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GROUNDWATER QUALITY ASSESSMENT PROGRAM PLAN FOR WASTE PIT NO. 4

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Groundwater Quality Assessment Program Plan
For Waste Pit No. 4
At the Feed Materials Production Center

Prepared by: Westinghouse Materials Company of Ohio

Prepared for: U. S. Department of Energy

Revision 1
March, 1989

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RCRA GROUNDWATER QUALITY ASSESSMENT PROGRAM PLAN FOR FMPC WASTE PIT 4

1.0 Introduction

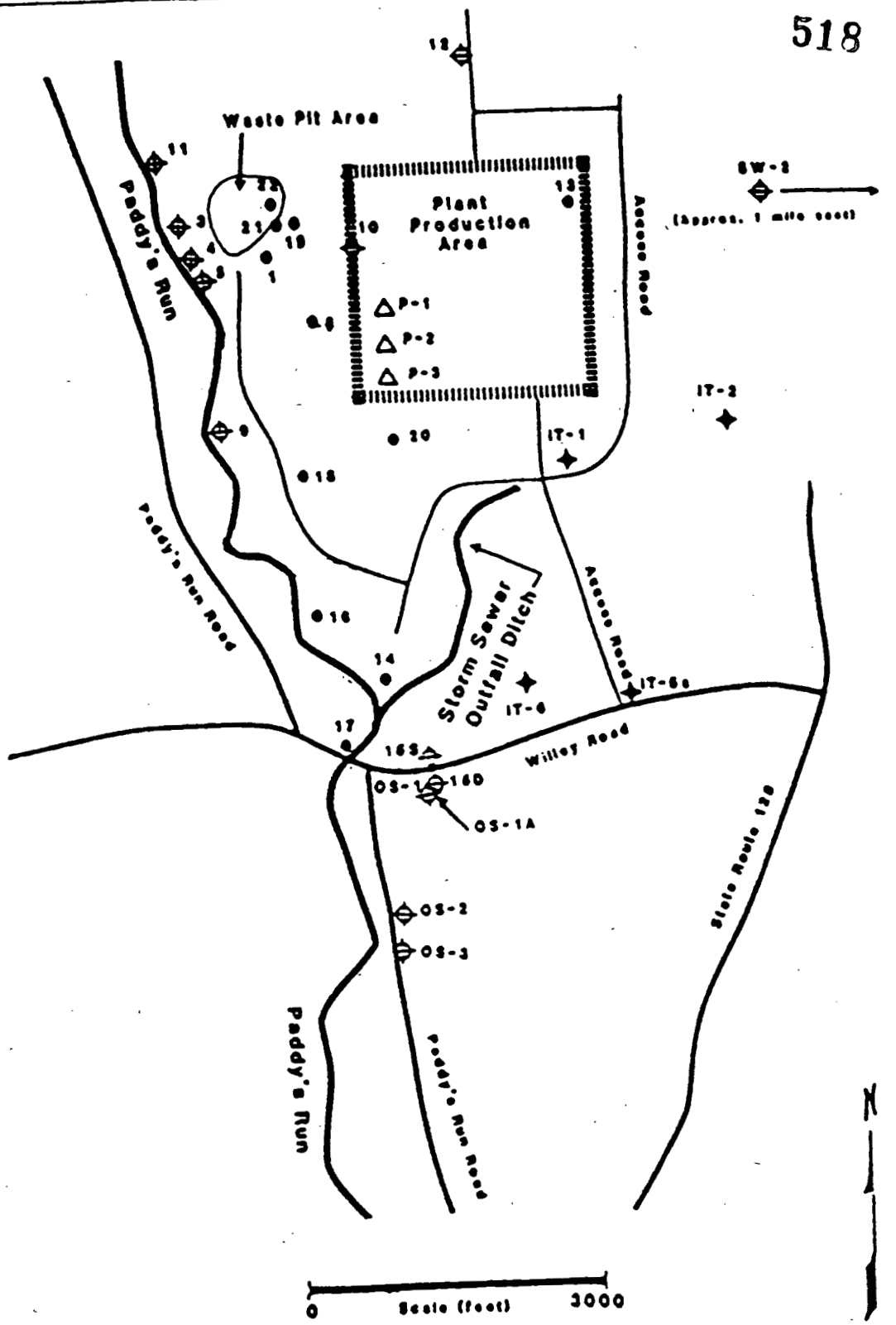
1.1 Background

Waste Pit No. 4 at the Feed Materials Production Center (FMPC) in Fernald, Ohio is subject to the regulations of the Resource Conservation and Recovery Act (RCRA). The RCRA Detection Monitoring Program for FMPC Waste Pit 4 began in August 1985. Samples were collected and analyzed from 41 wells under this detection program from August 1985 to November 1987 (RCRA Rounds 1-5). Required confirmatory sampling was conducted as Round 6 during December 1987. The OEPA and USEPA were notified by the Department of Energy (DOE) on November 13, 1987 that FMPC Waste Pit No. 4 could be affecting groundwater quality in accordance with OAC 3745-65-93 and 40 CFR 265.93. This notification was based on the statistical comparisons required by 40 CFR 265.93 (b), completed for the designated wells around Waste Pit No. 4. These comparisons indicated that statistically significant changes in several indicator parameters had occurred in the vicinity of the landfill. On November 25, 1987 a RCRA Groundwater Quality Assessment Program Plan for Waste Pit No. 4 was submitted to the OEPA and the USEPA. This plan stated that the groundwater assessment program for Waste Pit No. 4 would be completed as part of the ongoing sitewide Remedial Investigation/Feasibility Study (RI/FS) at the FMPC. The RCRA and CERCLA monitoring programs were consolidated because of the similar objectives of the RCRA groundwater assessment program and the RI/FS program.

Waste Pit No. 4 is one of 6 inactive solid and liquid waste disposal units (pits) at the FMPC. All these pits are located together in the FMPC Waste Storage Area northwest of the production area (Figure 1). Waste Pit No. 4 is regulated by RCRA due to disposal of barium salts in this pit from 1980 to 1983. This pit is currently undergoing interim closure under RCRA. All pits, including Waste Pit No. 4, will be remediated under CERCLA, following selection of technical alternatives in the RI/FS process. RCRA technical requirements for closure will be considered as Applicable or Relevant and Appropriate Requirements (ARARS) in the CERCLA remediation process.

1.2 Purpose

The purpose of this report is to provide a revised RCRA Groundwater Quality Assessment Program Plan (GQAPP) for FMPC Waste Pit 4. A GQAPP was submitted to U.S. EPA by DOE in November 1987. EPA's comments on the original plan were received by DOE on February 2, 1989. This submittal is a revision of the GQAPP based on the EPA's comments. This plan also defines the continuation of the Assessment Program, following completion of the RI/FS sampling program. This Plan specifies sampling groundwater for site specific analytical parameters, selected on the basis of Rounds 1 and 2 RI/FS data, and CIS data on the composition of the waste pits. This Plan also specifies sampling 43 RI/FS wells, selected to be upgradient and downgradient of the entire waste pit area, rather than Pit 4. Available analytical data shows that RCRA regulated groundwater constituents are scattered in occurrence, do not delineate a groundwater plume, and cannot be traced specifically to Pit 4 rather than adjacent Pits. No unique "fingerprint" hazardous waste or



Explanation:

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

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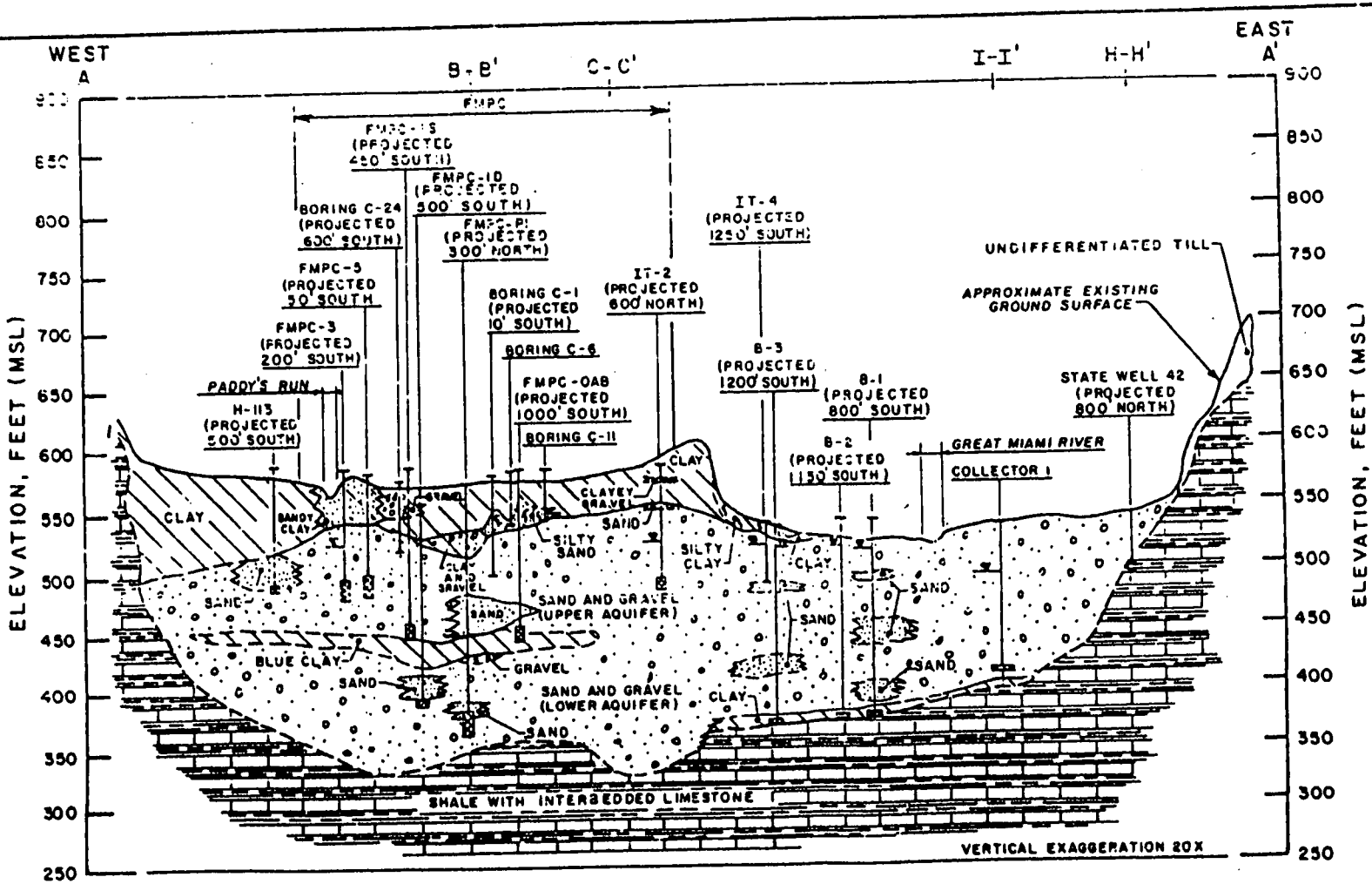
RCRA Detection Well Locations

Figure 1



LEGEND:

OPEN INTERVAL

WATER LEVELS (MEASURED 3/27/86 THRU 4/11/86.)

REFERENCES:

MODIFIED FROM U.S.G.S. PROFESSIONAL PAPER No. 605-A USING AVALIABLE OHIO STATE WATER WELL RECORDS, SOWC WATER WELL DATA, DAMES AND MOORE DOE, FEED MATERIALS PRODUCTION CENTER GROUND WATER STUDY TASKS A AND C REPORTS AND IT BORING LOGS.

FIGURE ADAPTED FROM FERNALD LITHO ON DRAWING NO. 303063-B16. PREPARED FOR U.S. DEPARTMENT OF ENERGY BY IT CORPORATION, NOVEMBER, 1986

CROSS SECTION A-A'

(LOOKING NORTH)

VERTICAL SCALE

0 100 200 FEET

HORIZONTAL SCALE

0 2000 4000 FEET

8

HE BORING LOGS AND RELATED INFORMATION EPICT SUBSURFACE CONDITIONS ONLY AT HE SPECIFIC LOCATIONS AND DATES INDICATED OIL CONDITIONS AND WATER LEVELS AT THER LOCATIONS MAY DIFFER FROM CONDITIONS CCURRING AT THESE BORING LOCATIONS ALSO HE PASSAGE OF TIME MAY RESULT IN A HANGE IN THE CONDITIONS AT THESE ORING LOCATIONS

HE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA NDICATED ON THE SECTIONS WERE GENERALIZED FROM AND INTERPOLATED BETWEEN THE TEST BORINGS NFORMATION ON ACTUAL SUBSURFACE CONDITIONS XISTS ONLY AT THE LOCATION OF THE TEST BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS ETWEEN THE TEST BORINGS MAY VARY FROM THOSE NDICATED

Figure 2

HYDROGEOLOGIC CROSS SECTION A-A'

PREPARED FOR

FERNALD RI/FS
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IT

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hazardous waste constituent found in groundwater can be traced specifically to Pit 4 rather than to the whole Waste Storage Area.

2.0 FMPC Geology and Hydrology

2.1 Background

The FMPC is located in a two-mile wide valley filled with glacial deposits. This valley parallels the Great Miami River between the towns of Ross and Hooven, Ohio. A generalized geologic cross-section for the FMPC site area is presented in Figure 2.

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

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

During subsequent Pleistocene glacial advances and retreats across the site area such as the Illinoisan (approximately 300,000 to 400,000 years ago) and the Wisconsin (approximately 10,000 years ago), the New Haven Trough was filled with about 200 feet of glacial sediments. These sediments were deposited by water flowing from the margins of the glaciers and consisted mainly of well sorted sand and gravel. A blanket of clay-rich, relatively impermeable glacial till from a more recent event was deposited atop the 200 feet of glacial sediments.

Erosion by the Great Miami River and its tributaries has subsequently removed significant portions of the glacial till which contributed to terrace remnants standing topographically higher than the surrounding bottom lands. The FMPC site lies atop one of these terrace remnants.

2.2 Glacial Till

At the land surface of the FMPC, a 20 to 50 foot thick layer of glacial till, composed of a dense, olive-gray silty clay, overlies the sand and gravel outwash deposits. The till varies in texture and composition, both laterally and vertically, and contains lenses of poorly sorted fine to medium grained sand and gravel (meltwater channel sands). The base of the till occurs at the estimated elevation of 540 mean sea level (MSL) and overlies the sand and gravel outwash deposits.

To the south and west of the FMPC production area, the silty clay till laterally grades into a sequence of silt and silty sand (Pleistocene lake deposits), with some layers of silty clay. The silty clay till is continuous to the north and east of the site, and directly overlies the bedrock in these areas. In the lower reaches of Paddy's Run and the storm sewer outfall ditch,

the silty clay till and lake bed silts have been eroded to expose the underlying sand and gravel aquifer.

A saturated zone occurs within the silty clay till at levels approximately 4 to 10 feet below the land surface in some areas of the FMPC site. This saturated zone is probably recharged by precipitation and may be present due to vertical variations of composition and texture of the till, or near-surface weathering and desiccation-induced fracturing of the till.

2.3 Sand and Gravel Aquifer

A sequence of highly permeable sand an gravel outwash deposits, laid down by the meltwaters of receding continental ice sheets, unconformably overlie the shale bedrock in the vicinity of the FMPC. These outwash deposits generally consist of an unconsolidated medium- to coarse- grained, olive brown layer of sand and gravel, ranging in thickness up to 200 feet. The sand and gravel is arranged in irregularly alternating layers of silty sand, medium to coarse sand, and medium to coarse gravel.

In the vicinity of the Waste Storage Area, this layer is separated into two units by a 10 to 20 foot thick layer of greenish-black silty clay. The FMPC production wells are completed below this "blue clay" layer. This blue clay layer underlies about 360 acres of the FMPC and apparently occurs only in the vicinity of the Waste Storage Area and the production wells. This layer was probably deposited in an ice marginal lake or as a backwater deposit of a glacial stream. The top of this blue clay layer lies about 125 feet below the land surface.

The upper 20 to 30 feet of the sand and gravel deposits are not saturated, with water in this aquifer generally occurring at levels approximately 60 to 90 feet below the land surface. These levels depend on the relative thickness of the glacial till and respective land surface elevation.

2.4 Potential Contaminant Pathways

Potential contaminant pathways in the FMPC waste storage area are migration of leachate through the bottom or sides of the pits through the till down to the sand and gravel aquifer. Pleistocene (surface) sediments at the FMPC consist of lake bed silts of moderate permeability, melt water channel sands of moderate permeability and glacial till of very low permeability. The waste storage area is underlain primarily by glacial till. In the waste storage area, glacial till is generally capable of restricting groundwater flow between the surface and the Great Miami Aquifer.

3.0 History of FMPC RCRA Groundwater Monitoring Systems

3.1 RCRA Detection Monitoring System

In August 1985 a program of RCRA groundwater detection monitoring for Pit 4 was initiated at the FMPC. Under this program 4 quarterly rounds of sampling and one semi-annual round of sampling was completed during the period of August 1985 to November 1987 (Rounds 1 through 5). The results of these

Rounds of sampling were provided to EPA. In this detection monitoring program, 41 wells were monitored for 94 analytical parameters. Figure 1 shows the locations of these 41 wells, which are located on the FMPC site and adjacent offsite area. Table 1 lists the 94 analytical parameters included in the detection monitoring program. These parameters included metals, anions, water quality parameters, indicator parameters, organic compounds and radionuclides.

3.2 Statistical Evaluation of Detection Data

In November 1987, DOE notified EPA that Pit 4 could be affecting ground water quality based on statistical evaluation of indicator parameters in wells adjacent to Pit 4 as compared to background wells. This evaluation was performed comparing the mean Total Organic Carbon (TOC), Total Organic Halogen (TOX), specific conductance (SC) and pH of upgradient wells established in monitoring Rounds 1-4 to Round 5 downgradient values using Cochran's Approximation to the Behren's Fisher Student's t-test. The upgradient till well MW-12 (1012) was compared to downgradient till wells MW-19TP (1019), MW-21TP (1021) and MW-22TP (1022). The upgradient sand and gravel well SW-2 (Southwestern Ohio Collector Well) was compared to downgradient wells MW-19s (2019), MW-19d (3019), MW-21s (2021) and MW-22s (2022). Details of this statistical comparison are described in the RCRA Groundwater Monitoring Report, v. 5, Round 5, Nov. 1987.

Results of these statistical comparisons showed that in the till wells:

1) There were no significant increases of TOX in downgradient wells
2) TOC concentrations increased significantly in all downgradient wells.
3) Specific conductance significantly increased in two of the three downgradient wells.
4) pH significantly increased in all downgradient wells.

Results of statistical comparisons in the sand and gravel wells showed:

1) TOX did not significantly increase in the downgradient wells.
2) TOC did not increase significantly in the downgradient wells.
3) Specific conductance increased significantly in all downgradient wells.
4) pH decreased significantly in one downgradient well.

As a result of this statistical analysis, the Ohio and U.S. EPA were notified on November 13, 1987 that FMPC Waste Pit 4 could be affecting groundwater quality in accordance with OAC 375-65-93 and 40 CFR 265.93 (b).

3.3 Confirmatory Sampling Round

The second semi-annual round (Round 6) of RCRA Detection sampling was completed in December 1987. Forty wells were sampled for 94 parameters during this round of sampling. Forty wells were sampled, rather than 41 wells, since one well was dry. The analytical results did not differ significantly from Round 5 results, and confirmed the conclusions made based on Round 5 samples.

Table 1

RCRA Detection Monitoring

ANALYTICAL PARAMETERS

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. Fluride
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

Table 1 (cont'd.)

RCRA Detection Monitoring

ANALYTICAL PARAMETERS (Cont'd.)

D. **Site Specific Parameters**

1. Nickel (1)
2. Cyanide (1)
3. Copper (1)
4. Zinc (1)
5. Magnesium (1)
6. Calcium (1)
7. Phosphorus (1)
8. Chlorobenzene (2)
9. Chlorodibromomethane (2)
10. Chloroethane (2)
11. 2-chloroethylvinyl (2)
12. Chloroform (2)
13. Dichlorobromomethane (2)
14. Dichlorodifluoromethane (2)
15. Total Dissolved Solids (TDS)
16. Total Potassium
17. Chemical Oxygen Demand (COD)
18. cis 1,2 Dichloroethene (2)
19. Tributylphosphate (2)
20. Acrolein (2)
21. Acrylonotrille (2)
22. Benzene (2)
23. bis (Chloromethyl) Ether (2
24. Bromoform (2)
25. Bromodichloromethane (
26. Bromoethane (2)
27. Carbon tetrachloride (2)
28. Chloromethane (2)
29. 1,2 Dichlorobenzene (2)
30. 1,3 Dichlorobenzene (2)
31. 1,4 Dichlorobenzene (2)
32. 1,1 Dichloroethane (2)
33. 1,2 Dichloroethane (2)
34. 1,1 Dichloroethylene (2)
35. 1,2 Dichloropropane (2)
36. 1,2 Dichloropropylene (2)
37. Ethylbenzene (2)
38. Methylbromide (2)

RCRA Detection Monitoring
ANALYTICAL PARAMETERS (Cont'd.) 518

39. Methylchloride (2)
40. trans-1,2 Dichloroethylene (2)
41. 1,3 Dichloropropene (2)
42. 1,1,2,2 Tetrachloroethane (2)
43. Tetrachloroethylene (2)
44. Toulene (2)
45. 1,1,1 Trichloroethane (2)
46. 1,1,2 Trichloroethane (2)
47. Trichloroethylene (2)
48. Trichlorofluoromethane (2)
49. Vinyl Chloride (Chloroethene) (2)

E. Radionuclide (1)

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

(1) Analyzed for all samples.

