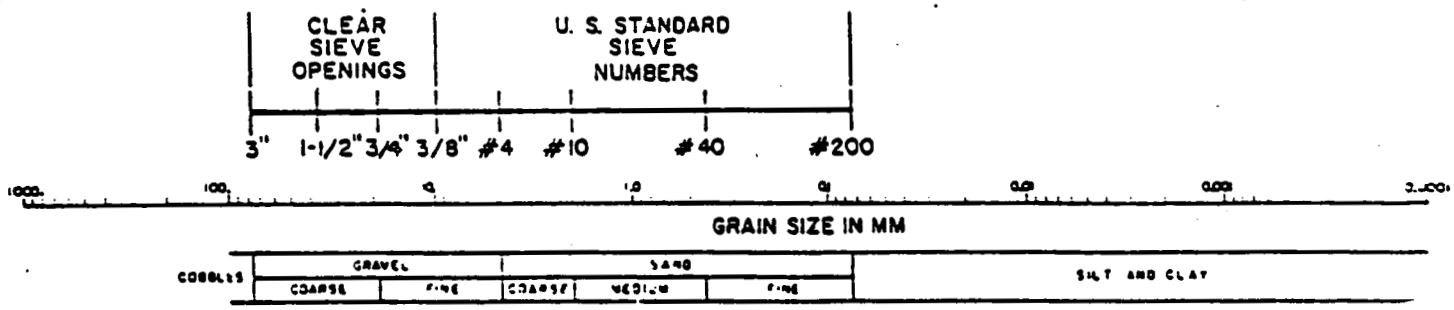
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald RIFS		
BORING NUMBER: 4010	COORDINATES:	DATE: 1-23-89	
ELEVATION: 582.2 G.S.	GWL: Depth Date/Time	DATE STARTED: 1-18-89	
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2-25-89	
DRILLING METHODS: Cable Tool		PAGE 8 OF 16	

DEPTH (Ft.) WAH 2-23-89	SAMPLE TYPE & NO. 08973	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS ~~Ago 2-14-8~~ 2/27/89
106	~~11075~~ 1600 1-23	5 8 9	4	Med. Dense gray brown poorly graded gravelly sand. (Gravel to 1in) (10yr 4/1) Wet	SP	N/A	Hnu = Bkg. α = Bkg. β = Bkg.
107				* Sampling rod sunk when weight was first put on.			
108							
109	WAH 2-23-89 08974						
110	~~11076~~ 0900 1-24	8 8 26	18	Dense, gray brown poorly graded sand. Trace gravel. (10yr 4/1) Damp.	SP	N/A	Hnu = Bkg α = Bkg β = Bkg
111							
112							
113							
114	WAH 2-23-89 08975						
115	~~11077~~ 1038 1-24	~~8~~ 7 ~~12~~ 6 11 ~~16~~ 13	6	Med. Dense, gray brown poorly graded sand. Some gravel (gravel .5 in) (10 yr 4/1) wet.	SP	N/A	Hnu = Bkg α = Bkg β = Bkg
116							
117				* This sample was taken on 2nd attempt.			
118							
119							

NOTES: Driller: Craig Coulter
Assist: Chris Coulter

Equipment Backgrounds: 1-23-89
Hnu = 2 ppm
α = 0 cpm
β = 80 cpm

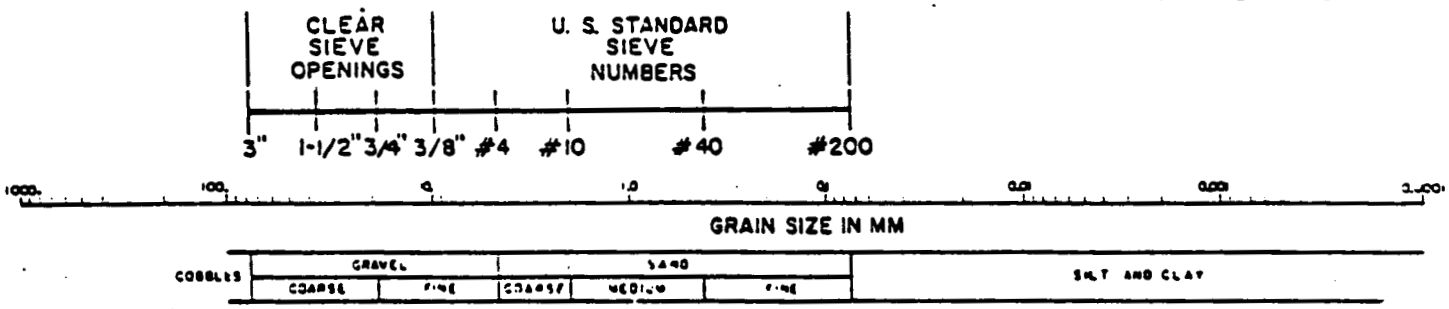
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE (1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: Fernald		
BORING NUMBER: 4010	COORDINATES:	DATE: 1/20/89	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1/18/89	17
ENGINEER/GEOLOGIST: L. Adams	Depth Date/Time	DATE COMPLETED: 2/25/89	
DRILLING METHODS: Cable Tool		PAGE 7 OF ~~16~~ 17	

DEPTH (ft) WAH 2-23-89	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS LA 2/27/89
91	~~1072~~ 1505 1-20-89	15 25 20	4	~~Med.~~ LA Dense, gray brown gravelly sand, well graded. Gravel to 1 in. Wet. (10 yr 4/1)	SW	N/A	Hnu = 0 ppm α = 0 cpm β = 80 cpm
92							
93							
94	WAH 2-23-89 08971						
95	~~1073~~ 1310 1-23	10 10 20	18	Med. dense, gray brown poorly graded sand, trace gravel. (gravel to .4 in.) (10 yr 4/1) Damp.	SP	N/A	Hnu = 0 ppm α = 0-1 cpm β = 60 cpm
97							
98							
99	WAH 2-23-89 08972						
100	~~1074~~ 1400 1-23	14 15 26	10	Dense, gray brown poorly graded to medium graded sand. Some gravel (10 yr 4/1) Damp	SP	N/A	Hnu = 0 ppm α = 0 cpm β = 80 cpm
101							
102							
103							
104							

NOTES: Drillers:
Craig Coulter
Chris Coulter

Instrument Backgrounds:
Hnu = 2 ppm
α = 0 cpm
β = 80 cpm

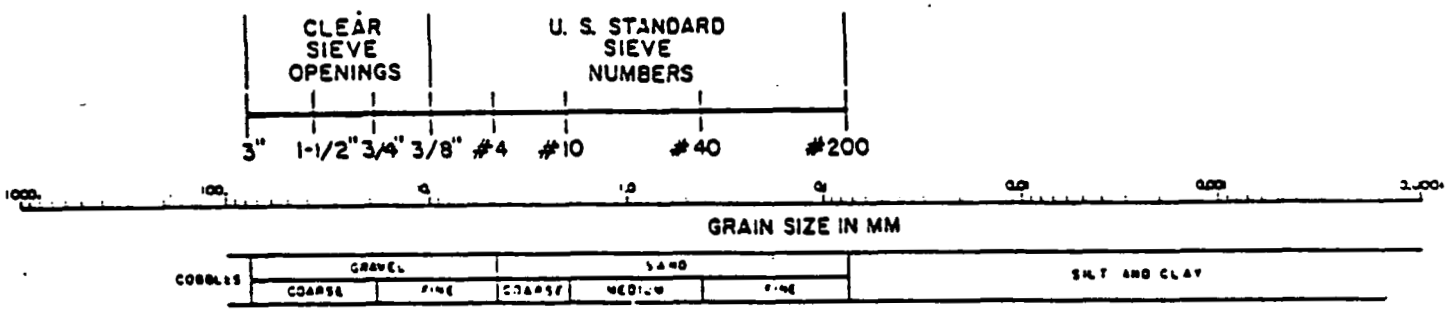
CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQUARE FOOT)
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

DENSITY OF GRANULAR SOILS

DENSITY	STANDARD PENETRATION RESISTANCE(1)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

(1) STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.



USCS CLASSIFICATION FOR SOILS

COARSE-GRAINED SOILS

CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GC	CLAYEY GRAVELS GRAVEL-SAND-CLAY MIXTURES
CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES

FINE-GRAINED/HIGHLY ORGANIC SOILS

SILTS AND CLAYS LIQUID LIMIT (LESS THAN 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
SILTS AND CLAYS LIQUID LIMIT (GREATER THAN 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

Reynolds Supply, Inc.

COMPLETE MUNICIPAL & INDUSTRIAL WATER SYSTEMS

258

FORMATION LOG OF WELL

Starting Da _____ Finished _____ Well Number Well #11

Owner NLO Location Whitewater, Ohio

TOTAL DEPTH	THICKNESS EACH STRATUM	FORMATION
0	14	Yellow clay
14	28	Blue clay & gravel
28	40	Gray clay
40	45	Blue clay
45	51	Yellow sand
51	64	Yellow sand
64	89	Gray sand & gravel
89	92	Dark gray sand & clay balls
92	96	Gray sand and gravel
96	100	Gray sand and gravel
100	115	Gray sand and boulders
5	125	Gray sand and boulders
125	130	gray sand and small boulders

170

ic Water Level 63' Draw Down _____

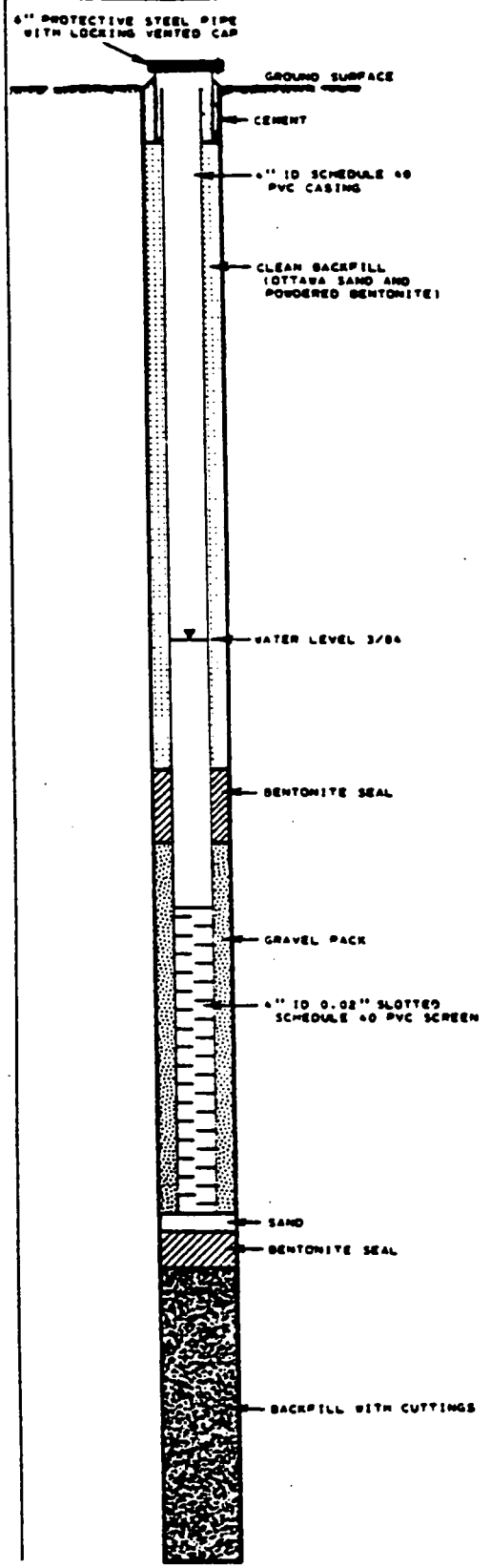
er Steve Reynolds

BORING 12

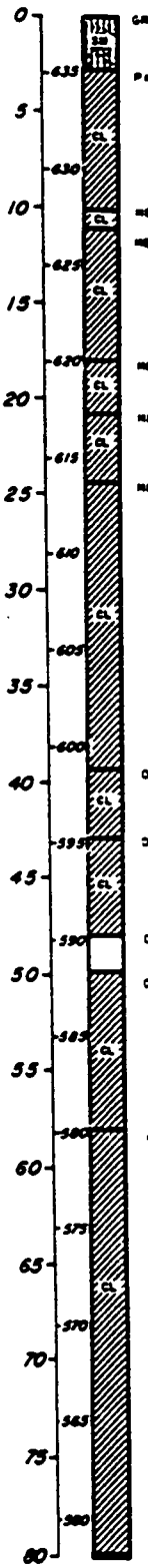
SURFACE ELEVATION 637.0'

WELL SCHEMATICS

12D



DEPTH IN FEET | ELEVATION IN FEET | GRAPHIC LOG | DESCRIPTIVE GEOLOGIC NOTES



GRASS. SILTY SAND WITH UNDERLYING RIP-RAP LIMESTONE COBBLES

PALE OLIVE (10Y6/2) MASSIVE CLAY WITH SOME IRON STAINED FRACTURES

MEDIUM BLUISH-GRAY CLAY (5B5/1) MASSIVE, DENSE, DRY, NO FRACTURES

MEDIUM BLUISH-GRAY CLAY (5B5/1) WITH SOME GRAVEL, IRON OXIDE STAINING

MEDIUM BLUISH-GRAY CLAY (5B5/1) WITH SOME SAND

MEDIUM BLUISH-GRAY CLAY (5B5/1) MORE FRIABLE THAN ABOVE

MEDIUM BLUISH-GRAY CLAY (5B5/1), MASSIVE, VARVED, FRIABLE

OLIVE GRAY (5Y3/2) CLAY WITH SILT

DARK GREENISH-GRAY (5GY4/1) CLAY WITH THIN GRAVEL LENS (~1/4" THICK) OF IRON STAINED QUARTZ. A FEW SHALE FRAGMENTS 1/2" DIAMETER PRESENT

DRILL BIT CHATTERING. CUTTINGS SHOW LIMESTONE FRAGMENTS. POSSIBLE BOULDERS OR BEDROCK

DARK GREENISH-GRAY (5GY4/1) CLAY, VERY DENSE, THINLY BEDDED, DRY, ALMOST A SHALE

NO SAMPLE. SOFT GREENISH-GRAY SHALE

BORING TERMINATED AT A DEPTH OF 80 FEET

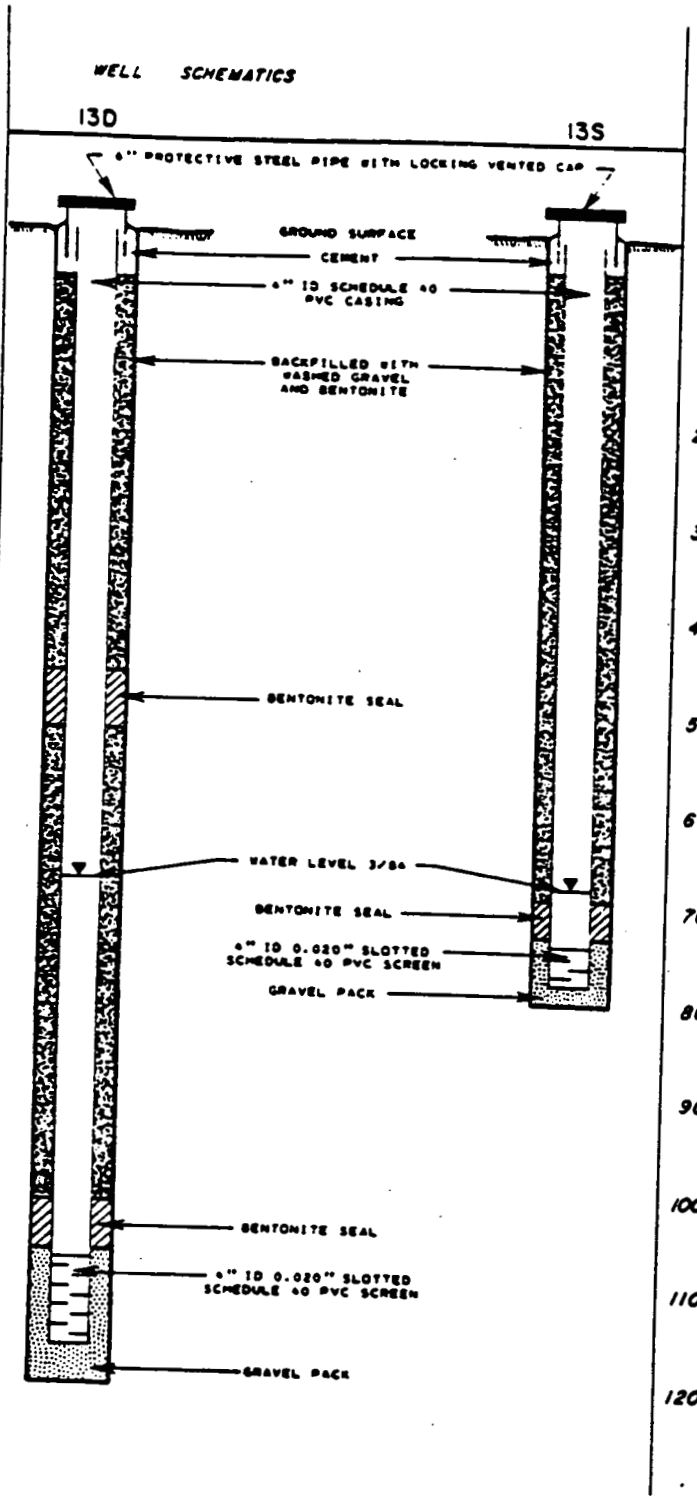
DAMES & MOORE

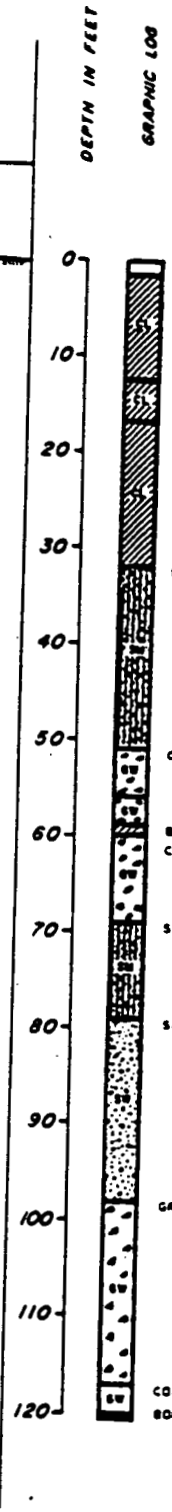
FIGURE A4-2

BORING 13

SURFACE ELEVATION 13D 588.52'
13S 588.73'

WELL SCHEMATICS





DESCRIPTIVE GEOLOGIC NOTES

LIMESTONE RIP-RAP

OLIVE GRAY (5Y3/2) CLAY WITH SOME SILT, LESS THAN 3% GRAVEL. SLIGHT YELLOWISH OXIDATION PARTICLES IN UPPER 2", CLAY IS PLASTIC, DENSE

ALMOST PURE CLAY AS ABOVE. LITTLE TO NO SILT OR GRAVEL

OLIVE GRAY (5Y3/2) SILTY CLAY WITH UP TO 5% GRAVEL. LARGE FRAGMENTS OF LIMESTONE AND QUARTZ (UP TO 2" IN DIAMETER)

LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED, MOIST WELL SORTED SILTY SAND. GRAVEL UP TO 2%

COARSE GRAVEL (QUARTZ AND LIMESTONE FRAGMENTS)

BROWN CLAY

COARSE GRAVEL

SILTY SAND WITH SOME GRAVEL

SAND-GRAVEL

GRAVEL

COARSE GRAVEL

BORING TERMINATED AT A DEPTH OF 120.0' ON 2/6/85

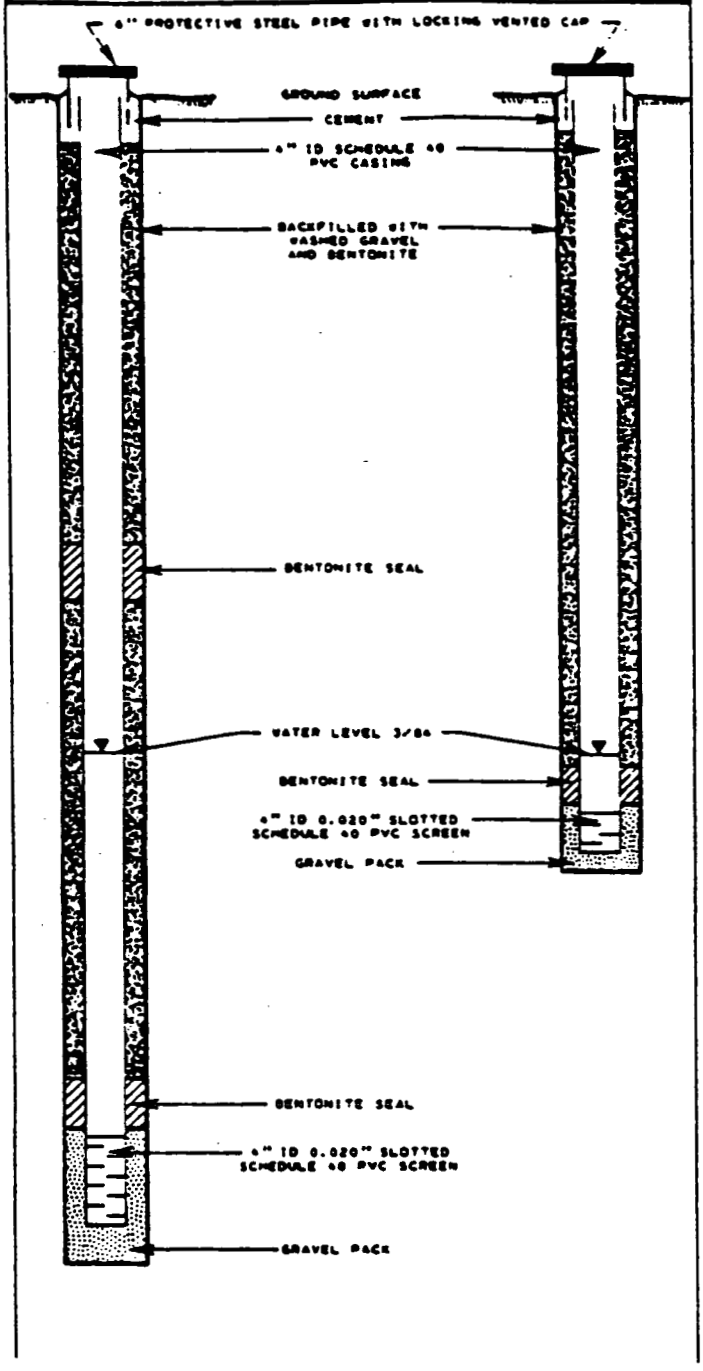
DAMES & MOORE

FIGURE A4-3

BORING 13

SURFACE ELEVATION 130 [illegible]
135 [illegible]

WELL SCHEMATICS



DEPTH IN FEET

GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES

LIMESTONE RIP-RAP
OLIVE GRAY (5Y3/2) CLAY WITH SOME SILT. LESS THAN 3% GRAVEL. SLIGHT YELLOWISH OXIDATION PARTICLES IN UPPER 2", CLAY IS PLASTIC, DENSE

ALMOST PURE CLAY AS ABOVE. LITTLE TO NO SILT OR GRAVEL

OLIVE GRAY (5Y3/2) SILTY CLAY WITH UP TO 5% GRAVEL. LARGE FRAGMENTS OF LIMESTONE AND QUARTZ (UP TO 2" IN DIAMETER)

LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED, MOIST WELL SORTED SILTY SAND. GRAVEL UP TO 2%

COARSE GRAVEL (QUARTZ AND LIMESTONE FRAGMENTS)

BROWN CLAY
COARSE GRAVEL

SILTY SAND WITH SOME GRAVEL

SAND-GRAVEL

GRAVEL

COARSE GRAVEL
BORING TERMINATED AT A DEPTH OF 120.0' ON 2/4/85

DAMES & MOORE

FIGURE A4.7

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. E. TREUNGER DATE 2-7-89
PROJECT NO. 1002 TASK 3.2.1 CHECKED BY W.A. Hertel DATE 3-3-89
BORING NO. 4013
PIEZOMETER NO. 4013 DATE OF INSTALLATION 1-6-89 TO 2-7-89

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 0.0 FT TO 222.5 FT.
FLUID — FROM — TO —

TYPE OF BIT HAMMER
CASING SIZE (S) USED:
SIZE 10 IN ID FROM 0.0 TO 222.5
SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE MONITORING WELL
DIAMETER OF PERFORATED SECTION 4.0 IN ID
PERFORATION TYPE:
SLOTS [X] HOLES [ ] SCREEN ~~[X]~~ WAH 3-3-89
AVERAGE SIZE OF PERFORATIONS 0.01 IN.
TOTAL PERFORATED AREA 10.0 FT

RISER PIPE MATERIAL STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8 IN. I.D. 4.0 IN.
LENGTH OF PIPE SECTIONS 2 FT, 10 FT, 11.5 SCREEN & SITP trap
JOINING METHOD SCREW TYPE THREADED FLUSH JOINTED.

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT
PROTECTIVE PIPE O.D. 10.75 IN.

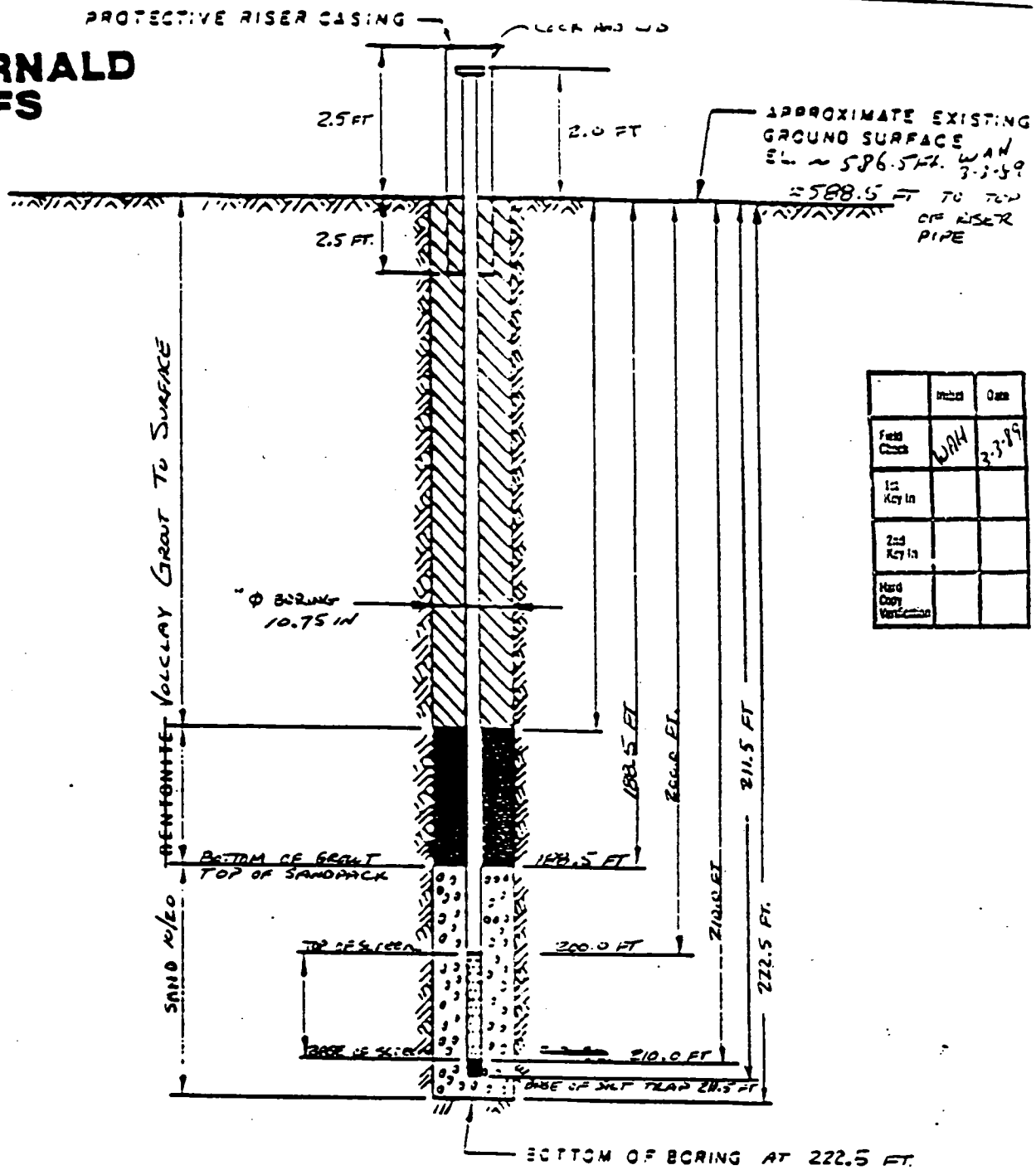
OTHER PROTECTION RISER PROTECTIVE PIPE LOCKING LID WITH INSTALLED PADLOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT.)		ELEVATION ( )	
TOP OF RISER PIPE	2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT / ~~SLURRY~~	TOP 0.0	BOTTOM 188.5	TOP	BOTTOM
~~BENTONITE~~ N/A ON 4000 SERIES	TOP N/A	BOTTOM N/A	TOP	BOTTOM
SAND 10/20	TOP 188.5	BOTTOM 222.5	TOP	BOTTOM
~~GRAVEL~~ ONLY SAND USED	TOP N/A	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 200.0	BOTTOM 210.0	TOP	BOTTOM
PIEZOMETER TIP	211.5			
BOTTOM OF BOREHOLE	222.5			
GWL AFTER INSTALLATION	71.8			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES [ ] NO [✓]
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES [ ] NO [✓]

REMARKS WELL DEVELOPMENT WILL DEVELOP THE WELL BEFORE INSTALLATION OF PIEZOMETER IS ENTIRELY COMPLETE.

FERNALD RI/FS



	Initials	Date
Field Check	WAH	3-3-89
1st Key In		
2nd Key In		
Hard Copy Verification		

DRAWN BY	CHECKED BY / APPROVED BY	DRAWING NUMBER
2-7-89 E.T.	WAH /	3-3-89

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. SS PIPE CONTINUOUS SLOT SCREEN (0.0 0 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED-SILT TRAP 1.5 FT (WELDED)
4. ELEVATION OF WATER LEVEL 74.5 FT 1-10-89
5. WATER LEVEL READING ON 72.0 FT 2-1-89
   71.8 FT 2-7-89

MATERIALS USED:

SAND: 22 BAGS (80 lb) 10/20
VOLCLAY GROUT: 47 BAGS (50 lb.)
BENTONITE PELLETS: NONE USED
WATER: 150C GALLONS DRILLING
140C GALLONS

INSTALLATION DETAILS
MONITORING WELL
MW-4013
PREPARED FOR

175

MONITORING WELL INSTALLATION 1-6-89 TO 2-7-89
Started Drilling and Sampling 1-6-89. Hole Cover emplaced 2-7-89. (WAH 3-3-89)

FERNALD RI/FS

6/29/89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6C2 TASK 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-6-89
ELEVATION: ≈ 588.5 FT.	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth Date/Time	DATE COMPLETED: 1-7-89
DRILLING METHODS: CABLE TOOL SPEED STAR		PAGE 1 OF 17

WAH 3-3-89

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	80449 1000 1-6	3 8 10	4	VERY STIFF, OLIVE YELLOW - BROWN, (2.5 Y 5/4) CLAY, HIGH PLASTICITY, WET TO MOIST.	CL	2.5	H_{nu} = BKG. α = BKG. βγ = 600 CPM
2 3	20500 1012 1-6	10 13 16	8	HARD, OLIVE YELLOW - GRAY, (5Y 5/4) CLAY, TRACE OF GRAVEL, HIGH PLASTICITY, MOIST.	CL	>4.0	H_{nu} = BKG. α = BKG. βγ = 450 CPM
4	20501 1020 1-6	14 17 21	8	VERY STIFF, GRAYISH BROWN, (2.5Y 5/2), CLAY, TRACE OF GRAVEL, HIGH PLASTICITY, MOIST.	CL	4.0	H_{nu} = BKG. α = BKG. βγ = 450 CPM
5 6	20502 1030 1-6	25 29 31	15	HARD, LIGHT OLIVE BROWN, (2.5Y 5/4), GRAVELLY CLAY, HIGH PLASTICITY, MOIST.	CL	>4.0	H_{nu} = BKG. α = BKG. βγ = 220 CPM
7	20503 1040 1-6	25 35 37	9	HARD, GRAYISH BROWN, (2.5Y 5/2), GRAVELLY CLAY, HIGH PLASTICITY, MOIST.	CL	>4.0	H_{nu} = BKG. α = BKG. βγ = 220 CPM
8 9	20504 1047 1-6	40 42 40	16	VERY STIFF, GRAY (5Y 4/1) CLAY, TRACE OF GRAVEL, HIGH PLASTICITY, MOIST.	CL	3.5	H_{nu} = BKG α = BKG βγ = 200 CPM
10	20505 1058 1-6	20 21 20	17	VERY STIFF, DARK GRAY, (5Y 4/1). CLAY, TRACE OF GRAVEL, HIGH PLASTICITY, MOIST.	CL	2.75	H_{nu} = BKG. α = BKG. βγ = 180 CPM
11 12	20506 1521 1-7	5 9 14	6	MEDIUM STIFF, GRAY, (2.5Y 5/0), CLAY, HIGH PLASTICITY, MOIST	CL	.75	H_{nu} = BKG α = BKG βγ = 240 CPM
13	20507 1534 1-7	4 5 8	8	STIFF, GRAYISH BROWN TO DARK GRAY, (10YR 4/1) CLAY, SOME COARSE SAND, MEDIUM TO HIGH PLASTICITY, MOIST.	CL	1.5	H_{nu} = BKG α = BKG βγ = 220 CPM
14	20508 1548 1-7	4 9 14	10	STIFF, GRAY, (10YR 5/1) CLAY, HIGH PLASTICITY, MOIST.	CL	1.5	H_{nu} = BKG. α = BKG. βγ = 200 CPM

NOTES:
1-6-89 PENN. DRILL CO.
1-7-89 DRILLER: Harry Dykes Jr.
ASSIST.: Jim Lang
MATERIALS
SAND: 22 (80 lb) bags 10/20
VOLCLAY GROUT: 47 BAGS (50 lb)
BENTONITE: NONE USED
WATER: 1500 GALS. DRILLING

Color WAH 3-3-89
SOIL DESCRIBED BY MUNSELL COLOR CHART
MND SAMPLING FOLLOWED ASTM STD. PENE. TEST.
ELEVATION TAKEN FROM DAMES AND MOORE DATA SHEET. TOP OF RISER PIPE

(ON SURFACE)
INSTRUMENT BACKGROUND
H_{nu} = 0.4 ppm
α = 0-5 CPM
βγ = 300-500 CPM
EXO TOX = 0-1 ppm LOL

1400 Gallons Grouting Total Water added = 2900 Gallons
WAH 3-3-89

JAN 2000 SDM 665

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6C2

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 01-08-89
ELEVATION: 588.5 Ft. Estimate	GWL: Depth Date/Time	DATE STARTED: 01-06-89
ENGINEER/GEOLOGIST: E. Trollinger W.A. Hertel	Depth Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 4

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (0.50ft)	RECOVERY (In.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	20509 1555 1-7	5 8 14	10	Stiff, Grey (10 YR 5/1) Clay, Trace of Gravel, High to Medium plasticity, Moist	CL	2.0	Hnu = BG α = BG βγ = 180 cpm
17 18	20510 1605 1-7	6 9 11	15	Stiff, Gray (10YR 5/1) Clay, Trace of gravel, Medium to High Plasticity Moist	CL	2.0	Hnu = BG α = BG βγ = 180 cpm
19	20511 1615 1-7	5 11 12	10	Stiff, Brownish Gray (10 YR 5/2) Clay Trace of Gravel - 0.5 In. Medium Plasticity, Moist	CL	1.5	Hnu = BG α = BG βγ = 200 cpm
20 21	20512 0900 1-8	18 10 17	4	Medium Dense, Gray (10YR 5/1) Poorly Graded Gravel (0.25 In. Ave)	GP	N/A	Hnu = BG α = BG βγ = 250 cpm Low Recovery Due to gravel Blocking split spoon opening.
22	20513 0910 1-8	7 9 16	10	Very Stiff, Grayish Brown (10YR 5/2) Inorganic Clay, Trace of Gravel, Medium Plasticity, Moist.	CL	2.25	Hnu = BG α = BG βγ = 220 cpm
23 24	20514 0925 1-8	4 8 11	12	Stiff, Gray, (10 YR 5/1) Inorganic Clay, Trace of Gravel, Medium Plasticity, Moist	CL	1.2	Hnu = BG α = BG βγ = 220 cpm
25	20515 0931 1-8	7 7 12	12	Very Stiff, Gray (10 YR 5/1) Inorganic Clay, Trace of Gravel, Medium Plasticity, Moist	CL	2.0	Hnu = BG α = BG βγ = 220 cpm
26 27	20516 0941 1-8	4 7 11	10	Medium Stiff, Grayish Brown (10YR 5/2) Inorganic Clay, Trace of Gravel, Medium Plasticity, Moist.	CL	0.80	Hnu = BG α = BG βγ = 250 cpm
28	20517 1000 1-8	6 10 14	18	Medium Stiff, Grayish Brown (10YR 5/2) Inorganic Clay, Trace of Gravel Medium Plasticity, Moist	CL	0.80	Hnu = BG α = BG βγ = 250 cpm
29	20518 1007 1-8	7 14 18	14	Very Stiff, Grayish Brown (10YR 5/2) Inorganic Clay, Trace of Gravel Medium Plasticity, Moist.	CL	2.5	Hnu = BG α = BG βγ = 250 cpm

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NOTES:

Penn Drill Rig 1
Rig Type: Speedstar
Driller: Harry Dykes
Assistant: Jim Lang
BILL HERTEL SAT 1-8-89

Instrument Backround @ Surface

	01-07-89	01-08-89
Hnu =	0.4 ppm	0.4 ppm
α =	0-5 cpm	0-5 cpm
βγ =	300-500 cpm	300-500 cpm

GPM

JAN 09 1989

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4013	COORDINATES:		DATE: 1-9-89
ELEVATION: ≈ 588.5	GWL: Depth	Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth	Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: CABLE TOOL · 72 SPEEDSTAR			PAGE 3 OF 17

WAH 3-3-89

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	20519 0947 1-9	11 10 13	8	VERY STIFF, OLIVE GRAY (5Y 5/2). SILTY CLAY, TRACE OF GRAVEL .25 IN - .5 IN, MED. PLASTICITY, MOIST.	CL	2.25	H_{an} = BKG. α = BKG. $\beta\gamma$ = 220 CPM
32 33	20520 1000 1-9	7 11 20	8	VERY STIFF, OLIVE GRAY (5Y 5/2) SILTY CLAY, MEDIUM PLASTICITY, MOIST.	CL	3.3	H_{an} = BKG. α = BKG. $\beta\gamma$ = 200 CPM
34	20521 1024 1-9	13 11 15	10	VERY STIFF, OLIVE GRAY TO GRAY, (5Y 5/2) SILTY CLAY, TRACE OF GRAVEL .25 IN - .5 IN, MED. TO HIGH PLASTICITY. MOIST.	CL	2.5	H_{an} = BKG. α = BKG. $\beta\gamma$ = 180 - 200
TILL F T → FT 35 36	20522 1051 1-9	35 50 50/2 IN	6	VERY DENSE, BROWN (10YR 5/4) POORLY GRADED SAND, VERY LITTLE FINES, DRY.	SP	N/A	H_{an} = BKG. α = BKG. $\beta\gamma$ = 160 - 180 CPM
37 38 39 40				SAMPLING AT 5 FT. INTERVALS HEREAFTER.			
41	20523 1500 1-9	28 40 43	12	VERY DENSE, YELLOWISH BROWN, (10YR 5/4) POORLY GRADED SAND, DRY TO MOIST.	SP	N/A	H_{an} = BKG α = BKG $\beta\gamma$ = 170 CPM
42 43 44							

NOTES: 1-9-89 / DRILLER: HARRY DYKES. ASSIST.: PETE MINELLIN

INSTRU. BKG. CW 1-9-89
H_{an} = 0.16 CPM
α = 0.5 CPM
$\beta\gamma$ = 180-220 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2.1	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-9-89
ELEVATION: ≈588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TRELLINGER	Depth Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: CABLE TOOL '72 SPEEDSTAR		PAGE 4 OF 11

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (WAL 3-3-0)
46	20524 1613 1-9	50+/5"	5	VERY DENSE, BROWN (10YR 4/3). POORLY GRADED SAND, DRY.	SP	N/A	Hnu = BKG α = BKG βγ = ~~BKG~~ EJ 160 CPM
47							
48							
49							
50	10665 1633 1-9	21 35 40	12	VERY DENSE, LIGHT BROWN (10YR4/2) POORLY GRADED SAND, DRY.	SP	N/A	Hnu = BKG α = BKG βγ = 160 CPM
51							
52							
53							
54							
55	10666 0935 1-10	50+/4½ in	4	VERY DENSE, BROWN, (10YR4/3), POORLY GRADED SAND, MOIST.	SP	N/A	Hnu = BKG. α = BKG. βγ = 160 CPM
56							
57							
58							
59							

179

NOTES:

HO-19 DRILLER: Harry Dykes Jr
ASSIST. Jim Lang

INSTRU. BKG.
Hnu = 0.4 ppm
α = 0-5 CPM
βγ = 260 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMDC RI/FS		
BORING NUMBER: 4013	COORDINATES: 74.5 FT	DATE: 1-10-89	
ELEVATION: ≈588.5 FT	GWL: Depth 4.06 Date/Time 1-10-89 @ 1600	DATE STARTED: 1-6-89	
ENGINEER/GEOLOGIST: E. TRILLINGER	Depth 120 FT Date/Time 2-7-89 @ 1600	DATE COMPLETED: 2-7-89	
DRILLING METHODS: CABLE TOOL 12 SPEED STARR 71.5' 2-7-89 @ 11:17		PAGE 5 OF 15	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (WAH 3-3-89)
61	10668 1020 1-10	50+/5 in	5	VERY DENSE, BROWN, (10YR 4/2), GRAVELLY SAND, POORLY GRADED, SOME GRAVEL (.25 in - .5 in), MOIST.	SP	N/A	Hmu = BKG α = BKG β/γ = 150 CPM
62							
63							
64							
65							
66	10668 1400 1-10	50+/5 in	4	VERY DENSE, LIGHT BROWN-GRAY, (10YR 4/2), POORLY GRADED SAND, MEDIUM TO FINE, MOIST ~~TO WET~~. C.T. 1-10-89	SP	N/A	Hmu = BKG. α = BKG. β/γ = 160-180 CPM
67							
68							
69							
70							
71	10669 1445 1-10	44 42 36	8	VERY DENSE, DARK GRAYISH BROWN, (10YR 4/2), POORLY GRADED SAND, MOIST.	SP	N/A	Hmu = BKG. α = BKG. β/γ = 120 CPM
72							
73							
74				WATER TABLE ELEV. 1-10-89			
							180

2-7-89
2-7-89
1-10-89

NOTES:
1-10-89 PENN DRILL.
DRILLER: Harry Dykes
ASSIST.: Jim Lang

INSTRU. BKG. 1-10-89
Hmu = 0.4 ppm
α = 0-5 CPM
β/γ = 200 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4013	COORDINATES:	DATE: 1-10-89 / 1-11/89	
ELEVATION: ≈ 588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89	
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth Date/Time	DATE COMPLETED: 2-7-89	
DRILLING METHODS: CABLE TOOL '72 SPEED STAR		PAGE 6 OF ~~15~~ 1	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (WAH 3-3-89)
76	10670 1556 1-10	21 32 50/4 IN	10	VERY DENSE, DARK BROWN (10YR 3/3), POORLY GRADED SAND, WET.	SP	N/A	H_{max} = BKG α = BKG $\beta\gamma$ = 140 CPM
77							
78							
79							
80							
81	10671 1620 1-10	50+/5 IN	4	VERY DENSE, DARK BROWN, (10YR 4/2) WELL GRADED, GRAVELLY SAND SOME GRAVEL .25-.5 IN, WET.	SW	N/A	H_{max} = BKG α = BKG $\beta\gamma$ = BKG - 160 BPM
82							
83							
84							
85							
86	10672 0930 1-11	46 50+/1 IN	6	VERY DENSE, DARK BROWN, (10YR 4/3), POORLY GRADED SAND, TRACE OF FINE GRAVEL .25 IN, WET.	SP	N/A	H_{max} = BKG α = BKG $\beta\gamma$ = 120 CPM
87							
88							
89							

NOTES:

DRILLER: Harry Dykes.
ASSIST.: Jim Laing

INSTRU. BKG.
H_{max} = 0.4 ppm
α = 0-5 CPM
$\beta\gamma$ = 200 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 402 TASK 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4013	COORDINATES:		DATE: 1-11-89 / 1-17-89
ELEVATION: ≈ 538.5 FT	GWL: Depth	Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TRUELINGER	Depth	Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: Cable Tool			PAGE 7 OF 11

WAH 3-3-89

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	10673 1030 1-11	28 27 25	12	VERY DENSE, DARK GRAYISH BROWN, (10YR 4/2), POORLY GRADED SAND, TRACE OF FINE GRAVEL (.25 IN), WET.	SP	N/A	Hum = BKG α = BKG βγ = 100 CPM
92							
93							
94							
95							
96	10674 1045 1-17	50 50+/4 IN	8	VERY DENSE, DARK BROWN, (10YR 4/3) POORLY GRADED SAND, TRACE OF GRAVEL @ 95.5 FT (.25-1.0 IN) WET.	SP	N/A	Hum = BKG α = BKG βγ = 90 CPM
97							
98							
99							
100							
101	10675 1340 1-17	2 5 9	7	MEDIUM DENSE, DRK GRAYISH BROWN (10YR 3/2) WELL GRADED SAND, TRACE OF GRAVEL (.25 IN - .5 IN) WET.	SW	N/A	Hum = BKG α = BKG βγ = 100 CPM
102							
103							
104							

182

NOTES:

1-11-89 DRILLER: Harry Dykes Jr
ASSIST.: Jim Long

1-17-89 DRILLER: Harry Dykes Jr
ASSIST.: Bob Yoest

INSTRU. BKG. 1-11-89
Hum = 0.4 ppm
α = 0-5 cpm
βγ = 180-200 cpm
BKG. SAME 1-17-89

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-18-89
ELEVATION: ~588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: CABLE TOOL '72 SPEED STAR		PAGE 8 OF 15

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (WAH 3-3-89)
106	10676 0856 1-18	22 50/5 IN	7	VERY DENSE, DARK BROWN, (10 YR 3/3), POORLY GRADED SAND, TRACE OF COARSE SAND AT 105.5 FT, WET.	SP	N/A	Hmax = BKG. α = BKG. βγ = 180 CPM
107							
108							
109							
110	10677 1010 1-18	40 37 50	12	VERY DENSE, DARK BROWN, (10 YR 3/3). POORLY GRADED SAND, TRACE OF GRAVEL, WET.	SP	N/A	Hmax = BKG. α = BKG. βγ = 120 CPM
111							
112							
113							
114							
115	10678 1118 1-18	21 27 50	10	VERY DENSE, DARK BROWN, (10 YR 3/3). POORLY GRADED SAND, TRACE OF GRAVEL AT 115.5 FT, WET	SP	N/A	Hmax = BKG α = BKG βγ = 100-120 CPM
116							
117							
118							
119							

183

NOTES:
1-5-89 DRILLER: Harry Dykes Jr.
ASSIST.: Bob Yates

INSTRU. BKG. 1-17-89
Hmax = 0.4 mR
α = 0-5 CPM
βγ = 180-200 CPM
BKG SAME AS ABOVE 1-18-89

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-18-89
ELEVATION: ~588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TRELLINGER	Depth Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: CABLE TOOL '72 SPEED STAR		PAGE 9 OF ~~15~~ 1[illegible]

WAH 3-3-89

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121	10679 1400 1-18	28 29 22	10	VERY DENSE, DARK BROWN (10YR 3/3) WELL GRADED GRAVEL, SOME SAND COARSE TO MEDIUM, WET.	GW	N/A	Hmu = BKG. α = BKG. βγ = 120 CPM
122							
123							
124							
125							
126	10680 1515 1-18	50+ 4IN	3	VERY DENSE, DARK GRAYISH BROWN, (10YR 4/2), GRAVELLY SAND, WELL GRADED, WET.	SW	N/A	Hmu = BKG. α = BKG. βγ = 100-110 CPM. Low recovery due to drame
127							
128							
129							
130							
131	10681 1620 1-18	7 11 11	8	MEDIUM DENSE, DARK BROWN, (10YR 3/3), POORLY GRADED SAND, TRACE OF GRAVEL (.25-.50 IN), WET.	SP	N/A	Hmu = BKG α = BKG βγ = 100 CPM
132							
133							
134							

NOTES:
1-18-89 DRILLER: Harry Dykes
ASSIST.: Bob. Yost

1-18-89 INSTRU. BKG.
Hmu = 0.4 DPM
α = 0.5 CPM
βγ = 180 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 607 TASK 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-19-89 / 1-23-89
ELEVATION: ~588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TRULLINGER	Depth Date/Time	DATE COMPLETED: [illegible]
DRILLING METHODS: CABLE TOOL '72 SPEED STAR		PAGE 10 OF 17

WAH 3-8-89

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136	10682 1415 1-21-89	17 50 50(4 in)	10	Very dense, Dark gray brown (10yr 4/2) Gravelly sand, well graded, wet	SW	N/A	Hrm = Bkg α = Bkg. βγ = 230 cpm
137							
138							
139							
140							
141	10683 1515 1-21	5 22 42	6	Very dense, dark gray brown (10yr 4/1) Poorly sorted sand, trace gravel. Wet	SP	N/A	Hrm = Bkg α = Bkg βγ = 180
142							
143							
144							
145							
146	10684 1107 1-23	45 47 50/4 in	12	VERY DENSE, GRAYISH BROWN, (10YR 4/2) POORLY GRADED SANDY GRAVEL (.25 in - .5 in), WET.	GP	N/A	Hrm = Bkg. α = Bkg βγ = 120-140 cpm.
147							
148							
149							

185

NOTES: Driller: Harry Dykes
Assist. Bob Yost

Lorrie Adams / Geologist
For 1-21-89, 02 samples.

1/21/89

Instrm Bkg
H_{rm} = .2 ppm
α = 0 cpm
βγ = 200 cpm - 230 cpm

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6002 TASK 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4013	COORDINATES:		DATE: 1-23-89
ELEVATION: ~588.5 FT	GWL: Depth	Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TRUNINGER	Depth	Date/Time	DATE COMPLETED: 1-7-89
DRILLING METHODS: CABLE TOOL			PAGE 11 OF ~~11~~ 17

WAH 3-3-89

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
151	10685 1345 01-23	50+ / 4in	4	VERY DENSE, GRAYISH BROWN (10YR 4/2) WELL GRADED SANDY GRAVEL, WET.	GW	N/A	Hmu = BKG. α = BKG. βγ = 90-100 CPM
152							
153							
154							
155							
156	10686 1525 01-23	17 20 19	12	DENSE, GRAYISH BROWN (10YR 3/2) WELL GRADED GRAVELLY SAND (.25-.50 IN) GRAVEL, WET.	SW	N/A	Hmu = BKG. α = BKG. βγ = 90-100 CPM
157							
158							
159							
160							
161	10687 1600 01-23	5 6 12	8	MEDIUM DENSE, DARK BROWN, (10YR 3/3) POORLY GRADED SAND, TRACE OF GRAVEL (.25-.50 IN), WET.	SP	N/A	Hmu = BKG. α = BKG. βγ = 100 CPM
162							
163							
164							

186

NOTES.
Driller: Harry Dykes
Assist: Robert Yost

INSTRU. BKG.
Hmu = 0.6 ppm
α = 0 cpm
βγ = 180-200 cpm

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1/24/89
ELEVATION: ~588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROMMINGER	Depth Date/Time	DATE COMPLETED: 2-7-89
DRILLING METHODS: CABLE TOOL 172 SPEED STAR		PAGE 12 OF ~~15~~ 17

WAH 3-3-89

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (ISF)	REMARKS
166	10688 0933 01-24	17 23 23	8	DENSE, DARK BROWN (10YR 3/3) POORLY GRADED SAND, TRACE OF GRAVEL (.25-.50 IN) @ 166.5, WET.	SP	N/A	Hmu = BKG. α = BKG. βγ = 100 CPM
167							
168							
169							
170							
171	10689 1013 01-24	5 7 12	6	MEDIUM DENSE, BROWN (10YR 4/3), POORLY GRADED SAND, TRACE OF FINE GRAVEL (.25-.50 IN), WET	SP	N/A	Hmu = BKG α = BKG βγ = 90-100 CPM
172							
173							
174							
175							
176	10690 1441 01-24	19 29 27	10	VERY DENSE, DARK BROWN (10YR 3/3) POORLY GRADED SAND, MEDIUM TO COARSE, WET.	SP	N/A	Hmu = BKG. α = BKG. βγ = 90-100 CPM
177							
178							
179							

NOTES:
1-24-89
DRILLER: Harry Dykes Jr.
ASSIST.: Robert Yost

INSTRU. BKG. 1-24-89
Hmu = 0.6 ppm
α = 0 CPM
βγ = 160 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-24-89 / 1-25-89
ELEVATION: ~583.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth Date/Time	DATE COMPLETED: 1-7-89
DRILLING METHODS: CABLE TOOL		PAGE 13 OF ~~15~~ 17

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (WAH 3-7-89)
181	10691 1535 01-24	17 19 50	8	VERY DENSE, DK BROWN (10YR 4/3) POORLY GRADED FINE SAND, WET.	SP	N/A	Hnu = BKG α = BKG. βγ = 100 cpm
182							
183							
184							
185							
186	10692 0943 01-25	12 50r/5in	8	VERY DENSE, GRAYISH BROWN (10YR 4/2) POORLY GRADED SAND, TRACE OF GRAVEL @ 186.5 (.75-1.0 in), WET.	SP	N/A	Hnu = BKG. α = BKG. βγ = 100 cpm
187							
188							
189							
190							
191	10693 1014 01-25	4 7 12	8	MEDIUM DENSE, BROWN, (10YR 4/2) POORLY GRADED SAND, TRACE OF FINE GRAVEL (.25 in), WET	SP	N/A	Hnu = BKG α = BKG. βγ = 100 cpm
192							
193							
194							

188

NOTES:

DRILLER: Harry Dykes.
ASSIST.: Richard Yost.

INSTRU. BKG.

1-24-89 Hnu = 0.6 ppm
α = 0 cpm
βγ = 160 cpm

1-25-89 Hnu = .4 ppm
α = 0 cpm βγ = 150 cpm

FERNALD R1/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC R1/FS	
BORING NUMBER: 4013	COORDINATES:	DATE: 1-25-89
ELEVATION: ~588.5 FT	GWL: Depth Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth Date/Time	DATE COMPLETED: 1-7-89
DRILLING METHODS: CABLE TOOL		PAGE 14 OF ~~15~~ 17

WAH 3-3-89

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
196	10694 1307 01-25	7 8 8	10	MEDIUM DENSE, BROWN (10YR 4/3) POORLY GRADED SAND, WET.	SP	N/A	Hmu = BKG. α = BKG. βγ = 100 CPM
197							
198							
199							
200							
201	10695 1400 01-25	8 17 46	12	VERY DENSE, BROWN, (10YR 4/3), POORLY GRADED SAND, MEDIUM GRAINED, WET.	SP	N/A	Hmu = BKG. α = BKG. βγ = 90 CPM
202							
203							
204							
205							
206	10696 1623 01-25	17 25 32	6	VERY DENSE, BROWN, (10YR 4/3) POORLY GRADED SANDY GRAVEL, (.25-.50 IN), WET	GP	N/A	Hmu = BKG α = BKG βγ = 90 CPM
207							
208							
209							

189

NOTES:

DRILLER: HARRY DYKES JR.
ASSIST.: BOB YOST

INSTRU. BKG. 1-25-89
Hmu = 0.4 ppm
α = 0 CPM
βγ = 160 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TASK 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 4013	COORDINATES:		DATE: 1-26-89 / 1-31-89
ELEVATION: ~558.5 FT	GWL: Depth	Date/Time	DATE STARTED: 1-6-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth	Date/Time	DATE COMPLETED: [illegible]
DRILLING METHODS: CABLE TOOL			PAGE 15 OF 17

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (WAH 3-3-89)
211	10697 1000 01-26	12 23 33	6	VERY DENSE, LIGHT BROWN (10YR 4/4) POORLY GRADED SAND, WET.	SP	N/A	Hnu = BKG α = BKG. βγ = 100 CPM
212							
213							
214							
215							
216	10698 1000 01-31	12 27 50	15	VERY DENSE, BROWN, (10YR 4/3) POORLY GRADED SAND, WET.	SP	N/A	Hnu = BKG α = BKG βγ = 100 CPM
217							
218							
219							
220							
221	10699 1115 01-31	50+ / 2 IN	2	VERY DENSE, BROWN, (10YR 4/3), WELL GRADED GRAVEL, SOME SAND, WET.	GW	N/A	Hnu = BKG. α = BKG. βγ = 100 CPM
222				BEDROCK @ 222.5 FT			
223							
224							

NOTES:

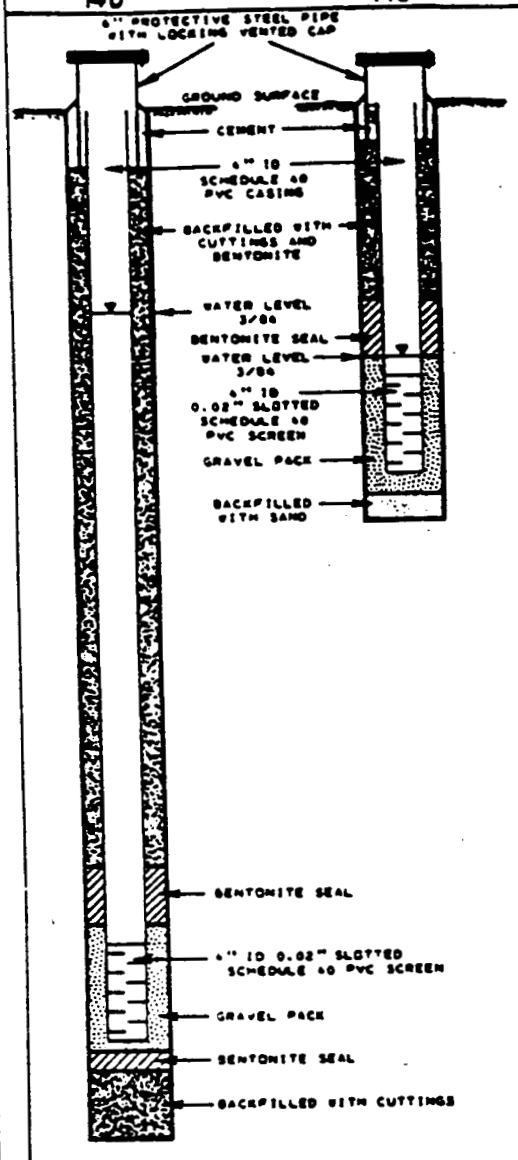
DRILLER: HARRY DYKES JR.
ASSIST.: ROBERT YOST

INSTRU. BKG. 1-26-89, 1-31-89
Hnu = 0.6 PPM
α = 0 CPM
βγ = 180 CPM

BORING 14

SURFACE ELEVATION 14D 533.71'
14S 533.79'

WELL SCHEMATICS

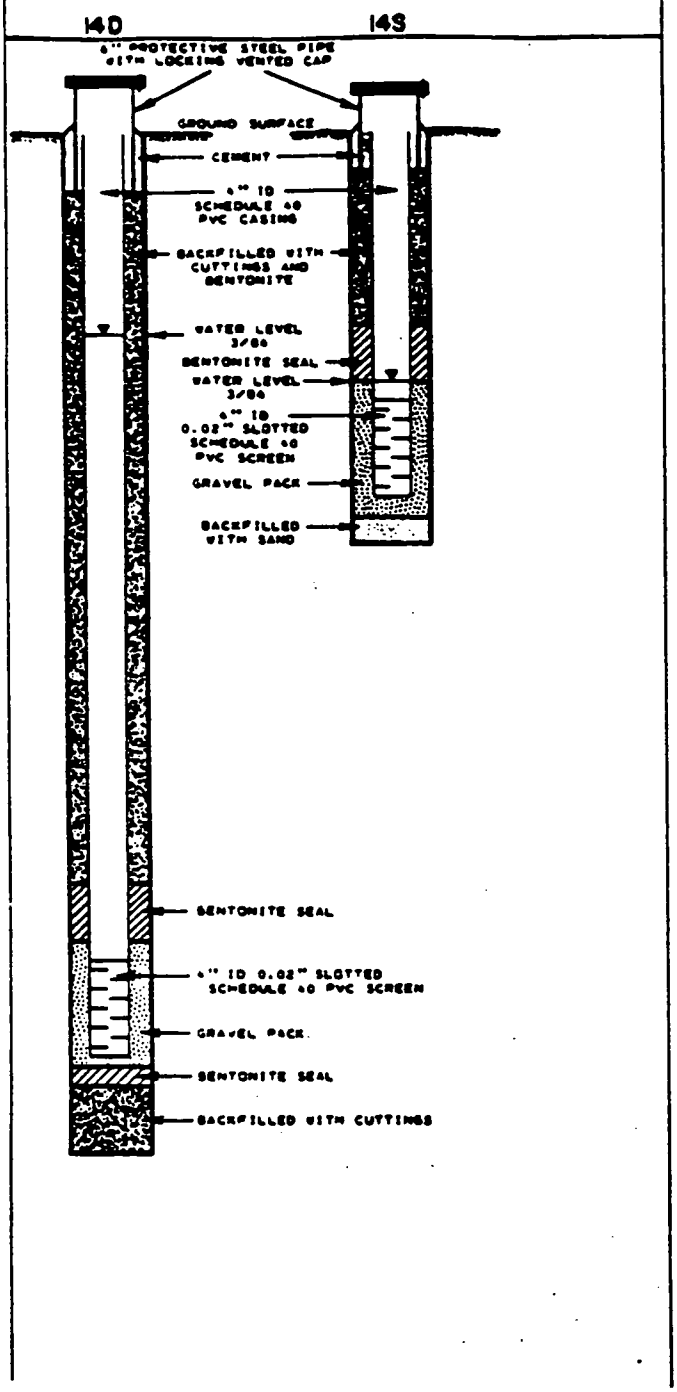


DEPTH IN FEET	ELEVATION IN FEET	GRAPHIC LOG	DESCRIPTIVE GEOLOGIC NOTES
0			GRASS OVER SILTY LOAM
5	530		OLIVE GRAY (5Y3/2) SILTY SAND WITH UP TO 10% GRAVEL. BLEACHED CLAY PODS PRESENT
			OLIVE BROWN (5Y4/4) COARSE GRAVEL IN MEDIUM SAND MATRIX
10	525		OLIVE BROWN (5Y4/4) MEDIUM TO COARSE GRAINED SAND, 3-10% GRAVEL
15	520		OLIVE BROWN (5Y4/4) FINE TO MEDIUM GRAINED SAND. LESS THAN 1% GRAVEL
			OLIVE BROWN (5Y4/4) MEDIUM TO COARSE SAND WITH UP TO 3% GRAVEL
20	515		
25	510		
			CONTAINS SEVERAL LARGE (1.5" DIAMETER) PEBBLES OF LIMESTONE AND QUARTZ
30	505		OLIVE BROWN (5Y4/4) COARSE SAND WITH SOME GRAVEL
35	500		OLIVE BROWN (5Y4/4) COARSE SAND WITH SILT. LESS THAN 1% GRAVEL
40	495		
45	490		
50	485		
55	480		
60	475		
65	470		BORING TERMINATED AT A DEPTH OF 65.0' ON 8/10/84

BORING 14

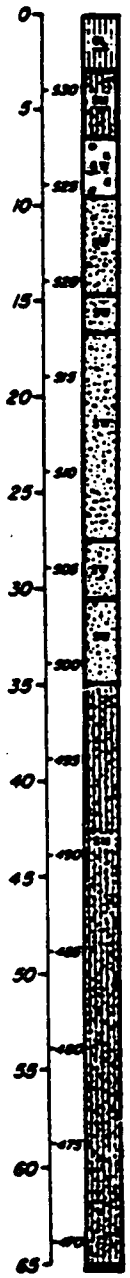
SURFACE ELEVATION 14D 533.71'
14S 533.79'

WELL SCHEMATICS



DEPTH IN FEET
ELEVATION IN FEET
GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES



GRASS OVER SILTY LOAM

OLIVE GRAY (5Y3/2) SILTY SAND WITH UP TO 10% GRAVEL. BLEACHED CLAY PODS PRESENT

OLIVE BROWN (5Y4/4) COARSE GRAVEL IN MEDIUM SAND MATRIX

OLIVE BROWN (5Y4/4) MEDIUM TO COARSE GRAINED SAND. 3-10% GRAVEL

OLIVE BROWN (5Y4/4) FINE TO MEDIUM GRAINED SAND. LESS THAN 1% GRAVEL

OLIVE BROWN (5Y4/4) MEDIUM TO COARSE SAND WITH UP TO 3% GRAVEL

CONTAINS SEVERAL LARGE (1.5" DIAMETER) PEBBLES OF LIMESTONE AND QUARTZ

OLIVE BROWN (5Y4/4) COARSE SAND WITH SOME GRAVEL

OLIVE BROWN (5Y4/4) COARSE SAND WITH SILT. LESS THAN 1% GRAVEL

BORING TERMINATED AT A DEPTH OF 65.0' ON 8/10/84

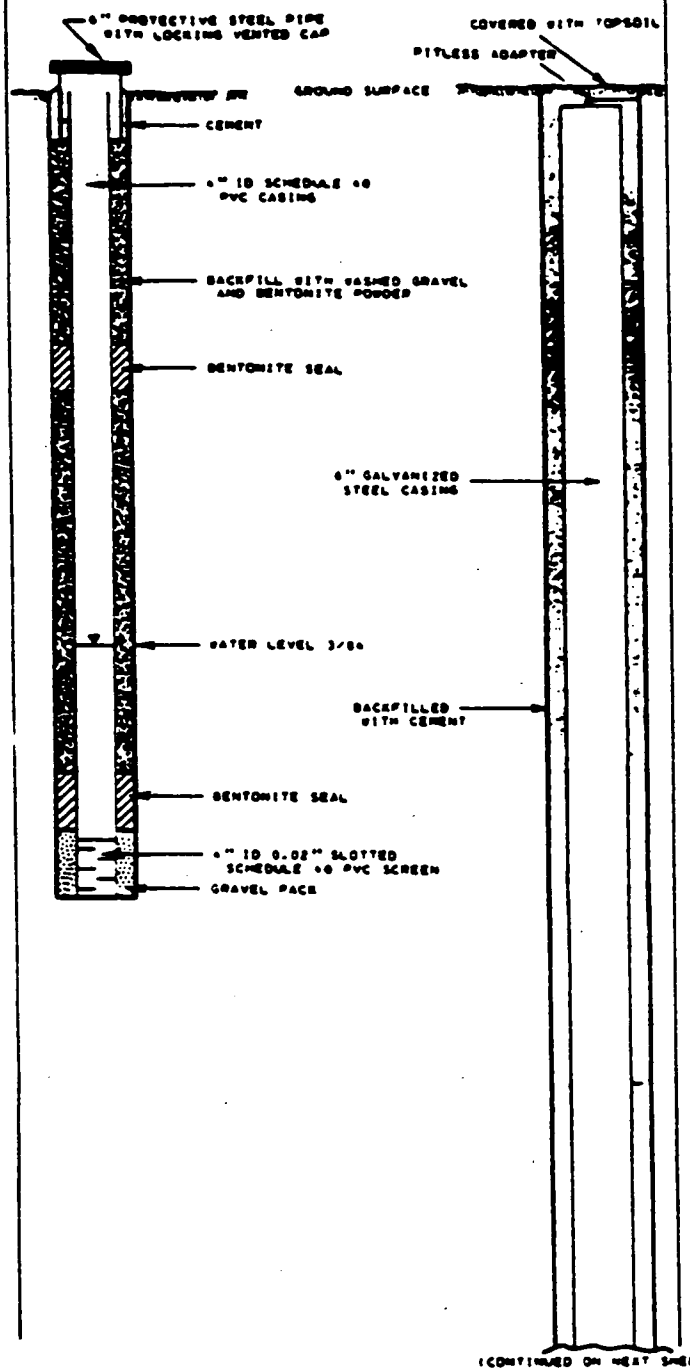
BORING 15

258

SURFACE ELEVATION 155 570.61'
150 577.60'

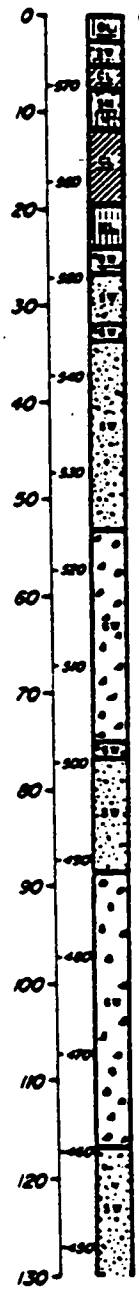
WELL SCHEMATICS

155 | 150



(CONTINUED ON NEXT SHEET)

DEPTH IN FEET | ELEVATION IN FEET | GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

CLAYEY LOAM TOPSOIL

MEDIUM TO FINE GRAINED SAND

LIGHT OLIVE BROWN (5Y5/6) SILTY CLAY WITH IRON STAINS AND BLEACHED PODS

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND AND SANDY SILT, WELL GRADED

GRAYISH OLIVE (10Y4/2) MASSIVE LENSE OF SILTY CLAY WITH SOME GRAVEL (UP TO 5-7%)

DENSE DRY CLAYEY SILT

MEDIUM TO COARSE GRAVEL

LIGHT OLIVE BROWN (5Y5/6) COARSE SAND WITH SOME GRAVEL (QUARTZ AND LIMESTONE FRAGMENTS)

GRAVEL WITH SOME CLAY

OLIVE BROWN (5Y5/6) MEDIUM TO COARSE SAND WITH SOME GRAVEL

COARSE WELL SORTED GRAVEL, LESS THAN 1% SILT OR CLAY

LIGHT OLIVE BROWN SANDY GRAVEL

LIGHT OLIVE BROWN GRAVELLY SAND

LIGHT OLIVE BROWN GRAVEL WITH SOME SAND

GRAYISH-BROWN GRAVELLY SAND

DAMES & MOORE

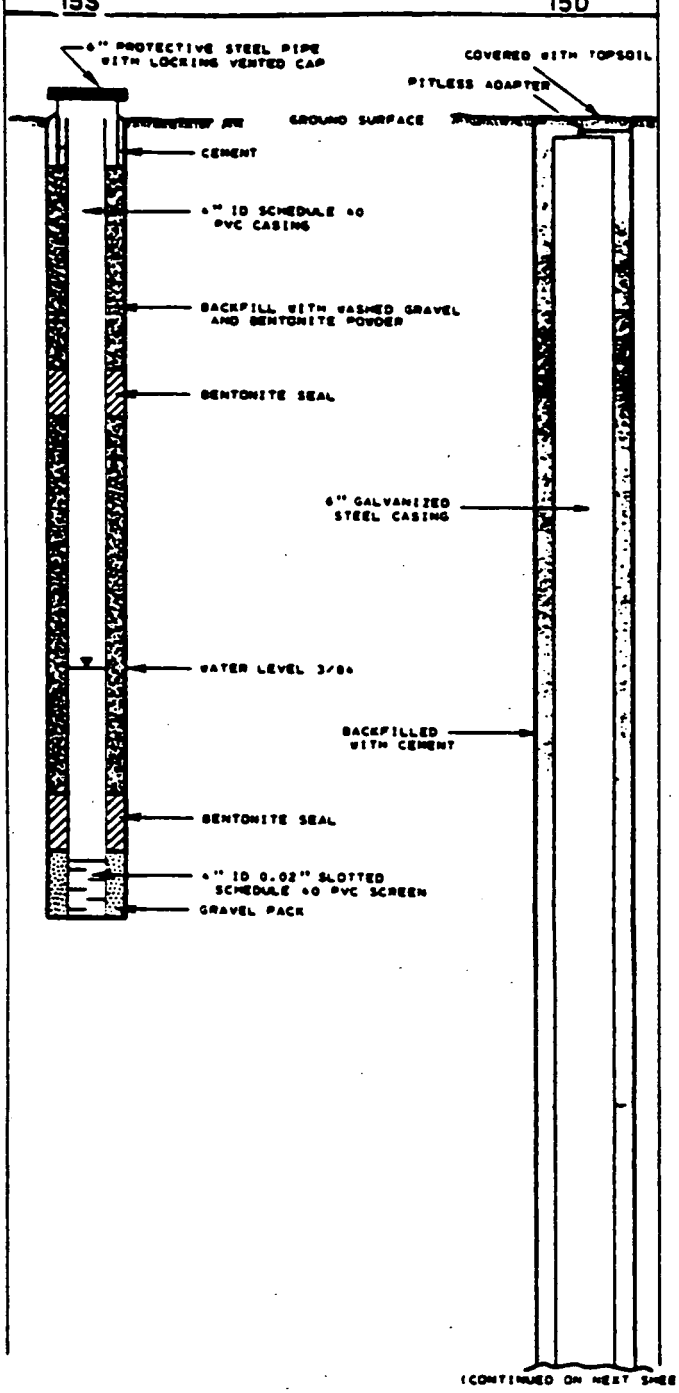
FIGURE A4-E4

BORING 15

258

SURFACE ELEVATION 15S 579.61'
15D 577.80'

WELL SCHEMATICS



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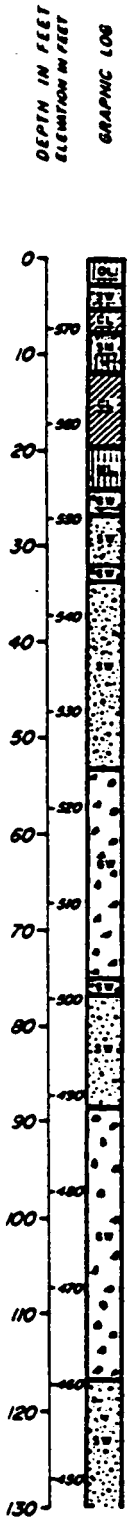


DESCRIPTIVE GEOLOGIC NOTES

- CLAYEY LOAM TOPSOIL
- MEDIUM TO FINE GRAINED SAND
- LIGHT OLIVE BROWN (5Y5/6) SILTY CLAY WITH IRON STAINS AND BLEACHED PODS
- LIGHT OLIVE BROWN (5Y5/6) SILTY SAND AND SANDY SILT, WELL GRADED
- GRAYISH OLIVE (10Y4/2) MASSIVE LENSE OF SILTY CLAY WITH SOME GRAVEL (UP TO 5-7%)
- DENSE DRY CLAYEY SILT
- MEDIUM TO COARSE GRAVEL
- LIGHT OLIVE BROWN (5Y5/6) COARSE SAND WITH SOME GRAVEL (QUARTZ AND LIMESTONE FRAGMENTS)
- GRAVEL WITH SOME CLAY
- OLIVE BROWN (5Y5/6) MEDIUM TO COARSE SAND WITH SOME GRAVEL
- COARSE WELL SORTED GRAVEL, LESS THAN 1% SILT OR CLAY
- LIGHT OLIVE BROWN SANDY GRAVEL
- LIGHT OLIVE BROWN GRAVELLY SAND
- LIGHT OLIVE BROWN GRAVEL WITH SOME SAND
- GRAYISH-BROWN GRAVELLY SAND

DAMES & MOORE

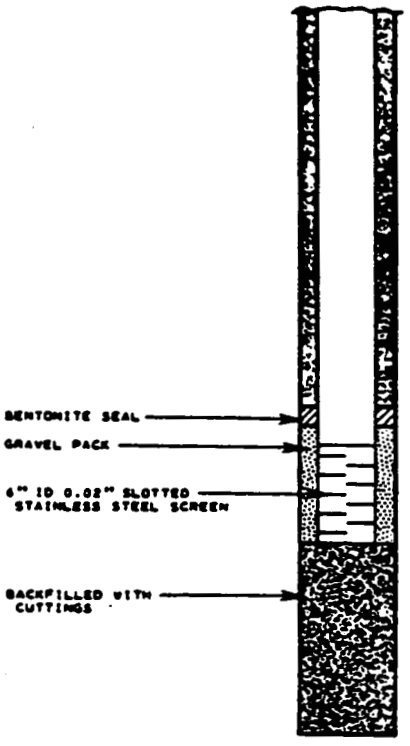
FIGURE A4-E4

BORING 15

258

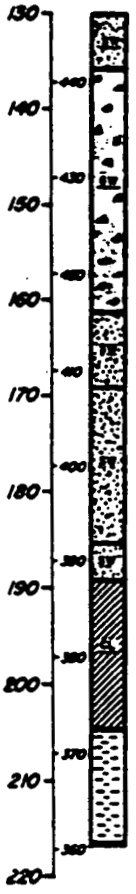
WELL SCHEMATICS

15D
(CONTINUED)



DEPTH IN FEET
ELEVATION IN FEET
GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES



GRAYISH-BROWN GRAVELLY SAND

GRAVEL WITH SOME SAND

GRAVELLY SAND

OLIVE GRAY SAND WITH UP TO 10% GRAVEL
SAND, NO GRAVEL

SAND, NO GRAVEL

GRAY CLAY GRADING INTO GREENISH-BLACK
("BLUE CLAY") SILTY CLAY, LARGE COBBLES
ON TOP OF CLAY LAYER

SHALE

BORING TERMINATED AT A DEPTH OF 217.0' ON 8/9/84

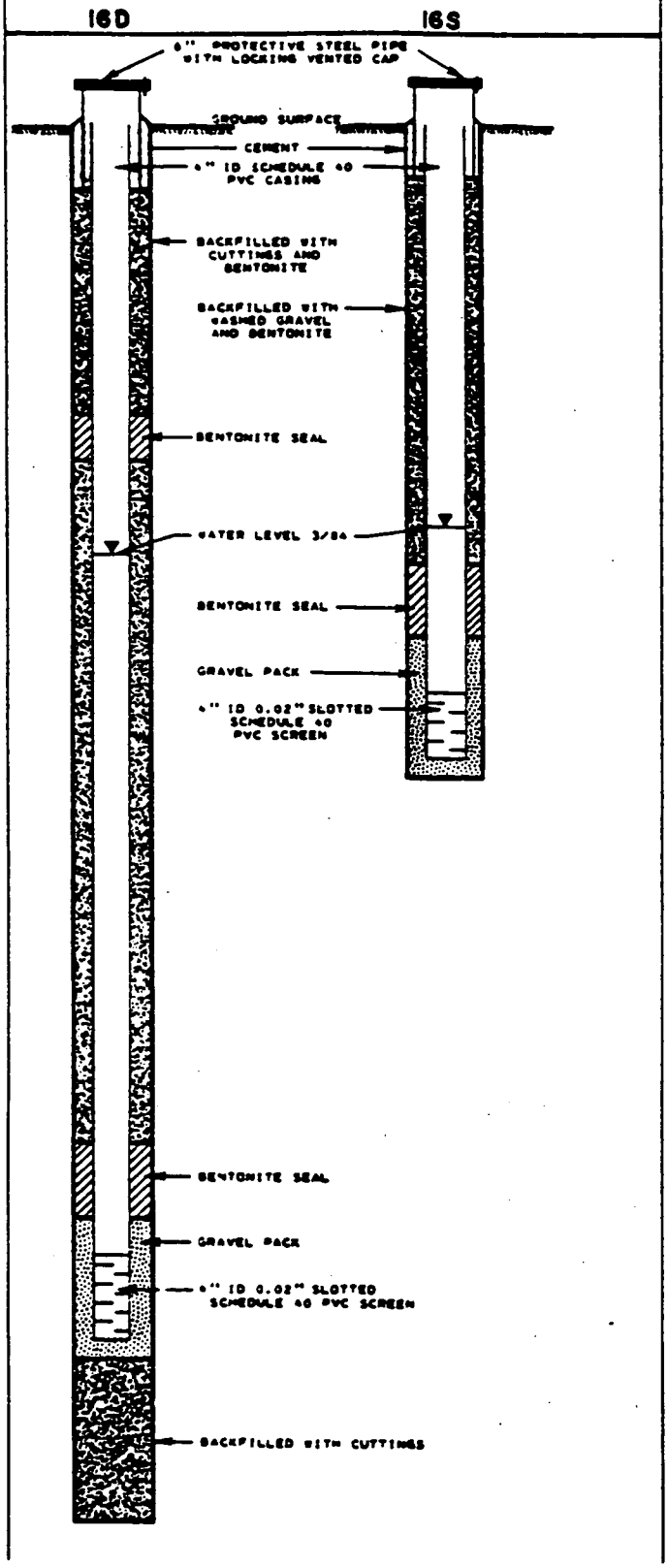
DAMES & MOORE

FIGURE A4-5R

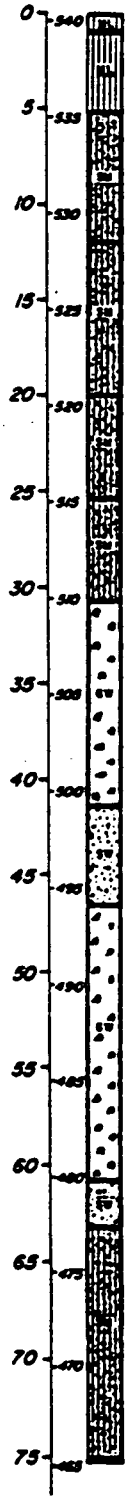
BORING 16

SURFACE ELEVATION 16D 540.47'
16S 540.30'

WELL SCHEMATICS



DEPTH IN FEET / ELEVATION IN FEET / GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

0-9" BLACK SILTY FILL MATERIAL (PROBABLY FLYASH)
DARK YELLOWISH BROWN (10YR5/4) CLAYEY SILT

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SILTY SAND. CONTAINS LIMESTONE FRAGMENTS UP TO 3" AND PEBBLES OF QUARTZ (SUBROUNDED TO ANGULAR) DECREASING IN QUANTITY WITH DEPTH

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND. NO PEBBLES WELL SORTED. DECREASING IN GRAIN SIZE WITH DEPTH

DUSKY YELLOW (5Y6/4) FINE GRAINED SILTY SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SANDY GRAVEL WITH PEBBLES OF QUARTZ (UP TO 1/2" DIAMETER) AND LIMESTONE (ROUNDED TO SUBROUNDED)

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SAND WITH GRAVEL. WELL SORTED