(2) Not required for RCRA, but analyzed for all wells except: MW-1s, MW-3, MW-5, P-1, P-2, P-3, MW-15d, OS-2 and OS-3.

3.4 RCRA Assessment Monitoring

3.4.1 RI/FS Monitoring Program, November 1987 to March 1989

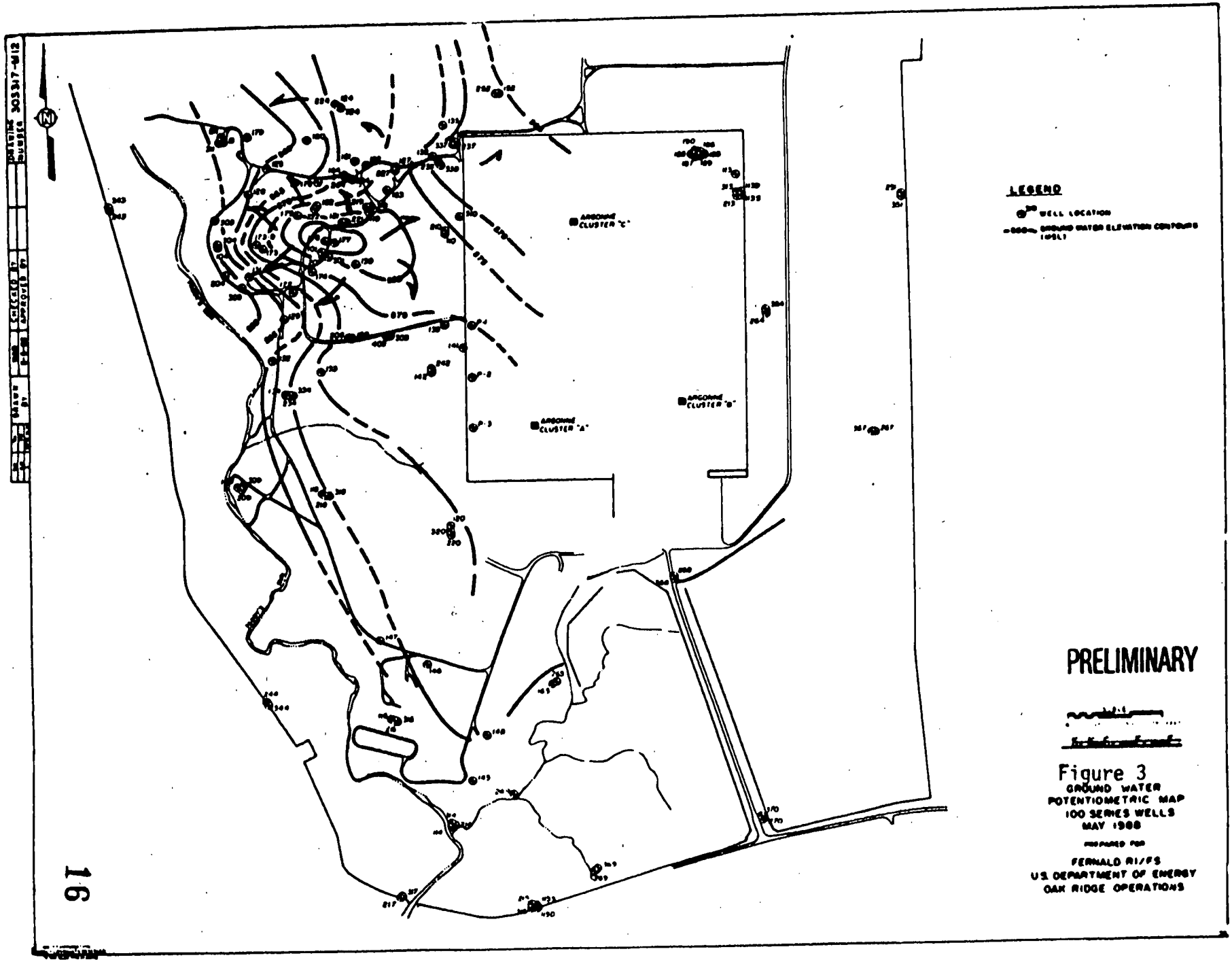
On November 25, 1987 a RCRA Groundwater Quality Assessment Program Plan for Waste Pit 4 was submitted to OEPA and USEPA. This plan stated that the groundwater assessment program for Waste Pit 4 would be completed as part of the ongoing sitewide Remedial Investigation/ Feasibility Study (RI/FS) at the FMPC. The RCRA and CERCLA monitoring programs were consolidated because of the similar objectives of the RCRA groundwater assessment program and the RI/FS.

Pit 4 is one of 6 inactive solid and liquid waste disposal units (pits) at the FMPC. All of these pits are located together in the FMPC Waste Storage Area northwest of the production area. All pits, including Pit 4, will be remediated under CERCLA, following selection of technical alternatives in the RI/FS process. RCRA technical requirements for closure will be considered as Applicable or Relevant and Appropriate Requirements (ARARS) in the CERCLA remediation process.

The first Round of RI/FS groundwater sampling took place in March and April 1988. The second Round of sampling took place in June and July 1988: the third Round occurred in October and November 1988. The fourth Round is currently taking place and will be completed in March 1989. Over 200 parameters were analyzed in groundwater samples, including radionuclides, general water quality indicators, and extended HSL list parameters (HSL volatile and semi-volatile organics, HSL inorganics, HSL pesticides and PCBs, organophosphorus pesticides and dioxins). The extended HSL list parameters were sampled during Round 1. More than 200 on- and off-site wells are being sampled as part of the RI/FS program, according to the RI/FS Workplan, Rev. 3, March 1988 as approved by U.S. EPA. These wells are located in the waste storage area, the production area and the general site area and north, south, east and west of the site,

Preliminary interpretations of Rounds 1 and 2 RI/FS groundwater monitoring data have shown that the piezometric surface in the till aquifer near pit 4 slopes toward the north and northwest and in a limited area to the northeast (see Figure 3). The arrows on Figure 3 show directions of groundwater flow. A groundwater mound is present in the till just south of Waste Pit 4. This mound is hydraulically upgradient of the pit area; any groundwater flow in the till in the pit area would be radial, away from this mound. RI/FS water level data taken over several seasons have confirmed the existence of this mound. This mound is located beneath a topographic low in the waste storage area. Due to the non-continuous nature of the groundwater in the till, there is limited potential for lateral migration of hazardous waste or hazardous waste constituents in the till.

Preliminary interpretation of Rounds 1 and 2 of the RI/FS monitoring data (shown in Appendix A) have shown that the constituents of major concern in the till in the waste storage area are uranium, gross alpha, gross beta, chloride, sulfate and dichloroethane. Of these constituents, only dichloroethane is regulated under RCRA. Barium, the RCRA constituent placed into Pit 4, was not


LEGEND
WELL LOCATION
GROUND WATER ELEVATION CONTOURS (MSL)
ARGONNE CLUSTER "C"
ARGONNE CLUSTER "B"
ARGONNE CLUSTER "A"
PRELIMINARY
Figure 3
GROUND WATER
POTENTIOMETRIC MAP
100 SERIES WELLS
MAY 1988
PREPARED FOR
FERNALD RI/FS
U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

found in levels above background levels in wells in the waste storage area. A small amount of methylene chloride (18 ppb) was also identified in a till well in the waste storage area. No pesticides, organophosphorus pesticides or PCBs were detected in till wells in the waste storage area.

Data shows (Figure 4) that the water surface in the sand and gravel aquifer below the waste storage area slopes to the east. The arrows on Figure 4 show the direction of groundwater flow. Groundwater velocities in the sand and gravel aquifer in this area have been estimated to be approximately 70 feet per year.

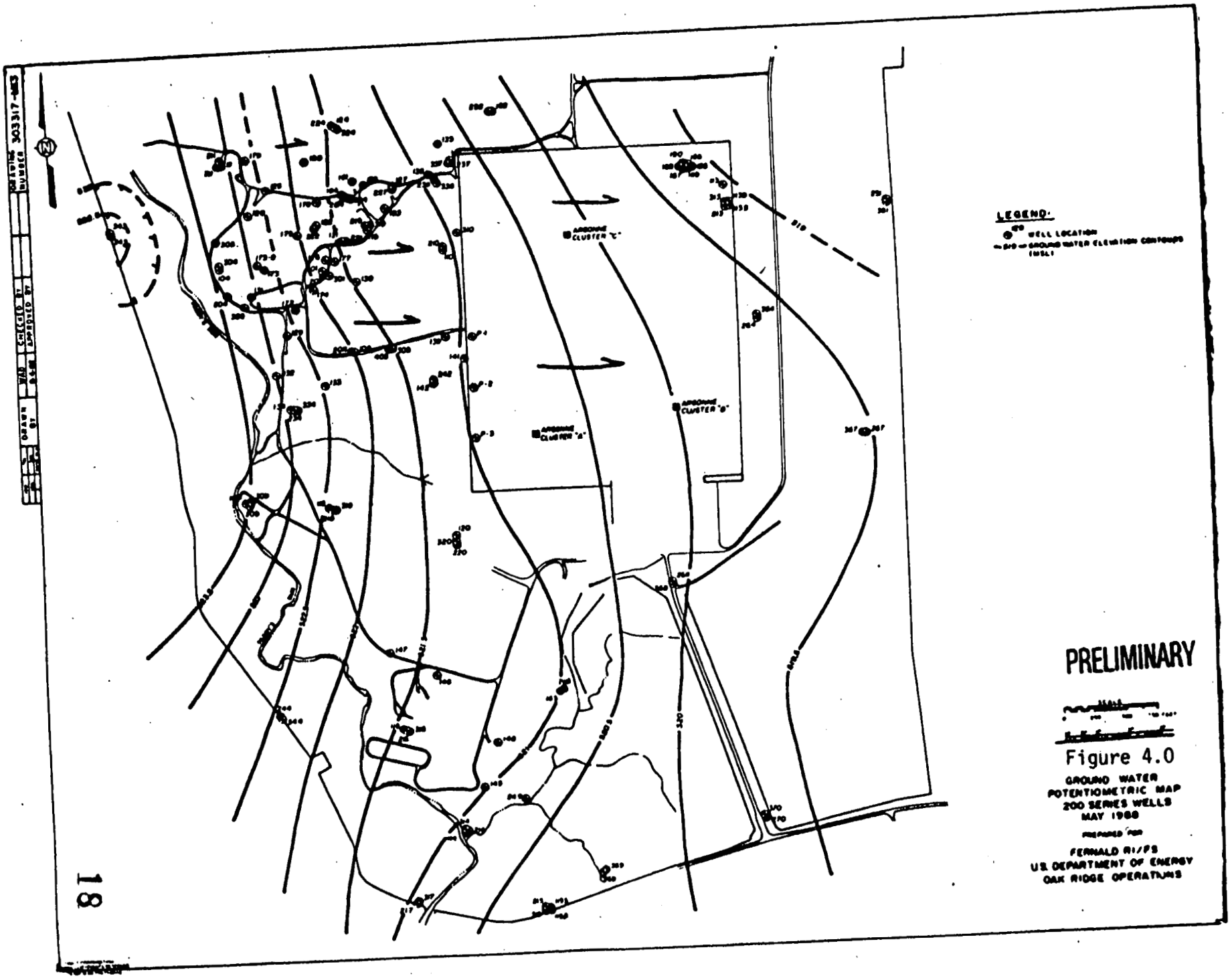
Based on preliminary interpretation of Round 1 and 2 data, the constituents of concern in the sand and gravel aquifer are uranium, gross alpha, gross beta, sulfate, nitrate and total dissolved solids. Small amounts of methylene chloride, toluene and acetone (generally less than 20 ppb) have been found in several scattered wells in the sand and gravel aquifer in the waste storage area (and also in wells outside the waste storage area as well). Again no pesticides, PCBs or dioxins were found in the sand and gravel wells in the pit area.

All data gathered to date indicates that the major constituent of concern, and the best indicator parameter at the FMPC is total uranium. RI/FS monitoring data shows that there are two distinct areas of above background uranium concentrations in groundwater at the FMPC (see Figures 5, 6 and 7). One, already discussed, beneath the site in the waste storage area; the other under the southern portion of the FMPC, extending offsite.

Wells in the south portion of the FMPC reservation, south of the storm sewer outfall ditch and wells off-site to the south of the site show above-background concentrations of uranium, gross alpha and gross beta. Evidence to date shows that the source of these constituents is storm water runoff from the FMPC production area and waste storage area. This surface water infiltrated directly into the aquifer in Paddy's Run and the Storm Sewer Outfall Ditch, where these waterways have eroded through the protective till layer, directly exposing the sand and gravel aquifer in the stream beds. The construction of the Storm Water Retention Basins has eliminated the routine discharge of production area runoff into the Storm Sewer Outfall Ditch.

3.4.2 Planned Assessment Program

Based on the results of the RCRA detection monitoring program, and the RI/FS program data available to date, 43 RI/FS wells adjacent to or downgradient from the waste storage area have been selected for continuation of the RCRA Groundwater Assessment Monitoring Program, following completion of the fourth round of RI/FS sampling. These wells will be sampled until the remediation of Waste Pit 4 is completed under CERCLA. The implementation of this planned program is discussed in section 4.0. The rationale for selection of locations and depths of these monitoring wells, and analytical parameters will be discussed in sections 4.2 and 4.3.


LEGEND:
WELL LOCATION
GROUND WATER ELEVATION CONTOURS (MSL)
ARGONNE CLUSTER "C"
ARGONNE CLUSTER "A"
ARGONNE CLUSTER "B"
PRELIMINARY
Figure 4.0
GROUND WATER POTENTIOMETRIC MAP 200 SERIES WELLS MAY 1988
FERNALD RI/FS
U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

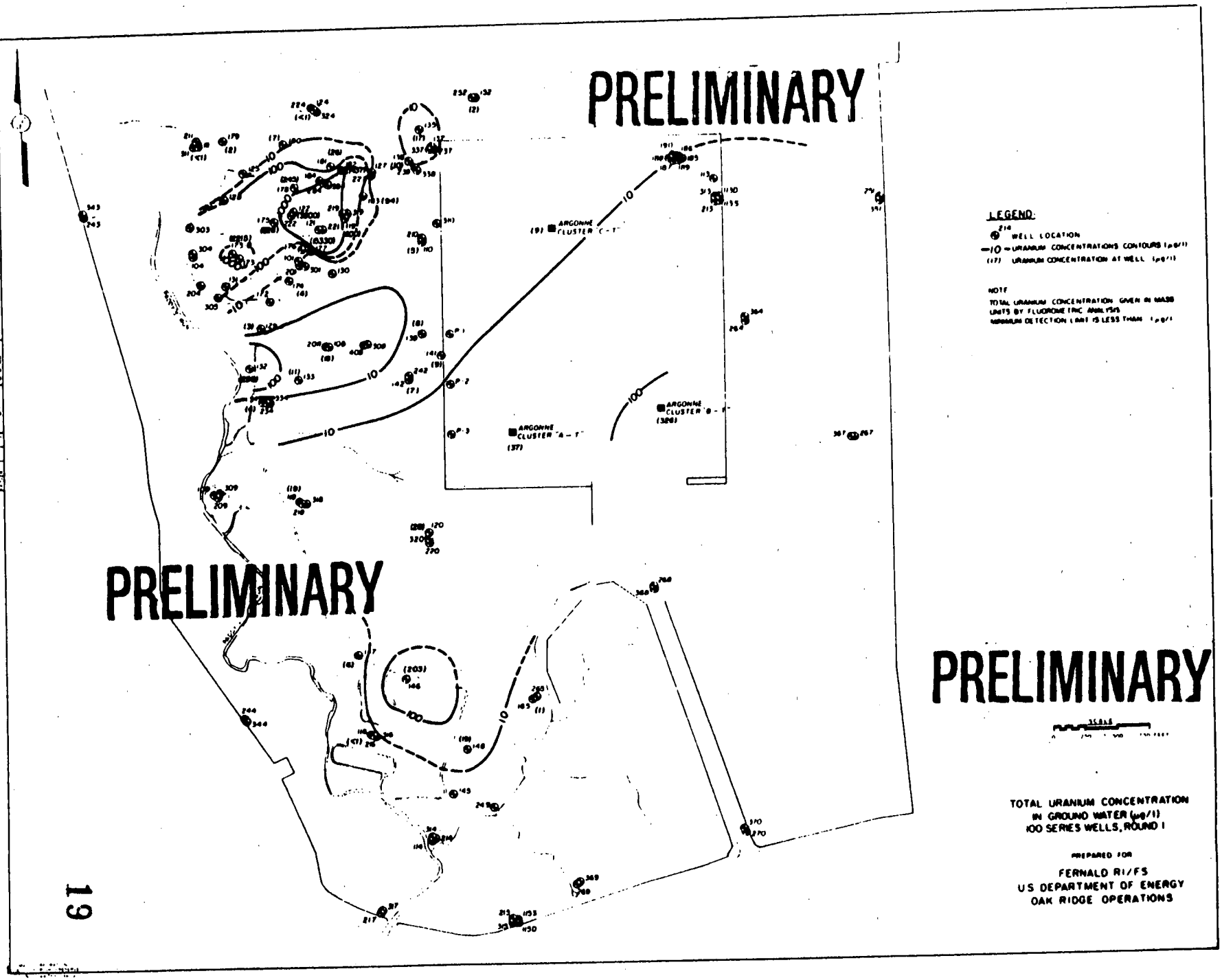

PRELIMINARY
PRELIMINARY
PRELIMINARY
LEGEND
WELL LOCATION
URANIUM CONCENTRATIONS CONTOURS
URANIUM CONCENTRATION AT WELL
NOTE
TOTAL URANIUM CONCENTRATION GIVEN IN MASS UNITS BY FLUOROMETRIC ANALYSIS
ARGONNE CLUSTER "A-1"
ARGONNE CLUSTER "B-1"
ARGONNE CLUSTER "C-1"
TOTAL URANIUM CONCENTRATION
IN GROUND WATER (µg/l)
100 SERIES WELLS, ROUND I
PREPARED FOR
FERNALD RI/FS
US DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

Figure 5

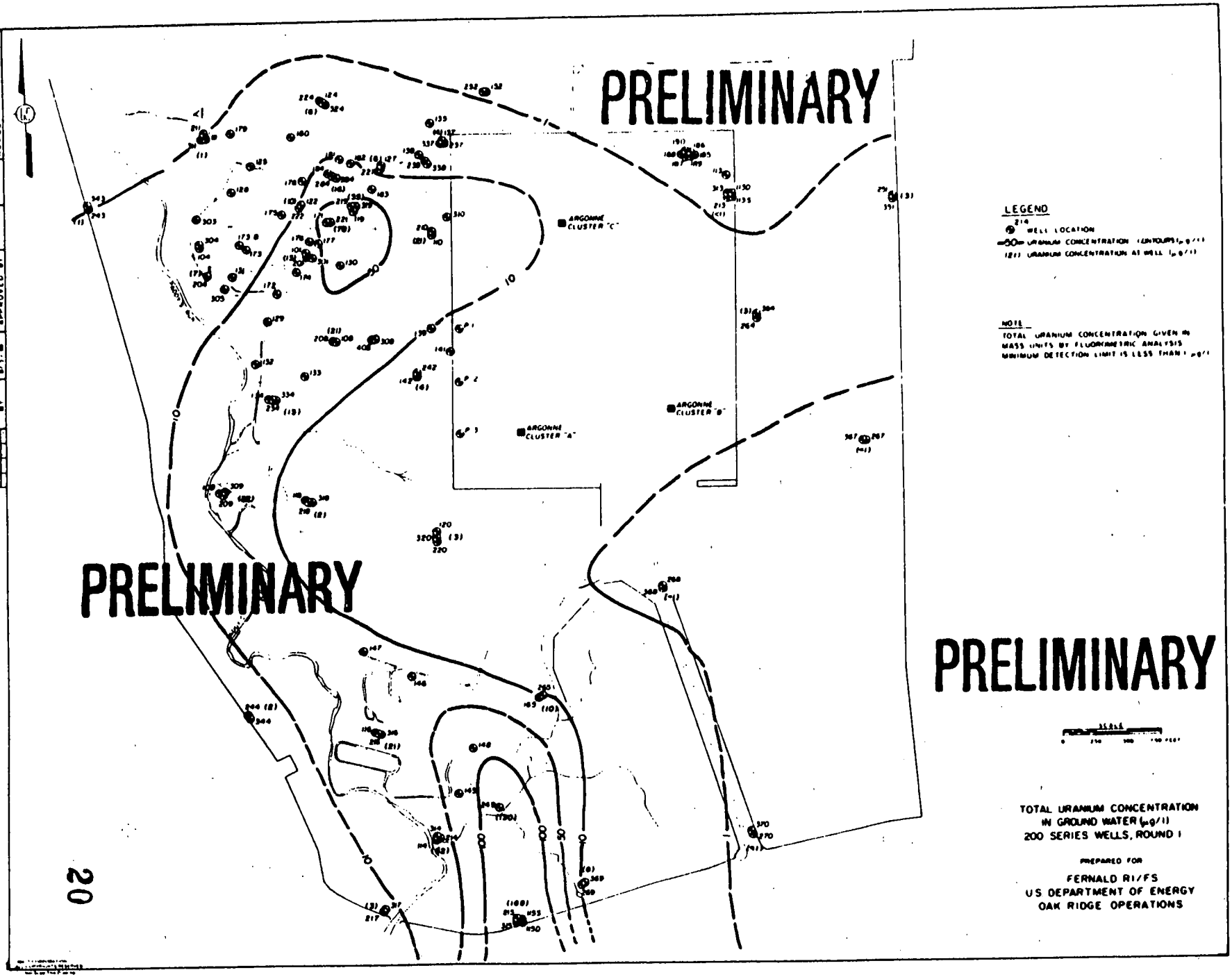

PRELIMINARY
PRELIMINARY
PRELIMINARY
ARGONNE CLUSTER "C"
ARGONNE CLUSTER "A"
ARGONNE CLUSTER "B"
LEGEND
WELL LOCATION
URANIUM CONCENTRATION (CONTOURS)
URANIUM CONCENTRATION AT WELL
NOTE
TOTAL URANIUM CONCENTRATION GIVEN IN MASS UNITS BY FLUORIMETRIC ANALYSIS
MINIMUM DETECTION LIMIT IS LESS THAN 1
SCALE
TOTAL URANIUM CONCENTRATION IN GROUND WATER (µg/l)
200 SERIES WELLS, ROUND I
PREPARED FOR
FERNALD RI/FS
US DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

Figure 6

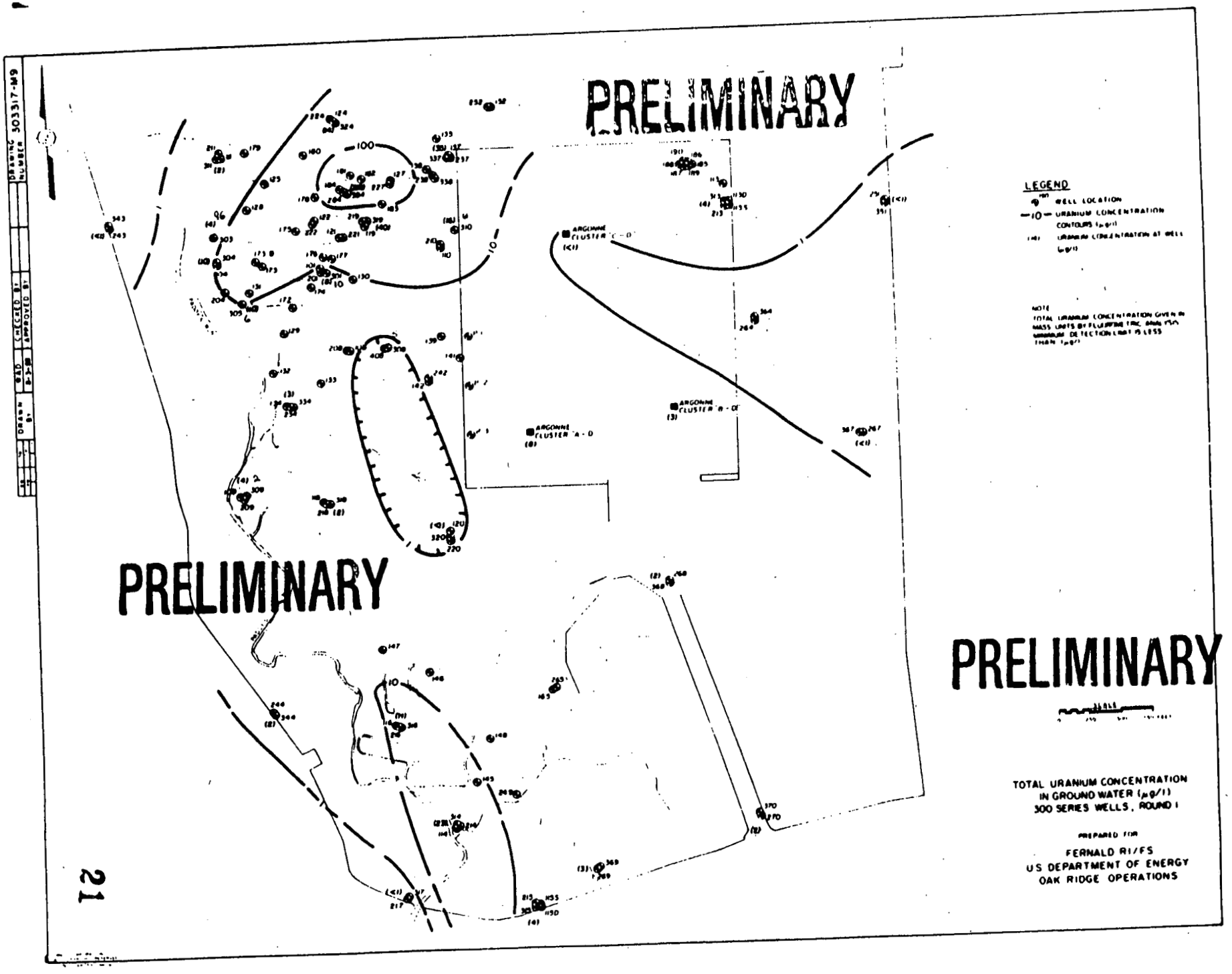

PRELIMINARY
PRELIMINARY
PRELIMINARY
LEGEND
WELL LOCATION
URANIUM CONCENTRATION CONTOURS
ARGONNE CLUSTER "C-D"
ARGONNE CLUSTER "A-D"
ARGONNE CLUSTER "B-D"
TOTAL URANIUM CONCENTRATION IN GROUND WATER (µg/l)
300 SERIES WELLS, ROUND I
PREPARED FOR
FERNALD RI/FS
US DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS
DRAWING NUMBER 303317-M9

Figure 7

4.0 Planned Assessment Program Implementation

4.1 Objectives/ Relationship to CERCLA

As defined in the Ohio Administrative Code and in 40 CFR, Part 265.93 the objectives of the Groundwater Assessment Program are to determine:

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

(b) The concentrations of the hazardous waste or hazardous waste constituents in the groundwater.

A sitewide RI/FS is being conducted at the FMPC. A Work Plan for conducting the RI/FS was submitted to OEPA and USEPA in December 1986. Revision 3 of this Work Plan was subsequently approved by USEPA in May 1988. Field activities associated with the RI/FS were initiated in July 1987. A focus of the RI/FS is the completion of a comprehensive hydrogeologic investigation of the potential effects of FMPC operations and waste disposal practices on regional groundwater. The objectives of the hydrogeologic investigation program of the RI/FS are to:

(a) Determine if subsurface water-bearing zones below the FMPC contain above background concentrations of chemical or radiological constituents;

(b) Determine the concentrations and sources of these constituents;

(c) Determine the rate and direction of groundwater flow and constituent movement within each separate hydrogeologic unit;

(d) Determine the effects of groundwater pumping and resulting recharge/discharge relationships on groundwater flow and contaminant transport;

(e) Define areas of subsurface migration and groundwater discharge for identified constituents; and

(f) Determine the nature and extent (both vertically and horizontally) of identified above background constituents.

Pit 4 is currently undergoing Interim RCRA Closure. This Interim Closure will be completed in the spring of 1989. Assessment monitoring will be continued until the Final Remediation of the waste pits under CERCLA. RCRA regulations will be considered as Applicable or Relevant and Appropriate Requirements (ARARS) for the remediation of Pit 4 under CERCLA. A RI/FS Report evaluating remediation alternatives for the waste pits is tentatively scheduled to be delivered to U.S. EPA in the third quarter of 1990. The USEPA is tentatively scheduled to issue a Record of Decision (ROD) selecting the remedial alternatives for the waste storage operable unit in the second quarter of 1991. Within 90 days of the issuance of the ROD by USEPA, plans for Post-Closure monitoring will be submitted to EPA, as specified in the Pit 4 RCRA Closure Plan.

4.2 Rationale for Monitoring Well Locations and Depths

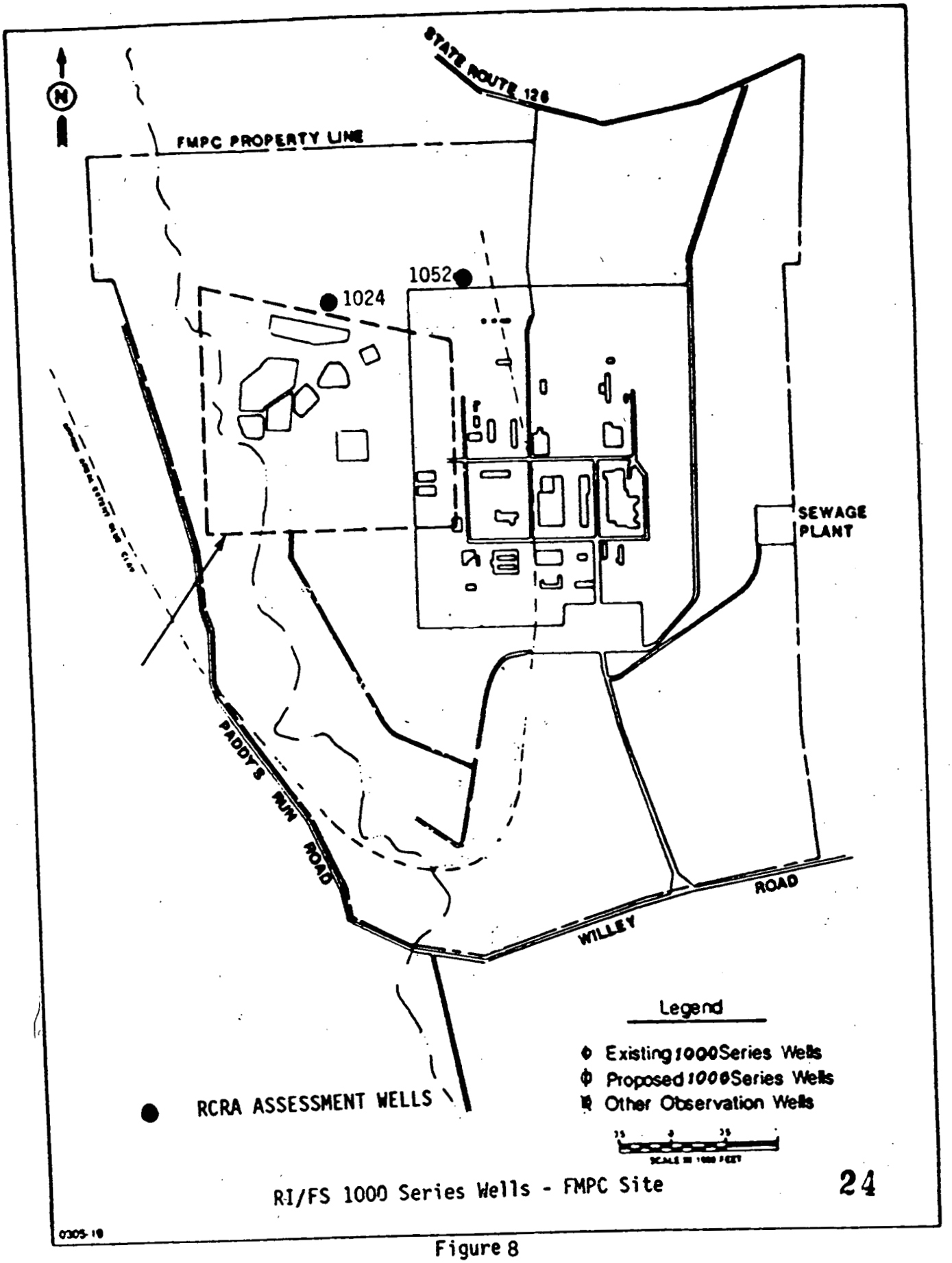
After March 1989, the Assessment program will consist of a quarterly sampling program for 43 wells selected from the RI/FS wells for continuation of the RCRA Assessment program, following completion of the fourth round of RI/FS sampling. Sixteen of the selected wells are 1000 series (till wells) and 27 are sand and gravel wells (2000, 3000 and 4000 series). This program includes two background till wells, outside the waste storage area, and 4 upgradient sand and gravel wells outside the waste storage area. The wells selected for continuation of the Assessment program are listed in Table 2. Figures 8 through 11 show the locations of these wells.

Due to the similar types of materials placed into the 6 waste pits, it is technically impossible to trace constituents to a single pit. Table 3 shows a summary of constituents of all waste pits. This Table demonstrates the similarities of materials found in all pits. No unique indicator constituent to monitor contamination coming from Pit 4 could be identified by examining data from the CIS characterization of the pits.

Since none of the RCRA regulated constituents found in the waste storage area groundwater can be traced specifically to Pit 4, rather than other adjacent waste pits, the RCRA monitoring system wells be placed downgradient from the entire waste storage area. To design a monitoring system specific to Pit 4, sand and gravel wells upgradient to Pit 4 would have to be placed downgradient from Pit 3 in order to isolate constituents coming from Pit 4. This upgradient well would not representative of background conditions. Likewise, since a groundwater mound in the till is located just south of Pit 4, upgradient till wells for Pit 4 would have to be placed on this mound, which is located in the waste storage area, and would not represent background conditions. The proposed RCRA Assessment monitoring system will be located downgradient from the entire waste storage area. Upgradient wells will be located outside of the waste storage area, and will be representative of background conditions. This approach is also justified since all 6 pits will be remediated under CERCLA, and closure options for all pits are being evaluated under a single Feasibility Study document.

To have the same Pleistocene geology as the pit area, background till wells need to be located either in the pit area, or north of the pit area, or in the production area or east of the production area. Wells in either the production area or waste storage area would not represent background conditions. Wells 1024 and 1052 were selected as the most representative RI/FS background wells for the glacial till. These wells are located 500 feet north and 1400 feet northeast of the pit area, respectively.

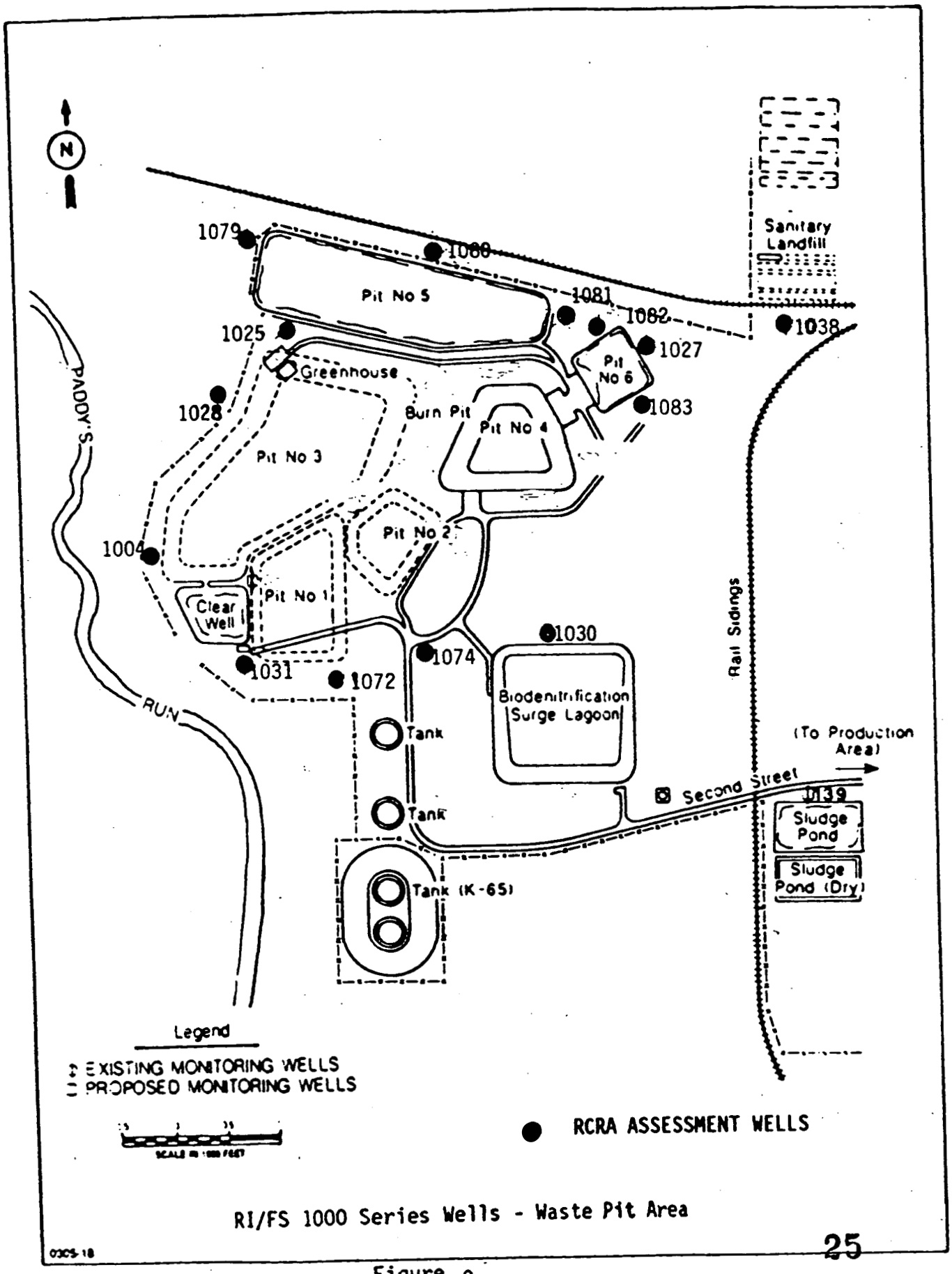
The 14 downgradient till wells (1000 series) ring the waste storage area, and are located downgradient from the groundwater mound shown in Figure 3. Wells 1079, 1080, 1027 1081, 1082 and 1038 are located north of the pit area. Wells 1038 1027, 1030, 1083 and 1074 are located east of the waste pits, Wells 1031, 1072, 1074 and 1030 are located south of the pit area. Wells 1011, 1079, 1028, 1040, 1025 and 1031 are located west of the waste storage area. Most of these wells are located within 20 feet of the edge of the waste pits.