LIGHT OLIVE BROWN (5Y5/6) COARSE GRAINED SANDY GRAVEL WITH SUBANGULAR TO SUBROUNDED PEBBLES OF QUARTZ AND LIMESTONE

OLIVE BROWN (5Y4/4) MEDIUM TO COARSE GRAINED SAND

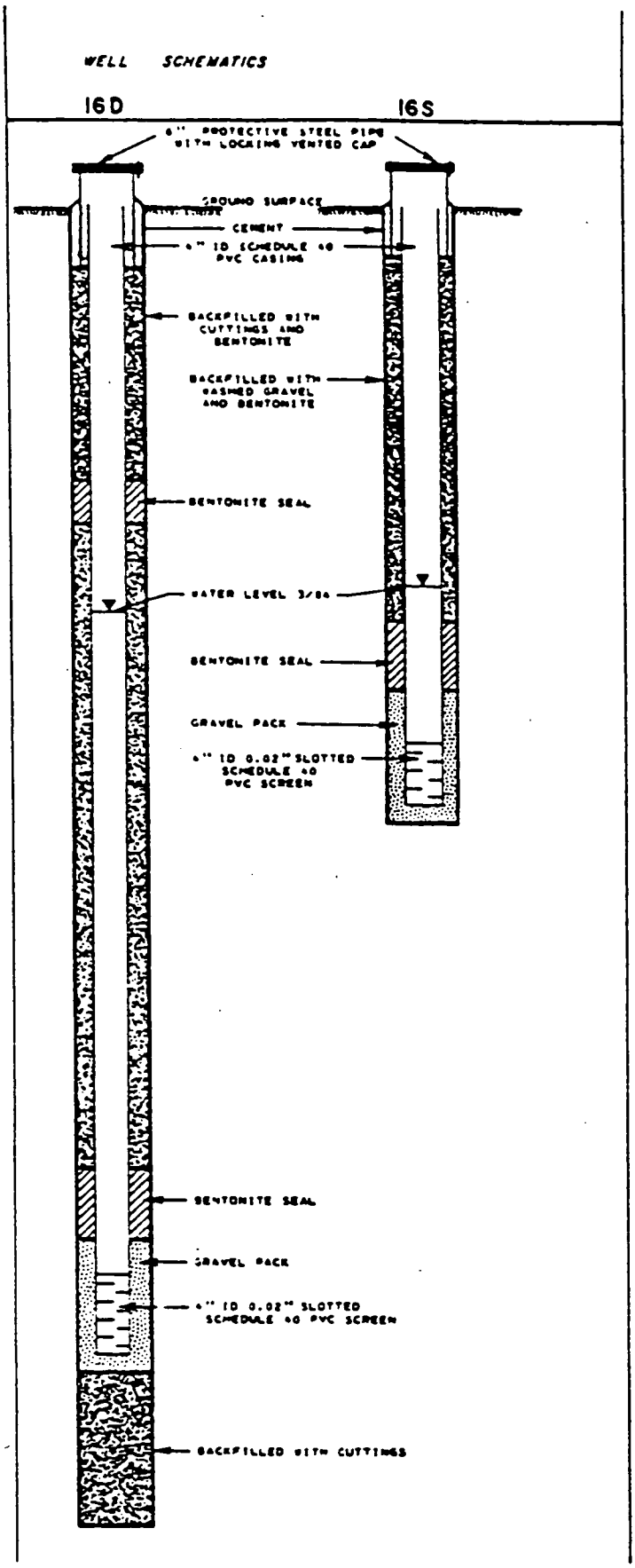
DARK OLIVE BROWN (5Y4/4) TO LIGHT OLIVE BROWN (5Y5/6) SILTY SAND

BORING TERMINATED AT A DEPTH OF 75.0' ON 1/17/85

DAMES & MOORE

FIGURE A6-6

WELL SCHEMATICS

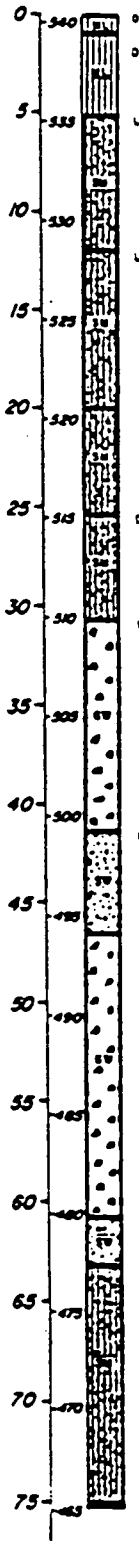


DEPTH IN FEET | ELEVATION IN FEET | GRAPHIC LOG

BORING 16

SURFACE ELEVATION 16D 540.47'
16S 540.30'

DESCRIPTIVE GEOLOGIC NOTES



0-6" BLACK SILTY FILL MATERIAL (PROBABLY FLYASH)
DARK YELLOWISH BROWN (10YR3/4) CLAYEY SILT

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SILTY SAND. CONTAINS LIMESTONE FRAGMENTS UP TO 3" AND PEBBLES OF QUARTZ (SUBROUNDED TO ANGULAR) DECREASING IN QUANTITY WITH DEPTH

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND. NO PEBBLES WELL SORTED. DECREASING IN GRAIN SIZE WITH DEPTH

DUSKY YELLOW (5Y6/4) FINE GRAINED SILTY SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SANDY GRAVEL WITH PEBBLES OF QUARTZ (UP TO 1/2" DIAMETER) AND LIMESTONE (ROUNDED TO SUBROUNDED)

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SAND WITH GRAVEL. WELL SORTED

LIGHT OLIVE BROWN (5Y5/6) COARSE GRAINED SANDY GRAVEL WITH SUBANGULAR TO SUBROUNDED PEBBLES OF QUARTZ AND LIMESTONE

OLIVE BROWN (5Y4/4) MEDIUM TO COARSE GRAINED SAND

DARK OLIVE BROWN (5Y3/4) TO LIGHT OLIVE BROWN (5Y5/6) SILTY SAND

BORING TERMINATED AT A DEPTH OF 75.0' ON 1/17/85

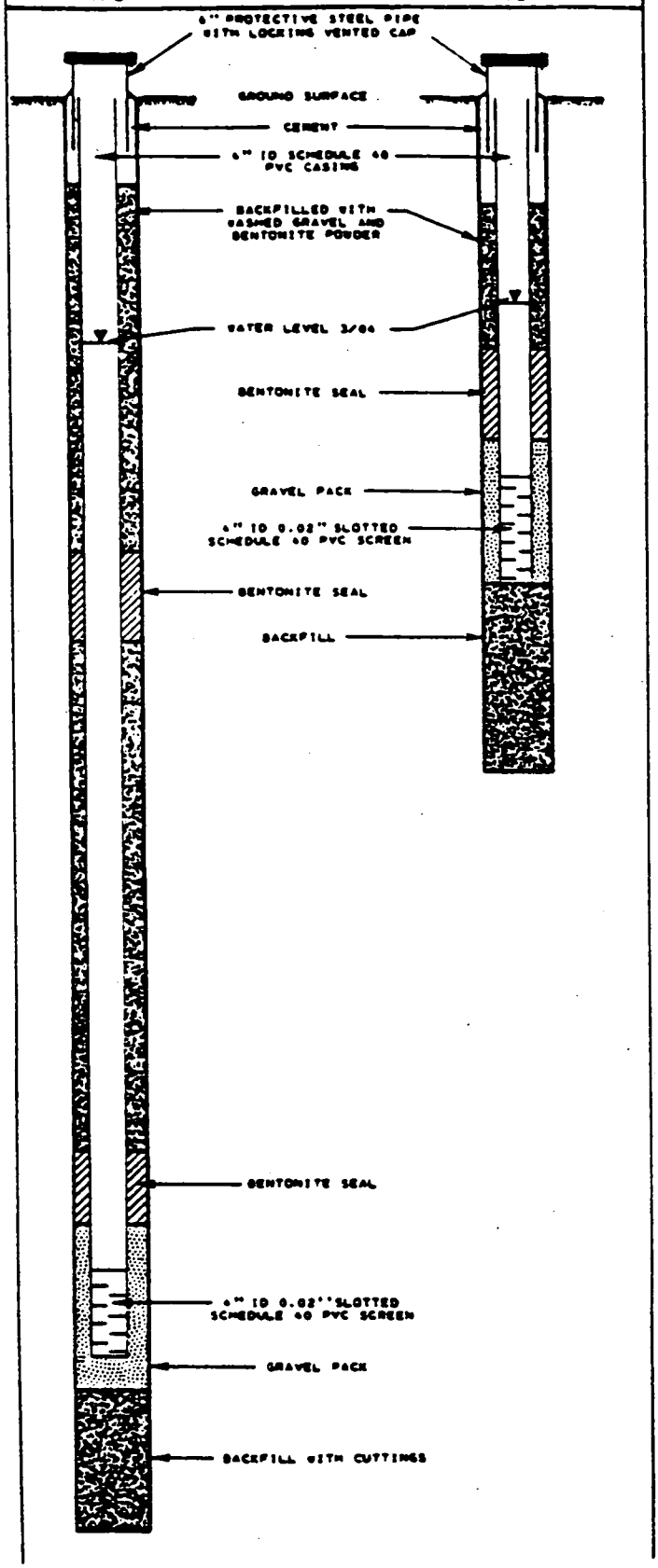
DAMES & MOORE

Figure A4-6

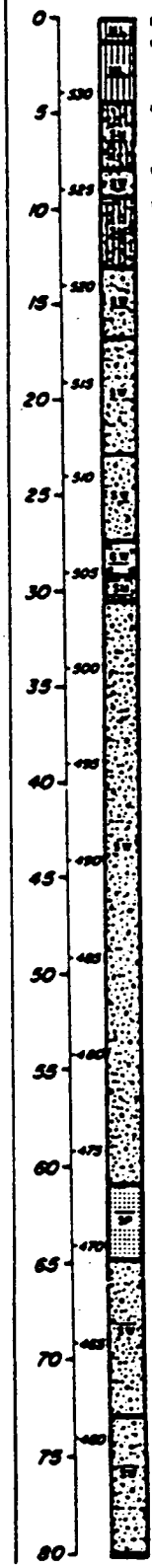
BORING 17

SURFACE ELEVATION 17D 534.28'
17S 534.03'

WELL SCHEMATICS



DEPTH IN FEET / ELEVATION IN FEET / GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

BROWN CLAYEY SILT

PALE BROWN (5YR6/2) CLAYEY SILT, SOME ROOTS CONTACT IS SHARP AND WELL DEFINED

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND WITH SMALL AMOUNT OF GRAVEL, DRY LOOSE, SOME YELLOW LIMONITE STAINING NEAR CONTACT WITH CLAYEY SILT

LIGHT OLIVE BROWN (5Y5/6) GRAVELLY SAND, CONTACT IS SHARP AND WELL DEFINED

MEDIUM TO FINE GRAINED LIGHT OLIVE BROWN (5Y5/6) SILTY SAND, WELL SORTED

LIGHT OLIVE BROWN (5Y5/6) COARSE GRAVELLY SAND, CONTACT IS GRADATIONAL

LIGHT OLIVE BROWN (5Y5/6) FINE TO MEDIUM WELL SORTED SAND, MODERATE OLIVE BROWN (5Y6/4) COARSE TO MEDIUM WELL SORTED SAND

LIGHT OLIVE GRAY (5Y5/2) TO LIGHT OLIVE BROWN (5Y5/6) GRAVELLY SAND WITH SOME SILT AND PEBBLES UP TO 1" IN DIAMETER, CONTACT IS SHARP AND WELL DEFINED

COARSE GRAVEL, WELL SORTED CONSISTING OF LIMESTONE AND QUARTZ PEBBLES, CONTACT IS GRADATIONAL WITH GRAVEL GOING TO A MEDIUM TO COARSE SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED, WELL SORTED SILTY SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE SAND WITH UP TO 5% GRAVEL

DARK OLIVE BROWN (5Y6/6) SAND WITH UP TO 1% GRAVEL, COARSER GRAINED AND NOT AS WELL SORTED AS ABOVE

DARK YELLOWISH BROWN (10YR6/6) MEDIUM TO COARSE SAND WITH 5% GRAVEL

DARK YELLOWISH BROWN (10YR6/6) FINE TO MEDIUM GRAINED SAND

BORING TERMINATED AT A DEPTH OF 80.0' ON 1/29/85

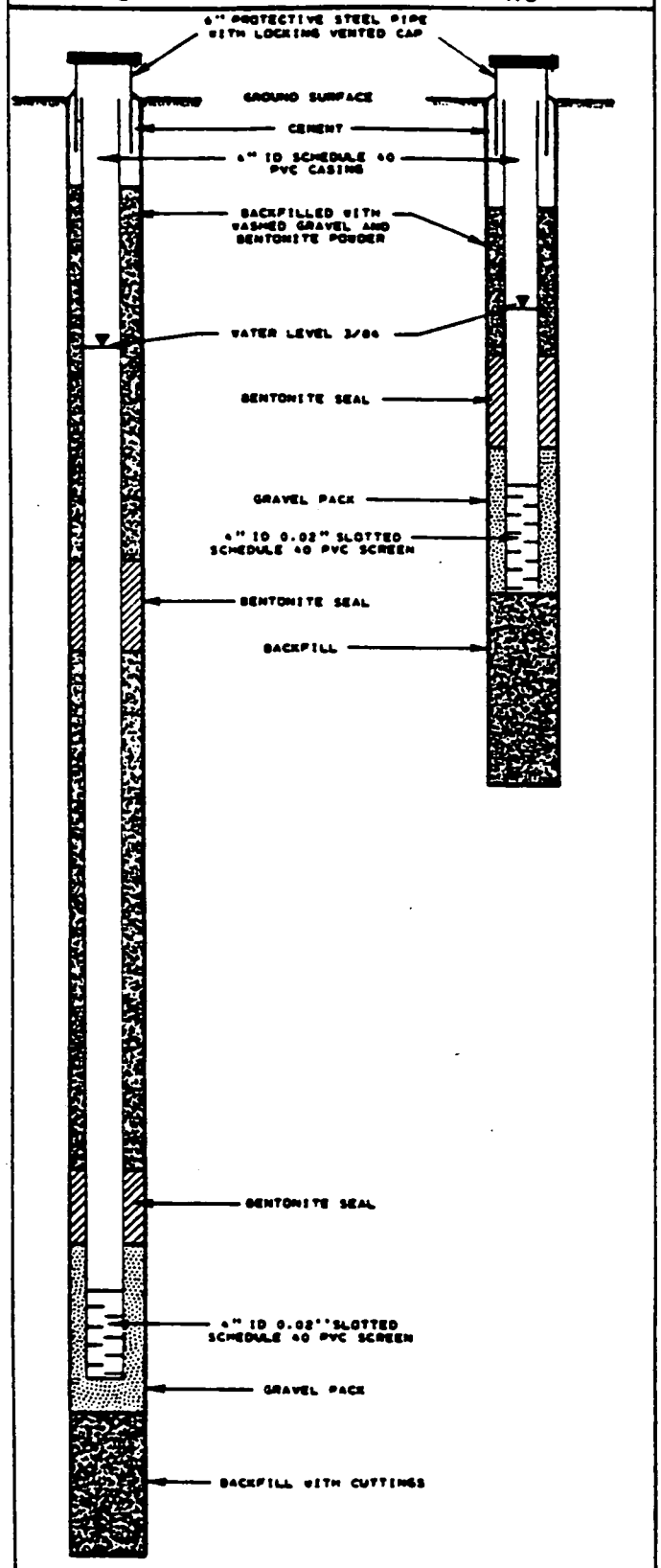
DAMES & MOORE

FIGURE A4-7

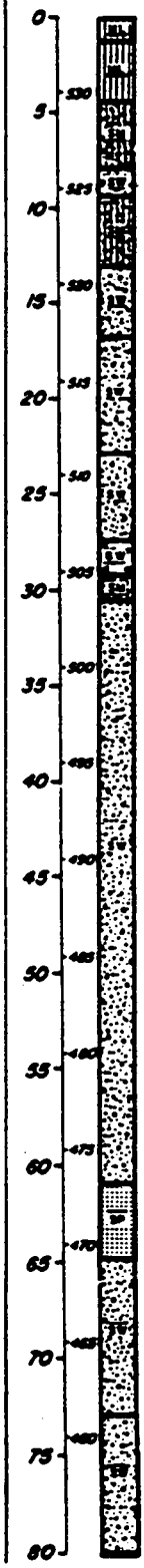
BORING 17

SURFACE ELEVATION 17D 534.28'
17S 534.43'

WELL SCHEMATICS



DEPTH IN FEET / ELEVATION IN FEET / GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

BROWN CLAYEY SILT

PALE BROWN (5YR5/2) CLAYEY SILT, SOME ROOTS
CONTACT IS SHARP AND WELL DEFINED

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND WITH SMALL AMOUNT OF GRAVEL, DRY LOOSE, SOME YELLOW LIMONITE STAINING NEAR CONTACT WITH CLAYEY SILT

LIGHT OLIVE BROWN (5Y5/6) GRAVELLY SAND, CONTACT IS SHARP AND WELL DEFINED

MEDIUM TO FINE GRAINED LIGHT OLIVE BROWN (5Y5/6) SILTY SAND, WELL SORTED

LIGHT OLIVE BROWN (5Y5/6) COARSE GRAVELLY SAND, CONTACT IS GRADATIONAL

LIGHT OLIVE BROWN (5Y5/6) FINE TO MEDIUM WELL SORTED SAND, MODERATE OLIVE BROWN (5Y4/4) COARSE TO MEDIUM WELL SORTED SAND

LIGHT OLIVE GRAY (5Y5/2) TO LIGHT OLIVE BROWN (5Y5/6) GRAVELLY SAND WITH SOME SILT AND PEBBLES UP TO 1" IN DIAMETER, CONTACT IS SHARP AND WELL DEFINED

COARSE GRAVEL, WELL SORTED CONSISTING OF LIMESTONE AND QUARTZ PEBBLES, CONTACT IS GRADATIONAL WITH GRAVEL GOING TO A MEDIUM TO COARSE SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED, WELL SORTED SILTY SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE SAND WITH UP TO 5% GRAVEL

DARK OLIVE BROWN (5Y4/6) SAND WITH UP TO 1% GRAVEL, COARSER GRAINED AND NOT AS WELL SORTED AS ABOVE

DARK YELLOWISH BROWN (10YR6/6) MEDIUM TO COARSE SAND WITH 5% GRAVEL

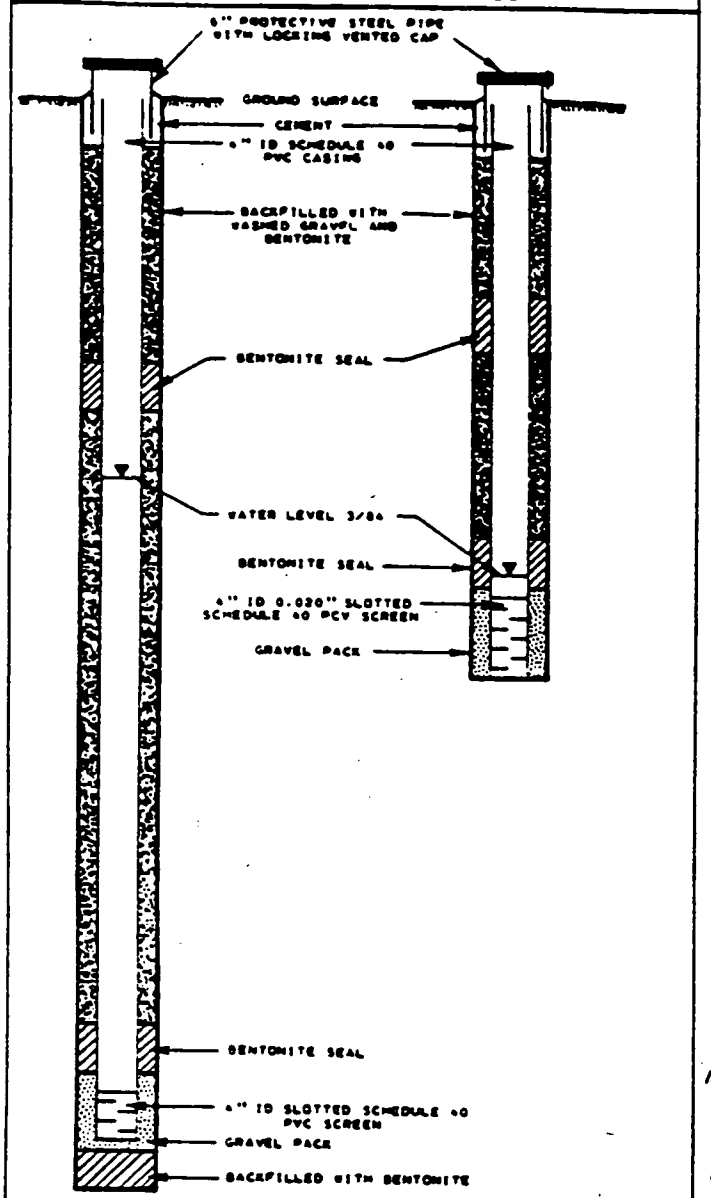
DARK YELLOWISH BROWN (10YR6/6) FINE TO MEDIUM GRAINED SAND

BORING TERMINATED AT A DEPTH OF 80.0' ON 1/29/85

DAMES & MOORE

FIGURE A4-7

WELL SCHEMATICS



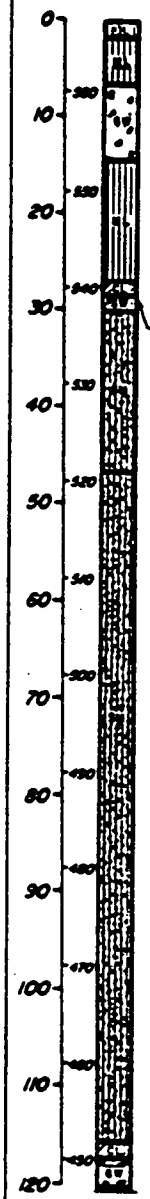
BORING 18

SURFACE ELEVATION 18D 521.54'
18S 521.31'

258

DEPTH IN FEET | ELEVATION IN FEET | GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES



FROZEN SOIL TO 1.3' MEDIUM TO COARSE SANDY LOAM

DUSKY YELLOW (5Y6/4) CLAYEY SILT. CONTAINS THIN BANDS OF LIGHT OLIVE BROWN CLAYEY SILT

LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT. CONTAINS LESS THAN 1% ANGULAR TO SUBANGULAR QUARTZ AND LIMESTONE FRAGMENTS. SILTY SAND ENCOUNTERED AT BOTTOM

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY WITH UP TO 10% GRAVEL CONSISTING OF QUARTZ AND LIMESTONE FRAGMENTS (0.5" IN DIAMETER)

LIGHT OLIVE BROWN (5Y5/6) SAND. WELL SORTED

LIGHT OLIVE GRAY (5Y5/2) SILTY SAND WITH SOME GRAVEL (1-4%)

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND. FINER GRAINED THAN ABOVE. NO NOTICEABLE GRAVEL

GREENISH-BLACK ("BLUE CLAY") SILTY CLAY (5G2/1)

COARSE GRAVEL 1/4-1/2" IN DIAMETER

BORING TERMINATED AT A DEPTH OF 120.0' ON 1/23/85

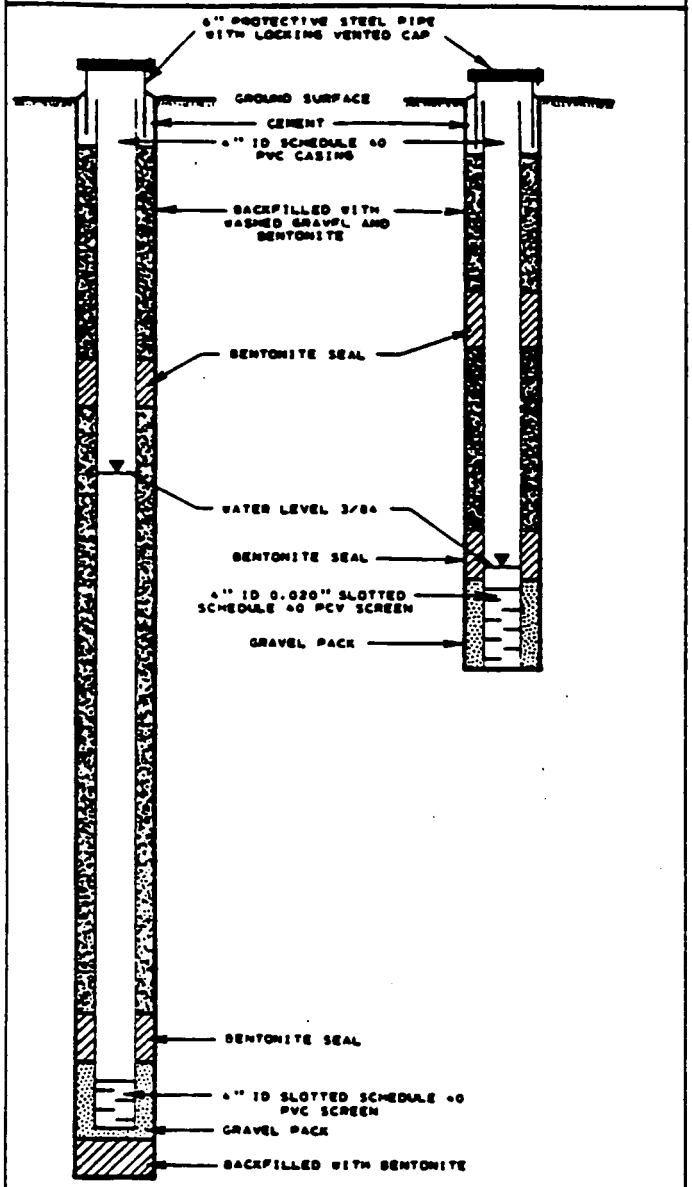
200

DAMES & MOORE

BORING 18

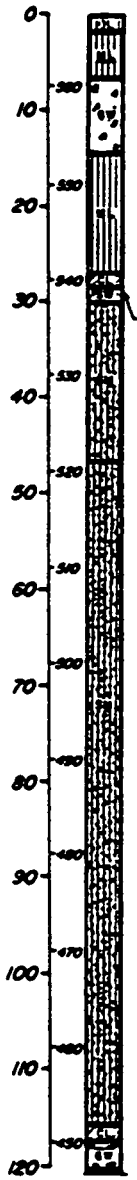
SURFACE ELEVATION 18D 521.56'
18S 521.31'

WELL SCHEMATICS



DEPTH IN FEET
ELEVATION IN FEET
GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES



FROZEN SOIL TO 1.3' MEDIUM TO COARSE SANDY LOAM
DUSKY YELLOW (5Y6/4) CLAYEY SILT. CONTAINS THIN BANDS OF LIGHT OLIVE BROWN CLAYEY SILT

LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT. CONTAINS LESS THAN 1% ANGULAR TO SUBANGULAR QUARTZ AND LIMESTONE FRAGMENTS. SILTY SAND ENCOUNTERED AT BOTTOM

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY WITH UP TO 10% GRAVEL CONSISTING OF QUARTZ AND LIMESTONE FRAGMENTS (0.5" IN DIAMETER)
LIGHT OLIVE BROWN (5Y5/6) SAND, WELL SORTED
LIGHT OLIVE GRAY (5Y5/2) SILTY SAND WITH SOME GRAVEL (1-4%)

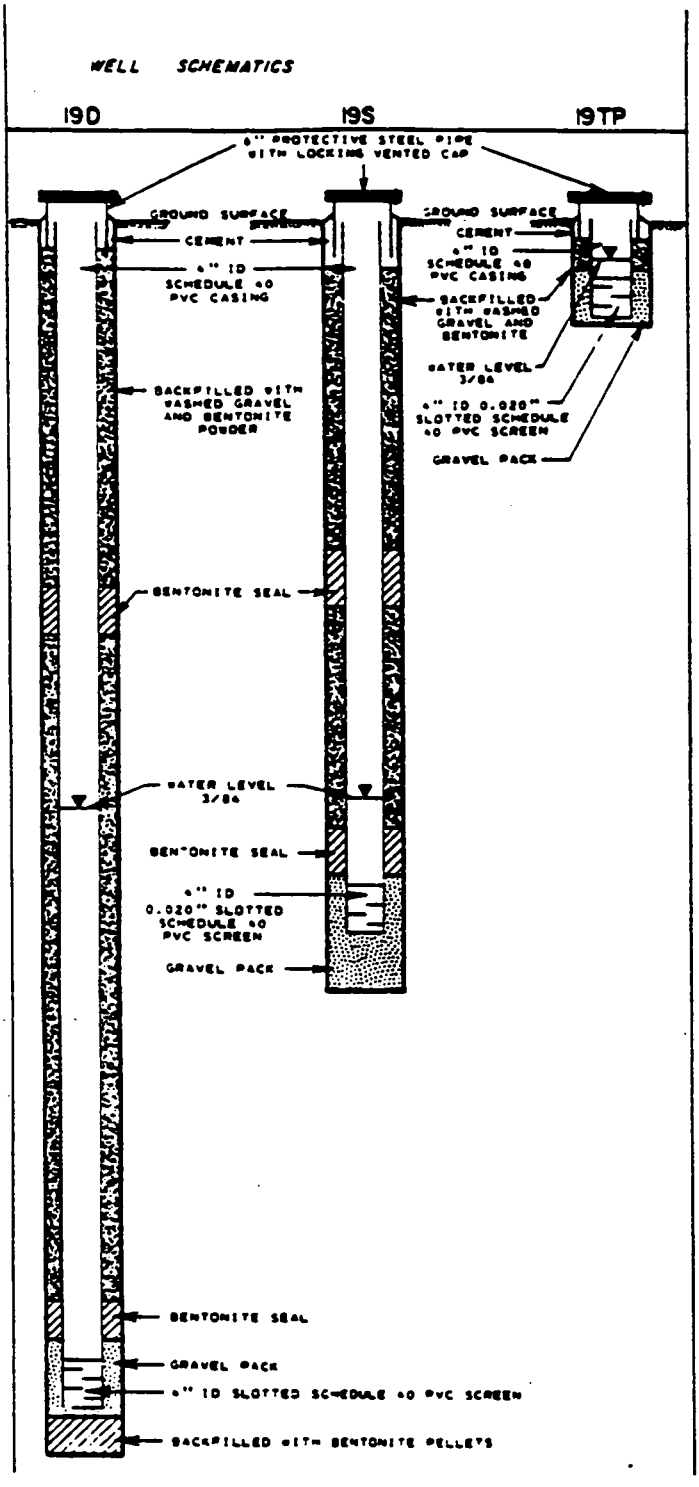
LIGHT OLIVE BROWN (5Y5/6) SILTY SAND. FINER GRAINED THAN ABOVE. NO NOTICEABLE GRAVEL

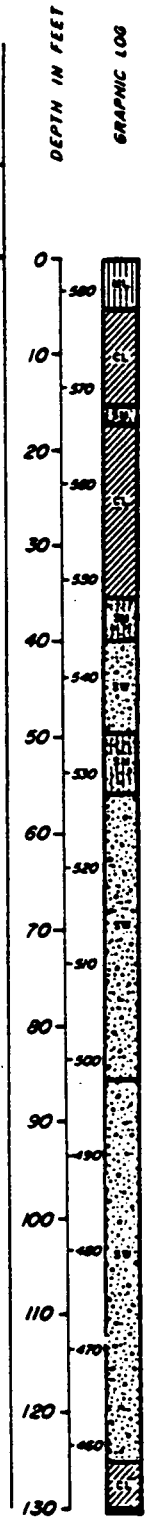
GREENISH-BLACK ("BLUE CLAY") SILTY CLAY (5G2/1)
COARSE GRAVEL 1/4-1/2" IN DIAMETER
BORING TERMINATED AT A DEPTH OF 120.0' ON 1/23/85

DAMES & MOORE

BORING 19

SURFACE ELEVATION 19D 583.28'
19S 583.26'
19TP 582.98'





DESCRIPTIVE GEOLOGIC NOTES

LIGHT OLIVE BROWN (5Y5/6) CLAYEY SILT, CONTAINS STREAKS OF DUSKY YELLOW SILT, SOME GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY, CONTAINS DUSKY YELLOW SILT, NO GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SANDY SILT WITH UP TO 5% GRAVEL, CONTACT IS SHARP AND WELL DEFINED

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY WITH 2% GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND WITH 3% GRAVEL

MODERATE OLIVE BROWN (5Y6/4) GRAVELLY SAND MEDIUM TO COARSE GRAINED, SOME GRAVEL, CONTACT IS GRADATIONAL

LIGHT OLIVE BROWN (5Y5/6) FINE TO MEDIUM GRAINED WELL SORTED SILTY SAND

OLIVE GRAY (5Y3/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED WELL SORTED SAND

GREENISH-BLACK ("BLUE CLAY") (5G2/1) SILTY CLAY

BORING TERMINATED AT A DEPTH OF 130.3' ON 3/6/85

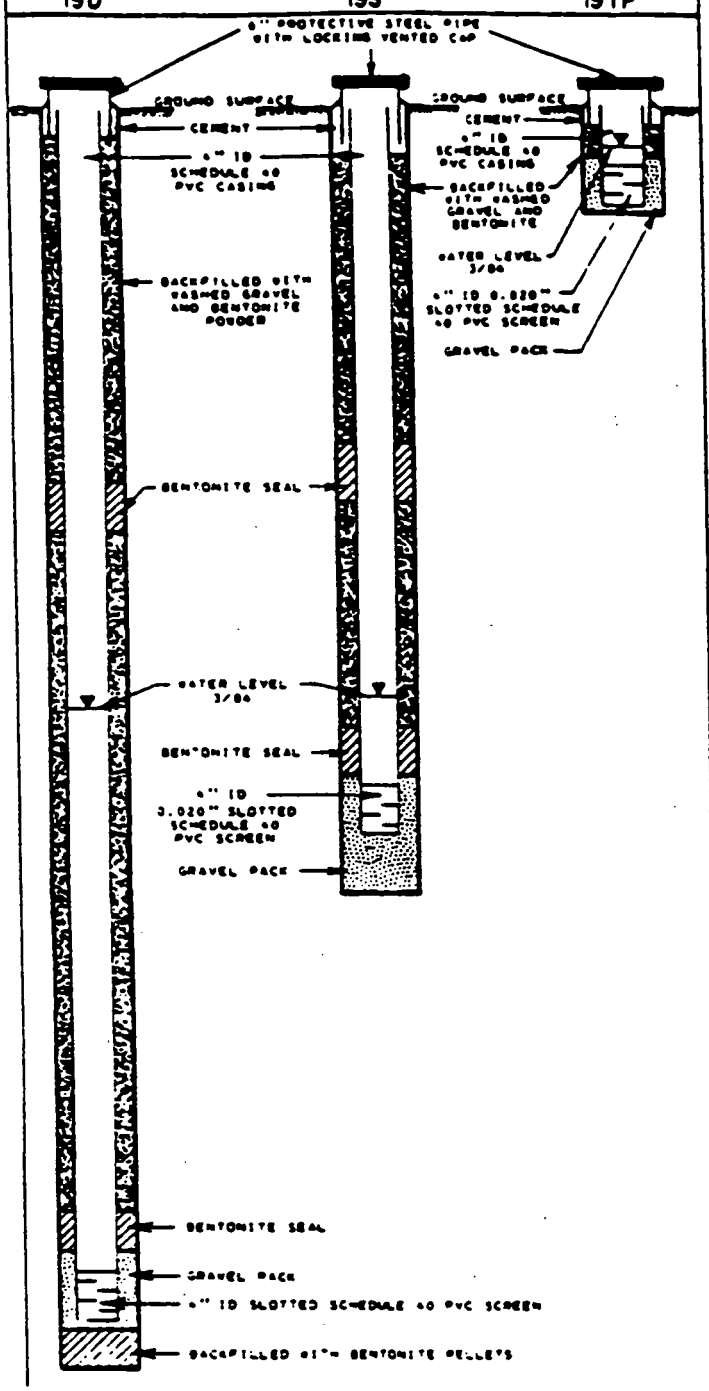
DAMES & MOORE

FIGURE 14-9

BORING 19

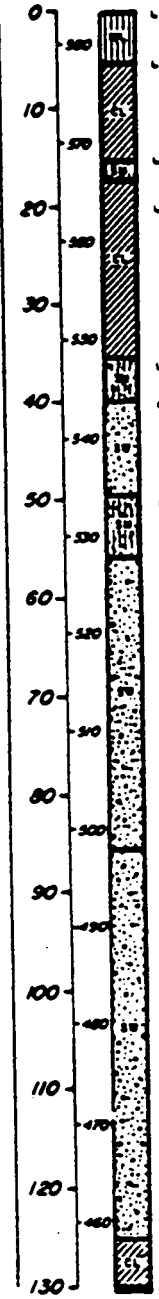
SURFACE ELEVATION 19D 503.28'
19S 503.28'
19TP 502.00'

WELL SCHEMATICS



DEPTH IN FEET

GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

LIGHT OLIVE BROWN (5Y5/6) CLAYEY SILT, CONTAINS STREAKS OF DUSKY YELLOW SILT, SOME GRAVEL

LIGHT OLIVE GRAY (5Y6/2) SILTY CLAY, CONTAINS DUSKY YELLOW SILT, NO GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SANDY SILT WITH UP TO 5% GRAVEL. CONTACT IS SHARP AND WELL DEFINED

LIGHT OLIVE GRAY (5Y6/2) SILTY CLAY WITH 2% GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND WITH 3% GRAVEL

MODERATE OLIVE BROWN (5Y4/4) GRAVELLY SAND MEDIUM TO COARSE GRAINED, SOME GRAVEL. CONTACT IS GRADATIONAL

LIGHT OLIVE BROWN (5Y5/6) FINE TO MEDIUM GRAINED WELL SORTED SILTY SAND

OLIVE GRAY (5Y3/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED WELL SORTED SAND

GREENISH-BLACK ("BLUE CLAY") (5G2/1) SILTY CLAY

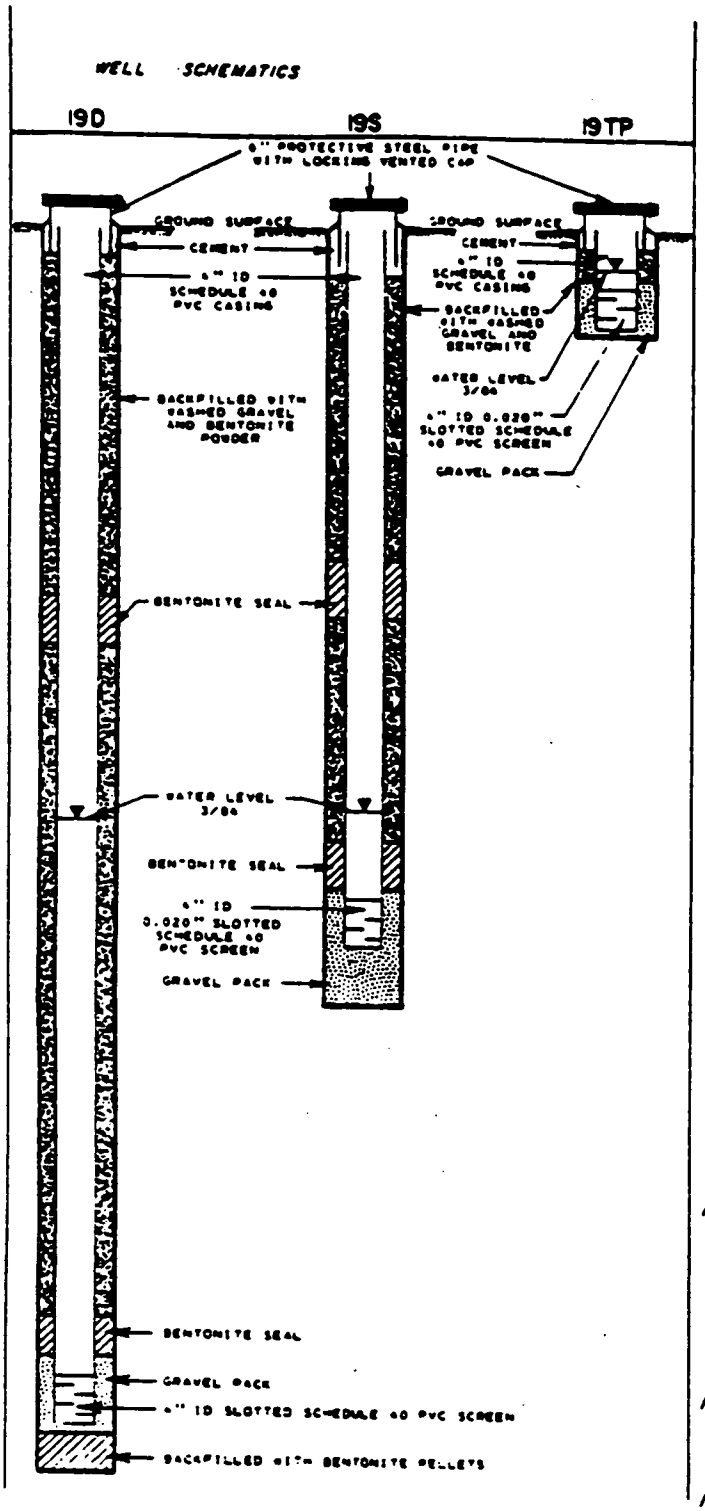
BORING TERMINATED AT A DEPTH OF 130.3' ON 3/6/85

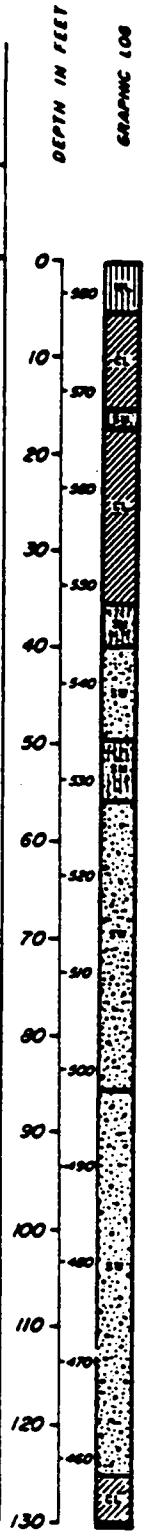
DAMES & MOORE

FIGURE 10-9

BORING 19

SURFACE ELEVATION 19D 583.20'
19S 583.26'
19TP 582.98'





DESCRIPTIVE GEOLOGIC NOTES

LIGHT OLIVE BROWN (5Y5/6) CLAYEY SILT, CONTAINS STREAKS OF DUSKY YELLOW SILT, SOME GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY, CONTAINS DUSKY YELLOW SILT, NO GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SANDY SILT WITH UP TO 5% GRAVEL. CONTACT IS SHARP AND WELL DEFINED

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY WITH 2% GRAVEL

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND WITH 3% GRAVEL

MODERATE OLIVE BROWN (5Y4/4) GRAVELLY SAND MEDIUM TO COARSE GRAINED, SOME GRAVEL, CONTACT IS GRADATIONAL

LIGHT OLIVE BROWN (5Y5/6) FINE TO MEDIUM GRAINED WELL SORTED SILTY SAND

OLIVE GRAY (5Y3/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED WELL SORTED SAND

GREENISH-BLACK ("BLUE CLAY") (5GY2/1) SILTY CLAY

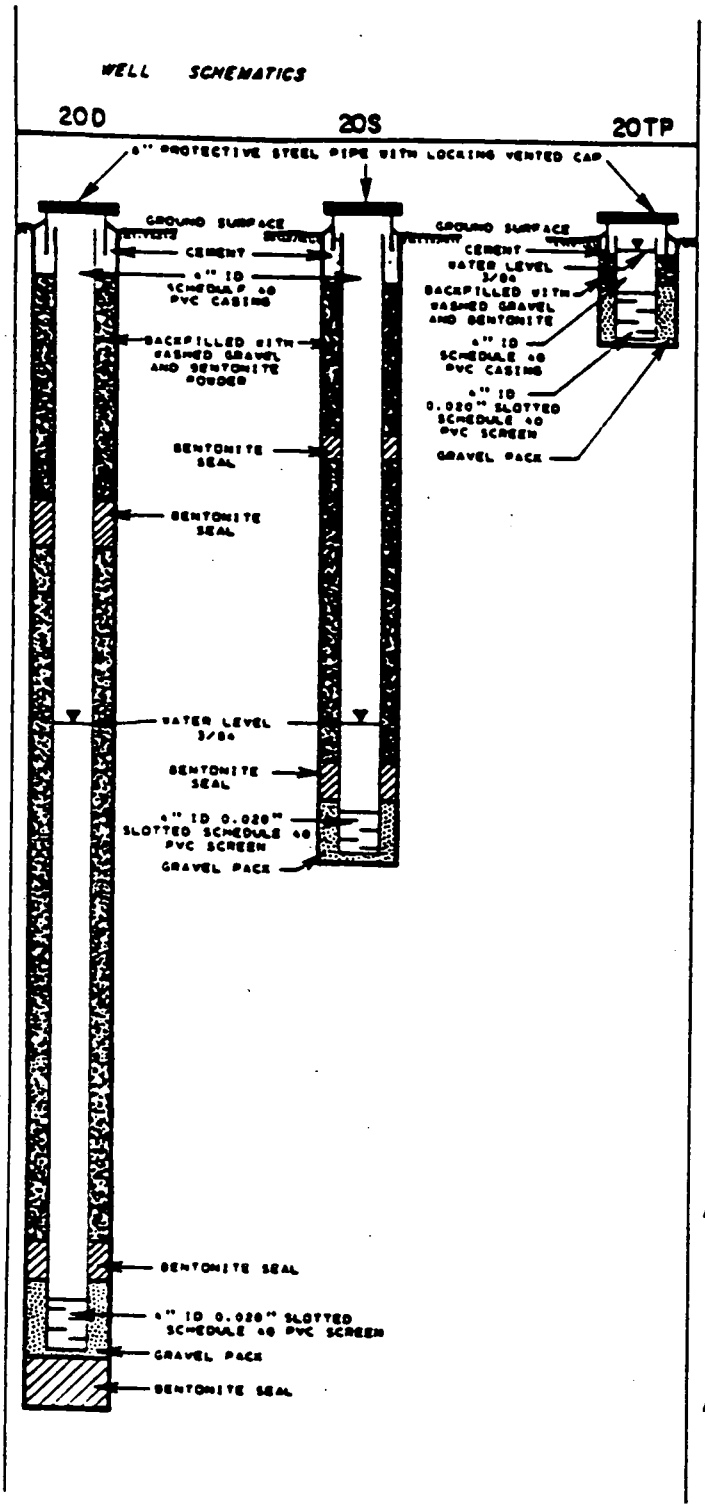
BORING TERMINATED AT A DEPTH OF 130.0' ON 3/6/85

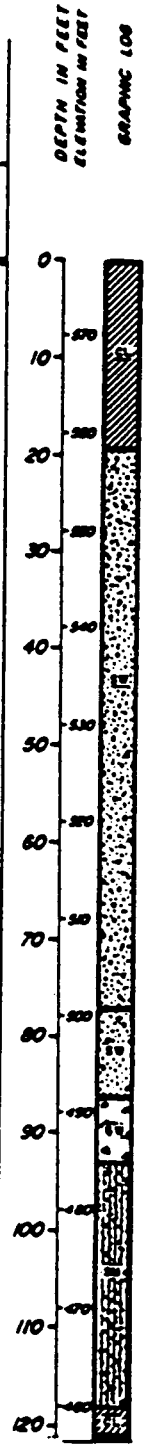
DAMES & MOORE

FIGURE 24-9

BORING 20

SURFACE ELEVATION 20D 573.31'
20S 573.42'
20TP 573.21'





DESCRIPTIVE GEOLOGIC NOTES

LIGHT OLIVE BROWN (5Y5/6) SILTY CLAY, DRY, DENSE, STIFF

LIGHT OLIVE BROWN (5Y5/6) SAND WITH UP TO 10% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) COARSE SAND WITH GRAVEL

GRAY SANDY GRAVEL

GRAYISH OLIVE (10Y6/2) MEDIUM TO COARSE WELL SORTED SILTY SAND

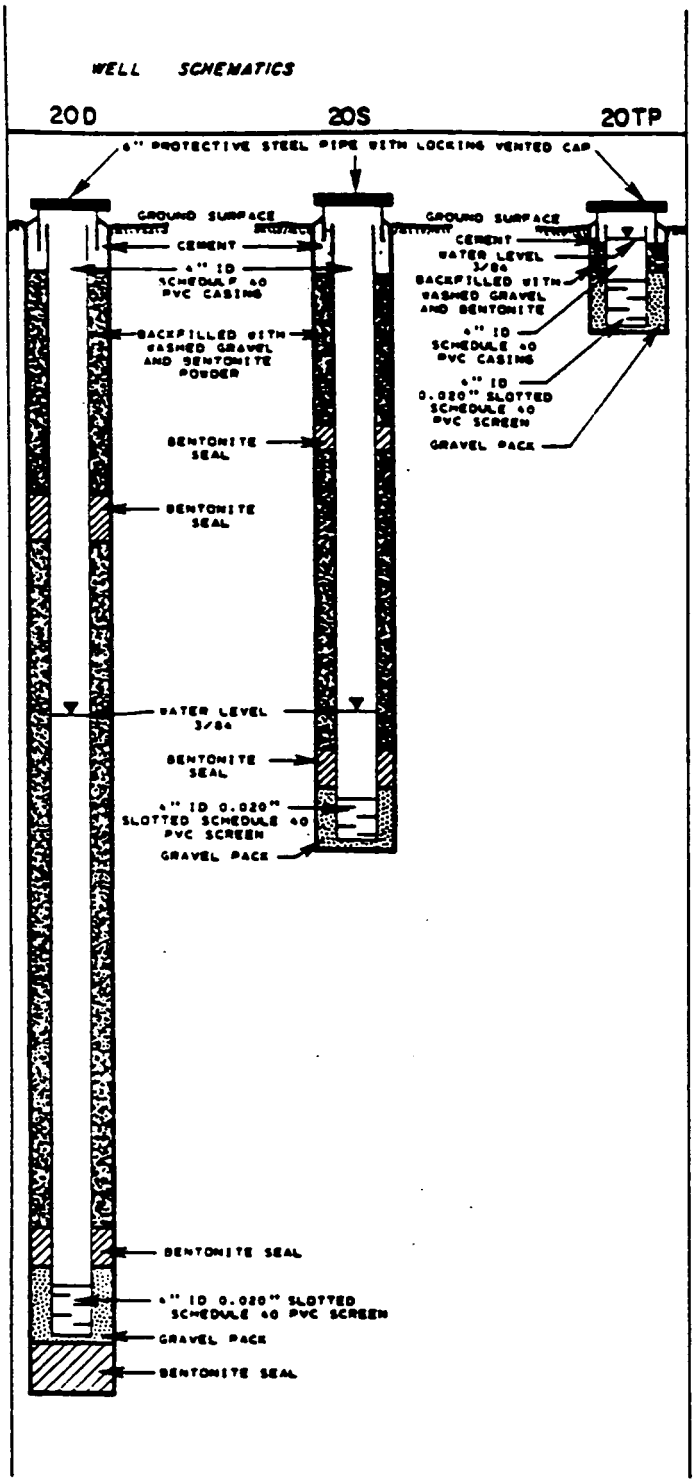
GREENISH-BLACK ("BLUE CLAY") (5GY2/1) SILTY CLAY
BORING TERMINATED AT A DEPTH OF 121.0' ON 1/28/85

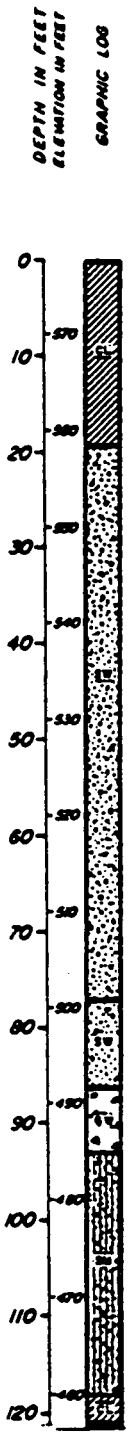
DAMES & MOORE

FIGURE A4-10

BORING 20

SURFACE ELEVATION 20D 573.31'
20S 573.42'
20TP 573.21'





DESCRIPTIVE GEOLOGIC NOTES

LIGHT OLIVE BROWN (5Y5/6) SILTY CLAY, DRY, DENSE, STIFF

LIGHT OLIVE BROWN (5Y5/6) SAND WITH UP TO 10% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) COARSE SAND WITH GRAVEL

GRAY SANDY GRAVEL

GRAYISH OLIVE (10Y4/2) MEDIUM TO COARSE WELL SORTED SILTY SAND

GREENISH-BLACK ("BLUE CLAY") (5G2/1) SILTY CLAY

BORING TERMINATED AT A DEPTH OF 121.0' ON 1/28/85

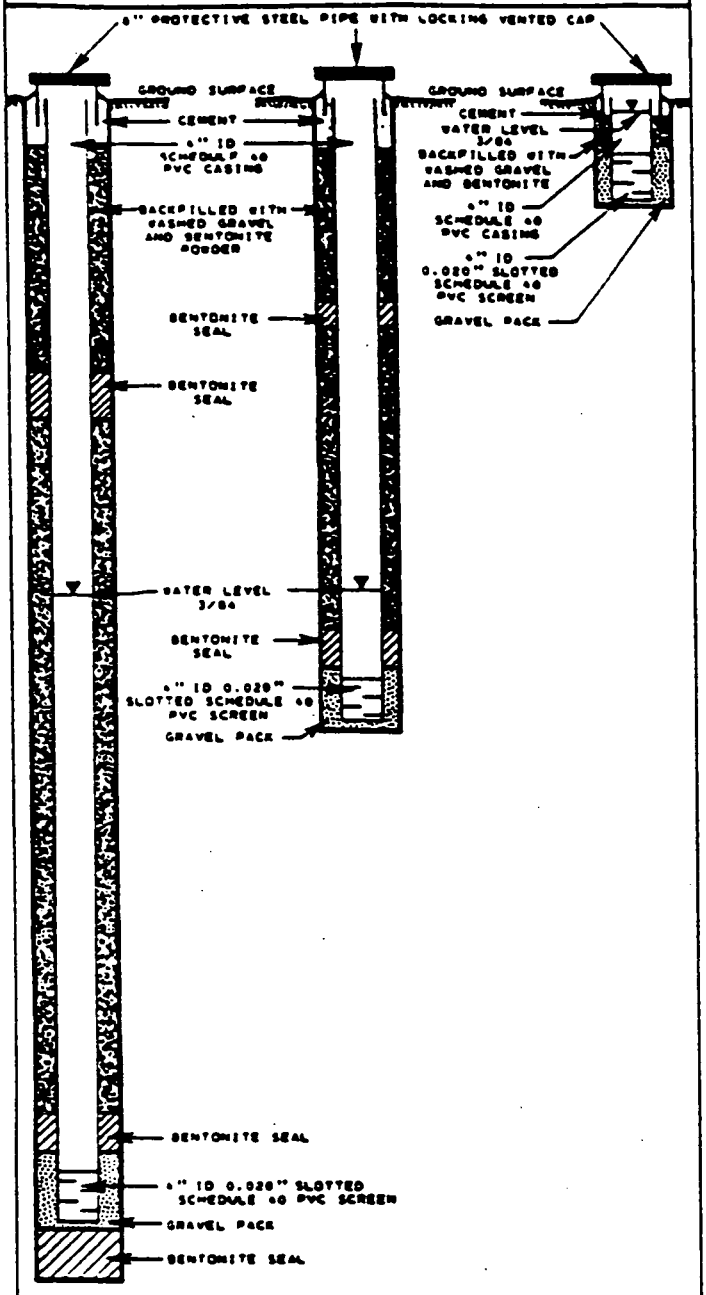
DAMES & MOORE

FIGURE A4-10

BORING 20

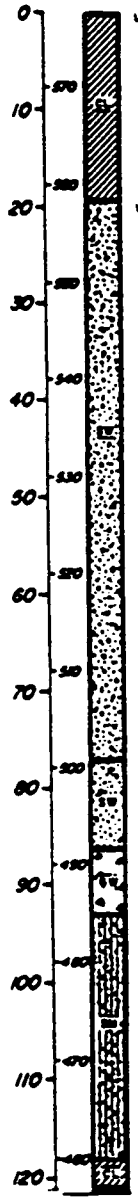
SURFACE ELEVATION 20D 573.31'
20S 573.42'
20TP 573.21'

WELL SCHEMATICS



DEPTH IN FEET
ELEVATION IN FEET
GRAPHIC LOG

DESCRIPTIVE GEOLOGIC NOTES



LIGHT OLIVE BROWN (5Y5/6) SILTY CLAY, DRY, DENSE, STIFF

LIGHT OLIVE BROWN (5Y5/6) SAND WITH UP TO 10% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) COARSE SAND WITH GRAVEL

GRAY SANDY GRAVEL

GRAYISH OLIVE (10Y4/2) MEDIUM TO COARSE WELL SORTED SILTY SAND

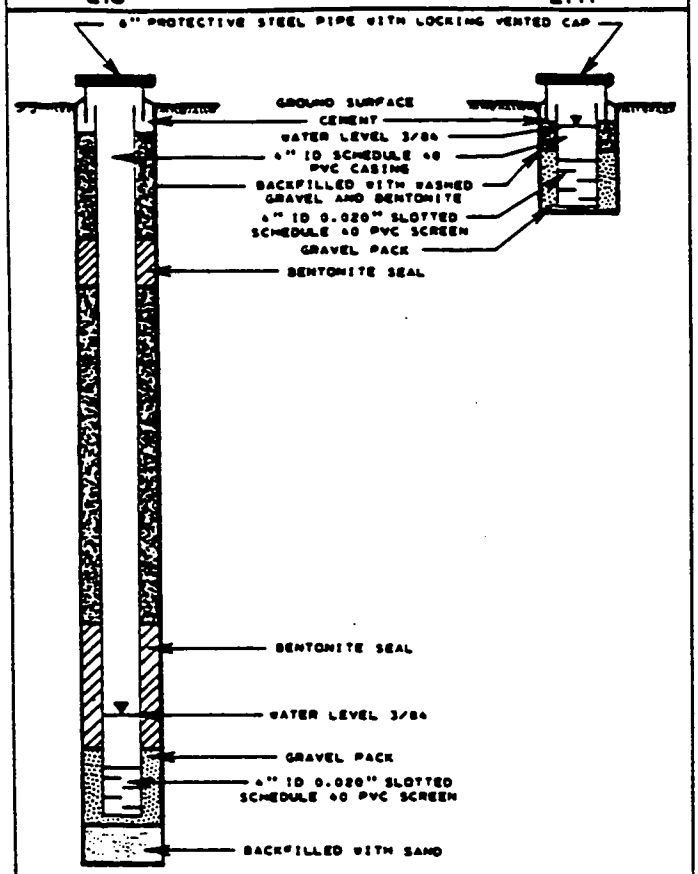
GREENISH-BLACK ("BLUE CLAY") (5GZ/1) SILTY CLAY

BORING TERMINATED AT A DEPTH OF 121.0' ON 1/28/85

DAMES & MOORE

FIGURE A4-10

WELL SCHEMATICS



BORING 21

SURFACE ELEVATION 21S 584.42'
21TP 584.06'

DEPTH IN FEET	ELEVATION IN FEET	GRAPHIC LOG	DESCRIPTIVE GEOLOGIC NOTES
0			ROAD FILL, COARSE GRAVEL
			DARK YELLOWISH BROWN (10YR4/2) CLAYEY SILT UP TO 5% SAND AND GRAVEL
10	575		LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT, WITH UP TO 5% SAND OR GRAVEL
20	565		LIGHT OLIVE GRAY (5Y5/2) SILTY GRAVEL
30	555		LIGHT OLIVE GRAY (5Y5/2) SILTY GRAVEL
			MIXTURE OF DARK YELLOWISH BROWN (10YR4/2) AND LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT, UP TO 5% GRAVEL. MEDIUM TO COARSE GRAINED SAND ENCOUNTERED AT 40.5'
40	545		LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND, UP TO 3% GRAVEL
50	535		
60	525		LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED SAND, SOME GRAVEL, CONTAINS THIN LAYER OF BROWNISH-YELLOW FINE SAND
			LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SAND (LESS THAN 1% GRAVEL) WITH SOME SILT
70	515		
80	505		COARSE GRAVEL WITH SOME SAND BORING TERMINATED AT A DEPTH OF 80.0' ON 2/13/85

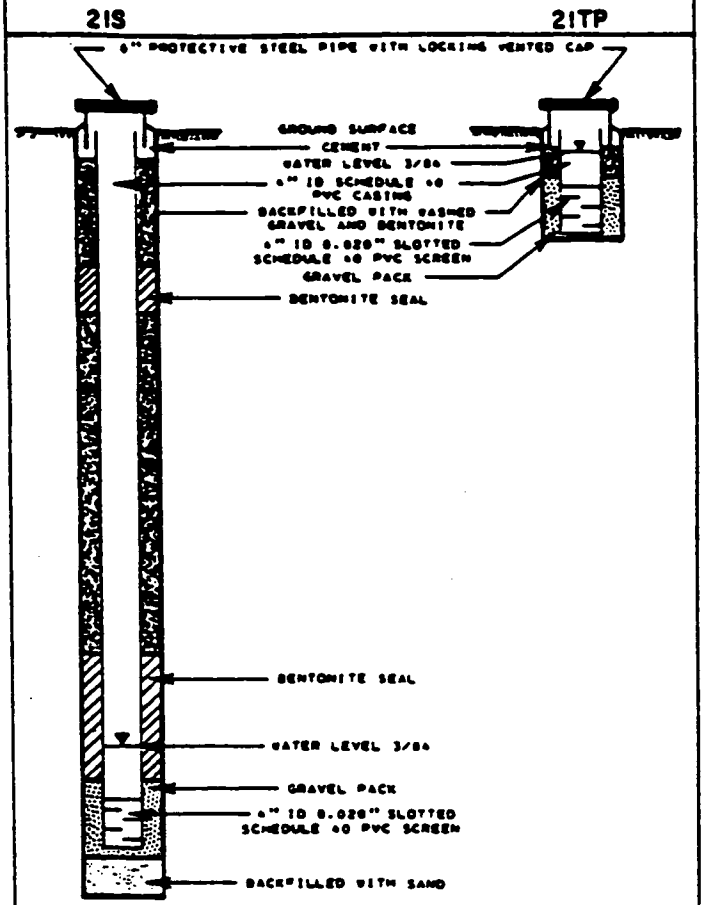
DAMES & MOORE

FIGURE A4-11

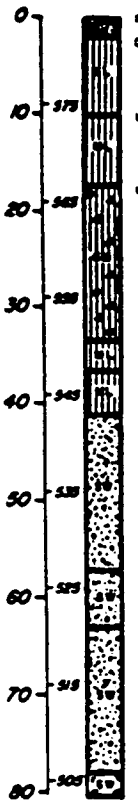
BORING 21

SURFACE ELEVATION 21S 584.45'
21TP 584.00'

WELL SCHEMATICS



DEPTH IN FEET
ELEVATION IN FEET
GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

ROAD FILL, COARSE GRAVEL

DARK YELLOWISH BROWN (10YR4/2) CLAYEY SILT UP TO 5% SAND AND GRAVEL

LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT, WITH UP TO 5% SAND OR GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY GRAVEL

LIGHT OLIVE GRAY (5Y5/2) SILTY GRAVEL

MIXTURE OF DARK YELLOWISH BROWN (10YR4/2) AND LIGHT OLIVE GRAY (5Y5/2) CLAYEY SILT, UP TO 5% GRAVEL. MEDIUM TO COARSE GRAINED SAND ENCOUNTERED AT 40.5'

LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED WELL SORTED SAND, UP TO 3% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) MEDIUM TO COARSE GRAINED SAND, SOME GRAVEL, CONTAINS THIN LAYER OF BROWNISH-YELLOW FINE SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO COARSE GRAINED SAND (LESS THAN 1% GRAVEL) WITH SOME SILT

COARSE GRAVEL WITH SOME SAND
BORING TERMINATED AT A DEPTH OF 80.0' ON 2/13/85

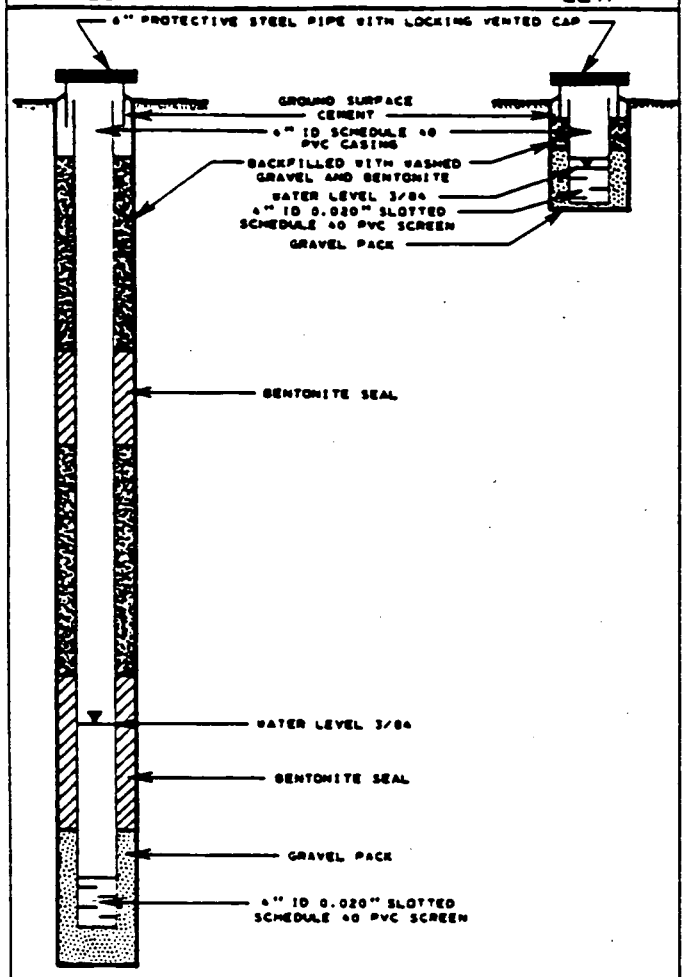
DAMES & MOORE

FIGURE A4-11

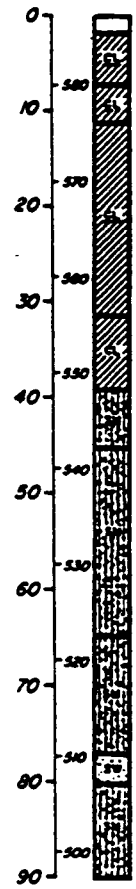
BORING 22

SURFACE ELEVATION 22S 582.93'
22TP 582.93'

WELL SCHEMATICS



DEPTH IN FEET / ELEVATION IN FEET / GRAPHIC LOG



DESCRIPTIVE GEOLOGIC NOTES

COARSE GRAVEL IN SILT MATRIX ON BERM

OLIVE GRAY (5Y3/2) SILTY CLAY, LESS THAN 1% VERY COARSE GRAVEL

DARK YELLOWISH BROWN (10YR4/2) SILTY CLAY, DRY, DENSE, STIFF

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY, STIFF, DRY, LESS THAN 1% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) GRAVELLY SILTY CLAY

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO FINE GRAINED WELL SORTED SILTY SAND, GRADES INTO MEDIUM TO COARSE GRAINED SILTY SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO FINE GRAINED SILTY SAND WITH SOME OLIVE BROWN CLAY

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND, UP TO 15% GRAVEL

COARSE SAND AND GRAVEL, UP TO 15% SILT

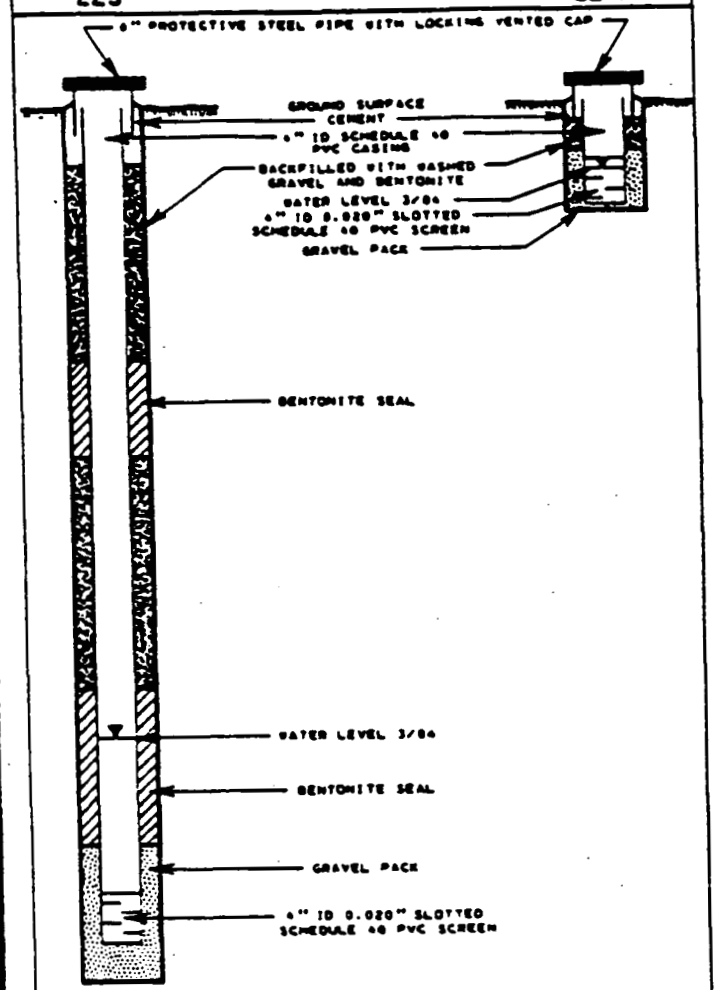
LIGHT OLIVE BROWN (5Y5/6) SILTY SAND, UP TO 15% GRAVEL

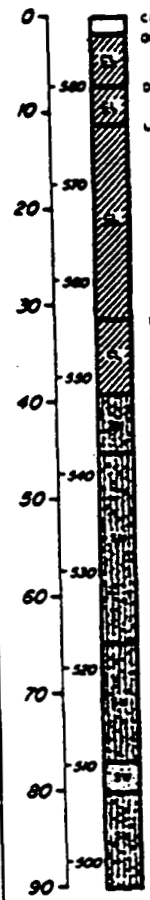
BORING TERMINATED AT A DEPTH OF 90.0' ON 2/14/85

BORING 22

SURFACE ELEVATION 22S 582.93'
22TP 582.93'

WELL SCHEMATICS





DESCRIPTIVE GEOLOGIC NOTES

COARSE GRAVEL IN SILT MATRIX ON BERM

OLIVE GRAY (5Y3/2) SILTY CLAY, LESS THAN 1% VERY COARSE GRAVEL

DARK YELLOWISH BROWN (10YR4/2) SILTY CLAY, DRY, DENSE, STIFF

LIGHT OLIVE GRAY (5Y5/2) SILTY CLAY, STIFF, DRY, LESS THAN 1% GRAVEL

LIGHT OLIVE GRAY (5Y5/2) GRAVELLY SILTY CLAY

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO FINE GRAINED WELL SORTED SILTY SAND, GRADES INTO MEDIUM TO COARSE GRAINED SILTY SAND

LIGHT OLIVE BROWN (5Y5/6) MEDIUM TO FINE GRAINED SILTY SAND WITH SOME OLIVE BROWN CLAY

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND, UP TO 15% GRAVEL

COARSE SAND AND GRAVEL, UP TO 15% SILT

LIGHT OLIVE BROWN (5Y5/6) SILTY SAND, UP TO 15% GRAVEL

BORING TERMINATED AT A DEPTH OF 90.0' ON 2/14/85

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS	
BORING NUMBER: 3B ~~324~~ 1024	COORDINATES:	DATE: 10-4-87
ELEVATION:	GWL: Depth 9.3' Date/Time 10-17/1100	DATE STARTED: 10-4-87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10/16/87
DRILLING METHODS: Cable Tool		PAGE 1 OF 2

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0				Detailed Continuous Samples were collected on borehole # ~~324~~ 3024. Please refer to that Soil Log for details			
1'							
2'							
3'							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14				Unsuccessful Shelby Tube Attempt.			Attempted to obtain a Shelby Tube from 14'-15.5'. Only recovered 5".
15'							

NOTES: Used a total of 35 gallons of water to drill hole.

212

402-11-88

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS		
BORING NUMBER: ~~124~~ 1024	COORDINATES:	DATE: 10/16/87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10-4-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10/16/87	
DRILLING METHODS: Cable Tool		PAGE 2 OF 2	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				See Well Log # ~~3241~~ 3024 for Soil descriptions RHH 2/6/91			
16	ST 07247		≈ 8"		CL		Shelby Tube: Cag [illegible] pulling up other 5" [illegible]
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27				Bottom of Boring = 27'			1st well - Drilling Completed but had to be redrilled due to bentonite pellets settling up & lifting Stainless Steel Cag with 10' Temp. Cag.
28							
29							
30							

NOTES:

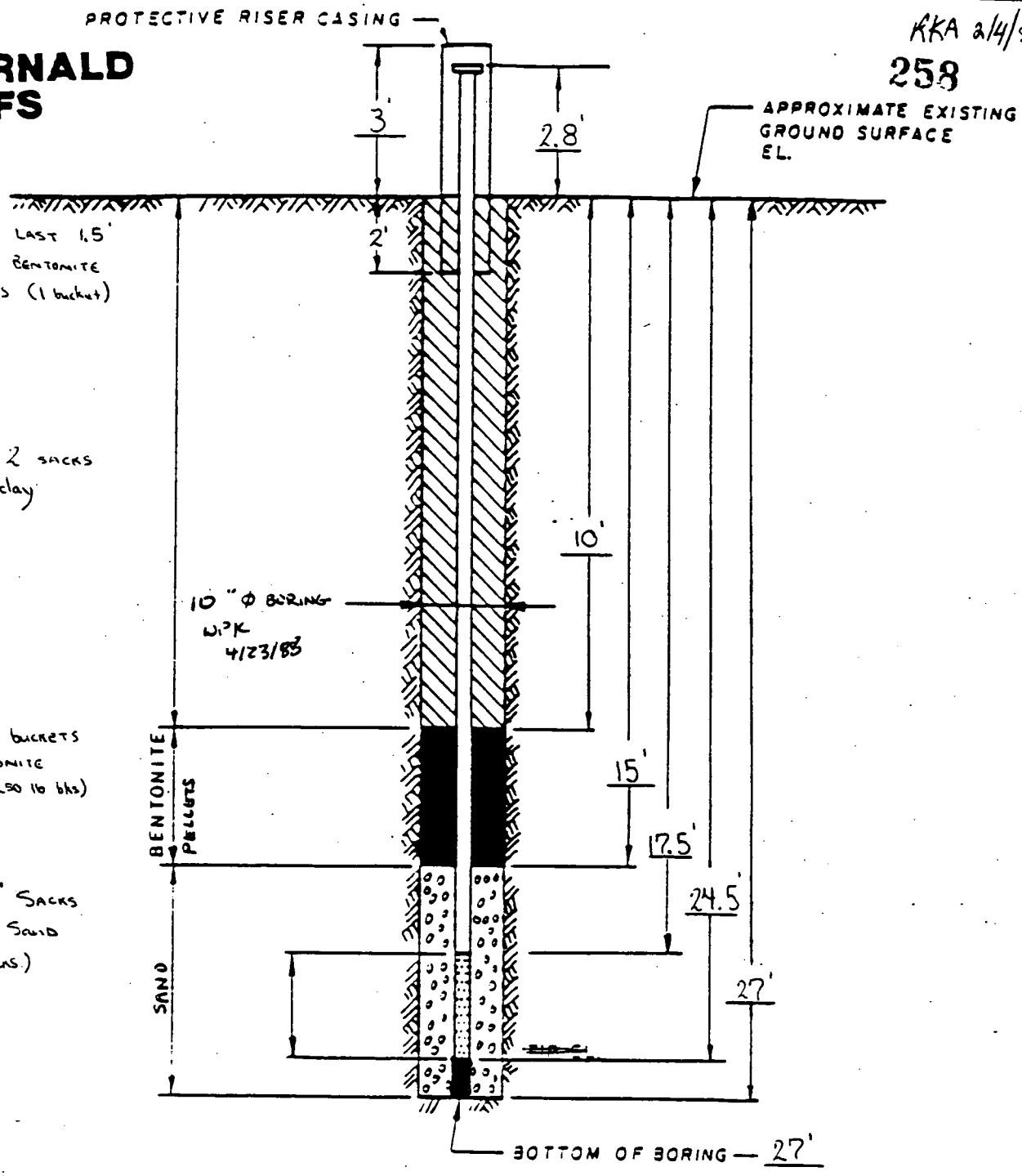
213

4002-111-888

KKA 2/4/87

258

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. S.S. PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~124~~ 1024

PREPARED FOR

FMPC RI/FS

RWL 2/6/89

214

FERNALD RI/FS

258

1st Key In | 2nd Key In | Hard Copy Verification

RKA 2/4/89

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. B. Dunning DATE 10/18/87
PROJECT NO. 602 CHECKED BY R Colborne DATE 2/4/89
BORING NO. ~~124~~ 1024 ~~DB 1-5-89~~
PIEZOMETER NO. NA DATE OF INSTALLATION 10-18-87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool	TYPE OF BIT Hammer
DRILLING FLUID (S) USED:	CASING SIZE (S) USED: WPK 4/23/88
FLUID Water FROM 0' TO 27'	SIZE 10" FROM Surface TO 27'
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel	RISER PIPE MATERIAL Stainless Steel (316)
DIAMETER OF PERFORATED SECTION 4"	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8" I.D. 4"
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10'
AVERAGE SIZE OF PERFORATIONS .010 IN.	JOINING METHOD Flush joint thread
TOTAL PERFORATED AREA 7'	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5'	OTHER PROTECTION Locking cap with lock.
PROTECTIVE PIPE O.D. 10"	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT.)		ELEVATION (FT.) MSL	
TOP OF RISER PIPE	2.9'			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	-2'			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0'	BOTTOM 10'	TOP	BOTTOM
BENTONITE	TOP 10'	BOTTOM 15'	TOP	BOTTOM
SAND	TOP 15'	BOTTOM 27'	TOP	BOTTOM
NO GRAVEL USED	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 17.5'	BOTTOM 24.5'	TOP	BOTTOM
PIEZOMETER TIP	WPK 4/23/88	27.0 (SILT TRAP)		
BOTTOM OF BOREHOLE	27'			
GWL AFTER INSTALLATION	= 9'			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑ 215

MARKS The white out corrections were made by B. Dunning at the time the form was completed. WPK 4/23/88

409-11-86

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: ~~324~~ 3024 BB	COORDINATES:		DATE: 9-14-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 9-14-87 @ 1330
ENGINEER/GEOLOGIST: B. Dunning	Depth	Date/Time	DATE COMPLETED: 10/3/87
DRILLING METHODS: Cable Tool - Split Spoon Samples			PAGE 1 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inches)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
.5 1.0'	S 07089	5 11 10	12"	Medium stiff, yellowish-brown clay with some sand, moist	CL		Background Ins $\gamma\beta$ = 40-60 α = 0 hnyx = 0 Sample Caught (1345)
2' 3'	S 07090	12 17 19	24"	Stiff, dark yellowish-brown silty sand with some fine gravel moist	SM		Background Levels (1400)
4'	S 07091	12 25 32	18	Medium dense dark yellowish-brown silty sand with some gravel moist	SP		Background Levels
				4.3' Coarse Gravel - grayish-brown	GW		(1440)
5' 6'	S 07092	22 12 15	14"	Medium dense dark yellowish-brown silty sandy gravel, moist.	GC		Background Levels
				5.5' Stiff yellowish-brown silty clay, moist	CL		(1445)
7'	S 07093	10 21 23	16"	Dense yellowish-brown silty gravel grading downward to a:	GC		Background Levels
				7' Hard dark gray clay with a trace of coarse sand and gravel moist 7'	CL	4.5	(1545)
8' 9'	S 07095	16 19 23	12"	Very stiff gray clay with a trace of fine gravel (slightly damp) moist.	CL	4.0	Background Levels End of Day 9-14-87 (1625)
10'	S 07096	6 11 15	6"	Medium dense, grayish-brown gravel moist.	GC		Start of Day 9-15-87 gravel is actually very loosely consolidated Background (0830)
11' 12'	S 07097	4 5 8	12"	Medium stiff olive-gray clay with a trace of fine gravel, moist.	CL	1.0	Background Lost entire first sample and had to use spring catcher (0935)
13	S 07098	6 11 17	18"		CL	.75	Background
				13.2' Loose gray, fine sand, moist. 13.2.	SM		(0942
14' 15'	S 07100	2 2 3	18"	Soft olive-gray clay with a trace of fine gravel, moist.	CL	.50	Background (1030)

NOTES: Background Levels 9-14-87 $\gamma\beta$ = 40-140 cpm α = 0 hnyx = 0

Background Levels 9-15-87 $\gamma\beta$ = 40-80 cpm α = 0 hnyx = 0

Used 40 gallons of H_2O 9-14-87

402-11-86

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		TASK 3.2
BORING NUMBER: ~~324~~ 3024	COORDINATES:	DATE: 9-15 & 9-16-87	
ELEVATION:	GWL: Depth 17.2 Date/Time 9-15 @ 1450	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 11.3 Date/Time 9-15 / 1600	DATE COMPLETED: 10-3-87	
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16'	S 07101	6 6 9	18"	Soft, olive gray clay with a trace to some sand and gravel, MOIST	CL	.50	Background Levels (1040)
17'	S 07102	2 3 12	6"			.50	Background Levels (1350)
18'				18.2' Soft olive gray clay, MOIST. 18.2'		.50	
19'	S 07103	20 45 40	18"	Very dense gray fine gravel MOIST	GP		Background levels (1355)
20'				19.8 Dark yellowish-brown coarse sand 19.8	SW	–	
21'	S 07104	46 30 27	18"	Very dense gray coarse gravel, MOIST Wet	GP	–	Background End of Day 9-15-87 (1530)
				21.5 21.5			Start Day 9-16-87
22'	S 07105	16 33 47	18"	21.8 Very dense gray fine to medium sand MOIST 21.8	SC	–	Sand is actually Medium dense
				22 Hard olive-gray clay - trace of gravel MOIST. 22	CL	>4.0	(0905)
23'	S 07106	14 16 22	18"	Dense gray unconsolidated gravel, MOIST. grading downwards to a:	GW		Background
				23.5 Hard gray clay, some gravel MOIST 23.5			(1005)
24' 25'	S 07107	20 50 (3")	12"	Medium dense grayish-brown fine to medium sand with trace of large quatz rock fragments Wet	SP		Background Split Spoon jammed with large rock (1420)
26' 27'	S 07108	8 18 30	18"	Hard, dark gray olive-gray clay with some sand and fine gravel	CL	>4.5	Background (1440)
				27.5 Very stiff, grayish-brown silty clay 27.5	ML	3.5	
28	S 07110	35 52 30	18"	28 Very hard gray clay 28	CL	>4.5	Background (1500)
29' 30'	S 07111	46 50 –	12"	Very stiff, gray clay with twig-like fragments ?? and a trace of gravel	CL		Background End Day 9-16-87 (1520)

NOTES: Background levels 9-15-87 $\gamma\beta$ = 40-80 cpm α = 0 $h\nu$ = 0

Background Levels 9-16-87 $\gamma\beta$ = 40-80 cpm α = 0 $h\nu$ = 0

Water level 9-15-87 @ 1600 was 11.3'

" " 9-16-87 @ 0800 " 9.3'

There appears to be a substantial aquafer at 18' - 21.5'

217

402-11-86

FERNALD
RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: ~~324~~ 3024	COORDINATES:	DATE: 9-17-87	
ELEVATION:	GWL: Depth 41.2 Date/Time 9-17-87 @ 1730	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 11	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30'							Start Day 9-17-87
31'	S 07112	12 20 24	6"	Stiff olive gray clay with a trace of fine gravel moist	CL	2.0	Background Levels (1045)
32' 33'	S 07113	10 11 16	18"	Very stiff gray clay with trace of gravel, moist			Background Levels - (B.G.) (1050)
34'	S 07114	10 25 37	24"	33.7 Stiff gray clay moist 33.7; 34 Very stiff olive-yellow clay moist 34'; Very dense yellow-brownish sand moist		1.5; 4.0	B.G. (1105)
35' 36'	S 07115	23 33 36	12"	Very dense yellowish-brown Sand moist.	SW	-	B.G. Sand is moist, but not saturated. (1400)
37'	S 07116	50 - -	9"	37' Medium stiff brownish-yellow silt clayey moist 37'	SM	-	B.G. (1530)
38' 39'	S 07117	9 24 42	13"	Very dense yellowish-brown, well sorted, fine grain sand Moist, but basically dry.			B.G. Very friable Sand Actually (1555)
40' 41' 42' 43' 44'					SW	-	Begin catching 5' Samples. Loose Unconsolidated Sand
45'	S 07118	25 43 45	18"				B.G. Sample 44'-45.5' End Day 9-18-87 1715

NOTES: Background Levels for 9-17-87 γB = 40-60 cpm, α = 0 hnu = 0

218

402-1 L.86

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 6B ~~9324~~ 3024	COORDINATES:	DATE: 9-18-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool		PAGE 4 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45'	07118	25 43 45	18"	SAND - As Described above	SW		End Clay 9-17-87 (1715)
46' 47' 48' 49' 50'				Very dense yellowish-brown well sorted fine grain sand moist.	SW	-	Start Clay 9-18-87
51'	S 07119	15 20 21	18"	Dense yellowish-brown, well sorted, damp, but not wet sand			B.G. Loose unconsolidated Sand (1345)
52' 53' 54' 55'							
56'	S 07120	13 27 (4") 50	12"	55.8 Loose grayish-brown coarse sand, moist 55.8 / 56.1 Hard gray clay moist. 56.1	CL		B.G. (1415)
57' 58'	S 07121	13 23 43	12"	Very dense gray, salt & pepper looking, medium to coarse grain sand with trace of fine gravel. moist	SW		B.G. Sand is actually loose & unconsolidated. (1440)
59' 60'							

NOTES:

219

402-11-86

KKG 2/4/93

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~3024~~ 3024	COORDINATES:	DATE: 9-19-87
ELEVATION:	GWL: Depth 51.6 Date/Time 9-19 / 1030	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 62.6 Date/Time 9-19 / 1730	DATE COMPLETED: 10-3-87
DRILLING METHODS:		PAGE 5 OF 11

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60'							
61'	S 07122	13 25 28	18"	Very dense, dark gray coarse sand with some fine gravel WET	SW		Background End of 9-18-87 (1515)
62'							End of 9-19-87 start
63'							
64'	S 07123	6 3 3	14"	Loose gray, lightly salt & peppered looking fine to coarse grain sand with a trace of gravel WET	SW		Borehole drilled down to 70'. Blow sand came up hole to 63' where this sample was taken. B.G. Levels (1545)
65'							
66'	4 None	5 2 2	0"	Sand pump indicates very loose, grayish-brown unconsolidated sand, WET	SM ?		Blow Sand coming into hole. Could not obtain a sample even with catcher End Day 9-19-87
67'							Start Day 9-20-87
68'							
69'							
70'							10" Temporary Casing Driven to 80' to cut off blow sand.
71'	S 07124	6 14 21	12"	Dense, gray coarse sand with some fine & coarse gravel. WET	SP		Background Levels Only (1000)
72'							
73'							Bailer - Sand Pump bringing up large cobbles i.e. 1½" x 2½" large - Diameter - ± 1½"
74'							
75'							

NOTES: Background Levels 9-19-87 $\xi\beta$ = 40-80 α = 0 $h\nu$ = 0
" " 9-20-87 $\xi\beta$ = 40-70 α = 0 $h\nu$ = 0

402-11-86

RI/FS

VISUAL CLASSIFICATION OF SOILS

Data Key in 9/9/11 | Data Entry Verification

3/4/91

258

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~9324~~ 3024	COORDINATES:	DATE: ~~9-19-87~~ & 9-20
ELEVATION:	GWL: Depth 61.5' Date/Time 9-20/0900	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool		PAGE 6 OF 11

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (FT.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75'							
76'	S 07125	16 31 46	14"	Very dense grayish-brown gravel (Color: 2.5 Y, 5/2) and Coarse Sand See Remarks →	GP		Background levels (B.G.) (1140)
77'							Sand pump collecting large carbonate cobbles & gravel rocks with fossil Inclusions.
78'							
79'							
80'							
81'	S 07126	2 6 16	18"	Medium dense, gray, very coarse grain sand with some fine gravel 80.8 / 80.8	SW		Background levels (1350)
				Medium dense grayish-brown fine gravel with some coarse gravel	GW		
82'							Drove 10" Temporary Casing to 90'
83'							Sand Pump bringing up fine to coarse gravel
84'							
85'							
86'	S 07127	20 50 (3")-50	12"	Very dense, dark gray, sandy gravel with fine to coarse sand. (Color: 2.5 Y, N4/) & large cobbles ie. 1" x 2" x 1½".	GP		Large rock jammed in Split Spoon. Actually a loose gravel. Background levels (1600)
87'							
88'							
89'							
90'							

NOTES: Background levels 9-20-87 : β = 40-75 cpm. α = 0, hnu = 0

221

402-11-86

RI/FS

2nd Key In 3/4 | Hard Copy Verification | 258 | 3/4/87

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: BO ~~9324~~ 3024	COORDINATES:	DATE: 9-20 & 9/21 1987
ELEVATION:	GWL: Depth 52' Date/Time 9-20/1400	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 52' Date/Time 9-21/0730	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool		PAGE 7 OF 11

DEPTH (Ft.) 20'	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (")	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91'		2 2 5 3 8 4	0"	Sand Pump collecting fine grain sand	SW		Lost Sample both times even with Catcher In.
92'							End 9-20-87 Start 9-21-87
93'				93 ± ? — — — ? — — — ?	?		Approximate depth of material change.
94'							
95'				Very Dark Gray, fine gravel with coarse sand (10YR 3/1)	GW		
96'	S 07128	18 29 36	24"	95.5 Dense gray fine to coarse gravel (2.5 Y N5) 95.5	GW GM		Background levels 1350
				96.25 Very dense, grayish-brown silty sand moist. 96.25 (Color: 2.5 Y, 5/2)			
97'							
98'							Sand pump quit sucking up sand. Sample Taken.
99'							
100'	S 07129	17 ~~13~~ 20	18"	Very Stiff, dark gray clay moist (Color: 5 Y, 4/1)	CL	3.5	Backgrounds levels (1500)
101'							
102'				— — ? — — ? — — ? — —	?		
103'							
104'							
105'							

NOTES: Background Levels 9-21-87 $\gamma\beta$ = 40-80 cpm, α = 0, hum = 0

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402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS		
BORING NUMBER: 3024	COORDINATES:	DATE: 9-22-87	
ELEVATION:	GWL: Depth 52' Date/Time 9-21/1700	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 64.5' Date/Time 9-22/1550	DATE COMPLETED: 10-3-87	
DRILLING METHODS: CABLE Tool	92' 9-22/1715	PAGE 8 OF 11	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
105'							
106'	S 07130	6 7 14	6"	Medium dense, grayish-brown fine grain, well graded, silty Sand (Color: 2.5 Y, 5/2)	SM		Background levels (1620)
107'							End 9-21-87
108'							
109'							
110'							
111'	S 07131	6 10 11	12"				Background levels (1035)
				111.4' Soft, dark gray silty clay (Color: 5 Y, 4/2) 111.4'	CL	~~.95~~ .5	
112'							
113'							Picking up clay on hammer 113' - 115'
114'							
115'				Medium Stiff, Olive-Gray Clay (5 Y, 4/2) 115.5' 115.5'	CL	.75	
116'	S 07132	9 14 18	18"	Very Stiff, olive gray clay (Color: 5 Y, 4/2)		3.5	Background levels (1338)
117'							Casing Driven Down To 120'
118'							
119'							
120'							

NOTES: Background Levels 9-22-87: $\gamma\beta$ = 40-80 cpm, α = 0, hnu = 0

402-11-86

RI/FS 258

2nd Key In 9/29/91 | Hard Copy Verification

RKA 2/4/87

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS	
BORING NUMBER: DB-5-9 324 3024	COORDINATES:	DATE: 9/22 & 9/23/87
ELEVATION:	GWL: Depth 64.5' Date/Time 9-22/1550	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 92' Date/Time 9-22/1715	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool	75' 9-23/1750	PAGE 9 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
120'							
121'	S 07133	2 3 6	18"	Medium Stiff, gray (5Y, 5/1) to Olive gray (5Y, 5/2) clay with some fine gravel wet	CL		Moderately gravelly Sand. Background levels (1650)
122'							End Day 9-22-87 Start Day 9-23-87
123'				123.5'			Noticed Sand & Gravel On Sticking On Hammer
124'							
125'							
126'	S 07134	27 17 10	6"	Medium Dense, Olive-~~Gray~~-Brown, fine to coarse gravel wet (Color: 2.5 Y, 4/4)	GP		Scanned - Background Readings Only (1025)
127'							
128'							
129'							
130'							
131'	S 07135	18 33 19	5"	Very Dense, Olive-Brown Fine Gravel (Color: 2.5 Y, 4/4) wet	GW		Background levels. Spoon Plugged with light Olive-brown carbonate rock fragment (2.5 Y, 5/4) (1108)
132'							132' Drilling became more difficult Lithology Change
133'							
134'							Drilled Down To 135' & Sand blew In To 124'
135'							Drive 10" Cog to 140'

NOTES: Water Level checked at 1550, 9-22-87 when temporary Casing was at 121'.

Background Levels 9-23-87: $\gamma\beta$ = 40-120 cpm hnu = 0, α = 0

Smelled Some Brackish, Semi-Petroliferous odor observed at 125'. Hole Monitored with LLE & hnu. No Readings Detected.

224

402-11-86

FERNALD
RI/FS

258

Key In		
2nd Key In		
Hard Copy Verification		

KKA 2/4/87

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3024	COORDINATES:	DATE: 9-24-87 / 9-29-87
ELEVATION:	GWL: Depth 66.4' Date/Time 9-24/1245	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 58.5 Date/Time 9/29/0900	DATE COMPLETED: 10-3-87
DRILLING METHODS: CABLE TOOL		PAGE 10 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
135'							End Day 9-23-87
136'		#1 #2 11 5 13 7 14 10	0"				Start Day 9-24-87 Attempted twice to obtain sample.
137'							Sand Pump indicates Fine Sand
138'							
139'							Drilled Down to 140', but sand blew in to 135'. Drive Csg to 145'
140'							
141'	S 07136	#1 50-(4") #2 45 (2")-50	12"	Very Dense, Very Dark Grayish-Brown Sand & Fine Gravel wet (Color: 2.5 Y, 3/2)	SW		B.G. Felt we hit a Rock (1115)
142'							
143'							Hammer Driving Hard Feels Like we were pounding a large rock.
144'							
145'							End Day 9/29 Start Day 9/29
146'	S 07137	38 (5") 50	12"	Very Dense, very dark brownish-gray sand with fine gravel, generally as above (Color: 2.5 Y, 3/2) wet	SP		Background - Scanned. (1050)
147'							
148'							
149'							
150'							

NOTES: Water level with Csg at 145' 9-24 @ 1245 = 66.4'
" " " " " " 9-29 @ 58.5' after well sitting 4 days

Background Levels 9/29/87: $\gamma\beta$ = 60-120
α = 0
hmu = 0

225

402-11-86

RI/FS

258

RKO 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: BB ~~3024~~ 3074	COORDINATES:	DATE: 9-29-87
ELEVATION:	GWL: Depth 60.7 Date/Time 9-29/1615	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 58.6 Date/Time 9-30/1340	DATE COMPLETED: 10-3-87
DRILLING METHODS: CABLE TOOL		PAGE 11 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
150							
151'	S 07138	20 37 (4")50	14"	Medium Dense, Gray Silty Sand grading downwards into: (Color 2.5 Y, N5/)	SM		Scanned - Background levels (1415)
				Very Dense, black fine gravel wet (Color: 2.5 Y, N2/)	GW		
152'							
153'							
154'							
155'							BOB.
156'	S 07139	7 22 45	18"	Very Dense, Dark gray coarse Sand w/ some fine gravel wet (Color: 5 Y, 4/1)			Scanned - Background levels (1540)
157'				Bottom of Borehole (10") = 155' Bottom of last Split Spoon = 156.5'			
158'							
159'							
160'							

NOTES: Blow Sand coming into hole with Csg @ 150'. to a depth of 147'
10" Csg Driven to 155' to obtain 150-151.5' Split Spoon Sample.

Used a total of 500 gallons to Drill Entire Well.

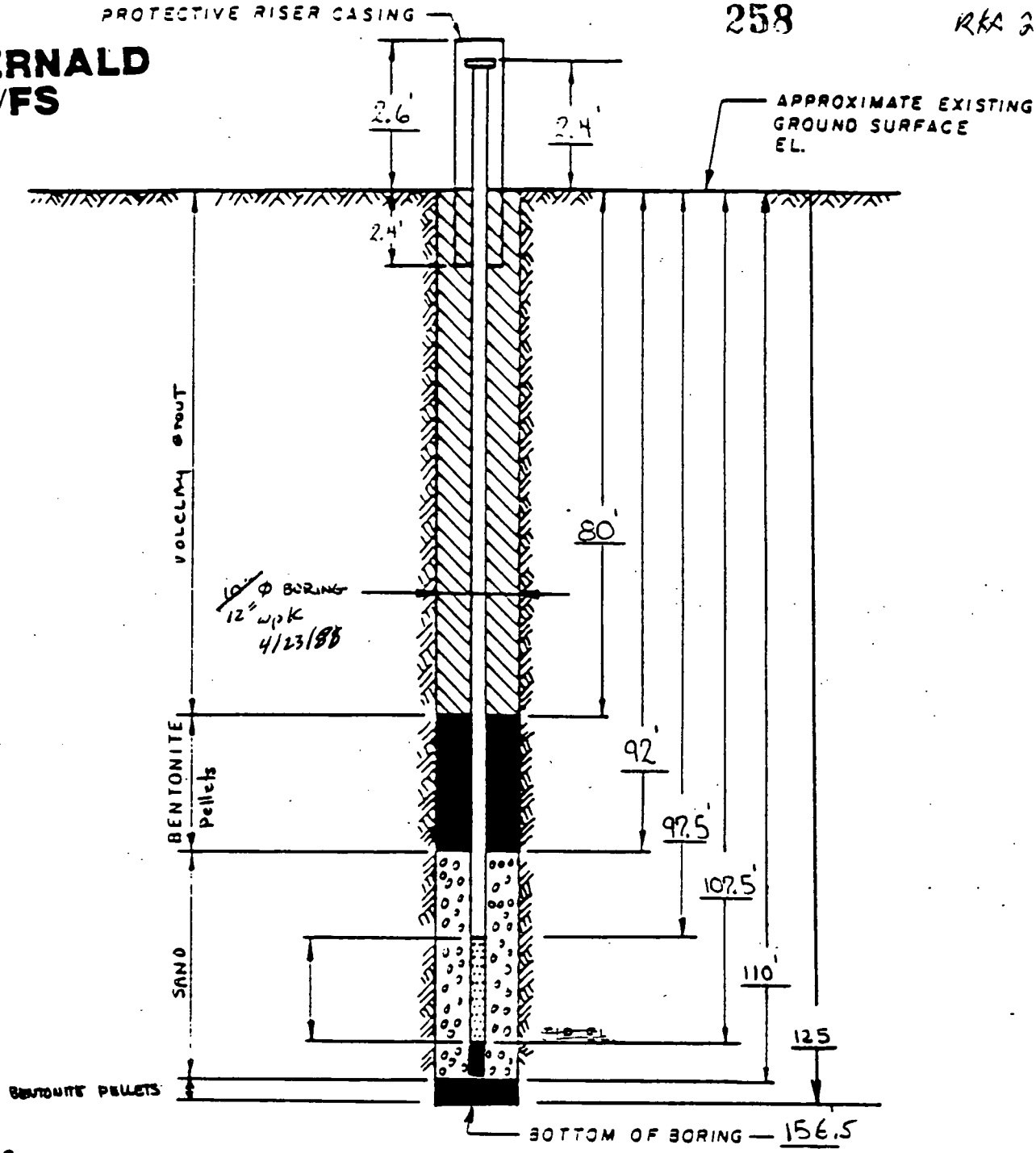
226

402-11-86

258

RKA 2/9/89

FERNALD RI/FS



NOTE: HOLE WAS ALLOWED TO COLLAPSE TO 125'. PLUGGED WITH BENTONITE 125'-110'.

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

while out corrections were made by B. Dunning at the time the form was completed

WPK
4/23/88

INSTALLATION DETAILS
MONITORING WELL ~~324~~ 3024 RKA 2/9/89

PREPARED FOR

FMPC RI/FS

DRAWN BY
CHECKED BY
APPROVED BY
DRAWING NUMBER

227

FERNALD RI/FS

WPK 4/22/98

258

AFN 2/4/99

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. B. Dunning DATE 10/16/87
PROJECT NO. 602 CHECKED BY RMB DATE 2/2/99
BORING NO. ~~BB 1549~~ ~~324~~ 3024
PIEZOMETER NO. ~~324~~ 3024 DATE OF INSTALLATION 10-3-87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool	TYPE OF BIT Hammer
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID H_2O FROM 0 TO 155'	SIZE 10" FROM 0' TO 155'
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel monitoring well	RISER PIPE MATERIAL Stainless Steel (316)
DIAMETER OF PERFORATED SECTION 4"	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8" I.D. 4"
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10'
AVERAGE SIZE OF PERFORATIONS .010"	JOINING METHOD Flush Joint Threaded
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10'	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5'	OTHER PROTECTION LOCKING CAP AND LOCK
PROTECTIVE PIPE ~~Ø~~ I.D. 10"	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft.)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	+ 2.4'			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	- ~~2.4~~ 2.6' RMB 2/2/99			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 80'	TOP	BOTTOM
BENTONITE	TOP 80'	BOTTOM 92'	TOP	BOTTOM
SAND	TOP 92	BOTTOM 110'	TOP	BOTTOM
BENTONITE PELLETS	TOP 110'	BOTTOM 125	TOP	BOTTOM
PERFORATED SECTION	TOP 97.5'	BOTTOM 107.5'	TOP	BOTTOM
PIEZOMETER TIP	~~110'~~ ~110'			
BOTTOM OF BOREHOLE	~~155.5'~~ 155.0' WPK 4/24/98			
GWL AFTER INSTALLATION	58'			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑ 228

REMARKS Hole was drilled to 155' to clearly define stratigraphy. Casing was pulled up to 125' and sand-hole was allowed to collapse in. The well was then plugged from 125' to 110' with bentonite to insure that no communication through "Blue Clay" was present. Well was then set from 110'.

409-1 1-86

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1-5-5 ~~0125~~ 1025	COORDINATES:	DATE: 12/21 - 12/23/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/21/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 01/08/88
DRILLING METHODS: Cable Tool		PAGE 1 OF 2

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	S 07800	4 16 15	15"	.5' Dense yellowish-brown sand (10 YR, 5/4) wet .5' 1.0' Dense light gray gravel rock (10 YR, 6/1) wet 1.0'	SM GW	- -	Hnu = 0 α = 0 γβ = 80 c.p.m. (1500)
2	S 07801	50 43 36	9"	Hard, dark brown clay (10 YR, 4/3) with some coarse gravel. Dry 2'	CL	4.5	Hnu = 0 α = 0 γβ = 60 c.p.m. (1504)
3				2.5' Hard dark olive gray clay (5 Y, 3/2) with some gravel 3' Light gray very dense gravel (10 YR, 6/1)	Dry GP	4.5+	
4	S 07802	10 13 13	18"	Hard, olive clay (5 Y, 4/3). Dry 5' 5'	CL		Hnu = 0 Met refusal first Attempt. α = 0 γβ = 80 c.p.m. (1645)
5	S 07803	31 22 28	18"	Hard, dark olive gray clay (5Y, 3/2) with a trace of fine gravel. Dry 7.5' 7.5'		4.5+	Hnu = 0 End Day 12/21/87 Start Day 12/21/87 α = 0 γβ = 80 c.p.m. (1916)
6							
7	S 07804	19 23 30	6"				Hnu = 0 α = 0 γβ = 60 c.p.m. (1031)
8	S 07806	13 17 20	15"	Hard, olive-gray clay (5Y, 4/2) with a trace of fine gravel Dry 10' 10'		4.5	Breeze picked-up & increased background levels. Hnu = 0 α = 0 γβ = 120 c.p.m. (1351)
9							
10	S 07807	25 27 33	18"				Hnu = 0 α = 0 γβ = 120 c.p.m. (1357)
				Stiff, yellowish-brown clay (10 YR, 5/6) silty and Dry 11' 11'		1.5	Attempted Shelby tube, but lost recovery.
11	S 07808	12 19 22	18"	Hard, brownish-yellow clay (10 YR, 6/8) with a trace of fine gravel. Dry 12' 12'		4.5	Hnu = 0 α = 0 γβ = 120 c.p.m. (1625)
12							End of Day 12/22/87 Start Day 12/23/87
13	S 07809	5 7 11	12"	Very stiff, yellowish-brown clay (10 YR, 5/4) to (10 YR, 5/8) with a trace of gravel. Dry		3.5	Hnu = 0 α = 0 γβ = 60 c.p.m. (0836)
14	S 07810	17 26 27	18"				Hnu = 0 α = 0 γβ = 40-60 c.p.m. (0840)
15							

NOTES:

I) Drilling Contractor: Pennsylvania Drilling
Driller: Tim Harris
Helper: Craig Coulter

II) Samples color by Munsell Color Chart & blow counts via ASTM

III) Background Measurements
12/21/87 = Hnu = 0 γβ = 250 cpm
α = 0
12/22/87 = α = 0
Hnu = 0
γβ = 180-250 c.p.m.

229

402-11-86

FERNALD RI/FS

GO/DA 12/3/89

258

	Initial	Date
1st Key In		
2nd Key In		5/11
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1025	COORDINATES:	DATE: 12/23/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/21/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 01/08/88
DRILLING METHODS: Cable Tool		PAGE 2 OF 2

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	ST 07 8 1	NA	14"	SHELBY TUBE PUSHED		4.5	Hnu = 0 α = 0 γB = 60-80 cpm. 0935
17	07 5 12	15 15 22	14"	Hard, Brownish yellow clay w/ trace of gravel (5Y 6/6) slightly moist @ 18 ft	CL	4.5	Hnu = 0 α = 0 γB = 60 cpm 0945
18	07 5 13	24 22 27	12" 19.5				Hnu = 0 α = 0 γB = 50 cpm 1010
20	07 5 14	12 17 18	12"	STIFF, Dark gray clay (10YR 4/1) Trace of gravel. moist	CL	1.5	Hnu = 0 α = 0 γB = 60-80 cpm 1350
21	07 1 5	3 4 3	14"	STIFF Dark grey clay (10YR 3/1) Trace of gravel. moist			Hnu = 0 α = 0 γB = 30 1500
23				23.0 ← BOTTOM OF BOREHOLE			
24							
25							
26							
27							
28							
29							
30							

NOTES: Background Levels 12/23/87
Hnu = 0
α = 0
γB = 180-250 cpm.

II. WATER USED: 30 + 20 = 50 gallons
15
65 gallons

III Background Measurements
01/07/88 = Hnu = 0
α = 0
γB = 200 cpm

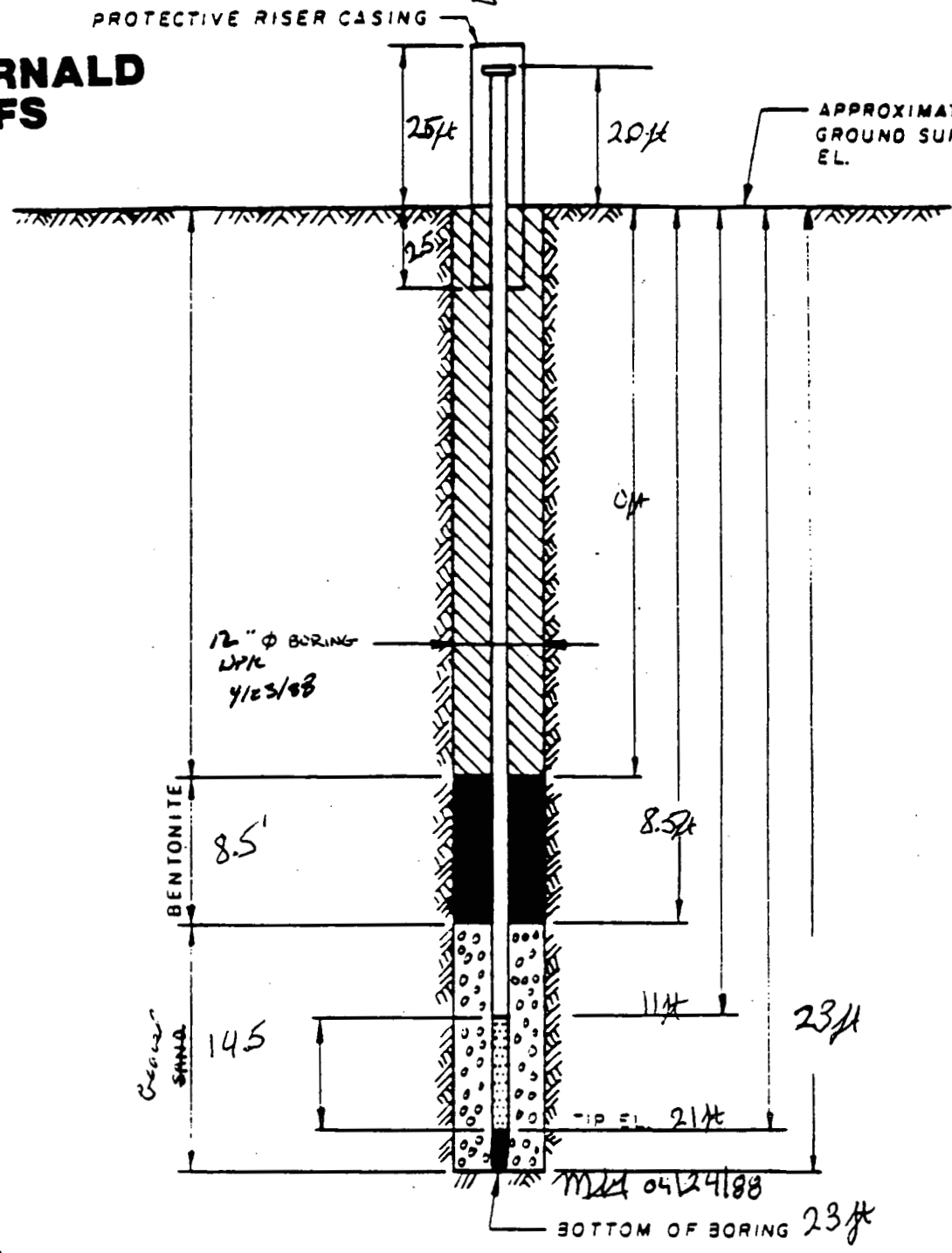
230

402-11-86

Monitoring Well #~~125~~ 1025 BB 1-1-89

258

FERNALD RI/FS



DRAWING NUMBER

DRAWN BY

CHECKED BY

APPROVED BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~125~~ 1025
RMG 2/6/89

PREPARED FOR

Gravel From 23 - 8.5 ft
Bentonite From 8.5 - surface

231

FERNALD RI/FS

258

1st Key In		
2nd Key In		
Hard Copy Verification		

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS
PROJECT NO. 602
BORING NO. ~~125~~ BB-1-89 1025
PIEZOMETER NO. ~~125~~ 1025

FIELD ENG./GEO. M. Goldberg DATE 01/08/88
CHECKED BY R Galbraith DATE 2/6/89
DATE OF INSTALLATION 01/08/88

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 3 ft TO 23
FLUID NA FROM NA TO NA

TYPE OF BIT Flathead
CASING SIZE (S) USED:
SIZE 10" FROM 0 TO 23 ft
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Monitoring
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 inch
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 ft

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8 in I.D. 4 in
LENGTH OF PIPE SECTIONS 10 ft
JOINING METHOD Thread and couple (FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 ft
PROTECTIVE PIPE I.D. 10" in

OTHER PROTECTION Lockable cap AND LOCK.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 ft			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 ft			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP N/A	BOTTOM N/A	TOP	BOTTOM
BENTONITE	TOP 0 ft	BOTTOM 8.5	TOP	BOTTOM
SAND	TOP 8.5 ft	BOTTOM 23 ft	TOP	BOTTOM
~~GRAVEL~~	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 11.0	BOTTOM ~~22.0~~ 21.0 ft MLH 04/24/88	TOP	BOTTOM
PIEZOMETER TIP	23 ~~feet~~ MLH 04/24/88			
BOTTOM OF BOREHOLE	23			
GWL AFTER INSTALLATION	NA			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒ 232

REMARKS

409-11-86

FERNALD RI/FS

258

1st Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~127~~ 1027 BB 1-5-89	COORDINATES:	DATE: 12-21-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12-21-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 12-22-87
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				SEE VISUAL CLASSIFICATION FOR WELL # ~~227~~. 2027 RMB 2/6/89			
10	ST 07805 15:57						12-22-87 8:30
20	ST 07876 10:10						
30				WELL TD 31.5 FT.			

NOTES:

WATER ADDED TO HOLE

~~HH~~ ~~HH~~ III

EACH MARK REPRESENTS 10 gals

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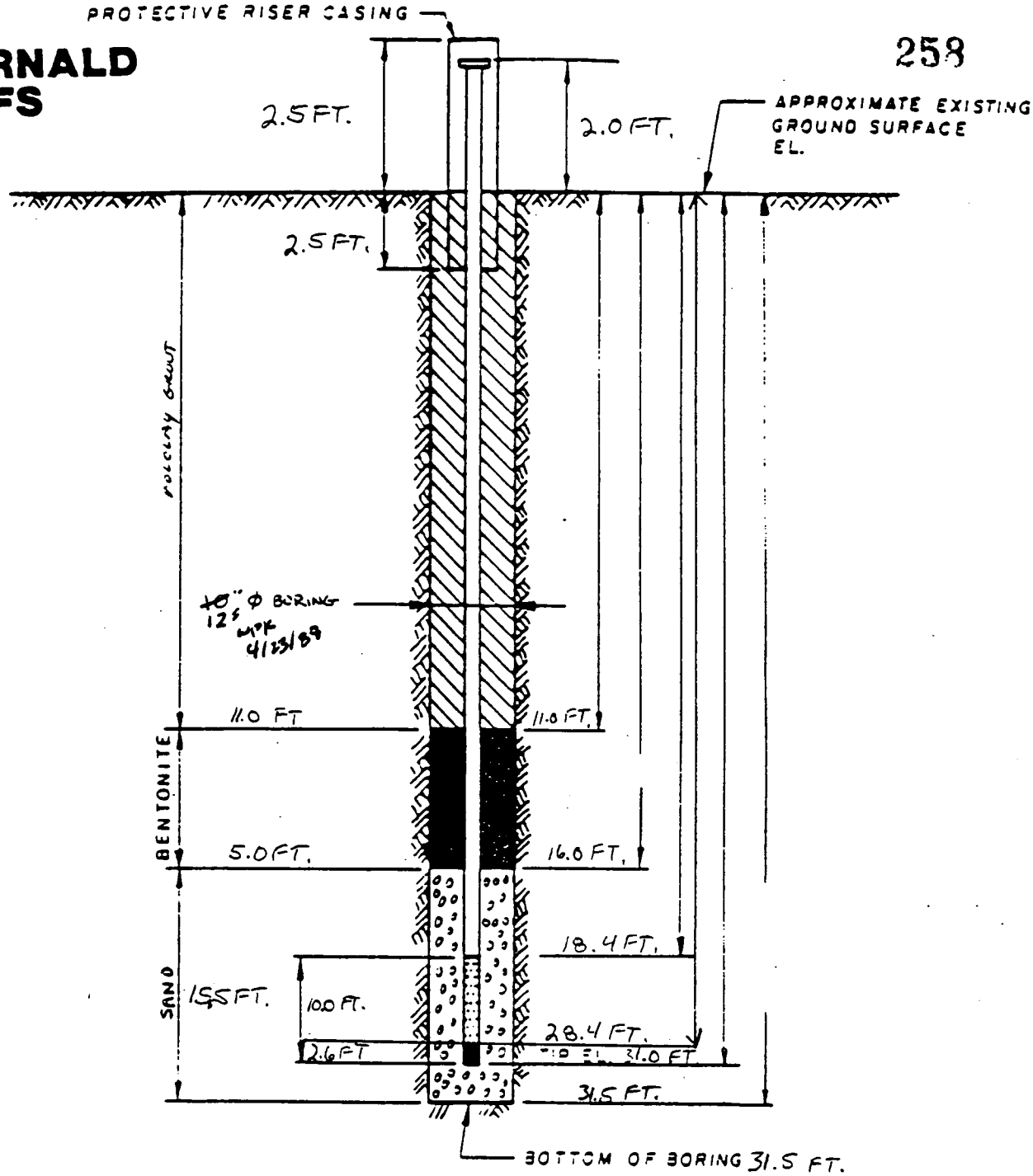
402-11-86

WELL # ~~127~~ 1027

FERNALD RI/FS

258



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~127~~ 1027

PREPARED FOR

RWL 2/6/89

DRAWN BY	D130	CHECKED BY	
		APPROVED BY	

DRAWING NUMBER

234

FERNALD RI/FS

258

1st Key In		
2nd Key In		
Hard Copy Verification		

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D. OAKLEY DATE 12-23-87
PROJECT NO. 692 CHECKED BY R Gallagher DATE 2/8/88
BORING NO. ~~127~~ 1027 8/9/88
PIEZOMETER NO. N/A DATE OF INSTALLATION 12-22-87 - 12-23-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT FLATHEAD
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID WATER FROM 4.0 TO 31.5 FT	SIZE 10 IN FROM 0 TO 30 FT.
FLUID ____ FROM ____ TO ____	SIZE ____ FROM ____ TO ____

PIEZOMETER DESCRIPTION

TYPE MONITORING	RISER PIPE MATERIAL 316 STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4 IN	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 IN I.D. 4 IN
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 FT.
AVERAGE SIZE OF PERFORATIONS .010 IN	JOINING METHOD THREAD AND
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 FT.	COUPLE

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.	OTHER PROTECTION LOCKING CAP
PROTECTIVE PIPE I.D. 10 IN.	with lock WPK 4/23/88

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0	BOTTOM 11.0 FT.	TOP	BOTTOM
BENTONITE	TOP 11.0	BOTTOM 16.0 FT.	TOP	BOTTOM
SAND	TOP 16.0	BOTTOM 31.5 FT	TOP	BOTTOM
~~GRAVEL~~	TOP N/A	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 18.4 FT.	BOTTOM 28.4 FT	TOP	BOTTOM
PIEZOMETER TIP	WPK 4/23/88 31.0			
BOTTOM OF BOREHOLE	31.5 FT.			
GWL AFTER INSTALLATION	NR			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒ 235
IS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS Write out correction was made by DBO at the time the form was completed WPK 4/23/88

409-11-88

FERNALD RI/FS

258

1st Key In		
2nd Key In		
Hard Copy Verification		

WPK 4/29/88 RVG #2

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 603	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~227~~ 2027	COORDINATES:	DATE: 12-10-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12-10-87
ENGINEER/GEOLOGIST: KELLEY/OAKLEY	Depth Date/Time	DATE COMPLETED: 12-17-87
DRILLING METHODS: CABLE & TOOL		PAGE 1 OF 6

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07811 13:10	4 4 4	14	VERY STIFF YELLOWISH BROWN (10YR 5/4) SILT, SOME SAND AND GRAVEL, TRACE CLAY - ~~TRAC~~ DRY 1.7	ML	3.5	HNU-0PPM BΔ-120CPM γ-0CPM
2 3	07842 13:35	4 7 7	12	HARD GRAY (2.5,5/0) SILT SOME SAND AND LIMESTONE GRAVEL. 3.9 TRACE CLAY -DRY	ML	4.5	HNU-0PPM BΔ-120CPM γ-0CPM
4	07813 13:50	8 8 9	15	HARD YELLOWISH BROWN (10YR,5/4) SILT AND CLAY, SOME GRAVEL-DRY	ML	4.0	HNU-0PPM BΔ 120CPM γ-0CPM
5	07844 14:00	14 24 28	15	HARD YELLOWISH BROWN (10YR,5/4) SILT 5.1 AND CLAY, SOME GRAVEL -DRY	ML	4.5	HNU-0PPM BΔ-120CPM γ-0CPM
6				DENSE LIGHT GRAY (10YR, 7/2) LIMESTONE GRAVEL AND CLAY - DRY 6.0	GC	4	
7	07845 14:10	14 23 26	15	HARD YELLOWISH BROWN (10YR,5/6) MOTTLED SILT AND CLAY, SOME GRAVEL AND SAND-DRY	ML	4.5+	HNU-0PPM BΔ-120CPM γ-0CPM
8 9	07846 16:23	4 12 19	14	HARD YELLOWISH BROWN (10YR,5/6) CLAY AND SILT, SOME SAND, TRACE GRAVEL - VERTICAL FRACTURES WITH IRON STAINING - DRY	CL	4.5+	HNU-0PPM BΔ-60 CPM γ-0CPM
10	07847 16:44	13 17 22	10	HARD STRONG BROWN (7.5YR, 5/6) SILT, SOME SAND AND CLAY-DRY VERTICAL FRACTURES WITH IRON STAINING	ML	4.5+	HNU-0PPM BΔ-60CPM γ-0CPM
11 12	07848 17:02	6 12 18	10	HARD YELLOWISH BROWN (10YR,5/6) SILT, SOME SAND AND CLAY- DRY. VERTICAL FRACTURES WITH IRON STAINING.	ML	4.5	HNU-0PPM BΔ-60CPM γ-0CPM
13	07849 8:25	12 15 24	18	HARD LIGHT YELLOWISH BROWN (2.5Y,6/4) SILT, SOME CLAY AND GRAVEL, TRACE SAND- DRY.	ML	3.25	12-11-87 8:00 HNU-0PPM BΔ-80CPM γ-0CPM
14 15	07850 8:50	7 12 6	13	VERY STIFF LIGHT YELLOWISH BROWN SILTY CLAY, TRACE FINE GRAVEL AND SAND - MOIST	CL	3.75	HNU-0PPM BΔ-80CPM γ-0CPM

NOTES:

CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARM DYMES SR.
ASSISTANT: JOHN VANDINE

WATER ADDED TO HOLE
1 = 10 GALLONS
~~HH~~ ~~HH~~ ~~HH~~
~~HH~~ ~~HH~~ ||

SAMPLES TAKEN ACCORDING TO ASTM STANDARD PENETRATION TESTS.
COLORS CLASSIFIED USING MUNSELL COLOR CHARTS

402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 227 227 BB 1-5-89	COORDINATES:	DATE: 12·11·87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12·10·87	
ENGINEER/GEOLOGIST: D.OAKLEY	Depth Date/Time	DATE COMPLETED: 12·17·87	
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 6	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	07851	5		VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND. MOIST	CL	3.5	HNU - 0 PPM
16	9:05	7 12	15	VERY STIFF GRAY (5Y, 5/1) CLAY, TRACE SAND AND SILT - MOIST. 16.5	CL	1.5	Bα - 70 CPM γ - 0 CPM
17	07852	7		VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, TRACE GRAVEL AND SAND - MOIST 18.2	CL	3.5	HNU - 0 PPM Bα - 70 CPM γ - 2 CPM
18	9:15	15 15	18				
19	07853 8:20	3 7 11	5	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SILT, TRACE GRAVEL AND SAND - WET.	CH	1.0	12-14-87 8:00 HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
20	07854	4		STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SILT AND GRAVEL - MOIST	CH	1.0	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
21	8:40	5 8	9	21.3 STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SILT, TRACE SAND - WET	CH	1.25	
22	07855 8:50	7 7 7	8	MEDIUM DENSE OLIVE GRAY (5Y, 5/2) SAND, SOME GRAVEL, TRACE CLAY - WET.	SW	–	HNU - 0 PPM Bα - 40 CPM γ - 0 CPM
23	07856	7		MEDIUM DENSE OLIVE GRAY (5Y, 5/2) SAND AND GRAVEL, TRACE CLAY - WET.	SW	–	HNU - 0 PPM Bα - 40 CPM γ - 0 CPM
24	9:15	7 6	7				
25	07857 9:35	22 14 21	7	DENSE OLIVE GRAY (5Y, 5/2) SAND AND GRAVEL - WET. 25.4	SW	–	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
				25.7 HARD LIGHT OLIVE GRAY (5Y, 6/2) CLAY, SOME SAND AND GRAVEL, TRACE SILT - DRY	CL	–	DARKER THAN THIS MUNSELL COLOR.
26	07858 10:40	11 31 37	5	VERY DENSE LIGHT OLIVE GRAY (5Y, 6/2) CLAYEY GRAVEL, SOME SAND - WET 27.4	GC	–	HNU - 0 PPM Bα - 40 CPM γ - 0 CPM
27							
28	07859 11:00	24 44 27	16	VERY DENSE LIGHT OLIVE GRAY (5Y, 6/2) SAND AND GRAVEL - MOIST. 28.1	SW	–	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
				HARD GRAYISH BROWN CLAY, SOME SILT - MOIST	CL	2.0	
29 30	07860 13:30	13 16 27	10	HARD OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST	CL	2.5	HNU - 0 PPM Bα - 100 CPM γ - 0 CPM

NOTES:

① NOT CLOSE TO ANY MUNSELL COLOR.

402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~227~~ 2027	COORDINATES:	DATE: 12.14.87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12.10.87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 12.17.87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 6	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	0861 13:50	4 11 15	14	VERY STIFF OLIVE GRAY (5Y,5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST	CL	2.5	HW - GRAY BX - 60CM T - 0CM
32 33	0862 14:15	7 11 27	14	HARD OLIVE GRAY (5Y,5/2) CLAY, TRACE GRAVEL, SAND, AND SILT	CL	2.75	HW - ? BX - 70CM T - 0CM
34	0863 15:30	5 15 17	15	HARD OLIVE GRAY (5Y,5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST	CL	2.75	HW - GRAY BX - 30CM T - 0CM
35 36	0864 15:50	5 12 19	10	HARD OLIVE GRAY (5Y,5/2) CLAY, TRACE GRAVEL, SAND, AND SILT, - MOIST	CL	2.5	HW - GRAY BX - 70CM T - 0CM
37	0865 9:45	7 11 18	3	VERY STIFF OLIVE GRAY (5Y,5/2) CLAY, TRACE GRAVEL, SAND, AND SILT - MOIST	CL	-	HW - GRAY BX - 60CM T - 0CM
38 39	0866 9:40	7 12 15	14	VERY STIFF OLIVE GRAY (5Y,5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST	CL	1.75	HW - GRAY BX - 60CM T - 0CM
40	0867 10:05	20 30 30	6	VERY STIFF OLIVE GRAY (5Y,5/2) CLAY, SOME GRAVEL TRACE SAND AND SILT - MOIST	CL	1.5	HW - GRAY BX - 60CM T - 0CM
41 42	0868 11:05	7 9 13	16	40.7 VERY STIFF GRAY (5Y,6/1) SILT, WET. 42.2 HARD GRAY (5Y,6/1) SILT - MOIST	ML	0.5	HW - GRAY BX - 60CM T - 0CM
43	0869 13:35	16 24 46	15	43.0 HARD GRAY (5Y,6/1) SILT - MOIST; VERY DENSE DARK YELLOWISH BROWN (10YR,4/4) SAND AND GRAVEL DRY	ML SW	- -	HW - GRAY BX - 60CM T - 0CM
44 45							

NOTES:

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FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6002	PROJECT NAME: FERNALD 121/FS		
BORING NUMBER: ~~227~~ 3027	COORDINATES:		DATE: 12.15.87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 12.10.87
ENGINEER/GEOLOGIST: D. OAHEY	Depth	Date/Time	DATE COMPLETED: 12.17.87
DRILLING METHODS: CABLE TOOL			PAGE 4 OF 6

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	07870 11:20	50-12"	5	VERY DENSE DARK YELLOWISH BROWN (10YR, 4/4) ~~SANDY GRAVEL~~ GRAVEL AND SAND MOIST	GW	—	HNU-0.2ppm
47							
48							
49							
50	07871 10:00	48 50 .4"	10	VERY DENSE DARK YELLOWISH BROWN (10YR, 4/4) GRAVEL AND SAND MOIST	GW	—	HNU ? BX. X-OCPM
51							
52							12.16.87 8:15
53							
54				54.5			DRILLERS CONTACT
55	07872 9:40	44 50 .4"	0	VERY DENSE YELLOWISH BROWN (10YR, 5/4) VERY FINE SAND + D.Z.	SP	—	HNU - 0.2ppm BX - 100.0ppm X - OCPM
56							
57							
58							
59							
60							

NOTES:

402-11-86

FERNALD RI/FS

1st Key In		
2nd Key In		
Hard Copy Verification		

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 2027	COORDINATES:	DATE: 12-16-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12-10-87	
ENGINEER/GEOLOGIST: D. CARLIEN	Depth Date/Time	DATE COMPLETED: 12-17-87	
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 6	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	07873 13:35	30 49 32	0	VERY DENSE YELLOWISH BROWN (10YR, 5/4) GRAVEL AND SAND, MOIST.	GW	-	HNU - OPPM BZ - 100 CPM γ - 0 CPM
				VERY DENSE GRAY (10YR, 5/1) SAND, SOME GRAVEL - MOIST	SW	-	
62							
63							
64							
65	07874 14:35	25 25 25	10	DENSE DARK GRAY (10YR, 4/1) SAND, SOME GRAVEL - WET.	SW	-	HNU - OPPM BZ - 70 CPM γ - 0 CPM
66							
67							
68							
69							
70	07875	11 13 15	4	MEDIUM DENSE DARK GRAY (10YR, 4/1) FINE SAND, TRACE GRAVEL - WET	SP	-	HNU - OPPM BZ - 50 CPM γ - 0 CPM
71							
72							
73							
74							
75							

NOTES: 1 1/2" x 1' 3" x 4"

402-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

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PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~227~~ 2027	COORDINATES:	DATE: 12.17.87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12.16.87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 12.17.87	
DRILLING METHODS: CASE TOW		PAGE 6 OF 6	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	07876 9:35	44 25 24	10	DENSE DARK GRAY (10YR, 4/1) SAND AND GRAVEL - WET 76.5 76.5	SW	-	HSA - CASE Bit - 6" CONE S - OCAM
77				BOTTOM OF BORING			
78							

NOTES:

402-11-86

WELL # ~~227~~ 2027 # 130

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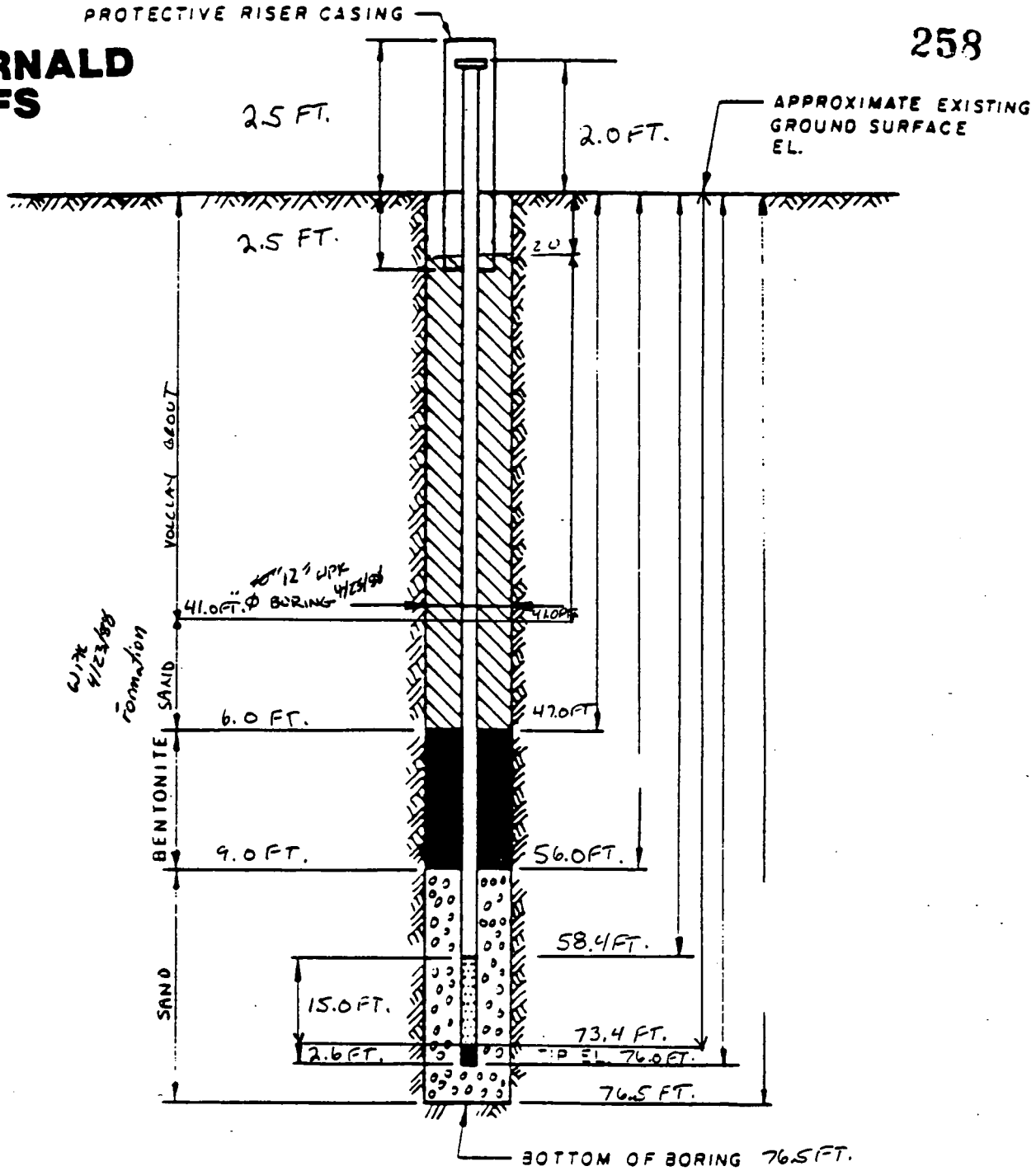
FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~227~~ 2027 RAW 2/6/87

PREPARED FOR

DRAWING NUMBER	
CHECKED BY	APPROVED BY
DBO	
DRAWN BY	

242

FERNALD RI/FS

Initial	Date
1st Rev In	258
GMT	02-18-89

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS
PROJECT NO. 602
BORING NO. ~~227~~ 2027 BB1-5-59
PIEZOMETER NO. NA

FIELD ENG./GEO. DAHLEN/HEGLEY DATE 12-18-87
CHECKED BY L Pickenitel DATE 2/6/89
DATE OF INSTALLATION 12-18-87 TO 12-20-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT FLATHEAD
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID WATER FROM 3.0 TO 76.5 FT.	SIZE 10 IN. FROM 0 TO 75
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Monitoring WPK 4/23/88	RISER PIPE MATERIAL 316 STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4 IN	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 IN. I.D. 4 IN.
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 FT.
AVERAGE SIZE OF PERFORATIONS .010 IN.	JOINING METHOD THREAD ~~AND COUPLING~~ RMG 2/6/89 Flush Joint
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 15 FEET	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FEET	OTHER PROTECTION LOCKING CAP AND LOCK
PROTECTIVE PIPE Ø.D. 10 INCH	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 2.0 FT.	BOTTOM 41.0 FT.	TOP	BOTTOM
~~BENTONITE~~ SAND	TOP 41.0 FT.	BOTTOM 47.0 FT.	TOP	BOTTOM
~~SAND~~ BENTONITE	TOP 47.0 FT.	BOTTOM 56.0 FT.	TOP	BOTTOM
~~GRAVEL~~ SAND	TOP 56.0 FT.	BOTTOM 76.5 FT.	TOP	BOTTOM
PERFORATED SECTION	TOP 58.4 FT.	BOTTOM 73.4 FT.	TOP	BOTTOM
PIEZOMETER TIP	~~NA~~ 76 ft RMG 2/6/89			
BOTTOM OF BOREHOLE	76.5 FT.			
GWL AFTER INSTALLATION	64.0 FT.			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
IS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒ 243

REMARKS 4 corrections were made by W Hegley at the time the form was completed.
WPK 4/23/88
REFER TO VARIANCE #6 in Field Activity Variances file.
WPK 4/23/88

409-11-86

FERNALD
RI/FS

RKA 2/4/

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS Task 3.2		
BORING NUMBER: 128 1025	COORDINATES:	DATE:	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/10/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 01/14/88	
DRILLING METHODS: Cable Tool		PAGE 1 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 INCH	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07 ② 17	27 24 17	14"	Hard, yellowish brown silt (10YR 5/4) Dry	ML	4.5	Hnu = 0 α = 0 δB = 0 0930
2 3	07 10	11 10 7	12"	Very stiff, yellowish brownish silt w/ trace gravel (10YR 5/4) dry	ML	2.5	Hnu = 0 α = 0 δB = 0 0945
4	07 5 7	16 29 29	6"	Silt size Flyash, dry (2.5Y 2/0) Brittle 5Ft	ML	—	Hnu = 0 α = 0 δB = 240 cpm 0955
5 6	07 10 10	18 15 18	12"	Hard, Dark Brown clay (10YR 4/3) Trace of gravel Dry	CL	4.5	Hnu = 0 α = 0 δB = 240 cpm 1000 Ran Shelby #7823 5.5-6.5 1300
7	07 ② 2 1	18 22 21	18	Very stiff Dark Brown clay (10yr 4/3) trace of gravel. Dry 8Ft		3.5	Hnu = 0 α = 0 δB = 120 cpm 1015
8 9	07 2 2	16 14 14	18"	Very stiff Dark Brown clay (10yr 4/3) with organics debris dry 9Ft	OL	2.5	Hnu = 0 α = 0 δB = 120 1020
10	07 ② 24	3 5 6	18"	Very stiff Dark Brown clay (10YR 4/3) with trace of gravel. moist	CL	3.0	Hnu = 0 α = 0 δB = 100 1415
11 12	07 ① 8 25	13 11 3	18"	Very stiff Dark Brown clay (10YR 4/3) w/ trace of gravel. encountered Lime sludge @ 12 Ft moist		2.5	Hnu = 0 α = 0 δB = 120 3-4 inch lense of lime sludge 11.7-12 Ft 1430
13	07 8 2 6	7 9 13	14"	Very stiff Dark Brown clay (10yr 4/3 trace of gravel. moist 13Ft		3.0	Hnu = 0 α = 0 δB = 120 1440
14 15	07 ② 8 27	13 17 19	18"	Hard Dark grey clay (10YR 4/1) w/ gravel. Trace of lime sludge @ 13.5 Ft moist		4.0	Hnu = 0 α = 0 δB = 120 1445

NOTES:
I) Drilling Contractor : Pennsylvania Drilling
Driller : Tim Harris
Helper : Craig Coulter

II) Background Measurements
A) Hnu = 0 B) α = 0 C) δB = 120 cpm

III) Water used = 55 gallons + 80 = 135 gallons

IV) Samples via Muncell colors ASTM

244

402-11-86

FERNALD RI/FS

258

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy		

RKA 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~128~~ 1025	COORDINATES:	DATE:
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01/10/88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 01/14/88
DRILLING METHODS: Cable Tool		PAGE 2 OF 2

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16 17	07 8 28	NA	1.8 Ft	Shelby Tube			Hnu=0 α=0 δB=120 1630
18	07 8 29	6 11 30	12"	Hard grey clay w/ trace of F gravel (2.5Y 5/0) dry	CL	4.0	Hnu=0 α=0 δB=100 0830
19 20	07 8 30	12 14 15	12"	Hard Dark grey clay (10YR 4/1) w/ trace of F gravel dry	CL	4.0	Hnu=0 α=0 δB=100 0906
21	07 8 31	7 11 7	12"	Hard Dark grey clay (10YR 4/1) w/ gravel. Dry 21.5	CL	4.0	Hnu=0 α=0 δB=100 0928
22 23	07 8 32	8 13 18	10"	Hard yellowish Brown clay (10YR 5/4) trace of F gravel. Dry			Hnu=0 α=0 δB=100 0955
24	07 8 33	13 18 26	18"	Hard yellowish Brown clay (10yr 5/4) trace of F gravel. Dry	CL		Hnu=0 α=0 δB=100 1025
25 26	07 8 34	8 3 11	10"	Hard yellowish Brown clay (10yr 5/4) trace of F gravel w/ Lense of Dark grey clay @ 25 Ft± (10yr 5/4) Dry 26.5		4.0	Hnu=0 α=0 δB=100 1038
27	07 8 35	16 18 21	18"	Dense yellowish Brown sand (10YR 5/6 Dry trace of F gravel	SW	2.0	Hnu=0 α=0 δB=100 1306
28 29	07 8 36	8 10 16	8"	Very stiff dark gray clay (10YR 4/1) moist	CL	3.5	Hnu=0 α= δB=90 1420
30 30.5	07 8 37	9 17 29	14"	very stiff dark grey clay (10YR 4/1) moist	CL	3.5	HNU=0 α=0 δB=60 1450

NOTES: TD

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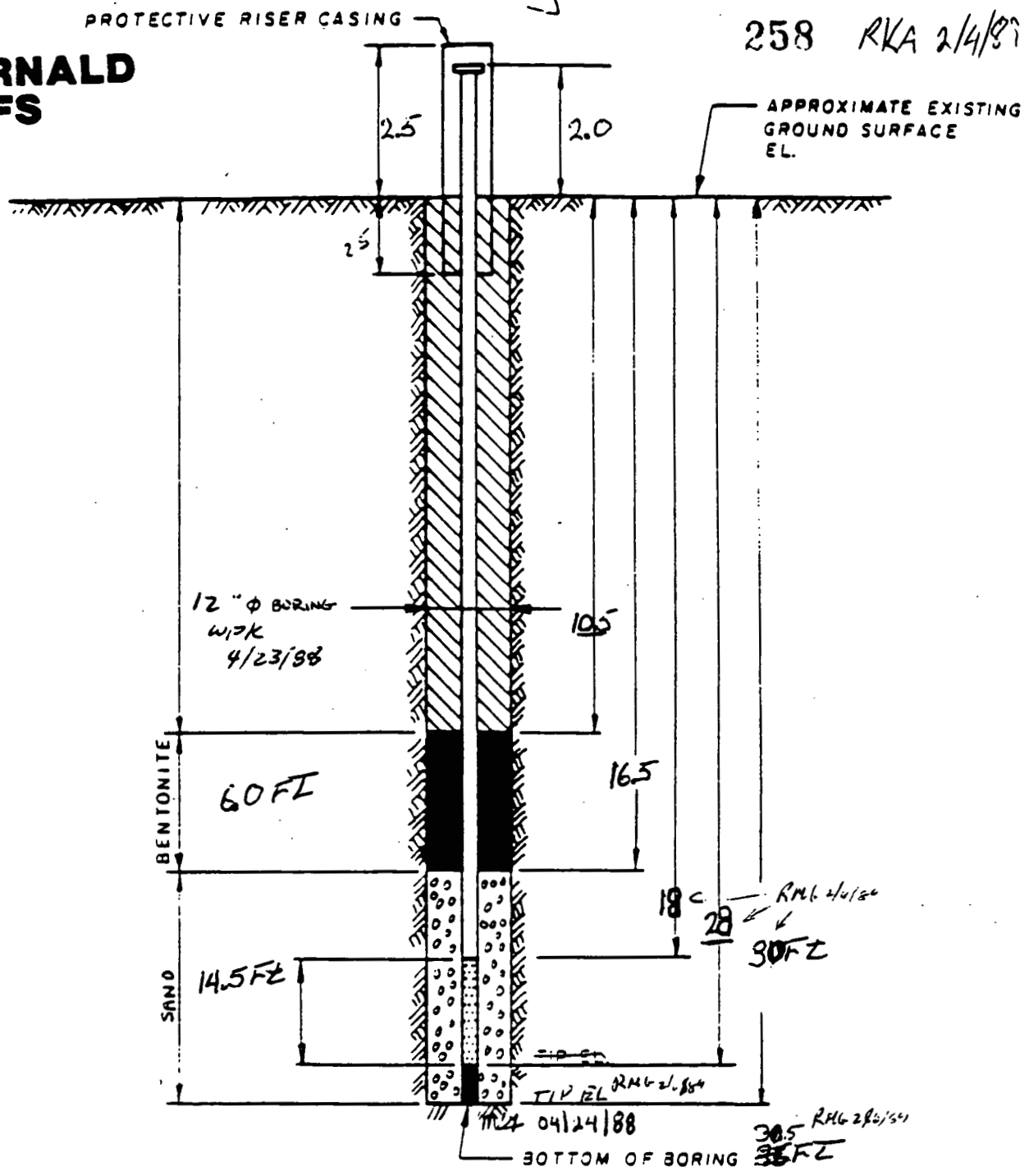
SEE PAGE 1 OF 1

402-11-86

Monitoring Well # ~~128~~ 1028 BB

258 RKA 2/4/89

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~128~~ 1028 RMG 2/6/89

PREPARED FOR

FMPC RI/FS

246

FERNALD RI/FS

258

RKA 2/4/89

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS FIELD ENG./GEO. M. Goldberg DATE 01/14/88
PROJECT NO. 601 CHECKED BY R Galbraith DATE 2/4/89
BORING NO. ~~128~~ 1028 BB1-5-39
PIEZOMETER NO. N/A DATE OF INSTALLATION 01/14/88

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID water FROM 3 Ft TO 31 Ft
FLUID NA FROM NA TO NA

TYPE OF BIT Flathead
CASING SIZE (S) USED:
SIZE 10" FROM 0 TO 31 Ft
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Monitoring
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 inches
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 Feet

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8" in I.D. 4" in
LENGTH OF PIPE SECTIONS 10 Ft
JOINING METHOD Thread and couple
(FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Ft
PROTECTIVE PIPE ~~Ø~~ I.D. 10" inches

OTHER PROTECTION Lockable cap AND lock

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FEET)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 Ft			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 10.5	TOP	BOTTOM
BENTONITE	TOP 10.5	BOTTOM 16.5	TOP	BOTTOM
SAND	TOP 16.5	BOTTOM 31	TOP	BOTTOM
~~GRAVEL~~	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 18	BOTTOM 28	TOP	BOTTOM
PIEZOMETER TIP	04/24/89 ~~31 ft~~ 30 ft			
BOTTOM OF BOREHOLE	~~31 Ft~~ 30.5 ft			
GWL AFTER INSTALLATION	NA			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

247

REMARKS

409-11-86

RI/FS

258

VISUAL CLASSIFICATION OF SOILS

WPK 4/23/88
RIG #1

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~130~~ 130	COORDINATES:	DATE: 3-16-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/16/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 03/17/88	
DRILLING METHODS: Cable Tool		PAGE 1 OF 4	

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	08 2 1 4	1 3 12	12"	Very STIFF Dark Yellowish Brown silty clay (10YR 4/4) Dry 1.5ft	ML	3.5	Hnu = 4ppm α = 0 δB = 120 1030
2 3	08 2 1 5	10 13 15	14"	Very STIFF yellowish Brown silty clay (10YR 5/6) Trace sand	OL	4.0	Hnu = 4ppm α = 0 δB = 100 1045
4	08 2 1 6	15 18 22	18"	Very STIFF yellowish Brown (10YR 5/6) silty clay trace sand. Dry	OL	4.0	Hnu = 4ppm α = 0 δB = 100 1050
5 6	08 2 1 7	35 45 42	18"	Hard Dark yellowish Brown (10YR 4/6) clay. Trace gravel w/silt 6.5ft	CL	<4.0	Hnu = 0.5ppm α = 0 δB = 100 1100
7	08 2 1 8	11 27 31	14"	Hard Yellowish Brown clay (10YR 5/6) Trace gravel DRY 7.5ft	CL	<4.0	Hnu = 0 α = 0 δB = 100 1450
8 9	08 2 1 9	36 46 50	10"	Hard Dark gray clay (5Y 4/1) Dry Trace gravel	CL	<4.0	Hnu = 0 α = 0 δB = 100 Blue clay fragments 1500
10	08 2 2 1	12 14 24	12"	Hard Dark grey clay (5Y 4/1) DRY trace gravel	CL	4.0	Hnu = 0 α = 0 δB = 120 Shelby Tube No 08220 1600
11 12	08 2 2 2	7 8 10	10"	Very STIFF Dark grey clay (5Y 4/1) Dry Trace gravel	CL	3.0	Hnu = 0 α = 0 δB = 120 1635
13	08 2 2 3	11 17 13	10"	Very STIFF Dark grey clay (5Y 4/1) DRY Trace gravel			Hnu = 0 α = 0 δB = 120 1640
14 15	08 2 2 4	7 8 15	10"	Very STIFF Dark gray clay (5Y 4/1) Dry. gravel			Hnu = 0 α = 0 δB = 120 03/17/88 0930

NOTES:

I) Drilling Contractor: Pennsylvania Drilling Co.
Driller: Tim Harris
Helper: Craig Coulter

II) Background measurements
A) Hnu = 0 B) α = 0 C) δB = 120 cpm

III) Water used 85 gallons

248

IV Colors via Munsell color chart

N/A = NOT Applicable

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~130~~ 1030	COORDINATES:	DATE: 3-17-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/16/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 3-18-88	
DRILLING METHODS: Cable Tool		PAGE 2 OF 4	

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16	08225	14 14 12	10"	STIFF Dark gray clay (5Y 4/1) DRY. Gravel Fragments →	CL	1.5	Hnu = 0 α = 0 δB = 120 Blue Fragments 0935
17	08226	6 6 7	10"	Very STIFF Dark gray clay (5Y 4/1) Dry Abundant Gravel		2.5	Hnu = 0 α = 0 δB = 100 1005
18							
19	08227	N/A	24"	SHELBY Tube 20.0ft	NA	NA	1100
20	08228	5 6	10"	Medium STIFF Dark grey silty clay (5Y 4/1) Trace sand. moist	ML	<1	Hnu = 5ppm α = 0 δB = 90 1450
21	08229	2 2 3	8"	Medium STIFF Dark grey silty clay (5Y 4/1). moist	ML	<1	Hnu = 0 α = 0 δB = 90 1505
22	08230	4 2 2	6"	Medium STIFF Dark grey silty clay (5Y 4/1) Trace gravel, moist	ML	<1	Hnu = 5ppm α = 0 δB = 110 1520
23	08231	2 3 2	6"	Med STIFF Dark grey silty clay (5Y 4/1) Trace gravel 25.5ft	ML	<1	Hnu = 5ppm α = 0 δB = 110 1530
24							
25							
26	08232	7 9 11	16"	Very STIFF olive gray clay (5Y 4/2) Trace gravel. DRY	CL	3.5	Hnu = 5ppm α = 0 δB = 110 1545
27	08233	18 22 31	18"	Very STIFF Dark gray clay (5Y 4/1) DRY Trace gravel	CL	3.5	Hnu = 7ppm α = 0 δB = 110 1630
28							
29	08234	10 14 18	18"	Very STIFF Dark gray clay (5Y 4/1) Dry trace gravel	CL	3.5	Hnu = 7ppm α = 0 δB = 110 1700
30							

NOTES:

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2	
BORING NUMBER: 130 ~~130~~ 1030	COORDINATES:	DATE: 3-18-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/16/88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 3-18-88
DRILLING METHODS: Cable Tool		PAGE 3 OF 4

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30							03/15/88
31	0 3 2 3 5	12 16 32	18"	Very STIFF Dark gray clay (5Y 4/1) Dry Trace Gravel 31 FT; Very STIFF Dark Yellowish Brown clay (10YR 4/2) Dry Trace Sand 31.5 FT	CL	3.5	Hnu = 0 α = 0 δB = 110 0915
32	0 3 2 3 5	6 19 19	18"	Dense Yellowish Brown sand (10YR 5/6) Dry	SP	<1	Hnu = 0 α = 0 δB = 110 0950
33							
34							
35							
36							
37							
38	0 8 2 3 12	19 50 50	18"	Very Dense yellowish Brown Sand (10YR 5/6) DRY	SP	<1	Hnu = 0 α = 0 δB = 110 1025
39							
40							
41							
42							
43	0 8 2 3 8	13 25 ~~50~~ 4	16"	Very Dense yellowish Brown gravel (10YR 5/6) with trace of sand, poorly sorted	GW	<1	Hnu = 0 α = 0 δB = 110 1515
44							
45							

NOTES:

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2	
BORING NUMBER: BB 1-5-3 ~~1130~~ 1030	COORDINATES:	DATE: 3-18-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/16/88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 3-18-88
DRILLING METHODS: Cable Tool		PAGE 4 OF 4

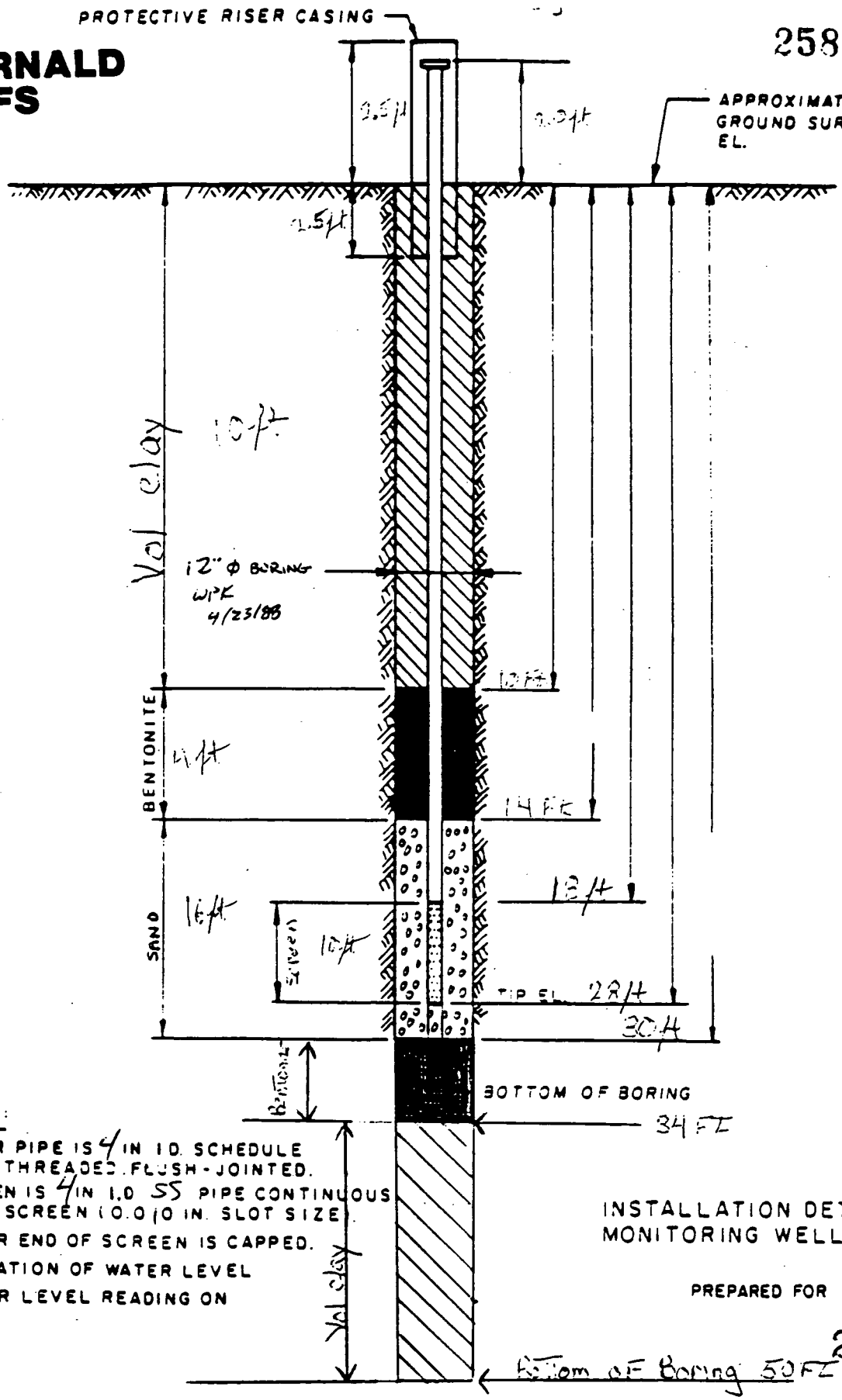
DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45							
46							
47							
48	0 3 2 3 9	17 31 45 50	24"	Very Dense gravel Yellowish Brown (10YR 4/4)	GW		Hnd=0 α=0 δB=90 1605
49				Very Dense Yellowish Brown sand (10YR5/8) DRY.	SP	41	
50				Bottom of Boring 50 FL.			

NOTES:

Monitoring Well # ~~[illegible]~~ 1030 pg...

258

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 1030

PREPARED FOR

252

FERNALD RI/FS

258

	Initials	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. M Goldberg DATE 03/19/88
PROJECT NO. 802 T32 CHECKED BY R Gatman DATE 2/6/89
BORING NO. ~~1030~~ 1030 BB 1-5-89
PIEZOMETER NO. ~~N/A~~ 1032 DATE OF INSTALLATION 03/19/88

BOREHOLE DRILLING

DRILLING METHOD Cable Tool	TYPE OF BIT Flat Head
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID Water FROM 3 ft TO 50 ft	SIZE 10" FROM 3 ft TO 50 ft
FLUID ____ FROM ____ TO ____	SIZE ____ FROM ____ TO ____

PIEZOMETER DESCRIPTION

TYPE Monitoring	RISER PIPE MATERIAL 316 Stainless Steel
DIAMETER OF PERFORATED SECTION ____	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8" I.D. 4" inches
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 ft
AVERAGE SIZE OF PERFORATIONS .010" inches	JOINING METHOD Thread and couple
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 ft	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT	OTHER PROTECTION Lockable cap
PROTECTIVE PIPE I.D. 10" inches	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.0 FT			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 10 FT	TOP	BOTTOM
BENTONITE	TOP 10 ft	BOTTOM 14 ft	TOP	BOTTOM
~~SAND~~	TOP NA	BOTTOM NA	TOP	BOTTOM
GRAVEL	TOP 14 ft	BOTTOM 30 ft	TOP	BOTTOM
PERFORATED SECTION	TOP 18 ft	BOTTOM 28 ft	TOP	BOTTOM
PIEZOMETER TIP	30 FT			
BOTTOM OF BOREHOLE	30 FT			
GWL AFTER INSTALLATION	N/A			

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒ 253
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS Well 130 was overdrilled to 50 ft to determine lithology. A Volclay plug was set from 50 FT → 34 ft with a 4 FT Bentonite Plug from 34 ft - 30 ft to seal Base of Till/sand contact @ 32.5 ft.

409-11-86

FERNALD RI/FS

RECEIVED 6/15/89

258 PA

RKA 2/4/

WPK 4/23/90

216 #1

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: ~~13~~ 1031 BB 1-5-89	COORDINATES:	DATE: 4-5-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 04/05/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 4-7-88	
DRILLING METHODS: Cable Tool		PAGE 1 OF 2	

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS 04/05/88
1	08 8 3 2	3 9 13	10"	Hard very dark grayish Brown clay (10YR 3/2) DRY	CL	>4	Hnu = 0 α = 0 γB = 260 0915
2 3	08 8 3 3	6 6 8	12"	Hard Dark Brown clay (10YR 4/3) DRY.	CL	74	Hnu = 0 α = 0 γB = 260 0920
4	08 8 3 4	21 10 11	12"	Very STIFF Dark Brown clay (10YR 4/3) DRY	CL	74	Hnu = 0 α = 0 γB = 200 0925
5 6	08 8 3 5	9 11 7	10"	5.5ft Medium STIFF gray clay (5Y 5/1) MOIST Trace gravel 6.0ft	CL	<1	Hnu = 0 α = 0 γB = 200 0930
7	08 8 3 6	8 11 7	10	Medium STIFF Dark Brown clay (10YR 4/3) moist. 7.5	CL	<1	Hnu = 0 α = 0 γB = 220 0935
8 9	08 8 3 7	9 11 12	12"	Medium STIFF gray clay (5Y 5/1) DRY trace gravel ← Shelby Tube 9.5	CL	<1	Hnu = 0 α = 0 γB = 210 0937 High Plasticity
10	08 8 3 8	16 11 13	18	Medium STIFF Yellowish Brown clay (10YR 5/8) MOIST. trace gravel 10.5	CL	<1	Hnu = 0 α = 0 γB = 210 0940 High Plasticity Shelby N008839 13
11 12	08 8 4 0	4 5 9	18"	Medium STIFF olive gray clay 5Y 4/2 DRY Trace gravel 13 Ft	CL	<1	Hnu = 0 α = 0 γB = 210 1400
13	08 8 4 1	5 7 11	18"	Medium STIFF very Dark gray (2.5Y 3/0) Trace gravel 13.5 Ft	CL	<1	Hnu = 0 α = 0 γB = 210 KJC
14 15	08 8 4 2	7 5 12	10'	Medium STIFF olive gray clay (5Y 4/2) DRY Trace Gravel	CL	<1	Hnu = 0 α = 0 γB = 210 1415

NOTES:

I) Drilling Contractor: Pennsylvania Drilling Co.
Driller: Tim Harris
Helper: Craig Coulter

II) Background Measurements
04/05/88 A) HNU = 0 B) α = 0 C) γB = 460 cpm

III) Water used = 254

IV Color via Munsell Color Chart

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 502	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: 88 1-5-89 ~~1-3~~ 1031	COORDINATES:	DATE: 4-6-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 04/05/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 4-7-88	
DRILLING METHODS: Cable Tool		PAGE 2 OF 2	

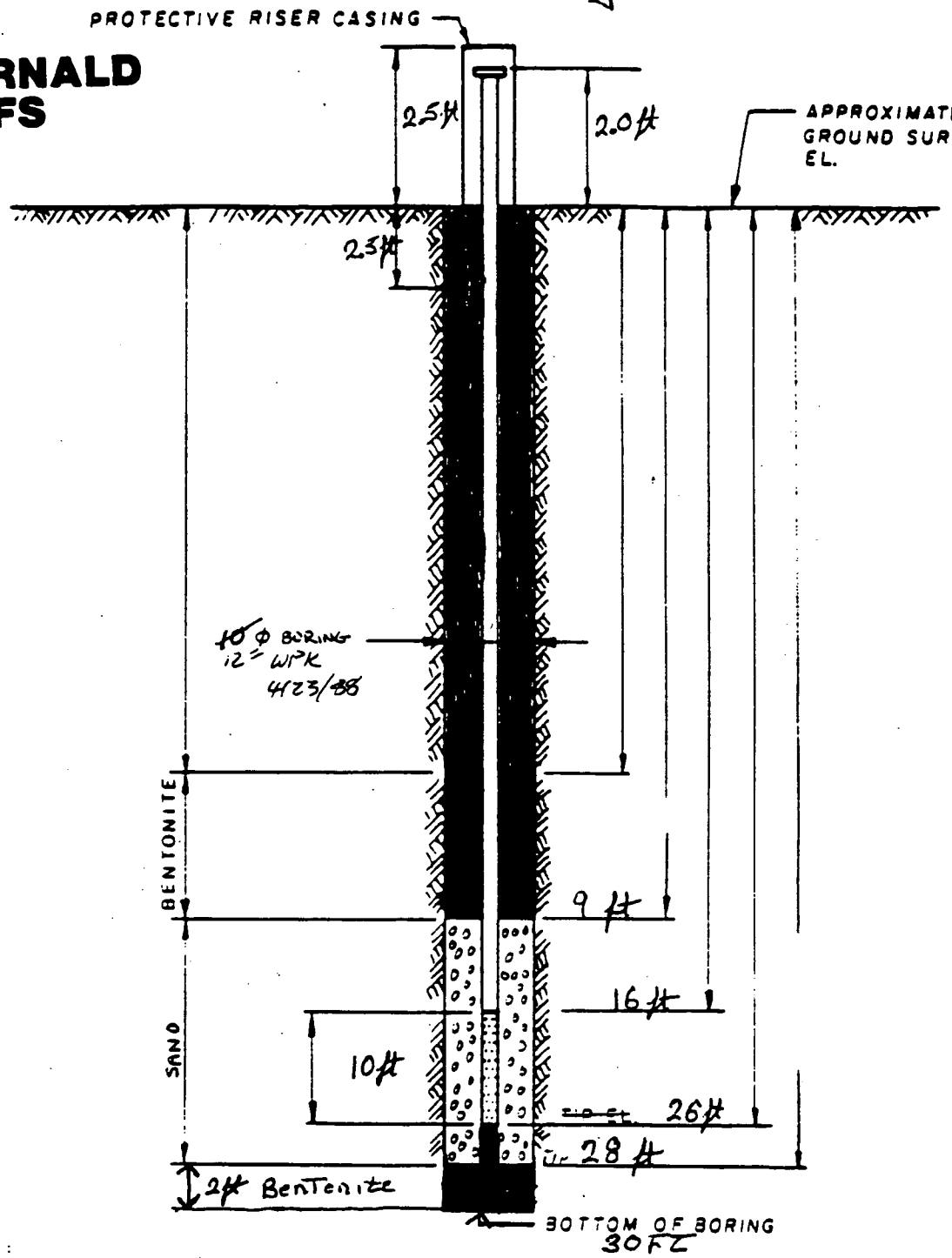
DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16	08 8 4 3	4 5 11	18	Medium STIFF Dark gray clay (5Y 4/1) DRY Trace gravel	CL	<1	Hna = 0 α = 0 δB = 200 1500
17 18	08 8 4 4	4 10 10	16"	Medium STIFF Dark gray clay (5Y 4/1) DRY Trace gravel	CL	<1	Hna = 0 α = 0 δB = 200 1510
19	08 8 4 5	N/A	18"	Shelby Tube	N/A	N/A	Pushed 2.5Ft Recovered 1.5Ft 1645
20 21	08 8 4 6	2 2 2	8"	Medium STIFF Yellowish Brown clay (10YR 5/6) Trace gravel	CL	<1	Hna = 0 α = 0 δB = 200 04/07/88 0930
22	08 8 4 7	5 4 7	10"	STIFF Dark Yellowish Brown clay (10YR 4/6) Trace gravel, DRY	CL	1.5	Hna = 0 α = 0 δB = 240 0940
23 24	08 8 4 8	16 13 14	6"	STIFF Dark Yellowish Brown clay (10YR 5/6) trace gravel. Trace gray clay (5Y 5/1) 24 ft	CL	1.5	Hna = 0 α = 0 δB = 240 0955
25	08 8 4 9	15 22 ~~52~~ 3	18"	Very Dense Dark Brown sandy silt (10YR 4/3) DRY. No clay 26 ft	SM	4.0	Hna = 0 α = 0 δB = 240 1040
26 27	08 8 5 0	14 32 36	18"	Very Hard Yellowish Brown clay w/ silt (10YR 5/8) DRY trace gravel	CL	4.0	Hna = 0 α = 0 δB = 240 1055
28	08 8 5 1	16 22 37	18"	Very Hard grayish Brown clay (2.5Y 5/2) Dry. Trace gravel 29 Ft	CL	>4.0	Hna = 0 α = 0 δB = 240 1300
29 30	08 8 5 2	20 22 17	18"	Dense yellowish Brown sand (10YR 5/8) Dry.	SW	<1	Hna = 0 α = 0 δB = 200 1315
NOTES:				Bottom of Boring 30 ft			255

N/A = NOT Applicable

Monitoring Well # ~~13~~ 131

RKA 2/4/

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL

PREPARED FOR

FMPC RI/FS

FERNALD RI/FS

258

Initial	Date
Set Key In	
Add Key In	
Hard Copy Verification	

PAC RKA 3/4/91

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. M. Goldberg DATE 04/07/88
PROJECT NO. 602 CHECKED BY R Galbraith DATE 2/2/89
BORING NO. ~~131~~ 1031 BB 1-5-89
PIEZOMETER NO. ~~N/A~~ 1031 DATE OF INSTALLATION 4-7-88

BOREHOLE DRILLING

DRILLING METHOD ~~Water~~ Cable Tool	TYPE OF BIT Flat Head
DRILLING FLUID (S) USED: wipe 4/23/88	CASING SIZE (S) USED:
FLUID ____ FROM 3 ft TO 30 ft	SIZE 10" FROM 0 TO 30 ft
FLUID ____ FROM ____ TO ____	SIZE ____ FROM ____ TO ____

PIEZOMETER DESCRIPTION

TYPE Monitoring	RISER PIPE MATERIAL 316 Stainless Steel
DIAMETER OF PERFORATED SECTION ____	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8" I.D. 4"
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 ft
AVERAGE SIZE OF PERFORATIONS .010" inches	JOINING METHOD Thread ~~and couple~~ Flush Joint RKK 2/6/89
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 Feet	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 ft	OTHER PROTECTION Lockable cap
PROTECTIVE PIPE ~~Ø~~ I.D. 10"	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.0 ft			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 ft			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP	BOTTOM	TOP	BOTTOM
BENTONITE	TOP 0	BOTTOM 9	TOP	BOTTOM
~~SAND~~	TOP N/A	BOTTOM N/A	TOP	BOTTOM
GRAVEL	TOP 9	BOTTOM 28 ft	TOP	BOTTOM
PERFORATED SECTION	TOP 16 ft	BOTTOM 26 ft	TOP	BOTTOM
PIEZOMETER TIP	28 ft			
BOTTOM OF BOREHOLE	30 ft			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

257

REMARKS A 2 ft Bentonite Plug was set from 30 ft - 28 ft to seal fill/sand contact @ 29 ft

409-11-86

FERNALD RI/FS

258

	Initial	Date
1st Key In		
2nd Key In		8/10
Hard Copy Verifier		

KKA 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 002 T3.2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~337~~ 2037 BB	COORDINATES:	DATE: 02 17 83
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 02 17 83
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 22 83
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	08/26 RMB 2/8/89			SHELBY TUBE PUSHED FROM 10.0 TO 12.0 FEET RECOVERED 2.0 feet			
20		From Sample Collection log.					
	08/27 RMB 2/8/89			SHELBY TUBE PUSHED FROM 27.0 TO 29.0 FEET, RECOVERED 0.5 Feet			
40							
60							
80							
84.0				BOTTOM OF BORING			258

NOTES:
contractor Pennsylvania Drilling
Driller: Harry Dyke Jr
Assistant: John VanDine

FOR DESCRIPTION OF SOILS PLEASE REFER TO BORING 337 VISUAL CLASSIFICATION OF SOILS LOG.