RI/FS 1000 Series Wells - FMPC Site

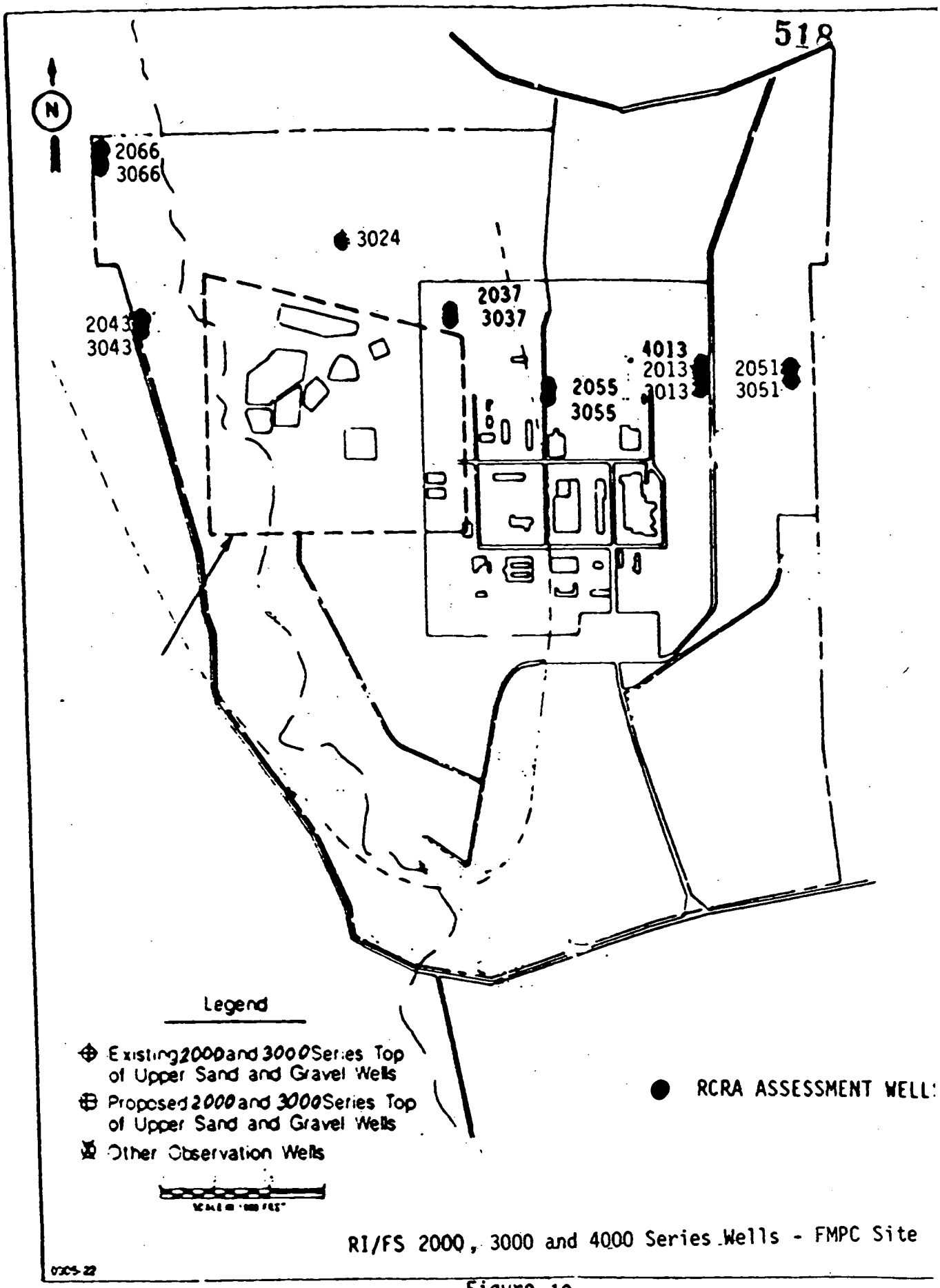
24

Figure 8



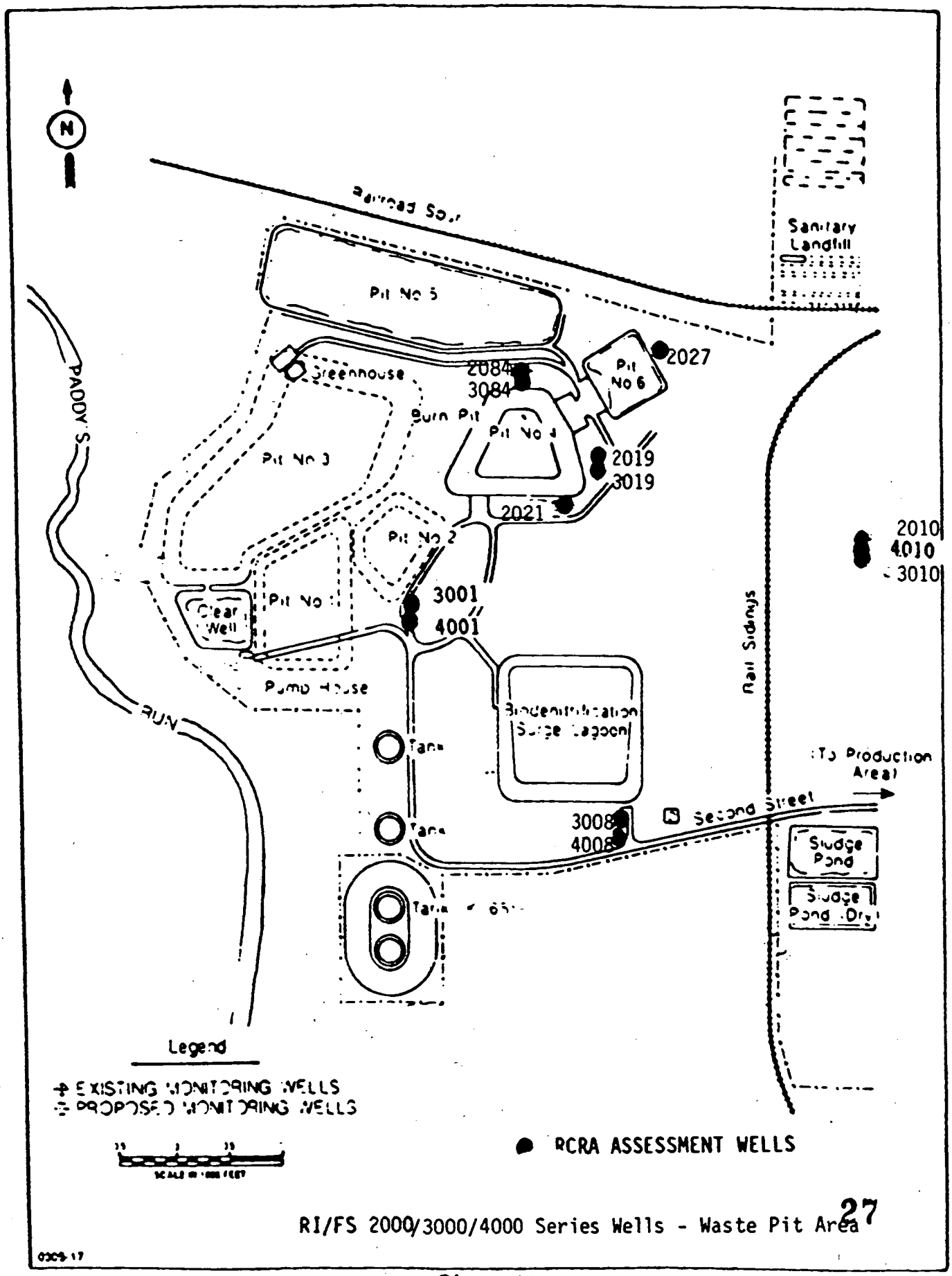
RI/FS 1000 Series Wells - Waste Pit Area

Figure 9



RI/FS 2000, 3000 and 4000 Series Wells - FMPC Site

Figure 10



RI/FS 2000/3000/4000 Series Wells - Waste Pit Area

Figure 11

TABLE 2

Selected RI/FS Wells and Site Specific
Parameters for the RCRA Assessment Program

PARAMETERS	UPGRADIENT TILL WELLS
Cobalt	1024
Beryllium	1052
Zinc	
Vanadium	DOWNGRADIENT TILL WELLS
Nickel	
Copper	1027
Magnesium	1080
Calcium	1079
Aluminum	1004
Barium	1074
Chromium	1031
Lead	1028
Silver	1072
Iron	1030
Fluoride	1038
Nitrate	1081
Chloride	1083
Sulfate	1082
pH	1025
Conductivity	
TOC	UPGRADIENT SAND & GRAVEL
TOX	
Tetrachloroethene	2066/3066
Methylene chloride	2043/3043
Dichloroethane	
Acetone	DOWNGRADIENT SAND & GRAVEL
Trichloroethene	
Toluene	3001/4001
Total Uranium	2084/3084
Uranium-234	2021
Uranium-235	2019/3019
Uranium-238	2027
Thorium-228	2010/3010/4010
Thorium-230	2013/3013/4013
Technetium-99	2051/3051
	2055/3055
	3008/4008
	3024
	2084/3084
	2037/3037

SUMMARY OF CONTENTS OF WASTE PITS

	METALS											ORGANICS				RADIONUCLIDES					
	Al	Ca	Fe	Mg	F	Ba	As	Hg	Pb	V	Ag	PCBs	VOCs	S-Vs	Pest.	U-234	U-235	U-238	Th-230	Tc-99	Ra-226
Pit 1	x	x	x	x								x	x	x		x	x	x	x	x	x
Pit 2	x	x	x	x								x	x	x	x	x	x	x	x	x	x
Pit 3	x	x	x	x	x	x	x		x	x		x				x	x	x	x	x	x
Pit 4	x	x	x	x	x	x						x	x	x	x	x	x	x	x	x	x
Pit 5	x	x	x	x			x	x		x		x				x	x	x	x	x	x
Pit 6	x	x		x				x	x		x	x	x			x	x	x		x	
Burn Pit	x	x	x	x					x		x	x	x	x		x	x	x	x	x	
Clearwell	x	x	x	x			x	x				x				x	x	x	x	x	x

PCBs are Arochlors
VOCs are chloroform, vinyl chloride, tetrachloroethylene, tetrachloroethane
S-Vs are chrysene, phenanthrene, fluoranthene, pyrenes
Pest. are DDT, malathion, ethyl parathion and methyl parathion

Data source is: Weston CIS Study, v. 2, 1987

TABLE 3

The upgradient sand and gravel wells are wells 2066/3066 and 2043/3043, located respectively 2300 feet northwest and 1500 feet west of the waste storage area. These wells are all hydraulically upgradient from the waste storage area.

The 23 downgradient sand and gravel wells are all located under the east edge or east or northeast of the waste storage area. Well 2084/3084 is in the east portion of the waste storage area. Wells 3001/4001, 2021, 2019/3019, and 2027 are located immediately adjacent to the waste storage area, usually within 20 feet of the pits. Wells 2037/3037 are located approximately 500 and 700 feet east and slightly north of the pit area respectively. Well 3024 is located approximately 600 feet north of the waste storage area. Well 3008/4008 is located approximately 800 feet southeast of the waste storage area, and well 2010/3010/4010 is located about 800 feet east (downgradient) of the waste storage area. Well 2055/3055 is located approximately 1600 feet east of the waste storage area. Wells 2013/3013/4013 and 2064/3064 are located approximately 3000 feet east of the waste storage area.

Figure 12 shows a cross section of the generalized monitoring well depths and screen locations. The 1000 series wells (till) monitor the till aquifer, which is just below the surface ranging from 30 to 40 feet in depth. These wells are screened at the interval where perched water is encountered in the till, which can be quite variable, generally anywhere from 17 to 35 feet below the surface. The screened interval of these wells is 2 feet. The till wells are appropriate to study migration of constituents from the waste pits into the till horizon, and study any vertical migration through the till down into the sand and gravel aquifer. Table 4 lists monitoring well depths, casing materials and screened elevations of FMPC wells selected for the RCRA Assessment program.

The 2000 series wells (upper sand and gravel) are screened at the top the water table in the sand and gravel aquifer, using 15 feet of screen installed so that five feet of the screen is above the water table and ten feet below. This will allow for a seasonal variation in the elevation of the top of the water table, allowing a minimum of 10 feet of water contacting the well screen. These wells are screened at depths below the surface generally ranging from 62 to 103 feet, depending on ground surface elevations. The 2000 series wells are appropriate for monitoring light organics or other pollutants as they first reach the water table.

The 3000 series wells (lower part of the upper sand and gravel) are screened just above the clay layer referred to as the blue clay. In the event that the blue clay was not encountered, the well was screened just above the depth at which the blue clay is generally encountered under the production area. The screened interval of the 3000 series wells is 10 feet. The depth of the screened interval generally varies between 117 and 146 feet below the surface, depending on the surface elevation. The 3000 series wells are appropriate for monitoring for heavy metals such as uranium. Rounds 1 and 2 RI/FS monitoring data confirm that uranium concentrations are higher in the 3000 series sand and gravel wells than in the 2000 series wells near the pit area.

The 4000 series wells (lower sand and gravel) are generally screened so that the bottom of the screen is 10 feet from the bedrock floor of the buried

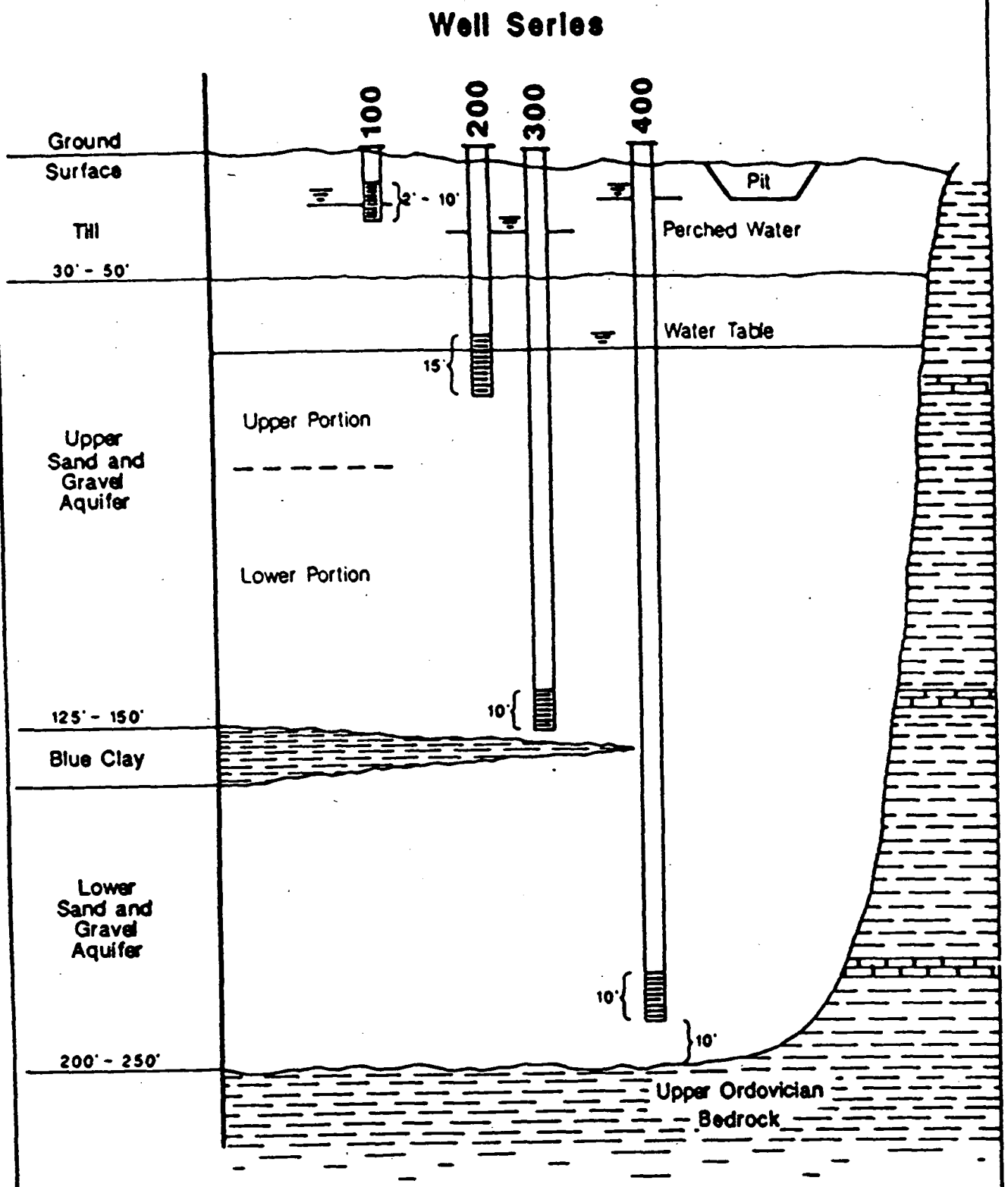


Figure 12 RI/FS General Monitoring Well Depths and Screen Locations

TABLE 4

RCRA PROGRAM ASSESSMENT WELLS
DEPTHS, CASING AND SCREENS

Well Number	Depth (ft)	Casing	Dia. (in)	Screen Elev.(MSL)	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
				Bottom Elevation	
Pit 1				560	
Pit 2				570	
Pit 3				548	
Pit 4				560	
Pit 5				558	
Pit 6				560	
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
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	Not Comp.	STS	4		15
2013	78	PVC	4	516-511	5
2051	102.4	STS	4	520-505	15

Table 4 (cont.)

RCRA PROGRAM ASSESSMENT WELLS
DEPTHS, CASING AND SCREENS

Well Number	Depth (ft)	Casing	Dia. (in)	Screen Elev.(MSL)	Length (ft.)
3066	137.4	STS	4	451-441	10
3043	120	STS	4	470-460	10
3084	102.4	STS	4	491-481	10
3019	124	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	Not Comp.	STS	4		10
4013	Not Comp.	STS	4		10

STS Stainless Steel
PVC Polyvinyl Chloride
ST Steel
GVST Galvanized Steel

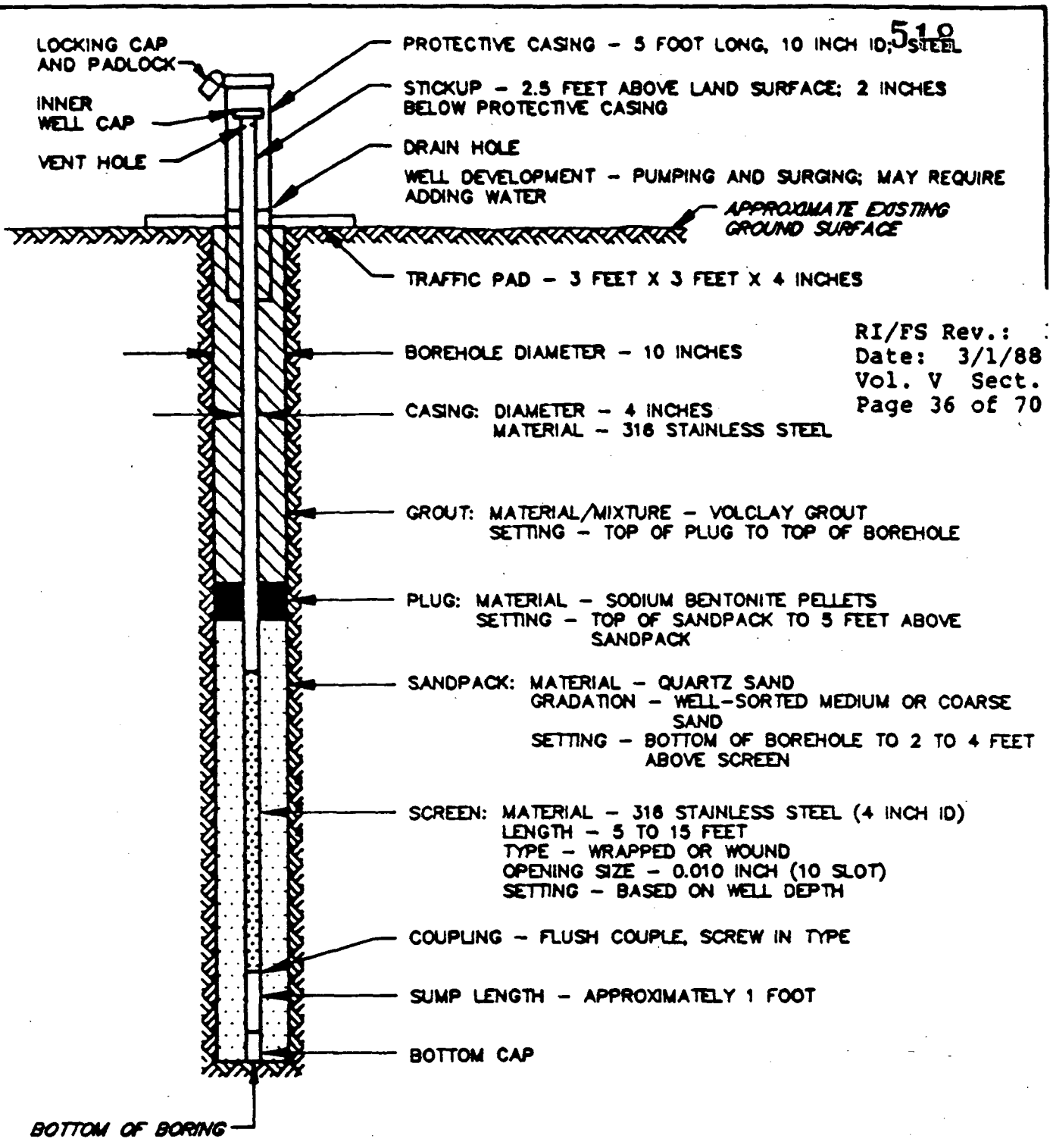
valley aquifer. The screened interval of the 4000 series wells is also generally 10 feet. The depth of the screened interval generally ranges from 160 to 200 feet depending on surface elevation and depth of the bedrock surface. The 4000 series wells will confirm if the blue clay layer is acting as an aquitard. Results to date show no contaminants in these wells. The purpose of these 4000 series wells is to confirm the absence of contaminants below the blue clay. Therefore, there are currently no 4000 series wells upgradient of the pit area. An extensive study of the aquifer will not be made at the 4000 level unless analytical results in these wells or groundwater modelling results suggest that contamination has reached the 4000 series wells.

4.3 Rationale for Selection of Site Specific Parameters

Assessment Program wells will be sampled quarterly beginning in May 1989 for selected site specific parameters. The wells will not be monitored for all Appendix IX constituents. Full Appendix IX monitoring is not technically justified, since the waste pits have previously been characterized in the CIS study and the groundwater in the waste storage area by the RI/FS. The pits were analyzed for Appendix IX constituents in the CIS study, and groundwater in the waste storage area has been analyzed in the RI/FS program for the extended HSL list parameters, as described in section 3.4. Site specific parameters were selected after reviewing the results of the CIS study, and previous RCRA and RI/FS groundwater monitoring data (see Appendices B and C). These parameters are: uranium (total and isotopic), thorium-230, technetium-99, aluminum, calcium, iron, magnesium, fluoride, barium, chromium, copper, lead, nickel, vanadium, zinc, beryllium, cobalt, silver, tetrachloroethene, methylene chloride, dichloroethane, acetone, trichloroethene and toluene. These parameters are also listed in Table 2. These parameters were either found in significant amounts in Waste Pit 4, or above detection limits in groundwater in the waste storage area, or both. HSL semi-volatile compounds, PCBs, pesticides and dioxins are not included in the list of site specific parameters, since they were not detected in waste storage area groundwater in the RI/FS monitoring program.

4.3 RI/FS Well Installation Methods and Materials

At this time, no additional well installation is planned for the Assessment Program; existing monitoring wells will be used. All monitoring wells previously installed as part of the RI/FS program were drilled using cable tool equipment using a casing-advance drilling methods. The casing advance method maintained an open borehole without the use of drilling muds and provided a barrier against the downward migration of contaminants from shallower aquifers. The backs of the drill rigs, tools, casing and well screens for each well were cleaned and decontaminated before moving to a new drilling location or well completion. Once the borehole reached the desired depth, the well was constructed according to the schematic drawings shown in Figures 13 and 14. The well casing and screens are 4 inch diameter 316 stainless steel. The screened area was backfilled with a sand pack, the casing above the screen was grouted. The monitoring wells were developed by pumping and flushing. A protective steel cover with a locked, hinged cover embedded in a cement grout cap was provided for each well riser. See Appendix D for details of RI/FS well installation and materials.