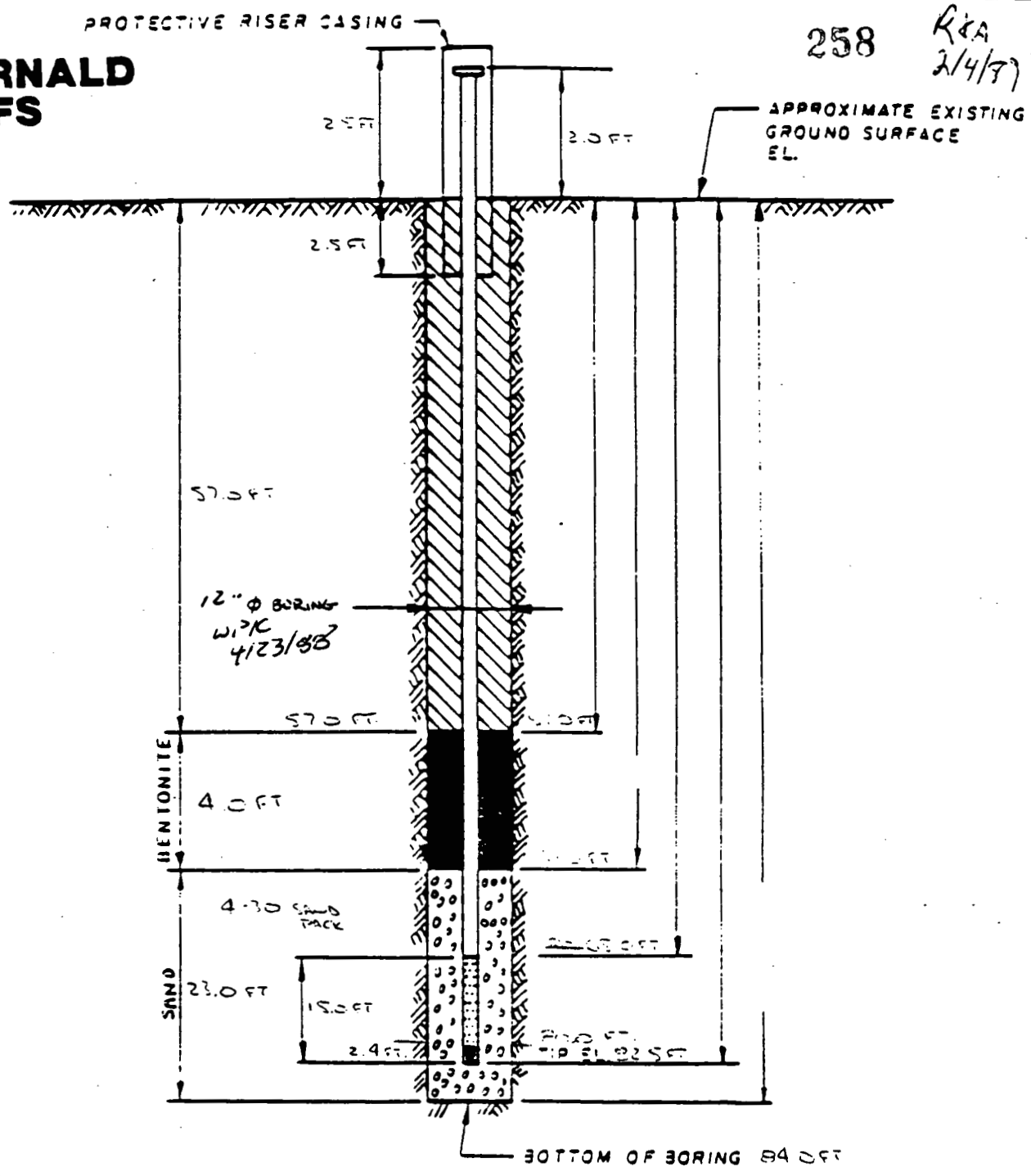
WATER ADDED TO HOLE 1500 gal

402-11-86

FERNALD RI/FS

258

R&A 2/4/87



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS IN I.D. PIPE CONTINUOUS SLOT SCREEN (0.0 0 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL

PREPARED FOR

259

FERNALD RI/FS

258

RKG 2/4/89

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS
FIELD ENG./GEO. MARK SLUZARSKI DATE 02-20-89
PROJECT NO. 602 T 3.2
CHECKED BY R Galbraith DATE 2/01/89
BORING NO. 255 2037 DB, 1-5-89
PIEZOMETER NO. 2037
DATE OF INSTALLATION 02-20-89

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
TYPE OF BIT FLAT HEAD
DRILLING FLUID (S) USED:
FLUID WATER FROM 4.0 FT TO 84.0 FT
FLUID _____ FROM _____ TO _____
CASING SIZE (S) USED:
SIZE 10 IN FROM 0 TO 84.0
SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE SERIES 2000 MONITORING WELL
DIAMETER OF PERFORATED SECTION 4 IN.
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 IN
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 15 FT
RISER PIPE MATERIAL _____
RISER PIPE DIAMETERS:
O.D. 4 3/8 IN I.D. 4 IN
LENGTH OF PIPE SECTIONS 6-10 FT, 1-5 FT, 2-2 FT
JOINING METHOD THREAD AND COUPLE

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT
PROTECTIVE PIPE Ø.D. 10 IN
OTHER PROTECTION LOCKABLE CAP

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 FT	BOTTOM 57.0	TOP	BOTTOM
BENTONITE	TOP 57.0 FT	BOTTOM 61.0 FT	TOP	BOTTOM
SAND	TOP 61.0 FT.	BOTTOM 84.0 FT	TOP	BOTTOM
GRAVEL	TOP N/A	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 65.0 FT	BOTTOM 80.0 FT.	TOP	BOTTOM
PIEZOMETER TIP	82.5 FT			
BOTTOM OF BOREHOLE	84.0 FT.			
GWL AFTER INSTALLATION				

IS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒ 260
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS _____

409-11-86

FERNALD RI/FS

47 KKA 2/4/88

1st Key In | 2nd Key In 8/16 | Verified

PK 4/23/88 258

KGH 2

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 TS.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 BB 1-5-89	COORDINATES:	DATE: 01 19 88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 19 88
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL / SPLIT SPOON		PAGE 1 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	079 5 3 1103	3 17 19	17	HARD BROWN (10YR 5/3) CLAY. some Gravel and silt - Dry.	CL	4.5+	Hnu = 0 ppm Bg = 60 cpm α = 0 cpm
2 3	079 5 4 1165	8 8 13	16	STIFF BROWN (10YR 5/3) silt some Sand and Clay Trace Gravel - Dry	ML	2.0	Hnu = 0 ppm Bg = 60 cpm α = 0 cpm
4	079 5 5 1300	12 10 9	10	STIFF Light Yellowish Brown (2.5Y 6/4) Silt and sand some GRAVEL TRACE CLAY DRY	ML	1.0	Hnu = 0 ppm Bg = 60 cpm α = 0 cpm
5 6	079 5 6 1314	6 6 4	4	VERY SOFT OLIVE BROWN (2.5Y 4/4) CLAY some Sand and silt trace gravel moist	CL	<.25	Hnu = 0 ppm Bg = 60 cpm α = 0 cpm
7	079 5 7 1321	5 5 10	10	6.8 VERY STIFF VERY DARK GREY (2.5 5/0) CLAY SOME SILT DRY	CL	3.0	Hnu = 0 ppm Bg = 60 cpm α = 0 cpm
8 9	079 5 8 0950	5 7 10	12	STIFF DARK GREY (5Y 4/1) CLAY SOME SILT - DRY	CL	1.5	Hnu = 0 Begin 01 26 88 Bg = 60 cpm α = 0
10	079 5 9 0920	3 5 8	15	9.6 VERY STIFF BROWNISH Yellow (10YR 6/8) mottled clay some silt - Dry	CL	2.5	Hnu = 0 Bg = 60 cpm α = 0
11 12	079 6 0 0928	4 5 8	17	VERY STIFF Yellowish Brown (10YR 5/8) mottled clay and silt - Dry	CL	2.5	Hnu = 0 Bg = 60 cpm α = 0
13	079 6 1 0942	4 5 7 11 8	16	VERY STIFF Yellowish Brown (10YR 5/4) CLAY AND SILT TRACE GRAVEL - DRY	CL	2.5	Hnu = 0 Bg = 60 α = 0
14	079 6 2 0955	6 12 15	18	VERY STIFF Yellowish Brown (10YR 5/4) CLAY AND SILT TRACE GRAVEL - DRY	CL	2.5	Hnu = 0 Bg = 60 cpm α = 0

NOTES:

CONTRACTOR: PENNDRILL
RIG CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOHN VANDINE
WATER ADDED TO HOLE 1 mark = 5 gal

SAMPLES COLLECTED AS PER ASTM STANDARD PENETRATION TEST.

COLORS: Identified using munsell color chart

Background Levels
Hnu = 0 Bg = 60 cpm
LEL-O_2 = 0 ppm LEL + 20.1% O_2 α = 0 cpm

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402-11-86

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~331~~ BB 1-5-89 3037	COORDINATES:	DATE: 01 20 88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 19 88
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 10

DEPTH (6 inch)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	0 7 9 63 1007	10 16 24	19	VERY STIFF STRONG BROWN (7.5YR 5/6) SILT AND CLAY SOME GRAVEL - TRACE SAND - DRY	ML	3.5	Hnu=0 Bd=9cpm α=0
17	0 7 9 64 1330	21 33 41	6	HARD DARK BROWN (10YR 5/3) SILT AND CLAY SOME GRAVEL - DRY	ML	4.25	Hnu=0 Bd=50cpm α=0
18				18.5			
19	0 7 9 65 1426	35 13 23	12	VERY STIFF DARK GREY SILT SOME CLAY and gravel - DRY	ML	4.0	Hnu=0 Bd=80cpm α=0
20	0 7 9 66 1439	4 10 14	16	VERY STIFF DARK GREY (5Y 5/1) CLAY and silt some Gravel - Dry	CL	2.5	Hnu=0 Bd=50cpm α=0
21 22	0 7 9 67 1505	6 10 12	13	VERY STIFF DARK GREY (5Y 4/1) CLAY and silt some gravel - DRY	CL	2.5	Hnu=0 Bd=80cpm α=0
23 24	0 7 9 68 1527	4 8 14	14	STIFF GREY (5Y 5/1) CLAY and silt SOME GRAVEL - DRY	CL	1.25	Hnu=0 Bd=50cpm α=0
25	0 7 9 69 1542	6 8 13	18	STIFF DARK GREY (5Y 4/1) Clay and silt some gravel - Dry	CL	1.25	Hnu=0 Bd=80cpm α=0
26 27	0 7 9 70 1551	4 7 12	12	STIFF DARK GREY (5Y 5/1) CLAY AND SILT SOME GRAVEL TRACE SAND - DRY	CL	1.5	Hnu=0 Bd=80cpm α=0
28	0 7 9 71 0920	4 5 11	4	VERY SOFT GREY (5Y 5/1) CLAY and SILT SOME GRAVEL DRY 28.5	CL	<1.25	Hnu=0 Begin 01 22 88 Bd=120cpm α=0
29	0 7 9 72 0945	27. 50/3	6	VERY DENSE GREY (5Y 5/1) clayey sand and gravel - DRY	SC	<4.5	Hnu=0 Bd=100cpm α=0

NOTES:
No drilling was performed on 1/21/88

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402-11-86

FERNALD RI/FS

RKA 3/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 BB 1559	COORDINATES:	DATE: 01 22 89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 19 89
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 89
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	0 7 9 7 3 1007	14 22 26	12	26.3 Hard grey (5Y 5/1) Clay some gravel trace silt - DRY	CL	74.5	HNU = 0 BZ = 80cpm α = 0 0.1 coming up in slurry Negative readings on instruments
32	0 7 9 7 4 1034	20 21 27	15	HARD GREY (5Y 5/1) CLAY SOME GRAVEL TRACE SILT - DRY	CL	3.75	HNU = 0 BZ = 80cpm α = 0
33 34	0 7 9 7 5 1056	6 13 16	16	VERY STIFF GREY (5Y 5/1) CLAY SOME GRAVEL AND SAND TRACE SILT - DRY	CL	4.0	HNU = 0 BZ = 80cpm α = 0
35	0 7 9 7 6 1335	11 12 15	15	STIFF GREY (5Y 5/1) CLAY AND SILT SOME GRAVEL AND SAND - DRY	CL	1.75	HNU = 0 BZ = 80cpm α = 0
36 37	0 7 9 7 7 1445	5 8 13	10	STIFF GREY (5Y 5/1) SILTY CLAY ~~and~~ SOME GRAVEL AND SAND - DRY	CL	1.5	HNU = 0 BZ = 80cpm α = 0
39.5	0 7 9 7 8 1505	5 10 13	3	VERY SOFT GREY (5Y 5/1) GRAVELLY CLAY SOME SAND AND SILT - MOIST	CL	0.25	HNU = 0 BZ = 80cpm α = 0
39.5 40.5	0 7 9 7 9 1535	1 5 8	12	STIFF GREY (5Y 5/1) SILTY CLAY SOME SAND AND GRAVEL - MOIST	CL	1.25	HNU = 0 BZ = 80cpm α = 0
41.5	0 8 1 0 5 1600	5 28 12	9	STIFF GREY (5Y 5/1) GRAVELLY CLAY SOME sand and silt - moist	CL	1.5	HNU = 0 BZ = 80cpm α = 0
42.5 43	0 8 1 0 6 1625	5 15 23	10	42.5 DENSE Yellowish BROWN (10YR 5/4) sand - DRY	SP	—	HNU = 0 BZ = 80cpm α = 0
44							

NOTES:

402-11-88

FERNALD RI/FS

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RKO 2/4/5

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME:	
BORING NUMBER: 337 BB 1-5-59 3037	COORDINATES:	DATE: 1 22 88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1 19 88
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	OS 107 1646	27 40 26	13	VERY DENSE YELLOWISH BROWN (10YR 5/4) SAND - DRY	SP	–	HNU=0 BZ=80cpm α=0
47							
48							
49							
50							Begin 1/23/88
51	OS 108 1010	50/3 50/2	5	VERY DENSE YELLOWISH BROWN (10YR 5/6) GRAVELLY SAND - DRY	SW	–	HNU=0 ppm BZ=60cpm α=
52							
53							DRILLER NOTED SAND WAS Difficult to Drill from 51.5-55.0 feet
54							
55							
56	OS 109 1411	50 50/4	8	VERY DENSE DARK YELLOWISH BROWN 10YR 3/4) SAND SOME GRAVEL - MOIST	SW	–	HNU=0 BZ=80cpm α=
57							
58							
59							

NOTES:

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402-11-86

FERNALD RI/FS

258

RKO 2/4/5

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 60	COORDINATES:	DATE: 1 23 88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1 19 88
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	Og 110 1530	81 50/5	6	VERY DENSE YELLOWISH BROWN (10YR 5/4) SAND SOME GRAVEL - DRY	SW	—	Hnu = 0 Bg = 60 cpm α =
62							
63							
64							
65							
66	Og 111 1710	15 50/5	10	VERY DENSE GRAYISH BROWN (10YR 5/2) SAND SOME GRAVEL - MOIST	SW	—	Hnu = 0 Bg = 60 cpm α =
67							
68							DRILLER NOTED FORMATION Easier to Drill 68.5 feet
69							
70							Begin 1 24 88
71	Og 112 1008	41 40 42	10	VERY DENSE DARK GREY (10YR 4/1) GRAVELLY SAND - WET	SW	—	Hnu = 0 Bg > 100 cpm α =
72							
73							BLOW SAND Encountered at 73.5 feet
74							

NOTES:

402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 BB 1-4-89	COORDINATES:	DATE: 1 24 88
ELEVATION:	GWL: Depth 77.35 Date/Time 1/24/88 1753	DATE STARTED: 1 19 88
ENGINEER/GEOLOGIST: W. HEGLEY	Depth 82.80 Date/Time 1/25/88 0910	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 6 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	0 8 11 3 1420	17 27 27	14	VERY DENSE GREY (10YR 5/1) SAND TRACE GRAVEL AND SILT - WET	SP	-	Hnu = 0 Bq = 60cpm α
77							
78							
79							
80	0 8 11 4 1554	30 27 32	15	VERY DENSE GREY (10YR 5/1) SAND SOME GRAVEL TRACE SILT - DRY	SP	—	Hnu = 0 Bq 60cpm α =
81							
82							
83							
84							Oil smell coming from Bailer at 84.0 feet
85	0 8 11 5 1739	50/4 50/1	12	VERY DENSE (10YR 5/1) GRAVELLY SAND Trace SILT - DRY	SP		Hnu = 0 Bq = 60cpm γ
86							
87							Begin 01 25 88
88							STRONG CRUDE OIL smell coming from Boring while Bailing is in operation
89							

NOTES:

BAILED BORING DRY check water Level at 1753 1/24/88 77.35 ft

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402-11-86

FERNALD RI/FS

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1st Key In	
2nd Key In	
Hard Copy Verification	

RKA 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 BB 1-3-89	COORDINATES:	DATE: 1 25 89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 19 87
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 7 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	0 8 11 6 1100	6 7 9	5	MEDIUM DENSE OLIVE GREY (5Y 5/2) SANDY GRAVEL TRACE SILT - WET	GW	—	HNU=0 BZ=60cpm α
92							
93							
94							
95	0 8 11 7 1330	14 19 28	10	DENSE GREY (10YR 5/1) SAND SOME GRAVEL TRACE SILT - WET	SW	—	HNU=0 BZ=40cpm α=0
96							
97							
98							
99							
100	0 8 11 8 1455	9 13 23	12	DENSE VERY DARK GREY (10YR 3/1) SAND TRACE GRAVEL AND SILT - WET	SP	—	HNU=0 BZ=40cpm α=
101							
102							
103							
104							

NOTES:

402-11-86

FERNALD RI/FS

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RKA 2/4/88

VISUAL CLASSIFICATION OF SOILS

ROJECT NUMBER: 602 T 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 337 3037	COORDINATES:	DATE: 1 25 88
ELEVATION:	GWL: Depth 72.6 Date/Time 1 26 88 0940	DATE STARTED: 1 19 88
ENGINEER/GEOLOGIST: W. KEGLEY	Depth 67.6 Date/Time 1 27 88 0940	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 8 OF 10

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106	8 9 11 9 1610	3 4 10	18	MEDIUM DENSE VERY DARK GREY (10YR 3/1) SAND - WET 106.5	SP	–	Hnu=0 Bq=60cpm α
107				MEDIUM DENSE VERY DARK GREY (10YR 3/1) GRAVEL SOME SAND-W	GW	–	BEGIN 1/26 88
108							
109							
110	9 8 12 0 1315	23 26 27	15	VERY DENSE DARK OLIVE GREY (5Y 5/2) SAND TRACE GRAVEL AND SILT - WET	SP	–	Hnu= Bq=40cpm α=
111							Begin 1/27/88
112							
113							
114							
115	9 9 12 1 1050	46 48 50/5	10	VERY DENSE GREY (5Y 5/1) FINE GRAINED SAND SOME GRAVEL TRACE SILT WET	SP	–	Hnu=0 Bq=60cpm α=
116							
117							
118							
119							

NOTES:

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402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.C	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 1-5-89	COORDINATES:	DATE: 01 27 89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1 19 89
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 9 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121	1414	3 8 15	0	NO RECOVERY - Probably VERY FINE Grained Sand as indicated by Bailer slurry			Hnu = Tried to Push Bar = spoon 2 times α = with 2 Different Sand catchers
122							
123							
124							
125							
126	0 3 1 2 2 1555	15 5015	15	VERY DENSE GREY (5Y 5/1) FINE GRAINED SAND SOME SILT - WET	SP	-	Hnu=0 βγ = 60cpm α =
127							BEGIN 01 28 88
128							
129							
130							
131	0920	3 13 23	0	NO RECOVERY - Probably Very Fine Grained sand as indicated by Bailer slurry			BLOW SAND 130.0 ft sand came up 6.0 feet inside casing
132							Tried to Drive spoon 2 times.
133							
134				134.9			MARKED DRILLING CHANGE BLUE CLAY CONTACT

NOTES:

402-11-86

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~337~~ 3037 ϕ^{0} 1,559	COORDINATES:	DATE: 02 03 88
ELEVATION:	GWL: Depth 69.70 Date/Time 02 03 88 0830	DATE STARTED: 01 19 88
ENGINEER/GEOLOGIST: William Keyley	Depth Date/Time	DATE COMPLETED: 02 03 88
DRILLING METHODS: CABLE TOOL		PAGE 10 OF 10

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136	0 8 1 2 3 0920	4 11 20	12	STIFF DARK GREY (5Y 4/1) Clay Trace SILT - Moist	CL	1.0	Mnu = 0 Bx = 60cpm d = 0
137	0 8 1 2 4 1030			SHELBY TUBE			Shelby Tube from 136.5 - 138.5 feet 2 feet recovery
138				BOTTOM OF BORING 138.5 feet			

NOTES:

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402-11-86

FERNALD RI/FS

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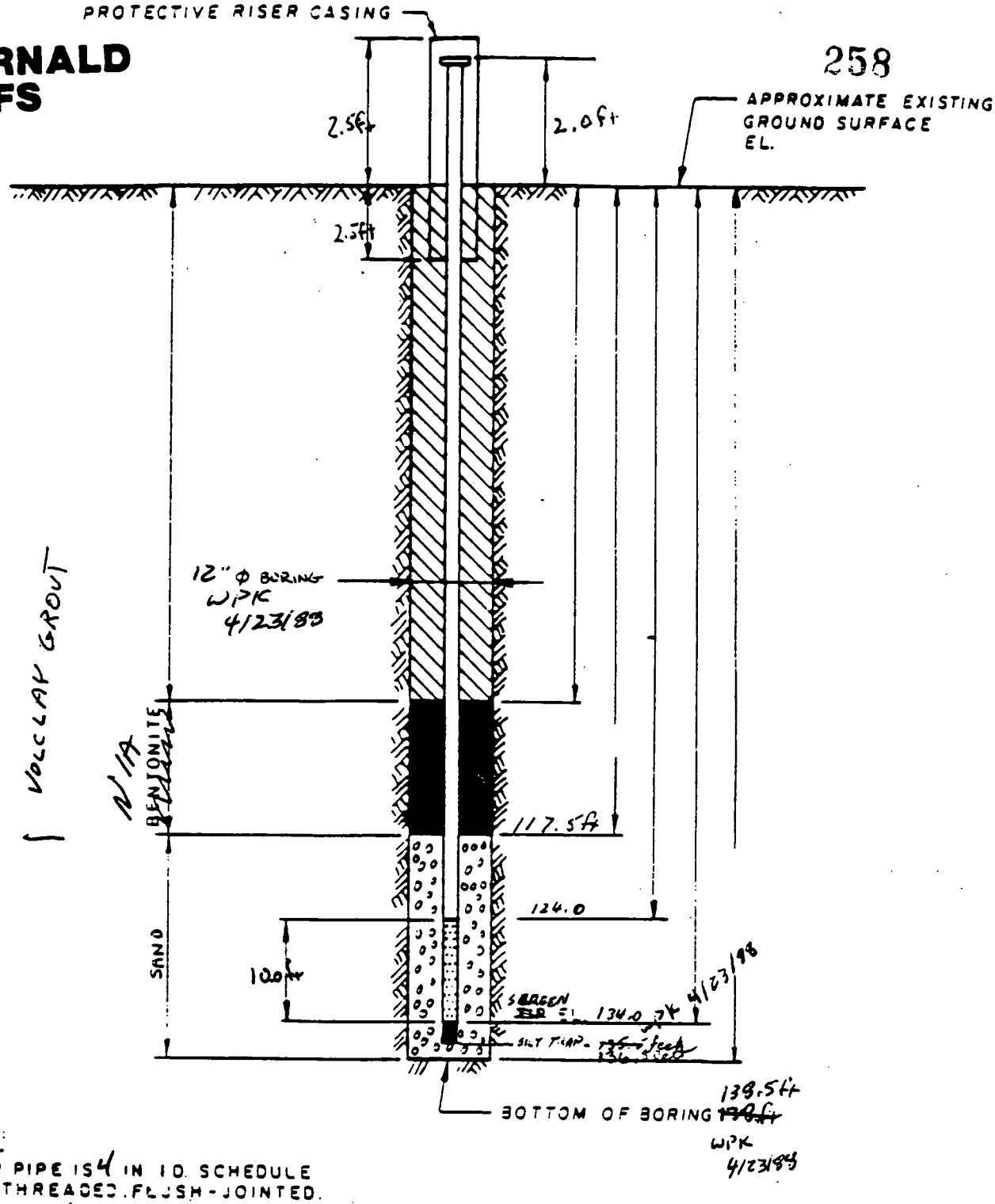

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D S.S PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 337 3037

PREPARED FOR BB 1-5-89

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

271

FERNALD RI/FS

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS
FIELD ENG./GEO. W. KEGLEY
DATE 02 04 88
PROJECT NO. 602 T3.2
CHECKED BY R Galbraith
DATE 2/6/89
BORING NO. ~~337~~ 3037 PB 1-5-89
PIEZOMETER NO. ~~337~~ 3037
DATE OF INSTALLATION 02 08 88

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID H_2O FROM 0.0 ft TO 138.5
FLUID _____ FROM _____ TO _____

TYPE OF BIT FLAT Head
CASING SIZE (S) USED:
SIZE 10 inch FROM 0.0 feet TO 135 feet
SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE MONITORING
DIAMETER OF PERFORATED SECTION 4 inch
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010"
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 ft

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8 inch I.D. 4.0 inch
LENGTH OF PIPE SECTIONS 10 feet & 2 feet
JOINING METHOD Thread ~~Couple~~ Flush Joint

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 feet
PROTECTIVE PIPE ~~Ø~~ I.D. 10 inch

OTHER PROTECTION LOCKABLE CAP

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft)		ELEVATION ( )	
TOP OF RISER PIPE	2.5 ft			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 ft			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 117.5 ft	TOP	BOTTOM
BENTONITE	TOP NA	BOTTOM NA	TOP	BOTTOM
SAND	TOP 117.5 ft	BOTTOM 138.5 ft	TOP	BOTTOM
GRAVEL	TOP NA	BOTTOM ~~135.5~~ 136.5	TOP	BOTTOM
PERFORATED SECTION	TOP 124	BOTTOM 134	TOP	BOTTOM
PIEZOMETER TIP	~~135.5~~ 136.5			
BOTTOM OF BOREHOLE	138.5			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
S A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS

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409-11-86

FERNALD RI/FS

DLG 3/4/89

258

PAC

WPK 4/23/89

R16 # 2

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 802 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~135~~ 1035 BB 1-5-89	COORDINATES:	DATE: 01 / 11 / 89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 / 11 / 89
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 01/13/89
DRILLING METHODS: CABLE TOOL, SPLIT SPOON		PAGE 1 OF 2

DEPTH (feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 inch)	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	0 78 16 1105	5/6/4 31 12	12	VERY STIFF DARK YELLOWISH BROWN (10YR 4/4) silt and gravel with clay - DRY	ML	3.0	Hav = 0ppm βγ = 100cpm α = 0cpm
2	0 78 17 1130	10 13 14	15	2.5			Hav = 0ppm βγ = 60-80 cpm α = 0cpm
3	0 76 18 1305	15 20 26	14	STIFF VERY DARK GREY (5Y 3/1) Clay - DRY	CL	1.5	
4				STIFF VERY DARK GREY (5Y 3/1) clay with silt TRACE SAND - DRY 4.6	CL	2.0	Hav = 0ppm βγ = 100-120cpm α = 0cpm
5	0 78 19 1310	10 12 12	18	STIFF Yellowish BROWN (10YR 5/4) MOTTLED clay TRACE GRAVEL AND SILT - DRY	CL	1.5	Hav = 0ppm βγ = 80-100cpm α = 0cpm
6	0 79 00 1315	9 10 12	16	STIFF YELLOWISH BROWN (10YR 5/6) mottled Clay TRACE GRAVEL AND SILT - DRY	CL	2.0	Hav = 0ppm βγ = 80-100cpm α = 0cpm
7							
8	0 79 01 0800	10 13 21	18	VERY STIFF YELLOWISH BROWN (10YR 5/4) mottled Clay TRACE GRAVEL AND SILT - DRY	CL	3.0	Hav = 0ppm BEGIN 01 12 89 βγ = 80-100cpm α = 0cpm
9	0 79 02 0815	17 16 21	7	STIFF Yellowish BROWN (2.5Y 6/4) MOTTLED ~~CLAY~~ SILT AND ~~SILT~~ CLAY WITH GRAVEL, SOME SAND - DRY.	ML	2.0	Hav = 0ppm βγ = 80 100 cpm α = 0cpm
10							
11	0 79 03 0850	12 20 26	17	HARD LIGHT YELLOWISH BROWN (2.5Y 6/4) MOTTLED CLAY AND SILT WITH GRAVEL, SOME SAND - DRY	CL	4.5	Hav = 0ppm βγ = 80-100cpm α = 0cpm
12							
13	0 79 04 0910	14 24 26	18	HARD STRONG BROWN (7.5YR 5/6) CLAY AND SILT WITH GRAVEL, SOME SAND - DRY 13.4	CL	4.5	Hav = 0ppm βγ = 80-100cpm α = 0cpm
14	0 79 05 0930	10 20 24	16	VERY STIFF GREY (5Y 5/1) CLAY and silt, TRACE GRAVEL - DRY Tight vertical Fracture with Fe_2O_3 stains	CL	3.0	Hav = 0ppm βγ = 80-100cpm α = 0cpm

NOTES:

CONTRACTOR: DENN DRILL

DRILLER: HARRY DUKES, JR.

ASSISTANT: JOHN JANDINE

WATER ADDED TO BORING 1 = 5 gal

SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST.

COLOR identified using Munsell color chart

BACKGROUND LEVELS

Hav = 0 ppm α = 0 cpm

βγ = 80-120 cpm LEL/O_2 = 0 ppm Explosive/20.5% O_2

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402-11-86

FERNALD RI/FS

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	Initial	Date
1st Key In		
2nd Key In		
Hand Carry		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 607 T 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~134~~ 1034 BB 1-5-89	COORDINATES:	DATE: 1 12 89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1 11 89
ENGINEER/GEOLOGIST: W. KIGGLEY	Depth Date/Time	DATE COMPLETED: 1 13 89
DRILLING METHODS: CABLE TOOL / SPLIT SPOON.		PAGE 2 OF 2

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16 / 16.5	07906 1049	4 8 14	8	Shelby Tube STIFF DARK GREY (5Y 4/1) CLAY SOME GRAVEL TRACE SAND	CL	1.5	Shelby Tube 15.0 - 15.9' SAMPLE # 07906 @ 1000hr. Hnu = 0ppm α = 0cpm βα = 100cpm
17 / 18	07908 1325	13 8 16	10	VERY STIFF GREY (5Y 5/1) CLAY SOME GRAVEL AND SAND - DRY 17.9	CL	3.0	Hnu = 0ppm βγ = 100cpm α = 0cpm
19	07909 1345	22 50/5 50/3	12	VERY DENSE GREY 5Y 5/1 SAND AND SILT, TRACE GRAVEL - TOP DRY BOTTOM MOIST	SM	4.5	Hnu = 0ppm βγ = 100cpm α = 0cpm
20 / 21	07945 1415	50/4 50/2	6	VERY DENSE GREY (5Y 5/1) SAND SOME SILT TRACE GRAVEL AND CLAY-MOIST	SM	4.0	Hnu = 0ppm βγ = 100cpm α = 0cpm
22	07946 1435	50/3 50/4	7	VERY DENSE GREY (5Y 5/1) SAND SOME SILT TRACE GRAVEL AND CLAY-MOIST	SM		Hnu = 0ppm βγ = 100cpm α = 0cpm
23 / 24	07947 1451	34 42 50/4	15	HARD GREY (5Y 5/1) silt and SAND SOME CLAY AND GRAVEL - DRY 23.8	ML	4.5+	Hnu = 0ppm βγ = 100cpm α = 0cpm
25	07948 1536	18 28 29	10	VERY STIFF GREY (5Y 5/1) clay and silt SOME SAND AND GRAVEL - DRY	CL	3.5	Hnu = 0ppm βγ = 100cpm α = 0cpm
26 / 27	07949 1621	10 19 26	13	STIFF OLIVE (5Y 5/3) CLAY SOME GRAVEL AND SILT, TRACE WOOD FRAGMENTS - DRY	CL	2.0	Hnu = 0ppm βγ = 100cpm α = 0cpm
28	07950 0857	18 22 24	14	Shelby Tube. HARD, OLIVE GREY (5Y 5/2) CLAY SOME SILT, TRACE GRAVEL 28.5 ft.	CL	4.5	Hnu = 0ppm βγ = 100cpm α = 0cpm Begin 1 13 89 Shelby tube Taken @ 0857 SAMPLE # 07950
				BOTTOM OF BORING			

NOTES:

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402-11-86

DLC 2/4/89

BORING ~~138~~ 1035 #4C

OB 1-5-89

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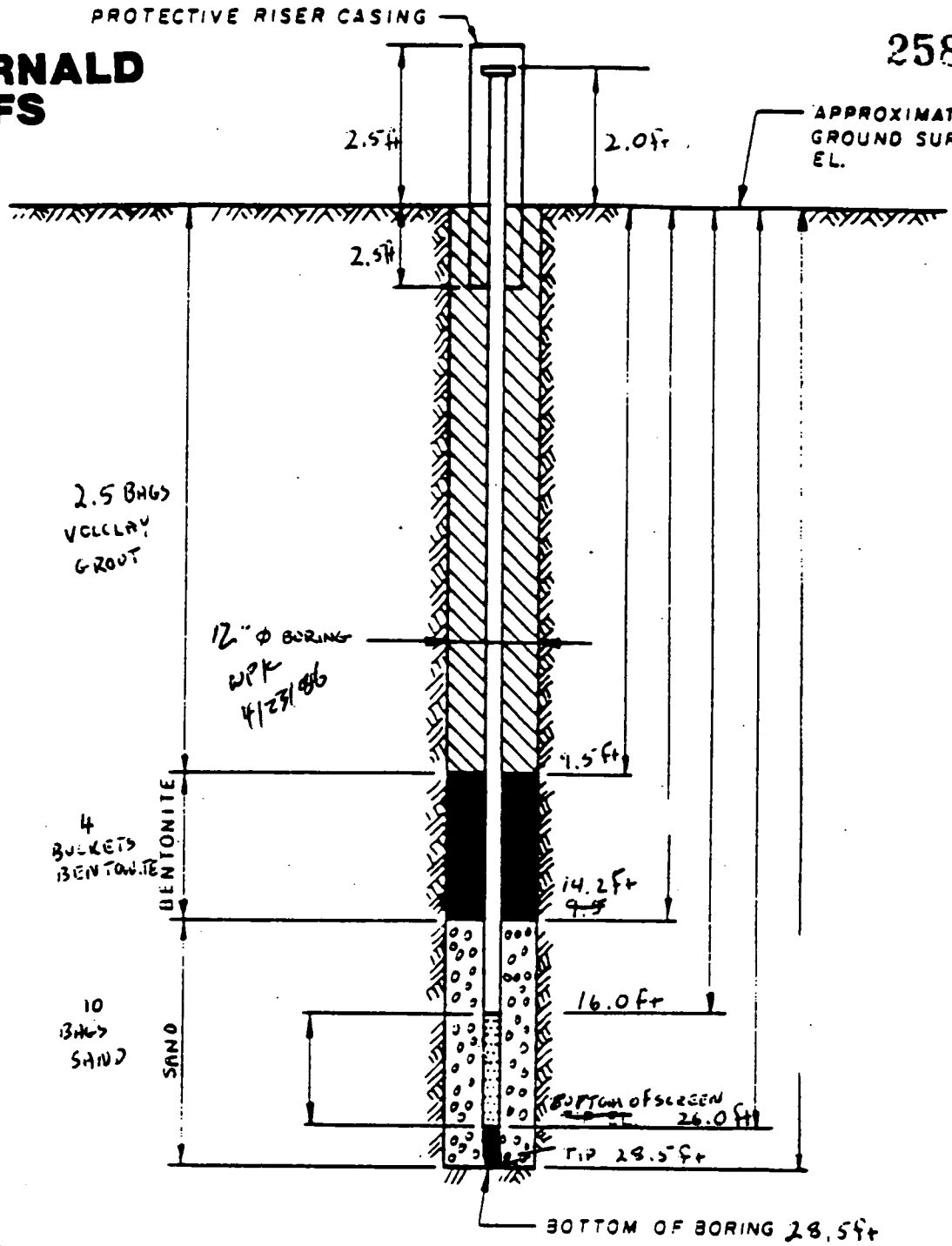
FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~138~~ 1035

PREPARED FOR RWG 2/6/89

DRAWING NUMBER

CHECKED BY

APPROVED BY

DATE

DRAWN BY

275

DLO 2/4/99

258

	Initial	Date
1st Key In		
2nd Key In		
Data Entry Verification		

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS
FIELD ENG./GEO. W. KEGLEY DATE 01 13 99
PROJECT NO. 607 T3.2
CHECKED BY R Galbreath DATE 2/6/99
BORING NO. ~~139~~ 1039 BB 1-5-99
PIEZOMETER NO. ~~139~~ 1039
DATE OF INSTALLATION 01 13 99

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID H_2O FROM 0 TO 28.5 feet
FLUID NA FROM NA TO NA

TYPE OF BIT FLAT HEAD
CASING SIZE (S) USED:
SIZE 10 inch FROM 0.0 TO 28.5 feet
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING
DIAMETER OF PERFORATED SECTION 4 inch
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 FEET

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8 inch I.D. 4 inch
LENGTH OF PIPE SECTIONS 10 feet
JOINING METHOD ~~THREADED COUPLE~~ (FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 feet
PROTECTIVE PIPE ~~O~~.D. 10 inch

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (feet)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 feet			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 feet			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 ft	BOTTOM 9.5 ft	TOP	BOTTOM
BENTONITE	TOP 9.5 ft	BOTTOM 14.2 ft	TOP	BOTTOM
SAND	TOP 14.2 ft	BOTTOM 29.5 ft	TOP	BOTTOM
GRAVEL	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 16.0 ft	BOTTOM 26.0 ft	TOP	BOTTOM
PIEZOMETER TIP	28.5 feet			
BOTTOM OF BOREHOLE	28.5 feet			
GWL AFTER INSTALLATION				

IS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS

409-11-86

FERNALD RI/FS

258

	Initial	Date
1st Key In		
2nd Key In		
Final Key Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~243~~ 3043	COORDINATES:	DATE: 12/14 & 12/15/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/14/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/16/87
DRILLING METHODS: Cable Tool		PAGE 1 OF 2

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0				Refer to sample descriptions from well ~~243~~ 3043 BMG 2/6/89			
3							
5	ST 077995	NA	24"	SHELBY TUBE	CL		(1130)
7							
10	S 07796	12 11 13		DUPLICATE SAMPLE TAKEN	CL	1.5	Anu=0 BB=20-40 α=0 (1348)
13							
15	ST 077997	NA	21"	SHELBY TUBE "	CL		(1618)
18							
20							
23							
25							
27							
30							

NOTES:

I.) Background Measurement 12/14 & 12/15/87 = α=0, Anu=0, BB=40-60 c.p.m.

II.) Drilling Contractor: Pennsylvania Drilling
Drilling Personnel.
Driller: Tim Harris
Helper: Craig Coulter

III. WATER USED 12/14 = 13 gal.
" " 12/15 = 80 gal.

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402-11-86

DLG 2/4/89

FERNALD RI/FS

258

	Initial	Date
1st Key In		
2nd Key In		
Data Check Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: B3 ~~243~~ 2042	COORDINATES:	DATE: 12/15 & 12/16/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/14/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/16/87
DRILLING METHODS: Cable Tool		PAGE 2 OF 3

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30							
32				See Descriptions on Soil log ~~343~~ 3043 RM G 2/6/89			
35							
40							End of Day 12/15/87 Start Day 12/16/87
45							
50							
55							
60							

NOTES:

I.) Background Measurements 12/16/87
Hnu = 0
α = 0
β = 40-50 c.p.m.

II.) Water Used 12/16/87 = 29 gallons

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402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~243~~ 3043	COORDINATES:	DATE: 12/16/87
ELEVATION:	GWL: Depth 57' Date/Time 12/16/87 2100	DATE STARTED: 12/14/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/16/87
DRILLING METHODS: Cable Tool		PAGE 3 OF 3

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60				See Soil Descriptions on Log for well ~~343~~ 3043 2/6/89 RMG			
63							
65	S 07798	9 14 17	36"	Duplicate Sample Taken	SW		Unw = 0 δβ = 40-60 cp.ir. α = 0 (1452)
68				69.3			Drilled Well To 69.3'
70				Bottom of Boring			Had to Drive 10" casing to 73' & keep a full hydrostatic head in it to keep sand from coming into borehole.
75							
80							

NOTES:

DLG 2/14/89 2043 BB 4-5-89 # 34

Monitor Well ~~243~~

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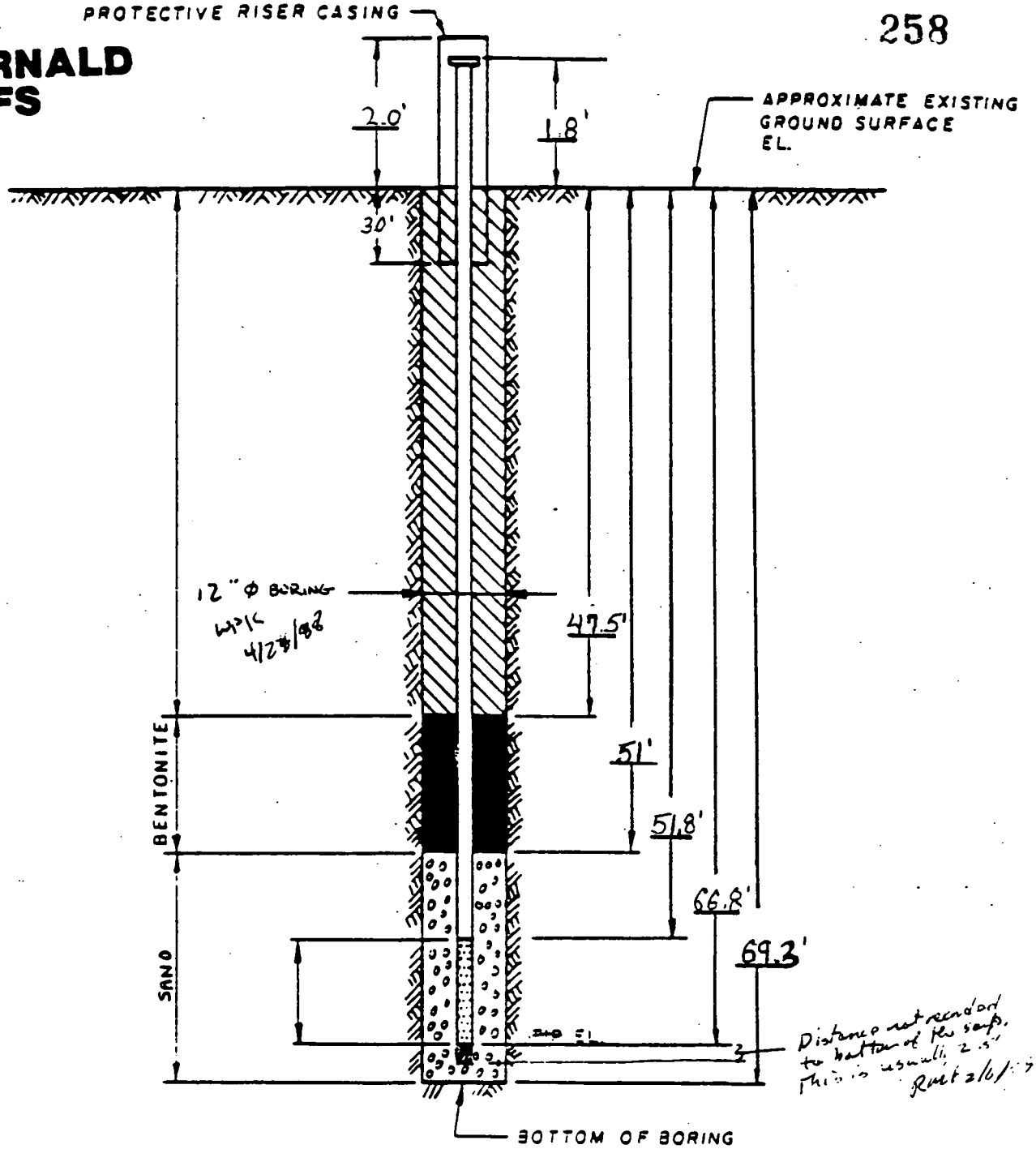
FERNALD RI/FS



DRAWING NUMBER

DRAWN BY

CHECKED BY

APPROVED BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~243~~ 2043 RWK 2/6/89

PREPARED FOR

FMPC RI/FS

280

FERNALD RI/FS

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS
PROJECT NO. 602 T 3.2
BORING NO. ~~243~~ 2043 BB 1-5-89
PIEZOMETER NO. NA 2043

FIELD ENG./GEO. B. Dunning DATE 12/18/87
CHECKED BY R Galloway DATE 2/6/89
DATE OF INSTALLATION 12/18/87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0 TO 69.2
FLUID NA FROM NA TO NA

TYPE OF BIT Hammer-Type
CASING SIZE (S) USED:
SIZE 10" FROM 0' TO 69.2'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel
DIAMETER OF PERFORATED SECTION 4" Ø
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.01"
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH ~~10'~~ 15' RW 2/6/89

RISER PIPE MATERIAL Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10' & 2½'
JOINING METHOD Flush Joint Threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT
PROTECTIVE PIPE Ø.D. 10 inches

OTHER PROTECTION LOCKING CAP WITH LOCK.

ITEM	DISTANCE ABOVE BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	+ 1.8 FT			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	3.0'			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 47.5'	TOP	BOTTOM
BENTONITE	TOP 47.5'	BOTTOM 51'	TOP	BOTTOM
SAND	TOP 51.0'	BOTTOM 69.3	TOP	BOTTOM
GRAVEL	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 51.8	BOTTOM 66.8	TOP	BOTTOM
PIEZOMETER TIP	NA			
BOTTOM OF BOREHOLE	69.3			
GWL AFTER INSTALLATION	57.0' TOC			

IS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

REMARKS

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409-11-86

Date correction was made on Brad Dunning at the time this form was completed. DLG 3/4/89

FERNALD RI/FS

258 4/23/88 WPK RIG # 1

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS Task 3.2		
BORING NUMBER: B13 5-57 ~~343~~ 3043	COORDINATES:	DATE: 12/4/87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/4/87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87	
DRILLING METHODS: Cable Tool		PAGE 1 OF 9	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	S 0 7 6 1 4	2 6 7	12"	Very soft, very dark grayish-brown clay (2.5 Y, 3/2). Silty & Dry with rootlets	OL	<.5	Hnu = 0 α = 0 γB = 20-40 cpm. (Time Sample collected) (0800)
2	S 0 7 6 1 5	5 7 8	12"	Very stiff, grayish-brown clay (2.5 Y, 5/2) Damp	CL	3.5	Hnu = 0 α = 0 γB = 20-50 cpm (0810)
3 4	S 0 7 6 1 6	11 11 14	12"	Stiff, light olive-brown clay. (2.5 Y, 4/4) with a trace of very fine gravel. Damp		2.0	Hnu = 0 α = 0 γB = 20-50 cpm. (0835)
5 6	S 0 7 6 1 7	9 11 10	15"	Soft, light olive-brown clay (2.5 Y, 5/6) Silty & Damp		.50	Hnu = 0 α = 0 γB = 20-40 cpm. (0840)
7	S 0 7 6 1 8	8 11 7	9"	Very soft, light olive-brown clay (2.5 Y, 5/6) Fair amount of moisture noted.	CL	<.25	Hnu = 0 α = 0 γB = 20-40 cpm. (0850)
8 9	S 0 7 6 1 9	10 10 10	18"				a/a (1055)
10	S 0 7 6 2 0	7 8 11	18"	Medium stiff, olive-yellow clay (2.5 Y, 6/8) Damp (10'–10.5') Stiff Olive-brown clay (2.5 Y, 4/4) Moist (10.5'–10.8')		1.0	a/a (1105)
11 12	S 0 7 6 2 1	12 11 13	18"	Medium stiff, light olive-brown clay (2.5 Y, 5/6) Dry (11'–11.7') Stiff, dark grayish-brown clay (2.5 Y, 4/2) (11.7'–12.5')		1.5	Hnu = 0 α = 0 γB = 20-50 cpm. (1120)
13	S 0 7 6 2 2	3 7 4	18"	Medium dense, light olive brown silty sand (2.5 Y, 5/6) Damp (12.5'–13') Medium dense, grayish-brown sand (2.5 Y, 5/2) (13'–13.5') Medium dense light olive-brown sand (2.5 Y, 5/6)	SM SC SP		Hnu = 0 α = 0 γB = a/a (1130)
14 15	S 0 7 6 2 3	11 13 17	18"	Very stiff, dark gray clay (5 Y, 4/1) with a trace of fine gravel Damp	CL	2.0	Hnu = 0 α = 0 γB = a/a (1140)

NOTES:

I.) Drilling Contractor : Pennsylvania Drilling
DRILLER : Tim Harris
HELPER : Craig Coulter

II.) Background Measurements
A.) Hnu = 0 B) α = 0 C) γB = 40-60 cpm.

III. WATER USED 12/4
20 gallons.

IV. a/a = As Above

V) Samples via Munsell Colors, ASTM

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402-11-86

FERNALD RI/FS

DG 12/4/89

1st Review		
2nd Review		
Hard Copy Verification		

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS Task 3.2	
BORING NUMBER: DB 3043	COORDINATES:	DATE: 12/4 & 12/5/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/4/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87
DRILLING METHODS: Cable Tool		PAGE 2 OF 9

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16	S 0 7 6 2 4	7 8 12	18"	Stiff, dark grayish-brown (2.5Y, 4/2) clay. Slightly silty. Dry	CL	1.5	Hnu = 0 α = 0 γβ = 20-60 c.p.m. (1540)
17	S 0 7 6 2 5	7 8 11	12"	17.5' 17.5'			Hnu = 0 α = 0 γβ = 20-60 c.p.m. (1550)
18				Medium dense, dark gray sand (5Y, 4/1), silty with some gravel	SP	–	
19	S 0 7 6 2 6	5 9 9	18"	Stiff, olive gray clay (5Y, 5/2) with a trace of gravel. Dry	CL	1.55	End of Day 12-4-87 Start Day 12-5-87 Hnu=0 α = 0 γβ = 50 c.p.m. (0830)
20	S 0 7 6 2 7	14 22 27	15"				Hnu = 0 α = 0 γβ = 40-60 c.p.m. (0841)
21							
22	S 0 7 6 2 8	8 11 16	6"	Medium dense, olive gray clayey gravel (5Y, 5/2), with some coarse gravel and rock fragments. Moist	GC	–	Hnu = 0 α = 0 γβ = 40-60 c.p.m. (0944)
23	S 0 7 6 2 9	15 37 29	18"	Hard, dark gray clay (5Y, 4/1) with a trace of fine to coarse gravel Damp.	CL	4.5+	Hnu = 0 α = 0 γβ = 20-50 (0950)
24							
25	S 0 7 7 7 0	17 22 31	18"	Stiff, gray clay (5Y, 5/1) with a trace of gravel. Dry 25.3' 25.3'		1.5	Hnu = 0 α = 0 γβ = 20-40 c.p.m. (1024)
26	S 0 7 7 7 1	17 24 30	6"	Very dense, gray to dark gray gravel (5Y, 5/1 to 4/1), clayey in parts. Wet.	GC	–	a/a (1035)
27				27.5' 27.5'			
28	S 0 7 7 7 2	5 17 17	18"	Stiff, dark gray clay (5Y, 4/1) with a trace of gravel	CL	1.5-2.0	a/a (1045)
29	S 0 7 7 7 3	4 11 17	15"	Stiff, dark gray clay (2.5Y, N/4) with a trace of gravel	CL	1.5	a/a (1400)
30							

NOTES: I.) Background Readings for 12/5/87
1.) Hnu = 0
2.) α = 0
3.) γβ = 20-60 c.p.m.

II.) Water Used 12/5/87 = 37 gallons

III.) a/a = as above

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402-11-86

FERNALD RI/FS

DLG 2/4/87

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS		
BORING NUMBER: BJ 5-89 ~~3045~~ 3043	COORDINATES:	DATE: 12/5/87 & 12/7/87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/4/87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87	
DRILLING METHODS: Cable Tool		PAGE 3 OF 10	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30							
31	S 0777 4	10 13 18	18"	Medium stiff, dark gray clay (2.5 Y, N 4/) with a trace of fine gravel.	CL	.75	Hnu = 0 α = 0 γB = 40-60 c.p.m. (1405)
32	S 0777 5	10 14 17	16"	32' Very stiff, dark yellowish-brown clay (10 YR, 4/4) 32'	CL	3.75	Hnu = 0 α = 0 γB = 40-60 c.p.m. (1420)
33	S 0777 6	11 14 15	18"	33' 33.2 Dark gray, dense, fine gravel (2.5 Y, N 4) 33.2 33'	GW		Hnu = 0 α = 0 γB = 40-60 c.p.m. (1440)
34				Medium dense, yellowish-brown sand (10 YR, 5/8) with a trace of fine gravel. Dry.			
35							
36				Upper Sand & Gravel contact @ 33.2 Ft.			Began collecting 5' Sample
37							
38							
39							
40				Very dense, multicolored brown, 40.5 loose, fine gravel 40.5			
41	S 0777 7	10 22 33	18"	Very dense, yellowish-brown sand (10 YR, 5/6) with a trace of fine gravel. Dry			Hnu = 0 α = 0 γB = 40-60 c.p.m. (1657)
42							
43							
44							
45							

NOTES: I.) Background Measurements 12/7/87
Hnu = 0
α = 0
γB = 20-80 cpm.

II.) Water Used 12/7/87 = 23 gallons

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402-11-86

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: BD 1-5-59 ~~343~~ 3043	COORDINATES:	DATE: 12/9/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/4/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87
DRILLING METHODS: Cable Tool		PAGE 4 OF 9

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45							12-7-87
46	S 0 7 7 8	11 28 30	16"	Very dense, yellowish-brown sand (10YR 5/6). Damp	SW		Hnu = 0 α = 0 βB = 20-50 c.p.m. 0940
47							
48							
49							
50	S 0 7 7 9	12 22 26	18"	Dense, yellowish-brown sand as above. Damp but not saturated.	SW		Hnu = 0 α = 0 βB = 30 c.p.m. 1006
51							
52							
53							
54							
55	S 0 7 7 8 0	12 23 29	18"	56' Very dense, dark grayish-brown (2.5Y, 4/2) sand, gray sand fairly moist 56'	SW		Hnu = α = βB = 1032
56							
57							
58							
59							
60							

gray-Y

NOTES: Background Measurements for 12/8/87

1.) Hnu = 0

2.) α = 0

3.) βB = 20-50 c.p.m.

285

402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~343~~ 3043 BB 1-5-54	COORDINATES:	DATE: 12/7/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/4/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87
DRILLING METHODS: Cable Tool		PAGE 5 OF 9

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ( )	RECOVERY ( )	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60							
* 94-hrs 61	S 0 7 7 8 1	9 17 26	16"	Dense, dark grayish-brown (2.5Y, 4/2) sand w/some fine gravel Moist, but questionable about being wet.	SW		4nu = 0 α = 0 γβ = 40-50 c.p.m. 1108
62							
63							
64							
65	S 0 7 7 3 2	9 14 17	18"	Dense, dark grayish-brown (10 YR, 4/2) coarse sand. Appears wet. 66.2	SW		4nu = 0 α = 0 γβ = 40-60 c.p.m. 1316
66				Dense, olive-gray (5Y, 4/2) fine sandy gravel	GW		
67							
68							
69							
70	S 0 7 7 8 3	50 50/4"	10"+	Very dense, dark grayish-brown sand (2.5Y, 4/2) WET	SW		4nu = 0 α = 0 γβ = 40-60 c.p.m. 1456
71				Very dense, dark gray (5Y, 4/1) clayey gravel	GC		
72							
73							
74							
75							

NOTES:

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FERNALD RI/FS

DLG 2/4/04

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: ~~343~~ 3043 B3	COORDINATES:	DATE: 12/7 & 12/8/87	
ELEVATION:	GWL: Depth 78' Date/Time 12/8/87 - 0800	DATE STARTED: 12/4/87	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87	
DRILLING METHODS: Cable Tool		PAGE 6 OF 9	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75							
76	S 0774	19 39 50	18"	Very dense, very dark gray sand with some fine to coarse gravel (5Y, 3/1)	SP		Hnu = 0 α = 0 γB = 40 c.p.m. 1621
77							Had to drive casing to 80' in order to obtain 75-76.5 & 80-81.5' Samples
78							
79							
80	S 0775	10 13 18	14"	Dense, multicolored (brown, grays, white, black) loose poorly graded fine to coarse gravel	GP		Hnu = 0 α = 0 γB = 40 c.p.m. 1645
81							
82							End of Day 12/7/87 Start Day 12/8/87
83							
84							
85	S 0776	18 39 50/2"	18"	multicolored gravel, gen a/a	GW		Hnu = 0 α = 0 γB = 30 c.p.m. 0845
86				Very dense, dark gray silty to clayey gravel (5Y, 4/1)	GM		
87							
88							
89							
90							

NOTES: Background 12/8/87

Hnu = 0

α = 0

γB = 30 - 60 c.p.m.

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FERNALD RI/FS

DLG 3/4/91

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	Initial	Date
1st Key In		
2nd Key In		8/8
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER:	PROJECT NAME:	
BORING NUMBER: BB ~~3-43~~ 3043	COORDINATES:	DATE: 12/8/87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/4/87
ENGINEER/GEOLOGIST:	Depth Date/Time	DATE COMPLETED: 12/9/87
DRILLING METHODS:		PAGE 7 OF 9

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
90							
91	S 0 7 7 8 7	7 17 29	16"	Dense, dark grayish-brown (2.5 Y, 4/2) sand with some fine gravel	SW		Hnu = 0 α = 0 γB = 40 c.p.m. 1006
92							
93							
94							
95	S 0 7 7 8 8	17 25 35	13"	Very dense, dark grayish-brown (2.5 Y, 4/2) sand	SW		Hnu = 0 α = 0 γB = 40-50 c.p.m. 1113
96							
97				WET			
98							
99							
100	S 0 7 7 8 9	23 35 38		Very dense, dark grayish-brown sand (a/a). 100.8			Hnu = 0 α = 0 γB = 40-60 c.p.m. 1137
101				Very dense, dark grayish-brown silty sand. (2.5 Y, 4/2) 100.8			
102							
103							
104							
105							

NOTES:

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402-11-86

FERNALD RI/FS

DLG 2/4/89

258

	Initial	Date
1st Key In		
2nd Key In		8/18
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS TASK 3.2	
BORING NUMBER: BB 1-5-49 ~~343~~ 3043	COORDINATES:	DATE: 12/8/87
ELEVATION:	GWL: Depth 68' Date/Time 12-8-87/0730	DATE STARTED: 12/4/87
ENGINEER/GEOLOGIST: B.D.	Depth Date/Time	DATE COMPLETED: 12/9/87
DRILLING METHODS: Cable Tool		PAGE 8 OF 9

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
105							While sandpumping the 105-106.5 sample was missed. Loose sand
106							
107							
108	S 0779 0	20 37 44	18"	Very dense, dark gray sand. (5Y, 4/1) silty with a trace of clay.	SM		Hnu = 0 α = 0 γB = 40 c.p.m. (1417)
109							
110							10" Casing had to be drove down to 120 Ft. inorder to obtain 115' Split Spoon sample Blow Sand.
111							
112							
113							
114							
115	S 0779 1	1 2 9	12"	Medium dense, bluish-green type of sand (No Munsell color chart correlation). Silty and slightly clayey.			Hnu = 0 α = 0 γB = 30 c.p.m. (1657)
116							
117							Split Spoon began to sink once it was on bottom. (Strap line depth.) 116.5' End of Day 12/8/87 Start of Day 12/9/87
118							
119	S 0779 2	7 4 12	18"	Medium dense, bluish-green sand with some gravel. very clayey.	SC		Hnu = 0 α = 0 γB = 30-40 c.p.m. (1055)
120							

NOTES: I.) Background Measurements 12/9/87 No Water added to hole 12/8 or 12/9

1.) Hnu = 0

2.) α = 0

3.) γB = 20-50 c.p.m.

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FERNALD RI/FS

DLG 2/11/89

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Hard Copy Verification	

PAC

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS Task 8.2	
BORING NUMBER: BB 1-5-84 ~~3-43~~ 3043	COORDINATES:	DATE: 12/9/87
ELEVATION:	GWL: Depth 56.7' Date/Time 12-17-87/1000	DATE STARTED: 12/4/87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 12/9/87
DRILLING METHODS: Cable Tool		PAGE 9 OF 9

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
120				120' 120'			
121				Medium dense, bluish-green to dark olive-gray clayey gravel. (5Y, 3/2).	GC		Could not get below casing depth without blow sand coming into borehole (120'-) Had to catch sample @ 119'.
122							
123							
124							
125				Loose, olive-gray silty sand 125.6' (5Y, 5/2) 125.6'			
126	S 0 7 9 3	2 2 3	18"	Soft, "blue-gray" clay. (No Munsell color correlation) closest correlation is (5Y, 4/1).		<1.0	Hnu = 0 α = 0 γβ = 40 c.p.m. (1336)
127							
128				— Bottom of Borehole @ 126.5' —			
129							
130							
131							
132							
133							
134							
135							

NOTES:

Total Water Added To Well To Drill. = 80 gallons

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402-11-86

FERNALD RI/FS

DLC 2/4/89

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	Initials	Date
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2nd Key In		
Hard Copy Verification		

DAC

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. B. Dunning DATE 12/11/87
PROJECT NO. 602 Task 3.2 CHECKED BY R Galbraith DATE 2/4/89
BORING NO. ~~345~~ 3643 BB 1-5-89
PIEZOMETER NO. NA 3643 DATE OF INSTALLATION 12/10/87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0 TO 126.5'
FLUID NA FROM NA TO NA

TYPE OF BIT Hammer - Type
CASING SIZE (S) USED:
SIZE 10" FROM 0' TO 125'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel
DIAMETER OF PERFORATED SECTION 4" Ø
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.01"
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10'

RISER PIPE MATERIAL Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10' & 2½'
JOINING METHOD Flush Joint Threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Ft.
PROTECTIVE PIPE Ø.D. 10 Inches

OTHER PROTECTION LOCKING CAP WITH LOCK

ITEM	DISTANCE ABOVE BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	+ 2.5'			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.4'			
BOREHOLE FILL MATERIALS:	(Surface)			
GROUT/SLURRY	TOP 0'	BOTTOM 94'	TOP	BOTTOM
BENTONITE	TOP 94'	BOTTOM 98'	TOP	BOTTOM
SAND	TOP 98'	BOTTOM 120'	TOP	BOTTOM
GRAVEL	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 107.6'	BOTTOM 117.6'	TOP	BOTTOM
PIEZOMETER TIP	120'			
BOTTOM OF BOREHOLE	~~120'~~ 126.5 RWG 2/6/89			
GWL AFTER INSTALLATION	56.7' TOC WPK 1/24/89			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

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REMARKS This well was drilled to a total depth of 126.5' thus penetrating into the "Blue Clay". It was allowed to collapse to 120' and the well was completed from that depth.

DLG 3/11/87

3

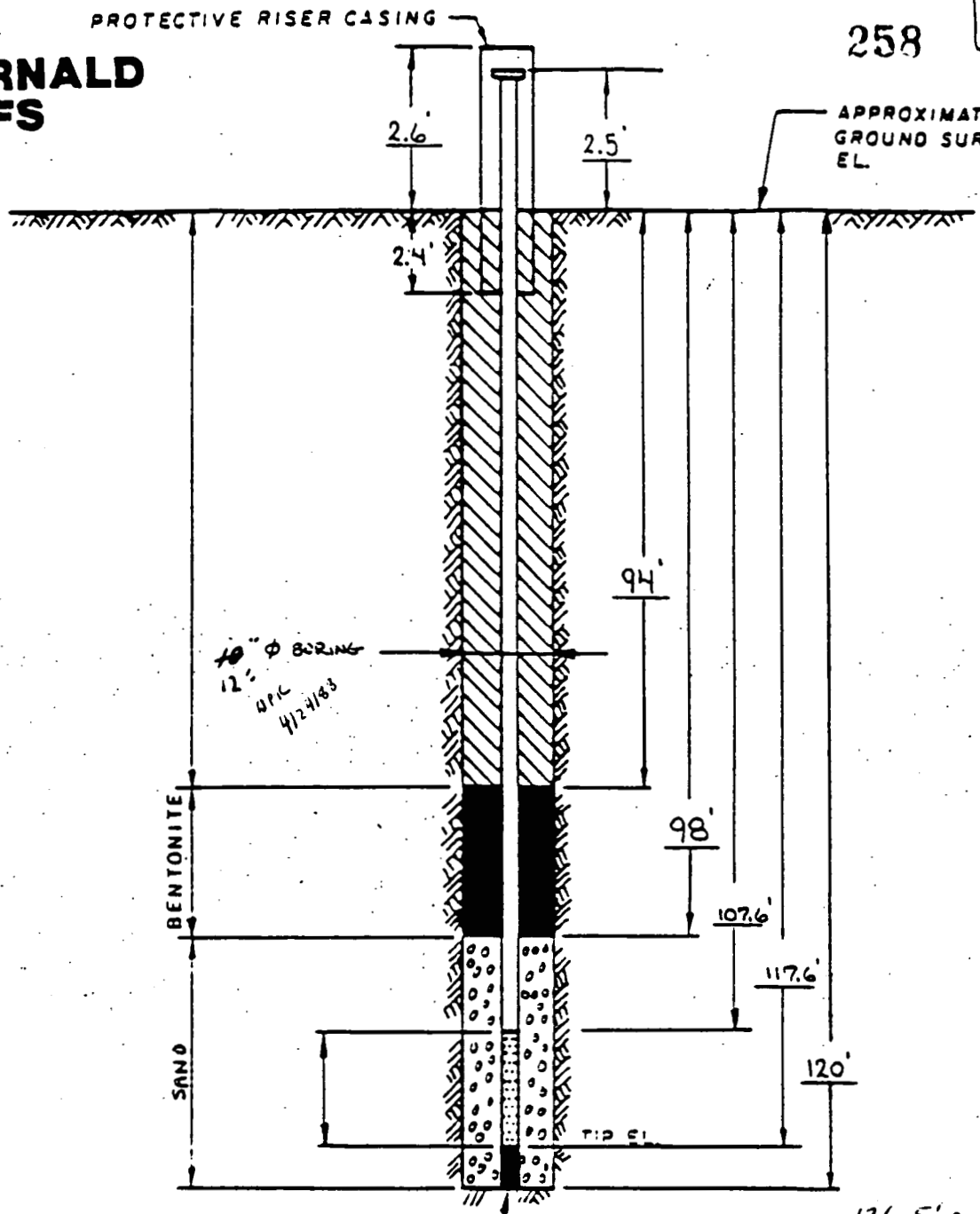
BOREHOLE - MONITOR WE

258

~~343~~

3043 BB

FERNALD RI/FS



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NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

NOTE: Well was drilled to 126.5' to tag the "Blue clay" then allowed to collapse in to 120'.

INSTALLATION DETAILS
MONITORING WELL ~~343~~ 3043

PREPARED FOR BB 1-5-89

FMPC RI/FS

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White out correction were made by [illegible] at the time [illegible]

FERNALD RI/FS 2/4/89

	Initials	Date
1st Key In		
2nd Key In		
Data Verification		

#24 JPR

WPF 4/23/88

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RIG #3

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: C251 B3051, 1-5-88	COORDINATES:	DATE: Nov 18, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Nov 17, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: Nov 19, 1987
DRILLING METHODS: Cable tool		PAGE 1 OF 4

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ ft)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				Detailed Soil Classification refer to Boring 3051			Consistency and density based on relative soil texture
5				hard brownish yellow 10YR 6/8 clay, some silt, and gravel, trace sand and pebbles-dry	cl	NA	
10	ST 0-1.0	1.0	1.0				Sample # 07425 10-14-87 @ 0800
				16.0			
				hard gray 10YR 5/1 clay, some gravel and silt, trace sand and pebbles-dry			
15					cl	NA	
20	ST	1.0	0.0				pushed shelby tube at 20 ft, NO RETURN, tried again at 22.0 ft. 10-14-87 @ 1115 Sample # 07426
	ST 22.0-23.0	1.0	0.9				
25							

NOTES: Pennsylvania Drilling Co
Driller Dave Neuman
Helper Bob Johnson
Drilling Rig Bucyrus Erie W24
water added to boring: 450 gallons

Shelby tube sampling follow ASTM Standard for undisturbed 2 in diameter, thin wall, 2 foot sampling tube

Background γ: 2 cpm HNU: 0 ppm
αβ: 140 cpm

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FERNALD RI/FS

yo 2/4/89

	Initials	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B251~~ B2051 BD 11-5-89	COORDINATES:	DATE: Nov 18, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Nov 12, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: Nov 19, 1987
DRILLING METHODS: Cable Tool		PAGE 2 OF 4

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
35				stiff gray 10YR 6/1 ~~gr~~ mottled brown 10YR 4/2 gravelly clay some silt and gravel, trace pebbles-dry	cl	NA	No ~~soil~~ soil samples collected
40							
45				46.0			
50				dense gray 5YR 6/1 sand and gravel mixed with gray silty clay, some pebbles-dry	sm	NA	
				53.0			
55				dense gray 5YR 6/1 sand and gravel some silt, clay and pebbles-moist	sm	NA	

NOTES:

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FERNALD RI/FS JJ 2/4/89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B25~~ ~~B03~~ B2C57 9B25-89	COORDINATES:	DATE: Nov 19, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Nov 2, 1987
ENGINEER/GEOLOGIST: Lowell Witke	Depth Date/Time	DATE COMPLETED: Nov 19, 1987
DRILLING METHODS: Cable tool		PAGE 3 OF 4

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				dense gray 5YR 5/1 sand and gravel, some silt and clay - trace pebbles - moist			no soil samples collected
65							
					SM	NA	
70							
75							
80				very dense gray 5YR 5/1 sand, some gravel and silt, trace clay and pebbles - moist	SM		very hard drilling
85						NA	

NOTES:

402-11-86

FERNALD RI/FS

JJ 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 60232	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B251~~ B2051 BD	COORDINATES:	DATE: Nov 16, 19, 87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Nov 12, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: Nov 19, 1987
DRILLING METHODS: Cable Tool		PAGE 4 OF 4

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (NA)	RECOVERY (NA)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				dense gray 7½YR6/0 sand and gravel, some silt, clay and pebbles - dry wet			No soil samples collected
95					Sm		
						NA	
100							
105				105.0			
				bottom of boring			
110							
115							

NOTES:

402-11-86

FERNALD RI/FS

2/4/89

	Initial	Date
Field Rev.		
Hard Copy Rev.		
Hard Copy Verification		

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS
PROJECT NO. 602.3.2
BORING NO. ~~B251~~ B2C47 BB 1-5-89
PIEZOMETER NO. 251

FIELD ENG./GEO. Lowell Wille DATE Nov 19, 1987
CHECKED BY R Galbraith DATE 2/4/89
DATE OF INSTALLATION Nov 17, 18 and 19

BOREHOLE DRILLING

DRILLING METHOD cable tool	TYPE OF BIT NA
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID NA FROM ___ TO ___	SIZE ~~[illegible]~~ FROM NA TO ___
FLUID — FROM — TO —	SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE Monitoring well	RISER PIPE MATERIAL Stainless steel
DIAMETER OF PERFORATED SECTION 4 in	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 5/8 in I.D. 4 in
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 ft
AVERAGE SIZE OF PERFORATIONS 0.010 in	JOINING METHOD screw FLUSH JOINT
TOTAL PERFORATED AREA ___	THREADS.

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 ft	OTHER PROTECTION NA locking cap
PROTECTIVE PIPE O.D. 10 3/4 in	AND lock.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	~~2.5~~ 2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM ~~78~~ 77	TOP	BOTTOM
BENTONITE	TOP 77 ~~78~~	BOTTOM 82	TOP	BOTTOM
SAND	TOP 82	BOTTOM 103	TOP	BOTTOM
NO GRAVEL USED.	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 85	BOTTOM 100	TOP	BOTTOM
PIEZOMETER TIP	102.4			
BOTTOM OF BOREHOLE	~~103.5~~ 105			
GWL AFTER INSTALLATION	91.7 top of casing			

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
AS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

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REMARKS

409-11-86

2/4/89

WELL ~~251~~ # 24

FERNALD RI/FS

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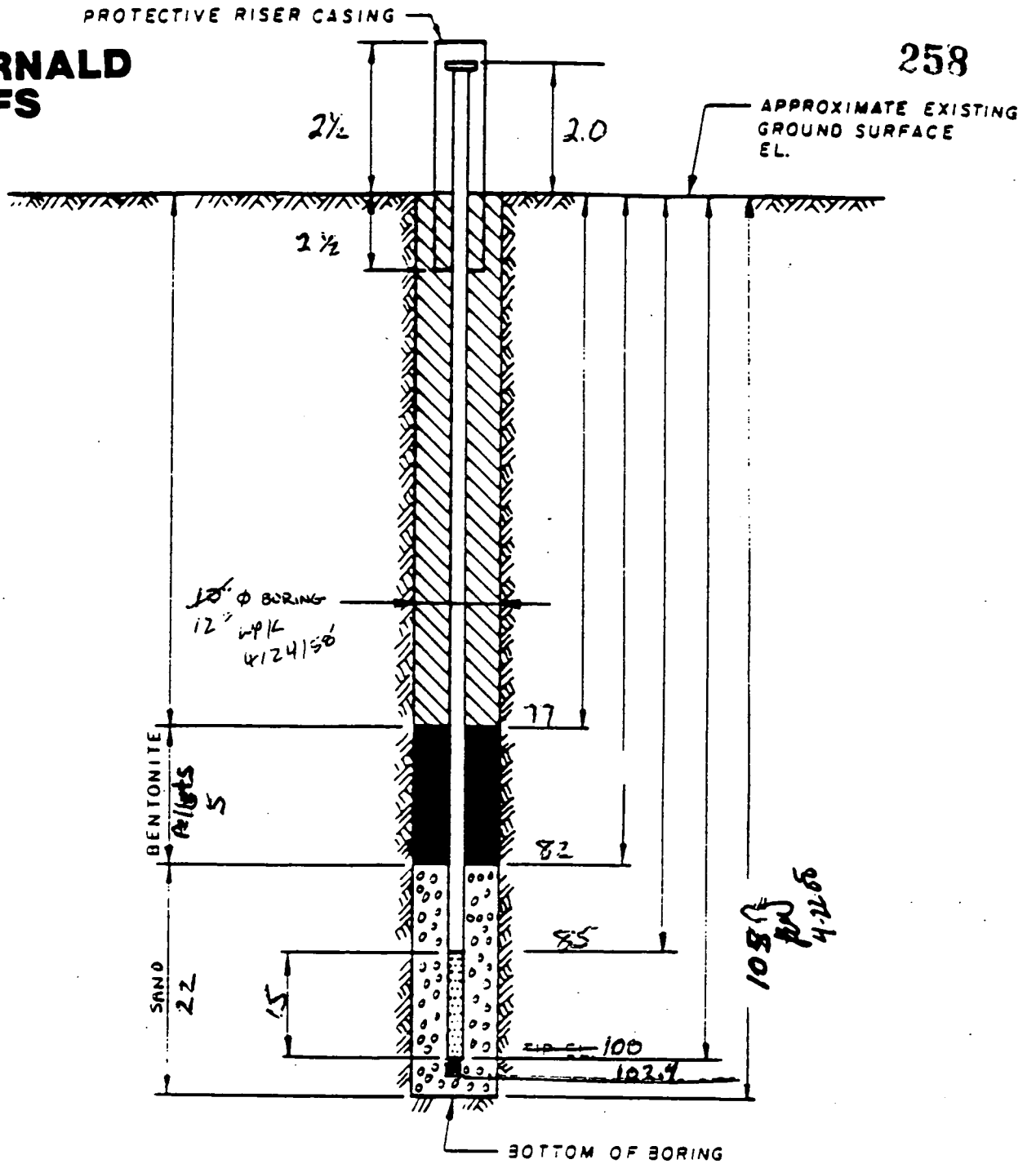

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. Stainless steel PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED. Stainless steel
4. ELEVATION OF WATER LEVEL 91.7 below top of casing
5. WATER LEVEL READING ON Nov 19, 1987

INSTALLATION DETAILS
MONITORING WELL ~~251~~ 205!

PREPARED FOR BB 1-5-89

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2/4/89

FERNALD RI/FS

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WPF 4/13/88

RIG # 3

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.32	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B351~~ 3051	COORDINATES:	DATE: 10-21-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10-21-87
ENGINEER/GEOLOGIST: Lowell Willo	Depth Date/Time	DATE COMPLETED: 11-13-87
DRILLING METHODS: Coble Tool		PAGE 1 OF 11

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1/2 FT	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	7333 1130	6 8 22	12	hard yellowish brown 10YR5/8 clay, trace silt and sand - dry	cl	>5	very slight "O" horizon at surface HNU=0 ppm γβ=50 cpm α=1 cpm
2, 3	7334 1140	15 32 36	13	hard brownish yellow 10YR6/6 clay, some silt, trace gravel and pebbles - dry	cl	>5	HNU=2 ppm γβ=60 α=2
4	7335 1145	33 42 33	16	hard, brownish yellow 10YR6/8 clay, some silt, sand and gravel, trace pebbles - dry	cl	>5	HNU=2 ppm γβ=60 α=2
5, 6	7336 1310	27 33 26	18	hard brownish yellow 10YR6/8 clay some silt, sand and gravel, trace pebbles, limestone rock @ 5.5' - dry	cl	>5	HNU=2 ppm γβ=60 α=2
7	~~7338~~ 7 1315	22 28 49	18	hard yellowish brown 10YR5/8 clay, some silt, sand, gravel and pebbles - dry	cl	>5	HNU=2 ppm γβ=60 α=2
8, 9	~~7339~~ 8 1515	11 18 19	7	hard brownish yellow 10YR6/8 ~~clay~~ mottled gray 10YR6/1, red and black ~~gravelly~~ clay silty clay some sand and gravel - dry	cl	4.5	HNU=2 ppm γβ=60 α=2
10	~~7340~~ 39 1530	25 43 50	18	very stiff brownish yellow ~~brown~~ 10YR6/6 mottled gray 10YR6/1 red and black gravelly clay some silt and sand, trace pebbles - dry	cl	2.5	HNU=2 ppm γβ=60 α=2
11, 12	~~7341~~ 40 1610	6 18 33	11	hard yellowish brown 10YR5/4 mottled gray 10YR6/1 red and black gravelly clay some silt and sand - dry 12.0	cl	3.5	HNU=2 ppm γβ=60 α=2
13	~~7342~~ 1 1630	3 7 10	7	hard to stiff gray 10YR5/1 gravelly clay some silt and pebbles, red 10YR4/6 sand lense at 13 ft - dry	cl / cl	3.5 / 2.5	HNU=2 ppm γβ=60 α=2
14	~~7343~~ 2 1645	6 10 20	12	hard gray 10YR5/1 gravelly clay some silt and pebbles, trace sand - dry	cl	3.5	HNU=2 ppm γβ=60 α=2

NOTES:

Pennsylvania Drilling Co
Driller Dave Newman
Helper Bob Johnson
Drilling Backus Erie 310

Background
γβ=60 cpm
α=2 cpm
HNU=2 ppm
LEL=0

samples taken with standard ASTM 2" OD split barrel sampler follow ASTM standard penetration test
Color based on Munsell Soil Color Chart.

water added to boring (5 gallon buckets) HHH HHH HHH HHH HHH HHH HHH HHH HHH HHH

402-11-86

JY 2/4/89

FERNALD RI/FS

PAC

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.32	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B351 B357 B3	COORDINATES:	DATE: Oct 21, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Oct 21, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: 11-13-87
DRILLING METHODS: Cable Tool		PAGE 2 OF 11

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	7343 1700	4 7 12	12	hard gray 10YR5/1 gravelly clay some sand trace silt, dry	cl	3.5	HNU = 1 ppm γβ: 60 α: 2
17 18	7344 930	5 5 8	7	stiff gray 10YR5/1 clay, some sand silt and gravel - dry	cl	1.5 1.0	HNU = 1 ppm γβ = 60 α = 2
19	7345 1000	4 5 10	9	very stiff gray 10YR5/1 gravelly clay some silt and sand - moist	cl	3.5	HNU: 1 ppm γβ: 60 α: 2
20 21	7346 1115	7 7 9	7	very stiff gray 10YR 5/1 clay, some sand ~~silt~~ and silt, trace gravel and pebbles - dry	cl	3.0	HNU = 1 ppm γβ = 66 α: 2
22	7347 1140	6 7 12	8	stiff gray 10YR 5/1 gravelly clay, some silt and sand, trace pebbles - moist	cl	1.5	HNU = 1 ppm γβ: 60 α: 2
23 24	7348 1150	5 6 12	7	hard gray 10YR 5/1 clay, some sand, silt and gravel - moist	cl	4.5	HNU = 1 ppm γβ: 60 α: 2
25	7349 1205	6 8 18	10	very stiff gray 10YR 5/1 clay some gravel, sand and silt - moist	cl	3.5	HNU = 1 ppm γβ: 60 α: 2
26 27	7455 905	7 10 16	15	very stiff gray 10YR 5/1 clay, some silt, sand and gravel - moist	cl	3.5	HNU = 1 ppm γβ = 60 α: 2
28	7456 925	12 12 15	16	stiff gray 2.5YR 5/6 gray mottled dark brown 7.5YR 3/2 clay, some silt, trace sand and gravel, trace wood - moist	cl	2.0	HNU = 1 ppm γβ = 60 α: 2 wood (spruce) encountered
29	7457 945	7 11 26	15	very stiff gray 5YR 5/1 mottled dark brown 10YR 3/1 clay, some silt, trace sand gravel and wood - moist	cl	2.5	HNU = 1 ppm γβ = 60 α = 2 several pieces of wood (spruce)

NOTES:

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2/4/89

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 60232	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B351~~ B351	COORDINATES:	DATE: 10-27-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10-22-87
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: 11-13-87
DRILLING METHODS: Cable Tool		PAGE 3 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ Ft.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	7458 1115	9 15 26	18	stiff gray 7½YR 5/1 silty clay, some sand trace gravel - moist	cl	2.0	HNU: 0 ppm γβ: 70 cpm α: 2 cpm
32 33	7459 1140	6 9 15	15	stiff gray 7½YR 5/1 silty clay some sands, trace gravel moist	cl	1.5	HNU: 0 ppm γβ: 60 cpm α: 2 cpm
34	7460 1200	6 18 22	12	stiff gray 5YR 5/1 silty clay some sand, trace gravel and pebbles-moist	cl	1.5	HNU: 0 ppm γβ: 70 cpm α: cpm
35 36	7461 1345	5 10 21	16	Stiff gray 7½YR 5/0 clay, some silt and sand, trace gravel -moist	cl	2.0	HNU: 0 ppm γβ: 75 α: 2
37	7462 1410	11 23 22	15	Stiff gray 7½YR 5/0 clay some silt wood sand, trace gravel and wood moist	cl	1.5	HNU: 0 ppm γβ: 80 cpm α: 2 cpm wood
38 39	7463 1430	11 33 36	18	Stiff gray 7½YR 5/0 clay some silt trace sand, gravel and pebbles - moist	cl	2.0	HNU: 0 ppm γβ: 60 cpm α: 2 cpm
40	7464 1455	12 30 35	18	very stiff gray 7½YR 5/0 silty clay some sand, trace gravel-moist	cl	2.5	HNU: 0 ppm γβ: 75 cpm α: 3 cpm
41 42	7465 1615	14 27 35	18	Stiff light gray 7½YR 7/0 silty clay some sand and gravel-moist	cl	2.0	HNU: 0 ppm γβ: 60 cpm α: 2 cpm
43	7466 1705	16 22 32	15	very stiff light gray 7½YR 7/0 clay some silt, trace sand, gravel and wood moist	cl	3.5	HNU: 0 ppm γβ: 80 cpm α: 2 cpm wood
44	7467 1725	12 22 33	18	stiff gray 10YR 5/1 clay some silt trace sand and gravel -moist	cl	2.5	HNU: 0 ppm γβ: 62 cpm α: 1 cpm

NOTES:

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ZJ 2/4/89

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.32	PROJECT NAME: Fernald RI/FS		
BORING NUMBER: ~~B35T~~ B304	COORDINATES:	DATE: Oct 28, 1987	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Oct 21, 1987	
ENGINEER/GEOLOGIST: Lowell Willis	Depth Date/Time	DATE COMPLETED: 11-13-87	
DRILLING METHODS: Cable Tool		PAGE 4 OF 11	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	7468	10 14 19	16	very stiff gray 5YR 6/1 clay some silt trace gravel and sand, some calicification cement - moist	cl	3.5	HNU = 0 ppm BG = 60 cpm α = 2 cpm
47 48	7469	6 12 18	18	hard gray 5YR 6/1 clay some sand and silt, trace gravel - moist	sp	4.0	HNU: 0 ppm BG = 70 cpm α = 2 cpm
				dense gray 5YR 6/1 sand and gravel some silt and clay - moist	sp	NA	
49	7470	7 16 24	18	very stiff gray 5YR 6/1 clay some sand and clay, trace gravel moist	cl	3.5 3.5	HNU = 0 ppm BG = 55 cpm α = 3 cpm
50 51	7471	8 14 31	18	very stiff gray 10YR 6/1 clay some sand and silt, trace gravel moist	cl	4.0	HNU = 0 ppm BG = 80 cpm α = 4 cpm
				very stiff gray 10YR 6/1 clay and silt some fine sand - dry	cl	1.5	
52	7472	39 44 50+	15	stiff brown 10YR 5/3 silt and fine sand, some clay - dry	sm	1.5 NA	HNU = 0 ppm BG = 70 cpm α = 2 cpm
						NA	
53 54	7473	16 41 50	15	stiff brown 10YR 5/3 silt and fine sand some clay - dry 52.0	sm	NA	HNU = 0 ppm BG = 60 cpm α = 2 cpm
				dense brown 10YR 5/6 sand and fine gravel some silt, trace clay and medium gravel - dry	sp		
55	7474	34 75+	12	dense yellowish brown 10YR 5/6 sand and gravel, some silt and clay, trace cobbles dry	sp	NA	HNU = 0 ppm BG = 70 cpm α = 3 cpm
56 57				dense yellowish brown 10YR 5/6 sand some gravel and silt, trace clay - dry	sp		
58							
59							

NOTES:

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JS 2/4/89

FERNALD RI/FS

pAC 258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.32	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B351~~ B305	COORDINATES:	DATE: OCT 28, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Oct 26, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: 11-13-87
DRILLING METHODS: Cable Tool		PAGE 5 OF 11

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	7425 1615	34 75	12	dense brownish gray 10YR 5/2 sand and gravel some silt clay and pebbles - moist 60 ft	gc	NA	HNU: 0 ppm βγ: 60 cpm α: 2 cpm
				hard brownish yellow 10YR 5/6 silty clay some sand - dry 61	cl	3.5	
62				very dense brownish yellow 10YR 5/6 coarse sand and gravel some silt and clay, trace to pebbles - moist	gc		only able to drive split spoon 12 in.
63							
64							
65							
66	7476 1530	43 72	12	dense brownish yellow 10YR 5/6 coarse sand and gravel, some silt, trace clay and pebbles dry	gm	NA	HNU = 0 ppm βγ: 70 cpm α: 2 cpm
67				dense ~~brownish~~ yellowish brown 10YR 5/6 sand, some silt, trace gravel and clay - moist	SW		only able to drive split spoon 12 in.
68							
69							
70							
71	7477 850	16 78	12	very dense light ~~gray~~ brownish gray 10YR 5/2 sand and gravel, some to pebbles, cobbles silt and clay - dry	gc	NA	HNU = 0 ppm βγ: 60 cpm α: 2 cpm
72							only able to drive split spoon 12 in.
73							
74							

NOTES:

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PAC

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: G02.3.2	PROJECT NAME: Fernald RI/FS Nov 1	
BORING NUMBER: ~~B351~~ B3057 DB	COORDINATES:	DATE: ~~Oct 29~~, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Oct 21, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: 11-13-87
DRILLING METHODS: Cable tool		PAGE 6 OF 11

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1/2 FT.	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	7478 1415	16 78	12	dense brownish yellow 10YR 6/6 sand some gravel, trace silt and clay - moist	gc	NA	HNU=0 ppm γβ=60cpm α=2 cpm
77							only able to drive split spoon 12 in.
78							
79							
80	7479 1630	20 30 40	11	dense brownish yellow 10YR 6/8 sand and gravel some silt clay and pebbles - moist	gc	NA	HNU=0ppm γβ=60cpm α=2cpm
81							
82							
83							
84							
85	7480 1745	29 22 27	12	dense brownish yellow 10YR 6/8 sand and gravel, some silt and clay - moist	gc	NA	HNU=0ppm γβ=60cpm α=0cpm
86							
87				87	---		
88				dense gray 7.5YR 6/0 sand, some silt and clay, trace gravel - moist	SP		density based on relative soil texture
89							

NOTES:

402-11-86

2/4/89

FERNALD RI/FS

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6022.32	PROJECT NAME: Fernald RI/FS	DATE: Nov 2 1987
BORING NUMBER: ~~B351~~ B3051 BB 1-5-91	COORDINATES:	DATE STARTED: Oct 21, 1987
ELEVATION:	GWL: Depth Date/Time	DATE COMPLETED: 11-13-87
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	PAGE 7 OF 11
DRILLING METHODS: Cable tool		

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	7481 940	9 25 26	18	dense gray 2½YR5/0 fine to medium sand some coarse sand and silt, trace clay, gravel and pebbles - moist	SP	NA	HNU = 0ppm OB = 50cpm α = 2cpm
92							
93							
94							
95	7482 1045	9 20 31	18	dense gray 7½YR5/0 fine to medium sand, some coarse sand and fine gravel trace silt and clay - moist	SP	NA	HNU = 0ppm OB = 60cpm α = 2cpm
96							
97							
98							
99							
100	7483 1640	5 8 10	17	dense gray 7½YR5/0 sand, some silt and clay. trace gravel - moist	SP	NA	HNU = 0ppm OB = 50cpm α = 2cpm
101							
102							
103							
104							

NOTES:

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2/4/89

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

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PROJECT NUMBER: 60232	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B351~~ B305 BB 1-5-89	COORDINATES:	DATE: Nov 3, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Oct 21, 1987
ENGINEER/GEOLOGIST: Howell Willo	Depth Date/Time	DATE COMPLETED: Nov 13, 1987
DRILLING METHODS: Cable tool		PAGE 8 OF 11

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ½ FT	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106	7484 1740	10 21 35	18	dense gray 7½YR 5/0 sand - some silt and clay, trace fine gravel - moist	SP	NA	HNU = 0ppm γB = 60cpm α = 2cpm
107							
108							
109							
110	7485 900	5 15 28	18	dense gray 7½YR 5/0 sand, some gravel, silt and clay - wet	SP	NA	HNU = 0ppm γB = 60cpm α = 2cpm
111							
112							
113				113	---		
114							
115	7486 945	5 7 13	18	dense gray 7½YR 5/0 sand and gravel some cobbles, silt and clay - wet	GM	NA	HNU = 0ppm γB = 60cpm α = 2cpm
116							
117							
118				118	---		
119					SP		

NOTES:

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FERNALD RI/FS

2/4/89

1st Review | 2nd Review | Hard Copy Verification

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	Nov 4, 1987
BORING NUMBER: ~~B357~~ B3057	COORDINATES:	DATE: ~~Oct 21, 1987~~
ELEVATION:	GWL: Depth 90.0 Date/Time 800 11-4-87	DATE STARTED: Oct 21, 1987
ENGINEER/GEOLOGIST: Lowell Wile	Depth 89.7 Date/Time ~~800~~ 730 11-5-87	DATE COMPLETED: Nov 13, 1987
DRILLING METHODS: Cable Tool		PAGE 9 OF 11

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (/N)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121	7487 1330	4 9 21	1.8	dense gray 10YR 5/1 sand, some silt and clay, trace gravel - wet	SP	NA	HNU = 0 ppm; ∂B - 60 cpm; α = 2 cpm
122							
123							
124							
125							
126	7488 1500	7 17 30	1.8	dense gray 10YR 5/1 sand and fine gravel, some silt and clay, trace sand to coarse gravel - wet	SP	NA	HNU = 0 ppm; ∂B = 60 cpm; α = 2 cpm
127							
128							
129							
130							
131	7489 1630	19 31 45	1.8	dense gray 10YR 5/1 sand and fine gravel some silt, clay and medium gravel, & trace coarse gravel and pebbles - wet	SP	NA	HNU = 0 ppm; ∂B = 60 cpm; α = 2 cpm
132							
133							
134							

NOTES:

402-11-86

FERNALD RI/FS

2/4/89

VISUAL CLASSIFICATION OF SOILS

258

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~B35~~ B305 BB 1-5-89	COORDINATES:	DATE: Nov 5, 1987
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Oct 21, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: Nov 13, 1987
DRILLING METHODS: Cable tool		PAGE 10 OF 11

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136	7420 840	10 11 17	18	dense gray 10YR 5/1 sand and fine gravel some silt, clay and medium to coarse gravel, trace pebbles - wet	SP	NA	HNU = 0ppm γB = 40cpm α = 2cpm
137							
138				138 1/2			
139					SM		density based on relative soil textures
140				loose gray 10YR 5/1 fine sand and silt, some clay - wet 140 1/2			
141	7421 1145	14 16 18	12	dense gray 10YR 5/1 sand and gravel, some silt, clay and pebbles - wet	SP	NA	HNU = 0ppm γB = 50cpm α = 2cpm
142							
143							
144							
145				very dense gray 10YR 5/1 sand and fine to medium gravel, some silt and clay - trace pebbles - wet			
146	7422 1530	30 40 50+	12		SP	NA	HNU : 0ppm γB : 50cpm α = 2cpm
147							
148							
149							

NOTES:

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FERNALD RI/FS

2/4/89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 802.	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B35+ B35I BO 1-59	COORDINATES:	DATE: Nov 5, 1987
ELEVATION:	GWL: Depth 89.6 Date/Time Nov 6/0800	DATE STARTED: Oct 21, 1987
ENGINEER/GEOLOGIST: Lowell Wille	Depth Date/Time	DATE COMPLETED: Nov 13, 1987
DRILLING METHODS: Cable Tool		PAGE 11 OF 11

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ Ft.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
151	7423 1705	15 32 42	18	dense gray 10YR 5/1 sand and fine gravel some medium to coarse gravel, silt and clay, trace pebbles - wet	SP	NA	HNU = 0 ppm γβ = 50 cpm α = 2 cpm
152				bottom of boring 151½ ft			
153							
154							
155							
156							
157							

NOTES:

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JT 2/4/89

351 BB 3/5

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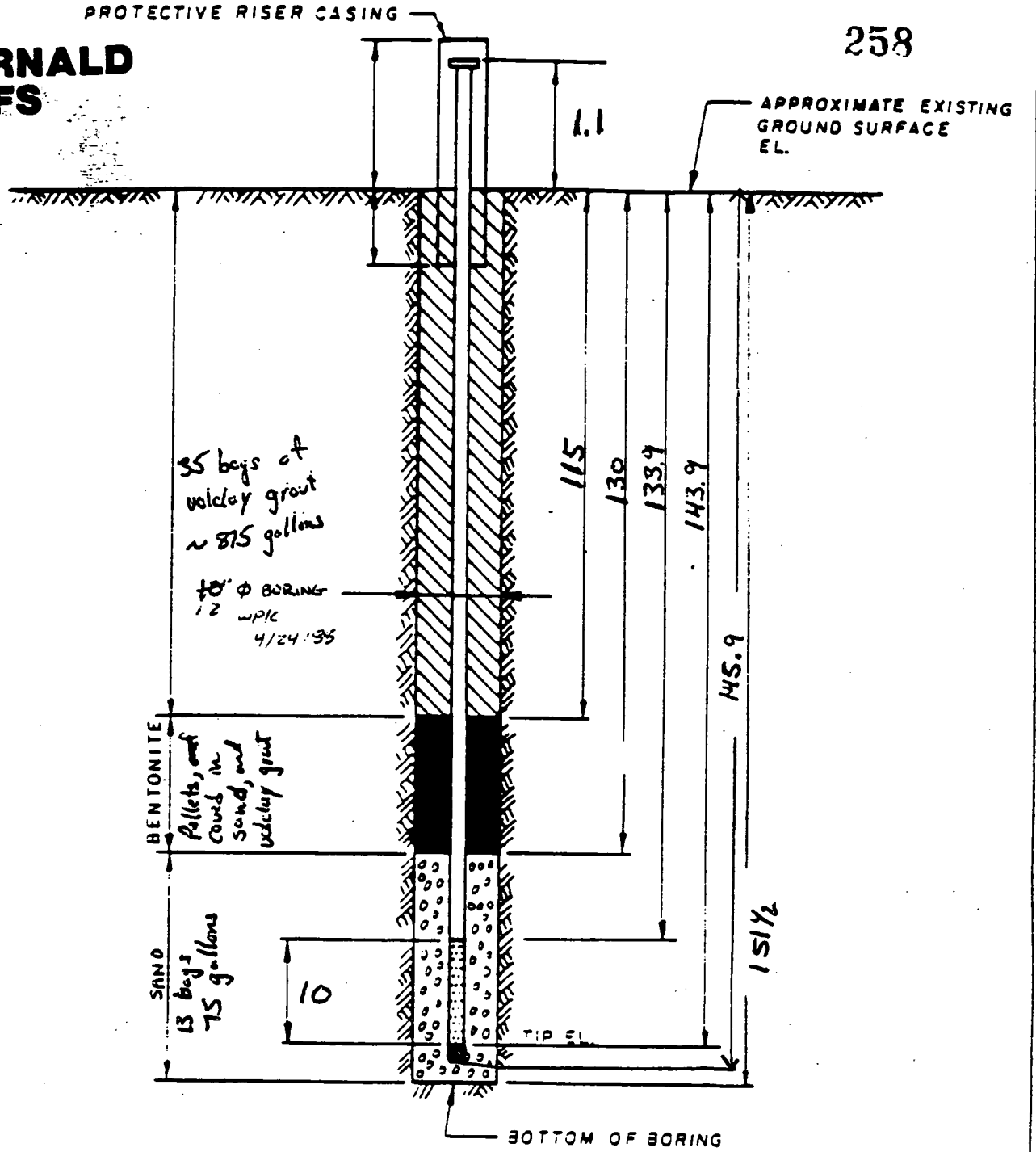
FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. Stainless PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL 89.9, ~~[illegible]~~
5. WATER LEVEL READING ON 11-17-87 @ 0800

INSTALLATION DETAILS
MONITORING WELL 351
3051 BB 1-5-89

PREPARED FOR

310

JJ 2/4/89 white out correction were made by [illegible] this form was completed 4/24/88 wpk

FERNALD RI/FS

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	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS FIELD ENG./GEO. Lowell Wille DATE Nov 12, 87
PROJECT NO. 602.3.2 CHECKED BY R Galbraith DATE 2/6/89
BORING NO. ~~351~~ 305' BB 1-5-90
PIEZOMETER NO. ~~351~~ 305' DATE OF INSTALLATION Nov 10, 11, 12, 1987

BOREHOLE DRILLING

DRILLING METHOD cable tool
DRILLING FLUID (S) USED: WATER
FLUID WATER FROM 0 TO 50 ft
FLUID NA FROM NA TO NA

TYPE OF BIT HAMMER
CASING SIZE (S) USED: TEMPORARY
SIZE 10 IN FROM 0 TO 150 ft
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Monitoring well
DIAMETER OF PERFORATED SECTION 4 in
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010 in
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 ft.

RISER PIPE MATERIAL Stainless steel
RISER PIPE DIAMETERS:
O.D. 4 3/8 in I.D. 4 in
LENGTH OF PIPE SECTIONS 10 ft
JOINING METHOD screw JOINT

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH ~~10~~ 5 ft
PROTECTIVE PIPE O.D. 10 3/4 in

OTHER PROTECTION LOCKING CAP AND LOCK.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	1.1			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 1	BOTTOM 115	TOP	BOTTOM
BENTONITE Pellets and coved in sand	TOP 115	BOTTOM 130	TOP	BOTTOM
SAND	TOP 130	BOTTOM ~~140~~ 150	TOP	BOTTOM
NO GRAVEL USED	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 133.9	BOTTOM 143.9	TOP	BOTTOM
PIEZOMETER TIP	145.9			
BOTTOM OF BOREHOLE	151.5			
GWL AFTER INSTALLATION	89.9 TOC WPK 4/24/88			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

311

REMARKS From 130 to 115 ~~feet~~ foot depth below ground surface, bentonite seal had formation sand and gravel mixed in with it.

409-11-86

6/24/89

TM/S 071198

258

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

W24 11/23/88
R16 #1

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		Task 3.2
BORING NUMBER: 152 1052	COORDINATES: N482,508.58/E1,180,147.58		DATE: 11/5 & 11/6/87
ELEVATION: 584.90 GS	GWL: Depth	Date/Time	DATE STARTED: 11/5 @ 1500
ENGINEER/GEOLOGIST: B. Dunning	Depth	Date/Time	DATE COMPLETED: 11/10/87
DRILLING METHODS: Cable Tool			PAGE 1 OF 2

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (In.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
.5, 1, 1.5, 2				See Detailed Soil Descriptions on Well Log for Reference 252			Began Well at 1500 11/5/87
3	51 11-05 0752 1700 2		16"	Shelby Tube	CL		Sample Driven at 1700. 3'-4.4'
4							
5							End of Day 11/5/87 Start of Day 11/6/87
6							
7							
8							
9							
10							
11							
12	57 11-06 0753 63		8½"	Shelby Tube			Taken @ 11/5 - 10/6/87
13							
14							
15							End of Day 11/6/87

NOTES: 1.) Drilling Contractor:
Pennsylvania Drilling
Driller: Tim Harris
Helper: Craig Coulter
Rig #2
Type: 71 Speed Star

2.) Water Used (1 = 5 gal.)
58 gallons

3.) Background Readings for 11/5 & 11/6
α β = 60-110
γ = 0
How = 0

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 152	COORDINATES:	DATE: 11/7/87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11/5 @ 1500	
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 11/10/87	
DRILLING METHODS: Cable Tool		PAGE 2 OF 2	

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (N/A)	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16							Beginning of Day 11/10/87
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30				BOB(*) = 30 Feet			End of Day 11/10/87

NOTES: 1.) Background Level 11/10/87 * BOB - BOTTOM OF BORING

Hmax = 0

γ = 0

α β = 40-140 cpm

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. B DUNNING DATE 11/10/87
PROJECT NO. 603 CHECKED BY DATE
BORING NO. 152
PIEZOMETER NO. 152 DATE OF INSTALLATION 11/10/87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED: Potable Water
FLUID H_2O FROM 0 TO 30'
FLUID NA FROM NA TO NA

TYPE OF BIT HAMMER
CASING SIZE (S) USED:
SIZE 10" FROM 0 TO 30'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE ~~STAINLESS STEEL~~ MONEL (316)
DIAMETER OF PERFORATED SECTION 4" INCHES
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.01
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10'

RISER PIPE MATERIAL STAINLESS STEEL 316
RISER PIPE DIAMETERS:
O.D. 4 3/8 INCHES I.D. 4 IN.
LENGTH OF PIPE SECTIONS 10'
JOINING METHOD FLUSH JOINT THREADED

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5'
PROTECTIVE PIPE O.D. 10"

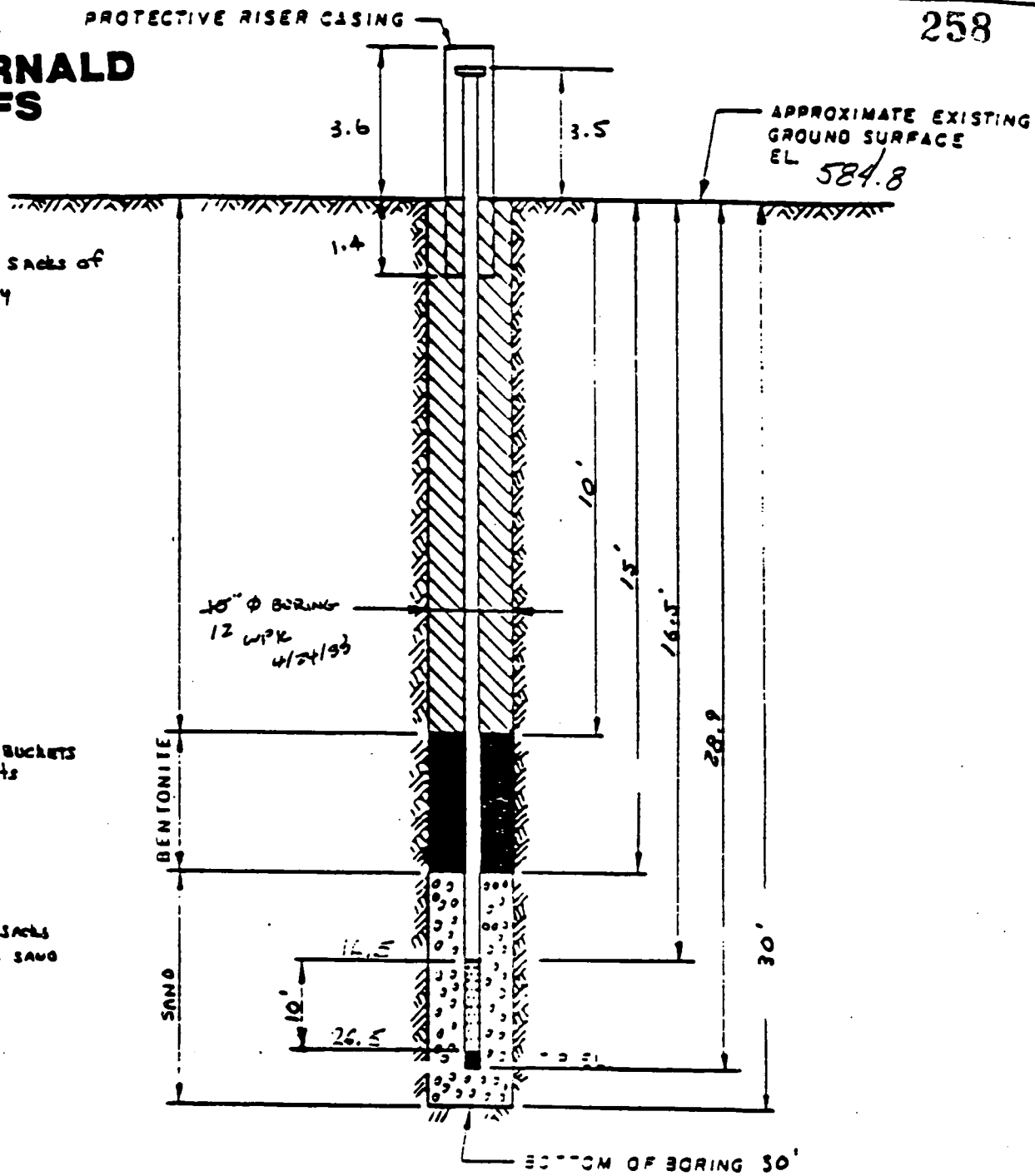
OTHER PROTECTION LOCKING CAP AND LOCK.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION ( )	
TOP OF RISER PIPE	~~3.4~~ 3.5		588.0	
GROUND SURFACE	0.0		584.8	
BOTTOM OF PROTECTIVE PIPE	1.4		583.4	
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 10'	TOP 584.8	BOTTOM 574.8
BENTONITE	TOP 10'	BOTTOM 15'	TOP 574.8	BOTTOM 569.8
SAND	TOP 15'	BOTTOM 30'	TOP 569.8	BOTTOM 554.8
GRAVEL	TOP NA	BOTTOM NA	TOP NA	BOTTOM NA
PERFORATED SECTION	TOP 16.5	BOTTOM 26.5	TOP 568.3	BOTTOM 558.3
PIEZOMETER TIP	29.9	NA ~~28.4~~ 30' (SUMP)	555.9	
BOTTOM OF BOREHOLE	30'		554.9	
GWL AFTER INSTALLATION	25.5 TOC		562.5	

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN 10 SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN 1.0 SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL 152

PREPARED FOR

FERNALD RI/FS

(ORIGINAL)

(* ELEVATION AND COORDINATES ESTABLISHED UPON SURVEY.)

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	Initial	Date
Field Check		
1st Key In		
2nd Key In		
Final Copy		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC R/FS	
BORING NUMBER: 2055	COORDINATES:	DATE: 3-10-89
ELEVATION:	GWL: Depth 68.1 Date/Time 3-12/0830	DATE STARTED: 3-10-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth 68.2 Date/Time 3-13/1000	DATE COMPLETED: 3-13-89
DRILLING METHODS: CABLE TOOL '72 SPEED STAR		PAGE 1 OF 8

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 (IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	10735 1338 03-10	2 8 8	8	SOFT, DARK YELLOWISH BROWN (10 YR 5/4), CLAYEY SILT, TRACE OF FINE GRAVEL, MOIST, MED. PLASTICITY.	ML	.25	Hnu = BKG α = 0 CPM βγ = 100-110 CPM
2 3	10736 1345 03-10	5 7 11	6	SOFT, YELLOWISH BROWN (10 YR 5/4) CLAYEY SILT, TRACE OF FINE GRAVEL, MOIST, LOW PLASTICITY.	ML	.25	Hnu = BKG α = 0 CPM βγ = 120-130 CPM
4	10737 1350 03-10	13 17 20	12	SOFT, LIGHT OLIVE BROWN (2.5 Y 5/4) CLAYEY SILT, TRACE OF FINE GRAVEL, MOIST, LOW TO MED. PLASTICITY.	ML	.50	Hnu = BKG α = 0 CPM βγ = 120-140 CPM
5 6	10738 1357 03-10	19 23 25	10	MEDIUM STIFF, BROWN (10 YR 5/3), SILTY CLAY, TRACE OF FINE TO MED. GRAVEL, MED. PLASTICITY, MOIST.	CL	.50	Hnu = BKG α = 0 CPM βγ = 120-140 CPM
7	10739 1407 03-10	40 42 37	6	MEDIUM STIFF, DARK GRAYISH BROWN, (10 YR 5/2), TRACE OF MED. GRAVEL, MED. PLASTICITY, MOIST.	CL	.75	Hnu = BKG α = 0 CPM βγ = 120-140 CPM
8 9	10740 1410 03-10	20 32 40	12	MEDIUM STIFF, GRAY, (10 YR 5/1), CLAY, TRACE OF MED. COARSE GRAVEL, MEDIUM PLASTICITY, MOIST.	CL	.50	Hnu = BKG α = 0 CPM βγ = 120 CPM
10	10741 1415 03-10	20 18 20	15	MEDIUM STIFF, DARK GRAY (5 Y 4/1), CLAY, TRACE OF FINE GRAVEL, MED. PLASTICITY, MOIST TO WET.	CL	.75	Hnu = 0.8 ppm α = 0 CPM βγ = 110-120 CPM
				SOFT, CLAYEY SILT (5 Y 4/1), WET.	ML	.50	
11 12	10742 1535 03-10	11 19 11	8	SOFT GRAY (5 Y 4/2), SANDY CLAY, TRACE OF FINE GRAVEL, MOIST TO WET SATURATED, MED TO LOW PLASTICITY.	CL	.50	Hnu = BKG α = 0 CPM βγ = 120 CPM
PERCHED ZONE 13	10743 0910 03-11	4 4 7	8	SOFT, GRAY, (2.5 Y 5/0), SLIGHTLY SILTY CLAY, LOW TO MED. PLASTICITY, MOIST TO WET.	CL	.25	Hnu = BKG α = 0 CPM βγ = 120-140 CPM
14	10744 0915 03-11	12 10 13	10	STIFF, GRAYISH BROWN (2.5 Y 5/2), CLAY, TRACE OF FINE GRAVEL, MOIST, MED. PLASTICITY.	CL	1.75	Hnu = 0.8 ppm α = 0 CPM βγ = 120-130 CPM

NOTES: PENN. DRILLING CO.
DRILLER: HARRY DYKES JR.
HELPER: ROBERT YOST

MATERIALS USED:
SAND: 20 80 lb. BAGS
GROUT: 12 50 lb. BAGS
BENTONITE: (5) 5 gal. BUCKETS, 1 AROUND TOP
WATER: 550 GALS DRILL, 300 GROUTING
850 TOTAL GALS.

SAMPLING IN ACCORDANCE WITH ASTM STANDARDS USING 18" SPLITSPOON.
MUNSELL COLOR CHART FOR DESCRIPTION.
color UAH 3-27-89

INSTRU. BACKGROUND
Hnu = 0.6 ppm
α = 0 CPM
βγ = 100-120 CPM
LEL CO_2 = 0-1%

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402-11-86

FERNALD RI/FS

2nd Key In
Hard Copy Verification

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2-	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 2055	COORDINATES:		DATE: 3-11-89
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 3-10-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth	Date/Time	DATE COMPLETED: 3-13-89
DRILLING METHODS: CABLE TOOL			PAGE 2 OF 8

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	10745 0922 03-11	10 9 9	9	MEDIUM STIFF, DARK GRAY (2.5Y 4/0), SANDY CLAY, TRACE OF COARSE SAND THROUGHOUT, LOW PLASTICITY, MOIST.	CL	1.0	Hnu = BKG. α = 0 CPM βγ = 110-120 CPM
17 18	10746 0934 03-11	5 9 9	10	MEDIUM STIFF, GRAY (2.5Y 5/0), CLAY, TRACE OF COARSE SAND THROUGHOUT, MOIST, MED. PLASTICITY.	CL	1.0	Hnu = BKG. α = 0 CPM βγ = 110-140 CPM
19	10747 1048 03-11	4 4 4	14	SOFT, OLIVE GRAY, (5Y 5/1), CLAY, TRACE OF FINE GRAVEL, MOIST TO WET, LOW TO MED. PLASTICITY.	CL	.25	Hnu = BKG. α = 0 CPM βγ = 120 CPM
20 21	10748 1055 03-11	5 7 10	16	SOFT, OLIVE GRAY, (5Y 5/2), CLAY, TRACE OF FINE GRAVEL, MOIST, MED. PLASTICITY.	CL	.50	Hnu = BKG. α = 0 CPM βγ = 120 CPM
22	10749 1315 03-11	3 5 5	16	SOFT, GRAY, (5Y 5/1), GRAVELLY CLAY, MOIST, LOW TO MED. PLASTICITY.	CL	.35	Hnu = BKG. α = 0 CPM βγ = 110-120 CPM
23 24	10750 1325 03-11	6 8 9	8	MEDIUM STIFF, GRAY, (5Y 5/1), CLAY, TRACE OF FINE GRAVEL AND COARSE SAND THROUGHOUT, MOIST, MED. PLASTICITY.	CL	1.0	Hnu = BKG. α = 0 CPM βγ = 100-120 CPM
25	10751 1336 03-11	7 8 8	8	MEDIUM STIFF, GRAY (5Y 5/1) SANDY CLAY, TRACE OF FINE GRAVEL, MOIST, MED. PLASTICITY.	CL	1.0	Hnu = BKG. α = 0 CPM βγ = 100-120 CPM
26 27	10752 1350 03-11	2 6 9	6	MEDIUM STIFF, GRAY (5Y 5/1), GRAVELLY CLAY, MOIST, MED. PLASTICITY.	CL	1.0	Hnu = BKG. α = 0 CPM βγ = 120 CPM
28	10753 1427 03-11	20 29 39	15	STIFF, VERY DARK GRAY, (5Y 3/1) GRAVELLY CLAY, MOIST, MED. PLASTICITY.	CL	2.0	Hnu = BKG. α = 0 CPM βγ = 120-140 CPM
29	10754 1450 03-11	48. 50T 5IN.	9	HARD, DARK OLIVE GRAY, (5Y 4/2) SANDY CLAY, TRACE OF FINE GRAVEL, MOIST, MED PLASTICITY.	CL	>4.0	Hnu = BKG. α = 0 CPM βγ = 120 CPM

NOTES:

DRILLER: Harry Dykes.
HELPER: Robert Yost.

INSTRUM. BKG.
Hnu = 0.4-0.8 ppm
α = 0 CPM
βγ = 150-180 CPM
LEL O_2 = 0%

402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6002 3.2.1	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2055	COORDINATES:	DATE: 3-11-89 / 3-12-89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 3-10-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth Date/Time	DATE COMPLETED: 3-13-89
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 8

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	10755 1630 03-11	39 18 24	10	VERY STIFF, DARK OLIVE GRAY, (5Y 5/1), GRAVELLY CLAY, MOIST, MED. PLASTICITY.	CL	3.0	Hnu = BKg. α = 0 CPM βγ = 120-130 CPM
32 33	10756 1636 03-11	30 50+ 3.in	8	VERY STIFF, DARK OLIVE GRAY (5Y 4/1), GRAVELLY CLAY, MOIST, MED. PLASTICITY.	CL	3.0	Hnu = BKg. α = 0 CPM βγ = 130 CPM
34	10757 0848 03-12	6 16 21	10	~~MEDIUM~~ STIFF, DARK OLIVE GREEN-GRAY (5Y 4/1) SANDY CLAY, TRACE OF FINE GRAVEL, MOIST, LOW TO MED PLASTICITY.	CL	2.0	Hnu = BKg. α = 0 CPM βγ = 120-130 CPM
35 36	10758 0900 03-12	9 12 21	16	MEDIUM STIFF, OLIVE GRAY, (5Y 5/2), SANDY CLAY, TRACE OF FINE GRAVEL AND SILT THROUGHOUT, MOIST MED. PLASTICITY.	CL	1.0	Hnu = BKg. α = 0 CPM βγ = 120-130 CPM
37	10759 0910 03-12	5 16 15	8	DENSE, GRAYISH BROWN (10YR 5/2), SANDY SILT, NON PLASTIC, MOIST.	ML	N/A	Hnu = BKg. α = 0 CPM βγ = 120-130 CPM
				DENSE, GRAYISH BROWN (10YR 5/2), POORLY GRADED SAND, MOIST TO DRY, 37.5	SP	N/A	
TILL DEPTH 38 39 40				EXTENT OF GLACIAL TILL, SAMPLING AT 5.0 FT INTERVALS FROM 40.0 FT. THEREAFTER.			
41	10760 1035 03-12	19 30 45	11	VERY DENSE, YELLOWISH BROWN, (10YR 5/4) POORLY GRADED SAND, MOIST TO DRY.	SP	N/A	Hnu = BKg. α = 0 CPM βγ = 130 CPM
42 43 44							

NOTES:

DRILLER: HARRY DYKES
HELPER: ROBERT YOST.

INSTRU. BACKGROUND
Hnu = 0.6-0.8 ppm
α = 0 CPM
βγ = 120-150 CPM

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FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2.1	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2055	COORDINATES:	DATE: 3-12-89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 3-10-89
ENGINEER/GEOLOGIST: E. TRULLINEER	Depth Date/Time	DATE COMPLETED: 3-13-89
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 8

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	10761 1100 03-12	50+ / 5 IN	5	VERY DENSE, YELLOWISH BROWN (10YR 5/4) POORLY GRADED SAND, MOIST.	SP	N/A	Hrm = BKg. α = 0 CPM βγ = 120 CPM
47							
48							
49							
50							
51	10762 1345 03-12	50+ / 4 IN	4	VERY DENSE, GRAYISH BROWN (10YR 5/2), POORLY GRADED SAND, TRACE OF FINE GRAVEL, MOIST.	SP	N/A	Hrm = BKg. α = 0 CPM βγ = 120-130 CPM
52							
53							
54							
55							
56	10763 1540 03-12	50+ / 5 IN	5	VERY DENSE, GRAYISH BROWN, (10 YR 5/2), POORLY GRADED SAND, TRACE OF FINE GRAVEL, MOIST.	SP	N/A	Hrm = BKg. α = 0 CPM βγ = 120 CPM
57							
58							
59							

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NOTES:

DRILLER: HARRY DYKOS JR.
HELPER: ROBERT YOST

INSTRU. BKg.

Hrm = 0.6 APM
α = 0 CPM
βγ = 150 CPM

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.21	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2055	COORDINATES:	DATE: 3-12-89 / 3-13-89
ELEVATION:	GWL: Depth 68.2 Date/Time 3-11 @ 1645	DATE STARTED: 3-10-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth 68.1 Date/Time 3-12 @ 0830	DATE COMPLETED: 3-13-89
DRILLING METHODS: CABLE TOOL	68.2 3-13 @ 1000	PAGE 5 OF 8

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	10764 1630 03-12	50+ / 5IN	5	VERY DENSE, GRAYISH BROWN (10YR 5/2), POORLY GRADED SAND, TRACE OF FINE GRAVEL, MOIST.	SP	N/A	Hmu = BKG. α = 0 CPM βγ = 120 CPM
62							
63							
64							
65							
66	10765 1000 03-13	50+ / 6IN	6	VERY DENSE, GRAYISH BROWN, (10YR 5/2), POORLY GRADED SAND, MOIST.	SP	N/A	Hmu = BKG α = 0 CPM βγ = 110-120 CPM
67							
68				WATER TABLE ELEVATION FROM GROUND SURFACE 68.2 FT.			
69							
70							
71	10766 1250 03-13	32 22 24	8	DENSE, DARK GRAYISH BROWN, (10YR 4/2), WELL GRADED SAND, TRACE OF FINE GRAVEL THROUGHOUT, WET.	SW	N/A	Hmu = BKG. α = 0 CPM βγ = 110-120 CPM
72							
73							
74							320

NOTES:

DRILLER: HARRY DYKOS JR.
HELPER: ROBERT YOST.

INSTRU. BKG.

Hmu = 0.6 ppm
α = 0 CPM
βγ = 150-170 CPM

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6022 32.1	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 2055	COORDINATES:		DATE: 3-13-89
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 3-10-89
ENGINEER/GEOLOGIST: E. TROLLINGER	Depth	Date/Time	DATE COMPLETED: 3-13-89
DRILLING METHODS: CABLE TOOL			PAGE 6 OF 8

DEPTH (FT.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	10767 1310 03-13	22 27 36	10	VERY DENSE, DARK GRAYISH BROWN, (10 YR 4/2), WELL GRADED SAND, WET.	SW	N/A	Hmu = Bkg. α = 0 CPM βγ = 120 CPM
				VERY DENSE, DARK GRAYISH BROWN (10 YR 4/2), POORLY GRADED SAND, WET.	SP		
77							
78							
79							
80							
81	10768 1430 03-13	48 45 36	15	VERY DENSE, DARK GRAYISH BROWN, (10 YR 4/2), WELL GRADED GRAVELLY SAND, WET.	SW	N/A	Hmu = Bkg. α = 0 CPM βγ = 110-120 CPM
82				SAMPLING ENDED AT 81.5 FT. DRILLING STOPPED AT 80.0 FT.			
83							
84							
85							

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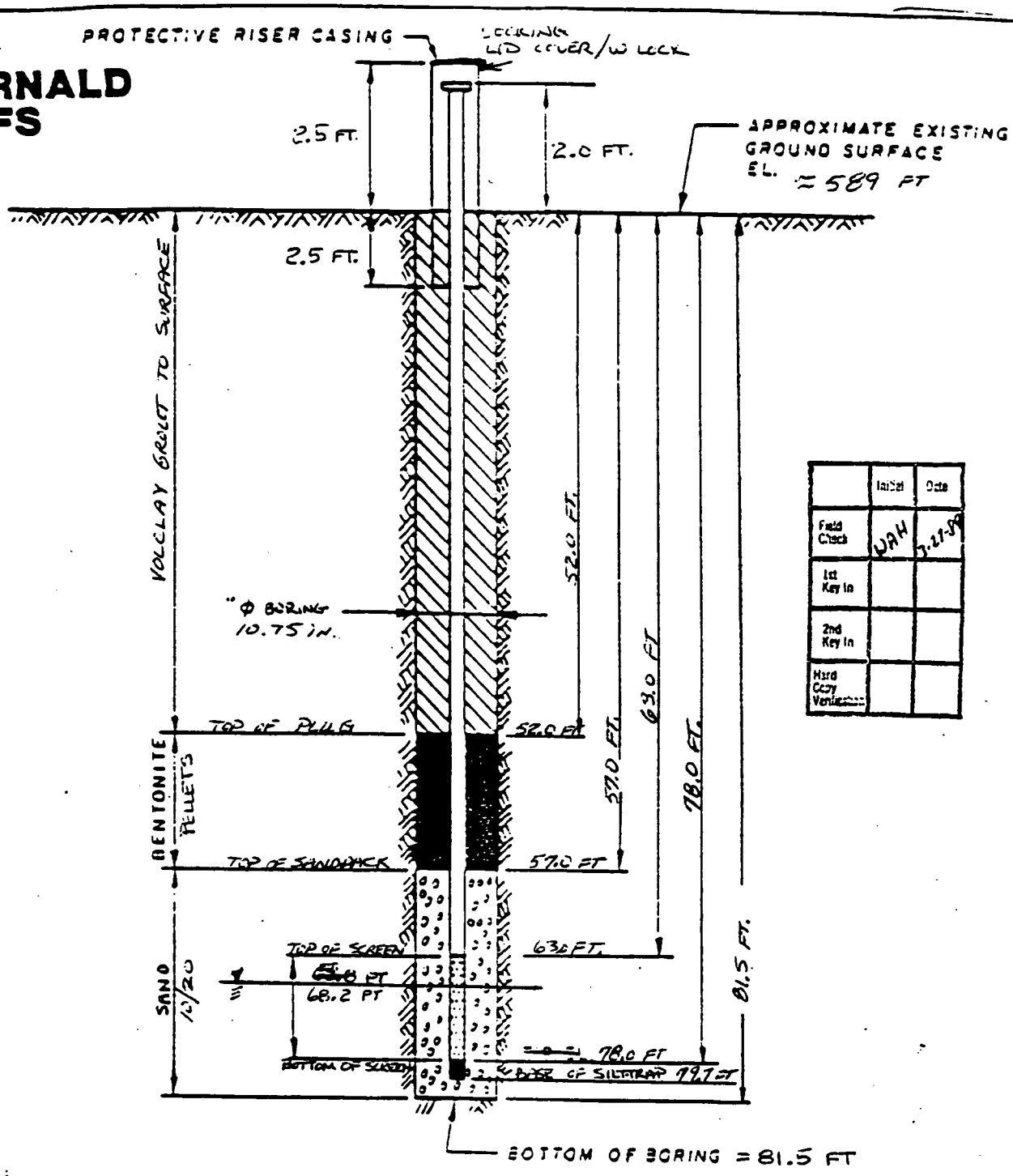
NOTES:

INSTRU. BKG.

Hmu = 0.6 ppm
α = 0 CPM
βγ = 140 CPM - 160 CPM

FERNALD RI/FS



	Initial	Date
Field Check	WAH	7-27-89
1st Key In		
2nd Key In		
Hard Copy Verification		

DRAWING NUMBER MW-2055

CHECKED BY / APPROVED BY

E.T.

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN 10 SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN 1.0 SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED (+1.7 FT WELDED SILT TRAP)
4. ELEVATION OF WATER LEVEL 68.2 FT, 68.2 FT, 68.1 FT
5. WATER LEVEL READING ON 3-11-89, 3-12-89, 3-13-89

MATERIALS USED TO COMPLETE

10/20 SAND = (20) 80lb. BAGS

BENTONITE PELLETS = (5) 5 gal. BUCKETS PLUG, 1 AROUND CASING AT TOP.

VOLCLAY GROUT 50(lb) = 12 BAGS

WATER = 550 gals DRILLING, 300 gals GROUTING ⇒ 850 TOTAL GALLONS WATER

PIPE SECTIONS: 5 FT., 10 FT., 15 FT. SCREEN, 1.7 FT SILT TRAP (WELDED), PROTECTIVE RISER CASING

INSTALLATION DETAILS
MONITORING WELL #2055

PREPARED FOR
FMPC RI/FS

FERNALD RI/FS

Field Check	DHH	3-27-89
1st Key In	[illegible]	[illegible]
2nd Key In	[illegible]	6-16-89
Data Verification		

8/8

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PIEZOMETER INSTALLATION SHEET

3-14-89 TC

PROJECT NAME FMPC RI/FS FIELD ENG./GEO. E. TRCHUNGER DATE 3-19-89
PROJECT NO. 602 3.2 CHECKED BY _____ DATE _____
BORING NO. 2055
PIEZOMETER NO. 2055 DATE OF INSTALLATION 3/9-89

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 0.0 FT. TO 81.5 FT.
FLUID — FROM — TO —

TYPE OF BIT HAMMER
CASING SIZE (S) USED:
SIZE 10.0 IN ID FROM 0.0 FT. TO 82.0 FT
SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE MONITORING WELL
DIAMETER OF PERFORATED SECTION 4.0 IN. ID
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SLOTTED SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010 IN
TOTAL PERFORATED AREA 15.0 FT.

RISER PIPE MATERIAL STAINLESS STEEL (316)
RISER PIPE DIAMETERS:
O.D. 4 3/8 IN. I.D. 4.0 IN
LENGTH OF PIPE SECTIONS 5, 10 FT., 15 FT SCREEN
JOINING METHOD THREADED, FLUSH JOINTED

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 FT.
PROTECTIVE PIPE O.D. 10.75 IN.

OTHER PROTECTION HINGED LID COVER WITH PADLOCK.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT.)		ELEVATION ( )	
TOP OF RISER PIPE	2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0	BOTTOM 52.0	TOP	BOTTOM
BENTONITE PELLETS	TOP 52.0	BOTTOM 57.0	TOP	BOTTOM
SAND 10/20	TOP 57.0	BOTTOM 81.5	TOP	BOTTOM
GRAVEL NONE USED	TOP N/A	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 63.0	BOTTOM 78.0	TOP	BOTTOM
PIEZOMETER TIP	79.7 FT.			
BOTTOM OF BOREHOLE	81.5 FT.			
GWL AFTER INSTALLATION	68.4 FT			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

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REMARKS

409-11-86

FERNALD RI/FS

DLG 3/4/88

	Initial	Date
1st Key In		
2nd Key In		
Verif.		

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VISUAL CLASSIFICATION OF SOILS

RIG #2

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~2~~ to 2066	COORDINATES:		DATE: 8/25/87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 8/25/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 8/31/87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 5

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN.)	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1.5	7000	6 6 5	13"	STIFF BROWN SILT, TRACE FINE SAND.	ML		SAMPLE SCANNED - BACKGROUND READINGS
3.0	7001	6 6 6	14"	STIFF BROWN SILTY CLAY, TRACE FINE SAND.	CL		SAMPLE SCANNED - BACKGROUND READINGS
4.5	7002	1 2 3	14"	MEDIUM STIFF REDDISH YELLOW CLAY - TRACE SILT	CL		SAMPLE SCANNED - BACKGROUND READINGS.
6.0	7003	1 2 3	17"	MEDIUM STIFF LIGHT GRAY CLAY TRACE SAND AND SILT	CL		SAMPLE SCANNED - BACKGROUND READINGS
7.5	7004	1 1 2	14"	MEDIUM STIFF LIGHT GRAY CLAY, TRACE SAND AND SILT.	CL		SAMPLE SCANNED - BACKGROUND READINGS 745 8-26-87
				SOFT LIGHT YELLOWISH BROWN CLAY	CL		
				SOFT LIGHT GRAY SILT, TRACE FINE SAND AND CLAY	ML		
9.0	7005	1 3 2	14"	LIGHT YELLOWISH BROWN SILT, SOME CLAY.	ML		SAMPLE SCANNED - BACKGROUND READINGS
				SOFT LIGHT GRAY CLAY, TRACE SILT.	CL		
10.5	7006	6 7 10	13"	MEDIUM STIFF YELLOWISH BROWN CLAY, SOME SILT, TRACE SAND.	CL		SAMPLES SCANNED - BACKGROUND READINGS
				MEDIUM DENSE YELLOWISH BROWN ~~COARSE~~ SAND, TRACE GRAVEL AND SILT.	SP		
12.0	7007	6 7 11	8"	VERY STIFF YELLOWISH RED SILT, SOME SAND TRACE CLAY	ML		SAMPLE SCANNED - BACKGROUND READINGS
13.5	7008	4 16 17	17"	~~VERY STIFF~~ REDDISH BROWN ~~COARSE~~ SAND ~~MEDIUM~~ DENSE TRACE ~~SOME~~ GRAVEL, ~~AND~~ SILT.	SP		PANCAKE - 100-120 COUNTS PER MINUTE. OTHER METER READINGS AT BACKGROUND.
				~~SANDY~~ HARD ~~SA~~ GRAY SANDY SILT, TRACE GRAVEL.	ML		
15.0	7009	2 5 6	9"	LENS REDDISH BROWN MEDIUM SAND, TRACE GRAVEL AND SILT.	SP		SAMPLE SCANNED - BACKGROUND READINGS
				STIFF GRAY SILT, TRACE CLAY	ML		
				STIFF DARK GRAY MEDIUM SAND SOME SILT, TR. GRAVEL	SM		

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
R16 - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" OD.

324

402-11-86

FERNALD RI/FS

258

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 206	COORDINATES:	DATE: 8-26-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 5

DEPTH 16"	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16.5	7010	3 6 7	9"	STIFF GRAY CLAY, SOME SILT, TRACE SAND AND GRAVEL.	CL		SAMPLE SCANNED - BACKGROUND READINGS.
18.0	7011	5 7 8	13"				SAMPLE SCANNED - BACKGROUND READINGS
19.5	7012	4 5 9	9"	STIFF GRAY SILT, SOME CLAY, TRACE GRAVEL	ML		SAMPLE SCANNED BACKGROUND READINGS
21.0	7013 7014	11 13 22	15"	HARD GRAY & CLAY AND SILT, TRACE GRAVEL.	CL		SAMPLE SCANNED BACKGROUND READINGS
22.5	7015	8 12 20	13"	HARD GRAY SILTY CLAY, TRACE GRAVEL AND SAND.	CL		SAMPLE SCANNED, BACKGROUND READINGS
24.0	7016 7017	20 15 25	12"				8-27-87 8:00 SAMPLE SCANNED- BACKGROUND READINGS
25.5	7018	9 19 26	13"				SAMPLE SCANNED - BACKGROUND READINGS
27.0	7019	5 26 REF. 50	10"				SAMPLE SCANNED- BACKGROUND READINGS
28.5	7020 7021	7 10 50	16"				SAMPLE SCANNED- BACKGROUND READINGS
30.0	7022 7023	17 27 40	14"				SAMPLE SCANNED- BACKGROUND READINGS.

NOTES:

DRILLER - HARRY DYMES
ASSISTANT - TIM HARRIS
RIG - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" OD

325

402-11-86

FERNALD RI/FS

DLG 2/4/89

1st Key In		
2nd Key In		
Hard Copy Verification		

PAC

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~266~~ 2006 BD	COORDINATES:	DATE: 8-27-87
ELEVATION:	GWL: Depth 19.5' Date/Time 8-28-87 8:00	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 5

DEPTH (IN)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31.5	7024	13 17 37	13	HARD GRAY CLAY, SOME SILT AND GRAVEL, TRACE ~~EE~~ SAND.	CL		SAMPLE SCANNED - BACKGROUND READINGS.
				HARD GRAY SILTY CLAY, TRACE GRAVEL AND SAND.	CL		
33.0	7025	5 7 10	10	VERY STIFF GRAY SILTY CLAY, TRACE SAND AND GRAVEL.	CL		SAMPLE SCANNED - BACKGROUND READINGS
34.5	7026	13 16 40	16	VERY DENSE STRONG BROWN SAND, TRACE GRAVEL AND SILT.	SP		SAMPLE SCANNED - BACKGROUND READINGS.
36.6	7027	14 51 REF 20	12	VERY DENSE STRONG BROWN SAND, TRACE GRAVEL.	SP		8-28-87 8:00 SAMPLE SCANNED - BACKGROUND READINGS
40.0							
41.5	7028	30 50 REF	9"	VERY DENSE STRONG BROWN SANDY GRAVEL, TRACE CLAY.	GP		SAMPLE SCANNED, BACKGROUND READINGS
45.0				HARD GRAY SILT, TRACE CLAY AND SAND.	ML		

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
R/6 - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" O.D.

326

402-11-86

FERNALD RI/FS

DLG 2/4/89

258

	Initial	Date
1st Keyin		
2nd Keyin		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~2066~~ 2066 BB 1-7-89	COORDINATES:	DATE: 8-31-87
ELEVATION:	GWL: Depth 39.45 Date/Time 8:10 8-31-87	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time 13:00 8-31-87	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 5

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46.5	7029	18 25 17	17	HARD GRAY SILT, TRACE CLAY AND SAND, LENS GRAY CLAY.	ML		8-31-87 8:10 SAMPLES SCANNED - BACKGROUND READINGS.
50.0							ADDED ~15 GAL. OF WATER TO HOLE.
51.5	7030	4 20 18	16	HARD GRAY CLAY, TRACE SILT	CL		SAMPLE SCANNED - BACKGROUND READINGS IN WATER ?.
				HARD GRAY SILT, SOME SAND, TRACE CLAY.	ML		
55.0							
56.5	7031 7032		18"	VERY STIFF GRAY SILT, SOME SAND, TRACE CLAY.	ML		SAMPLE SCANNED - BACKGROUND READINGS.
				VERY STIFF GRAY CLAY, SOME SAND, TRACE SILT.	CH		
				MEDIUM DENSE ~~SOFT~~ GRAY ~~SAND~~, TRACE CLAY, SOME SILT.	SM		WET SAND
60.0							

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
RIG - CYCLONE 42

SAMPLES TAKEN WITH STANDARD SPLIT SPOON SAMPLER - 2.0" O.D.

327

402-11-86

White correction was made by D. Oakley at the time this form was completed. WPK 4/24/89

DLO 2/4/89

FERNALD RI/FS

258

	Initials	Date
1st Review		
2nd Review		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~206~~ 2066 DO 1-5-89	COORDINATES:	DATE: 8-31-87
ELEVATION:	GWL: Depth 52.5 Date/Time 8/4/87 14:25	DATE STARTED: 8-25-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth 51.65 Date/Time 8/31/87 14:45	DATE COMPLETED: 8-31-87
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 5

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	7033	6	18	MEDIUM DENSE GRAY SAND, SOME SILT, TRACE CLAY.			
	7034	6					
61.5		10		VERY STIFF GRAY CLAY, TRACE SAND AND SILT.			
62.0							
63.0				63.0' TD			NEW TD 9-9-87

NOTES:

DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
RIG - CYCLONE 42

SPLIT SPOON SAMPLES TAKEN WITH STANDARD TUBE - 2.0" OD

328

402-11-86

FERNALD RI/FS

DLG 7/14/89

258

	Initial	Date
1st Review		
2nd Review		
Hard Copy Verification		

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D. OAKLEY DATE 9-23-87
PROJECT NO. 602 CHECKED BY R Calhoun DATE 2/7/89
BORING NO. ~~266~~ 2066 DB 1-5-5 T
PIEZOMETER NO. ~~266~~ 2066 DATE OF INSTALLATION 8-31-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 5 TO 62'
FLUID ~~NA~~ FROM NA TO NA

TYPE OF BIT FLAT HEAD HAMMER
CASING SIZE (S) USED: TEMPORARY
SIZE 12" FROM 0 TO 60'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE STAINLESS STEEL (316)
DIAMETER OF PERFORATED SECTION 4" ID
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .01 INCH
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 15'

RISER PIPE MATERIAL STAINLESS STEEL (316)
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE
(FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE ~~O~~.D. 10 INCHES

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY (NO CLAY)	TOP 2'	BOTTOM 38.5'	TOP	BOTTOM
BENTONITE PELLETS	TOP 38.5'	BOTTOM 44.0'	TOP	BOTTOM
SAND	TOP 44.0	BOTTOM 63'	TOP	BOTTOM
NO ~~GRAVEL~~ USED	TOP ~~NA~~	BOTTOM ~~NA~~	TOP	BOTTOM
PERFORATED SECTION	TOP 45'	BOTTOM 60'	TOP	BOTTOM
PIEZOMETER TIP	62' (SILT TRAP)			
BOTTOM OF BOREHOLE	63'			
GWL AFTER INSTALLATION	39'			

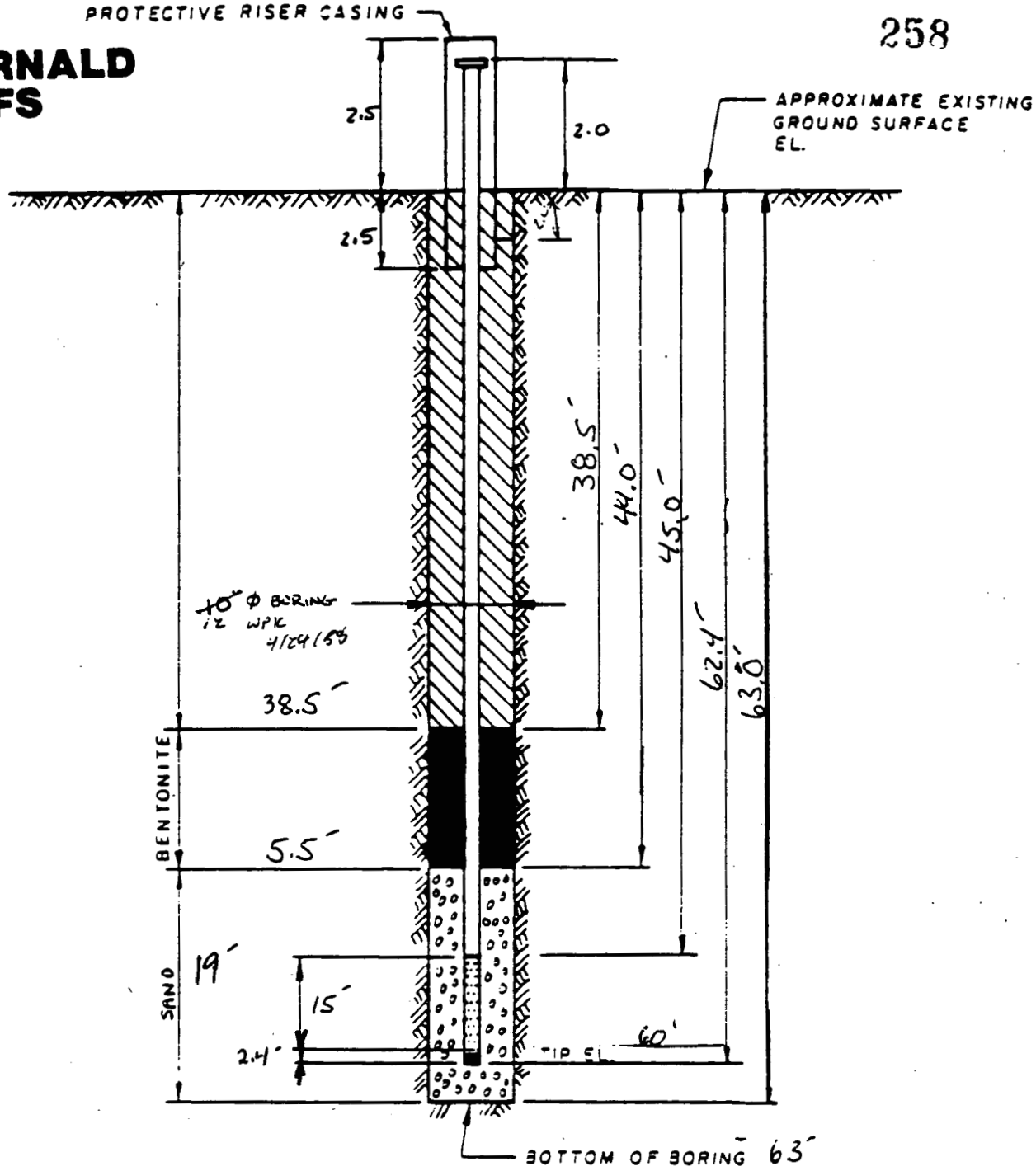
WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒ **329**
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS WELL TO BE DEVELOPED LATER.

White out corrections were made by D Oakley at the time this form was completed.

WELL #~~266~~ 2066 BB

258

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

while out correction was made by D Dudley at the time this form was completed.
WPK 4/24/89

INSTALLATION DETAILS
MONITORING WELL ~~266~~ 2066 BB 1-5-89

PREPARED FOR

FMPC RI/FS

330

DRAWING NUMBER	
CHECKED BY	APPROVED BY
D130	
DRAWN BY	

FERNALD RI/FS

DLG 2/4/88

	Initial	Date
1st Key In		
2nd Key In		
Verification		

PAC 258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 002	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~366~~ 3066 HB 1-5-89	COORDINATES:	DATE: 9-16-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth. Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 7

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
65				FOR DESCRIPTION OF SOILS FROM 0 – 62.0 ft SEE VISUAL CLASSIFICATION of soils from well 266.			
63.5	ST 7041	NA	24	62.0			SHELBY TUBE.
65							
66.5	7035 7036	6 ~~[illegible]~~ 23 ~~[illegible]~~ 50	14	HARD, GRAY SILT, SOME CLAY, - MOIST	ML		SAMPLE SCANNED – BACKGROUND READINGS.
70				68.5			ADDED 20 GALLONS WATER.
71.5	7037 7038	15 25 40	18	HARD GRAY SILTY CLAY - DRY	CL	2.25 TONS/FT²	SAMPLE SCANNED – BACKGROUND READINGS

NOTES: SEE LOG FROM WELL # 266 FOR DESCRIPTION OF FIRST 62'.

RIG - CYCLONE #2
DRILLER - HARRY LYTES
ASSISTANT - TIM HARRIS

BACKGROUND READINGS
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

402-11-86

FERNALD RI/FS

DLG 3/4/K-1

	Initial	Date
Log Check		
Log Key In		
Data Comp.		

PAC 258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI FS	
BORING NUMBER: ~~3066~~ 3056 B13	COORDINATES:	DATE: 9-16-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 7

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
70.5	7039 7040	8 15 19	16	HARD GRAY SILTY CLAY - MOIST	CL	1.5	SAMPLE SCANNED - BACKGROUND READINGS.
80				79.5			ADDED 25 GALLONS WATER.
81.5	7042 7043	11 22 31	18	HARD GRAY CLAY, TRACE SILT, - DRY	CL	3.0	SAMPLE SCANNED - BACKGROUND READINGS.
85				84.0			
87.5							
89	7044 7045	6 15 14	18	MEDIUM DENSE GRAY FINE SAND - WET 88.5	SP	.20	SAMPLE SCANNED - BACKGROUND READINGS.
				GRAY CLAY, SOME SAND, TRACE SILT 89.3	CL		

NOTES: SEE LOG FROM WELL #266 FOR DESCRIPTION OF FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY CYRUS
ASSISTANT - TIM HARRIS

BACKGROUND READINGS
HNU - 2 GIZO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

332

402-11-86

FERNALD RI/FS

DLS 2/4/19

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 002	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~3~~ 3066 BB	COORDINATES:	DATE: 9-17-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. DARTLEY	Depth Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 7	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS 7:30 9-17-87
91.5	7046 7047	7 9 11	18	MEDIUM DENSE DARK GRAY CINS GRAINED SAND, TRACE CLAY AND SILT - WET. 91.4	SP	.20	SAMPLE SCANNED - BACKGROUND READINGS.
				GRAY CLAY, TRACE SAND AND SILT 92	CL		ADDED 25 GALLONS WATER.
95				DARK GRAY FINE GRAINE SAND. 94.5	SP		
96.5	7048	30 50REF	8	~~DRY~~ HARD GRAY CLAY, SOME SILT, TRACE SAND - DRY	CL	2.5	SAMPLE SCANNED - BACKGROUND READINGS.
100				99			ADDED 20 GALLONS WATER.
101.5	7049	9 14 25	13	HARD GRAY SILT, SOME CLAY, TRACE SAND - DRY	ML	.75	SAMPLE SCANNED - BACKGROUND READINGS
							ADDED 20 GALLONS WATER.

NOTES: SEE LOG FROM WELL #266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYMES
ASSISTANT - TIM HARRIS

BACKGROUND READINGS
HNU - @ ZERO
ALPHA - 0 COUNTS/MIN
BETA/GAMMA - 40-80 COUNTS/MIN.

333

402-11-86

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~366~~ 3066	COORDINATES:	DATE: 9-17-87	
ELEVATION:	GWL: Depth / Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth / Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 7	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106.5	7050 7051	27 50 REF. 50	16	HARD GRAY SILTY CLAY, TRACE SAND - DRY	CL	3	SAMPLE SCANNED - BACKGROUND READINGS
110							ADDED 25 GALLONS WATER.
111.5	7052 7053	11 24 43	18	HARD DRY SILTY CLAY	CL	2.5	SAMPLE SCANNED - BACKGROUND READINGS
113.5	ST 7054	NA	23				SHELBY TUBE
115							ADDED 20 GALLONS WATER.
116.5	7055	11 16 23	12	HARD GRAY SILTY CLAY - DRY	CL	2.5	SAMPLE SCANNED - BACKGROUND READINGS
							7:30 9-18-87

NOTES: SEE LOG FROM WELL #266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY OYNES
ASSISTANT - TIM HARRIS

BACKGROUND READINGS
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

334

402-11-86

FERNALD RI/FS

DLG 3/4/89

258

	Initial	Date
Data Entry		
Data Review	DL	1/1/88
Hard Copy Verification		

PAC

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~366~~ 3066 DD-349	COORDINATES:	DATE: 9-18-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: D. SAKLEV	Depth Date/Time	DATE COMPLETED: 9-19-87	
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 7	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	7056	12	18	HARD GRAY CLAY, TRACE SILT - MOIST	CL	2.0	SAMPLE SCANNED - BACKGROUND READINGS
	7057	10		DENSE GRAY SAND, SOME CLAY - MOIST	SP	1.0	
121.5		21		DENSE DARK GRAY SAND, SOME CLAY, TRACE GRAVEL - MOIST	SW	0.5	
125							
	7058	16	18	VERY DENSE GRAY SAND, TRACE GRAVEL, TRACE CLAY - WET, MEDIUM GRAIN SIZE.	SW	0.2	SAMPLE SCANNED - BACKGROUND READINGS
126.5	7059	25 50					
130							WELL MAKING LARGE AMOUNTS OF WATER. - 55' WATER IN CASING.
	7060	17	18	VERY DENSE GRAY COARSE SAND, SOME GRAVEL - WET	SW	0.3	SAMPLE SCANNED - BACKGROUND READINGS
131.5	7061	38 46					
							ADDED 25 GALLONS WATER.

NOTES: SEE LOG FROM WELL # 266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS
SCREEN SET FROM 125-135'.

BACKGROUND
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

335

402-11-86

FERNALD RI/FS

DLG 2/4/14

258

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~366~~ 3066 DB	COORDINATES:	DATE: 9-18-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. CAHLEY	Depth Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL		PAGE 6 OF 7

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136.5	7062	11 17 31	8	VERY DENSE GRAY SAND-WET MEDIUM GRAIN SIZE	SP	0.2	FIRST SPLIT SPOON EMPTY. PUT IN TRAP. SAMPLE SCANNED-BACKGROUND READINGS.
140				139			
141.5	7063 7064	9 18 19	18	HARD ~~GRAY~~ DARK GRAY SANDY CLAY, TRACE SILT - MOIST	CL	1.0	SAMPLE SCANNED-BACKGROUND READINGS
145							
146.5	—	17 50 50	0				~~AS~~ TWO ATTEMPTED SPLIT SPOONS WERE EMPTY.
148							
149.5	7065 7066	21 31 35	15	GRAY SANDY CLAY - MOIST 148.5 HARD, GRAY CLAY, SOME SILT - MOIST	CL	.75	SAMPLE SCANNED-BACKGROUND READINGS

NOTES: SEE LOG FROM WELL #266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS

BACKGROUND
HNU - ZERO
ALPHA - 0 COUNTS/MIN.
BETA/GAMMA - 40-80 COUNTS/MIN.

336

402-11-86

write out correction was made by D. Oakley 258 at the time this form was completed 4/24/89

DLG 2/4/94

	Initial	Date
1st Keyin		
2nd Keyin		
Hard Copy		
Verification		

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~366~~ 306 BB 1-5-89	COORDINATES:	DATE: 9-19-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 9-19-87
DRILLING METHODS: CABLE TOOL		PAGE 7 OF 7

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
150							
152	ST-7067	NA	20	HARD, GRAY SILTY CLAY, MOIST. SAMPLE TD 152 ft.			SHELBY TUBE DESCRIPTION based on previous sample and classification of soils observed at ends of tube

NOTES: SEE LOG FROM WELL # 266 FOR FIRST 62'.

RIG - CYCLONE 42
DRILLER - HARRY DYKES
ASSISTANT - TIM HARRIS

~~BAR PROBING~~ (V)

HOLE TD 150' - SHELBY TAKEN FROM 150 TO 152' - APPARENTLY IN SILT AND CLAY.

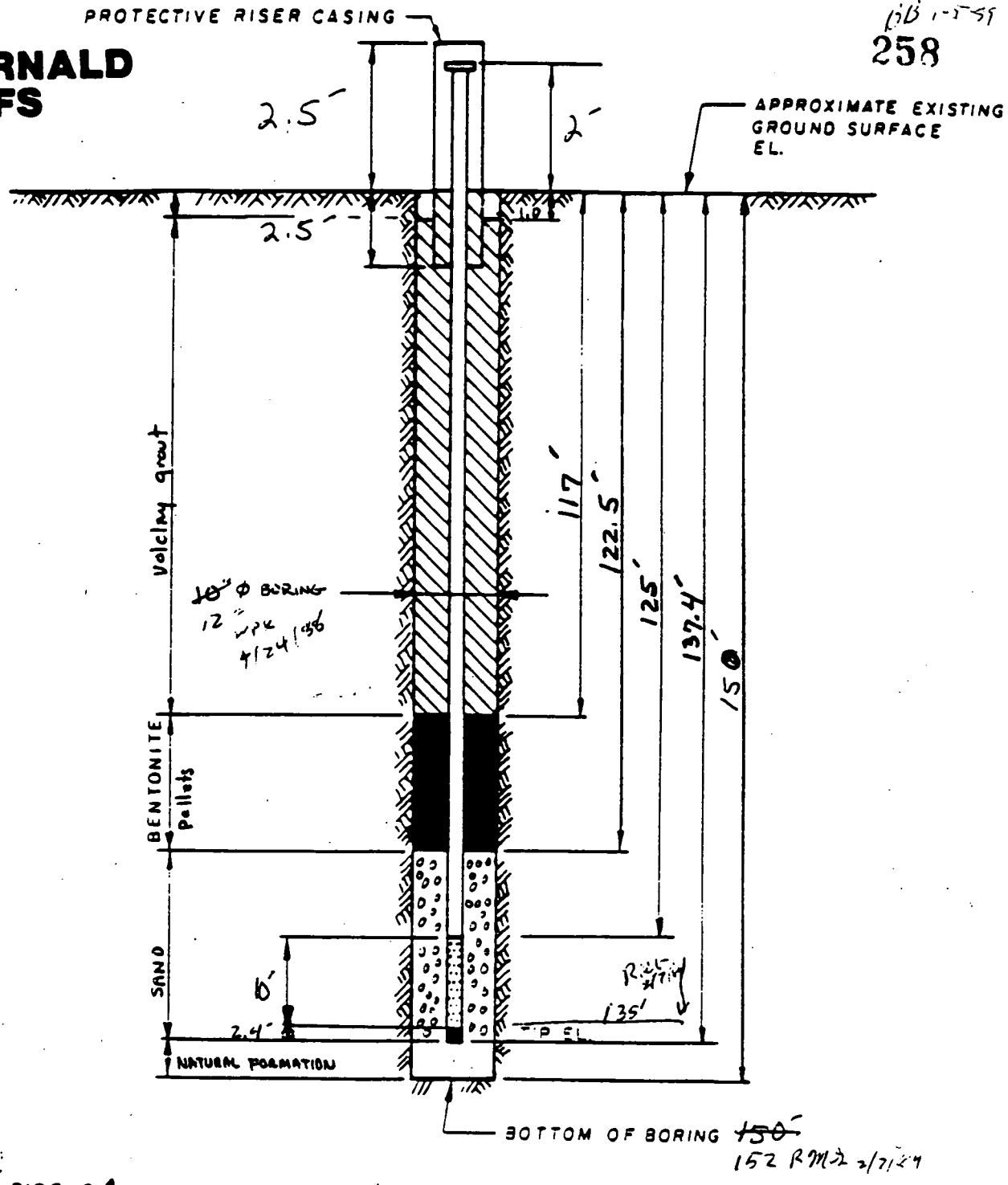
337

402-11-86

WELL # ~~366~~ 3066

258

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DBO

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. S.S. PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~366~~ 3066 BB 1-5-89

PREPARED FOR

FMPC RI/FS

338

FERNALD RI/FS

258

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS
PROJECT NO. 602
BORING NO. 366 ~~366~~ DH ...-89
PIEZOMETER NO. ~~366~~ 366

FIELD ENG./GEO. D. OAKLEY DATE 9-22-87
CHECKED BY R Galbraith DATE 2/7/89
DATE OF INSTALLATION 9-22-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM .5' TO ~~[illegible]~~ 132'
FLUID — FROM — TO —

TYPE OF BIT FLAT HEAD HAMMER
CASING SIZE (S) USED: TEMPORARY
SIZE 10" FROM 0 TO 150'
SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE 316 STAINLESS steel monitoring well
DIAMETER OF PERFORATED SECTION 4" ID
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010 inch
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 15'

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD ~~AND COUPLE~~ RWG 2/7/
(FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE O.D. 10 INCHES

OTHER PROTECTION LOCKABLE CAP

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY VOLCLAY	TOP 1'	BOTTOM 117'	TOP	BOTTOM
BENTONITE PELLETS	TOP 117'	BOTTOM 122.5'	TOP	BOTTOM
SAND	TOP 122.5'	BOTTOM 137.4'	TOP	BOTTOM
FORMATION	TOP 137.4'	BOTTOM 152	TOP	BOTTOM
PERFORATED SECTION	TOP 125'	BOTTOM 135'	TOP	BOTTOM
PIEZOMETER TIP	137.4			
BOTTOM OF BOREHOLE	152'			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

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REMARKS SHELBY TUBE TAKEN FROM 150' - 152'

WELL TO BE DEVELOPED LATER.

while corrections were made by D. Oakley at the time this form was completed
4/24/88 WPC

409-11-86

FERNALD RI/FS

JD 2-4-89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2		
BORING NUMBER: 1072	COORDINATES:	DATE: 3-6-88	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/06/88	
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 03/15/88	
DRILLING METHODS: Cable Tool		PAGE 1 OF 4	

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	08 1 88	3 5 7	12"	Very STIFF light olive Brown clay (2.5Y 5/4) DRY 1.5ft	2.5	CL	Hnu=0 α=0 γB=120 1035
2 3	08 1 88	3 6 6	14"	STIFF Dark grayish Brown clay (10YR 4/2) DRY 3 Ft	2.0	CL	Hnu=0 α=0 γB=100 1045
4	08 1 90	9 13 14	14"	STIFF yellowish Brown clay (10YR 5/6) DRY Trace sand & silt	1.5	ML	Hnu=0 α=0 γB=120 1050
5 6	08 1 90	14 34 43	18"	Very STIFF Yellowish Brown clay (10YR 5/6) Trace sand and silt 6 Ft	2.5	ML	Hnu=0 α=0 γB=120 1055
7	08 1 92	NA	12"	Shelby Tube 7 Ft	N/A	N/A	Hnu= α= 1600
8 9	08 1 93	2 3 2	12"	STIFF Yellowish Brown clay (10YR 5/6) wet 9 Ft	2.0	CI	Hnu=0 α=0 γB=140 very plastic 1635
10	08 1 94	3 4 3	18"	Very SOFT yellowish Brown clay (10YR 5/4) WET 10.5 Ft	<1	CH	Hnu=0 α=0 γB=160 Very plastic 1640
11 12	08 1 95	13 16 23	18"	Very STIFF yellowish BROWN clay (10YR 5/8) DRY 12 Ft.	2.5	CL	Hnu=0 α=0 γB=150 3/7/88 0850
13	08 1 96	20 23 26	18"	Very STIFF Reddish Brown clay (5YR 4/4) Trace gravel DRY 14 Ft	2.5	CL	Hnu=0 α=0 γB=150 0900
14 15	08 1 97	11 12 16	18"	STIFF gray clay (5Y 5/1) DRY Trace gravel	1.5	CL	Hnu=0 α=0 γB=130 0935

Drilling Contractor: Pennsylvania Drilling
Driller: Tim Harris
Helper: Craig Coulter

III Water used ≈ 400 gallons

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II) Background measurements
a) Hnu = 0 B) α = 0 c) γB = 120cpm

IV Samples via Munsell Color Chart

N/A = not Applicable

FERNALD RI/FS

2-4-89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2	
BORING NUMBER: ~~[illegible]~~ 1072	COORDINATES:	DATE: 3-7-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 3-6-88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 3-15-88
DRILLING METHODS: Cable Tool		PAGE 2 OF 4

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16	08198	3 5 7	12"	STIFF gray clay (5Y 5/1) DRY trace gravel	1.5	CL	Hnu = 0 α = 0 δB = 130 0940
17	08199	6 7 9	18"	Medium STIFF gray clay (5Y 5/1) Dry trace gravel	1.0	CL	Hnu = 0 α = 0 δB = 120 0945
18 19	08200	2 6 6	18"	Soft gray clay (5Y 5/1) Dry Trace gravel	<1	CL	Hnu = 0 α = 0 δB = 140 1410
20 21	08201	6 7 12	18"	Soft gray clay (5Y 5/1) DRY Trace gravel	<1	CL	Hnu = 0 α = 0 δB = 140 1417
22 23	08202	NA	24"	SHELBY Tube	NA	NA	~~Hnu~~ = ~~α~~ = ~~δB~~ = ~~Hnu~~ = 1555
24	08203	3 6	12"	medium STIFF gray clay (5Y 5/1) DRY trace gravel	1.0	CL	α = 0 Hnu = 0 δB = 140 ~~Hnu~~ 1635
25	08204	5 6 13	12"	Medium STIFF Dark gray clay (5Y 5/1) Dry trace gravel			Hnu = 0 α = 0 δB = 110 03/08/88 0850
26 27	08205	3 4 6	10"	STIFF Dark gray clay (5Y 5/1) DRY Trace gravel	1.5	CL	Hnu = 0 α = 0 δB = 100 0915
28	08206	4 6 18	16"	STIFF Dark gray clay (5Y 5/1) DRY Trace gravel.	1.5		Hnu = 0 α = 0 δB = 100 1020
29 30	08207	22 30 41	18"	Hard Dark gray clay (5Y 5/1) DRY Trace gravel. Blue gravel and clay STRINGERS	4.0	CL	Hnu = 0 α = 0 δB = 120 Bright Blue Traces of clay 1105

NOTES:

FERNALD RI/FS

LJ 2-4-89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T 3.2	
BORING NUMBER: ~~179~~ 1072	COORDINATES:	DATE: 3-8-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/06/88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 3-15-88
DRILLING METHODS: Cable Tool		PAGE 3 OF 4

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30							
31	08208	12 22 41	18"	Very STIFF Dark olive grey clay (5Y 3/2) Abundant Gravel, DRY.	3.5	CL	Hnu = 0 α = 0 ⊗B = 100 1425
32	08209	12 22 38	18"	Very STIFF Yellowish Brown silty clay (10YR 6/8) DRY 32 Ft	2.5	CL	Hnu = 0 α = 0 ⊗B = 100 1600
33				Dense Yellowish Brown sand (10YR 6/6) dry 32.75 Ft	<1	SW	
34							
35							
36							
37							
38	08210	17 31 37	18"	Very Dense Yellowish Brown sand (10YR 6/6) DRY	<1	SW	Hnu = 0 α = 0 ⊗B = 140 03/09/88 0930
39							
40							
41							
42							
43	08211	26 28 34	18"	Very Dense Yellowish Brown sand (10YR 6/6) DRY. Trace gravel.	<1	SW	Hnu = 0 α = 0 ⊗B = 160 1035
44							
45							

NOTES:

FERNALD RI/FS

2-4-89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS T3.2	
BORING NUMBER: 1072	COORDINATES:	DATE: 3-8-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 03/06/88
ENGINEER/GEOLOGIST: M. Goldberg	Depth Date/Time	DATE COMPLETED: 3-15-88
DRILLING METHODS: Cable Tool		PAGE 4 OF 4

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ( )	RECOVERY ( )	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45							
46							
47							
48							
49	B 2 1/2	10 28 50 30	20"	Very Dense yellowish Brown sand (10YR 6/6) DRY trace gravel	SW		Hnu = 0 α = 0 GB = 140cpm 1115
50				Bottom of Boring 50 FT			

NOTES:

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FERNALD RI/FS

2-4-89

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS
PROJECT NO. 602
BORING NO. ~~172~~ 1072 BB 1-5-59
PIEZOMETER NO. N/A 1072

FIELD ENG./GEO M. Goldberg DATE 03/15/88
CHECKED BY R Coalbrunith DATE 4/7/89
DATE OF INSTALLATION 03/15/88

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 3 TO 50ft
FLUID — FROM — TO —

TYPE OF BIT Flat Head
CASING SIZE (S) USED:
SIZE 10" FROM 3ft TO 50ft
SIZE — FROM — TO —

PIEZOMETER DESCRIPTION

TYPE Monitoring
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010" inches
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 Feet

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4" inches
LENGTH OF PIPE SECTIONS 10 Ft
JOINING METHOD ~~Thread and couple~~ Flush Jointed Rivet. 2/7/89

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Ft
PROTECTIVE PIPE O.D. 10" inches

OTHER PROTECTION Lockable cap

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.0 Ft			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 Ft			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 10Ft	TOP	BOTTOM
BENTONITE	TOP 10 Ft	BOTTOM 14ft	TOP	BOTTOM
~~SAND~~	TOP N/A	BOTTOM N/A	TOP	BOTTOM
GRAVEL	TOP 14 Ft	BOTTOM 31 Ft	TOP	BOTTOM
PERFORATED SECTION	TOP 19 Ft	BOTTOM 29 Ft	TOP	BOTTOM
PIEZOMETER TIP	31 ft			
BOTTOM OF BOREHOLE	31 ft			
GWL AFTER INSTALLATION	N/A			

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WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS Well 172 was overdrilled to 50 ft to determine Lithology. A Volclay plug was set from 50ft → 36ft with a 5Ft Bentonite Plug from 36ft → 31ft to seal Till/sand contact @ 33Ft.