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APPROVED BY
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FIGURE 13

SUMMARY OF SPECIFICATIONS FOR WELL COMPLETION
100- AND 200- SERIES WELLS

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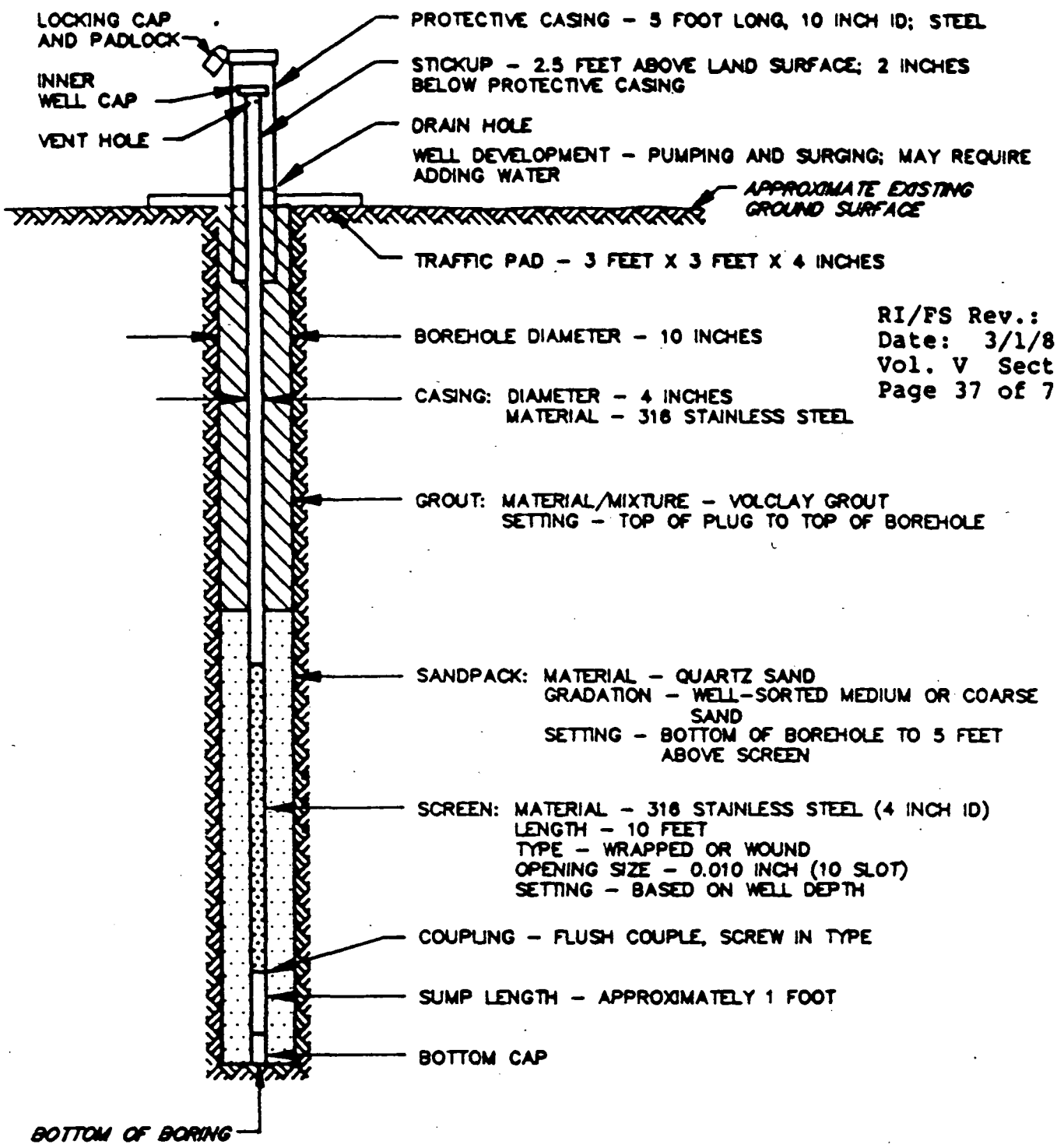

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FIGURE 14

SUMMARY OF SPECIFICATIONS FOR WELL COMPLETION
300- AND 400- SERIES WELLS

"Do Not Scale This Drawing"

4.4 Sample Collection Methods

These sampling methods were used in collection of groundwater samples for the RI/FS program, and will continue to be used in the Assessment Program. Three well volumes are evacuated from each well before sampling. Only stainless steel or teflon pumps and bailers are used to evacuate the wells and collect water samples. After the well is evacuated, the water samples are collected in order of stability and volatility. Samples for VOCs, pH, specific conductivity, temperature and dissolved oxygen are collected first. All samples are analyzed in the field for pH, temperature, conductivity and dissolved oxygen. Samples are collected using positive displacement gas displacement pumps or bailers. Plastic sheeting is spread to cover the ground near the well head as samples are taken. All pumps and sampling equipment is cleaned between sampling different wells using non-phosphate detergents, tap water rinses, dilute acid, alcohol and distilled water rinses as appropriate for various analytical parameters. After samples are collected, they are sealed, chain-of-custody papers, field collection reports, sample collection logs and lab analyses request forms are filled out, and samples are placed in a cooler at 4 °C. Sample collection methods are detailed in Appendix E.

4.5 Analytical Methods

These analytical methods were used in analysis of groundwater samples for the RI/FS program, and will continue to be used in the Assessment Program. When samples are received in the analytical laboratory, the bottles received are checked against chain of custody papers and sample holding times. The laboratory provides each sample with a unique sample number and logs the sample into the laboratory. Samples are placed in appropriate storage conditions after a radiological screening to evaluate radiological hazard associated with the sample. Samples are then analyzed by the laboratory following the procedures and QA/QC objectives listed in Appendix B. The chemical and radiological parameters analyzed in the assessment program are listed in Table 2.

4.6 Modeling and Additional Hydrologic Studies

A three dimensional flow and solute transport model, Swift III is being developed as part of the RI/FS program. The flow model has been verified against known analytical and numerical models, and has also been calibrated using field water level data. Sensitivity analyses of the flow model have also been conducted. The solute transport portion of the model is still undergoing development. Geochemical modeling will also be performed to aid in understanding of any potential chemical reactions in groundwater. As part of the geochemical modeling program, sorption determinations will be made experimentally, leaching tests performed and soil mineralogy studied. This groundwater model will be used primarily in the Risk Assessment for the Remedial Investigation and evaluation of remedial alternatives in the Feasibility Study. If need arises, however, this model can be used in evaluating groundwater and constituent flow for the RCRA monitoring program.

As part of the RI/FS, slug testing has been performed on till wells 1008, 1012, 1016, 1018, 1025, 1031, 1034, 1035, 1041, 1046, 1048, 1065 and 1079 to

aid in estimating hydrologic properties of the till unit (1000 series). Wells 1079 and 1031 are included in the RCRA assessment monitoring program. Falling head field permeability tests were used for slug testing. In this procedure, a known volume of water is added to the well and a number of depth-time measurements are taken, until the water level returns to equilibrium conditions (or enough measurements to define a straight line on semi-log plot of head vs. time). FMPC fire hydrant water was used for this purpose. The only solid materials allowed to contact the well water were stainless steel and teflon. The first water level measurement was made 10 to 15 seconds after the slug was added. Slug tests are generally a reliable field method of determining permeability or transmissivity near the screened zone of the well in units of low hydraulic conductivity (10-4 to 10-7 cm/sec), such as the 1000 series wells. The hydraulic conductivity of well 1079 was 1.8x10-5 cm/sec (19 ft/yr). The hydraulic conductivity of well 1031 is not included, since the screened interval of this well was only partially saturated, and would not represent the saturated hydraulic conductivity of the till in the vicinity of this well.

4.7 Procedures for Data Interpretation

Existing RI/FS data for Assessment Program wells and site specific parameters will be analyzed, as well future data collected in the continuing Assessment Program. Background (upgradient) levels (means) will be established for all site specific parameters, and data from downgradient data will be compared to these upgradient levels. Data will be compiled in tabular format, and mapped and plotted as appropriate. If this approach provides no clear determination of the rate of migration or extent of release, statistical comparisons of upgradient concentrations and downgradient concentrations will be made using appropriate statistical techniques.

5.0 Schedule

Beginning in May 1989 these wells will be sampled quarterly for the site specific parameters listed in Table 2. This sampling will be conducted in May, August, November, and February of each year. This schedule of sampling will continue until Final Remediation of the pits, anticipated to begin in 1992 or early 1993. After the ROD for remediation of the pits is issued by EPA (tentatively scheduled in the second quarter of 1991), a post-closure groundwater monitoring plan will be developed within 90 days.

APPENDIX A

Round 1

WELLS UPGRADIENT TO PIT 4
SHALLOW (TILL) GROUNDWATER
(All results in ppm except as noted)

Name	WELL 1024	WELL 1012	WELL 1011
Arsenic	< 0.2	< 0.03	< 0.03
Barium	0.091	0.11	0.15
Cadmium	< 0.005	< 0.005	< 0.005
Chloride	1.4	100	14
Chromium	< 0.02	< 0.01	< 0.01
Fluoride	0.83	2.1	1.9
Iron	0.667	0.12	16.4
Lead	< 0.05	< 0.03	< 0.03
Manganese	0.08	0.005	1.7
Mercury	< 0.0002	< 0.001	< 0.001
Nitrates	< 0.1	< 5	< 5
Phenol	< 0.01	< 0.01	0.01
Selenium	< 0.2	< 0.001	< 0.06
Silver	< 0.01	< 0.005	< 0.005
Sodium	19.73	212	5.3
Specific conductivity (mmhos/cm)	480	1400	980
pH	7.1	7.83	6.84
VOCs (ppb)	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA
Dioxin (ppt)	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3
Total Uranium (ppb)	< 1	< 1	< 1
Sulfate	50	< 2	80

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 2

WELLS UPGRADIENT TO PIT 4
SHALLOW (TILL) GROUNDWATER
(All results in ppm except as noted)

Name	WELL 1024	WELL 1012	WELL 1011
Arsenic	< 0.01	< 0.01	< 0.2
Barium	< 0.2	< 0.5	0.135
Cadmium	< 0.005	< 0.005	< 0.002
Chloride	18	135	4
Chromium	0.12	< 0.01	< 0.02
Fluoride	1.3	1.3	0.4
Iron	4.9	< 0.1	1.299
Lead	< 0.2	< 0.005	< 0.05
Manganese	0.22	< 0.01	1.225
Mercury	0.0004	< 0.0002	< 0.0002
Nitrates	< 0.1	0.06	< 0.1
Phenol	< 0.05	< 0.002	< 0.01
Selenium	< 0.005	< 0.005	< 0.2
Silver	< 0.01	< 0.01	< 0.01
Sodium	12	340	5.16
Specific conductivity (mmhos/cm)	700	1300	1000
pH	7.21	7.5	6.81
VOCs (ppb)	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA
Dioxin (ppt)	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1
Radium 228 (pCi/l)	< 3	< 3	3.1
Total Uranium (ppb)	2	< 1	< 1
Sulfate	130	< 1	41
TOX	NA	NA	NA

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 1

WELLS DOWNGRADIENT OF PIT 4
SHALLOW (TILL) GROUNDWATER
(All results in ppm except as noted)

Name	WELL 1078	WELL 1076	WELL 1077	WELL 1084	WELL 1022	WELL 1021	WELL 1019	WELL 1027	WELL 1083
Arsenic	0.0073	0.0021	< 0.2		< 0.2	< 0.002	< 0.002	< 0.2	< 0.0019
Barium	0.14	0.0594	0.092		0.025	0.127	0.1	0.051	0.0738
Cadmium	< 0.0007	< 0.0007	0.0059		< 0.005	< 0.002	< 0.002	< 0.005	< 0.0007
Chloride	237	9.1	10.7		12.2	136	305	8.8	31.4
Chromium	< 0.0017	< 0.0017	< 0.02		< 0.02	< 0.02	< 0.02	< 0.02	< 0.0017
Fluoride	1.95	0.22	1.1		0.9	1.6	0.6	1.2	0.41
Iron	0.0854	0.0297	0.25		< 0.005	< 0.005	0.746	0.3	0.0773
Lead	< 0.0105	< 0.0021	< 0.05		< 0.05	< 0.002	< 0.002	< 0.05	< 0.0021
Manganese	0.106	0.147	0.048		0.315	0.791	1.046	0.081	0.0627
Mercury	< 0.00029	< 0.00029	< 0.0002		< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrates	1.67	< 0.08	0.1		0.1	0.1	< 0.1	0.3	0.3
Phenol	< 0.06	< 0.05	0.02		0.01	< 0.01	< 0.01	0.02	< 0.01
Selenium	< 0.0018	< 0.0018	< 0.2		< 0.2	0.0021	< 0.002	< 0.2	< 0.0018
Silver	< 0.0043	< 0.0043	0.2		0.174	< 0.0005	< 0.0005	< 0.02	0.0043
Sodium	27.0	20.8	11.3		8.5	8.88	118.3	9.02	17.1
Specific conductivity (mmhos/cm)	1980	1080	625		1800	590	1990	725	850
pH	6.78	7.28	7		6.9	7.57	6.7	6.3	7
VOCs (ppb)	ND	ND	NA		NA	ND	43 ppb	NA	ND
Semi-Volatiles (ppb)	10 Unk.	1 Unk.	NA		NA	3 Unk.	5 Unk	NA	7 Unk.
Pesticides/PCBs (ppb)	ND	ND	NA		NA	ND	NA	NA	NA
Organo-Phos. Pesticides(ppb)	ND	ND	NA		NA	ND	ND	NA	ND
Dioxin (ppt)	NA	ND	NA		NA	ND	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	0.8		< 1	< 1	NA	< 1	1.5
Radium 228 (pCi/l)	< 3	< 3	< 3		< 3	< 3	NA	< 3	< 3
Total Uranium (ppb)	245	16	30	Dry	3800	15330	600	1	94
Sulfate	157	132	57		1180	305	575	60	185

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 2

WELLS DOWNGRADIENT OF PIT 4
SHALLOW (TILL) GROUNDWARTER
(All results in ppm except as noted)

Name	WELL 1078	WELL 1076	WELL 1077	WELL 1084	WELL 1022	WELL 1021	WELL 1019	WELL 1027	WELL 1083
Arsenic	0.34	< 0.002	< 0.002	< 0.002	< 0.2	< 0.2	0.44	< 0.01	< 0.002
Barium	0.143	0.058	0.098	0.113	0.04	0.2	0.17	< 0.2	0.082
Cadmium	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.005	< 0.002
Chloride	270	2.5	3	4	67.5	15.5	1750	9.6	32.5
Chromium	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	< 0.02
Fluoride	0.78	1.1	0.86	1.6	0.98	1.75	0.25	1.7	0.55
Iron	0.017	< 0.005	0.018	< 0.005	0.027	0.651	0.924	2.1	< 0.005
Lead	< 0.05	< 0.002	< 0.002	< 0.002	< 0.05	< 0.05	< 0.05	< 0.005	< 0.002
Manganese	0.284	0.354	0.265	0.023	2.1	2.1	1.6	0.07	0.079
Mercury	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0003	< 0.0002
Nitrates	13	0.22	0.27	0.17	0.19	0.17	0.13	0.13	1.6
Phenol	0.02	0.02	0.02	0.01	< 0.01	< 0.01	0.02	< 0.05	0.02
Selenium	< 0.2	< 0.002	< 0.002	< 0.002	< 0.2	< 0.2	< 0.2	< 0.005	< 0.002
Silver	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium	24.43	25.5	13.1	42	22.7	10.3	360	12	22
Specific conductivity (mmhos/cm)	1800	1100	820	1130	2650	720	4680	750	970
pH	7.3	7.3	7.3	7.4	6.9	7.3	6.6	7.3	7.2
VOCs (ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diowin (ppt)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3	< 3	< 3	< 5	< 3	< 3	< 3
Total Uranium (ppb)	53	33	86	590	3500	10000	207	< 1	71
Sulfate	140	< 2	138	498	1120	184	266	140	139
TOX	NA	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.24	NA	< 0.05

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 1

WELLS UPGRADIENT TO PIT 4
SAND AND GRAVEL AQUIFER
(All results in ppm except as noted)

Name	WELL 2066	WELL 2043	WELL 2011	WELL 3066	WELL 3043	WELL 3011
Arsenic	< 0.2	< 0.2	< 0.002	< 0.2	< 0.2	< 0.2
Barium	0.758	0.195	0.014	0.509	0.214	0.097
Cadmium	< 0.005	< 0.002	< 0.002	< 0.005	< 0.002	< 0.005
Chloride	96	51.1	18.4	826	2.75	20.2
Chromium	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Fluoride	0.94	0.58	< 0.17	0.23	0.46	0.38
Iron	1.6	NA	< 0.005	19.3	NA	0.6
Lead	< 0.05	< 0.05	< 0.002	< 0.05	< 0.05	< 0.05
Manganese	0.068	0.168	0.04	0.11	0.06	0.148
Mercury	0.001	< 0.0002	0.0003	0.0008	< 0.0002	0.0011
Nitrates	< 0.1	< 0.1	0.1	< 0.1	0.12	< 0.1
Phenol	0.01	0.02	0.03	< 0.01	0.05	0.01
Selenium	< 0.2	< 0.2	< 0.002	< 0.2	< 0.2	< 0.2
Silver	< 0.01	< 0.01	< 0.005	< 0.01	< 0.01	< 0.01
Sodium	46.6	35.3	9.76	276	13.8	13.9
Specific conductivity (mmhos/cm)	600	910	600	2050	500	NA
pH	7.6	7.25	7.3	7.12	7.4	7.4
VOCs (ppb)	NA	NA	50 ppb	NA	NA	NA
Semi-Voletiles (ppb)	NA	NA	6 Unk	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	ND	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	ND	NA	NA	NA
Dioxin (ppt)	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	< 1	1.4	< 1	< 1	1.7	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3	< 3	< 3	< 3
Total Uranium (ppb)	< 1	1	1	< 1	< 1	2
Sulfate	< 2	40	< 2	29	8	109

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 2

WELLS UPGRADIENT TO PIT 4
SAND AND GRAVEL AQUIFER
(All Results in ppm except as noted)

Name	WELL 2066	WELL 2043	WELL 2011	WELL 3066	WELL 3043	WELL 3011
Arsenic	0.03	< 0.01	< 0.2	0.1	0.01	< 0.2
Barium	0.8	0.02	0.132	0.5	0.3	0.157
Cadmium	< 0.005	< 0.005	< 0.002	< 0.005	< 0.005	< 0.002
Chloride	68	66	9.6	680	11.5	14.5
Chromium	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.02
Fluoride	0.9	0.58	0.25	< 0.1	0.34	0.25
Iron	1.7	1.1	2.16	18	4	1.44
Lead	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.05
Manganese	0.06	0.15	0.17	0.12	0.05	0.134
Mercury	< 0.0002	< 0.0003	< 0.0002	< 0.0002	< 0.0003	< 0.0002
Nitrates	< 2.5	< 0.1	< 0.1	< 2.5	< 0.1	< 0.1
Phenol	< 0.01	0.03	< 0.01	< 0.01	0.02	< 0.01
Selenium	< 0.005	< 0.005	< 0.2	< 0.005	< 0.005	< 0.2
Silver	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium	48	40	9.53	320	16	9.94
Specific conductivity (mmhos/cm)	680	830	500	2320	500	520
pH	6.5	7.12	7.17	7	7.62	7.35
VOCs (ppb)	NA	NA	NA	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA	NA	NA	NA
Dioxin (ppt)	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1	1.9	8.5	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3	< 3	< 3	< 3
Total Uranium (ppb)	< 1	1	< 1	< 1	< 1	< 1
Sulfate	< 1.5	13	80	< 7.5	12	73
TOX	NA	NA	NA	NA	NA	NA

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 1

WELLS DOWNGRADIENT OF PIT 4
SAND AND GRAVEL AQUIFER
(all results in ppm except as noted)