409-11-86

87
2-4-89 Monitoring Well #172 1072 BC

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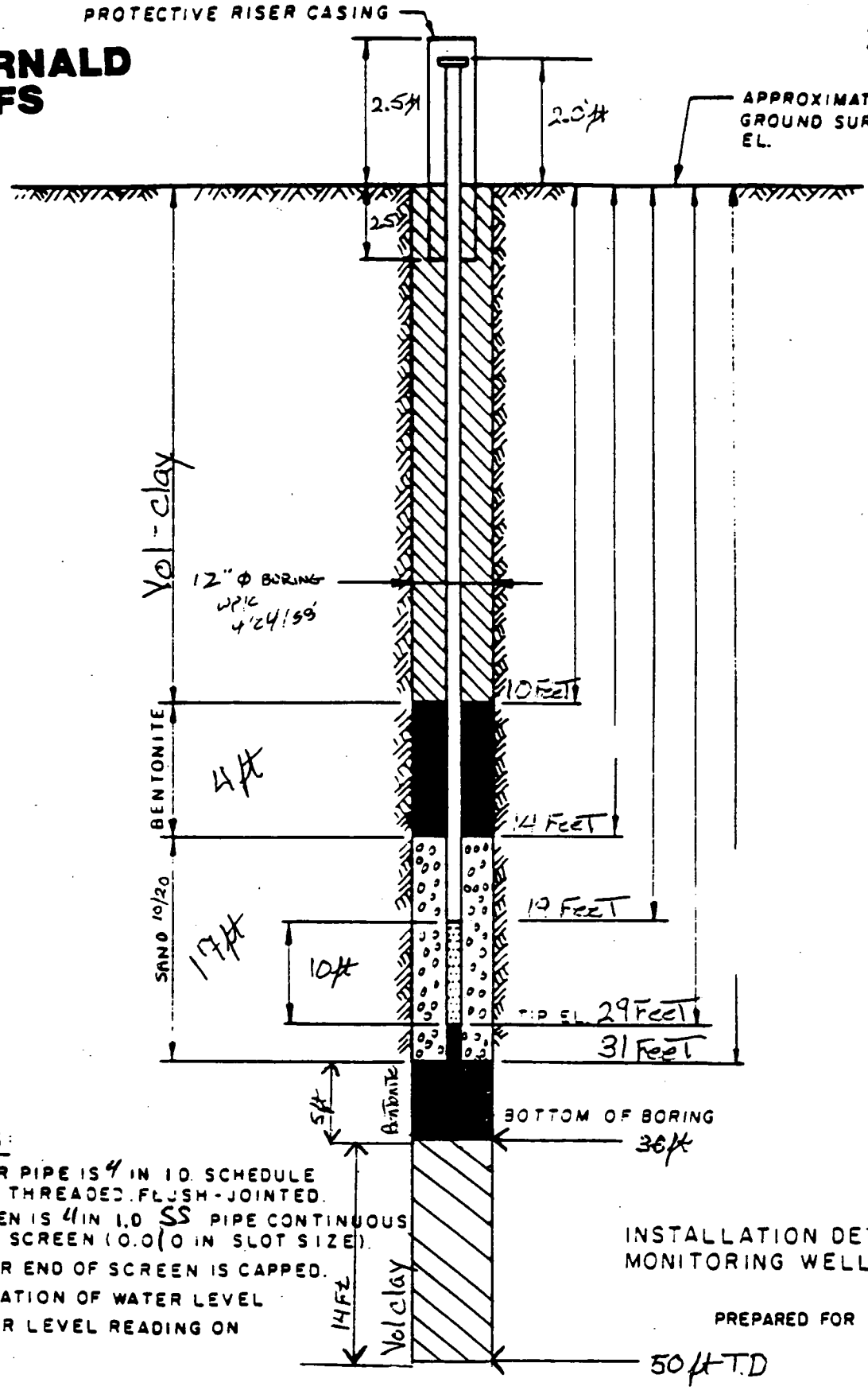
FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL

PREPARED FOR FMPC RI/FS

DRAWING NUMBER
CHECKED BY
APPROVED BY
DRAWN BY

FERNALD RI/FS

DLG 2/4/89

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~174~~ 1074 BB 1-E-89	COORDINATES:	DATE: 04-13-89
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 04-12-89
ENGINEER/GEOLOGIST: M. SLUSARSKI	Depth Date/Time	DATE COMPLETED: 04-13-89
DRILLING METHODS: Cable Tool		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 (FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	08463 0940 04-12	3 7 18	12	VERY STIFF YELLOW-BROWN (10YR 5/3) CLAY, SOME SILT, ROOTLETS, DRY	CL	4.0	HNU = 0 α = — BS = 140 CPM
2 3	08464 0952 04-12	7 23 26	14	VERY STIFF, YELLOW-BROWN (10YR 5/3) CLAY SOME SILT, SOME FINE GRAVEL, DRY	CL	4.0	HNU = 0 α = — BS = 140 CPM
4	08465 0957 04-12	25 35 31	14	VERY STIFF, YELLOW-BROWN (10YR 5/3) CLAY SOME SILT, SOME FINE GRAVEL, DRY	CL	4.0	HNU = 1 PPM α = — BS = 140 CPM
5 6	08466 1003 04-12	32 35 32	18	VERY STIFF, YELLOW-BROWN (10YR 5/4) CLAY SOME SILT, SOME FINE GRAVEL, DRY	CL	3.5	HNU = 1 PPM α = — BS = 140 CPM
7	08467 1011 04-12	28 32 32	18	VERY STIFF, YELLOW-BROWN (10YR 5/4) CLAY SOME SILT, SOME FINE GRAVEL, TRACE COARSE GRAVEL (~.5 IN) DRY	CL	3.5	HNU = 0 α = — BS = 140 CPM
8 9	08468 1018 04-12	33 37 47	18	VERY STIFF, YELLOW-BROWN (10YR 5/4) SOME CLAY SILT, SOME FINE GRAVEL, TRACE COARSE GRAVEL (~.5 IN) DRY 85	CL	3.5	HNU = 0 α = — BS = 140 CPM
10 11	08469 1500 04-12			VERY STIFF (5Y 4/1) GREY, CLAY, SOME FINE GRAVEL, DRY PUSHED SHELBY TUBE FROM 9.0 FT TO 11.0 FT RECOVERED 1.5 FT			HNU = 0 α = — BS = 140 CPM
12	08470 1539 04-12	9 10	12	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE GRAVEL, WET	CL	1.5	HNU = 0 α = — BS = 120 CPM
13	08471 1620 04-12	23 17 15	4	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE GRAVEL, TRACE COARSE GRAVEL (~.5 - 1.0 IN) WET	CL	1.5	HNU = 0 α = — BS = 120 CPM
14	08472 1630 04-12	2 3 4	12	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE GRAVEL, WET	CL	1.5	HNU = 0 α = — BS = 120 CPM

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NOTES: CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOHN VANDINE

SAMPLES COLLECTED AS PER ASTM STANDARD PENETRATION TEST
COLORS IDENTIFIED USING MUNSELL COLOR CHART
BACKGROUND LEVELS: HNU = 0 LEL O_2 = 0 PPM LEL α = — 20.6% O_2 BS = 140 CPM

WATER ADDED TO HOLE: 200 GALLONS

402-11-88

FERNALD RI/FS

DLC 2/4/89

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	Initials	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3 2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~174~~ 1074 BB 1-554	COORDINATES:	DATE: 04-13-88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 04-12-88
ENGINEER/GEOLOGIST: M. SLUSARSKI	Depth Date/Time	DATE COMPLETED: 04-13-88
DRILLING METHODS: Cable tool		PAGE 2 OF 2

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	08473 1647 04-12	4 5 6	4	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE GRAVEL, TRACE COARSE GRAVEL (~.5-1.0 IN) WET	CL	1.5	HNU = 0 α = — BS = 120 CPM
17 18	08474 1650 04-12	4 9 10	10	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE SAND, SOME FINE GRAVEL, WET 18.5	CL	1.5	HNU = 0 α = — BS = 120 CPM
19	08475 1717 04-12	5 5 7	6	STIFF, GREY (5Y 5/1) CLAY, SOME FINE GRAVEL, DRY 19.5	CL	2.0	HNU = 2-3 PPM α = — BS = 120 CPM
20 21	08476 1731 04-12	4 7 13	14	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE SAND, DRY	CL	1.5	HNU = 0 α = — BS = 120 CPM
22	08477 0951 04-13	7 6 8	6	STIFF, GREY (5Y 5/1) SILTY CLAY, SOME FINE SAND, TRACE FINE GRAVEL, DRY 22.5	CL	1.5	HNU = 0 α = — BS = 120 CPM
23 24	08478 1001 0443	5 5 6	14	STIFF GREY (5Y 5/1) CLAY, SOME SILT AND FINE GRAVEL, TRACE FINE SAND, DRY	CL	1.5	HNU = 0 α = — BS = 120 CPM
25 26 27 28 29				BOTTOM OF BORING @ 24.0 FT.			

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NOTES:

402-11-86

DLG 2/4/89

BORING # ~~174~~ 1074

BB 1-5-89

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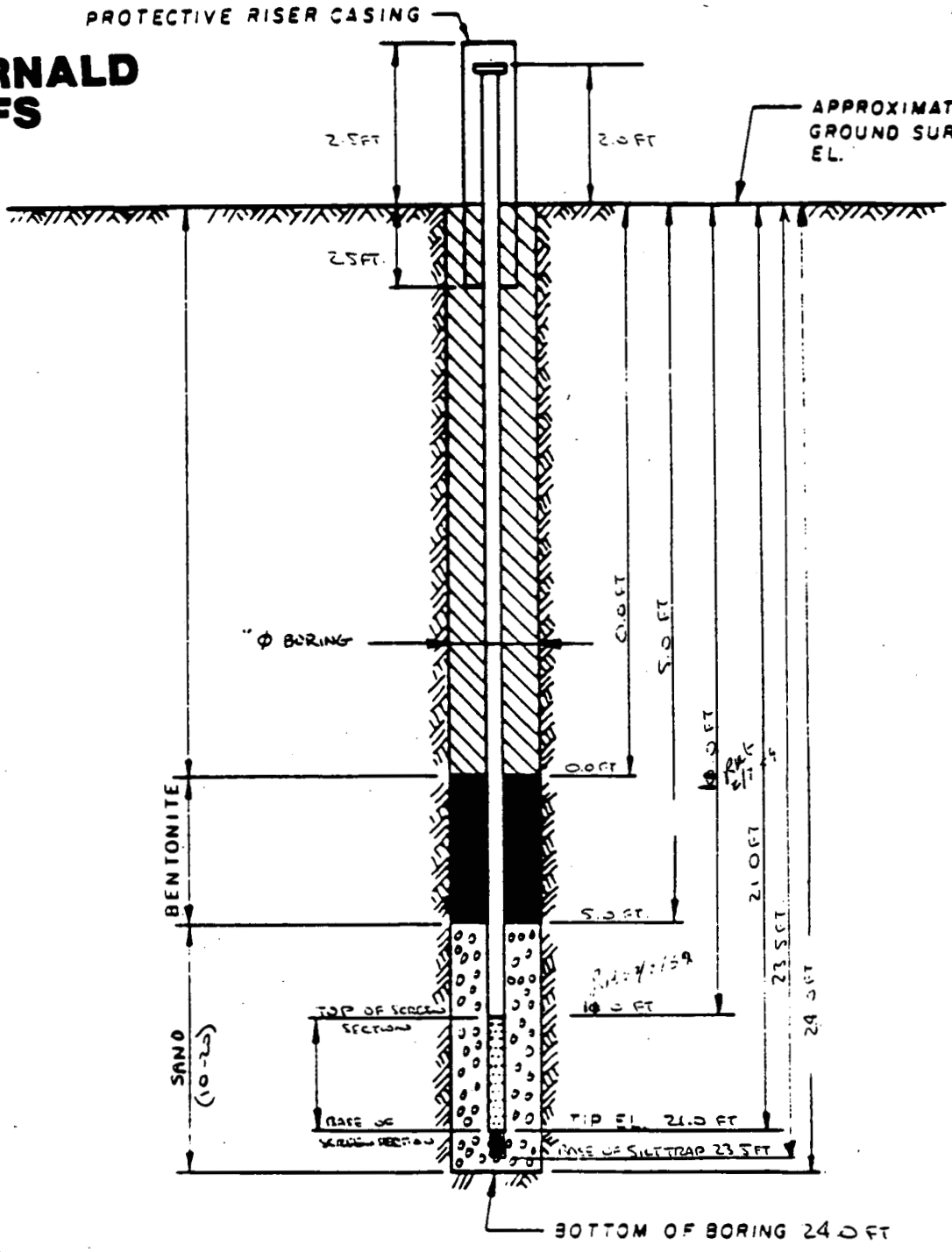
FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL
04-13-88
PREPARED FOR
BORING # ~~174~~ 1074

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BB 1-5-89

MATERIALS USED: 10-20 SAND (100LB SACKS): 8 SACKS
BENTONITE: 5 BUCKETS

FERNALD RI/FS

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PIEZOMETER INSTALLATION SHEET

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. M. SLUSARSKI DATE 04-13-88
PROJECT NO. 602 3.2 CHECKED BY R Colbert DATE 2/7/89
BORING NO. ~~174~~ 1074 OB 1-5-89
PIEZOMETER NO. ~~174~~ 1074 DATE OF INSTALLATION 04-13-88

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT HAMMER
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID WATER FROM 0.0 FT. TO 24.0 FT	SIZE 10" ID FROM 0.0 FT TO 24.0 FT
FLUID ____ FROM ____ TO ____	SIZE ____ FROM ____ TO ____

PIEZOMETER DESCRIPTION

TYPE MONITORING WELL	RISER PIPE MATERIAL STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4" ID	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 IN I.D. 4.0 IN
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS ____
AVERAGE SIZE OF PERFORATIONS 0.010	JOINING METHOD SCREW TYPE
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 FT	FLUSH JOINT THREADED

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 FT.	OTHER PROTECTION LOCKING CAP
PROTECTIVE PIPE O.D. 10 3/4 IN	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.5			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP N/A	BOTTOM N/A	TOP	BOTTOM
BENTONITE	TOP 0.0 FT.	BOTTOM 5.0 FT	TOP	BOTTOM
SAND	TOP 5.0 FT	BOTTOM 24.0 FT.	TOP	BOTTOM
GRAVEL	TOP N/A Rev. 2/7/89	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 10.0 FT.	BOTTOM 21.0 FT	TOP	BOTTOM
PIEZOMETER TIP	23.5			
BOTTOM OF BOREHOLE	24.0			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

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REMARKS

409-11-86

write out corrections were made by D. Oakley GLI/DH/2.4.88
[illegible] this form was completed.
WDIL 4/24/88

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

WDL 4/24/88
BIG #2

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 125 11.79 88 1-50	COORDINATES:	DATE: 10.19.87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10.19.87	
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 10.20.87	
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 3	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 ft	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				0 YELLOW BROWN SILT, TRACE GRAVEL AND CLAY - DRY	ML		MUNSELL 10YR 5/4
1.5	7369	5 13 17	13	HARD, VERY PALE BROWN CLAY, TRACE SILT AND TRACE SAND - DRY	CL	4.5+	MUNSELL 10YR 7/4 SAMPLE SCANNED AT BACKGROUND
3.0	7370	26 24 33	18	HARD, LIGHT YELLOWISH BROWN CLAY AND SILT, TRACE SAND - DRY	CL ML	4.5+	MUNSELL 10YR 6/4 SAMPLE SCANNED - AT BACKGROUND
4.5	7371	50 REF	4	HARD, LIGHT YELLOWISH BROWN CLAY, SOME SILT AND SAND, TRACE GRAVEL - DRY	CL	4.5+	MUNSELL 10YR 6/4 SAMPLE SCANNED - AT BACKGROUND
				4.6 "			
6.0	7372	8 11 13	14	MEDIUM STIFF GRAY SILT, TRACE CLAY AND SAND - DRY	ML	4.5+	MUNSELL 5Y 6/1 SAMPLE SCANNED - AT BACKGROUND
				5.5 MEDIUM STIFF LIGHT YELLOWISH BROWN 6.0 CLAY, TRACE SILT, GRAVEL, AND SAND - DRY	CL	3.5	MUNSELL 10YR 6/4
				6.2 GRAY GRAVEL AND SILT, TRACE SAND AND CLAY.	GM		1ST SPOON EMPTY
7.5	7373	8 6 8 15 3 7	12	MEDIUM STIFF GRAY SILT, TRACE CLAY AND SAND - DRY	ML	NK	SAMPLE SCANNED - AT BACKGROUND
9.0	7374	6 8 13	14	MEDIUM STIFF GRAY SILT, SOME CLAY, TRACE SAND - DRY	ML	2.0	SAMPLE SCANNED - AT BACKGROUND
				8.8 GRAVEL AND			
				MEDIUM STIFF, OLIVE CLAY, SOME SILT DRY	CL		MUNSELL 5/3
10.5	7375	5 6 8	16	STIFF YELLOWISH RED CLAY, TRACE SILT, 9 - DRY / WOOD FRAGMENTS	CL	1.25	MUNSELL 5YR 5/8 SAMPLE SCANNED AT BACKGROUND.
				10.0 0.3 STIFF GRAY SILT, SOME CLAY - MOIST	ML	.1	MUNSELL 5Y 5/1
				LIGHT YELLOWISH BROWN SILT, TRACE SAND AND CLAY.	ML	.1	MUNSELL 10YR 6/4
12.0	7376	5 6 8	18	STIFF REDDISH YELLOW CLAY - TRACE SILT AND SAND - DRY	CL	1.75	MUNSELL 7.5YR 6/8 SAMPLE SCANNED - AT BACKGROUND.
				11.5 GRAY CLAY SOME SILT TRACE SAND - DRY	CL		MUNSELL 5Y 5/1
				12.2 OLIVE GRAY SILT, TRACE GRAVEL AND SAND - MOIST	ML		MUNSELL 5Y 5/2
13.5	7377	2 10 12	10	MEDIUM DENSE OLIVE YELLOW SAND, SOME GRAVEL, SOME CLAY, TRACE SILT	SC	.2	MUNSELL 2.5Y 5/4 SAMPLE SCANNED - AT BACKGROUND.
				13.6 PALE OLIVE CLAY, TRACE SILT, GRAVEL, SAND. MOIST	CL	-	MUNSELL 5Y 6/3
15.0	7378	8 10 15	12	VERY STIFF LIGHT YELLOWISH BROWN GRAVEL, SOME CLAY, TRACE SILT AND SAND MOIST	GC	-	SAMPLE SCANNED - AT BACKGROUND
				14.7 LIGHT OLIVE BROWN CLAY, SOME SILT TRACE SILT, MOIST	CH	-	

NOTES:

216 - CYCLONE 42
DRILLER - HARRY DYKES JR
ASSISTANT - JOE BARLE
JOHN VAUGHNE
WATER ADDED TO HOLE - TILL = 5 GALLONS
HHH

BACKGROUND
HNU - ZERO
LEL - ZERO
ALPHA - ZERO
BETA/GAMMA - 40-80 COUNTS/MIN.

350

402-11-86

GCY DH/2.4.88

FERNALD RI/FS

258

1st Key In
2nd Key In
Hard Copy Verification

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 1079	COORDINATES:	DATE: 10.19.87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10.19.87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 10.20.87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 3

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16.5	7379	10 16 27	12	15.5 GRAY CLAY, SOME SILT, TRACE SAND. HARD, GRAY CLAY, SOME GRAVEL, TRACE SILT AND SAND, MOIST	CL CL	1.25	MUNSELL 5Y 5/1 MUNSELL 2.5Y N/6 SAMPLE SCANNED AT BACKGROUND 730 10.2
18.0	7381 7380	2 1 13	10	VERY STIFF, LIGHT GRAYISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST	CH	.25	ST 7380 FULL RIX. MUNSELL 2.5Y 6/2
19.5	7382	2 6 10	5	VERY STIFF, LIGHT GRAYISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST	CL	2.0	MUNSELL 2.5Y 6/2
21.0	7383	10 12 20	13	HARD, LIGHT GRAYISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - WET	CL	1.25	MUNSELL 2.5Y 6/2
22.5	7384	5 10	3	STIFF LIGHT YELLOWISH BROWN CLAY SOME GRAVEL, TRACE SILT AND SAND - WET	CH		1ST BARREL EMPTY MUNSELL 2.5Y 6/2
24.0	7385	4 6 9	15	STIFF, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SAND AND SILT - WET	CH	1.25	MUNSELL 2.5Y 6/2 LESS GRAVEL THAN PREV. SAMPLES.
25.5	7386	4 6 15	18	STIFF, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST	CH	1.25	MUNSELL 2.5Y 6/2
27.0	7387	5 20 48	13	STIFF LIGHT YELLOWISH BROWN CLAY, WET SOME GRAVEL, TRACE SAND AND SILT VERY DENSE, GRAY GRAVEL, SOME SAND, TRACE CLAY AND SILT - WET	CH GC	1.0	MUNSELL 2.5Y 6/2 MUNSELL 2.5Y N5/1
28.5	7388	34 20 29	15	DENSE, LIGHT YELLOWISH BROWN, WET GRAVEL, SOME SAND, TRACE CLAY	GC		MUNSELL 2.5Y 6/2
30.0	7389	10 17 35	15	HARD, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL AND SILT, TRACE SAND - MOIST HARD, LIGHT YELLOWISH BROWN CLAY, TRACE GRAVEL, SAND, AND SILT - MOIST HARD, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL AND SILT, TRACE SAND - MOIST	CL CL CL	4.5 4.5	MUNSELL 2.5Y 6/2

NOTES: WATER ADDED TO HOLE - TOTAL = 50 GALLONS

~~HH~~ ~~HH~~ 1

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FERNALD RI/FS

1st Key In | 2nd Key In | Hard Copy Indicator

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VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 1079	COORDINATES:	DATE: 10.20.87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 10.19.87
ENGINEER/GEOLOGIST: D. OATLEY	Depth Date/Time	DATE COMPLETED: 10.20.87
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 3

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				30.3 ~~LIGHT YELLOWISH BROWN CLAY SOME GRAVEL, TRACE SILT DRY~~	CL		MUNSELL 2.5Y 6/2
31.5	7390	12 22 32	17	~~OLIVE~~ HARD OLIVE CLAY, SOME GRAVEL AND SILT, TRACE SAND - DRY.	CL	4.5	MUNSELL 5Y 5/3
				32.0 OLIVE CLAY, SOME GRAVEL ~~AND TRACE~~ ~~OR~~ SILT AND SAND ~~DRY~~			MUNSELL 5Y 5/3
33.0	7391	11 50LEF	~~12~~ 12	HARD LIGHT BROWNISH GRAY SILT, SOME SAND ~~GRAVEL AND FOOD~~, - ~~DRY~~ MOIST	ML	2.0	MUNSELL 2.5Y 6/2
34.5	7392	20 28 30	18	HARD LIGHT BROWNISH GRAY SILT, SOME SAND, TRACE GRAVEL - ~~DRY~~ MOIST	ML	2.5	MUNSELL 2.5Y 6/2
				34.1 HARD OLIVE CLAY, SOME FINE GRAVEL, TRACE SILT AND SAND	~~CL~~ CL	4.5	MUNSELL 5Y 5/3
36.0	7393	9 17 27	18	HARD OLIVE CLAY, SOME GRAVEL, TRACE SILT AND SAND-MOIST	CL	4.25	MUNSELL 5Y 5/3
37.5	~~7394~~	9 10 13	13	VERY STIFF, OLIVE SILT, TRACE CLAY - WET	ML	1.25	LACUSTRIANE DEPOSIT ~~OR FLUVIAL~~ LAYERED SILT MUNSELL 5Y 5/3
				37.3 OLIVE SILT, SOME CLAY - WET	ML		
				37.7 OLIVE SILT SOME CLAY, TRACE SAND - WET			MUNSELL 5Y 5/3
39.0	7395	0 18 30	15	HARD BROWNISH YELLOW SILT, SOME CLAY - MOIST	ML	3.5	MUNSELL 10YR 6/8
				38.3 DENSE YELLOWISH BROWN SAND TRACE SILT.	SW	1.5	MUNSELL 10YR 5/6
				TD 39.0 FT.			

NOTES:

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402-11-86

CC/DH/2.4.89

WELL # ~~179~~ 1C79 BB

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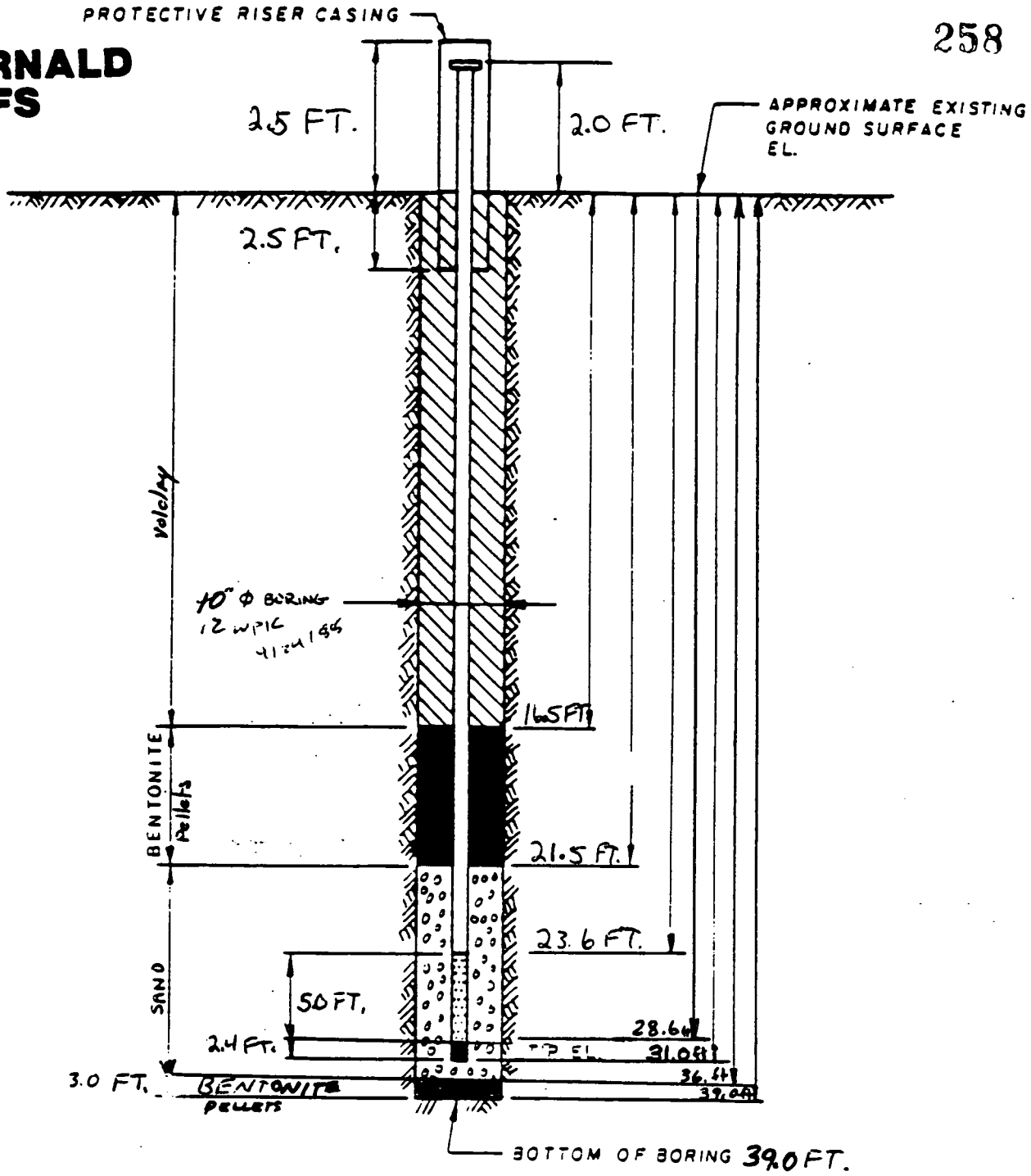
FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

White out corrections were made by D. Oakley at the time this form was completed.
4/24/86 WPIC

INSTALLATION DETAILS
MONITORING WELL ~~179~~ 1C79 BB

PREPARED FOR 1-5-89

353

FERNALD RI/FS

1st Key In	
2nd Key In	
Hard Copy Verification	

PAR

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD
PROJECT NO. 602
BORING NO. 1079
PIEZOMETER NO. ~~NA~~ 1079

FIELD ENG./GEO. D. OAKLEY DATE 10-21-87
CHECKED BY R Calhoun DATE 3/7/89
DATE OF INSTALLATION 10-21-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 1 TO 26 FT.
FLUID NA FROM NA TO NA

TYPE OF BIT FLATHEAD HAMMER
CASING SIZE (S) USED:
SIZE 10 IN FROM 0 TO 35 FT.
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING 316 STAINLESS
DIAMETER OF PERFORATED SECTION 4 IN
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 INCH
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 5 FT.

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8 IN I.D. 4 IN
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE ~~O~~.D. 10 INCH

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) NSL	
TOP OF RISER PIPE	2.0 FT			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 1.0 FT	BOTTOM 16.5 FT.	TOP	BOTTOM
BENTONITE	TOP 16.5 FT	BOTTOM 21.5 FT.	TOP	BOTTOM
SAND	TOP 21.5 FT	BOTTOM 36.0 FT.	TOP	BOTTOM
~~NO GRAVEL USED~~ BENTONITE	TOP 36.0	BOTTOM 39.0	TOP	BOTTOM
PERFORATED SECTION	TOP 23.6 FT.	BOTTOM 28.6 FT.	TOP	BOTTOM
PIEZOMETER TIP	31.0			
BOTTOM OF BOREHOLE	39.0 FT.			
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

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REMARKS White corrections were made by D. Oakley at the time this form was completed

409-11-86

FERNALD RI/FS

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RKP 2/4/87

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3 2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 180 1150 80 1-5-87	COORDINATES:	DATE: 4/26/88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth Date/Time	DATE COMPLETED: 4/27/88
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 4

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0.0	08780	3 7 5	6	M Dense, Very Pale Brown (10YR 8/4) Gravelly Sand. Fill. Dry			t = 0918 Hnu = 0ppm α = 2cpm γ/β = 40cpm
2.5	08781	4 5 6	4	Very Stiff, Dark Yellowish Brown (10YR 4/4) Clay, some silt. Moist.	CL		t = 0924 Hnu = 0ppm α = 2cpm γ/β = 40cpm Pebble blocked spoon.
	08782	5 9 11	12	Very Stiff, Dark Brown (10YR 3/3) Silty Clay, trace sand, trace gravel. Moist	CL	3.7	t = 0928 Hnu = 0ppm α = 2cpm γ/β = 40cpm
5.0	08783	8 10 14	13	Very Stiff, Dark Yellowish Brown (10YR 4/4) with gray mottled Silty Clay, trace gravel, trace sand Moist.	CL	2.7	t = 0933 Hnu = 0ppm α = 2cpm γ/β = 40cpm
	08784	14 17 19	13	Very Stiff, Very Dark Brown (10YR 2/2) Silty Clay, trace gravel, trace sand. Moist.	CL	3.3	t = 0940 Hnu = 0ppm α = 2cpm γ/β = 40cpm
7.5	08785	5 11 15	14	Very Stiff, Dark Gray (2.5Y 4/0) Clay, some silt, trace gravel, trace sand. Moist.	CL	3.5	t = 1118 Hnu = 0ppm α = 2cpm γ/β = 40cpm
10.0	08786	2 10 17	12	Very Stiff, Very Dark Gray (2.5Y 3/0) Clay, some silt, trace sand. Moist	CL	2.8	t = 1142 Hnu = 0ppm α = 2cpm γ/β = 55cpm
	ST 08787	NA	12				t = 1327 Pushed Shelby 1.5 Ft 1.0 Ft recovery
12.5	08788	16 24 32	18	Hard, Yellowish Brown (10YR 5/6) Silty Clay, trace sand and gravel. Moist	CL	4.1	t = 1339 Hnu = 0ppm α = 2cpm γ/β = 40cpm
15.0	08789	4 14 25	9	Very Stiff, Brownish Yellow (10YR 6/8) Silty Clay, trace sand and gravel ~~Moist~~ B.O Dry	CL	2.5	t = 1355 Hnu = 0ppm α = 2 cpm γ/β = 40cpm

NOTES: Drilling Contractor : Pennsylvania Drilling
Driller : Joe Basile
Helper : John Vandine
Rig : 72 Speedstar

Water Used During Drilling = 350 gallons
Soil Sampling as per ASTM
Color Descriptions as per Munsell
Field Measurements : Hnu, γ/β, α

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FERNALD RI/FS

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1st Keyin		
2nd Keyin		
Hard Copy Verification		

PRC

RKA 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6.2.1.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~180~~ 150 BH-50	COORDINATES:	DATE: 4/26/88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth Date/Time	DATE COMPLETED: 4/27/88
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 4

DEPTH (Ft.) 15.0	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	08790	9 34 14	16	Hard, Yellowish Brown (10YR 5/4) Silty Clay, trace sand and gravel. Moist 16.4	CL	>4.5	t: 1416 Hm: 0ppm α: 2cpm γ/β: 60cpm
17.5	08791	3 8 11	12	Very Stiff, Gray (2.5Y 5/0) Silty Clay, trace sand and gravel. Moist.	CL	2.5	t: 1430 Hm: 0ppm α: 2cpm γ/β: 40cpm
	08792	4 8 13	17	Stiff, Dark Gray (2.5Y 4/0) Silty Clay trace sand and gravel. Moist	CL	1.6	t: 1450 Hm: 0ppm α: 2cpm γ/β: 40cpm
20.0	08793	2 5 8	14	Stiff, Gray (2.5Y 5/0) Silty Clay trace sand and gravel. Moist.	CL	1.6	t: 1501 Hm: 0ppm α: 2cpm γ/β: 40cpm
							t: 1605 Pushed Shelby no recovery
22.5	08668	8 10 15	13	Stiff, Gray (2.5Y 5/0) Silty Clay trace sand and gravel. Moist.	CL	1.1	t: 1629 Hm: 0ppm α: 2cpm γ/β: 40cpm
25.0	08794	NA	21				t: 1715 Pushed Shelby 2.0 Ft ~~into~~ 2.0. 1.75 Ft recovery
	08795	5 9 40	5	Stiff, Gray (2.5Y 5/0) Silty Clay, some gravel, trace sand. Moist	CL	1.5	t: 0743 4/27/88 Hm: 0ppm α: 2cpm γ/β: 40cpm
27.5	08796 08797 08798	12 36 58	14	Hard, Dark Gray (2.5Y 4/0) Silty Clay, some gravel, trace sand. Moist.	CL	>4.5	t: 0805 Hm: 0ppm α: 2cpm γ/β: 40cpm
30.0	08799	15 50 50/4"	16	Hard, Gray (2.5Y 5/0) Silty Clay, trace sand and gravel. Moist. 29.6 ~~Hard~~ V. Dense, Gray 2.5Y 5/0 Fine sand some silt 29.8	CL SW	>4.5	t: 0833 Hm: 0ppm α: 2 γ/β: 40cpm

NOTES:

Pushed Shelby from 21.0-23.0 Feet. No recovery.

See Following page

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402-11-86

FERNALD RI/FS

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VISUAL CLASSIFICATION OF SOILS

1st Key In	
2nd Key In	
Hand Key Verification	

RKA 2/4/89

PROJECT NUMBER: 602 3-2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~180~~ 1080 BB 1-5-90	COORDINATES:	DATE: 4/27/88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth Date/Time	DATE COMPLETED: 4/27/88
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 4

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30.0	08800	38 50/4	10	Hard, Dark Gray (5Y 4/1) Sandy Silt, some clay. Moist ~31 ft	ML	>4.5	t: 0857 Hm: 0ppm α: 2cpm γ/β: 40cpm
30.9							
32.5	08801	14 24 29	18	Very Stiff, Dark Gray (5Y 4/1) Clay, some silt, trace sand and gravel. Moist	CL	3.5	t: 0958 Hm: 0ppm α: 2cpm γ/β: 40
	08802	5 11 18	4	Dark Gray (5Y 4/1) Clay, some silt and gravel. Moist.	CL		t: 1015 Hm: 0cpm α: 2cpm γ/β: 40cpm Rock in end of sampler
35.0	08803	5 9 12	17	Very Stiff Dark Gray (5Y 4/1) Silty Clay trace sand and gravel. Moist			t: 1027 Hm: 0ppm α: 2cpm γ/β: 40cpm
	08804	7 21 27	15	Very Stiff, Dark Gray (5Y 4/1) Silty Clay trace sand and gravel moist. 36.6 Hard, Brownish Yellow (10YR 6/8) Silty Clay. Moist.	CL CL	2.1 >4.5	t: 1042 Hm: 0ppm α: 2cpm γ/β: 50cpm
37.5				Very Dense, Very Pale Brown (10YR 7/4) Fine sand, well sorted, trace silt. Dry	SW		
40.0	08665	16 36 50	16	Very Dense, Very Pale Brown (10YR 7/4) Fine Sand, well sorted, trace silt. Slightly Moist.	SW		t: 1100 Hm: 0ppm α: 2cpm γ/β: 50cpm
42.5							
45.0							

NOTES: Bottom of till 36.8 Feet

402-11-86

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6C2.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: 1180	COORDINATES:	DATE: 4/27/88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth Date/Time	DATE COMPLETED: 4/27/88
DRILLING METHODS:		PAGE 4 OF 4

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45.0	08666	35 49 44	18	Very Dense, Very Pale Brown (10YR 7/4) Fine sand, trace med. sand to fine gravel, trace silt. Slightly moist	SW		t: 1258 Hm = 0 ppm α: 2cpm γ/β: 40cpm
47.5							
50.0	08667	22 33 50	17	Very Dense, Brownish Yellow (10YR 6/6) Fine sand, trace med. sand to fine gravel, trace silt, Moist.			t: 1411 Hm = 0ppm α: 2cpm γ/β: 40cpm
51.5				END OF BORING 51.5 FT.			

NOTES:

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402-11-86

FERNALD RI/FS

258

1st Key In	
2nd Key In	
Hard Copy Verification	

RKA 2/4

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS FIELD ENG./GEO. DAVIES DATE 4/28/88
PROJECT NO. 602.3.2 CHECKED BY R Galbraith DATE 2/7/89
BORING NO. ~~180~~ 1050 DD 1-17-89
PIEZOMETER NO. 1080 DATE OF INSTALLATION 4/28/88

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID 350 gallon H_2O FROM 0 TO 51.5
FLUID _____ FROM _____ TO _____

TYPE OF BIT Steel
CASING SIZE (S) USED:
SIZE ~~4 in~~ OD FROM ~~30.9~~ BD TO _____
SIZE 10 in FROM 0.0 TO 46.0 Ft

PIEZOMETER DESCRIPTION

TYPE Monitoring Well
DIAMETER OF PERFORATED SECTION 4 in
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS 0.010 in
TOTAL PERFORATED AREA 10 Ft

RISER PIPE MATERIAL Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8 in I.D. 4.0 in
LENGTH OF PIPE SECTIONS 10 Ft.
JOINING METHOD Screw wrench tight.

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Ft
PROTECTIVE PIPE O.D. 10 3/4 in

OTHER PROTECTION Steel cover, lockable
Stainless Steel vented cap.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft)		ELEVATION ( )	
TOP OF RISER PIPE	2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE				
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0	BOTTOM 9.1	TOP	BOTTOM
BENTONITE	TOP 9.1	BOTTOM 14.1	TOP	BOTTOM
SAND	TOP 14.1	BOTTOM 31.3	TOP	BOTTOM
~~GRAVEL~~ Bentonite Grout	TOP 31.3 31.9	BOTTOM 31.9 49.5	TOP	BOTTOM
PERFORATED SECTION	TOP 18.5 Just 2/7/89	BOTTOM 28.5 Just 2/7/89	TOP	BOTTOM
PIEZOMETER TIP	30.9			
BOTTOM OF BOREHOLE	51.5			
GWL AFTER INSTALLATION	NA			

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒ 359
AS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS Screen section measured 10.5 Ft with 10.0 Ft perforated

409-11-86

Boring [illegible] 56 1-5-59

RKA 2/4/

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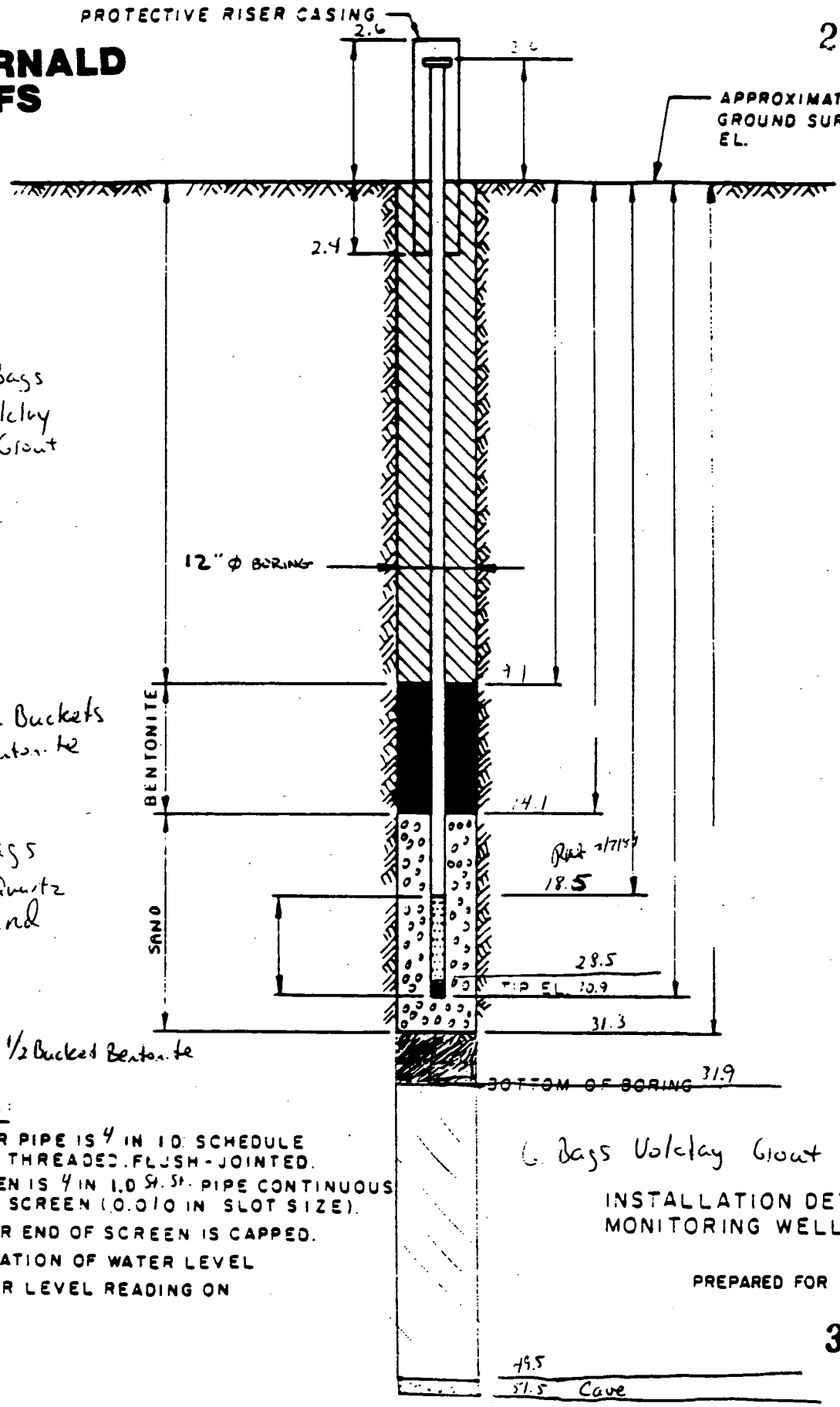
FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

BD

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. ST. ST. PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL

PREPARED FOR

360

FERNALD RI/FS

DLG 2/4/89

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VISUAL CLASSIFICATION OF SOILS

RIG #2

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 1081	COORDINATES:		DATE: 12.1.87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 12.1.87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 12.2.87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 3

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				0.3 STIFF BROWN (10YR 5/3) SILT TRACE CLAY AND GRAVEL DRY	ML	3.0	
1	07633 8:50	5 6 6	12	STIFF LIGHT GRAY (5Y, 6/1) SILT, SOME CLAY, TRACE GRAVEL AND SAND - DRY	ML	3.5	HNU - 0PPM Bd - 600PPM γ - 0CPM
2 3	07634 9:20	4 9 19	14	VERY STIFF LIGHT GRAY (5Y, 6/1) SILT, SOME CLAY AND GRAVEL - DRY.	ML	4.0	HNU - 0PPM Bd - 500PPM γ - 0CPM
4	07635 10:00	12 16 17	15	3.4 HARD YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SAND AND SILT, TRACE FINE GRAVEL DRY	CL	4.0	HNU - 0PPM Bd - 700PPM γ - 0CPM
				4.5 HARD PALE BROWN (10YR, 6/3) CLAY, SOME SAND, TRACE SILT - DRY	CL	3.5	
5 6	07636 10:15	12 12 8	11	VERY STIFF BROWNISH YELLOW (10YR, 6/4) CLAY, SOME ~~SILT~~ SAND, TRACE GRAVEL AND SILT - DRY	CL	2.25	HNU - 0PPM Bd - 700PPM γ - 0CPM
7	07637 10:50	4 5 4	14	6.6 STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, 7.2 SOME SILT - MOIST	CL	1.0	HNU - 0PPM Bd - 500PPM γ - 0CPM
				STIFF LIGHT YELLOWISH BROWN (2.5Y 6/4) CLAY, SOME SILT, TRACE SAND AND FINE GRAVEL - DRY.	CL	2.5	
8 9	07638 11:00	6 6 7	13	STIFF BROWN (10YR, 5/4) CLAY, SOME SILT, TRACE SAND AND GRAVEL - DRY	CL	2.5	HNU - 0PPM Bd - 600PPM γ - 0CPM
10	07639 14:50	9 9 13	14	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SAND AND SILT - MOIST.	CL	2.5	HNU - 0PPM Bd - 400PPM γ - 0CPM
11 12	07640 15:10	5 7 9	15	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SAND AND SILT, TRACE GRAVEL - MOIST	CL	2.5	HNU - 0PPM Bd - 400PPM γ - 0CPM
				12.2 VERY STIFF DARK BROWNISH (2.5Y 4/2) SILT, SOME CLAY, TRACE SAND - DRY	ML	—	
13	07641 15:25	7 9 10	4	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SAND AND SILT - MOIST.	CL	2.5	HNU - 0PPM Bd - 900PPM γ - 0CPM
14 15	07642 15:50	3 7 9	9	VERY STIFF YELLOWISH BROWN (10YR, 5/4) SILTY CLAY, TRACE GRAVEL AND SAND - MOIST	CL	2.25	HNU - 0PPM Bd - 500PPM γ - 0CPM

NOTES: CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOHN VANDINE.
WATER ADDED TO HOLE: 1 TANK - 5 GALLONS.
~~HH HH HH HH HH HH~~ 11

SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST.
COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

BACKGROUND
HNU - 0PPM
LEL - 0%

γ - 0CPM
Bd 60-140 CPM
(AIR) (GROUND)

361

402-11-86

FERNALD RI/FS

DLG 2/4/91

1st Key In | 2nd Key In | Hard Copy Verification

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~1ST~~ 1081 DD-5-90	COORDINATES:	DATE: 12·2·87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12·1·87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 12·2·87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 3

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION (LIGHT YELLOWISH BROWN 2.5Y (6/4))	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	4.00 ST-07643 07:54	4 7 10	0	VERY STIFF BROWNISH ~~YELLOW~~ (~~2.5Y~~) CLAY, SOME GRAVEL AND SILT, TRACE SAND - MOIST	CL	1.25	HNU - 0PPM BZ - 30CPM T - 0CPM
17	07645 10:00	3 4 10	10	STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND - MOIST	CL	1.5	HNU - 0PPM BZ - 40CPM T - 0CPM
18 19	07646 10:30	5 12 18	15	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND - ~~DRY~~ MOIST	CL	3.0	HNU - 0PPM BZ - 50CPM T - 0CPM
20 21	07647 10:54	3 12 18	14	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, SAND, AND FINE GRAVEL - MOIST	CL	2.75	HNU - 0PPM BZ - 50CPM T - 0CPM
22	07648 11:15	5 14 27	16	HARD LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME GRAVEL, SILT, AND SAND - MOIST	CL	4.0	HNU - 0PPM BZ - 60CPM T - 0CPM
23 24	07649 13:20	~~3 5 8~~	6	STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME GRAVEL, SILT, AND SAND - MOIST	CL	2.0	HNU - 0PPM BZ - ~~40~~CPM T - 0CPM
25	07650 13:45	4 10 13	11	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) ~~SILTY~~ CLAY, AND SILT, SOME SAND, TRACE FINE GRAVEL - ~~DRY~~ MOIST	CL	1.0	HNU - 0PPM BZ - 40CPM T - 0CPM
26 27	07651 14:00	2 8 12	14	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, TRACE SILT, SAND, AND FINE GRAVEL - MOIST	CH	.75	HNU - 0PPM BZ - 40CPM T - 0CPM
28	07652 14:45	1 4 7	5	STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, ~~TRACE~~ SOME GRAVEL, TRACE SILT AND SAND - MOIST	CH	.75	HNU - 0PPM BZ - 40CPM T - 0CPM
29 30	07653 15:00	5 7 9	13	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, TRACE SAND, GRAVEL, AND SILT, MOIST	CH	.5	HNU - 0PPM BZ - 40CPM T - 0CPM

NOTES:

402-11-86

FERNALD RI/FS

DLG 2/4/89

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

PAC

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD	
BORING NUMBER: LET 1081 GB 1-5-89	COORDINATES:	DATE: 12.2.87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12.1.87
ENGINEER/GEOLOGIST: D OAHLEY	Depth Date/Time	DATE COMPLETED: 12.2.87
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 3

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	07654 15:40	11 7 10	14	VERY STIFF GRAYISH BROWN (2.5Y 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST	CH	1.0	HNU - 0PPM 3α - 60 CPM γ - 0 CPM
32	07655 15:55	3 7 9	14	VERY STIFF GRAYISH BROWN (2.5Y 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST	CH	1.0	HNU - 0PPM 3α - 50 CPM γ - 0 CPM
33				WELL TD 33.0 FT. Bottom of Boring			

NOTES:

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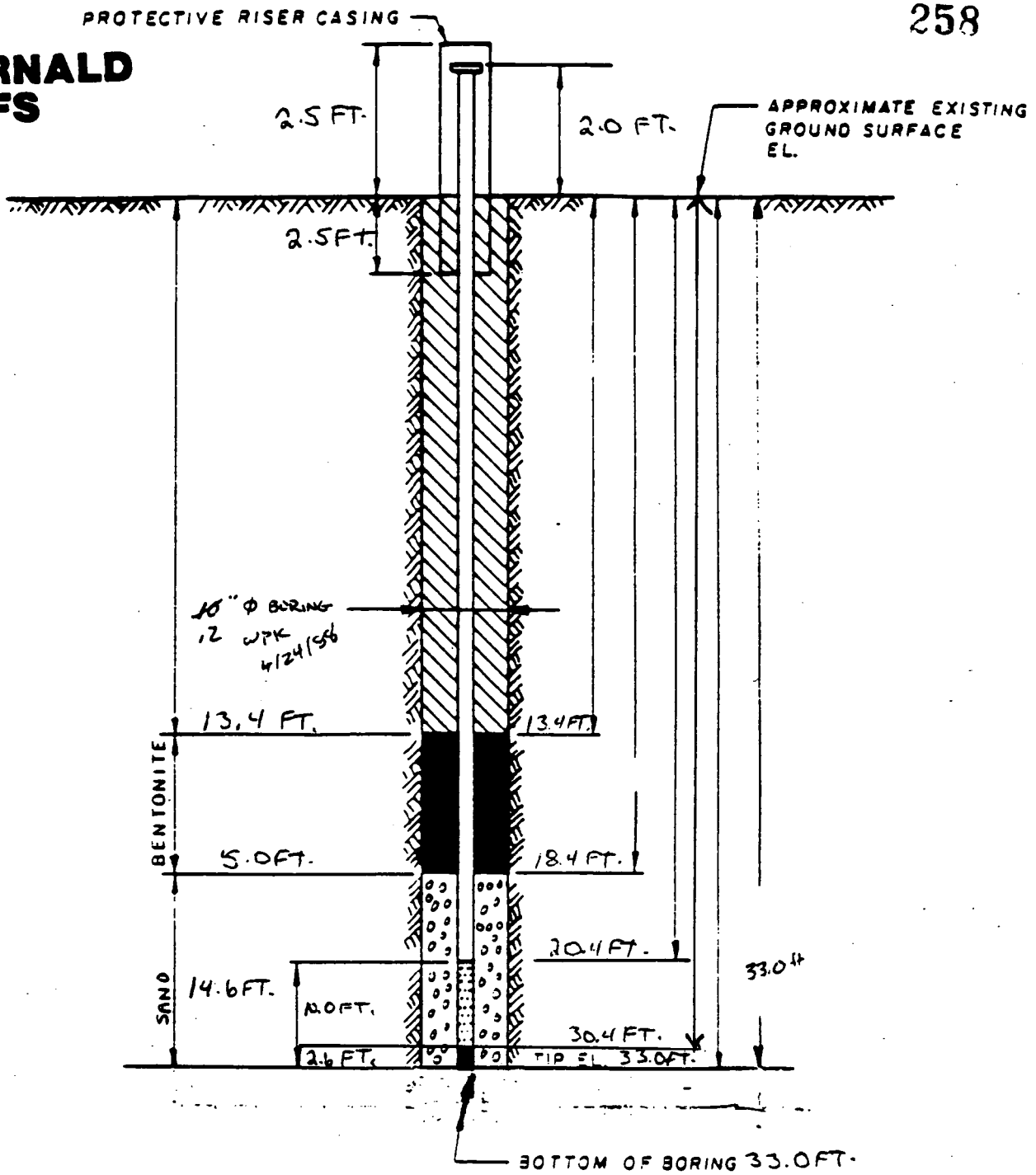
402-11-86

DG 3/4/89 WELL # ~~101~~ 105 OB 1-5-89 #27

258

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

~~white out corrections~~ This form did not represent the installed monitoring well, therefore, it has been modified with white out by D. Oakley, WPK 4/24/88

INSTALLATION DETAILS
MONITORING WELL ~~101~~ 105 BB 1-5-89

PREPARED FOR

364

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY DBO

DLG
2/4/89

FERNALD RI/FS

Initial	Date
1st Key In	
2nd Key In	
Hard Copy Verification	

258

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD FIELD ENG./GEO. D. OAKLEY DATE 12-3-87
PROJECT NO. 602 CHECKED BY R Gallowitz DATE 2/7/89
BORING NO. ~~1051~~ 1051 BR 1-7-88
PIEZOMETER NO. ~~NA~~ 1051 WPK 4/24/88 DATE OF INSTALLATION 12-3-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT FLATHEAD
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID WATER FROM 4 TO 33 FT.	SIZE 10" FROM 0 TO 30 FT.
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING	RISER PIPE MATERIAL 316 STAINLESS STEEL
DIAMETER OF PERFORATED SECTION 4 INCH	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 IN. I.D. 4 IN
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10.0 FT.
AVERAGE SIZE OF PERFORATIONS .010 INCH	JOINING METHOD THREAD ~~AND COUPLE~~
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10.0 FT.	(FLUSH JOINT THREAD)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.	OTHER PROTECTION LOCKING CAP
PROTECTIVE PIPE ~~O~~.D. 10 INCH	WITH LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 FT.	BOTTOM 13.4 FT.	TOP	BOTTOM
BENTONITE	TOP 13.4 FT.	BOTTOM 18.4 FT.	TOP	BOTTOM
SAND	TOP 18.4 FT.	BOTTOM 33.0 FT.	TOP	BOTTOM
~~GRAVEL~~	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 20.4 FT.	BOTTOM 30.4 FT.	TOP	BOTTOM
PIEZOMETER TIP	33.0 FT			
BOTTOM OF BOREHOLE	33.0 FT.			
GWL AFTER INSTALLATION	NA			

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

365

REMARKS White out correction was made by D. Oakley at the time this form was completed. WPK 4/24/88

409-11-86

QC/DH/2/4/89

258

PAC

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

4/23/88 WPK

RIG #2

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 182 1092 BB 1-5-89	COORDINATES:		DATE: 12-4-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 12-4-87
ENGINEER/GEOLOGIST: D. OAHLEN	Depth	Date/Time	DATE COMPLETED: 12-4-87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 2

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07657 9:50	5 6 23	8	VERY STIFF YELLOWISH BROWN (10YR, 5/4) SILT, SOME CLAY, TRACE SAND AND GRAVEL - ~~DRY~~, MOIST.	ML	2.25	HNU - 0 PPM Bα - 200 CPM γ - 0 CPM
				18 STIFF YELLOWISH BROWN ~~SILT~~ (10YR/5/4) SILT, SOME CLAY, TRACE SAND - MOIST	ML	—	
2 3	07658 10:00	8 5 5	11	STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT, TRACE GRAVEL AND SAND - MOIST	CL	1.25	HNU - 0 PPM Bα - 100 CPM γ - 0 CPM
4	07659 10:10	5 4 6	8 0	STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT AND GRAVEL, TRACE SAND. MOIST.	CL	1.25	HNU - 0 PPM Bα - 160 CPM γ - 0 CPM
5 6	07660 10:20	6 14 16	11	VERY STIFF LIGHT YELLOWISH BROWN (10YR 6/4) SILTY CLAY, ~~SOME~~ TRACE SAND - MOIST	CL	2.5	HNU - 0 PPM Bα - 80 CPM γ - 0 CPM
7	07661 10:40	15 17 19	18	HARD LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT, TRACE SAND AND FINE GRAVEL. - DRY	CL	2.75	HNU - 0 PPM Bα - 80 CPM γ - 0 CPM
8 9	07662 13:00	5 9 15	18	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND - ~~MOIST~~ DRY.	CL	3.0	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
10	ST 07663 13:15 / 07664 14:00	5 16 13	14	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT, TRACE GRAVEL AND SAND - MOIST	CL	3.5	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
11 12	07665 14:30	3 10 15	14	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND - MOIST	CL	4.0	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
13	07666 14:45	6 20 22	12	VERY STIFF YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SILT AND GRAVEL, TRACE SAND - MOIST	CL	3.5	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
14 15	07667 15:00	7 16 25	14	HARD YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SILT, TRACE GRAVEL AND SAND - MOIST	CL	4.25	HNU - 0 PPM Bα - 80 CPM γ - 0 CPM

NOTES: CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARRY OYMES JR.
ASSISTANT: JOHN VANDINE
WATER ADDED TO HOLE 17 ICM = 10 GALLONS
HTT HH III

SAMPLES TAKEN USING ASTM STANDARD PENETRATION TESTS.
SOILS COLORS CLASSIFIED ACCORDING TO MUNSELL COLOR CHARTS.
BACKGROUND
HNU - 0 PPM
LEL - 0%
Bα 100 (AIR) - 800 (GROUND) CPM
γ - 0 CPM

366

402-11-86

QC/DH/2.4.89

	Initials	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 662 ~~FEGRAND2/FS~~	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 182 1052 BB 159	COORDINATES:	DATE: 12-4-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12-4-87
ENGINEER/GEOLOGIST: D. CAHLEY	Depth Date/Time	DATE COMPLETED: 12-4-87
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	07668 15:10	15 18 20	18	HARD YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SILT, TRACE GRAVEL AND SAND. 15.5 MOIST	CL	3.5	HNU - 0PPM BG - 50CPM B - 0CPM
				HARD GRAY (10YR, 6/1) CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST	CL	2.5	
17	07669 16:00	6 10 21	8	HARD GRAY (10YR, 6/1) CLAY, TRACE GRAVEL, SILT, AND SAND - MOIST	CL	3.5	HNU - 0PPM BG - 60CPM B - 0CPM
18	07670 16:15	6 10 11	15	VERY STIFF GRAY (10YR, 5/1) CLAY, TRACE ~~GRAVEL~~, SILT, GRAVEL, AND SAND - ~~DRY~~ MOIST	CL	2.0	HNU - 0PPM BG - 60CPM B - 0CPM
19							
20	07671 16:30	5 10 12	12	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, ~~S~~ TRACE GRAVEL, SILT, AND SAND - MOIST	CL	2.0	HNU - 0PPM BG - 50CPM B - 0CPM
21							
22	07672 16:45	5 7 12	13	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, TRACE GRAVEL, SILT, AND SAND - MOIST	CL	2.0	HNU - 0PPM BG - 60CPM B 0CPM
23	07673 17:00	2 4 7	7	STIFF OLIVE GRAY (5Y, 5/2 CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST	CL	1.5	HNU - 0PPM BG - 60CPM B 0CPM
~~25~~ 24				WELL TD 24.0 FT.			
~~26~~							

NOTES:

402-11-88

QC/DH/24.89

	Initial	
1st Key In		
2nd Key In		
Hard Copy Verification		

PAC

258

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D. OAKLEY DATE 12-5-87
PROJECT NO. 602 CHECKED BY R Galbraith DATE 2/7/89
BORING NO. ~~182~~ 1032 BB 1-5-89
PIEZOMETER NO. ~~AA~~ 1032 WPK 4/24/88 DATE OF INSTALLATION 12-5-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 4 TO 24 FT.
FLUID NA FROM NA TO NA

TYPE OF BIT FLATHEAD
CASING SIZE (S) USED:
SIZE 10 IN FROM 0 TO 20 FT.
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING
DIAMETER OF PERFORATED SECTION 4 IN.
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 SLOT
TOTAL PERFORATED AREA 10 FT.

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4-3/8 IN. I.D. 4 IN.
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD ~~AND COUPLE~~ RWG 2/7/89
FLUSH JOINT THREAD

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE O.D. 10 IN.

OTHER PROTECTION LOCKING CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
~~GROUT/SLURRY~~	TOP NA	BOTTOM	TOP	BOTTOM
BENTONITE	TOP 0.0 FT.	BOTTOM 8.0 FT.	TOP	BOTTOM
SAND	TOP 8.0 FT.	BOTTOM 24.0 FT.	TOP	BOTTOM
~~GRAVEL~~	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 10.4 FT.	BOTTOM 20.4 FT.	TOP	BOTTOM
PIEZOMETER TIP	23.0			
BOTTOM OF BOREHOLE	24.0 FT.			
GWL AFTER INSTALLATION	NA - DRY			

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒ **368**
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

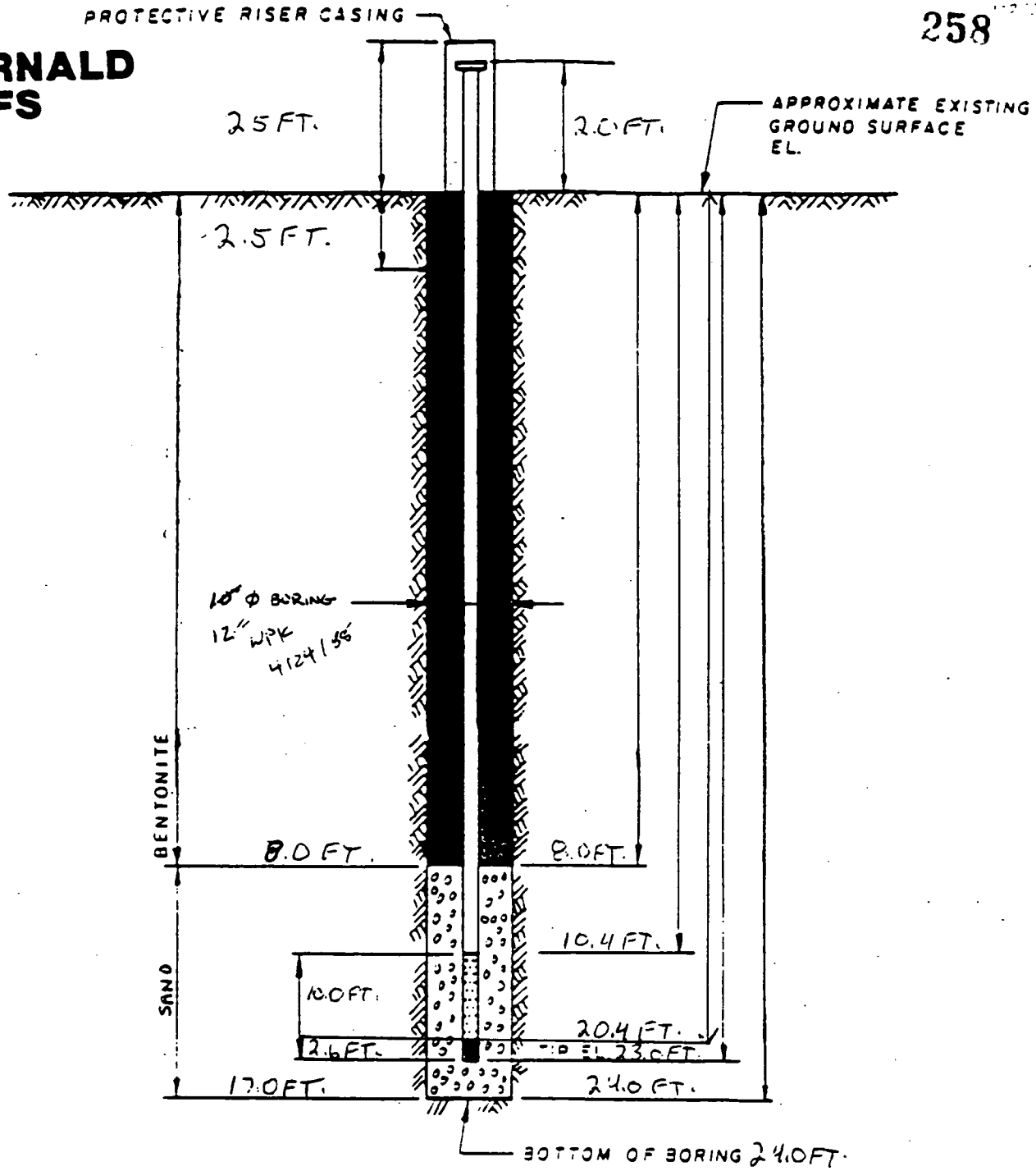
REMARKS white out correction was made by D. Oakley when this form was completed. WPK 4/28/88

QC/DH/2.4.89

WELL # ~~258~~ /182 #30

258

FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN 10 SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN 1.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~182~~ 1092 BB

PREPARED FOR 1-5-89

This form did not represent the installed monitoring well, therefore, it has been modified with white out by D. Oakley.
WPK 4/24/86

369

DRAWING NUMBER	
CHECKED BY	APPROVED BY
DBO	
DRAWN BY	

FERNALD RI/FS

SAMPLE # 07894 was a shelby tube taken on 01/10/88 a 3 feet Deep hole was excavated beside boring 183 and the tube was pushed from 3 to 5.0 feet with 1.9 feet recovery. WPK 4/24/88

DLG 2/4/89

WPK 4/23/88 RIG #2

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~183~~ 1083	COORDINATES:	DATE: 01 07 88
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 07 88
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 01 09 88
DRILLING METHODS: CABLE TOOL / SPLIT SPOON		PAGE 1 OF 2

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 1 ft	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07879 1345	9 9 5	13	VERY STIFF, BROWN (10YR 5/3) SILT and clay with gravel - Dry	ML	3.5	HNU = 0ppm βγ = 180 cpm unshielded α = 0cpm
2	07880 1350	6 7 11	12	HARD BROWN (10YR 5/3) clay and silt with gravel - DRY	CL	4.5+	HNU = 0ppm βγ = 180cpm unshielded α = 0cpm
3				Shelby Tube			HNU = 0ppm Shelby Tube TAKEN 01/10/88 07894 WPK 4/1 βγ = 140 cpm unshielded H30 α = 0 cpm
4	07881 1355	9 10 11	12	3.8' VERY STIFF LIGHT YELLOWISH BROWN (10YR 6/4) MOTTLED CLAY WITH SILT - DRY	CL	2.5	
5	07882 1400	13 12 10	UPF 12 4/24	STIFF LIGHT YELLOWISH BROWN (10YR 6/4) MOTTLED CLAY WITH SAND	CL	1.5	HNU = 0ppm βγ = 140 cpm unshielded α = 0cpm
6 7	07883 1405	5 5 6	18	6.3' MEDIUM DENSE, LIGHT YELLOWISH BROWN (10YR 6/4) SAND AND CLAY - WET 7.4'	SC	0.5	HNU = 0ppm βγ = 200cpm unshielded α = 0cpm
8	07884 1300	6 14 11	15	MEDIUM STIFF, LIGHT YELLOWISH BROWN (10YR 6/4) CLAY AND SILT SOME SAND - MOIST	CL	1.5	HNU = 0ppm βγ = 180cpm α = 0 cpm RECORD ON 7 8 88
9 10	07885 1305	2 3 18	8	9.2' MEDIUM DENSE, Yellowish BROWN (10YR 5/4) SAND AND GRAVEL SOME SILT - WET	SW		HNU = 0ppm βγ = 180cpm α = 0cpm
11 12	07886 1430	30 16 21	16	10.9 DENSE YELLOWISH BROWN (10YR 5/4) SAND SOME SILT AND CLAY - WET	SP		HNU = 0ppm βγ = 180 cpm α = 0cpm
13	07887 1500	12 23 7	15	MEDIUM DENSE YELLOWISH BROWN (10YR 5/4) GRAVEL AND SAND SOME SILT - WET	GW		HNU = 0ppm βγ = 120 shielded α = 0cpm
14	07888 1530	6 4 7	7	13.9 VERY SOFT OLIVE GREY (5Y 5/2) clay SOME SILT TRACE GRAVEL - DRY	CL	0.25	HNU = 0ppm βγ = 120 shielded α = 0cpm

NOTES: CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOHN VANDINE
WATER ADDED HOLE: 1 Tick = 5 gal
~~LHT LHT LHT LHT LHT~~

SAMPLES TAKEN USING ASTM STANDARD Penetration TEST.

COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

BACKGROUND LEVELS
GEL-O_2: 0ppm HNU = 0ppm βγ = 180 cpm α = 0 cpm

370

402-11-86

FERNALD RI/FS

DLG 2/14/89

258

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 T3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1083	COORDINATES:	DATE: 01 08 87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 01 07 87
ENGINEER/GEOLOGIST: W. KEGLEY	Depth Date/Time	DATE COMPLETED: 01 09 87
DRILLING METHODS: CABLE TOOL / SPLIT SPOON		PAGE 2 OF 2

DEPTH (inch)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6	RECOVERY (inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	0 7 8 9 1630	2 2 2	6in	SOFT OLIVE GREY ~~CLAY~~ (5Y 5/2) clay with gravel moist	CL	0.5	SAMPLE 7889 IS SALLY TUBE TAKEN AT 1545hr. HNU=0ppm BX=120cpm shielded γ=0cpm
17							Tried to ~~take~~ Drive sample BEGIN 01 09 88 Three times no Recovery
18	0 7 8 9 1 1055	1 2 12	5	VERY SOFT OLIVE GREY (5Y 5/2) CLAY with Gravel ~~moist~~ WET	CL	0.25	HNU=0ppm Bα=120 cpm shielded γ=0 cpm
19							
20	0 7 8 9 2 1105	2 4 5	10	VERY SOFT OLIVE GREY (5Y 5/2) clay with Gravel - moist	CL	0.25	HNU=0ppm Bα=120 cpm shielded γ=0 cpm
21							
22	0 7 8 9 3 1110	1 2 3	8	VERY SOFT OLIVE GREY (5Y 5/2) clay with gravel - wet	CL	0.25	HNU=0ppm Bα=120 cpm shielded γ=0 cpm
				BOTTOM OF BORING 22.5' WJK 4/24/88			

NOTES:

371

402-11-88

DLG 2/4/89

BORING ~~183~~ 1083 #38 BB 1-5-89

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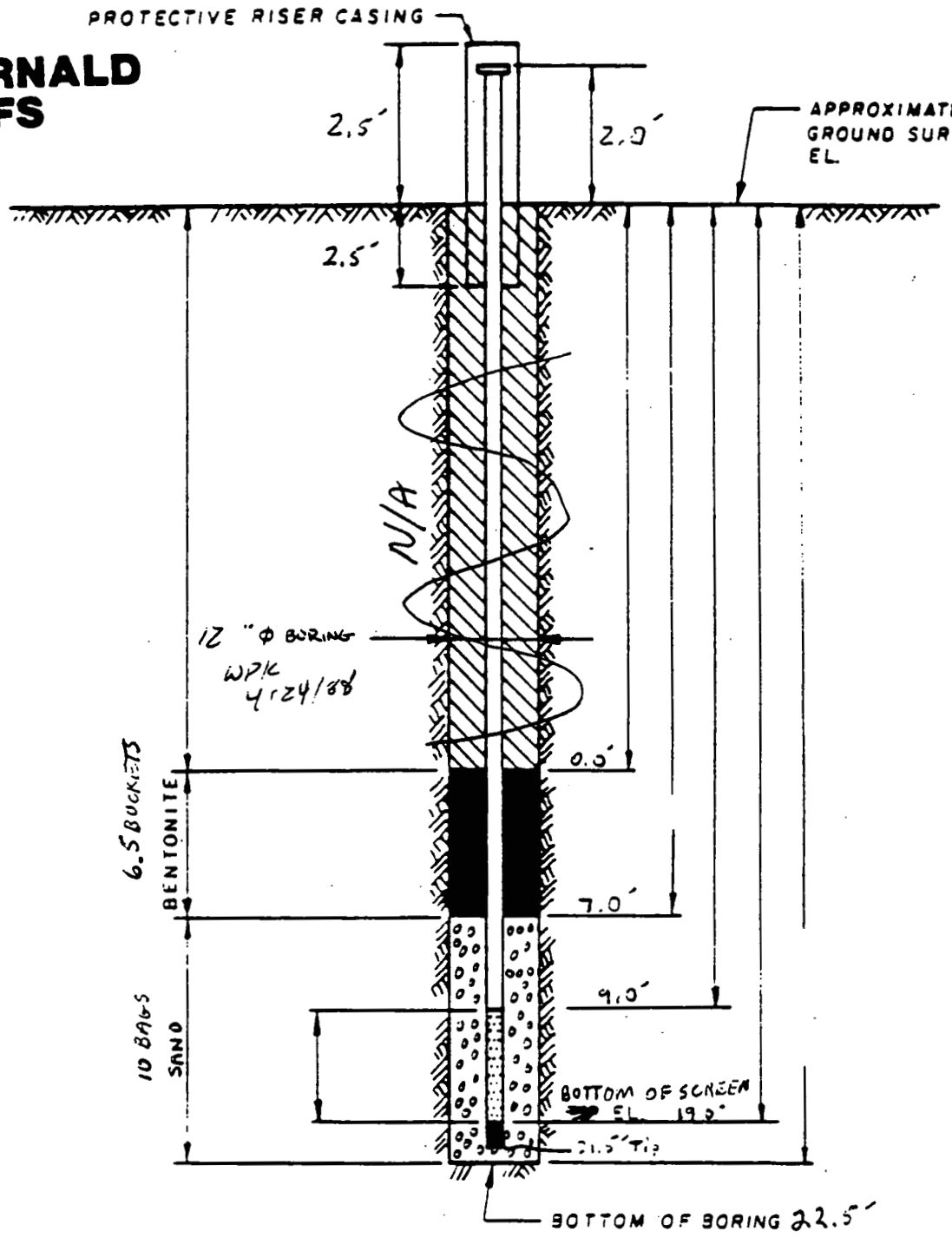
FERNALD RI/FS



DRAWN BY	KEGLEY 01 09 88	CHECKED BY / APPROVED BY	DRAWING NUMBER

NOTES:

1. RISER PIPE IS IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS IN I.D. PIPE CONTINUOUS SLOT SCREEN (0.0 0 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~183~~ 1083

PREPARED FOR BB 1-5-89

372

FERNALD RI/FS

DLG 3/4/89

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Validation		

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI IFS
FIELD ENG./GEO. W. Kiggler DATE 01 09 88
PROJECT NO. 602 T3.2
CHECKED BY R Galbraith DATE 2/7/89
BORING NO. ~~183~~ 1093 DB 1-5-89
PIEZOMETER NO. ~~183~~ 1093
DATE OF INSTALLATION 01 09 88

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID H_2O FROM 0.0 TO 21.5'
FLUID NA FROM NA TO NA

TYPE OF BIT FLAT HEAD
CASING SIZE (S) USED:
SIZE 10 in FROM 0 TO 21.5
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING
DIAMETER OF PERFORATED SECTION 4 inch
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 inch
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10 feet

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8 inch I.D. 4 inch
LENGTH OF PIPE SECTIONS 10 feet
JOINING METHOD THREAD ~~AND COUPLE~~ SMG 2/8/89
(FLUSH JOINT THREADED)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Feet
PROTECTIVE PIPE ~~Ø~~ I.D. 10 inch

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0'			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5'			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP NA	BOTTOM NA	TOP	BOTTOM
BENTONITE	TOP 0.0'	BOTTOM 7.0'	TOP	BOTTOM
SAND	TOP 7.0'	BOTTOM 22.5'	TOP	BOTTOM
GRAVEL	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 9.0'	BOTTOM 19.0'	TOP	BOTTOM
PIEZOMETER TIP	21.5 feet			
BOTTOM OF BOREHOLE	22.5 feet			
GWL AFTER INSTALLATION				

AS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☐
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☐

373

REMARKS

QC/DH/2.4.89

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

258

4/23/90 WAL

FAC

RIG # 2

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 2084	COORDINATES:	DATE: 11-16-87
ELEVATION:	GWL: Depth 63.3FT Date/Time 11-18-87/17:00	DATE STARTED: 11-16-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 11-18-87
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ( )	RECOVERY ( )	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				SEE VISUAL CLASSIFICATION of soils FOR WELL # ~~384.~~ 3084 RMG 2/7/89			
15	17.0FT ST-0131 19.0FT						
30							
45							
60							WATER LEVEL 63.3 FT.
75				WELL TO 77 FT.			
				BOTTOM OF BORING			

NOTES: CONTRACTOR - PENNDRILL
DRILLER - HARRY DYMES
ASSISTANT - JOHN VANWINIE
RIG: CYCLONE 42

WATER ADDED TO HOLE - 1 TICK = 5 GALLONS
~~|||| ||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ||||

SCREEN - 58.4 - 73.4 FT.