Name	WELL 2084	WELL 2022	WELL 2021	WELL 2019	WELL 2027	WELL 2010	WELL 2013	WELL 2051	WELL 2064
Arsenic	< 0.2	0.0042	0.0047	< 0.002	< 0.0019	< 0.005	< 0.2	< 0.2	< 0.002
Barium	0.08	0.0521	0.067	0.056	0.105	0.0873	0.06	0.073	0.092
Cadmium	< 0.005	< 0.0007	< 0.0007	< 0.002	< 0.0007	< 0.005	< 0.005	< 0.005	< 0.002
Chloride	200	57.9	42.4	38.4	79.9	< 27	62.6	5.8	26.2
Chromium	< 0.02	< 0.0017	< 0.0017	< 0.02	< 0.0017	< 0.01	< 0.02	< 0.02	< 0.02
Fluoride	0.21	0.66	0.35	0.41	0.3	0.2	0.31	0.27	0.3
Iron	2.3	0.0255	0.0254	0.1	8.06	0.265	2.58	1.721	2.372
Lead	< 0.05	0.0034	< 0.0021	0.0024	< 0.0021	< 0.005	< 0.05	< 0.05	0.0138
Manganese	0.53	0.0063	0.0114	0.005	0.461	0.329	0.2	0.278	0.492
Mercury	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrates	0.1	0.1	9.2	17	< 0.1	< 0.02	< 0.1	< 0.1	< 0.1
Phenol	0.01	0.01	0.01	< 0.01	< 0.01	< 0.011	0.02	< 0.01	< 0.01
Selenium	< 0.2	< 0.0018	< 0.0018	< 0.002	< 0.0018	< 0.005	< 0.2	< 0.2	< 0.002
Silver	< 0.01	< 0.0043	< 0.0043	< 0.0005	< 0.0043	< 0.01	< 0.01	< 0.01	< 0.005
Sodium	66.5	29.2	46.8	24.64	30.6	14.6	12.2	10.36	17.36
Specific conductivity (mmhos/cm)	1600	810	1100	850	1450	690	780	700	975
pH	6.8	7	7.15	6.8	6.7	7.21	7.3	7.2	7.1
VOCs (ppb)	NA	ND	ND	35 ppb	ND	ND	NA	NA	ND
Semi-Volatiles (ppb)	NA	14 Unk.	6 Unk.	2 TIC	4 Unk.	ND	NA	NA	1 Unk.
Pesticides/PCBs (ppb)	NA	NA	NA	NA	NA	ND	NA	NA	ND
Organo-Phos. Pesticides(ppb)	NA	ND	ND	ND	ND	ND	NA	NA	NA
Dioxin (ppt)	NA	ND	ND	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1	< 1	1.6	< 1	< 1	1.4	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Total Uranium (ppb)	16	10	78	9	6	21	< 1	3	3
Sulfate	428	123	111	14	645	160	85	120	40

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 2

WELLS DOWNGRADIENT OF PIT 4
SAND AND GRAVEL AQUIFER
(All Results in ppm except as noted)

Name	WELL 2084	WELL 2022	WELL 2021	WELL 2019	WELL 2027	WELL 2010	WELL 2013	WELL 2051	WELL 2064
Arsenic	< 0.002	< 0.2	< 0.2	0.4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Barium	0.07	0.06	0.07	0.053	< 0.2	< 0.2	< 0.2	< 0.5	< 0.5
Cadmium	< 0.002	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chloride	185	95	47	48	120	31	25	39	29
Chromium	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	0.21	0.69	0.34	0.37	1.8	0.1	0.1	0.26	0.3
Iron	4.2	0.017	0.008	< 0.005	6.1	4.7	2.6	4.5	2.8
Lead	0.02	< 0.05	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Manganese	0.5	0.003	0.003	0.04	0.49	0.35	< 0.19	0.33	0.23
Mercury	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0003	< 0.0002	< 0.0002	0.0004	< 0.0002
Nitrates	16	< 0.15	0.28	23.4	0.11	< 2.5	< 5	0.12	0.11
Phenol	< 0.01	< 0.1	< 0.1	0.02	< 0.1	< 0.01	< 0.01	< 0.002	< 0.002
Selenium	< 0.002	< 0.2	< 0.2	< 0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Silver	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium	58.7	32.2	47.8	23.3	34	15	12	14	19
Specific conductivity (mmhos/cm)	1950	1100	1180	800	1175	1050	650	950	640
pH	7	7.3	7.3	7.3	7.2	6.93	7.27	7.04	7.2
VOCs (ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dioxin (ppt)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	1.1	< 1	< 1	< 1	1.2	< 1	< 1	< 1	< 1
Radium 228 (pCi/l)	3.7	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Total Uranium (ppb)	19	6	1	< 1	6	2	< 1	1	2
Sulfate	339	80	52	58	300	310	100	311	140
TOX	< 0.05	< 0.05	< 0.05	< 0.05	NA	< 0.05	< 0.05	NA	NA

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 1

WELLS DOWNGRADIENT OF PIT 4
SAND AND GRAVEL AQUIFER
(all results in ppm except as noted)

Name	WELL 3084	WELL 3019	WELL 3010	WELL 3055	WELL 3013	WELL 3051	WELL 3064
Arsenic	< 0.2	< 0.2	< 0.2	< 0.002	< 0.2	< 0.2	< 0.2
Barium	< 0.05	< 0.05	< 0.05	< 0.067	0.08	0.158	0.078
Cadmium	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.005	< 0.005
Chloride	153	170	74.2	51.5	70.3	53.6	18
Chromium	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Fluoride	0.29	0.21	0.24	0.53	0.26	0.35	0.21
Iron	0.6	0.23	0.26	1.87	6.58	0.583	0.977
Lead	< 0.05	< 0.05	< 0.05	0.002	< 0.05	< 0.05	< 0.05
Manganese	2.4	2.54	3.84	0.078	0.37	0.161	0.214
Mercury	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrates	< 0.1	8.4	22.8	0.1	< 0.1	0.17	< 0.1
Phenol	0.02	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01
Selenium	< 0.2	< 0.2	< 0.2	< 0.002	< 0.2	< 0.2	< 0.2
Silver	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium	68	38.5	96.8	56.8	42.2	26.59	13.9
Specific conductivity (mmhos/cm)	1650	1200	2810	1170	1120	810	590
pH	6.6	6.6	6.74	6.8	7.1	7.2	7.3
VOCs (ppb)	NA	NA	NA	NA	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA	NA	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA	NA	NA	NA	NA
Dioxin (ppt)	NA	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1	1.1	1.5	< 1	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Total Uranium (ppb)	218	40	16	< 1	4	< 1	< 1
Sulfate	530	650	800	159	322	103	70

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

Round 2

WELLS DOWNGRADIENT OF PIT 4
SAND AND GRAVEL AQUIFER
(All Results in ppm Except Where Noted)

Name	WELL 3084	WELL 3019	WELL 3010	WELL 3055	WELL 3013	WELL 3051	WELL 3064
Arsenic	< 0.002	< 0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Barium	0.03	0.027	< 0.2	< 0.2	< 0.2	< 0.5	< 0.5
Cadmium	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Chloride	207	70	68	58	62	79	35
Chromium	0.04	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	0.16	0.14	< 0.1	< 0.1	< 0.1	0.24	0.19
Iron	0.3	0.037	0.5	5.5	7.1	3.7	2.5
Lead	0.038	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Manganese	2.8	2.9	3.9	< 0.23	0.37	< 0.13	0.02
Mercury	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrates	< 2.5	10.1	< 5	< 2.5	< 2.5	0.1	0.22
Phenol	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.002	< 0.002
Selenium	< 0.002	< 0.2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Silver	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium	66.1	42.3	110	53	46	33	15
Specific conductivity (mmhos/cm)	1600	1040	1450	1100	1080	800	575
pH	6.9	6.9	6.89	7	7.2	7.25	7.3
VOCs (ppb)	NA	NA	NA	NA	NA	NA	NA
Semi-Volatiles (ppb)	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ppb)	NA	NA	NA	NA	NA	NA	NA
Organo-Phos. Pesticides(ppb)	NA	NA	NA	NA	NA	NA	NA
Dioxin (ppt)	NA	NA	NA	NA	NA	NA	NA
Radium 226 (pCi/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Radium 228 (pCi/l)	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Total Uranium (ppb)	25	23	17	< 1	4	< 1	< 1
Sulfate	335	390	730	340	280	130	107
TOX	0.05	< 0.05	< 0.05	NA	< 0.05	NA	NA

< = AT OR BELOW DETECTION LIMIT
ND = Not Detected
NA = Not Analyzed

PRELIMINARY HSL RESULTS

RI/FS GROUND WATER SAMPLING PROGRAM

1000-Series Wells Waste Pit Area	VOCs	BNA's (Semivolatiles)	Pesticides/PCB's	Organo-Phosphorus Pesticides	Dioxin
1019	18 ppb MC 25 ppb DCA 1 UNK	ND 5 UNK		ND	
1083	ND	ND 7 UNK		ND	
1029	ND	ND	ND		
1010	ND 1 TIC (50 ppb)	ND, 3 UNK (14-64 ppb)		ND	
1075	ND	ND, 4 UNK (10-700 ppb) 2 TIC (30-80 ppb)	ND	ND	
1021	ND	ND, 3 UNK (20-30 ppb)	ND	ND	ND
1076	ND	ND, 1 UNK (10 ppb)	ND	ND	ND
1078	ND	ND, 10 UNK (10-30 ppb)	ND	ND	
1073	76 ppb DCA	ND, 4 UNK (10-100 ppb)	ND	ND	
1074	ND	ND, 1 UNK (50 ppb)	ND	ND	
1025	ND	ND, 5 UNK (5-70 ppb)	ND		
Fly Ash Area					
1016	ND	ND	ND		

LEGEND

ND = NOT DETECTED UNK - UNKNOWN COMPOUND TIC = TENTATIVELY IDENTIFIED COMPOUND

PRELIMINARY HSL RESULTS

RI/FS GROUND WATER SAMPLING PROGRAM

2000-Series Wells Waste Pit Area	VOCs	BNA's (Semivolatiles)	Pesticides/PCB's	Organo-Phosphorus Pesticides	Dioxin
2019	22 ppb MC 13 ppb Acetone	ND, 2 TIC (8-16 ppb)		ND	
2042	9 ppb MC	ND, 1 TIC, 1 UNK (8-37 ppb)		ND	
2008	ND	ND	ND	ND	
2010	ND	ND	ND	ND	
2021	ND	ND, 6 UNK (10-48 ppb)		ND	ND
2027	ND	ND, 4 UNK (8-50 ppb)		ND	
2022	ND	ND, 14 UNK (10-146 ppb)		ND	ND
2001	10 ppb Toluene	ND	ND	ND	
2034	ND	ND, 1 UNK (10 ppb)	ND	ND	
2037	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	

LEGEND

ND = NOT DETECTED UNK - UNKNOWN COMPOUND TIC = TENTATIVELY IDENTIFIED COMPOUND

PRELIMINARY HSL RESULTS
RI/FS GROUND WATER SAMPLING PROGRAM

2000-Series Wells Outside Production Area and Waste Pits	VOCs	BNA's (Semivolatiles)	Pesticides/PCB's	Organo-Phosphorus Pesticides	Dioxin
2064	ND	ND, 1 UNK (14 ppb)	ND		
2011	37 ppb Acetone 8 ppb Carbon Dieulfide 5 ppb Toluene 1 TIC	ND, 6 UNK (6–84 ppb)	ND	ND	
2065	ND	20 ppb Diethylphthalate			
2015	6 ppb TCA	ND			
2020	ND	ND	ND		
2016	ND	ND, 1 UNK (18 ppb)	ND		
2014	ND	ND, 2 UNK (15–32 ppb)	ND		
2052	1 TIC (11 ppm)	ND	ND	ND	ND

LEGEND

ND = NOT DETECTED

UNK - UNKNOWN COMPOUND

TIC = TENTATIVELY IDENTIFIED COMPOUND

APPENDIX B

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.	REFERENCE
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.

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
Barium	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
Beryllium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	5 ug/l (water) 1 mg/kg (solids)	200.7 200.7	12 12
Boron	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 12
Cadmium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	5 ug/l (water) 1 mg/kg (solids)	200.7 200.7	12 12
Calcium	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.

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS (%)	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
Cation Exchange Capacity	Atomic Absorption Spectrophotometer	Daily (solids)	±10	±20	90	1 mg/kg (solids)	3.2.17	2
Chloride	Buret/Indicator	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	500 ug/l (water) 5 mg/kg (solids)	325.3 10-2,325.3	1 11,1
Chromium (Total)	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 12
Chromium VI	UV/VIS Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 1 mg/kg (solids)	7196 7196	3 3
Cobalt	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 12
Copper	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 12
Cyanide (Total)	Distillation with UV/VIS Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	20 ug/l (water) 0.50 mg/kg (solids)	335.2 9010	1 3
Dissolved Solids (Total)	Filtration/ Analytical Balance	3 months (water)	±10	-	90	1000 ug/l (water)	160.1	1

See footnotes at end table.

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
Fluoride	pH meter with Specific Ion Electrode	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	100 ug/l (water) 1 mg/kg (solids)	340.2 10-2,340.2	1 11,1
Iron	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
Iron (Leachable)	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (solids)	±10	±20	90	1 mg/kg (solids)	200.7(e)	5,12
Lead	Atomic Absorption Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	5 ug/l (water) 1 mg/kg (solids)	239.1,239.2 7420,7421	1 3
Lithium	Atomic Absorption Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	100 ug/l (water) 2 mg/kg (solids)	303A 303A	6 6
Magnesium	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.

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
Manganese	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 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) Daily (solids)	±10 ±10	±20 ±20	90 90	0.2 ug/l (water) 0.10 mg/kg (solids)	245.1 7471	1 3
Molybdenum	Atomic Absorption Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	246.1,246.2 246.1,246.2	1 1
Nickel	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	30 ug/l (water) 6 mg/kg (solids)	200.7 200.7	12 12
Nitrate	UV/VIS Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	100 ug/l (water) 1 mg/kg (solids)	352.1 10-2,352.1	1 11,1

See footnotes at end of table.

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION RPD %(a)	TYPICAL ACCURACY % OF RECOVERY	EXPECTED COMPLETENESS	EXPECTED METHOD DETECTION LIMIT(i)	METHOD NO.	REFERENCE
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.

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) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 12
Sodium	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
Specific Conductance	Conductivity Meter	Daily (water) Daily (solids)	±10 ±10	- -	90 90	1 umho/cm (water) 1 umho/cm (solids)	120.1 10-2,120.1	1 11,1
Strontium	Atomic Absorption Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	303A 303A	6 6
Sulfate	UV/VIS Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	2000 ug/l (water) 10 mg/kg (solids)	375.4 3.2.6	1 2
Sulfide	Buret/Indicator	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	500 ug/l (water) 10 mg/kg (solids)	376.1 9030	1 3
Thallium	Atomic Absorption Spectrophotometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2.0 mg/kg (solids)	279.1,279.2 7840,7841	1 4

See footnotes at end of table.

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) Daily (solids)	±10 ±10	±20 ±20	90 90	50 ug/l (water) 10 mg/kg (solids)	200.7 200.7	12 12
Vanadium	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	50 ug/l (water) 10 mg/kg (solids)	200.7 200.7	12 12
Zinc	Inductively Coupled Argon Plasma Emission Spectrometer	Daily (water) Daily (solids)	±10 ±10	±20 ±20	90 90	10 ug/l (water) 2 mg/kg (solids)	200.7 200.7	12 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.

(c)A method number is not assigned to the iron and manganese leaching procedures cited from the corresponding reference.
(i)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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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 RPDZ(a) Water	MATRIX SPIKE PRECISION RPDZ(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.

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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			-	-	-	-	-	-		5	5		
Toluene			13	21	76-125	59-139	-	-		5	5		
Chlorobenzene			13	21	75-130	60-133	-	-		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			-	-	-	-	-	-		10	330		
N-Nitroso-di-n-propylamine			38	38	41-116	41-126	-	-		10	330		
Hexachloroethane			-	-	-	-	-	-		10	330		
Nitrobenzene			-	-	-	-	-	-		10	330		
Isophorone			-	-	-	-	-	-		10	330		

See footnotes at end of table.

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	23	39-98	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			-	-	-	-	-	-		50	1600		
2,4,5-Trichlorophenol			-	-	-	-	-	-		10	330		
2-Chloronaphthalene			-	-	-	-	-	-		10	330		
2-Nitroaniline			-	-	-	-	-	-		50	1600		
Dimethylphthalate			31	19	46-118	31-137	-	-		10	330		
Acenaphthylene			-	-	-	-	-	-		50	1600		
3-Nitroaniline			-	-	-	-	-	-		50	1600		
Acenaphthene			-	-	-	-	-	-		10	330		
2,4-Dinitrophenol			50	50	10-80	11-114	-	-		10	330		
4-Nitrophenol			-	-	-	-	-	-		10	330		
Dibenzofuran			38	47	24-96	28-89	-	-		10	330		
2,4-Dinitrotoluene			-	-	-	-	-	-		10	330		
2,6-Dinitrotoluene			-	-	-	-	-	-		10	330		
Diethylphthalate			-	-	-	-	-	-		50	1600		
4-Chlorophenyl Phenyl Ether			-	-	-	-	-	-		50	1600		
Fluorene			-	-	-	-	-	-		10	330		
4-Nitroaniline			-	-	-	-	-	-		10	330		
4,6-Dinitro-2-methylphenol			-	-	-	-	-	-		10	330		
N-Nitrosodiphenylamine			-	-	-	-	-	-		50	1600		
4-Bromophenyl Phenyl Ether			-	-	-	-	-	-		10	330		
Hexachlorobenzene			50	47	9-103	17-109	-	-					
Pentachlorophenol			-	-	-	-	-	-					
Phenanthrene													

See footnotes at end of table.

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
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.

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:													
Dibutylchlorendate			-	-	-	-	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 NSL compounds are 100, 60, and 15 times individual low water CRDL. Medium solids CRDLs for Volatile, Acid/Base-Neutral Extractable, and Pesticide NSL compounds are 100, 60, and 15 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," WA-87-4236, Washington, D.C.

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(e)	METHOD NO.	REFERENCE
Gross Alpha	Tennelec Low Background Alpha/Beta Counting System	Daily (c)	±20	±30	90	1.0 pCi/l(f,h) (water)	RSL-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)	RSL-308	1
Radium-226	Alpha Spectrometer	Daily	±20	±30	90	1.0 pCi/l (water) 300 pCi/kg(g) (solids)	RSL-309 RSL-201, RSL-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-223	Tennelec Low Background Alpha/Beta Counting System	Daily	±20	±30	90	3.0 pCi/l (water) 500 pCi/kg (solids)	RSL-309 RSL-201, RSL-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)	RSL-305 RSL-201, RSL-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)	RSL-310 RSL-201, RSL-310	9 9
Thorium, Isotopic	Alpha Spectrometer	Daily	±20	±30	90	1.0 pCi/l (water) 600 pCi/kg (solids)	RSL-304 RSL-201, RSL-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.

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	Alpha Spectrometer	Daily	±20	±30	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
Uranium, total	and							
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data Systems Only)	NA	NA	NA	NA			
Plutonium, Isotopic	Alpha Spectrometer	Daily	±20	±30	90	1.0 pCi/l (water) 600 pCi/kg (solids)	RSL-304 RSL-201, RSL-304	2,3,4,5 2,3,4,5
	and							
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data Systems Only)	NA	NA	NA	NA			
Neptunium-237	Alpha Spectrometer	Daily	±20	±30	90	1.0 pCi/l (water) 600 pCi/kg (solids)	RSL-304 RSL-201, RSL-304	2,3,4,5 2,3,4,5
	and							
	Nuclear Data Computer Based Gamma Spectrometer Model ND9900 (Data Systems Only)	NA	NA	NA	NA			
Cesium-137 Gamma Spec	Intrinsic Germanium Detectors	Daily	±20	±30	90	20 pCi/l (water) 200 pCi/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			

See footnotes at end of table.

PARAMETER	INSTRUMENT	FREQUENCY OF CALIBRATION CHECKS	TYPICAL PRECISION % RSD(a)	TYPICAL ACCURACY % Bias(b)	COMPLETENESS (%)	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 analyzed versus actual spike concentration for the indicated method.

(c)Each day samples are analyzed.

(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 = picocurie per kilogram.

(h)For sample with solids <500 ppm.

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APPENDIX C

Pit One

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	1702.92	20223.31	MG/KG	6
ARSENIC, TOTAL	14.46	15.20	MG/KG	2
BARIUM, EP LEACHATE	1018.00	3743.00	UG/L	4
BARIUM, TOTAL	116.48	395.37	MG/KG	6
BERYLLIUM, TOTAL	2.03	2.20	MG/KG	2
CADMIUM, TOTAL	1.46	4.96	MG/KG	3
CALCIUM, TOTAL	4755.83	192497.97	MG/KG	6
CHROMIUM, TOTAL	6.35	46.33	MG/KG	5
COBALT, TOTAL	27.85	27.85	MG/KG	1
COPPER, TOTAL	19.05	160.79	MG/KG	6
IRON, TOTAL	1832.56	19687.98	MG/KG	6
LEAD, EP LEACHATE	660.00	660.00	UG/L	1
LEAD, TOTAL	4.98	89.92	MG/KG	6
MAGNESIUM, TOTAL	7613.78	36957.20	MG/KG	6
MANGANESE, TOTAL	144.81	2914.70	MG/KG	6
MERCURY, TOTAL	.26	.36	MG/KG	2
NICKEL, TOTAL	9.22	64.53	MG/KG	5
POTASSIUM, TOTAL	165.48	2564.10	MG/KG	6
SILVER, TOTAL	2.25	33.09	MG/KG	3
SODIUM, TOTAL	386.12	3638.58	MG/KG	5
VANADIUM, TOTAL	13.74	66.74	MG/KG	5
ZINC, TOTAL	6.09	57.91	MG/KG	4

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Pit One

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
4,4-DDT	1600.00	1600.00	UG/KG	1
AROCLOR-1248	3500.00	3500.00	UG/KG	1
AROCLOR-1254	720.00	10000.00	UG/KG	4
AROCLOR-1260	7000.00	7000.00	UG/KG	1
CHLOROFORM	210.00	210.00	UG/KG	1
CHRYSENE	510.00	510.00	UG/KG	1
PHENANTHRENE	770.00	2300.00	UG/KG	2

Pit One

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	.20	1.10	PCI/G	5
NP-237	.10	.30	PCI/G	5
PU-238	.10	.10	PCI/G	5
PU-239/240	.10	.10	PCI/G	5
RA-226	12.00	60.20	PCI/G	5
RU-106	2.00	4.00	PCI/G	5
SR-90	.30	.60	PCI/G	5
TC-99	1.00	15.00	PCI/G	5
TH-228	1.80	18.00	PCI/G	5
TH-230	122.00	1980.00	PCI/G	5
TH-232	1.80	17.00	PCI/G	5
U-234	244.00	1180.00	PCI/G	5
U-235	16.00	151.00	PCI/G	5
U-238	360.00	6980.00	PCI/G	5

Pit Two

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	7242.30	22421.77	MG/KG	5
ARSENIC, TOTAL	2.75	10.06	MG/KG	4
BARIUM, EP LEACHATE	4221.00	9458.00	UG/L	3
BARIUM, TOTAL	62.57	208.49	MG/KG	5
BERYLLIUM, TOTAL	1.87	8.92	MG/KG	3
CADMIUM, TOTAL	3.04	9.59	MG/KG	5
CALCIUM, TOTAL	34414.38	80154.23	MG/KG	5
CHROMIUM, TOTAL	16.17	91.26	MG/KG	5
COBALT, TOTAL	13.63	450.56	MG/KG	4
COPPER, TOTAL	26.18	329.06	MG/KG	5
IRON, TOTAL	13265.46	24037.73	MG/KG	5
LEAD, TOTAL	20.70	190.29	MG/KG	5
MAGNESIUM, TOTAL	8884.98	26676.81	MG/KG	5
MANGANESE, TOTAL	495.43	916.57	MG/KG	5
MERCURY, EP LEACHATE	.27	.27	UG/L	1
MERCURY, TOTAL	.22	.70	MG/KG	4
NICKEL, TOTAL	28.75	608.90	MG/KG	5
POTASSIUM, TOTAL	667.42	4318.50	MG/KG	5
SELENIUM, TOTAL	1.59	10.19	MG/KG	3
SILVER, TOTAL	5.90	23.16	MG/KG	3
SODIUM, TOTAL	410.72	2303.20	MG/KG	5
VANADIUM, TOTAL	26.95	105.94	MG/KG	5
ZINC, TOTAL	53.58	3247.15	MG/KG	5

Pit Two

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
2-METHYLNAPHTHALENE	7000.00	7000.00	UG/KG	1
4,4-DDT	580.00	1400.00	UG/KG	2
4-CHLOROPHENYL-PHENYLETHER	62000.00	62000.00	UG/KG	1
ACENAPHTHENE	43000.00	43000.00	UG/KG	1
ANTHRACENE	120000.00	120000.00	UG/KG	1
AROCLOR-1248	321.00	321.00	UG/KG	1
AROCLOR-1254	323.00	323.00	UG/KG	1
AROCLOR-1260	740.00	1800.00	UG/KG	2
BENZO(A)ANTHRACENE	860.00	180000.00	UG/KG	3
BENZO(A)PYRENE	700.00	140000.00	UG/KG	3
BENZO(B)FLUORANTHENE	760.00	110000.00	UG/KG	2
BENZO(G,H,I)PERYLENE	42000.00	42000.00	UG/KG	1
BENZO(K)FLUORANTHENE	600.00	120000.00	UG/KG	3
CHRYSENE	920.00	180000.00	UG/KG	2
DIBENZOFURAN	36000.00	36000.00	UG/KG	1
FLUORANTHENE	590.00	460000.00	UG/KG	3
FLUORENE	62000.00	62000.00	UG/KG	1
INDENO(1,2,3-CD)PYRENE	46000.00	46000.00	UG/KG	1
NAPHTHALENE	16000.00	16000.00	UG/KG	1
PHENANTHRENE	1700.00	370000.00	UG/KG	2
PYRENE	1600.00	310000.00	UG/KG	2
VINYL CHLORIDE	670.00	670.00	UG/KG	1

Pit Two

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	.20	3.60	PCI/G	5
NP-237	.10	.40	PCI/G	5
PU-238	.10	.10	PCI/G	5
PU-239/240	.05	.60	PCI/G	5
RA-226	12.20	412.00	PCI/G	5
RU-106	2.00	35.00	PCI/G	5
SR-90	.30	1.00	PCI/G	5
TC-99	1.00	618.00	PCI/G	5
TH-228	.30	73.00	PCI/G	5
TH-230	1.20	3980.00	PCI/G	5
TH-232	.10	88.00	PCI/G	5
U-234	39.00	18200.00	PCI/G	5
U-235	1.00	8780.00	PCI/G	5
U-238	53.00	17900.00	PCI/G	5

Pit Three

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	8219.61	64100.08	MG/KG	7
ARSENIC, EP LEACHATE	514.00	3116.00	UG/L	4
ARSENIC, TOTAL	15.41	3049.06	MG/KG	7
BARIUM, TOTAL	251.19	14354.90	MG/KG	7
BERYLLIUM, TOTAL	2.76	24.01	MG/KG	6
CADMIUM, TOTAL	1.91	12.65	MG/KG	7
CALCIUM, TOTAL	53183.03	178241.20	MG/KG	7
CHROMIUM, TOTAL	16.38	151.84	MG/KG	7
COPPER, TOTAL	79.50	2332.66	MG/KG	7
IRON, TOTAL	10730.37	26919.20	MG/KG	7
LEAD, TOTAL	25.57	613.21	MG/KG	7
MAGNESIUM, TOTAL	21492.80	51570.00	MG/KG	7
MANGANESE, TOTAL	407.29	10570.89	MG/KG	7
MERCURY, EP LEACHATE	.25	7.23	UG/L	2
MERCURY, TOTAL	.45	4.01	MG/KG	4
NICKEL, TOTAL	22.34	503.97	MG/KG	7
POTASSIUM, TOTAL	810.24	2894.00	MG/KG	7
SELENIUM, EP LEACHATE	257.00	257.00	UG/L	1
SELENIUM, TOTAL	1.29	89.80	MG/KG	4
SILVER, TOTAL	3.54	8.11	MG/KG	4
SODIUM, TOTAL	1191.68	7640.00	MG/KG	7
SULFIDE	1.95	1.95	MG/KG	1
THALLIUM, TOTAL	5.89	12.21	MG/KG	2
VANADIUM, TOTAL	50.06	9695.51	MG/KG	7
ZINC, TOTAL	37.87	311.19	MG/KG	7

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Pit Three Organic Data Summary

Borehole Number	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure	Qualifier
03-02	FMP-PS-03-089	8704-145-0060	AROCLOR-1254	82.00	UG/KG	J
			BIS(2-ETHYLHEXYL)PHTHALATE	660.00	UG/KG	*
			DI-N-BUTYL PHTHALATE	84.00	UG/KG	J*
			ACETONE	91.00	UG/KG	J*
03-03	FMP-PS-03-008	8704-121-0010	AROCLOR-1254	140.00	UG/KG	J
			PENTACHLOROPHENOL(2)	1300.00	UG/KG	J
			BIS(2-ETHYLHEXYL)PHTHALATE	250.00	UG/KG	J*
			ACETONE	150.00	UG/KG	J*
			N-NITROSODIPHENYLAMINE(1)	130.00	UG/KG	J
03-04	FMP-PS-03-028	8704-121-0080	BIS(2-ETHYLHEXYL)PHTHALATE	480.00	UG/KG	J*
			AROCLOR-1254	550.00	UG/KG	J
			PENTACHLOROPHENOL(2)	630.00	UG/KG	J
			ACETONE	130.00	UG/KG	J*
03-05	FMP-PS-03-051	8704-145-0010	ACETONE	98.00	UG/KG	J*
			DI-N-BUTYL PHTHALATE	84.00	UG/KG	J*
			BIS(2-ETHYLHEXYL)PHTHALATE	280.00	UG/KG	J*
			AROCLOR-1254	100.00	UG/KG	J
03-06	FMP-PS-03-072	8704-145-0020	ACETONE	210.00	UG/KG	J*
			AROCLOR-1254	74.00	UG/KG	J
			DI-N-BUTYL PHTHALATE	84.00	UG/KG	J*
			BIS(2-ETHYLHEXYL)PHTHALATE	110.00	UG/KG	J*
03-07	FMP-PS-03-109	8704-180-0010	ACETONE	390.00	UG/KG	J*
			BENZO(B)FLUORANTHENE	110.00	UG/KG	J
			BENZO(A)ANTHRACENE	60.00	UG/KG	J
			CHRYSENE	75.00	UG/KG	J
			2-BUTANONE	3600.00	UG/KG	*
			METHYLENE CHLORIDE	420.00	UG/KG	*
			PYRENE	190.00	UG/KG	J
			BIS(2-ETHYLHEXYL)PHTHALATE	1100.00	UG/KG	*
			PHENANTHRENE	120.00	UG/KG	J
			FLUORANTHENE	230.00	UG/KG	J

J = Concentration is below quantification level; * = Common laboratory contaminant

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Pit Three Organic Data Summary

Borehole Number	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure	Qualifier
03-07	FMP-PS-03-109	8704-180-0010	AROCLOR-1254	140.00	UG/KG	J

J = Concentration is below quantification level; * = Common laboratory contaminant

Pit Three

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	.20	6.00	PCI/G	7
NP-237	.10	2.10	PCI/G	7
PU-238	.05	1.00	PCI/G	7
PU-239/240	.05	14.00	PCI/G	7
RA-226	3.10	369.00	PCI/G	7
RU-106	2.00	35.00	PCI/G	7
SR-90	.50	26.00	PCI/G	7
TC-99	1.00	1110.00	PCI/G	7
TH-228	1.00	82.00	PCI/G	7
TH-230	15.00	21900.00	PCI/G	7
TH-232	1.00	121.00	PCI/G	7
U-234	27.00	475.00	PCI/G	7
U-235	2.50	21.00	PCI/G	7
U-238	134.00	1380.00	PCI/G	7

Pit Four

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	3645.60	10325.99	MG/KG	5
ARSENIC, EP LEACHATE	582.00	582.00	UG/L	1
ARSENIC, TOTAL	4.63	4.63	MG/KG	1
BARIUM, EP LEACHATE	1023.00	81470.00	UG/L	3
BARIUM, TOTAL	444.03	6668.76	MG/KG	5
BERYLLIUM, TOTAL	13.30	13.30	MG/KG	1
CADMIUM, EP LEACHATE	141.00	141.00	UG/L	1
CADMIUM, TOTAL	1.92	28.72	MG/KG	3
CALCIUM, TOTAL	14252.84	61252.80	MG/KG	5
CHROMIUM, TOTAL	7.92	93.63	MG/KG	5
COBALT, TOTAL	84.06	84.06	MG/KG	1
COPPER, TOTAL	20.35	187.73	MG/KG	5
FLUORIDE	47812.36	124576.13	MG/KG	4
IRON, TOTAL	3045.60	16127.52	MG/KG	5
LEAD, EP LEACHATE	753.00	753.00	UG/L	1
LEAD, TOTAL	13.71	62.51	MG/KG	5
MAGNESIUM, TOTAL	11423.80	24251.31	MG/KG	5
MANGANESE, TOTAL	1383.43	3596.38	MG/KG	5
MERCURY, EP LEACHATE	1.06	1.06	UG/L	1
MERCURY, TOTAL	.18	.63	MG/KG	3
NICKEL, TOTAL	20.67	49.73	MG/KG	3
PHENOL	.43	.83	MG/KG	3
POTASSIUM, TOTAL	303.10	1920.00	MG/KG	4
SILVER, EP LEACHATE	2767.00	2767.00	UG/L	1
SILVER, TOTAL	2.59	443.65	MG/KG	4
SODIUM, TOTAL	254.90	1237.55	MG/KG	5
SULFIDE	.50	.50	MG/KG	1
VANADIUM, TOTAL	13.85	235.36	MG/KG	4
ZINC, TOTAL	13.92	84.06	MG/KG	5

Pit Four

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
ANTHRACENE	510.00	510.00	UG/KG	1
AROCLOR-1242	99.00	1034.00	UG/KG	2
AROCLOR-1248	460.00	854.00	UG/KG	2
AROCLOR-1254	1008.00	1008.00	UG/KG	1
BENZO(A)ANTHRACENE	750.00	750.00	UG/KG	1
BENZO(A)PYRENE	550.00	550.00	UG/KG	1
BENZO(B)FLUORANTHENE	510.00	510.00	UG/KG	1
BENZO(K)FLUORANTHENE	560.00	560.00	UG/KG	1
CHLOROFORM	430.00	1300.00	UG/KG	2
CHRYSENE	760.00	760.00	UG/KG	2
ETHYL PARATHION	82.00	860.00	UG/KG	3
FLUORANTHENE	1000.00	2200.00	UG/KG	3
MALATHION	670.00	670.00	UG/KG	1
METHYL PARATHION	370.00	2100.00	UG/KG	3
PHENANTHRENE	1000.00	2100.00	UG/KG	3
PYRENE	670.00	1400.00	UG/KG	3
TETRACHLOROETHENE	530.00	30000.00	UG/KG	2
TRICHLOROETHENE	300.00	300.00	UG/KG	1

Pit Four

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	.20	.50	PCI/G	4
NP-237	.10	.40	PCI/G	4
PU-238	.10	.50	PCI/G	4
PU-239/240	.10	.40	PCI/G	4
RA-226	5.00	20.00	PCI/G	4
RU-106	2.00	4.00	PCI/G	4
SR-90	.40	1.00	PCI/G	4
TC-99	6.80	225.00	PCI/G	4
TH-228	.30	24.00	PCI/G	4
TH-230	2.20	566.00	PCI/G	4
TH-232	.30	21.00	PCI/G	4
U-234	149.00	2320.00	PCI/G	4
U-235	35.00	426.00	PCI/G	4
U-238	509.00	15800.00	PCI/G	4

Pit Five

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	6373.77	15400.00	MG/KG	6
ANTIMONY, TOTAL	28.00	28.00	MG/KG	1
ARSENIC, EP LEACHATE	516.00	516.00	UG/L	1
ARSENIC, TOTAL	139.00	2800.00	MG/KG	6
BARIUM, EP LEACHATE	2260.00	3171.00	UG/L	2
BARIUM, TOTAL	15800.00	36938.95	MG/KG	7
BERYLLIUM, TOTAL	2.85	18.00	MG/KG	5
BERYLLIUM,TOTAL	8.80	8.80	MG/KG	1
CADMIUM, TOTAL	17.00	17.00	MG/KG	1
CADMIUM,TOTAL	4.40	4.40	MG/KG	1
CALCIUM, TOTAL	116000.00	206144.40	MG/KG	6
CHROMIUM, TOTAL	25.66	223.29	MG/KG	6
COBALT, TOTAL	16.00	43.99	MG/KG	3
COPPER, TOTAL	672.21	3370.00	MG/KG	6
IRON, TOTAL	10979.43	17900.00	MG/KG	6
LEAD, TOTAL	59.50	236.00	MG/KG	6
MAGNESIUM, TOTAL	25201.76	63200.00	MG/KG	6
MANGANESE, TOTAL	346.29	4740.00	MG/KG	6
MERCURY, EP LEACHATE	1.90	6.20	UG/L	3
MERCURY, TOTAL	.39	1.80	MG/KG	6
NICKEL, TOTAL	52.55	202.00	MG/KG	3
POTASSIUM, TOTAL	611.10	1490.00	MG/KG	6
SELENIUM, TOTAL	2.80	7.47	MG/KG	3
SILVER, TOTAL	8.18	9.40	MG/KG	2
SODIUM, TOTAL	1425.90	9980.00	MG/KG	6
THALIUM, TOTAL	2.80	2.80	MG/KG	1
VANADIUM, TOTAL	791.98	5380.00	MG/KG	6
ZINC, TOTAL	116.92	212.00	MG/KG	6

Pit Five

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
AROCLOR-1254	750.00	750.00	UG/KG	1

Pit Five

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	2.00	76.00	PCI/G	6
NP-237	.30	23.00	PCI/G	6
PU-238	.10	4.40	PCI/G	6
PU-239/240	.10	13.00	PCI/G	6
RA-226	235.00	999.00	PCI/G	6
RU-106	13.00	35.00	PCI/G	6
SR-90	.80	25.00	PCI/G	6
TC-99	428.00	2990.00	PCI/G	6
TH-228	41.00	191.00	PCI/G	6
TH-230	3080.00	20200.00	PCI/G	6
TH-232	21.00	90.00	PCI/G	6
U-234	310.00	1250.00	PCI/G	6
U-235	14.00	79.00	PCI/G	6
U-238	387.00	1230.00	PCI/G	6

Pit Six

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	4730.37	4730.37	MG/KG	1
ARSENIC, TOTAL	7.61	7.61	MG/KG	1
BARIUM, EP LEACHATE	1092.00	1092.00	UG/L	1
BARIUM, TOTAL	95.22	95.22	MG/KG	1
BERYLLIUM, TOTAL	2.00	5.73	MG/KG	2
CADMIUM, EP LEACHATE	251.00	251.00	UG/L	1
CADMIUM, TOTAL	.60	5.73	MG/KG	2
CALCIUM, TOTAL	22189.54	22189.54	MG/KG	1
CHROMIUM, TOTAL	4.80	29.74	MG/KG	4
COBALT, TOTAL	26.09	26.09	MG/KG	1
COPPER, TOTAL	13.00	222.02	MG/KG	4
IRON, TOTAL	2749.88	2749.88	MG/KG	1
LEAD, EP LEACHATE	1894.00	1894.00	UG/L	1
LEAD, TOTAL	5.00	59.62	MG/KG	4
MAGNESIUM, TOTAL	32101.13	32101.13	MG/KG	1
MANGANESE, TOTAL	34.96	34.96	MG/KG	1
MERCURY, TOTAL	.03	.07	MG/KG	3
NICKEL, TOTAL	7.70	51.39	MG/KG	4
POTASSIUM, TOTAL	913.15	913.15	MG/KG	1
SILVER, EP LEACHATE	2068.00	2068.00	UG/L	1
SILVER, TOTAL	158.10	158.10	MG/KG	1
SODIUM, TOTAL	600.07	600.07	MG/KG	1
VANADIUM, TOTAL	100.18	100.18	MG/KG	1
ZINC, TOTAL	4.80	51.00	MG/KG	4

Pit Six

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
1,1,2,2-TETRACHLOROETHANE	29000.00	29000.00	UG/KG	1

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Pit Six

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	4.00	31.00	PCI/G	4
NP-237	.90	4.50	PCI/G	4
PU-238	.40	1.40	PCI/G	4
PU-239/240	4.00	15.00	PCI/G	4
RA-226	16.00	30.00	PCI/G	4
RU-106	35.00	35.00	PCI/G	4
SR-90	.50	4.00	PCI/G	4
TC-99	84.00	164.00	PCI/G	4
TH-228	.20	2.00	PCI/G	4
TH-230	14.00	41.00	PCI/G	4
TH-232	.20	1.20	PCI/G	4
U-234	2000.00	5330.00	PCI/G	4
U-235	350.00	1750.00	PCI/G	4
U-238	12500.00	18700.00	PCI/G	4

Burn Pit

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	2911.89	11935.61	MG/KG	7
ARSENIC, TOTAL	4.38	20.91	MG/KG	4
BARIUM, EP LEACHATE	1252.00	4291.00	UG/L	7
BARIUM, TOTAL	56.23	7097.22	MG/KG	6
BERYLLIUM, TOTAL	1.45	16.38	MG/KG	2
CADMIUM, TOTAL	1.33	34.84	MG/KG	4
CALCIUM, TOTAL	10114.49	116321.92	MG/KG	7
CHROMIUM, TOTAL	7.87	87.52	MG/KG	7
COBALT, TOTAL	22.22	104.11	MG/KG	2
COPPER, TOTAL	12.25	166.54	MG/KG	7
IRON, TOTAL	3746.90	17444.92	MG/KG	7
LEAD, TOTAL	6.68	52.58	MG/KG	7
MAGNESIUM, TOTAL	3859.06	57078.97	MG/KG	7
MANGANESE, TOTAL	119.19	1717.27	MG/KG	7
MERCURY, EP LEACHATE	.21	.32	UG/L	3
MERCURY, TOTAL	.14	.24	MG/KG	3
NICKEL, TOTAL	8.91	59.73	MG/KG	5
POTASSIUM, TOTAL	485.94	1451.80	MG/KG	7
SELENIUM, TOTAL	1.91	1.91	MG/KG	1
SILVER, TOTAL	6.84	506.05	MG/KG	2
SODIUM, TOTAL	355.52	1265.14	MG/KG	5
VANADIUM, TOTAL	14.09	289.53	MG/KG	7
ZINC, TOTAL	14.53	74.66	MG/KG	7

Burn Pit

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
2-METHYLNAPHTHALENE	50.00	50.00	UG/KG	1
AROCLOR-1016	290.00	290.00	UG/KG	1
AROCLOR-1242	290.00	290.00	UG/KG	1
AROCLOR-1248	200.00	200.00	UG/KG	1
AROCLOR-1254	1957.00	2700.00	UG/KG	2
BENZO(A)ANTHRACENE	61.00	64.00	UG/KG	2
BENZO(B)FLUORANTHENE	69.00	170.00	UG/KG	4
BENZO(G,H,I)PERYLENE	85.00	85.00	UG/KG	1
CHRYSENE	73.00	77.00	UG/KG	2
ETHYLBENZENE	270.00	270.00	UG/KG	1
FLUORANTHENE	74.00	220.00	UG/KG	4
PENTACHLOROPHENOL(2)	1200.00	2600.00	UG/KG	2
PHENANTHRENE	100.00	190.00	UG/KG	3
PHENOL	650.00	650.00	UG/KG	1
PYRENE	79.00	140.00	UG/KG	3
TETRACHLOROETHENE	260.00	260.00	UG/KG	1
TOTAL XYLENES	890.00	890.00	UG/KG	1