RC/DIT/2-4-89
WELL # 208-1

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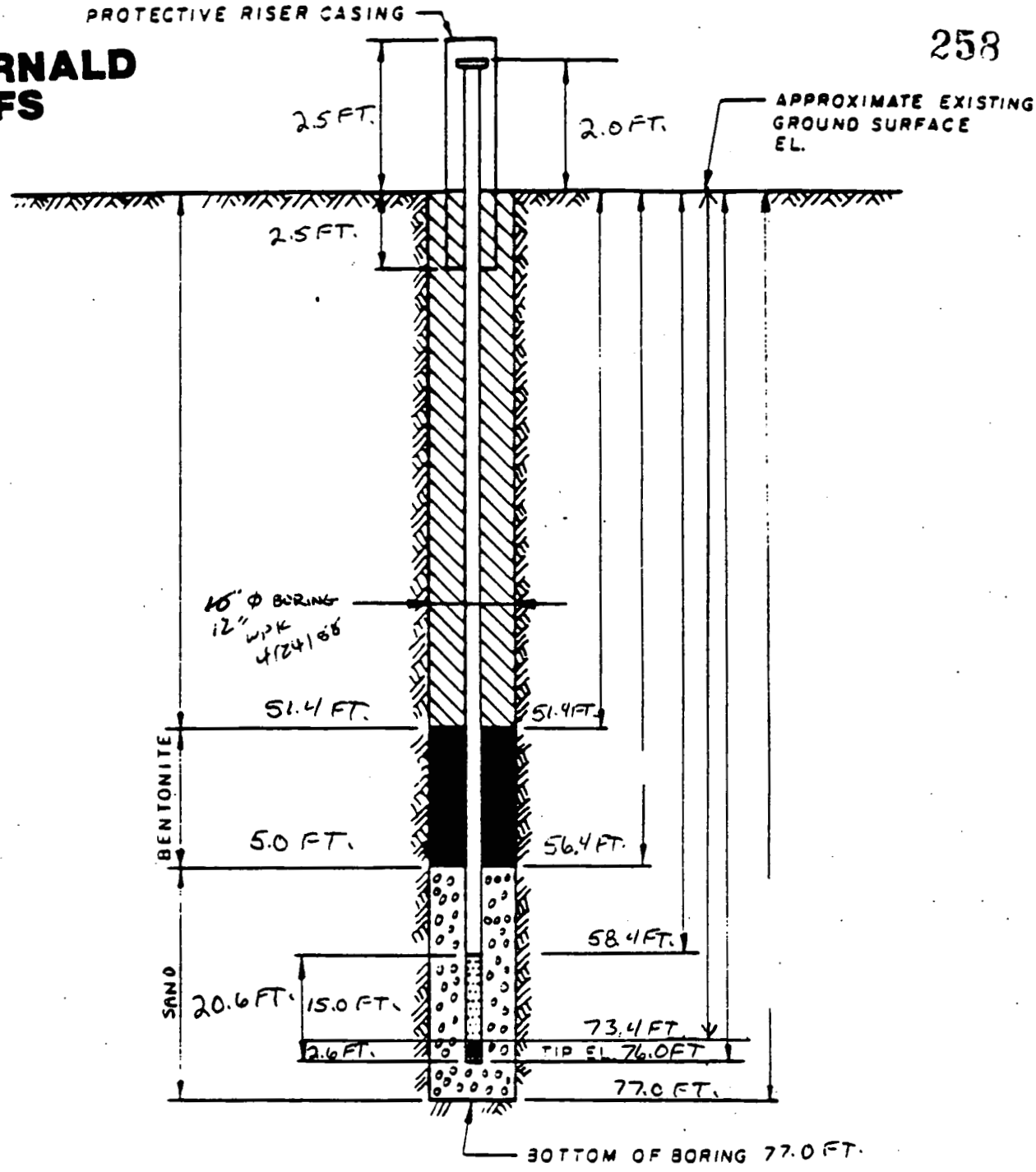
FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~284~~ 2084

PREPARED FOR BB 1-5-89

DRAWING NUMBER
CHECKED BY
APPROVED BY
DATE
DRAWN BY

375

QC/DH/2.4.89

FERNALD RI/FS

258

1st Key In		
2nd Key In		
Hard Copy Verification		

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FERNALD RI/FS FIELD ENG./GEO. D OAKLEY DATE 11-19-87
PROJECT NO. 602 CHECKED BY R Galbraith DATE 2/7/89
BORING NO. ~~2084~~ 2054 DD 1-5-89
PIEZOMETER NO. NA 2094 DATE OF INSTALLATION 11-19-87

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL
DRILLING FLUID (S) USED:
FLUID WATER FROM 4 TO 77 FT.
FLUID NA FROM NA TO NA

TYPE OF BIT FLATHEAD
CASING SIZE (S) USED:
SIZE 10 IN FROM 0 TO 77 FT.
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE MONITORING
DIAMETER OF PERFORATED SECTION 4 IN
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010 INCH
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 15 FT.

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4 IN
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE.
(FLUSH JOINT THREADS)

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 FT.
PROTECTIVE PIPE O.D. 10 INCH

OTHER PROTECTION LOCKABLE CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	2.0 FT.			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT.			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0 FT.	BOTTOM 51.4 FT.	TOP	BOTTOM
BENTONITE	TOP 51.4 FT.	BOTTOM 56.4 FT.	TOP	BOTTOM
SAND (WIRE WRAP TOP 56.4)	TOP ~~58.4 FT~~	BOTTOM 77.0 FT	TOP	BOTTOM
NO GRAVEL USED	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 58.4	BOTTOM 73.4	TOP	BOTTOM
PIEZOMETER TIP	76.0 ft			
BOTTOM OF BOREHOLE	77.0 FT			
GWL AFTER INSTALLATION	63.3 FT. ~~FOC~~ PP 11/24/88			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑ 376
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

REMARKS

QC/DR/2.4.89

	Initial	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

258

WPK 4/20/89

RIG #2

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: 3/84	COORDINATES:		DATE: 11-3-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 11-23-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth	Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6/N)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07512 8:00 07534 07535	3 12 12	12	VERY STIFF DARK BROWN (10YR, 3/3) SILT, TRACE CLAY, SAND, AND GRAVEL - DRY	ML	2.0	HNU - 0PPM γ - 0CPM Bd - 1000 CPM
2 3	07513 8:10	9 10 12	15	VERY STIFF YELLOWISH BROWN (10YR, 5/4) SILT, SOME CLAY, TRACE SAND AND GRAVEL - DRY	ML	4.0	HNU - 0PPM γ - 0CPM Bd - 60CPM
4	07514 8:25	15 17 21	15	VERY STIFF GRAYISH BROWN (10YR, 5/2) 3.6 SILT, SOME CLAY, TRACE SAND - DRY	ML	4.0	HNU - 0PPM γ - 0CPM Bd - 60 CPM
				HARD DARK BROWN (10YR, 4/3) CLAY, SOME SILT, TRACE SAND - DRY	CL	3.5	
5 6	07515 8:40	22 26 19	16	HARD DARK BROWN (10YR, 3/3) CLAY, SO SOME SILT, TRACE SAND - DRY	CL	3.5	HNU - 0PPM γ - 0CPM Bd - 60 CPM
				HARD YELLOWISH BROWN (10YR, 5/4) CLAY, 6.6 SOME SILT, TRACE SAND - DRY	CL	3.5	
				STIFF GRAYISH BROWN (10YR 5/2) CLAY, 6.4 SOME SILT, TRACE SAND - MOIST.	CH	1.0	
7	07516 15:55	3 4 8	10	STIFF YELLOWISH BROWN (10YR, 5/6) CLAY, SOME SILT, TRACE SAND - DRY	CL	2.0	HNU - 0PPM γ - 0CPM Bd - 60 CPM
8 9	07517 16:10	2 2 6	15	MEDIUM STIFF BROWN (10YR, 5/3) CLAY, TRACE SAND AND SILT - MOIST.	CH	1.0	HNU - 0 PPM γ - 0 CPM Bd - 60 CPM
10	07518 7:50	3 4 7	13	STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME GRAVEL, ~~AND~~ TRACE SAND AND SILT - MOIST	CH	1.25	HNU - 0 PPM γ - 0 CPM Bd - 50 CPM
11 12	07519 8:05	6 8 12	16	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST.	CL	2.5	HNU - 0PPM γ - 0CPM Bd 60 CPM
13	07520 8:20	3 11 15	17	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SAND, TRACE GRAVEL AND SILT - DRY	CL	2.75	HNU - 0PPM γ - 0CPM Bd - 50CPM
14 15	07521 8:35	4 11 15	18	VERY STIFF LIGHT YELLOWISH BROWN (10YR, 6/4 CLAY, SOME SAND, TRACE 14.6 FINE GRAVEL AND SILT - MOIST	CL	2.75	HNU - 0PPM γ - 0CPM Bd - 50 CPM
				VERY STIFF GRAY (5YR, 5/1) CLAY, SOME SAND, TRACE GRAVEL AND SILT - MOIST	CL	3.25	

NOTES: CONTRACTOR: PENNDRILL
RIG: CYCLONE 42
DRILLER: HARRY DYKES JR.
ASSISTANT: JOAN VANDINE
WATER ADDED TO HOLE - 1 TICK = 5 GALLONS

ASTM STANDARD PENETRATION TEST USED FOR SPLIT SPOON SAMPLING
COLORS CHARACTERIZED USING MUNSELL COLOR CHARTS.

BACKGROUND
HNU - 0PPM
γ - 0CPM
LEL - 0 %
Bd - 300 CPM - GROUND

377

402-11-86

QC/DH/2-4-89

258

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD		
BORING NUMBER: ~~384~~ 30S4011	COORDINATES:		DATE: 11-4-87
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D. DATTLE	Depth	Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL			PAGE 2 OF 9

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	07522 8:55	3 8 12	18	VERY STIFF GRAY (5Y, 5/1) CLAY, SOME SAND, TRACE GRAVEL, AND SILT - MOIST	CL	3.25	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
17 18	07523 10:00	3 6 9	12	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE GRAVEL AND SILT - MOIST.	CL	1.25	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
19	07524 10:20	3 4 5	8	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE GRAVEL AND SILT, MOIST.	CH	.75	HNU - 0 PPM Bα - 60 CPM γ - 0 CPM
20 21	07525 10:35	5 6 11	13	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE GRAVEL AND SILT - MOIST	CH	1.25	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
22	07526 10:50	5 6 12	15	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME SAND, TRACE FINE GRAVEL AND SILT - MOIST	CH	1.0	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
23 24	07527 11:10	2 6 7	13	STIFF OLIVE GRAY (5Y 5/2) CLAY, SOME SAND AND GRAVEL, TRACE SILT, MOIST	CH	.75	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
25	07528 11:40	1 3 7	10	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME FINE GRAVEL, TRACE SAND AND SILT - MOIST	CH	.75	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
26 27	07529 15:20	4 5 7	12	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT, MOIST	CH	.75	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
28	07530 15:50	2 4 7	12	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST	CH	0.5	HNU - 0 PPM Bα - 50 CPM γ - 0 CPM
29 30	07531 16:10	6 6 7	6	STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - MOIST	CH	1.0	HNU - 0 PPM Bα - 70 CPM γ - 0 CPM

NOTES:

BACKGROUND IN LEAD SHIELD - 40-70 CPM.

402-11-88

QC/DH/2-4-89

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~384~~ 3054	COORDINATES:	DATE: 11-4-87	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87	
ENGINEER/GEOLOGIST: D OAKLEY/W HEGLEY	Depth Date/Time	DATE COMPLETED: 11-12-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 9	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	07532 16:30	4 10 21	13	HARD OLIVE GRAY (5Y 5/2) CLAY, SOME GRAVEL AND SAND TRACE ~~CLAY~~ SILT - MOIST	CL	3.25	HNU - 0 PPM βα - 70 CPM γ - 0 CPM
32	07533 16:45	22 24 24	15	HARD OLIVE GRAY (5Y 5/2) CLAY, SOME GRAVEL AND SAND, TRACE SILT - DRY	CL	4.5	HNU - 0 (PPM) βα - 50 CPM γ - 0 CPM END 11 4 87
33							
34	07536 0840	7 16 22	14	VERY STIFF OLIVE GRAY (5Y 5/2) CLAY SOME GRAVEL AND SILT - DRY	CL	2.5	BEGIN 11 5 87 HNU = 0 ppm βα = 60 CPM γ = 0 CPM
35 36	07537 0945	16 18 22	16	HARD GREY (5Y 5/1) CLAY ~~GRAVEL~~ SOME GRAVEL TRACE SAND	CL	4.5	HNU = 0 ppm βα = 60 cpm γ = 0 cpm
37	07538 1040	8 11 19	12	VERY STIFF GREY (5Y 5/1) CLAY SOME GRAVEL AND SAND TRACE OF SILT - MOIST	CL	2.5	HNU - 0 ppm βα = 60 cpm γ 0 cpm
38 39	07539 1126	6 12 16	12	38.0 ~~VER~~ MEDIUM DENSE ~~CLF SAND AND~~ SILT SILT AND SAND reddish BROWN (7.5 YR 6/5) - MOIST	SM	1.0	HNU 0 ppm βα 60 cpm γ 0 cpm
40 41	07540 07541 07542 1330	11 22 26	14	DENSE Yellowish Brown (10YR 5/4) FINE SAND TRACE SILT - MOIST	SP ~~SM~~		HNU = 0 ppm βα = [illegible] cpm γ = 0 cpm
42							
43							
44							
45							

NOTES:

402-11-86

QC/DN/2 4.89

1st Key In		
2nd Key In		
Hard Copy Verification		

PAC

258

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 - 3.2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~2-84~~ ~~3-84~~ 3094 BA 1-5-89	COORDINATES:	DATE: 11 5 87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11 3 87
ENGINEER/GEOLOGIST: U KEGLEY/DCH	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 4 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	07543 1600	12 23 30	13	VERY DENSE DARK YELLOWISH BROWN (10YR 4/4) SAND TRACE OF GRAVEL - DRY	SP	—	HNU = 0ppm BG = 60cpm γ = 0cpm
47							
48							
49							
50	07544 1440	16 36 37	12	VERY DENSE DARK YELLOWISH BROWN (10YR 4/3) SAND TRACE OF GRAVEL - DRY	SP	—	HNU 0ppm BG 60-50cpm γ = 0cpm
51				VERY DENSE YELLOWISH BROWN 10YR 5/4 FINE SAND MOIST			
52							
53							
54							
55							7:15 11-6-87 D CAHLES
56	07545 8:30	17 27 50	18	VERY DENSE DARK YELLOWISH BROWN (10YR 4/3) FINE SAND - TRACE GRAVEL - MOIST	SP	—	HNU 0PPM BG - 50CPM γ - 0CPM
57							
58							
59							

NOTES:

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402-11-86

QC/DH/2.4.89

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

258

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~384~~ 3094	COORDINATES:	DATE: 11-6-87
ELEVATION:	GWL: Depth 62.75 Date/Time 11-10-87 8:00	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 5 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	07546	10		VERY DENSE DARK YELLOWISH BROWN (10YR, 4/4) SAND AND GRAVEL - MOIST	SW	—	HNU - 0 PPM
60.8							γ - 0 CPM
61	9:00	21 30	16	VERY DENSE DARK GRAY (10YR, 4/1) FINE SAND, TRACE GRAVEL - DRY	SP	—	Bα - 60 CPM
62							
63							GWL 62.75
64							
65	07547	14		VERY DENSE DARK GRAY (10YR, 4/1) FINE SAND, TRACE FINE GRAVEL - WET.	SP	—	HNU - 0 PPM
66	9:55	22 35	18				γ - 0 CPM
							Bα - 70 CPM
67							
68							
69							
70				DENSE DARK GRAY (10YR, 4/1) FINE SAND,			
70.6	07548	6		TRACE FINE GRAVEL - WET.	SP	—	HNU - 0 PPM
71	10:40	16 28	18	DENSE DARK YELLOWISH BROWN (10YR, 4/4) FINE SAND, TRACE GRAVEL - WET	SP	—	γ - 0 CPM
							Bα - 60 CPM
							11-10-87 7:50
72							
73							
74							
75							

NOTES:

402-11-86

QC/DH/2.4.89

pmc

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: ~~384~~ 3084 BB 1-5-89	COORDINATES:	DATE: 11-10-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 6 OF 9

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6/in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75	07549 13:20	6 11 15	12	~~MEDIUM DENSE GRAYISH BROWN (10YR 5/2) VERY FINE SAND-WET~~ MEDIUM DENSE GRAY (5Y 4/1) SAND SOME FINE GRAVEL - WET.	SP SW	— —	HNU - 0PPM γ - 0CPM Bα - 60CPM
77							
78							
79							
80	07550 15:40	8 5 7	6	MEDIUM DENSE GRAYISH BROWN (10YR 5/2) SAND, SOME FINE GRAVEL - WET.	SW	-	HNU - 0PPM γ - 0CPM Bα - 60 CPM
81							
82							
83							
84							
85	07551 8:30	18 30 45	12	VERY DENSE GRAYISH BROWN (10YR 5/2) GRAVELLY SAND - WET.	SW	-	HNU - 0PPM γ - 0CPM Bβ - 60CPM
86							
87							
88							
89							
90							

NOTES:

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402-11-86

QC/DH/24.39

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 384 3084 dd 1-5-89	COORDINATES:	DATE: 11-11-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D.O AHLEY	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 7 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	07552 10:15	6 8 10	13	MEDIUM DENSE GRAYISH BROWN (10YR, 5/2) SAND, SOME FINE GRAVEL - WET 90.8	SW	–	HNU - 0 PPM γ - 0 CPM Bα - 70 CPM
				MEDIUM DENSE YELLOWISH BROWN (10YR, 5/6) FINE SAND - WET	SP	–	
92							
93							
94							
95	07553 13:45	25 39 42	16	VERY DENSE GRAYISH BROWN (2.5Y, 5/2) MEDIUM SAND, TRACE FINE GRAVEL - 95.9 WET.	SP	–	HNU - 0 PPM γ - 0 CPM Bα - 60 CPM
96				VERY DENSE DARK BROWN (10YR, 4/3) MEDIUM SAND, TRACE FINE GRAVEL - WET 97.0	SP	–	DRILLERS ESTIMATE
97							
98							
99							
100	07554 16:25	11 7 7	8	MEDIUM DENSE GRAYISH BROWN (2.5Y, 5/2) SAND AND GRAVEL - WET.	SW	–	HNU - 0 PPM γ - 0 CPM Bα - 60 CPM
101							
102							
103							
104							
105							

NOTES:

383

402-11-86

QC/DH/2.4.89

PAC

258

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 002	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 384 3054.13B	COORDINATES:	DATE: 11-11-87
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-3-87
ENGINEER/GEOLOGIST: D OAKLEY	Depth Date/Time	DATE COMPLETED: 11-12-87
DRILLING METHODS: CABLE TOOL		PAGE 8 OF 9

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106	07555 16:55	17 31 42	18	VERY DENSE GRAYISH BROWN (2.5Y, 5/2) SAND AND FINE GRAVEL - WET. 105.8 VERY DENSE DARK GRAYISH BROWN (2.5Y, 4/2) VERY FINE SAND - WET	SW SP	- -	HNU - 0 PPM γ - 0 CPM Bα - 60 CPM
107							
108							
109							
110 111	07556 9:40	3 5 8	14	MEDIUM DENSE DARK GRAYISH BROWN (2.5Y, 4/2) VERY FINE SAND - WET	SP	-	HNU - 0 PPM γ - 0 CPM Bα - 40 CPM
112							
113							
114							
115 116	07557 10:45	3 7 16	18	MEDIUM DENSE DARK GRAYISH BROWN (2.5Y, 4/2) VERY FINE SAND - WET	SP	-	HNU - 0 PPM γ - 0 CPM Bα - 40 CPM
117							
118							
119				119.0 "BLUE CLAY"			DRILLERS CONTACT.
120					CL	-	

NOTES:

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402-11-86

GC/DH/2-4-89

FERNALD RI/FS

258

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FERNALD RI/FS		
BORING NUMBER: ~~389~~ 3054	COORDINATES:	DATE: 11-12-87	
ELEVATION:	GWL: Depth / Date/Time	DATE STARTED: 11-3-87	
ENGINEER/GEOLOGIST: D OATLEY	Depth / Date/Time	DATE COMPLETED: 11-12-87	
DRILLING METHODS: CABLE TOOL		PAGE 9 OF 9	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121	07558 13.45	9 16 25	15	HARD OLIVE GRAY (5Y, 4/2) CLAY, TRACE SILT - MOIST	CL	2.5	INJ - 0.4PM 8 - 0CPM 32 - 50CPM *
122							* MUNSELL COLOR NOT ACCURATE. MORE OF A SILVER-BLUE COLOR - NOT FOUND IN CHARTS
123	51 07559	NA	24				
124				WELL TO 124.0 FT.			

NOTES:

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402-11-86

QC/DH/2.4.89
WELL # ~~384~~ 3084
60

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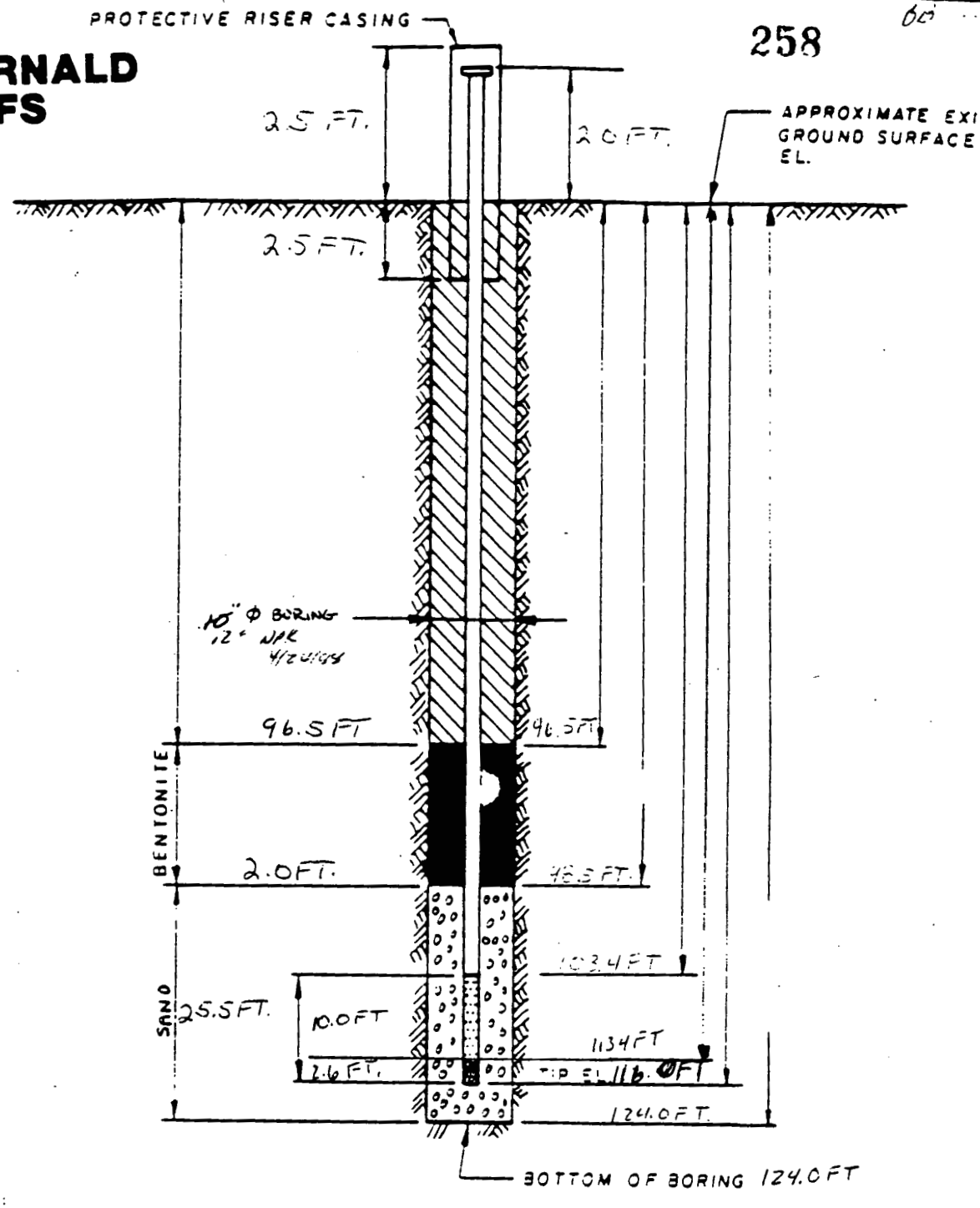
FERNALD RI/FS



NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL ~~384~~ 3084

PREPARED FOR BB 1-5-89

DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY DAS

386

Hard Copy Verification

PIEZOMETER INSTALLATION SHEET

ME FERNALD RI/FS
- 1.0.0
~~54~~ 3.54 GG 1-5-51
NO. NA 3-34

FIELD ENG./GEO. D. CATLEY DATE 11-18-87
CHECKED BY R Galbraith DATE 2/7/88
DATE OF INSTALLATION 11-14-87 11-15-87

DRILLING

METHOD UNDE TOOL
FLUID (S) USED:
EN FROM 2 FT. TO 124 FT.
— FROM — TO —

TYPE OF BIT FLATHEAD
CASING SIZE (S) USED:
SIZE 10" FROM 0 FT. TO 124 FT.
SIZE — FROM — TO —

DESCRIPTION

UCTORING
PERFORATED SECTION 4 IN.
TYPE:
HOLES ☐ SCREEN ☒
OF PERFORATIONS .010 INCH
LENGTH
ATED AREA 10 FT.

RISER PIPE MATERIAL 316 STAINLESS STEEL
RISER PIPE DIAMETERS:
O.D. 4 3/8" IN I.D. 4 IN
LENGTH OF PIPE SECTIONS 10 FT.
JOINING METHOD THREAD AND COUPLE

STEM

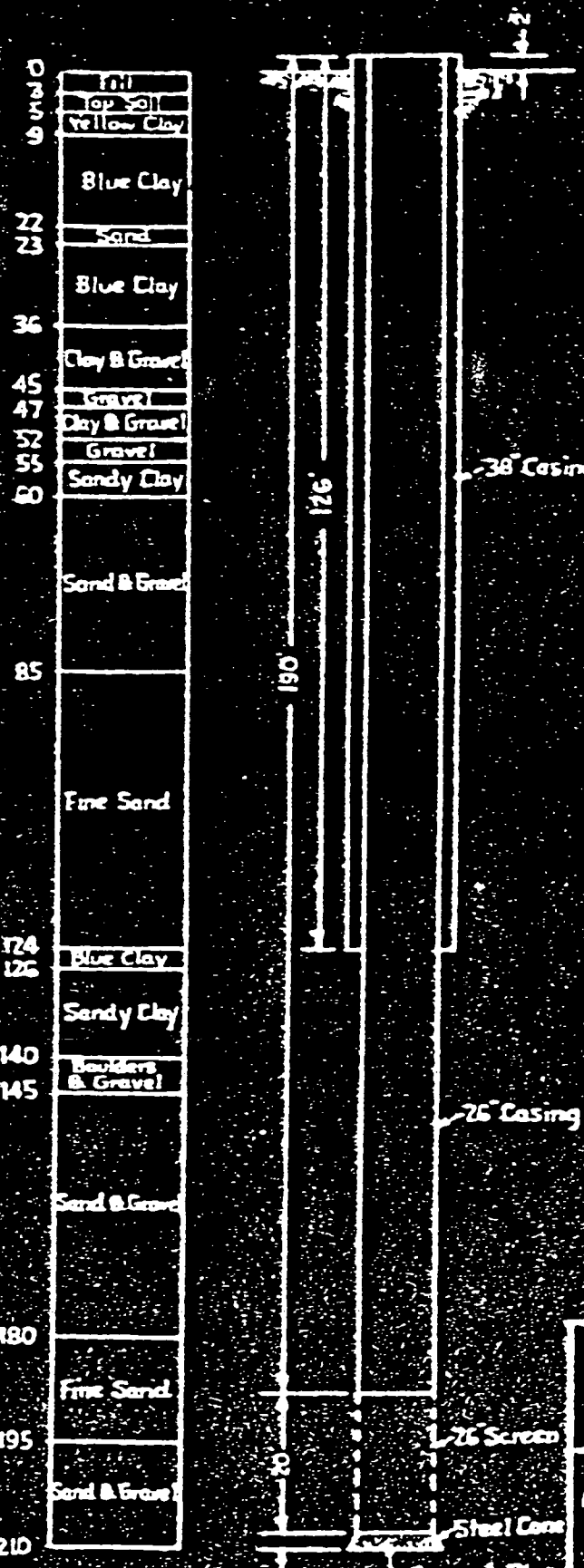
IVE PIPE LENGTH 5 FT.
PE 10 IN

OTHER PROTECTION LOCKABLE WITH LOCK

	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEV (FT)	
	2.0 FT.			
	0.0			
IVE PIPE	2.5 FT			
TERIALS:				
	TOP 0.0 FT	BOTTOM 96.5 FT	TOP	BOTTOM
	TOP 96.5 FT.	BOTTOM 98.5 FT.	TOP	BOTTOM
	TOP 98.5 FT.	BOTTOM 124.0 FT.	TOP	BOTTOM
	TOP NA	BOTTOM NA	TOP	BOTTOM
	TOP 103.4 FT.	BOTTOM 113.4 FT.	TOP	BOTTOM
	116.			
	124.0 FT.			
ON				

SHED AFTER INSTALLATION? YES ☐ NO ☒
ERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
This was made by D. Catley at the time this was made 11/24/88

409-11-86



MATERIAL:

Pipe: 126' of 38" x 5/8" Steel Casing & 190' of 26" x 1/4" Steel Casing.

Screen: 20' of 26" Bronze Shutter Screen.

Cone: 26"-34" x 2' Steel Cone.

PUMP:

No.		Stag No.	
Type	RKLC	Size	12"
Setting	120'	Stages	5
Suction	8" x 10"	Impellers	Bronze
Discharge	8"	Shaft	
Tubing	2½"	Press. B. P.	
Shafting	1½"		

MOTOR:

Make	U.S.	Type	C. F. N.
Volts	440	Cycle	60
Phase	3	Amp.	
H. P.	50	R. P. M.	1750
Frame	405	Serial	

WELL:

Capacity	715 G.P.M.	Static Level	55
Guarantee	700 G.P.M.	P. Level	90'-7"
Started	8-24-51	Pressure	
Finished	10-6-51	Pumped	715 G.P.M.
Accepted	10-6-51	Depth	210'

REMARKS:

Used 200 tons of Washed Gravel.

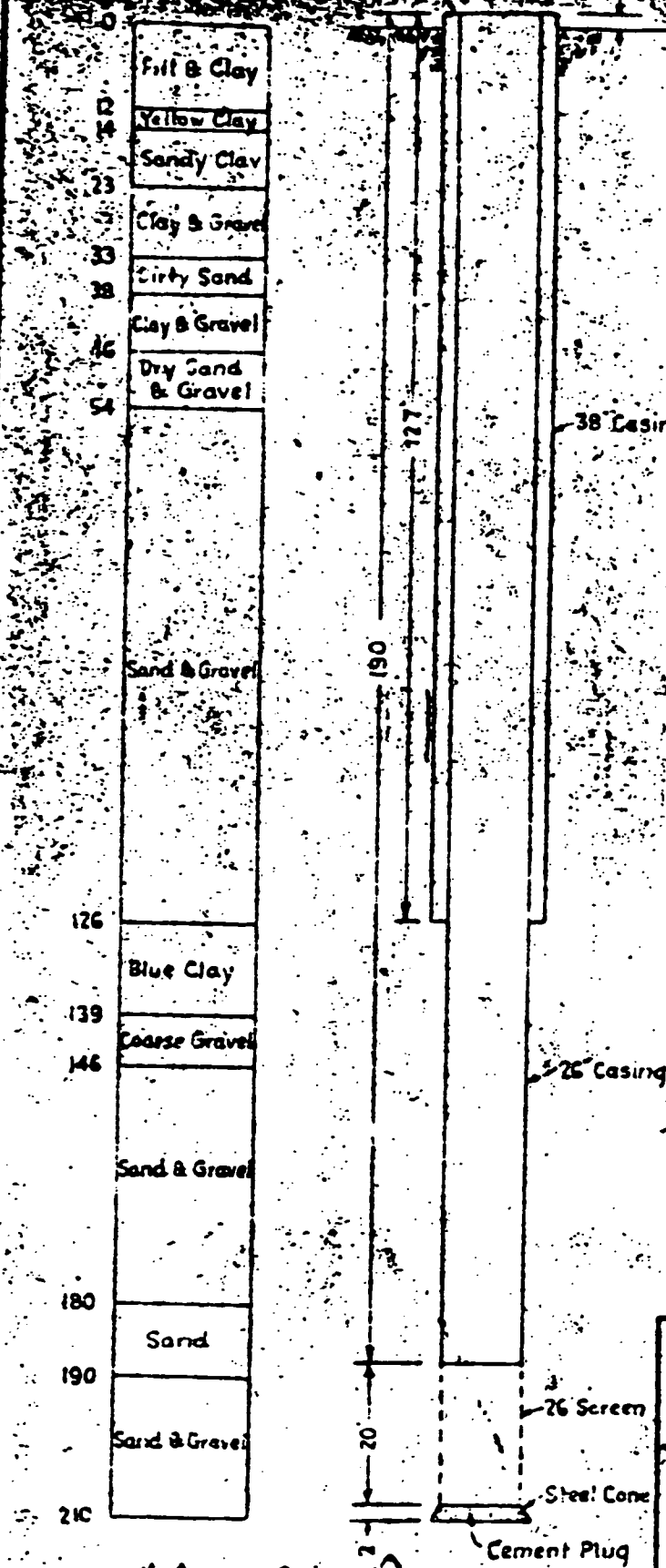
Return to L.W.
North
Wells

Driller: Neil Morris
Installer:

THE LAYNE-OHIO CO.
WATER SUPPLY CONTRACTORS
COLUMBUS OHIO

ATOMIC ENERGY COMMISSION
(FERNALD STA.)
VENICE, OHIO

DRAWN BY O.L.M.S. CHECKED BY
WELL NO. 1 DRAWING NO. 1103



MATERIAL:

Pit. 127 of 38" x ¼ Steel Casing & 190' of 26" x ¼ Steel Casing

Screen: 20' of 26" x ¼ Bronze Shutter Screen

Cone 26" x 34" x 2' Steel Cone

PUMP: 258

No.		Shop No.	
Type	R.K.L.C.	Size	12
Setting	120'	Stages	5
Suction	9" x 10"	Impellers	Bronze
Discharge	8"	Head	
Tubing	2½"	Press. B. P.	
Shafting	1½"		

MOTOR:

Make	U.S.	Type	C.F.N.
Volts	440	Cycle	60
Phase	3	Amp.	
H. P.	50	R. P. M.	1750
Frame	405	Serial	

WELL:

Capacity	700 G.P.M.	Static Level	55
Guarantee	700 G.P.M.	P. Level	70
Started	9-13-51	Pressure	
Finished	10-16-51	Pumped	715
Accepted		Depth	210

REMARKS:

Middle

elevation base of pump
Concrete. 577.66

Driller: Russell Branch
Installer:

THE LAYNE-OHIO CO.
WATER SUPPLY CONTRACTORS
COLUMBUS OHIO

ATOMIC ENERGY COMMISSION
(FERNALD STATION) 389
VENICE, OHIO

O.L.Ms
2

1104

No 2 Production Well

THE LAYNE-OHIO CO

ATOMIC ENERGY COMMISSION
(PERNALD STATION)
VENICE, OHIO

RCRA SAMPLING AND ANALYSIS PLAN

FOR

WASTE PIT #4

LOCATED AT THE

FEED MATERIALS PRODUCTION CENTER

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R*

TABLES

1 Monitor Well Sampling Order

2 Containers and Preservatives Used for RCRA Groundwater Sampling

3 Preservation of Groundwater Samples Prior to Laboratory Analysis

4 Analytical Methods and Detection Limits for Groundwater Samples - Water Quality Indicators

5 Analytical methods and Detection Limits for Groundwater Samples - Volatiles

6 Analytical Methods and Detection Limits for Groundwater Samples - Radionuclides

FIGURES

1 Field Sampling Record

2 Chain of Custody Record

1.0 Introduction

Waste Pit #4 at the Feed Materials Production Center in Fernald, Ohio is subject to regulations of the Resource Conservation and Recovery Act (RCRA). Interim status regulations (as described in Task B.5 of the Federal Facilities Compliance Agreement (FFCA)) are addressed by this Response which presents a Sampling and Analysis Plan (SAP) prepared in conformance with 40 CFR 265.92.

The SAP presents information on:

- Groundwater sample collection from both monitoring and water supply wells.
- Sample preservation and shipment procedures.
- Analytical procedures and chain of custody controls.

The groundwater sampling program at the FMPC is a dynamic one. As such, field procedures described herein, may from time to time be modified based on weather and other conditions at the well. However, all sampling procedures utilized are designed to be consistent with USEPA/OEPA objectives and guidelines.

2.0 Scope of Plan

This document presents the Sampling and Analysis Plan required by Subpart F, Section 265.92 of the Resource Conservation and Recovery Act (RCRA).

This plan has been developed in accordance with specific regulations and guidelines. The following references have been used in its preparation:

(1) Procedures Manual for Ground Water Monitoring at Solid Wastes Disposal Facilities, 1979, U.S. EPA-530/SW-611 (reprinted 1980).

(2) Manual of Ground Water Sampling Procedures, 1981, Marion R. Scalf, et. al., NWWA/EPA Series.

(3) Standard Methods for Analysis of Water and Wastewater, 1985, 20th Edition, APHA-AWWA-WPCF.

(4) RCRA Ground - Water Monitoring Technical Enforcement Guidance Document, 1986, U.S. EPA, OSWER-9950.1. R

As required by the referenced regulation, this plan for groundwater monitoring contains procedures for sample collection, sample preservation and shipment, analytical procedures and chain of custody controls.

3.0 SAMPLE COLLECTION

This section of the sampling and analysis plan presents procedures use to evacuate, sample and preserve groundwater samples collected from the FMPC monitoring well networks.

3.1 Sampling Order

In order to minimize the possibility for cross contamination, samples will be collected beginning at the well least likely to contain elevated levels of hazardous wastes or their constituents (upgradient well) and ending at the well most likely to contain elevated levels of hazardous wastes or their constituents. The sampling order for monitor well locations is indicated in Table 1. During field sampling activites, wells are grouped into on-site and off-site locations. Each sampling team then samples its series of wells in the prescribed order.

3.2 Sampling Technique

The sampling technique can be divided into three separate stages:

- Pre-sampling measurements
- Well evacuation
- Sample acquisition

Figure 1 is an example of a Field Sampling Record, used during the well sampling activities. This form follows the three stages mentioned above and is completed for each well sampled.

Prior to pre-sampling measurements, the following information is recorded in permanent ink on the Field Sampling Record.

TABLE 1

Monitoring Well Sampling Order

Sampling Order	Well Number	Location
1	12	Off North access road
2	SW-2	Southwest collector
3	P-1	West side production area
4	P-2	West side production area
5	P-3	Water treatment Plant
6	OS-1 deep	Farm house on Willey Road
7	OS-1 dug	Farm house on Willey Road
8	15s	Pasture on Willey Road
9	16d	Guard training area
10	16s	Shooting range
11	17d	Willey Road Bridge
12	17s	Willey Road Bridge
13	18d	South of production area
14	18s	South of production area
15	20d	Southwest of production area
16	20s	Southwest of production area
17	20TP	Southwest of production area
18	14d	Confluence of SSOD with Paddy's Run
19	14s	Confluence of SSOD with Paddy's Run
20	9	Paddy's Run-East bank
21	11	North of production area
22	13d	East of scrap metal site
23	13s	East of scrap metal site
24	8d	South of waste pit storage area
25	8s	South of waste pit storage area
27	3	East of pit 3 area
28	4	South of pit 3
29	5	South of pit 3
30	1d	North of K-65 tanks
31	1s	North of K-65 tanks
32	19d	East of pit 4
33	19s	East of pit 4
34	19TP	East of pit 4
35	21s	South of pit 4
36	21TP	South of pit 4
37	22s	West of pit 4
38	22TP	West of pit 4
39	OS-1	Exterior tap in yard of farm house off Willey Road
40	OS-2	East side of Paddy's Run Road
41	OS-3	East side of Paddy's Run Road

DAMES & MOORE
FIELD SAMPLING RECORD

Job _____ Date _____
Job # _____

Well # _____ Well Diameter _____
Location _____

I Water Level Measurements (From Top of Casing) in Feet.
Total Well Depth:
Depth to Water:
Height of Water Column:
Volume Conversion Factor:
Gallons in Well:

Conversion Factor
0.16 = 2" ID
0.65 = 4" ID
1.47 = 6" ID

II Well Evacuation
Pumping: Submersible
Nitrogen
Centrifugal

Bailing: Kemmerer
Bucket Bailer
: Other (Describe)

Pump On:
Pump Off:
Pumping Time:
Pumping Rate:
Gallons Removed:

Bailing Started:
Bailing Stopped:
Gallons Removed:

III Sampling
Withdrawal: Pumped (describe)
Bailed (describe)

Time: Date:
Sample I.D. #:
Trip Blank #:
No. of containers filled (primary lab):
No. of containers filled (replicate samples):
Physical appearance and odor:

Refrigerated: Date:
Time:

Field Tests (Before After Evacuation)
Temperature (°C/°F):
pH:
Spec Cond (umhos/cm):
Dissolved oxygen (mg/l):

Weather:

Comments:

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FIGURE 1

- o Facility Name
- o Name of sampling personnel, affiliation, date and time of sampling
- o Well number, location and well diameter
- o Short description of weather conditions

3.2.1 Pre-sampling measurements

Pre-sampling measurements consist of recording total depth of the well, depth to water, well diameter and other well characteristics as indicated on the Field Sampling Record.

Measurement of total well depth is made with a weighted tape, divided into feet, inches and tenths of an inch. The accuracy of the measurement is to the 0.01 ft.

The water level measurement is made with a water level indicator model 51453 made by Slope Indicator Co. (or equivalent). The accuracy of this measurement is also to the nearest 0.01 ft.

Both measurements are made from the same chisel mark on the top of the outer protective (metal) well casing.

Subtracting the depth to the water table from the total well depth, the height of the water column in the well can be calculated. Multiplying this by the well conversion factor (based on well diameter) the number of gallons of water in the well can be estimated.

In addition, field measurements such as pH, conductivity, and temperature are made initially and are observed continuously throughout the well evacuation process prior to sampling in order to determine if the chemistry of the produced water has stabilized (see Section 3.2.2). R*

3.2.2 Well Evacuation

The composition of the water within the well casing and in close proximity to the well (e.g. the gravel pack) is usually not representative of the overall ground water quality at the sampling site. This is because important geochemical conditions such as the oxidation-reduction potential may differ drastically near the well from those in the surrounding water bearing materials. For this reason it is essential that a well be pumped or bailed until the well is thoroughly flushed of standing water and contains fresh water from the aquifer. Conductivity, temperature, and pH measurements are continuously observed during the well evacuation process in order to adequately determine when the chemistry of the produced water has stabilized.

The recommended amount of water required to be pumped or bailed from the well before sampling is dependent on many factors including the characteristics of the well, the hydrogeological nature of the aquifer, the type of evacuation equipment being used, and the parameters being sampled. The time required may range from the time needed to pump or bail one casing volume to the time needed to pump several casing volumes. At the FMPC, between 3 and 5 casing volumes of water are normally removed prior to sampling the well. A minimum of one casing volume is removed from low yielding wells and at least three casing volumes are evacuated from wells with higher yields. Well water will be evacuated either by purge pumping or bailing.

<u>Pumping</u>

The majority of monitoring wells currently in place at the FMPC have dedicated 3.75" submersible pumps and discharge tubing installed in them. These pumps are used to purge the wells. As each of these pumps are dedicated to a single

well, no special cleaning at the pump or discharge tubing prior to or after sampling is required.

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Purge water withdrawn from the wells within the plant production area is collected in a tank truck and eventually fed into the FMPC's wastewater treatment system. Purge water withdrawn from outside the plant production area is discharged onto the ground surface and directed away from the casing.

For those wells that do not have a dedicated pump, a 3.5" portable submersible pump is used to purge the wells. The pump and associated tubing is cleaned after each use by pumping water with a non-phosphate detergent, tap water and then distilled water through the pump and tubing prior to its use in another well (see Section 3.2.5).

The pumping start time is marked on the field sampling record and the pumping rate is monitored with a flow meter or by the time needed to fill a vessel (bucket) of known volume. Based on the pumping rate, pumping time is established to typically remove 3 to 5 volumes of water from the well.

Bailing

There are several shallow wells in the surficial till layer which have recoveries too slow to allow for continuous pumping. In this case, wells are evacuated using a 2 foot long, 1.75 inch i.d. stainless steel bailer with a teflon check valve. If the well is bailed dry prior to removing the required volumes it is allowed to reach 80% of recovery and then immediately sampled.

New nylon weave rope is used in the manipulation of the bailer and separate lengths are dedicated to each well. The rope is bagged and disposed after use on the site.

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A biodegradable, non-phosphate cleaning solution (e.g., ALCONOX) is used to clean the bailers upon completion of well evacuation. The bailer is triple rinsed with tap water, distilled water, and acetone prior to rinsing with pesticide quality hexane and wrapping with aluminum foil before reuse (see Section 3.2.5). Bailed water from wells within the plant production area is collected in a tanker and disposed in the FMPC's wastewater treatment system. Bailed water from wells outside the plant production area, as well as wash and rinse water is discharged to the nearby ground surface.

3.2.3 Sample Collection

After removal of the required volumes from the well, the sample bottles are clearly labelled in permanent ink.

For collection of samples from pumps, the pump discharge tubing is placed near the bottom of the sample bottle and gradually withdrawn as the container fills. All sample bottles are filled to the top without overflowing, and the caps are firmly hand tightened to prevent leakage. Because of the relatively low turbidity of the ground water at this site, no field filtering of samples is performed. Only samples for non-volatile, inorganic constituents are collected using the dedicated pumping equipment.

In the case of sampling with a bailer, the water sample from the bailer is minimally handled and transferred immediately to the sample bottle. Bailing is used to collect samples for volatile organic constituents and total coliform. Bailing takes place subsequent to inorganic sampling; however, sufficient time is allowed to let the water stabilize prior to bailing.

As each full set of samples is collected from each monitoring point, they are stored in sampling kits comprised of an insulated container containing ice and appropriate shipping and handling instructions.

3.2.4 Field Blanks

As part of the ongoing QA program, samples are accompanied to the lab by field blanks. Field blanks are divided into cleaning blanks and trip blanks.

Cleaning blanks are made prior to each round of sampling, at least one each day of sampling. They consist of distilled, deionized water which is collected from the bailers after cleaning. They are analyzed and values are used to interpret the effectiveness of the cleaning procedures and bottle handling procedures.

In addition to the cleaning blanks, two types of trip blanks accompany the samples. These consist of sample bottes filled with distilled, deionized water and capped in the laboratory. One trip blank remains capped and accompanies the sample at all times until returning to the laboratory where it is opened and tested along with the other samples. The other trip blank is set aside during the sampling of the wells and left open to the atmosphere. The purpose of these trip blanks is to ensure that proper sample bottle preparation and handling techniques have been employed, and to evaluate the potential for atmospheric influences on sampling equipment.

3.2.5 Decontamination Procedures

Sampling equipment such as bailers, metering probes, and non-dedicated pumps and associated tubing used for RCRA groundwater monitoring at the FMPC are thoroughly cleaned and dried prior to reuse. Since organics are of concern with the FMPC detection monitoring efforts, the following procedure is practiced: clean with a non-phosphate detergent (e.g. ALCONOX); and rinse with tap water, distilled water, acetone, and pesticide quality hexane. If organics are of prime concern, then the following procedure would be followed: clean with a non-phosphate detergent; and rinse with 0.1N hydrochloric or nitric acid, tap water, and distilled water.

4.0 Sample Preservation and Shipment

In order that laboratory results be representative of the actual sample condition at the time of collection, it is important that proper methods be used for the preservation and transport of the samples prior to their delivery to the lab. These procedures are summarized below and are consistent with USEPA requirements as described in References 1 and 2.

4.1 Sample Containers

Proper types and materials must be utilized for the sample containers (bottles) in order to ensure that the samples, and in particular the parameters to be analyzed from that particular bottle, do not react with the container material and alter the concentration or values of the parameter. Sample bottles are supplied by the subcontracted laboratory and have been carefully selected to meet these performance objectives. A variety of materials, such as amber glass, clear glass, and polyethylene are employed as required. Where necessary, specialized sample bottles are utilized, such as for VOC measurements. Table 2 provides a more detailed description of the types of sample bottles used during RCRA groundwater monitoring at the FMPC.

4.2 Sample Preservation

In addition to selection of proper container materials, other methods are often required in order to reduce the possibility of chemical reactions and/or precipitations occuring within the container which could alter analytical results. Those sample bottles which require chemical perservatives (e.g. acid) have the preservatives added by the laboratory prior to shipment of the bottles to the site. In addition, all sample bottles are placed in iced thermal coolers and kept as close to 4°C as possible during the period of time

TABLE 2

CONTAINERS AND PRESERVATIVES USED FOR RCRA GROUNDWATER SAMPLING

Parameter	Recommended Container	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
		Indicators of Groundwater Contamination		
•pH	Plastic	Field determined	None	25 ml
•Specific conductance	Plastic	Field determined	None	100 ml
•TOC	Amber glass (teflon-lined cap)	Cool, 4°C	28 days	4 x 15 ml
•TOX	Amber glass (teflon-lined cap)	Cool, 4°C	7 days	4 x 15 ml
		Groundwater Quality Characteristics		
•Chloride	Plastic	Cool, 4°C	28 days	50 ml
•Iron Manganese Sodium	Plastic	Field acidified to pH <2 with HNO_3	6 months	200 ml

TABLE 2 (CONTINUED)

CONTAINERS AND PRESERVATIVES USED FOR RCRA GROUNDWATER SAMPLING

Parameter	Recommended Container	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
•Phenols	Glass	4°C plus field acidified to pH <2 with HNO_3	28 days	500 ml
•Sulfate	Plastic	Cool, 4°C	28 days	50 ml
		EPA Interim Drinking Water Characteristics		
•Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver	Plastic	Field Acidified to pH <2 with HNO_3	6 months	1000 ml
•Fluoride	Plastic	Cool, 4°C	28 days	300 ml
•Nitrate/ nitrite	Plastic	4°C plus field acidified with with H_2SO_4	14 days	1000 ml
•Endrin Lindane Methoxychlor Toxaphene 2, 4 D	Glass	Cool, 4°C	7 days	2000 ml

TABLE 2 (CONTINUED)

CONTAINERS AND PRESERVATIVES USED FOR RCRA GROUNDWATER SAMPLING

Parameter	Recommended Container	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
2, 4, 5 TP Silvex				
*Uranium, total Gross alpha Gross beta Radium 226, 228 Potassium 40 Technetium 99 Thorium 228,230, 232 Cesium 137 Strontium 90 Ruthenium 106 Neptunium 237 Plutonium 238, 239, 240	Plastic	Cool, 4°C plus lab acidified with HNO_3 or HCl	6 months	4 liters
*Coliform bacteria	Polypropylene	Cool, 4°C	6 hours	200 ml
Other Groundwater Characteristics of Interest				
*Cyanide	Plastic	Cool, 4°C plus Na OH to pH >12	14 days	500 ml

TABLE 2 (CONTINUED)

CONTAINERS AND PRESERVATIVES USED FOR RCRA GROUNDWATER SAMPLING

Parameter	Recommended Container	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
•Semivolatile, nonvolatile organics	Glass	Cool, 4°C	7 days	1000 ml
•Volatiles	Glass (teflon-lined cap)	Cool, 4°C	14 days	1000 ml

between collection and delivery to the lab. This refrigeration aids in the suppression of bacterial growth in the samples. Tables 2 and 3 list various preservatives and their applications.

TABLE 3

Preservation of Groundwater Samples Prior to Laboratory Analysis

Preservative	Action	Applicable to:
$HgCl_2$	Material Inhibitor	Nitrogen forms, Phosphorous forms
Acid (HNO_3)	Metals solvent, prevents precipitation	Metals
Acid (H_2SO_4)	Bacterial Inhibitor	Organic samples (COD, oil & grease, organic carbon)
	Salt formation with organic bases	Ammonia, amines
Alkali (NaOH)	Salt formation with volatile compounds	Cyanides, organic acids
Refrigeration	Bacterial Inhibitor	Acidity-alkalinity, organic materials, BOD, color, odor, organic Phosphorous, organic Nitrogen, carbon, etc. biological organisms (coliform, etc.)

4.3 Sample Shipment

In order to minimize the potential for loss, destruction, or tampering, all samples are delivered personally to the lab by a member of the sampling team. Sample bottles in their coolers are loaded onto a truck. The truck is kept locked with only the sampling team possessing a key. The bottles are then delivered directly to the lab and turned over to lab personnel. Chain-of-custody control is exercised throughout the sampling and sample shipment process as described in Section 6.0.

5.0 Analytical Procedures

All analyses of ground water samples in connection with RCRA groundwater sampling is conducted by Howard Labs, Inc. of Dayton, Ohio. Howard Labs is certified by both USEPA and OEPA to conduct such analyses. Analyses are conducted according to USEPA protocols and procedures as outlined below.

5.1 Constituents Being Monitored

A list of constituents that should be tested for in the FMPC groundwater was developed prior to the initiation of expanded monitoring in August, 1985 to meet RCRA requirements. This list addresses five (5) types of parameters:

- o Parameters used to evaluate general water quality. These include chloride, iron, manganese, phenols, sodium and sulfate.
- o Indicators of groundwater contamination. These include pH, specific conductance, total organic carbon and total organic halogen. These parameters are tested in quadruplicate as required by 40 CFR Part 264.90.

- Constituents evaluating drinking water suitability. These include 11 metals, 3 radionculides, 6 pesticides/herbicides and coliform bacteria.

- Parameters related specifically to past or current FMPC operations. This list includes 8 metals, 31 synthetic organic compounds, total dissolved solids and chemical oxygen demand (COD).

- Radionuclides related to past or current FMPC operations. Fifteen are analyzed, including isotopes of uranium, radium, thorium and plutonium.

A complete list of all parameters being tested for in the FMPC groundwater is provided in Table 4. Appendix IX of 40 CFR 264 parameters are to be analyzed for selected RCRA wells as part of the Weston Characterization Investigation Study (CIS) for the Waste Pit Storage Area in support of the Environmental Impact Statement (EIS) at the FMPC. This sampling, along with additional monitoring well installation, will be conducted as expeditiously as possible.

5.2 Analytical Methods

Chemical analysis of the samples is conducted according to methods specified in EPA-600/4-79-020, "Methods for Chemical Analysis of Water and Wastes". Radiological analyses are performed in accordance with procedures specified in EPA-600/4-80-032, Prescribed Procedures for Measurement of Radioactivity in Drinking Water." Where no EPA-approved method exists, analyses are conducted according to generally accepted standards and practices of the analytical profession under direct supervision of a chemistry Ph.D. The parameters analyzed, detection limits and the methods utilized are summarized in Tables 4, 5, 6 and 7.

TABLE 4

PARAMETERS TO BE ANALYZED

A. For General Water Quality [1]

1. Chloride
2. Iron
3. Manganese
4. Phenols
5. Sodium
6. Sulfate

B. For Indicators of Contamination (Quadruplicate Analysis) [1]

1. pH
2. Specific Conductance
3. Total Organic Carbon (TOC)
4. Total Organ Halogen (TOX)

C. For Drinking Water Suitability [1]

1. Arsenic
2. Barium
3. Cadmium
4. Chromium - Hexavalent
   - Total
5. Fluoride
6. Lead
7. Mercury
8. Nitrate
9. Selenium
10. Silver
11. Gross Alpha
12. Gross Beta
13. Radium

TABLE 4 (Con't.)

14. Endrin
15. Lindane
16. Methoxychlor
17. Toxaphene
18. 2,4-D
19. 2,4,5-TP
20. Coliform Bacteria

D. Site Specific Parameters [2]

1. Nickel
2. Cyanide
3. Copper
4. Zinc
5. Magnesium
6. Calcium
7. Phosphorus
8. Chlorobenzene
9. Chlorodibromomethane
10. Chloroethane
11. 2-chloroethylvinyl
12. Chloroform
13. Dichlorobromomethane
14. Dichlorodifluoromethane
15. Total Dissolved Solids (TDS)
16. Total Potassium
17. Chemical Oxygen Demand (COD)
18. per Chloroethylene
19. cis 1,2 Dichloroethylene
20. Tributylphosphate
21. Acrolein
22. Acrylonotrille
23. Benzene
24. bis (chloromethyl) Ether
25. Bromoform
26. Bromodichloromethane
27. Bromomethane
28. Carbon tetrachloride
29. Chloromethane
30. 1,2 Dichlorobenzene
31. 1,3 Dichlorobenzene
32. 1,4 Dichlorobenzene

Table 4 (Con't.)

33. 1,1 Dichloroethane
34. 1,2 Dichloroethane
35. 1,1 Dichloroethylene
36. 1,2 Dichloropropane
37. 1,2 Dichloropropylene
38. Ethylbenzene
39. Methylbromide
40. Methylchloride
41. trans-1,2 Dichloroethylene
42. 1,3 Dichloropropene
43. 1,1,2,2 Tetrachloroethane
44. Tetrachloroethylene
45. Toulene
46. 1,1,1 Trichloroethane
47. 1,1,2 Trichloroethane
48. Trichloroethylene
49. Trichlorofluoromethane
50. Vinyl Chloride

E. Radionuclide [2]

1. Potassium 40
2. Total Uranium
3. Radium 226
4. Radium 228
5. Technetium 99
6. Thorium 228
7. Thorium 230
8. Thorium 232
9. Cesium 137
10. Strontium 90
11. Ruthenium 106
12. Neptunium 237
13. Plutonium 238
14. Plutonium 239
15. Plutonium 240

F. Schedule - Quarterly for one (1) year, semiannual thereafter (or as necessary according to regulations).

[1]Required for RCRA and analyzed for each sample.

[2]Not required for RCRA, but also analyzed for each sample.

TABLE 5

Analytical Methods and Detection Limits for Groundwater Samples
Water Quality Indicators

Parameter	Detection Limit	Analytical Method**
Chloride	1 ppm	325.3
Iron	50 ppb	236.2
Manganese	20 ppb	243.2
Phenols (total)	5 ppb	420.3
Sodium	50 ppb	273.2
Sulfate	1.0 ppb	375.2
pH	0.1 std./units	150.1
Specific Conductance	1 umho/cm	120.1
Total Organic Carbon (TOC)	1 ppb	415.1
Total Organic Halogen (TOX)	10 ppb	*
Arsenic	5 ppb	206.2
Barium	200 ppb	208.2
Cadmium	2 ppb	213.2
Chromium-Hexavalent	5 ppb	218.4
Chromium-Total	5 ppb	218.2
Fluoride	10 ppb	340.2
Lead	5 ppb	239.2
Mercury	2 ppb	245.2
Nitrate (as N)	20 ppb	352.1
Selenium	2.5 ppb	270.2
Silver	30 ppb	272.2
Gross alpha	15 pCi/l	900.0
Gross beta	5 pCi/l	900.0
Radium	5 pCi/l	900.1
Endrin	0.2 ppb	608
Lindane	0.2 ppb	608
Methoxychlor	0.2 ppb	608
Toxaphene	0.5 ppb	608
2,4-D	0.2 ppb	608
2,4,5-TP Silvex	0.2 ppb	608
Coliform Bacteria	2/100 ml	*
Nickel	5 ppb	249.2
Cyanide	5 ppb	335.3
Copper	25 ppb	220.2
Zinc	25 ppb	289.2
Magnesium	10 ppb	242.1
Calcium	50 ppb	215.1
Phosphorus	20 ppb	365.4
Total Dissolved Solids (TDS)	10 ppb	*
Total Potassium	50 ppb	258.1

* Approved analytical method not available. Analysis performed according to generally accepted analytical procedures.

** As described in References 3, 4 and 5.

Analytical Methods and Detection Limits for Groundwater Samples - Volatiles

	Detection Limit	Analytical Method
Chlorobenzene	2.0 ppb	1624
Chlorodibromomethane	2.0 ppb	1624
Chloroethane	2.0 ppb	1624
2-Chloroethlvinyl Ether	2.0 ppb	1624
Chloroform	2.0 ppb	1624
Dichlorobromomethane	2.0 ppb	1624
Dichlorodifluoromethane	2.0 ppb	1624
Chemical Oxygen Demand (COD)	10 ppb	405.1
per Chloroethlyene	2.0 ppb	*
cis 1,2 Dichloroethylene	2.0 ppb	1624
Tributylphosphate	2.0 ppb	*
Acrolein	2.0 ppb	*
Acrylonitrille	2.0 ppb	*
Benzene	2.0 ppb	1624
bis (Chloromethyl)Ether	2.0 ppb	*
Bromoform	2.0 ppb	1624
Bromodichloromethane	2.0 ppb	1624
Bromomethane	2.0 ppb	1624
Carbon tetrachloride	2.0 ppb	1624
Chloromethane	2.0 ppb	1624
1,2 Dichlorobenzene	2.0 ppb	1625
1,3 Dichlorobenzene	2.0 ppb	1625
1,4 Dichlorobenzene	2.0 ppb	1625
1,1 Dichloroehtane	2.0 ppb	1624
1,2 Dichloroethane	2.0 ppb	1624
1,1 Dichloroethylene	2.0 ppb	1624
1,2 Dichloropropane	2.0 ppb	1624
1,2 Dichloropropylene	2.0 ppb	*
Ethylbenzene	2.0 ppb	1624
Methylbromide	2.0 ppb	1624
Methylchloride	2.0 ppb	1624
Trans 1,2 Dichloroethylene	2.0 ppb	1624
1,3 Dichloropropene	2.0 ppb	*
1,1,2,2 Tetrachloroethane	2.0 ppb	1624
Tetrachloroethylene	2.0 ppb	1624
1,1,1 Trichloroethane	2.0 ppb	1624
1,1,2 Trichloroethane	2.0 ppb	1624
Trichloroethylene	2.0 ppb	1624
Trichlorofluoromethane	2.0 ppb	1624
Vinyl Chloride	2.0 ppb	1624

* Approved analytical method not available. Analysis performed according to generally accepted analytical procedures.

Analytical Methods and Detection Limits for Groundwater Samples - Radionuclides

Parameter	Detection Limit	Analytical Method
Cesium 137	5 pCi/l	901.0
Strontium 90	5 pCi/l	905.0
Ruthenium 106	5 pCi/l	*
Neptunium 237	5 pCi/l	*
Plutonium 239	5 pCi/l	*
Plutonium 240	5 pCi/l	*
Potassium 40	5 pCi/l	*
Radium 226	5 pCi/l	903.1
Radium 228	5 pCi/l	904.0
Technetium 99	5 pCi/l	*
Thorium 228	5 pCi/l	*
Thorium 230	5 pCi/l	*
Thorium 232	5 pCi/l	*
Uranium 233/234	5 pCi/l	*
Uranium 235	5 pCi/l	*
Uranium 238	5 pCi/l	*

* Approved analytical method not available. Analysis performed according to generally accepted analytical procedures.

6.0 Chain of Custody Control

A chain-of-custody control program is employed in order to provide for tracing of possession and handling of individual samples from the field collection through laboratory analysis. The various components of that program are summarized below.

6.1 Sample Labels

In order to avoid misidentification of the sample containers, each container has an adhesive label attached which indicates the sample identification number (well number), date and time of collection, and identification of the facility from which the sample was taken.

6.2 Sample Seals

As each thermal cooler is filled with sample bottles it is sealed by placing an adhesive band entirely around the cooler. This seal is then signed by the member of the collection team emplacing it. The seal is placed and signed such that opening of the cooler will result in obvious disruption of the seal.

6.3 Chain-of-Custody Records

In order to establish the documentation necessary to trace sample possession from time of collection, chain of custody information is recorded for each sample on a standard Chain-of-Custody form.

These data includes:

- Sample I.D. number
- Reason for sampling
- Witnesses

- o Collection Procedure
- o Method of Preservation
- o Name, Signature, and Affiliation of each person taking possession of sample
- o Date and time of each transfer
- o Purpose of each transfer
- o Other pertinent remarks

An example of the Chain-of-Custody record presently in use is provided in Figure 2.

6.4 Field Sampling Records

In addition to the Chain-of-Custody forms, additional dates regarding the circumstances of sample collection are recorded in the Field Sampling Records. These were discussed in Section 3.2.

1. Manual of Ground Water Sampling Procedures, 1981, Marion R. Scalf, James F. McNabb, William J. Dunlap, Roger L. Cosby, John Fryberger, NWWA/EPA Series.

2. Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilites, USEPA, 1980 #SW-611.

3. USEPA, 1983, Methods For Chemical Analysis Of Water and Wastes, Publication Number 600/4-79-020.

4. USEPA, 1980, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Publication Number 600/4-80-032.

5. Howard Laboratories, Inc. 1986, Quality Assurance/Quality Control Program, Publication Number HLI-QC.EF.

6. USEPA, 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD), OSWER-9950.1.

ATTACHMENT 1

HOWARD LABS QA/QC PROGRAM

HOWARD LABORATORIES. INC.
Quality Assurance/Quality Control Program

INTRODUCTION: The Quality Assurance/Quality Control Program (QA/QC) utilized by Howard Laboratories, Inc., is a comprehensive program which utilizes the same concept in each of the different departments within the lab. Each department, however, differs in their QC portion due to the different parameters analyzed in each of the different departments.

Basically, the QA program insures that the chemicals utilized for different standards are consistent and correct within strict limitations. All standards are prepared or purchased such that at least two different sources of standards are utilized to insure the precision of the standard(s) utilized in all analyses. Due to the vast number of parameters which are determined by HLI, not all standards are directly tracable to NBS standards or US EPA standards. All standards which are available from regulatory agencies are utilized within the QA program to insure precision in preparation and control of internally prepared or externally purchased standards. All standards are stored per regulatory recommendations, or where no such recommendations exist, storage has been limited to insure reliability. Further, instruments utilized in the analysis at HLI are calibrated continuously, not just on a day-to-day basis, but throughout the day and throughout the analytical run. These instruments are all state-of-the-art and are automated to reduce human error. Most instruments are controlled by computers. Calibration of these instruments includes the recommendations by the manufacturer and/or regulatory agencies.

The QC program consists of utilizing the standards described above, calibration of instruments on a multi-level calibration curve within a linear range of the instrument being utilized and comparing this response to previous calibration curves and standards. Due to the different departmental requirements, all samples and/or standards are analyzed in at least duplicate. Many are run in triplicate.

For example, the AA Department for metals determines all metals in triplicate. The MS department determines all samples in duplicate and some in quadruplicate, as required by the parameter. Each department has determined the specific acceptance criteria for each parameter. These acceptance criteria have been determined to be those recommended by regulatory agencies where applicable. Where regulatory agencies do not recommend an acceptance criteria, HLI has determined its own acceptance criteria based upon three levels of QC. These include percent recovery of spiked samples, reproducibility of replicate analyses and recovery of known standards. The following are specific QC/QA criteria:

WET CHEMISTRY -

pH	Instrument standardized three to four times daily with commercially purchased buffer standards plus HLI Stds.
Residue	Precision and accuracy data are not applicable to these tests. However, periodic replicates of samples are run for evaluation purposes.
Color	No precision or accuracy data are applicable to this test. Color standards are prepared according to Standard Methods, 15'th edition, method 204.A.
Fecal Coliform	3 dilutions per sample set are employed. Quarterly count comparisons are performed. Records are kept for incubator temperature, pH, autoclave use, and water suitability.
Bromide	One quality control sample per five samples analyzed. Acceptable limits are +/- 10% of true value.
Chloride	One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
1 - 10 mg/L	+/- 15

	10 - 50	+/- 10
	50 - 125	+/- 5

Cyanides

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.005 - 0.050 mg/L	+/- 20
0.050 - 0.300	+/- 10

Fluorides

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.02 - 0.05 mg/L	+/- 20
0.05 - 2.00	+/- 10

Ammonia

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.050 - 0.250 mg/L	+/- 20
0.250 -25.000	+/- 10

TKN

One quality control sample per five samplea analyzed. Acceptable limits:

Conc. Range	% True Value
0.10 - 0.25 mg/L	+/- 20
0.25 - 25.00	+/- 10

Nitrate/ Nitrite

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.050 - 0.250 mg/L	+/- 20
0.250 -25.000	+/- 10

Phosphorus

One quality control sample per five samples analyzed. Acceptable limits:

Conc. Range	% True Value
0.050 - 0.500 mg/L	+/- 20
0.500 - 2.000	+/- 10

Sulfate

One quality control sample per five samples analyzed. Acceptable limits not established by US. EPA.

COD	One quality control sample per five samples analyzed. Acceptable limits: Low level +/- 20% High level +/- 10%
BOD	Controls, blanks and standards run with each lot. Acceptable limits: +/- 10% of True Value
PHENOLS	One quality control sample per five samples analyzed. Acceptable limits: Conc. Range % True Value 0.005 - 0.050 mg/L +/- 20% 0.050 - 0.250 +/- 10%

METALS

Three levels of quality control samples are employed over the linear working range of the parameter. One entire series is run with each lot analysis. Acceptable limits:

Furnace range	+/- 20%
Flame range	+/- 10%

One calibration check sample is performed every sixth analysis to verify calibration curve. Acceptable range:

Furnace	+/- 20%
Flame	+/- 10%

Out of limit condition requires re-standardization of instrument.

Exceptions -

Mercury - One quality control check every nine samples. Acceptable limits +/- 20% of true value. Analysis of all samples run in triplicate.

Arsenic & Selenium - Three levels of quality control are run twice per lot analysis. Acceptable results are +/- 20%. All analysis are run with spike. Acceptable limits of recovery +/- 20%

In addition to the above procedures, samples analyzed for

EP Toxicity are run by the method of additions, which entails running each sample at three levels of spike addition. The results of expected versus observed values are calculated in a linear regression analysis, and the slope of the line expressed as a percent. Acceptable limits are between the values of 80 to 120 % for all EP Toxic metals.

ORGANIC ANALYSIS

Standards are maintained in groups for purgibles, acid extractable, base/neutral, and pesticide/PCB's. These groups are subdivided into lower groups to facilitate identification and reduce costs in standard preparation.

The quality control procedures listed in the December 3, 1979 Federal register are utilized to maintain instrument specifications. These procedures utilize deuterated anthracene and purgibles not on the priority pollutant list. In addition Howard Laboratories utilizes the following procedures to further improve upon detection limits and quality control:

1. Each sample is duplicated where required
2. A standard of known value is analyzed at least every ten samples along with a blank
3. In the case of PCB's, quantitation is duplicated on a second column.
4. Acceptable limits of recovery must meet the following:

   a. Recovery of known standards:

      80% at a level 5 times the detection limit
      50% at a level 2 times the detection limit

   b. Recovery of spike values:

      80% at a level 5 times the detection limit
      50% at a level 2 times the detection limit

   NOTE: PCB analysis have more stringent requirements.

PCB ANALYSIS

a. Recovery of known standards:

1. Aqueous standards -

0.01 - 0.05	+/- 0.005
0.05 - 0.50	+/- 0.01
0.50 - 5.00	+/- 0.05
Above 5.00	+/- 0.50

2. Oil standards -

Below 1.00	as appropriate
1.0 - 10.0	+/- 0.2 to +/- 2.0
10.0 - 50.0	+/- 2.0 to +/- 5.0
50.0 -500.0	+/- 5.0 to +/- 50.0
Above 500.0	as appropriate

b. Recovery of Spike values:

1. Aqueous -

0.01 - 0.05	>50%
0.05 - 0.50	>80%
0.50 - 5.00	>80%
Below 1.0	as appropriate
1.0 - 10.0	20%
10.0 - 50.0	10 to 20%
50.0 -500.0	10%
Above 500.0	10%

Duplication of samples

Duplicate samples must be reproducible at the same dilution by the following factors:

1. Aqueous -

0.01 - 0.05	+/- 0.005 - 0.01
0.05 - 0.50	+/- 0.01 - 0.05
0.50 - 5.00	+/- 0.05 - 0.10
Above 5.00	+/- 0.10

2. Oils -

Below 1.0	as appropriate
1.0 - 10.0	+/- 0.2 to 1.0
10.0 - 50.0	+/- 1.0 to 5.0
50.0 -500.0	+/- 5.0 to 50.0
Above 500.0	+/- 50.0 for each 500.0

GCSCAN ANALYSES:

GCSCAN is a code for multiple analyses utilizing gas chromatography along with a specified methodology. That methodology may be ASTM, EPA, NIOSH, AOAC or other method widely recognized in the analytical field. The specific method is specified with the results when applicable. The same QA/QC is provided as for PCBs and when peaks cannot be identified, GC/MS is utilized. Quantitation is by GC using multiple level calibration.

GCMS ANALYSES:

GCMS is a code for multiple methods of analyses utilizing a gas chromatograph equipped with mass spectrometer detector. This method identifies compounds and quantitates the same with external or internal standards, as appropriate. Specific methods will be specified when such methods are recognized by the scientific community or regulatory agencies. Since not all procedures are specified, the use of GCMS for organic analyses will be performed by an academically trained analyst with experience in the application of GC and ability to interpret data which may not be found on NBS or other recognized spectral libraries. The operation of GCMS will be under the direct supervision of a Ph.D.

PRIORITY POLLUTANT ANALYSES:

Priority pollutants, TTO's or fractions of these compounds will be by the method described in the December 3, 1979 Federal Register. Exact specifications for all parameters will be by protocol. QA includes recovery of spiked samples, reproducibility of the same sample, duplicate standards and at least one other source of comparison standards derived from the US EPA, NBS, or other recognized source.

Base Neutral Fraction: Method 1625 (capillary column use of Method 625) will be utilized. Internal standards will include D-10 Anthracene or D-10 Phenanthrene, with other recognized internal standards to determine retention times,

insure proper spectral retrival and maintain quality control on the internal standards themselves. Quantitation will be based upon each individual parameter and not grouped or quantitated based upon area of a known amount of internal standard. The charge/mass ratio of the internal standards is not the same for the internal standards as it is for the compounds in question; therefore internal standards will be utilized to determine recovery while quantitation will be based upon known standards when recoveries have been met satisfactorily.

Acid Fraction: Method 1625 will be utilized and the same information as that utilized for Base Neutrals will be followed.

Volatile Fraction: Method 1624, utilizing cryogenic purge and trap will be utilized for the volatile parameters. The entire system is automated to reduce human error, and each sample group will be spiked to determine recovery and acceptability of the data. We have found that Method 624, which utilizes a packed column will not satisfactorily quantitate the very volatile purgibles, and for that reason, have chosen to use liquid nitrogen trap to collect the sample. This method also allows the detection of more compounds than that listed in the volatile fraction.

Pesticide/PCB Fraction: GC/ECD will be utilized to screen the Pesticide/PCB (PESTPP) fraction, utilizing US EPA Method 608. This method is more than 10 times as sensitive as the GC/MS method. If compounds are detected, GC/MS analyses are utilized to identify such compounds. Quantitation will be by GC.

Special Parameters: Although the above methods are recognized for all priority pollutant parameters, the detection limits for certain of these parameters is quite high (e.g. 2,3,7,8-Dioxin). The recommended US EPA procedure of utilizing GC for screening of this parameter will be utilized.

8000 SERIES METHODS:

SW 846 Manual covers the analyses of hazardous wastes. The methods cited in SW 846 for organic analyses have not been approved by US EPA but are only recommended at this time. This firm has spent many weeks performing such analyses and in determining recoveries of each of the parameters under the 8000 series recommended procedures. We have been unsuccessful in finding 13 of the compounds for standards. All others are available. We have further modified (added to) the methods of analyses in SW 846 to better determine certain parameters. These methods are being prepared to submit to US EPA for their information. Certain methods of preparation have been reversed in addition to normal extraction procedures. For example, base neutral/acid fraction normally requires the base fraction be extracted first, then the acid fraction. In addition to this normal method, we include the acid extraction first followed by base neutral. This allows confirmation of certain organic salts by GCMS which are not normally capable of being analyzed by GC or GC/MS.

SUMMARY:

This firm maintains all of the equipment listed for US EPA methods. This includes GC/MS, GC, HPLC and all of the special detectors required for these analyses. Further, we maintain automatic equipment which operates on a 24 hour basis, 7 days per week. Such automation and continued operation have proven to provide better data (free of human error) and better operation of equipment. We have found that startup and shutdown of equipment promotes poor operation of the equipment and causes greater problems in stability of that equipment.

Organic analyses are conducted by protocol where recommended protocol exists. Otherwise, scientifically recognized procedures are utilized for such analyses. All organic analyses are performed under the direction of a Ph.D., with many years of experience, and well over 100,000 analyses.

Data is provided on formats utilizing the largest laboratory data management system available. Such data

is stored on 9 track mag tapes and archived per US EPA requirements.

Specific questions concerning these methods and data should be directed to the Laboratory Director.

FMPC

COMPLIANCE MONITORING

PROGRAM

SAMPLE COLLECTION, PRESERVATION

SHIPMENT, AND ANALYTICAL PROCEDURES

SAMPLE COLLECTION

Detailed project sampling plans have been prepared to document the scope and methodology of exploration, radiation measurement, and sampling activities for the FMPC.

The following considerations form the basis for the site-specific sampling program:

- Frequency of sampling
- Location and number of monitoring stations to be sampled
- Methods of sampling to be employed
- Media to be sampled
- Number of samples to be collected
- Volume of samples to be collected
- Type and kind of analyses to be performed in the field
- Type and kind of analyses to be performed at laboratories
- Procedures and precautions to be followed during sampling
- Methods of preservation and shipment.

Sampling will be frequent enough to identify materials and to describe important material changes. Methods of sampling employed shall preserve the integrity of material parameters.

The following actions will be taken for each sampling effort to maintain a consistent and accurate FMPC field sampling program:

- Prepare an FMPC site map showing the location of sample monitoring stations.
- Review the sample collection program to become familiar with the overall scope of the study and also sampling procedures and equipment, sample handling procedures, and shipping requirements.
- Determine the characteristics of the material to be sampled, become familiar with the safety precautions and practices, and obtain the necessary safety equipment.
- Obtain equipment and materials necessary to perform field sampling and analyses.
- Review manufacturer's instructions on equipment calibration and sensitivity.
- Calibrate all field equipment prior to field work according to manufacturer's instructions and calibration procedures. Note: Certain equipment may require calibration in the field before each measurement.
- Fill out the appropriate sample field collection reports completely prior to leaving the field location.
- Label all sample containers with appropriate information. This includes project number and name, sample number, location, sampling date and time, preservatives added, and sampler's initials.
- Complete Chain-of-Custody form (Figure 1) and Laboratory Request for Analysis form (Figure 2) which will accompany all samples during shipment.

CHAIN-OF-CUSTODY RECORD

R/A Control No. _____

C/C Control No. 00150

PROJECT NAME/NUMBER _____ LAB DESTINATION _____

SAMPLE TEAM MEMBERS _____ CARRIER/WAYBILL NO. _____

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No

Special Instructions: _____

Possible Sample Hazards: _____

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: _____

   Received By: _____

2. Relinquished By: _____

   Received By: _____

3. Relinquished By: _____

   Received by: _____

4. Relinquished By: _____

   Received By: _____

WHITE - To accompany samples
YELLOW - Field copy

Figure 1. Chain-of-Custody Form.

00391

REQUEST FOR ANALYSIS

R/A Control No.
C/C Control No. _____

PROJECT NAME _____
PROJECT NUMBER _____
PROJECT MANAGER _____
BILL TO _____

PURCHASE ORDER NO. _____

DATE SAMPLES SHIPPED _____
LAB DESTINATION _____
LABORATORY CONTACT _____
SEND LAB REPORT TO _____

DATE REPORT REQUIRED _____
PROJECT CONTACT _____
PROJECT CONTACT PHONE NO. _____

Sample No	Sample Type	Sample Volume	Preservative	Requested Testing Program	Special Instructions

TURNAROUND TIME REQUIRED: (Rush must be approved by the Project Manager)

Normal _____ Rush _____ (Subject to rush surcharge)

POSSIBLE HAZARD IDENTIFICATION (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances)

Nonhazard _____ Flammable _____ Skin Irritant _____ Highly Toxic _____ Other _____ (Please Specify)

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis. Lab will charge for packing, shipping, and disposal)

Return to Client _____ Disposal by Lab _____

FOR LAB USE ONLY

Received By _____ Date/Time _____

WHITE - Original, to accompany samples
YELLOW - Field copy

Figure 2. Laboratory Request for Analysis Form.

The following guidelines are applicable for sample packaging to avoid breakage or cross contamination:

- Sample container lids are never to be mixed. Sample lids will stay on the original container until time of sampling (sample container will only be opened at the time of sampling). The original sample containers will arrive in the field in packages with custody tape affixed at the appropriate access points. When sample container packages are received in the field, the Chain-of-Command form (Figure 1) for shipping the empty containers to the field will be appropriately marked to state if the custody seal was affixed when the package arrived.
- After a sample is placed in a plastic/glass container, the sample container will be secured with a custody seal and placed in a plastic bag to minimize the potential for contamination from vermiculite or other packing material. Sample containers may be placed between cardboard inserts and will not need to be placed in plastic bags.
- Upon arrival of the samples at the laboratory, the Quality Control (QC) coordinator, or designee will examine the contents of the shipping container and document on the chain-of-custody record if any sample containers do not have the custody tape affixed.
- Rigid, plastic shipping coolers (or ice chests) transmitting plastic/glass sample containers will be filled initially with approximately three inches of vermiculite or suitable substitute (noncombustible, absorbent packing material). Under no circumstances will locally obtained material (sawdust, sand, etc.) be used. Earth or ice will not be used as packing materials.

- The secured sample containers will be placed in the cooler in such a way so they do not touch one another. Additional container protection will be used, if necessary. (Cooler will be kept closed except when placing sample in cooler.)
- Commercially available self-contained artificial icing material (such as "blue ice") will be used. If unavoidable, ice may be used, provided that is is placed in a plastic bag. Ice is not to be used as a substitute for packing material.
- Remaining space in the cooler will be filled with inert packing material.
- The original Chain-of-Custody form (Figure 1) and Request-for-Analysis for (Figure 2) will be placed in a plastic bag and taped to the bottom of the cooler lid. (Chain-of-custody and request-for-analysis procedures are discussed in Section 4.0.)

Samples will be properly packaged and labeled for shipment and dispatched to the appropriate laboratory for analysis. Separate chain-of-custody and request-for-analysis records will be prepared for each laboratory. The following requirements for shipping containers will be followed:

- United States Department of Transportation (DOT) regulations covering the transport of hazardous materials are contained in the Code of Federal Regulations (CFR) Title 49, Parts 170-179. Field personnel shall acquaint themselves with the general provisions of these requirements and IT's Manual of Practice: Sample Packaging and Shipment.
- Shipping cooler containers are to be padlocked or custody-sealed for shipment, as appropriate. The packing custody seal should consist of filament tape wrapped around the container, with a

custody seal affixed at appropriate access points. In this way, access to the container can be gained only be cutting the filament tape and breaking the seal.

- Shipping cooler containers will be secured by field personnel with a proper custody seal, marked with indelible pen or ink, and addressed to the appropriate laboratory.
- Field personnel will make arrangements for transportation of samples. When custody is relinquished to a shipper, field personnel will telephone the receiving laboratory custodian to report the expected time of arrival of the sample shipment and the existing time constraints (holding times) for sample analysis.

1.1 GROUNDWATER SAMPLING TECHNIQUES

The primary consideration in groundwater sampling is to obtain a representative sample of the groundwater body. To safeguard against collecting nonrepresentative stagnant water from a well or piezometer, the following guidelines and techniques shall be observed during sample withdrawal:

- As a general rule, all monitoring wells will be pumped or bailed prior to collecting a sample. Evacuation of a least three well volumes of water is recommended for a representative sample.
- For wells that can be pumped or bailed dry, the well will be evacuated and allowed to recover prior to sample withdrawal. If the recovery rate is fairly rapid and if time allows, evacuation of more than one volume of water is recommended.

- As soon as the well recovers, samples will be collected in accordance with the stability and volatility of the parameters to be tested and the Water Quality Field Collection Report (Figure 3) will be completed. For instance, samples for Hazardous Substance List (HSL) volatile organic compounds, pH, specific conductance, and temperature will be collected first. Parameters which are not sensitive to pH or volatilization shall be drawn last.
- For wells that cannot be pumped or bailed dry, at least three well volumes of water will be removed before collecting samples.
- Care will be taken to avoid excessive pumping of a monitoring well. Excessive pumping can lead to an increase or decrease in the concentrations of a contaminant at the sampling point of interest.
- A stainless steel submersible pump will be used to purge the monitoring wells prior to sample collection. A water-level measurement will be initially taken to determine the depth to groundwater in the casing. The submersible pump will be lowered to a depth of five to ten feet below the water level, always above the well screen. The well will be initially purged from this depth so that fresh water from the screened interval will move upward through the casing and completely flush the well. The pumping rate will be less than 20 gallons per minute and will continue until field pH, temperature, and specific conductance readings have stabilized.
- The purge pump and lines will be decontaminated between wells, using procedures specified below.

- If significant drawdown occurs during purging, the submersible pump will be lowered to keep the pump five to ten feet below the water level in the well casing and the pumping rate will be reduced.
- Once the well has been purged and allowed to recharge and stabilize, samples will be collected using a positive gas displacement stainless steel and/or Teflon bladder pump or Teflon bailer.
- During sampling, the pump will be operated continuously and the flow rate reduced to one liter/minute for the collection of volatile organic compound samples.
- When the pump and lines are removed from a well, they will be placed on plastic sheeting to avoid contact with the ground.
- Prior to reuse, the pump and lines will be drained and the outside surfaces will be decontaminated with a water wash and deionized water rinse. The internal surfaces will be decontaminated by pumping deionized water through the pump system.. Purging of the next monitoring well will further reduce the possibility of cross contamination. Should the equipment become visible contaminated, it will be disassembled and cleaned by the following procedures:

  - In the case of inorganic contaminants, the equipment will first be washed with a nonphosphate detergent and then rinsed with dilute (0.1 N) hydrochloric acid followed by two separate deionized water rinses.

- In the case of organic contaminants, the equipment will first be washed with a nonphosphate detergent and then rinsed with tap water, methanol, and two separate deionized water rinses. (Acetone may be substituted for methanol if volatile organic compounds are not being determined.)
- As described above, the equipment shall be thoroughly rinsed with two deionized water rinses to remove traces of hydrochloric acid, detergent, and methanol (acetone).
- Sampling equipment will not be placed directly on the ground or on other contaminated surfaces prior to insertion into the well, but will be placed on a clean plastic sheet adjacent to or around the well.
- One sample of the final deionized water rinse will be collected in sample bottles containing the appropriate preservatives. Rinsate samples will be analyzed at a frequency of one per every set of twenty samples or fraction thereof to check for cross contamination between monitoring wells.
- Decontamination of the submersible sampling pump(s) and other sampling equipment will be performed at a designated central staging area at the FMPC. If this is not possible due to extenuating circumstances, the sampling equipment may be decontaminated in the field.

o Existing wells with limited access will be sampled from the pump discharge.

o Field measurements will be performed on unpreserved samples immediately after sample collection. Samples collected for field measurements will be kept separate from samples preserved for shipment to the laboratory.

- A sufficient amount of sample will be collected to perform all the required analyses. The sample bottles containing the appropriate preservatives will be filled to the bottle neck with the sample, without overflowing. Sample container lids will be tight and secure.
- Samples collected will be stored in the field in a cooler and maintained at approximately 4 degrees Celsius (39°F) using blue ice or other approved, sealed artificial icing materials.
- Samples will be properly labeled and the Chain-of-Custody form (Figure 1), the Laboratory Request for Analysis form (Figure 2), the Water Quality Field Collection report (Figure 2), and the Sample Collection Log (Figure 3), and will be properly filled out.

1.1.1 Parameter-Specific Sampling Procedures

Water sample collection for volatile organic compounds, acid and base-neutral extractable compounds, dissolved metals, and general chemistry parameters shall be performed in accordance with the following procedures:

- Volatile Organic Compounds

  - Two screw-cap vials with Teflon-lined silicone rubber septa (U.S. EPA-approved vials) will be filled to overflowing and sealed without any entrapped air bubbles. The size of these vials will be 40 milliliters or larger.
  - Each vial will be visually checked for air bubbles and placed in a cooler.

- A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment. The field/trip blank will monitor for ambient contamination levels in the cooler during transport. Field/trip blanks will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.
- Either rinsate samples will be collected from sample collection tools following each well sampling to monitor for potential cross contamination of samples between wells or laboratory cleaned sampling equipment will be used for each well. Rinsate samples will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.
- A Sample Collection Log (Figure 4), a Chain-of-Custody record (Figure 1), a Laboratory Request for Analysis form (Figure 2), and a sample label (Figure 5) will be completed in the field. All these forms, except for the sample collection log, will accompany the samples to the laboratory.
- The cooler will be packed with artificial icing material [to maintain the samples at 4 degrees Celsius (39°F) during shipment], sealed, and transported to the laboratory.

o Acid and Base-Neutral Extractable Compounds and Pesticides/Polychlorinated Biphenyls (PCBs)

- Appropriate glass sample bottles complete with Teflon-lined caps will be filled to capacity and sealed.

- The sample bottles will be placed in a cooler with sufficient packing to prevent breakage during shipment.
- A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment. Field/trip blanks will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.

DATE						
TIME						
PAGE ____ OF ____						
PAGE						

WATER QUALITY
FIELD COLLECTION REPORT

PROJECT NAME _____
PROJECT NUMBER _____
DATE COLLECTED _____
TIME COLLECTED _____
COLLECTED BY _____
DATE RECEIVED BY LAB _____
RECEIVED BY _____

SAMPLE DESCRIPTION

SAMPLE NUMBER _____
SAMPLE TYPE:
CHEM. _____ BACT. _____
FIXED _____ D.O. _____
(METALS) ORGANIC _____
NUTRIENTS _____

SAMPLING INFORMATION

AIR TEMPERATURE _____
WATER TEMPERATURE _____
DEPTH OF SAMPLE _____
pH _____ μ _____ μMHOS/CM
D.O. _____ MG/L

LOCATION SKETCH

METER CALIBRATION

pH TEMP	pH STD.	pH STD.	D.O. TEMP.	D.O. @ 0	D.O. @ STD
OK ✓			OK ✓		

REDOX:
SAMPLE _____ mv @ _____ °C ZOBEL _____ mv @ _____ °C

EXACT LOCATION _____

WEATHER CONDITIONS _____

SOURCES OF POLLUTION _____

ADDITIONAL REMARKS _____

Figure 3. Water Quality Field Collection Report.

SAMPLE COLLECTION LOG

UNIQUE SAMPLE NUMBER	SAMPLE LOCATION	COLLECTOR DETAILS	COLLECTION DATE			COLLECTION TIME		COORDINATES		SAMPLE DEPTH INTERVAL	SAMPLE TYPE	SAMPLE MEDIA	PRESERVATIVE	SEQUENCE	BLANK	SPIKE	DUPLICATE	DUPLICATE OF SAMPLE NUMBER	SPLIT	SPLIT OF SAMPLE NUMBER	DETAIL
			MO	DY	YR	HR	MIN	NORTH	EAST												

Figure 4. Sample Collection Log.

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Project Name _____ Project No. _____

Sample Location _____ Number _____

Boring/Well No. _____ Date _____

Collector's Name _____ Time _____

Sample Type: ____ Ground Water ____ Surface Water

____ Soil ____ Sludge/Waste

Parameters _____ Preservative _____

Bottle _____ of _____ ____ Filtered ____ Nonfiltered

Figure 5. Sample Label.

- Either rinsate samples will be collected following each well sampling to monitor for potential cross contamination of samples between wells or laboratory cleaned sampling equipment will be used in each well. Rinsate samples will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.
- A Sample Collection Log (Figure 4), a Chain-of-Custody record (Figure 1), a Laboratory Request for Analysis form (Figure 2), and a sample label (Figure 5) will be filled out in the field. All of these forms, except for the sample collection log will accompany the samples to the laboratory.
- The cooler will be packed with artificial icing material [to maintain the samples at 4 degrees Celsius (39°F) during shipment], sealed, and transported to the laboratory.

o Dissolved Metals

- To determine concentrations of dissolved metals in a water system, the sample should be filtered in the field as soon as possible after collection. Filtering shall be accomplished through the use of a 0.45-micron filter using a Millipore filtration apparatus, or equivalent, equipped with a hand or electrical vacuum pump.
- The filtering apparatus or equivalent shall be cleaned or rinsed thoroughly with deionized water before filtering each sample.
- It is recommended that the first 100 to 150 milliliters of filtrate from each sample be discarded to rinse the filter and filtration apparatus of any contaminating substances.

- The filtered sample will be immediately transferred to a 500-milliliter plastic bottle containing one milliliter of concentrated nitric acid preservative per 100 milliliters of sample.
- The sample pH will be checked with pH paper or a pH meter to check that the pH is less than two. The bottle will be sealed with a plastic cap fitted with a polyethylene liner.
- A Sample Collection Log (Figure 4), a Chain-of-Custody record (Figure 1), a Laboratory Request for Analysis form (Figure 2), and a sample label (Figure 5) will be completed in the field. All of these forms, except for the sample collection log, will accompany the sample to the laboratory.

o General Chemistry Parameters

- Sample bottles will be either polyethylene or glass and will contain the appropriate chemical preservatives. Sample bottle caps will be plastic with fitted polyethylene liners.
- Sample bottles will be filled to capacity and sealed.
- A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment. Field/trip blanks will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.
- Either rinsate samples will be collected following each well sampling to monitor for potential cross contamination of samples between wells or laboratory cleaned sampling equipment

will be used for each well. Rinsate samples will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.

- The sample bottles will be placed in a cooler with sufficient packing to prevent breakage during shipment.
- Collected samples will be stored in the field in a cooler packed with artificial icing material and maintained at approximately 4 degrees Celsius (39°F).
- Samples will be properly labeled (Figure 5) and Sample Collection Logs (Figure 4), Chain-of-Custody records (Figure 1), and a Laboratory Request for Analysis form (Figure 2) will be properly completed.

o Radionuclide Parameters

- In general, samples for radionuclide analyses will be collected in the same manner as samples for other chemical analyses.
- Sample lines will be flushed and sampling equipment with sample medium to minimize radionuclide adsorption effects.
- Sample containers made of Teflon, polyethylene, or polyvinyl chloride (PVC) will be used to minimize radionuclide losses by adsorption. (Glass and metal containers tend to adsorb radionuclides.)
- Suspended sediments will be avoided when sampling groundwater.
- The pump or Teflon bailer will be decontaminated, in accordance with the procedures in Groundwater Sampling Techniques (Section 1.1), to minimize contamination of subsequent samples.

- When dissolved radionuclides are to be determined, water samples will be filtered in the field through an 0.45-micron membrane filter as soon as possible after sample collection. Containers without preservative will be used to initially collect samples prior to filtration. Samples will be transferred to containers with preservative after filtration has been performed. When samples are collected for analysis of total radionuclide concentrations, containers with preservative will be used to collect the sample and filtration will not be required.
- Sample container lids will be tightly secured.
- Samples will be properly labeled (Figure 5) and Chain-of-Custody records (Figure 1), Sample Collection Logs (Figure 4), and Laboratory Request for Analysis forms (Figure 2) will be properly completed.

1.1.2 Water Level Measurements

The following procedures shall be followed for collecting water level data from wells:

- o Permission from owner to measure water level in well will be obtained (if required off site)
- o In the case of domestic wells, the owner will be asked not to use water for short time so pump does not activate and affect water level. Water level shall be determined to be stable.
- o Well cap shall be removed if an access hole is not available. (Water-level measurements shall not be taken in the riser pipe from the pump discharge line.)

- An M-scope probe will be lowered until water is reached (this will be indicated by a buzzer, meter needle deflection, or light); probe shall be raised above the water level and slightly shaken; the M-scope will then be lowered again and water depth will be rechecked. Care shall be taken not to get tangled with electrical wiring from pump, if present.
- Depth to water to 0.01 foot from the measuring point shall be noted (i.e., top of casing, top of sanitary seal).
- Water level and measuring point shall be entered in log with date and time or on Piezometer Data Sheet (Figure 6).
- Cover on well will be replaced when sampling effort has been completed.

1.2 FIELD ANALYTICAL PROCEDURES FOR GROUNDWATER SAMPLES

Immediately following sample collection, temperature, pH, specific conductance, and dissolved oxygen will be measured in the field and documented on the Water Quality Field Collection Report (Figure 3). The following field procedures pertain to these tests. All determinations will be performed on unpreserved samples. In adverse weather conditions, field determinations may be performed indoors in an area maintained at 20 to 25 degrees Celsius (68° to 77°F). Groundwater field measurements may also be taken in situ (downhole) to avoid changes which might occur if the sample is removed from the well.

1.2.1 Temperature

Scope and Application

PAGE ___ OF ___					
PAGE					

PIEZOMETER DATA SHEET

PROJECT NAME _____ PROJECT NO. _____

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER	PIEZOMETER READINGS - FEET (1)										
	# EL (2)	# EL	# EL	# EL	# EL	# EL	# EL	# EL	# EL	# EL	# EL

ELEVATION OF WATER LEVEL - FEET

Figure 6. Piezometer Data Sheet.

The temperature of surface and groundwater is important for numerous applications. It is required to normalize data from other analytical determinations such as pH, specific conductance, alkalinity, dissolved oxygen, etc.

Summary of Method

Temperature readings will be obtained by partially immersing the thermometer in a sample and allowing it to equilibrate for about two minutes. A minimum of two consecutive readings are obtained on each sample.

Apparatus

A metal-cased, direct-reading thermocouple with a normal range of zero to 50 degrees Celsius (32° to $122^{o}F$) measured in two-degree intervals is used.

Measurement Practices

- Temperature readings will be taken immediately after sample collection on unpreserved samples.
- Readings will be taken until two identical values for each sample are obtained.
- The average readings for each sample will be documented immediately on a Water Quality Field Collection form (Figure 3).

Reference

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 212, pp. 126-127.

Scope and Application

pH is defined as the negative logarithm of hydrogen-ion activity in a sample and is a measure of effective hydrogen-ion concentration. The pH values are very useful for assessing the acidic or basic nature of a body of water and also for elucidating complex chemical reactions occurring in water.

Summary of Method

The pH of water is normally determined by immersing a combination electrode (glass and reference electrode) in the solution and measuring the potential difference with a pH meter.

Apparatus

- Standard pH meter (battery operated) with an expanded scale capable of measuring pH to the nearest 0.01 unit.
- Combination electrode.
- Three standard buffer solutions
  - pH 4.0
  - pH 7.0
  - pH 10.0.
- A metal-cased direct-reading thermocouple with a normal range of zero to 50 degrees Celsius (32° to $122^{o}F$) measured in two-degree intervals.

Calibration

- Expose filling hole by lowering rubber sleeve.
- Make sure that the electrode is filled with potassium chloride (KCl) solution.
- Rinse electrodes with distilled water.
- Set pH meter to proper ambient water temperature. Temperature correction of readings is automatic.
- Calibrate pH meter with at least two appropriate buffers before starting pH measurement and also after every fifth sample. Follow manufacturer's instructions for calibration.

Sample Measurement

- Rinse electrodes with distilled water.
- Transfer sample into a 100-milliliter beaker.
- Insert electrode into the sample solution and let it equilibrate for a few minutes. Stir the sample during measurement.
- Read the pH values on the pH meter to the nearest 0.1 unit.

Measurement Practices

- Measure temperature and set meter to the correct temperature setting.
- Rinse electrodes with distilled water between each measurement.
- Make sure that the line cord is properly attached to the instrument.
- Expose filling hole on the electrode by lowering rubber sleeve.
- Electrode tip needs to be immersed only one inch to obtain accurate readings.

- Never move or touch connecting cables during pH measurement.

References

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 423, pp. 429-437.

2. American Society for Testing and Materials (ASTM), 1985, Water, Standard D1293-84, pp. 253-264.

3. Instruction Manual for Orion's 407A Specific Ion Meter.

1.2.3 Specific Conductance

Scope of Application

The ability of a solution to carry an electric current under specific conditions is reflected by specific conductance values. These values also indicate the concentration of dissolved solids in the natural water. Since specific conductance of a sample can change with time, this determination will be carried out in the field. The field measurement can also aid in assessing whether the sample is representative of the site.

Summary of Method

A conductivity cell is immersed in a sample of water and the conductance in micromhos per centimeter (umhos/cm) is measured directly from the meter. The readings are corrected for temperature and are recalculated for 25 degrees Celsius (77°F).

Apparatus

- Conductivity cell or probe.
- Conductivity meter.
- Thermometer.

Calibration

- Switch on the instrument and let it warm up for a few minutes.
- Calibrate according to the manufacturer's instructions.

Sample Measurement

- Insert the probe completely into the sample.
- Switch the meter to the appropriate scale and record the readings in umhos/cm.
- Measure the temperature of the sample with a thermometer.
- Record all readings on the Water Quality Field Collection Report (Figure 3).
- Correct the specific conductances values for temperature using appropriate temperature correction factors.

Measurement Practice

- Replace battery when the read line adjustment cannot be accomplished.
- Rinse probe with distilled water between each measurement.

References

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 205, pp. 76-80.

2. Instruction Manual for YSI Model 33 S-C-T Meter, Yellow Springs Instrument Company.

1.2.4 Dissolved Oxygen

Scope and Application

Adequate dissolved oxygen is necessary to maintain the life of aquatic organisms. The dissolved oxygen concentration may also have an effect on the redox potential of groundwater and the chemical behavior of aqueous constituents. Physical, chemical, and biochemical activities in water may affect the dissolved oxygen levels.

Summary of Method

Dissolved oxygen is normally measured in the field by immersing a membrane electrode into the water. Oxygen gas molecules diffuse through a membrane into a measuring cell at a rate proportional to the concentration of molecular oxygen in the water. Inside the sensor, the oxygen reacts with an electrolyte

and is reduced spontaneously or by an applied voltage, depending on the instrument. The current that is generated is directly proportional to the concentration of molecular oxygen in the water outside the sensor. The instrument reading is converted to the concentration of molecular oxygen present by calculation or proper calibration of the instrument.

Apparatus

- Oxygen-sensitive membrane electrode (polarographic or galvanic); this includes two solid metal electrodes separated from the test solution by a selective membrane (commonly polyethylene or fluorocarbon).
- Samples with known dissolved oxygen concentration for calibration or reading against water-saturated air.
- Distilled water for calibration and instrument cleaning.
- A metal-cased, direct-reading thermocouple with a normal range of zero to 50 degrees Celsius (32° to $122^{o}F$) measured in two-degree intervals.

Calibration

Follow the manufacturer's calibration instructions. Generally, calibration is performed against water-saturated air or water with a known dissolved oxygen concentration when measuring fresh water containing possible interfering substances.

Measurement Practices

- Temperature measurements should be taken at the time of dissolved oxygen reading.
- Insert probe into the sample.
- Allow sufficient sample flow across membrane surface to overcome any erratic responses of instrument.
- Read current from meter (correct for temperature if the equipment is so equipped).
- Record all readings on Water Quality Field Collection Report (Figure 3).
- Convert current generated to concentration and correct for temperature (if the equipment does not compensate for temperature).
- Frequently change and calibrate membrane electrode to eliminate interference from gases other than oxygen.
- Rinse probe with distilled water between each measurement.
- Store the probe in a water-saturated air environment.

References

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 421F, pp. 422-426.

E-6h(2) SAMPLE PRESERVATION AND SHIPMENT

2.1 FIELD STORAGE AND SHIPMENT OF SAMPLES

Samples will be stored in a cool place away from direct sunlight. As soon as samples are collected, filtered (if necessary), and preserved, they should be stored in a rigid, plastic cooler packed with plenty of self-contained artificial icing material, such as "blue ice." Field personnel should make sure that sample container lids are tight and secure before storing them in a cooler. Samples must be promptly shipped to the appropriate laboratory to avoid exceeding sample holding times.

Transportation of samples must be accomplished not only in a manner designed to protect the integrity of the sample, but also to prevent any detrimental effects from the potentially hazardous nature of the samples. Regulations for packaging, marking, labeling, and shipping of hazardous materials, substances and wastes are promulgated by the U.S. Department of Transportation (DOT) and described in 49 CFR 171 through 177 (in particular, 172.402h, Packages Containing Samples). In general, these regulations were not intended to cover the shipment of samples collected at hazardous waste sites. However, the U.S. EPA has deemed it prudent to package, mark, label, and ship samples observing these DOT procedures. The information contained in this section is for general guidance and, although factual, should not be misconstrued as identical to DOT regulations for transportation of hazardous materials.

Samples collected at the FMPC site shall be classified as either environmental or hazardous substance (or waste) samples. In general, environmental samples are collected off site, such as water samples from the various drainages, and are not expected to be grossly contaminated with high levels of toxic substances. Samples of soil or water from certain locations in the waste storage area will be considered hazardous substances. A distinction between the two types of samples, environmental and hazardous, must be made for two major reasons: (1) to determine the appropriate procedures for the

transportation of the samples; and (2) to protect the health and safety of the laboratory personnel receiving the samples. Special precautions, procedures, and secondary containment areas within laboratories will be used when samples other than environmental samples are received. If there is any doubt as to the classification of a sample, it will be considered a hazardous sample and shipped accordingly.

2.2 ENVIRONMENTAL SAMPLES

Samples judged to be environmental are not considered hazardous material; however, environmental samples will be packaged and shipped according to the following procedures.

Environmental samples will be packaged following the procedures for samples classified as "flammable liquids" or "flammable solids," excluding packages being placed inside metal cans as required for "flammable liquids." Sample containers properly identified and with a sealed lid will be placed in sealed polyethylene bags, then packed in fiberboard containers or metal picnic cooler-type containers. Sufficient incombustible, absorbent cushioning material will be used to minimize the possibility of sample container breakage.

Sample containers will have a completed sample identification label (Figure 5). The outside container will be marked "Environmental Sample." No DOT marking and/or labeling are required. No DOT shipping papers are required, and there are no DOT restrictions on mode of transportation.

2.3 HAZARDOUS SUBSTANCE SAMPLES

FMPC samples not determined to be environmental samples or samples known or expected to contain hazardous material must be considered hazardous substance samples and transported according to the following requirements. If the material in the sample is known or can be identified, then it should be packaged, marked, labeled, and shipped according to the specific instructions for that material if listed in the DOT Hazardous Materials Table 49 CFR 172.101. For those samples of hazardous substances where the contents are unknown, the selection of the appropriate transportation category will be based upon the DOT Hazardous Material Classification, a prioritized system of transportation categories. This system is presented in Table 1. For purposes of packaging safety, liquid and solid samples will be classified no lower than "flammable" as per Table 1.

The selection of the correct category for an unknown sample is through the process of elimination utilizing the DOT classification system. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample will be considered radioactive and appropriate shipping regulations for radioactive material will be followed. If radioactive material is eliminated, the sample will be considered to contain Poison "A" materials, the next material on the list. Poison "A" is defined by DOT as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquid, mixed with air, is dangerous to life. The class "A" poisons listed in 49 CFR 172.101 and their physical state at normal temperatures are presented in Table 2.

If poison "A" is eliminated as a shipment category, the next two classifications are "flammable" and "nonflammable" gases. Since few gas samples will be collected, flammable liquids would be the next category. The elimination of the classification of radioactive, Poison "A," flammable gas,

and nonflammable gas which require more stringent shipping procedures, permits the sample to be classified as a flammable liquid (or solid) and shipped accordingly. The shipping requirements for flammable liquids would also suffice for shipping any other samples classified below flammable liquids on the DOT classification schedule. For samples containing unknown materials,

other categories listed below flammable liquids/solids on Table 2 will not be considered. As a minimum, samples will be treated and shipped according to DOT flammable liquids standards.

2.4 SAMPLES CLASSIFIED AS RADIOACTIVE

Federal regulations governing the transport of radioactive sample material are extremely complex and reflect overlapping jurisdiction of many federal agencies. The important features of the DOT regulations (49 CFR 173, dated 1 November 1983) are summarized with their application to samples contaminated with uranium and associated daughter radionuclides.

Certain samples may fall into categories for which special packaging and shipping restrictions are mandated. Guidelines for determining the category to which a particular sample shipment belongs and for selecting a suitable mode of shipment and appropriate packaging are described below.

The following definitions are summarized from those presented in 49 CFR 173.403:

- Natural Thorium-Thorium characterized by the naturally occurring distribution of thorium isotopes (essentially 100 weight-percent thorium-232).
- Natural Uranium-Uranium characterized by the naturally occurring distribution of uranium isotopes (approximately 0.711 weight-percent uranium-235 and the remainder essentially uranium-238).

- o Specific Activity-In reference to a radionuclide, the activity of the nuclide per unit mass of the nuclide. The specific activity of a material in which a radionuclide is uniformly distributed is expressed as the activity per unit mass of the material.
- o Radioactive Material-Any material having a specific activity greater than 0.002 microcurie per gram.
- o Special Form Radioactive Material-Radioactive material that is either a single, solid piece or is obtained in a sealed capsule.
- o Normal Form Radioactive Material-Radioactive material that is not "Special Form Radioactive Material."
- o Transport Index-The dimensionless number (rounded up to the first decimal place) marked on the label of a package to designate the degree of control to be exercised by the carrier during transport. Generally, the transport index is the number expressing the maximum radiation level, in millirem per hour, occurring at distance of 1 meter (3.3 feet) from the external surface of the package. Other considerations may apply to certain fissile materials.

2.4.1 Quantities of Radioactivity in Packages

The regulations impose limits on the total activity (i.e., specific activity times the weight of the package) contained within a package of radioactive material. With respect to Type A packages, the limits are expressed as two quantities, A1 and A2, which refer to the maximum permissible activity for radionuclides in Special Form and Normal Form radioactive materials, respectively. Since the samples from the FMPC fall into the Normal Form radioactive materials category, the A2 value sets the activity limits for

packages of such samples. In those cases where contaminated material shipments are designated Low Specific Activity (LSA) or Limited Quantity, some fraction of the A2 value will normally apply.

Table 3 lists the A1 and A2 values cited in 49 CFR 173.435 for radionuclides of the uranium decay series. Values for radionuclides not listed in the regulations (e.g., lead-214, bismuth-214, polonium-214) have been assigned in accordance with the specifications set forth in 49 CFR 173.433 (a)(2).

Determination of permissible quantities for samples that are contaminated with FMPC waste is more complicated than simple reference to the A2 values, since such material contains a mixture of radionuclides. For such mixtures, two rules apply. A mixture of radionuclides from a single decay chain is considered to be a single radionuclide if the following criteria are met: (1) the parent and daughters are present in their naturally occurring proportions (for example, in secular equilibrium); (2) no daughter has a half-life longer than the parent radionuclide. For such a mixture, the A2 quantity to be applied is that of the parent radionuclide [49 CFR 173.433 (b)(2)]. For those mixtures in which the identity and activity of radionuclides is known, the permissible quantity for each radionuclide must be such that the following equation is true:

$$F_1 + F_2 + \ldots + F_k \ldots F_n \leq 1$$

where F_k is the ratio of the total activity of the kth radionuclide to its A1 or A2 quantity [49 CFR 173.433 (b)(3)].

2.4.2 Low Specific Activity Materials

Low Specific Activity (LSA) materials include uranium and thorium ores, physical and chemical concentrates of these ores (e.g., yellow cake), unradiated natural or depleted uranium or thorium, nonradioactive material externally contaminated with radioactivity that is not readily dispersible, and material in which the radioactivity is essentially uniformly distributed and does not exceed certain prescribed concentration limits. These limits for radionuclides of the uranium decay series, beginning with thorium-230, are listed in Table 4. In general, these concentrations will not be exceeded in FMPC samples.

Details for shipping LSA materials are described in 49 CFR 173.425. The chief advantage of shipping under the LSA category arises when the shipment is consigned Exclusive Use; that is, under the supervision or direction of a single consignor from point of origin to final destination [49 CFR 173.403 (i)]. When packaged shipments of LSA materials are consigned as Exclusive Use, the shipment is exempt from specification packaging, labeling and marking. Requirements that must be met include the following [49 CFR 173.425 (b)]:

- The shipment must be consigned Exclusive Use, unloaded from the conveyance in which it was originally loaded, and accompanied by written instructions for the maintenance of Exclusive Use shipping controls. LSA materials cannot be shipped by air.
- The material must be packaged in strong, tight packages that will not leak under normal conditions of transport, and each package must be marked "Radioactive - LSA."
- The package must not exceed the limits for removable radioactive contamination and radiation level.

- The transport vehicle must be appropriately placarded, unless the shipment consists solely of unconcentrated uranium and thorium ores.

2.4.3 Limited Quantities of Radioactive Material

Limited quantity shipments of radioactive material must meet the requirements specified in 49 CFR 173.421 and 173.423. If the activity per package does not exceed 10^{-3} A2 quantity of the radionuclide, then it is exempt from specification packaging and from the associated shipping-paper, marking, and labeling requirements. Instead, the package need only comply with the following requirements:

- The material must be packaged in strong, tight packages that will not leak under normal conditions of transport. The outside of the inner packaging, or the outside of the packaging itself (when there is no inner packaging), must be marked "Radioactive."
- The package must not exceed the limits for removable radioactive contamination and radiation level.
- The package must be certified as being acceptable for transport by having a notice enclosed in or attached to the package, stating the name of the consignor and including this statement: "This package conforms to conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, not otherwise specified (n.o.s.), UN2910."

One advantage of limited quantity shipments is that there are no restrictions on air transport. [Guidelines specified in the International Civil Aviation Organization (ICAO) regulations should be consulted for air shipments of radioactive materials.] The major disadvantage is the low concentrations and quantity weights permissible for mixtures of different radionuclides.

2.5 RADIATION AND CONTAMINATION CONTROL

Measurements of radiation level (dose rate) and of nonfixed (removable) radioactive contamination are conducted on radioactive-material shipments to control exposure to radioactivity. Inspectors of such shipments can readily determine whether the packages comply with the regulations summarized below.

2.5.1 Radiation Limits

Radiation level is the radiation dose-equivalent rate expressed in millirem per hour (mrem/h) [49 CFR 173.403(v)]. Permissible radiation levels for various shipping categories are described below:

- Limited Quantity Packages: The radiation level at any point on the external surface of the package may not exceed 0.5 mrem/h [49 CFR 173.421(b)].
- LSA Packages: The radiation level of the LSA packages transported as Exclusive Use shipments shall not at any time during transport exceed any of the following limits [49 CFR 173.441(b)]:

  - 200 mrem/h on the accessible external surface of the package; or 1,000 mrem/h if the following criteria are met: the shipment is made in a closed transport vehicle, the package is secured so that its position remains fixed during transport, and no unloading/loading operations occur between the beginning and end of transport;
  - 10 mrem/h at any point on the outer surface of the transport vehicle;
  - 10 mrem/h at any point 2 meters (6.6 feet) from the outer surfaces of the transport vehicle; and

- 2 mrem/h at any normally occupied position in the transport vehicle. This provision does not apply to private motor carriers when personnel operate under a radiation protection program.

o Other Packages: The radiation level must not exceed 200 mrem/h at any point on the external surface of the package, and the transport index must not exceed 10.

2.5.2 Contamination Control

Nonfixed (removable) radioactive contamination is defined as radioactive contamination that is easily removed from the surface by wiping with an absorbent material [49 CFR 173.403(r)]. The maximum permissible limits for removable radioactive contamination, as set forth in 49 CFR 173.443(a), are summarized below; these limits apply to any area of 300 square centimeters.

o 10^{-5} micro Ci/cm^2 or 22 disintegrations per minute (dpm)/cm^2, for beta/gamma-emitting radionuclides, all radionuclides with half-lives less than 10 days, natural uranium, natural thorium, uranium-235, uranium-238, thorium-232, and thorium-228 and thorium-230 when contained in ore and physical concentrates; and

o 10^{-6} micro Ci/cm^2 or 2.2 dpm/cm^2, for all other alpha-emitting radionuclides.

Exclusive use consignments of radioactive material may not exceed these limits at the beginning of transport, and may not exceed 10 times the limits at any time during transport (49 CFR 173.443).

2.6 <u>SAMPLES CLASSIFIED AS POISON "A"</u>

Using the word "poisonous" does not convey the certain knowledge that a sample is in fact poisonous, or to what degree it may be poisonous; however, it is intended to describe the class of packaging in order to comply with DOT regulations.

2.6.1 Packaging

Collect samples in a polyethylene or glass container which is of an outer diameter narrower than the valve hole in a DOT Spec. #3A1800 or #3A1800 metal cylinder. Fill sample container allowing sufficient ullage (approximately 10 percent by volume) so it will not be liquid-full at 54 degrees Celsius (130°F). Seal sample container. Attach a properly completed identification tag to sample container.

With a string or flexible wire attached to the neck of the sample container, lower it into a metal cylinder which has been partially filled with incombustible, absorbent loose packaging material (vermiculite or diatomaceous earth). Allow sufficient absorbing material between the bottom and sides of the container and the metal cylinder to prevent breakage and absorb leakage. After the cylinder is filled with cushioning material, drop the ends of the string or wire into the cylinder valve hole. Only one sample may be placed in a metal cylinder.

Replace valve, torque to 250 feet/pound (for one-inch opening) and replace valve protector on metal cylinder, using Teflon tape.

One or more cylinders may be placed in a DOT-approved outside container.

2.6.2 Marking and Labeling

Abbreviations will be used only when specified. The following information will be placed on the side of the cylinder, or on a tag wired to the cylinder valve protector, either hand printed or in label form: "Poisonous Liquid, n.o.s." or "Poisonous Gas, n.o.s. NA9035," laboratory name and address. The following DOT label will be placed on the cylinder: "Poisonous Gas" (even if the sample is liquid).

If the metal cylinders are placed in an outside container, both the container and cylinders inside will have the same markings and labels as above. In addition, "Laboratory Sample" and "Inside Packages Comply with the Prescribed Specifications" will be marked on the top and/or front side of the outside container. "THIS SIDE UP" marking will be placed on the topside of the container, with upward pointing arrows on all four sides.

2.6.3 Shipping Papers

The bill of lading will be completed and the certification statement signed (if the carrier does not provide a certification statement, a standard industry form will be used) with the following information in the order listed. One form may be used for more than one exterior container. Abbreviations will be used only as specified: "Poisonous Liquid, n.o.s. NA9035," "Limited Quantity" or "Ltd. Qty.", net weight or net volume. The net weight or net volume must be placed just before or just after the "Poisonous Liquid, n.o.s." marking.

A chain-of-custody record will also be properly executed and included in the container or with the cylinder, if legal use of samples is required or anticipated.

Unless samples are driven to the laboratory, an employee will accompany shipping container to the transport carrier and, if required, open the outside container for freight inspection. Alternately, samples may be shipped through the WMCO Transportation Department.

2.6.4 Transportation

Poison "A" categorized packages may not be transported by Federal Express Corporation (air cargo) or other common carrier aircraft, or by rental, nongovernment aircraft. Samples may be shipped by ground transport or government-owned aircraft.

2.7 SAMPLES CLASSIFIED AS FLAMMABLE LIQUIDS OR FLAMMABLE SOLIDS PROCEDURES

2.7.1 Packaging

Samples will be collected in a glass container with a nonmetallic, Teflon-lined screw cap allowing sufficient ullage (approximately 10 percent by volume) so that the container is not liquid full at 54 degrees Celsius (130°F). If an air space in the innermost container cannot be tolerated in order to maintain sample integrity, the sample will be placed within a second container to provide the required ullage. A properly completed sample identification tag (Figure 5) will be attached to the sample container.

The sample container closure will be sealed and the sample placed in a two-millimeter-thick (or thicker) polyethylene bag, one sample per bag. The sample identification tags will be positioned to enable it to be read through the bag.

The polyethylene bag will be sealed and placed inside an appropriate size metal can with enough incombustible, absorbent, cushioning matter (e.g., vermiculite, diatomaceous earth) to prevent breakage and absorb liquid; only one bag will be contained per can. The can will be pressure closed using clips, tape, or other positive means to hold the lid securely, tightly, and effectively.

One or more metal cans will be placed (or a single one-gallon bottle) and surrounded with incombustible, absorbing packaging material for stability during transport into a strong outside container, such as a cooler or inside an approved fiberboard box.

2.7.2 Marking and Labeling

Abbreviations will be used only when specified. The following information will be placed on the metal can (or one-gallon bottle), either hand printed or in label form: laboratory name and address, "Flammable Liquid n.o.s. UN1993" or "Flammable Solid n.o.s. UN1325." Not otherwise specified (n.o.s.) is not used if the flammable liquid or solid is identified. In that case, the name of the specific material is used and listed before the category (e.g., "Flammable Liquid").

The following DOT labels will be placed on the outside of the can (or bottle): "Flammable Liquid" or "Flammable Solid." The "Dangerous When Wet" label will be used with the "Flammable Solid" label if the material meets the definition of a water reactive material. The "Cargo Aircraft Only" label will be used if the net quantity of the sample in each package is greater than one quart (for "Flammable Liquid, "n.o.s.) or weighs 25 pounds or more (for "Flammable Solid" n.o.s.) [49 CFR 172.402, 172.101].

If the cans are placed in an exterior container, both the container and the inside can (or bottle) will have the same markings and labels as above.

The words "THIS END UP" or "THIS SIDE UP" will be clearly printed on the top of the outer package. Upward pointing arrows will be placed on the sides of the package. The words "LABORATORY SAMPLES" will also be printed on the top of the package.

2.7.3 Transportation

Unknown hazardous substances classified as flammable liquids may be transported by rented or common carrier truck, bus, railroad, or by Federal Express Corporation, but they should not be transported by any other common carrier air transport, even "cargo only" aircraft. (DOT regulations permit "cargo only" aircraft such as TWA, United, etc.; however, difficulties with regular airline transportation suggests avoiding these types of transportation.)

These procedures are designed to enable air cargo shipment by entities such as Federal Express; however, they should not be construed as an endorsement of a particular commercial carrier.

If samples are transported by any type of government-owned vehicle, including aircraft, DOT regulations are not applicable. However, personnel will use the packaging procedures described. The bill of lading with a certification is an exception and does not have to be executed.

2.8 SAMPLE BOTTLE PREPARATION AND SAMPLE PRESERVATION

Sample containers and appropriate preservatives are presented in Table 5 for specific chemical and radiological parameters. Sample bottles containing premeasured amounts of the appropriate chemical preservatives are prepared in the laboratory and are shipped to the field. Sample bottles are either purchased precleaned in accordance with U.S. EPA specifications or are cleaned in the laboratory to U.S. EPA specifications. Volatile organic analysis (VOA) vials are purchased precleaned. Glass containers for other organic analyses are washed with a nonphosphate detergent, rinsed with deionized water, and allowed to air dry. Plastic containers for metals analyses are washed with a nonphosphate detergent, rinsed with tap water and deionized water, and then rinsed with dilute nitric acid. Plastic containers for other general chemistry and radiological procedures are washed with a nonphosphate detergent and rinsed with tap water and deionized water.

E-6h(3). ANALYTICAL PROCEDURE

Quality assurance (QA) objectives have been established for precision, accuracy, completeness, representativeness, and comparability for each major measurement parameter for the FMPC project. These objectives are presented in Tables 5, 6, and 7 ~~and 8~~ and are pertinent to both the analytical laboratories and

field procedures. Data will be calculated and reported in units consistent with Contract Laboratory Program analytical procedures and other organizations reporting similar data to allow for comparability of data. Definitions for precision, accuracy, completeness, representativeness, and comparability are as follows:

- Precision - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Comparison of replicate values is best expressed as the relative percent difference. Various measures of precision exist depending upon the "prescribed similar conditions."
- Accuracy - The degree of agreement of a measurement (or an average of replicate measurements), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system.
- Completeness - A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.
- Representativeness - Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental concern.
- Comparability - Expresses the confidence with which one data set can be compared to another.

E-6h(4). CHAIN-OF-CUSTODY

4.1 FIELD SAMPLING

The following will be used in the chain-of-custody process for sample tracking and field activities:

- Sample identification and labeling (Figure 5).
- Chain-of-Custody form (Figure 12.
- Sample Collection Log (Figure 4).
- Laboratory Request for Analysis form (Figure 2).

4.1.1 Sample Identification and Labeling

All samples will be adequately marked for identification from the time of collection and packaging through shipping and storage. Marking will generally be made on the sample container (jar, bottle, etc.) but may be applied directly to the sample, or on a tag or label attached to the sample or container, depending on the type of sample and its intended use. Sample identification will include, as appropriate:

- Project name and number
- Sample number
- Sample location (e.g., boring, test pit, depth or sampling interval, and field coordinates)
- Sampling date and time
- The initials of the individual(s) performing the sampling
- Sample preservative used.

An example of a standard sample label is illustrated in Figure 5. A sample numbering system will be established for the purpose of identifying the samples according to location and type.

4.1.2 Chain-of-Custody Record

Documentation of the sample chain-of-custody is provided by the use of a Chain-of-Custody record (Figure 1). This record contains information that includes the sampling location, the type and amount of samples collected, the date and time of sample collection, the name(s) of the person(s) responsible for sample collection, the date and time of all custody transfers, the signature of the person relinquishing and accepting sample custody, and other pertinent information.

Chain-of-custody procedures document sample possession from the time of collection to disposal. A sample is considered in custody if it is:

- In one's physical possession
- In view, after being in physical possession
- Locked so that no one can tamper with it, after having been in physical custody
- In a secured area, restricted to authorized personnel.

A chain-of-custody record will be initiated in the field and will accompany each group of samples during shipment to the laboratory. Each time custody of the sample changes, the new custodian will sign the record and indicate the dates of transfer. An example of a chain-of-custody record is included in Figure 1.

If the samples are shipped to the laboratory by commercial carrier, the original chain-of-custody form shall be sealed in a watertight container, placed in the shipping container, and the shipping container sealed prior to giving it to the carrier. If the samples are directly transported to the laboratory, the original chain-of-custody form shall be kept in possession of the person delivering the samples.

For samples shipped by commercial carrier, the waybill shall serve as an extension of the chain-of-custody record between the final field custodian and receipt in the laboratory. (The carrier and waybill number will be written on the chain-of-custody form. If the original chain-of-custody form is sealed in the shipping container before the waybill number is received, then this number will be written on the copy of the chain-of-custody form.)

Upon receipt of the samples in the laboratory, the Quality Control coordinator, or representative, shall open the shipping containers, compare the contents with the chain-of-custody record, and sign and date the record. The Quality Control coordinator will also record the carrier and waybill number on the original chain-of-custody form, if it is not already present.

All original chain-of-custody records, analytical data, and other project documentation will be maintained in a project file. Project files will be stored in a central filing system pending disposition by WMCO.

A legible copy of the field chain-of-custody record will be maintained. Once samples are received in the laboratory, chain-of-custody records will be signed by a designated representative of the laboratory and copies of the signed chain-of-custody records will be submitted to xxxxxxxxxxxxxx or other designated representative.

4.1.3 Sample Collection Log

A sample collection log is prepared for each sample to record information pertaining to the location and collection of a sample. The following information is required on the sample collection log, as appropriate:

- Unique sample number
- Sample location
- Collector initials
- Date and time sample collected
- Sample coordinates (Ohio State Planar System)
- Sample identification (type, media, sequence, blank, spike, duplicate, split).

An example of a sample collection log is provided in Figure 4.

4.1.4 Laboratory Request for Analysis Form

The laboratory request for analysis form is prepared to indicate the testing program required for the collected samples. The following information is recorded on the laboratory request for analysis form:

- Project name and number

- Date samples shipped
- Required report date and turnaround times for analysis
- Contact with telephone number for receipt of the analytical report and billing invoices
- Sample identification numbers
- Sample volume collected and appropriate preservatives.

An example of a laboratory request for analysis form in provided in Figure 2.

4.2 ANALYTICAL LABORATORY

4.2.1 Laboratory Sample Receipt

Upon receipt of sample, the QC coordinator or designee shall:

- Examine all samples and determine if proper temperature has been maintained during shipment. The receiving temperature will be recorded on the chain-of-custody record. If samples have been damaged during shipment, the remaining samples shall be carefully examined to determine whether they were affected. Any samples suspected of being affected shall also be considered damaged. It will be noted on the chain-of-custody record what specific samples were damaged and that the samples were removed from the sampling program. Field personnel will be notified in writing as soon as possible of an estimate of the cause of damage, that samples were damaged and that they must be resampled, or the testing program changed.
- Compare samples received against those listed on the chain-of-custody record.

- Verify that sample holding times have not been exceeded. If the sample holding time has been exceeded, the QC coordinator, or designee, will notify field personnel in writing that this has occurred and will prepare a Nonconformance Report (see Figure 7).
- Sign and date the chain-of-custody record and attach the waybill to the chain-of-custody record.
- Place the samples in adequate laboratory storage.
- Enter the samples in the laboratory sample log-in book which contains the following information:
  - Project identification number
  - Sample numbers
  - Type of samples
  - Date received in laboratory.
- Notify the laboratory manager or group leaders of sample arrival.
- Place the completed chain-of-custody records in the project file.

If samples collected arrive without chain-of-custody or with incorrect chain-of-custody records, the following actions shall be undertaken by the QC coordinator:

- If the chain-of-custody record is incorrect, a memorandum to the project director and field personnel is prepared stating the deviations. The memorandum must be signed and dated by the person originating the chain-of-custody and by the QC coordinator. The memorandum will serve as an amendment to the chain-of-custody. If the information on the chain-of-custody record cannot be corrected by the QC coordinator or the field personnel, the samples affected shall be removed from the sampling program.

- If the chain-of-custody record is not shipped with the samples, the field personnel shall be contacted and a memorandum prepared which lists the persons involved in collecting, shipping, and receiving the samples and the times, dates, and events. Each

NONCONFORMANCE REPORT

PROJECT NO. _____ PAGE ___ OF ___

PROJECT NAME _____ DATE: _____

NONCONFORMANCE:

IDENTIFIED BY: _____ DATE: _____

CORRECTIVE ACTION REQUIRED:

TO BE PERFORMED BY: _____ DATE: _____

MUST CORRECTION BE VERIFIED? YES ___ NO ___

TO BE VERIFIED BY: _____ PREPARED BY: _____ DATE: _____

CORRECTIVE ACTION TAKEN:

PERFORMED BY: _____ DATE: _____

VERIFIED BY: _____ DATE: _____

CC:

Approved By: _____ Date: _____

_____ Date: _____

Figure 7. Nonconformance Report.

person involved must sign and date this memorandum. The completed memorandum will be maintained in lieu of the chain-of-custody record.

4.2.2 Laboratory Storage of Samples

The primary considerations for sample storage are:

- o Maintaining the prescribed temperature, if required, which is typically 4 degrees Celsius (39°F).
- o Extracting and/or analyzing samples within the prescribed holding time for the parameters of interest.

The requirements of Table 5 for temperatures and holding times shall be used. Placing of samples in the proper storage environment is the responsibility of the QC coordinator or designee, who should notify the laboratory manager or group leaders if there are any samples which must be analyzed immediately because of holding time requirements.

4.2.3 Initiation of Testing Program

As stated in Section 3.1.4, a request for analysis form shall be submitted with the samples to the laboratory. If the analytical program is not defined with the sample shipment, the QC coordinator shall immediately notify the manager responsible for the work for definition of the analysis program.

The laboratory manager and group leaders are responsible for prioritizing samples on the basis of holding time and of the required time needed to include the samples into the laboratory sample stream.

4.2.4 Sample Disposal

The chain-of-custody for the sample is completed as part of sample disposal. There are several possibilities for sample disposition:

- The sample may be completely consumed during analysis.
- Samples may be returned to the client or location of sampling for disposal.
- The samples may be stored after analysis. Proper environmental control and holding time must be observed if reanalysis is anticipated. If reanalysis is not anticipated, environmental conditions for storage will not be observed.

The laboratory manager shall determine disposition of samples if not specified on the laboratory request for analysis form (Figure 2).

In general, samples and extracts will not be maintained longer than six months beyond completion of analysis, unless otherwise specified.

Table 1.

DOT HAZARDOUS MATERIALS CLASSIFICATION

1. Radioactive Material
2. Poison "A"
3. Flammable Gas
4. Nonflammable Gas
5. Flammable Liquid
6. Oxidizer 13. ORM-B
7. Flammable Solid
8. Corrosive Materials (liquid)
9. Poison B
10. Corrosive Material (solid)
11. Irritating Materials
12. Combustible liquid (in containers having capacity exceeding 110 gallons)
13. ORM-B
14. ORM-A
15. Combustible liquids (in containers having capacity of 100 gallons or less)
16. ORM-E

Table 2.

CLASS "A" POISONS AND THEIR PHYSICAL STATE AT ROOM TEMPERATURES

Compound	Physical State
arsine	gas
bromoacetone	liquid
chloropicrin & methyl chloride mixture	gas
chloropicrin & nonflammable, nonliquified compressed gas mixture	gas
cyanogen chloride containing less than 0.9% water	gas
cyanogen gas	gas
gas identification set	gas
gelatin dynamite (H. E. Germaine)	gas
grenade (with poison "A" gas charge)	gas
hexaethyl tetraphosphate & compressed gas mixture	gas
hydrocyanic acid (prussic solution)	liquid
hydrocyanic acid, liquified	gas
insecticide liquified gas, containing poison "A" or poison "B" materials	gas
methyldichloroarsine	liquid
nitric oxide	gas
nitrogen dioxide	liquid
nitrogen peroxide	liquid

nitrogen tetroxide	liquid
organic phosphate	gas
parathion & compressed gas mixture	gas
phosgene (diphosgene)	gas
phosphine	gas
poisonous liquid or gas not otherwise specified	liquid or gas
tetraethyl dithiopyrophosphate	gas
tetraethyl pyrophosphate	gas

Table 3.

A_1 AND A_2 QUANTITIES FOR RADIONUCLIDES OF THE URANIUM DECAY SERIES

Isotope	Atomic Number	Decay	Half-Life[a]	Quantity in Curies A1	A2
U-238	92	Alpha	4.5×10^9 y	Unlimited	Unlimited
Th-234	90	Beta	24 d	10	10
U-234	92	Alpha	2.5×10^5 y	100	0.1
Th-230	90	Alpha	7.5×10^4 y	3	0.003
Ra-226	88	Alpha	1622 y	10	0.05
Rn-222	86	Alpha	3.8 d	10	2.0
Pb-210	82	Beta	22 y	100	0.2
Bi-210	83	Beta	5 d	100	4.0
Po-210	84	Alpha	138 d	200	0.2

[a]Abbreviations: y = years; d = days; m = minutes; s = seconds

Table 4.

LOW SPECIFIC ACTIVITY (LSA) CONCENTRATION LIMITS FOR RADIONUCLIDES OF THE URANIUM DECAY SERIES
[FROM 49 CFR 173.403(N)(4)]

Nuclide	A2 Value (curies)	Estimated Average Concentration	
		Microcuries/Gram	Curies/Kilogram
Th-230	0.003	0.1	0.0001
Ra-226	0.05	0.1	0.0001
Rn-222	2.0	300	0.3
Pb-210	0.2	5.0	0.005
Bi-210	4.0	300	0.3
Po-210	0.2	5.0	0.005

Table 5

CONTRACT LABORATORY PROGRAM (CLP)
HAZARDOUS SUBSTANCE LIST (HSL) COMPOUND
METHOD REFERENCES AND QUALITY CONTROL OBJECTIVES
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	MATRIX SPIKE PRECISION RPDE(a) Water	MATRIX SPIKE PRECISION RPDE(a) Solids	MATRIX SPIKE ACCURACY % OF RECOVERY Water	MATRIX SPIKE ACCURACY % OF RECOVERY Solids	SURROGATE SPIKE ACCURACY % OF RECOVERY Water	SURROGATE SPIKE ACCURACY % OF RECOVERY Solids	EXPECTED COMPLETENESS %	EXPECTED METHOD DETECTION LIMIT(b) Water ug/l(c)	EXPECTED METHOD DETECTION LIMIT(b) Solids ug/kg(d)	METHOD NO.	REFERENCE
Volatiles:	Gas Chromatograph/ Mass Spectrometers	Daily							90			Exhibit D	1
Chloromethane			-	-	-	-	-	-		10	10		
Bromomethane			-	-	-	-	-	-		10	10		
Vinyl Chloride			-	-	-	-	-	-		10	10		
Chloroethane			-	-	-	-	-	-		10	10		
Methylene Chloride			-	-	-	-	-	-		5	5		
Acetone			-	-	-	-	-	-		10	10		
Carbon Disulfide			-	-	-	-	-	-		5	5		
1,1-Dichloroethene			14	22	61-145	59-172	-	-		5	5		
1,1-Dichloroethane			-	-	-	-	-	-		5	5		
trans-1,2-Dichloroethene			-	-	-	-	-	-		5	5		
Chloroform			-	-	-	-	-	-		5	5		
1,2-Dichloroethane			-	-	-	-	-	-		5	5		
2-Butanone			-	-	-	-	-	-		10	10		
1,1,1-Trichloroethane			-	-	-	-	-	-		5	5		
Carbon Tetrachloride			-	-	-	-	-	-		5	5		
Vinyl Acetate			-	-	-	-	-	-		10	10		
Bromodichloromethane			-	-	-	-	-	-		5	5		
1,1,2,2-Tetrachloroethane			-	-	-	-	-	-		5	5		
1,2-Dichloropropane			-	-	-	-	-	-		5	5		
trans-1,3-Dichloropropene			-	-	-	-	-	-		5	5		
Trichloroethene			14	24	71-120	62-137	-	-		5	5		
Dibromochloromethane			-	-	-	-	-	-		5	5		
1,1,2-Trichloroethane			-	-	-	-	-	-		5	5		
Benzene			11	21	76-127	66-142	-	-		5	5		
cis-1,3-Dichloropropene			-	-	-	-	-	-		5	5		

See footnotes at end of table.

Table 5
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	MATRIX SPIKE PRECISION RPDE(a) Water	MATRIX SPIKE PRECISION RPDE(a) Solids	MATRIX SPIKE ACCURACY % OF RECOVERY Water	MATRIX SPIKE ACCURACY % OF RECOVERY Solids	SURROGATE SPIKE ACCURACY % OF RECOVERY Water	SURROGATE SPIKE ACCURACY % OF RECOVERY Solids	EXPECTED COMPLETENESS %	EXPECTED METHOD DETECTION LIMIT(b) Water ug/l(c)	EXPECTED METHOD DETECTION LIMIT(b) Solids ug/kg(d)	METHOD NO.	REFERENCE
Volatiles (continued):													
2-Chloroethyl Vinyl Ether			-	-	-	-	-	-		10	10		
Bromoform			-	-	-	-	-	-		5	5		
2-Hexanone			-	-	-	-	-	-		10	10		
4-Methyl-2-pentanone			-	-	-	-	-	-		10	10		
Tetrachloroethene			13	21	76-125	59-119	-	-		5	5		
Toluene			13	21	75-130	60-133	-	-		5	5		
Chlorobenzene			-	-	-	-	-	-		5	5		
Ethylbenzene			-	-	-	-	-	-		5	5		
Styrene			-	-	-	-	-	-		5	5		
Total Xylenes			-	-	-	-	-	-		5	5		
Surrogate Compounds:													
Toluene-d_8			-	-	-	-	88-110	81-117		-	-		
4-Bromofluorobenzene			-	-	-	-	86-115	74-121		-	-		
1,2-Dichloroethane-d_4			-	-	-	-	76-114	70-121		-	-		
Acid/Base-Neutral Extractables:	Gas Chromatograph/ Mass Spectrometers	Daily							90			Exhibit D	1
Phenol			42	35	12-89	26-90	-	-		10	330		
Bis(2-Chloroethyl)ether			-	-	-	-	-	-		10	330		
2-Chlorophenol			40	50	27-123	25-102	-	-		10	330		
1,3-Dichlorobenzene			-	-	-	-	-	-		10	330		
1,4-Dichlorobenzene			28	27	36-97	28-104	-	-		10	330		
Benzyl Alcohol			-	-	-	-	-	-		10	330		
1,2-Dichlorobenzene			-	-	-	-	-	-		10	330		
2-Methylphenol			-	-	-	-	-	-		10	330		
Bis(2-Chloroisopropyl)ether			-	-	-	-	-	-		10	330		
4-Methylphenol			38	38	41-116	41-126	-	-		10	330		
N-Nitroso-di-n-propylamine			-	-	-	-	-	-		10	330		
Hexachloroethane			-	-	-	-	-	-		10	330		
Nitrobenzene			-	-	-	-	-	-					
Isophorone			-	-	-	-	-	-					

See footnotes at end of table.

Table 65
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	MATRIX SPIKE PRECISION RPD(a) Water	MATRIX SPIKE PRECISION RPD(a) Solids	MATRIX SPIKE ACCURACY % OF RECOVERY Water	MATRIX SPIKE ACCURACY % OF RECOVERY Solids	SURROGATE SPIKE ACCURACY % OF RECOVERY Water	SURROGATE SPIKE ACCURACY % OF RECOVERY Solids	EXPECTED COMPLETENESS %	EXPECTED METHOD DETECTION LIMIT(b) Water ug/l(c)	EXPECTED METHOD DETECTION LIMIT(b) Solids ug/kg(d)	METHOD NO.	REFERENCE
Acid/Base-Neutral Extractables: (Continued)													
2-Nitrophenol			-	-	-	-	-	-		10	330		
2,4-Dimethylphenol			-	-	-	-	-	-		10	330		
Benzoic acid			-	-	-	-	-	-		50	1600		
Bis(2-chloroethoxy)methane			-	-	-	-	-	-		10	330		
2,4-Dichlorophenol			-	-	-	-	-	-		10	330		
1,2,4-Trichlorobenzene			28	21	19-98	38-107	-	-		10	330		
Naphthalene			-	-	-	-	-	-		10	330		
4-Chloroaniline			-	-	-	-	-	-		10	330		
Hexachlorobutadiene			-	-	-	-	-	-		10	330		
4-Chloro-3-methylphenol			42	33	23-97	26-103	-	-		10	330		
2-Methylnaphthalene			-	-	-	-	-	-		10	330		
Hexachlorocyclopentadiene			-	-	-	-	-	-		10	330		
2,4,6-Trichlorophenol			-	-	-	-	-	-		10	330		
2,4,5-Trichlorophenol			-	-	-	-	-	-		50	1600		
2-Chloronaphthalene			-	-	-	-	-	-		10	330		
2-Nitroaniline			-	-	-	-	-	-		50	1600		
Dimethylphthalate			-	-	-	-	-	-		10	330		
Acenaphthylene			31	19	46-118	31-137	-	-		10	330		
3-Nitroaniline			-	-	-	-	-	-		50	1600		
Acenaphthene			-	-	-	-	-	-		10	330		
2,4-Dinitrophenol			-	-	-	-	-	-		50	1600		
4-Nitrophenol			50	50	10-80	11-114	-	-		50	1600		
Dibenzofuran			-	-	-	-	-	-		10	330		
2,4-Dinitrotoluene			38	47	24-96	28-89	-	-		10	330		
2,6-Dinitrotoluene			-	-	-	-	-	-		10	330		
Diethylphthalate			-	-	-	-	-	-		10	330		
4-Chlorophenyl Phenyl Ether			-	-	-	-	-	-		10	330		
Fluorene			-	-	-	-	-	-		10	330		
4-Nitroaniline			-	-	-	-	-	-		50	1600		
4,6-Dinitro-2-methylphenol			-	-	-	-	-	-		50	1600		
N-Nitrosodiphenylamine			-	-	-	-	-	-		10	330		
4-Bromophenyl Phenyl Ether			-	-	-	-	-	-		10	330		
Hexachlorobenzene			-	-	-	-	-	-		10	330		
Pentachlorophenol			50	47	9-103	17-109	-	-		50	1600		
Phenanthrene			-	-	-	-	-	-		10	330		

See footnotes at end of table.

Table 65
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	MATRIX SPIKE PRECISION RPD(a) Water	MATRIX SPIKE PRECISION RPD(a) Solids	MATRIX SPIKE ACCURACY % OF RECOVERY Water	MATRIX SPIKE ACCURACY % OF RECOVERY Solids	SURROGATE SPIKE ACCURACY % OF RECOVERY Water	SURROGATE SPIKE ACCURACY % OF RECOVERY Solids	EXPECTED COMPLETENESS %	EXPECTED METHOD DETECTION LIMIT(b) Water ug/l(c)	EXPECTED METHOD DETECTION LIMIT(b) Solids ug/kg(d)	METHOD NO.	REFERENCE
Acid/Base-Neutral Extractables: (Continued)													
Anthracene			-	-	-	-	-	-		10	330		
Di-n-butylphthalate			40	47	11-117	29-135	-	-		10*	330		
Fluoranthene			-	-	-	-	-	-		10	330		
Pyrene			31	36	26-127	35-142	-	-		10	330		
Butyl Benzyl Phthalate			-	-	-	-	-	-		10	330		
3,3'-Dichlorobenzidine			-	-	-	-	-	-		20	660		
Benzo(a)anthracene			-	-	-	-	-	-		10	330		
Bis(2-ethylhexyl)phthalate			-	-	-	-	-	-		10	330		
Chrysene			-	-	-	-	-	-		10	330		
Di-n-octylphthalate			-	-	-	-	-	-		10	330		
Benzo(b)fluoranthene			-	-	-	-	-	-		10	330		
Benzo(k)fluoranthene			-	-	-	-	-	-		10	330		
Benzo(a)pyrene			-	-	-	-	-	-		10	330		
Indeno(1,2,3-cd)pyrene			-	-	-	-	-	-		10	330		
Dibenzo(a,h)anthracene			-	-	-	-	-	-		10	330		
Benzo(g,h,i)perylene			-	-	-	-	-	-		10	330		
SURROGATE COMPOUNDS:													
Nitrobenzene-d_5			-	-	-	-	35-114	23-120		-	-		
2-fluorobiphenyl			-	-	-	-	43-116	30-115		-	-		
p-terphenyl-d_{14}			-	-	-	-	33-141	18-137		-	-		
Phenol-d_5			-	-	-	-	10-94	24-113		-	-		
2-Fluorophenol			-	-	-	-	21-100	25-121		-	-		
2,4,6-Tribromophenol			-	-	-	-	10-123	19-122		-	-		
Pesticides/Polychlorinated Biphenyls:	Gas Chromatograph	Daily							90			Exhibit D	1
alpha-BHC			-	-	-	-	-	-		0.05	8.0		
beta-BHC			-	-	-	-	-	-		0.05	8.0		
delta-BHC			-	-	-	-	-	-		0.05	8.0		
gamma-BHC			15	50	56-123	46-127	-	-		0.05	8.0		
Heptachlor			20	31	40-131	35-130	-	-		0.05	8.0		
Aldrin			22	43	40-120	34-132	-	-		0.05	8.0		

See footnotes at end of table.

Table 65
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	MATRIX SPIKE PRECISION RPD(a) Water	MATRIX SPIKE PRECISION RPD(a) Solids	MATRIX SPIKE ACCURACY % OF RECOVERY Water	MATRIX SPIKE ACCURACY % OF RECOVERY Solids	SURROGATE SPIKE ACCURACY % OF RECOVERY Water	SURROGATE SPIKE ACCURACY % OF RECOVERY Solids	EXPECTED COMPLETENESS %	EXPECTED METHOD DETECTION LIMIT(b) Water ug/l(c)	EXPECTED METHOD DETECTION LIMIT(b) Solids ug/kg(d)	METHOD NO.	REFERENCE
Pesticides/Polychlorinated Biphenyls: (Continued)													
Heptachlor Epoxide			-	-	-	-	-	-		0.05	8.0		
Endosulfan I			-	-	-	-	-	-		0.05	8.0		
Dieldrin			18	38	52-126	31-134	-	-		0.10	16.0		
4,4'-DDE			-	-	-	-	-	-		0.10	16.0		
Endrin			21	45	56-121	42-139	-	-		0.10	16.0		
Endosulfan II			-	-	-	-	-	-		0.10	16.0		
4,4'-DDD			-	-	-	-	-	-		0.10	16.0		
Endosulfan Sulfate			-	-	-	-	-	-		0.10	16.0		
4,4'-DDT			27	50	38-127	23-134	-	-		0.10	16.0		
Endrin Ketone			-	-	-	-	-	-		0.10	16.0		
Methoxychlor			-	-	-	-	-	-		0.5	80.0		
Chlordane			-	-	-	-	-	-		0.5	80.0		
Toxaphene			-	-	-	-	-	-		1.0	160.0		
Aroclor 1016			-	-	-	-	-	-		0.5	80.0		
Aroclor 1221			-	-	-	-	-	-		0.5	80.0		
Aroclor 1232			-	-	-	-	-	-		0.5	80.0		
Aroclor 1242			-	-	-	-	-	-		0.5	80.0		
Aroclor 1248			-	-	-	-	-	-		0.5	80.0		
Aroclor 1254			-	-	-	-	-	-		1.0	160.0		
Aroclor 1260			-	-	-	-	-	-		1.0	160.0		
SURROGATE COMPOUND:													
Dioctylchlorendate			-	-	-	-	24-154(e)	20-150(e)		-	-		

(a) RPD equals relative percent difference.

(b) The indicated detection limits are appropriate to low level water and solids samples. Medium water Contract Detection Limits (CRDL) for Volatile, Acid/Base-Neutral Extractable, and Pesticide HSL compounds are 100 times the individual low water CRDL. Medium solids CRDLs for Volatile, Acid/Base-Neutral Extractable, and Pesticide HSL compounds are 100, 60, and 150 times individual low solid CRDL, respectively.

(c) ug/l equals micrograms per liter or parts per billion (ppb).

(d) ug/kg equals micrograms per kilogram or parts per billion (ppb).

(e) The indicated surrogate spike percent recovery limits are for advisory purposes only. These limits are not used to determine whether a sample should be reanalyzed.

REFERENCES

(1) U.S. Environmental Protection Agency (EPA), 1987, "Chemical Analytical Services for Multi-Media, Multi-Concentration Organics, GC/MS Techniques." MA-87-K236, Washington, D.C.

Table 7C

LABORATORY RADIOLOGICAL TESTING
QUALITY CONTROL PERFORMANCE SUMMARY
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION % RSD(a)	TYPICAL ACCURACY % Bias(b)	COMPLETENESS (%)	EXPECTED METHOD DETECTION LIMIT(a)	METHOD NO.	REFERENCE
Gross Alpha	Tennelec Low Background Alpha/Beta Counting System	Daily (c)	±20	±30	90	1.0 pCi/l(f,h) (water)	BSL-308	1
	or							
	Ludlum Scaler Scintillation Counters Models 1000, 2000, and 2200	Daily	±20	±30	90			
Gross Beta	Tennelec Low Background Alpha/Beta Counting System	Daily	±20	±30	90	4.0 pCi/l(h) (water)	BSL-308	1
Radium-226	Alpha Spectrometer	Daily	±20	±30	90	1.0 pCi/l (water) 300 pCi/kg(g) (solids)	BSL-309 BSL-201, BSL-309	2,3,4,5 2,3,4,5
	and/or							
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data System Only)	NA	NA(d)	NA	NA			
Radium-228	Tennelec Low Background Alpha/Beta Counting System	Daily	±20	±30	90	3.0 pCi/l (water) 500 pCi/kg (solids)	BSL-309 BSL-201, BSL-309	2,3,4,5 2,4,3,5
Strontium-90	Tennelec Low Background Alpha/Beta Counting System	Daily	±20	±30	90	5 pCi/l (water) 500 pCi/kg (solids)	BSL-305 BSL-201, BSL-305	6,7,8 6,7,8
Technetium-99	Packard Liquid Scintillation Spectrometer	Daily	±20	±30	90	30 pCi/l (water) 900 pCi/kg (solids)	BSL-310 BSL-201, BSL-310	9 9
Thorium, Isotopic	Alpha Spectrometer	Daily	±20	±30	90	1.0 pCi/l (water) 600 pCi/kg (solids)	BSL-304 BSL-201, BSL-304	2,3,4,5 2,3,4,5
	and							
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data System Only)	NA	NA	NA	NA			

See footnotes at end of table.

Table 1
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION % RSD(a)	TYPICAL ACCURACY % Bias(b)	COMPLETENESS (%)	EXPECTED METHOD DETECTION LIMIT(c)	METHOD NO.	REFERENCE
Uranium, Isotopic Uranium, Total	Alpha Spectrometer and	Daily	±20	±10	90	1.0 pCi/l (water) 600 pCi/kg (solids) 1 ug/l (total)	RSL-304 RSL-201, RSL-304	2, 3, 4, 5 2, 3, 4, 5
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data Systems Only)	NA	NA	NA	NA			
Plutonium, Isotopic	Alpha Spectrometer and	Daily	±20	±10	90	1.0 pCi/l (water) 600 pCi/kg (solids)	RSL-304 RSL-201, RSL-304	2, 3, 4, 5 2, 3, 4, 5
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data Systems Only)	NA	NA	NA	NA			
Neptunium-237	Alpha Spectrometer and	Daily	±20	±10	90	1.0 pCi/l (water) 600 pCi/kg (solids)	RSL-304 RSL-201, RSL-304	2, 3, 4, 5 2, 3, 4, 5
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data Systems Only)	NA	NA	NA	NA			
Cesium-137 Gamma Spec	Intrinsic Germanium Detectors and	Daily	±20	±10	90	20 pCi/l (water) 200 pCi/kg (solids)	RSL-201, RSL-112 RSL-201, RSL-112	1 1
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data System Only)	NA	NA	NA	NA			

See footnotes at end of table.

Table 7G
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION % RSD(a)	TYPICAL ACCURACY % Bias(b)	COMPLETENESS (4)	EXPECTED METHOD DETECTION LIMIT(e)	METHOD NO.	REFERENCE
Ruthenium-106	Intrinsic Germanium Detectors	Daily	±20	±30	90	150 pCi/l (water) 1 nCi/kg (solids)	RSL-201, RSL-112 RSL-201, RSL-112	1 1
	and							
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data System Only)	NA	NA	NA	NA			

(a)Precision is expressed as the percent relative standard deviation of the corresponding method.

(b)Accuracy is expressed as the percent bias of the analysed versus actual spike concentration for the indicated method.

(c)Each day samples are analysed.

(d)The indicated instrumentation is a system used for data acquisition and reduction. Therefore, analytical definitions of method precision and accuracy are not applicable.

(e)The indicated method detection limits (MDLs) represent the 95 percent confidence limit for false detection and false rejection discrimination.

(f)pCi/l = picocuries per liter.

(g)pCi/kg = picocuries per kilogram.

(h)For sample with solids <500 ppm.

REFERENCES

(1)Krieger, H. L. and E. L. Whittaker, August 1980, "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, U.S. Environmental Protection Agency (U.S. EPA).

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Table 8.7

SAMPLING AND PRESERVATION REQUIREMENTS FOR WATER SAMPLES FEED MATERIALS PRODUCTION CENTER FERNALD, OHIO

PARAMETER	CONTAINER(a)	VOLUME REQUIRED (ml)	PRESERVATION(b)	MAXIMUM HOLDING TIMES(c)
Inorganics				
o Alkalinity	P,G	50	Cool 4°C	14 days
o Ammonia	P,G	100	Cool 4°C, H_2SO_4 to pH <2	28 days
o Chloride	P,G	50	None required	28 days
o Cyanide (Total)	P,G	1,000	Cool 4°C, NaOH to pH >12, 0.6g Ascorbic Acid(d)	14 days(e)
o Fluoride	P	300	None required	28 days
o Redox Potential (Eh)	P,G	100	None required	Analyze immediately
o Hydrogen Ion (pH)	P,G	100	None required	Analyze immediately
o Hexavalent Chromium	P,G	50	Cool 4°C	24 hours
o Mercury(f)	P,G	100	HNO_3 to pH <2	28 days
o Metals, Except Hexavalent Chromium and Mercury(f)	P,G	200	HNO_3 to pH <2	6 months
o Nitrate	P,G	100	Cool 4°C	48 hours
o Organic Carbon (Total) (TOC)	G	25	Cool 4°C, HCl or H_2SO_4 to pH <2	28 days
o Organic Halogen (Total) (TOX)	G	100	Cool 4°C, H_2SO_4 to pH <2	14 days
o Organic Nitorgen (Total)	P,G	500	Cool 4°C, H_2SO_4 to pH <2	28 days

See footnotes at end of table.

Table 8 7
(Continued)

PARAMETER	CONTAINER(a)	VOLUME REQUIRED (ml)	PRESERVATION(b)	MAXIMUM HOLDING TIMES(c)
o Oxygen, Dissolved	G bottle and top	300	None required	Analyze immediately
o Phenols (Total)	G	500	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction
o Phosphorus (Total)	P,G	50	Cool 4°C, H_2SO_4 to pH <2	28 days
o Residue, Filterable (TDS)	P,G	100	Cool 4°C	7 days
o Specific Conductance	P,G	100	Cool 4°C	28 days
o Sulfate	P,G	100	Cool 4°C	28 days
o Sulfide	P,G	500	Cool 4°C, add zinc acetate plus sodium hydroxide to pH >9	7 days
o Temperature	P,G	1,000	None required	Analyze immediately
<u>HSL Organic Compounds</u>(g)				
o Volatiles	G, Teflon-lined septum	40	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days(i)
o PCBs	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction
o Pesticides	G, Teflon-lined cap	1,000	Cool 4°C, NaOH or HCl to pH 5-9(h), 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction
o Acid/Base Neutral Extractables	G, Teflon-lined cap	1,000 each	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction
o Polychlorinated dibenzo-p-Dioxins and Polychlorinated Dibenzofurans	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction

See footnotes at end of table.

Table 8.2
(Continued)

PARAMETER	CONTAINER(a)	VOLUME REQUIRED (ml)	PRESERVATION(b)	MAXIMUM HOLDING TIMES(c)
Radiological Samples				
o Gross Alpha	P,G	1,000	HNO_3 to pH <2	6 months
o Gross Beta	P,G	1,000	HNO_3 to pH <2	6 months
o Radium-226	P,G	1,000	HNO_3 to pH <2	6 months
o Radium-228	P,G	1,000	HNO_3 to pH <2	6 months
o Strontium-90	P,G	1,000	HNO_3 to pH <2	6 months
o Technetium-99	P,G	1,000	HNO_3 to pH <2	6 months
o Cesium-137, Gamma Spec	P,G	1,000	HNO_3 to pH <2	6 months
o Ruthenium-106	P,G	1,000	HNO_3 to pH <2	6 months
o Plutonium, Isotopic	P,G	1,000	HNO_3 to pH <2	6 months
o Neptunium-237	P,G	1,000	HNO_3 to pH <2	6 months
o Thorium, Total	P,G	1,000	HNO_3 to pH <2	6 months
o Thorium, Isotopic	P,G	1,000	HNO_3 to pH <2	6 months
o Uranium, Total	P,G	1,000	HNO_3 to pH <2	6 months
o Uranium, Isotopic	P,G	1,000	HNO_3 to pH <2	6 months

See footnotes at end of table.

Table ~~8~~ 7
(Continued)

(a)Polyethylene (P) or glass (G).

(b)Sample preservation will be performed immediately upon sample collection.

(c)Samples will be analyzed as soon as possible after collection. The times listed are maximum times that samples should be held in the laboratory before analysis.

(d)Will only be used in the presence of residual chlorine. Sodium thiosulfate is only proposed as a sample preservative for HSL organics when residual free chlorine is known to be present. Sodium thiosulfate will be omitted in all other cases.

(e)Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment to determine if sulfide is present.

(f)Samples will be filtered immediately following collection on site before adding preservatives for dissolved metals.

(g)Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(h)The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

(i)If acid preservation (HCl to pH<2) is used, the maximum holding time can be extended from 7 days to 14 days.

Reference: This table includes the requirements of the U.S. Environmental Protection Agency, as published in the Code of Federal Regulations, Vol. 49, No. 209, 40 CFR 136, October 26, 1984, pg, 43260. HSL organic compound requirements are promulgated in "Chemical Analytical Services for Multi-Media Multi-Concentration Organics, GC/MS Techniques," WA-87-K236, U.S. Environmental Protection Agency, Washington, D.C., 1987.

Table 8.

GENERAL CHEMISTRY AND METALS
METHOD REFERENCES AND QUALITY CONTROL OBJECTIVES
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS (%)	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENC
Alkalinity	pH meter	Daily(b) (water)	±10	-	90	1000 ug/l(g)(water)	310.1	1
		Daily (solids)	±10	-	90	500 mg/kg(h)(solids)	3.2.3	2
Aluminum	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	100 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	20 mg/kg (solids)	200.7	12
Ammonia	Distillation with UV/VIS Spectrophotometer	Daily (water)	±10	±20	90	50 ug/l (water)	350.2	1
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	33-2,350.2	11,1
	Specific Ion Meter/ Microprocessor	Daily (water)	±10	±20	90	50 ug/l (water)	350.2	1
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	33-2,350.2	11,1
Antimony	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	10 ug/l (water)	204.1,204.2	1
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	7040,7041	3
Arsenic	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	10 ug/l (water)	206.2	1
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	7060	3

See footnotes at end of table.

Table 38
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFEREN
Barium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	100 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	20 mg/kg (solids)	200.7	12
Beryllium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	5 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	1 mg/kg (solids)	200.7	12
Boron	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12
Cadmium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	5 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	1 mg/kg (solids)	200.7	12
Calcium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	100 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	20 mg/kg (solids)	200.7	12

See footnotes at end of table.

Table 53
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS (%)	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFEREN
Cation Exchange Capacity	Atomic Absorption Spectrophotometer	Daily (solids)	±10	±20	90	1 mg/kg (solids)	3.2.17	2
Chloride	Buret/Indicator	Daily (water)	±10	±20	90	500 ug/l (water)	325.3	1
		Daily (solids)	±10	±20	90	5 mg/kg (solids)	10-2,325.3	11,1
Chromium (Total)	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12
Chromium VI	UV/VIS Spectrophotometer	Daily (water)	±10	±20	90	10 ug/l (water)	7196	3
		Daily (solids)	±10	±20	90	1 mg/kg (solids)	7196	3
Cobalt	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12
Copper	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12
Cyanide (Total)	Distillation with UV/VIS Spectrophotometer	Daily (water)	±10	±20	90	20 ug/l (water)	335.2	1
		Daily (solids)	±10	±20	90	0.50 mg/kg (solids)	9010	3
Dissolved Solids (Total)	Filtration/ Analytical Balance	3 months (water)	±10	-	90	1000 ug/l (water)	160.1	1

See footnotes at end table.

Table 83
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERE
Fluoride	pH meter with Specific Ion Electrode	Daily (water)	±10	±20	90	100 ug/l (water)	340.2	1
		Daily (solids)	±10	±20	90	1 mg/kg (solids)	10-2,340.2	11,
Iron	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	100 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	20 mg/kg (solids)	200.7	12
Iron (Leachable)	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (solids)	±10	±20	90	1 mg/kg (solids)	200.7(e)	5,1
Lead	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	5 ug/l (water)	239.1,239.2	1
		Daily (solids)	±10	±20	90	1 mg/kg (solids)	7420,7421	3
Lithium	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	100 ug/l (water)	303A	6
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	303A	6
Magnesium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	100 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	20 mg/kg (solids)	200.7	12

See footnotes at end of table.

Table 58
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFEREN
Manganese	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12
Manganese (Leachable)	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (solids)	±10	±20	90	1 mg/kg (solids)	200.7(e)	5,12
Mercury	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	0.2 ug/l (water)	245.1	1
		Daily (solids)	±10	±20	90	0.10 mg/kg (solids)	7471	3
Molybdenum	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	10 ug/l (water)	246.1,246.2	1
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	246.1,246.2	1
Nickel	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	30 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	6 mg/kg (solids)	200.7	12
Nitrate	UV/VIS Spectrophotometer	Daily (water)	±10	±20	90	100 ug/l (water)	352.1	1
		Daily (solids)	±10	±20	90	1 mg/kg (solids)	10-2,352.1	11,1

See footnotes at end of table.

Table 58
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENC
Organic Carbon (Total) (TOC)	Total Organic Carbon Analyzer	Daily (water) Daily (solids)	±25 ±25	±20 ±20	90 90	1000 ug/l (water) 1 mg/kg (solids)	415.1 (f)	1 8
Organic Halogens (Total) (TOX)	Total Organic Halide Analyzer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 0.1 mg/kg (solids)	9020 9020	3 3
Organic Nitrogen (Total)	Distillation with UV/VIS Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	1.0 mg/l (water) 2 mg/kg (solids)	351.3 351.3	1 1
	Specific Ion Meter/ Microprocessor	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	1.0 mg/l (water) 2 mg/kg (solids)	351.3 351.3	1 1
pH	pH meter	Daily (water) Daily (solids)	±10 ±10	- -	90 90	0.05 pH unit (water) 0.05 pH unit (solids)	150.1 3.2.2	1 2
Phosphorus	UV/VIS Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 100 ug/kg (solids)	365.2 (f)	1 9
Potassium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	100 ug/l (water) 20 mg/kg (solids)	200.7 200.7	12 12
Selenium	Atomic Absorption Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	5 ug/l (water) 1 mg/kg (solids)	270.2 7740	1 3
Silicon	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	100 ug/l (water) 20 mg/kg (solids)	200.7 200.7	12 12

See footnotes at end of table.

Table 18
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS (%)	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
Silver	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12
Sodium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	100 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	20 mg/kg (solids)	200.7	12
Specific Conductance	Conductivity Meter	Daily (water)	±10	-	90	1 umho/cm (water)	120.1	1
		Daily (solids)	±10	-	90	1 umho/cm (solids)	10-2,120.1	11,1
Strontium	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	10 ug/l (water)	303A	6
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	303A	6
Sulfate	UV/VIS Spectrophotometer	Daily (water)	±10	±20	90	2000 ug/l (water)	375.4	1
		Daily (solids)	±10	±20	90	10 mg/kg (solids)	3.2.6	2
Sulfide	Buret/Indicator	Daily (water)	±10	±20	90	500 ug/l (water)	376.1	1
		Daily (solids)	±10	±20	90	10 mg/kg (solids)	9030	3
Thallium	Atomic Absorption Spectrophotometer	Daily (water)	±10	±20	90	10 ug/l (water)	279.1,279.2	1
		Daily (solids)	±10	±20	90	2.0 mg/kg (solids)	7840,7841	4

See footnotes at end of table.

Table 58
(Continued)

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
Tin	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	50 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	10 mg/kg (solids)	200.7	12
Vanadium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	50 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	10 mg/kg (solids)	200.7	12
Zinc	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water)	±10	±20	90	10 ug/l (water)	200.7	12
		Daily (solids)	±10	±20	90	2 mg/kg (solids)	200.7	12

(a)RPD = relative percent difference.

(b)Each day samples are analyzed.

(c)The indicated relative percent difference is representative of the corresponding U.S Environmental Protection Agency (U.S. EPA) Contract Laboratory Program (CLP) Hazardous Substance List (HSL) compounds as a group.

(d)The indicated percent recovery range represents the minimum and maximum acceptable value for the indicated U.S. EPA CLP HSL compounds as a group. However, individual percent recovery ranges have been established for each matrix spike compound. Consult "Chemical Analytical Services for Multi-Media Multi-Concentration Organics, GC/MS Techniques," WA-87-K236, U.S. EPA, Washington, D.C., 1987 for more detailed quality assurance/quality control criteria.

Table 55
(Continued)

(e)A method number is not assigned to the iron and manganese leaching procedures cited from the corresponding reference.
(f)A method number is not assigned to the indicated analytical procedures cited from the corresponding reference.
(g)ug/l equals micrograms per liter or parts per billion (ppb)
(h)mg/kg equals milligrams per kilogram or parts per million (ppm).
(i)Method detection limits may vary with sample matrix.

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