Burn Pit

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	.20	.60	PCI/G	6
NP-237	.10	.70	PCI/G	6
PU-238	.10	.50	PCI/G	6
PU-239/240	.10	.40	PCI/G	6
RA-226	2.00	3.90	PCI/G	6
RU-106	2.00	2.00	PCI/G	6
SR-90	.50	.90	PCI/G	6
TC-99	.40	64.00	PCI/G	6
TH-228	.10	9.60	PCI/G	6
TH-230	.10	26.00	PCI/G	6
TH-232	.10	7.70	PCI/G	6
U-234	9.90	415.00	PCI/G	6
U-235	.50	27.00	PCI/G	6
U-238	22.00	454.00	PCI/G	6

Clear Well

Inorganic

Compound	Minimun Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
ALUMINUM, TOTAL	12939.30	23770.50	MG/KG	4
ARSENIC, TOTAL	8.41	18.46	MG/KG	4
BARIUM, EP LEACHATE	1222.00	2613.00	UG/L	3
BARIUM, TOTAL	733.35	6913.40	MG/KG	4
BERYLLIUM, TOTAL	9.10	9.10	MG/KG	1
CADMIUM, TOTAL	5.11	7.15	MG/KG	2
CALCIUM, TOTAL	129304.89	183078.02	MG/KG	4
CHROMIUM, TOTAL	41.17	76.05	MG/KG	4
COBALT, TOTAL	18.34	18.34	MG/KG	1
COPPER, TOTAL	194.61	1119.30	MG/KG	4
CYANIDE, TOTAL	9.18	9.18	MG/KG	1
IRON, TOTAL	19618.07	21066.50	MG/KG	4
LEAD, TOTAL	32.26	83.00	MG/KG	4
MAGNESIUM, TOTAL	16784.64	44629.00	MG/KG	4
MANGANESE, TOTAL	761.15	1660.41	MG/KG	4
MERCURY, EP LEACHATE	.32	1.25	UG/L	4
MERCURY, TOTAL	.42	4.38	MG/KG	4
NICKEL, TOTAL	46.62	66.95	MG/KG	2
POTASSIUM, TOTAL	1690.00	3653.28	MG/KG	4
SELENIUM, TOTAL	3.72	3.72	MG/KG	1
SILVER, TOTAL	3.30	3.30	MG/KG	1
SODIUM, TOTAL	1293.44	3501.06	MG/KG	4
VANADIUM, TOTAL	99.70	2596.10	MG/KG	4
ZINC, TOTAL	81.81	194.35	MG/KG	4

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Clear Well

Organic

Compound	Minimun Concentration	Maximum Concentration	Unit Of Measure	No. Of Measurements
AROCLOR-1248	308.00	308.00	UG/KG	1
AROCLOR-1254	737.00	737.00	UG/KG	1

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Clear Well

Radiochemistry

Compound	Minimum Activity Concentration	Maximum Activity Concentration	Unit Of Measure	No. Of Measurements
CS-137	18.00	450.00	PCI/G	4
NP-237	.40	2.70	PCI/G	4
PU-238	.10	.10	PCI/G	4
PU-239/240	.10	.10	PCI/G	4
RA-226	21.60	458.00	PCI/G	4
RU-106	3.00	24.00	PCI/G	4
SR-90	1.30	26.00	PCI/G	4
TC-99	.40	278.00	PCI/G	4
TH-228	.20	41.00	PCI/G	4
TH-230	.30	5600.00	PCI/G	4
TH-232	.10	39.00	PCI/G	4
U-234	242.00	376.00	PCI/G	4
U-235	24.00	49.00	PCI/G	4
U-238	548.00	670.00	PCI/G	4

APPENDIX D

D.1 DRILLING PROCEDURES

Soil borings are made to determine the nature, arrangement, thickness and extent of the soil strata. The depth of borings, frequency, and the type of testing and sampling required are dependent upon the purpose of the subsurface investigation.

Borehole advancement for monitoring wells will be performed using cable tool drilling techniques. The use of mud rotary or continuous flight hollow stem augers is prohibited for monitoring wells. A soil auger drilling rig will be used to collect undisturbed soil samples in clay layers that may be found in the till. With the cable tool techniques, the hammer is used to dislodge the soils and mix them with potable water for recovery and removal from the hole. Cable tool borehole drilling will be performed in accordance with Section 2.2.5, Percussion Drilling Borehole Advancement, IT Manual of Practice, Subsurface Investigations.

Comments from the IT Manual of Practice, Subsurface Investigations pertinent to the cable tool drilling technique follow:

- When advancing the boring using cable tool drilling techniques, a temporary steel casing will be drilled, driven, or pushed as the borehole is advanced. The temporary casing will be nominal ten-inch diameter to allow for construction of the monitoring well. Cuttings will be removed from the borehole using a sand pump or dart valve bailer.

- During the process of drilling monitoring wells, disturbed soil samples will be collected. Disturbed samples will be collected with a split-barrel or split-spoon sampler in accordance with ASTM D1586.

- Relatively undisturbed soil samples will be collected with thin-walled tubes or Shelby tubes in accordance with ASTM D1587. These samples will be collected with a soil auger drill rig. The soil auger drill rig will only be used for borings to collect samples for geochemical and geotechnical purposes. Undisturbed samples are not being collected from borings for monitoring wells because the heavy blows from cable tool (percussion) drilling will result in significant densification of cohesionless soils and remolding of cohesive soils, which will adversely affect sampling and testing operations.

- Drilling operations shall be performed in such a manner to minimize the introduction of contaminants into the subsurface soil and ground water. Accordingly, only clear, potable water will be used as a drilling fluid and only as a last resort. Water samples will be collected from the on-site source and each water tank hose and analyzed for the full list of organic, inorganic, and radiological parameters. If possible, all drilling operations will be performed dry without the use of water.

- The source(s) of any water to be used in drilling, grouting, and well and/or piezometer installation must be approved prior to field operations. Water used in aid of drilling will be analyzed and results reviewed prior to introduction into the borehole.

- Field Activity Daily Logs (Figure D-1) will be completed daily to indicate drilling and sampling activities such as footage drilled, materials used, etc. Boring logs (Figure D-2) will be generated to document subsurface conditions.

- The abandonment of borings and wells will be approved by the project director prior to any casing removal or sealing/backfilling. Once approved, these borings and/or wells shall be sealed by grouting from the bottom of the boring or well to ground surface. This shall be done by placing a grout pipe to the bottom of the boring or well and pumping grout through this until undiluted grout flows from the boring or well at ground surface. The grout shall consist of Volclay grout mixed properly with the recommended activator. After the grout has set (about 72 hours), the contractor shall check the abandoned site for grout settlement.

FIELD ACTIVITY DAILY LOG

PROJECT NAME	PROJECT NO.
FIELD ACTIVITY SUBJECT:	
DESCRIPTION ON DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:
PERSONNEL ON SITE:	
SUPERVISOR:	DATE:

FIGURE D-1

Any depression in the grout shall then be filled with additional grout. Methods other than those set forth herein may be implemented as dictated by appropriate state and/or local agencies.

- The use of dug sumps is not allowed. The use of drums or a plastic-lined, above-ground holding structure is required for cuttings and water removed from the borehole.

- No dyes, tracers, or other substances shall be used or otherwise introduced into borings, wells, piezometers, grout, backfill, ground water, or surface water unless specifically required by the contract.

- Drilling equipment that enters a boring will be cleaned using a high-pressure, hot-water sprayer between borings to prevent cross-contamination.

- Each operating drill rig shall have a geologist assigned to it who will be responsible for logging the samples, preparing the boring logs (Figure D-2) and well sketches, and installing the well. No geologist will be responsible for more than one operating rig per project site or installation involving soil sampling, rock coring, or monitoring well installation functions.

- Soils will be sampled continuously to the base of the till, then at five-foot intervals or at every lithologic change thereafter. These samples are to be obtained with a driven split-spoon or pushed thin-wall Shelby tube sampler or both in each boring. A sufficient number of continuous cores will be completed to adequately characterize the geology of the site.

The contractor shall be responsible for securing any and all boring or well drilling permits required by state or local authorities and for complying with any and all state or local regulations with regard to the submission of well logs, samples, etc.

The contractor shall also be responsible for complying with any and all regulations (to include placement) for drilling safety and underground utility detection.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER:	PROJECT NAME:	
BORING NUMBER:	COORDINATES:	DATE
ELEVATION:	GWL: Depth Date/Time	DATE STARTED:
ENGINEER/GEOLOGIST:	Depth Date/Time	DATE COMPLETED:
DRILLING METHODS:		PAGE OF

DEPTH (') (')	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (')	RECOVERY (') (')	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS

NOTES

FIGURE D-2

D.2 MONITORING WELL/PIEZOMETER DESIGN AND INSTALLATION

To provide proper quality control of monitoring well design and installation, the following standard operating procedures have been set forth, along with the applicable forms, to successfully complete a field drilling investigation that obtains hydrogeological and future water quality information.

All field measurements and comments will be recorded on the appropriate forms (Figures D-3 through D-7). Per data reporting format and protocols, all lines on the forms will be completed. The letter designation "NA" for not applicable or "NK" for not known will be used in all blank spaces. Also acceptable is a neat and precisely drawn arrow through applicable spaces from an "NA" or "NK." If some steps or procedures were not performed as described, the reason must be stated as completely as possible on the appropriate form or submitted as an attachment thereto.

All monitoring wells/piezometers will use the following design and materials:

- Well casing will be four-inch inside diameter, 316 stainless steel with flush-thread joints for monitoring wells.
- Five, ten, and fifteen foot sections of commercial 0.01-inch-slot stainless steel screens will be used (minimum three square inches open area per foot of screen).
- Screen gravel pack material will be a well-sorted medium or coarse quartz sand. A representative sample will be retained for documentation.
- Sodium bentonite pellets and Volclay grout will be used in the backfill for 1000- and 2000-series wells. Only Volclay grout will be used in 3000- and 4000-series wells. Samples of all grouts will be retained for documentation.
- Wells (1000 and 2000 series) will be backfilled with a sand pack to a height of two to four feet above the screen, then a five foot bentonite pellet plug will be placed on top of the sand pack and, finally, grout to the surface. The 3000- and 4000-series wells will be

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME _____ FIELD ENG./GEO. _____ DATE _____
PROJECT NO. _____ CHECKED BY _____ DATE _____
BORING NO. _____
PIEZOMETER NO. _____ DATE OF INSTALLATION _____

BOREHOLE DRILLING

DRILLING METHOD _____	TYPE OF BIT _____
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE _____	RISER PIPE MATERIAL _____
DIAMETER OF PERFORATED SECTION _____	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. _____ I.D. _____
SLOTS ☐ HOLES ☐ SCREEN ☐	LENGTH OF PIPE SECTIONS _____
AVERAGE SIZE OF PERFORATIONS _____	JOINING METHOD _____
TOTAL PERFORATED AREA _____	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH _____	OTHER PROTECTION _____
PROTECTIVE PIPE O.D. _____	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE				
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE				
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP	BOTTOM	TOP	BOTTOM
BENTONITE	TOP	BOTTOM	TOP	BOTTOM
SAND	TOP	BOTTOM	TOP	BOTTOM
GRAVEL	TOP	BOTTOM	TOP	BOTTOM
PERFORATED SECTION	TOP	BOTTOM	TOP	BOTTOM
PIEZOMETER TIP				
BOTTOM OF BOREHOLE				
GWL AFTER INSTALLATION				

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

FIGURE D-3

DATE						
TIME						
PAGE ___ OF ___						
PAGE						

FERNALD RI/FS

PIEZOMETER SENSITIVITY TEST

PROJET NAME _____ TESTED BY _____ DATE _____

PROJECT NO. _____

BORING NO. _____

PIEZOMETER NO. _____

TEST TRIAL NO. _____

GWL BELOW TOP OF PIPE PRIOR TO TEST _____ (M-scope, 0.01 foot accuracy

TIME READING TAKEN _____

THE PIEZOMETER WAS FILLED WITH WATER. THE FOLLOWING DATA SHOW THE DROP OF WATER FROM THE TOP OF THE PIPE AS TIME ELAPSED.

ELAPSED TIME (MINUTES)	DROP OF WATER (FEET)

BASED ON THE ABOVE DATA, IT IS CONCLUDED THAT THE PIEZOMETER IS:

_____ FUNCTIONING PROPERLY

_____ NOT FUNCTIONING PROPERLY

FIGURE D-4

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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)										
	ELEVATION OF WATER LEVEL - FEET										
	# EL (2)	# EL	# EL	# EL	# EL	# EL	# EL	# EL	# EL	# EL	# EL

FIGURE D-5

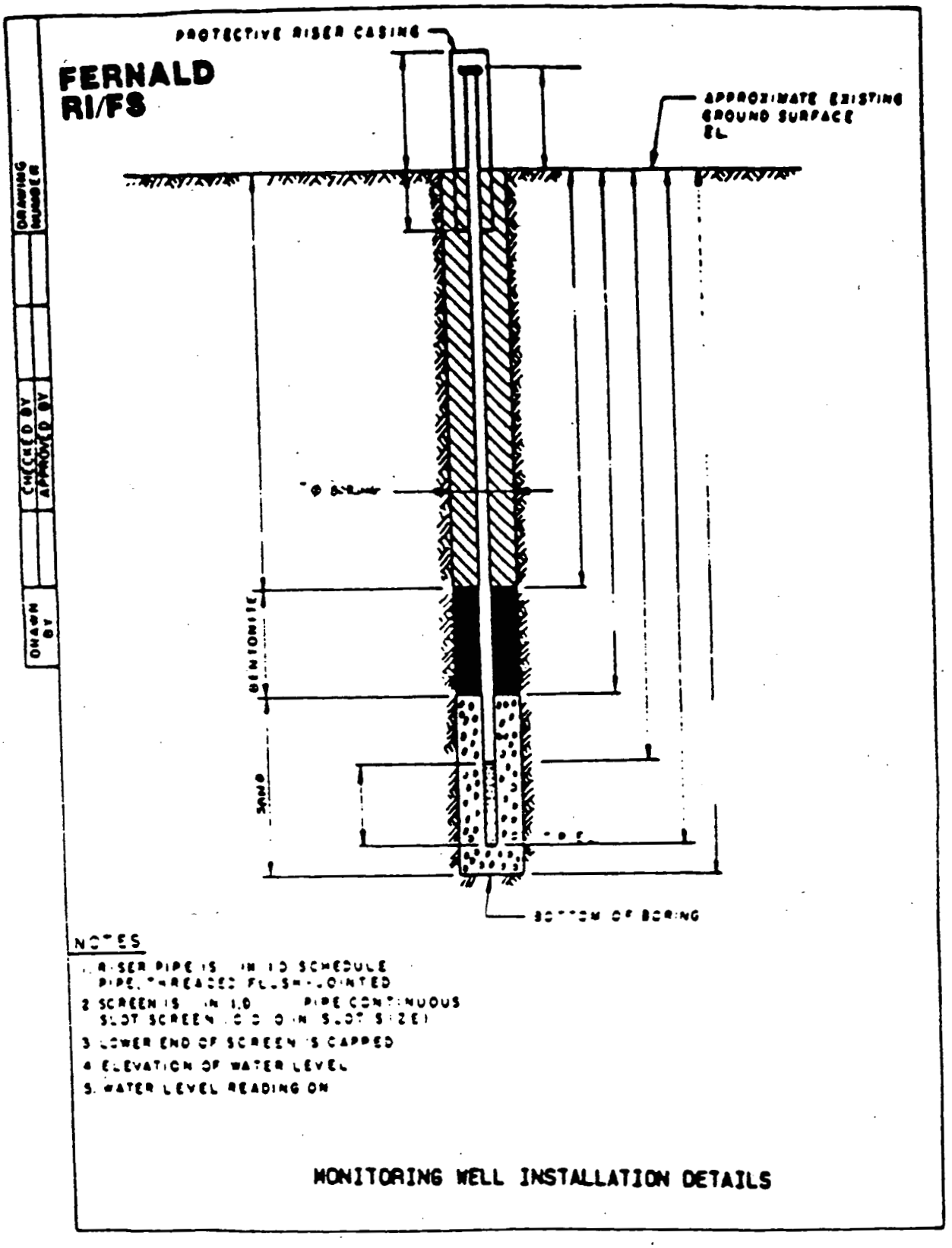
FERNALD
RI/FS
PROTECTIVE RISER CASING
APPROXIMATE EXISTING GROUND SURFACE EL
BENTONITE
SAND
BOTTOM OF BORING
DRAWING NUMBER
CHECKED BY
APPROVED BY
DRAWN BY
NOTES
1. RISER PIPE IS IN I.D SCHEDULE PIPE, THREADED FLUSH-JOINTED
2 SCREEN IS IN I.D PIPE CONTINUOUS SLOT SCREEN
3 LOWER END OF SCREEN IS CAPPED
4 ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON
MONITORING WELL INSTALLATION DETAILS

FIGURE D-6

PAGE ___ OF ___

PAGE

FMPC RI/FS
MONITORING WELL COMPLETION CHECKLIST
PROJECT 602

WELL NUMBER

ITEM											COMMENTS.
1. A steel protective casing with steel lid and hasp welded to casing has been installed with a lock.											
2. The protective casing has been painted satisfactorily.											
3. The well identification no. has been welded into the top of the protective casing.											
4. The well I.D. number has been painted with enamel type paint on the inside of the lid of the protective casing.											
5. The grout seal has been installed in the annulus between the well riser and the outer protective casing to a height of about 6" above ground surface.											
6. A weep hole has been drilled through the protective casing at the proper location.											
7. A 3 foot by 3 foot by 4 inch concrete pad has been installed around the protective casing.											
8. The disturbed area around the well has been regraded as per project specifications.											
9. The well riser is finished with a vented stainless steel cap.											
10. A measuring point notch is filed on the top of the well riser for vertical control.											
11. 3" diameter steel posts, located 4' radially around the well, placed 2' below the ground and having 4' minimally above the ground are concreted in place.											

Y - YES
N - NO
NA - NOT APPLICABLE

DATE: _____

SIGNED: _____

FIGURE D-7

backfilled with a sandpack to a height of five feet above the screen and then grouted to the surface. The grout will consist of a slurry of American Colloid Company Volclay grout. A sample of the backfill material will be collected for analysis to identify the presence of contaminants of interest.

- Annular space grout seals will be composed of a Volclay grout mixed with potable water and activator as per manufacturer's instructions.

- All grout material will be placed using pumps and tremie line methods.

- A five-foot length (minimum thickness 1/4 inch) of ten-inch inside diameter black iron pipe will be used as a protective casing. Each protective casing will be fitted with a hinged cap, hasp, and lock. A drain hole will be drilled in the oversleeve one foot above the land surface.

- A mixture of approximately 1:2 cement:sand and approved water will be placed between the well riser and the outer protective casing to a height just below the drain hole mentioned above. This design will allow water which enters the annulus to drain.

- The top of the inside casing will be finished with a vented stainless steel cap or an airtight cap and a vent hole not more than six inches from the top of the casing.

- All wells and piezometers will be identified with a number welded into the lid of the protective casing. All protective casings will be painted high-visibility orange.

- A measuring point notch will be filed on the inner casing of each well and will be identified on the notes and well sketches.

- All disturbed drilling areas will be regraded and restored to near original conditions upon completion.

A one-quart or one-liter representative sample of each type of proposed granular backfill shall be submitted by the contractor for approval prior to use. Each sample shall be described in terms of lithology, grain size distribution, and source (both company from whom purchased and pit or quarry of origin). This

material shall be clean, inert, and siliceous. Typically, graded sand meeting the requirements of ASTM C-33 for fine aggregate (concrete sand) is sufficient.

A sketch of any well installation (see Figures D-8 and D-9) including piezometers, shall be recorded and shall show (by depth from surface grade) the bottom of the boring, screen location, granular backfill, seals, grout, cave-in, centralizers, if used, and height of riser above ground surface. The actual composition of the grout, seals, and granular backfill shall also be recorded. Also indicated shall be the screen, slot size (in inches), and slot configuration. Any use of polyvinylchloride (PVC) solvents, glues, or cleaners is prohibited.

Well sketches shall also include details of the protective casing.

Protective casing shall be installed around all monitoring wells. Exceptions will be on a case-by-case basis, as determined. Minimum elements in the protection design include:

- A five-foot minimum length of black 10-inch-diameter iron pipe or galvanized pipe extending approximately 2.5 feet above the ground surface and set in Volclay grout and concrete apron.
- A locking cover and lock shall be provided and secured to the top of each protective casing.
- The location identification shall be labeled on the well protector in two places using two methods: (1) painted on the inside of the cover with enamel type paint; and (2) welded into the top of the locking cover. Location identification shall conform with format and shall be designated by the site manager.
- The cover must keep precipitation out of the protective casing and shall be secured to that casing with a padlock.
- All padlocks at a given site shall be able to be opened by the same key.
- Protective casings are to be painted high-visibility orange.

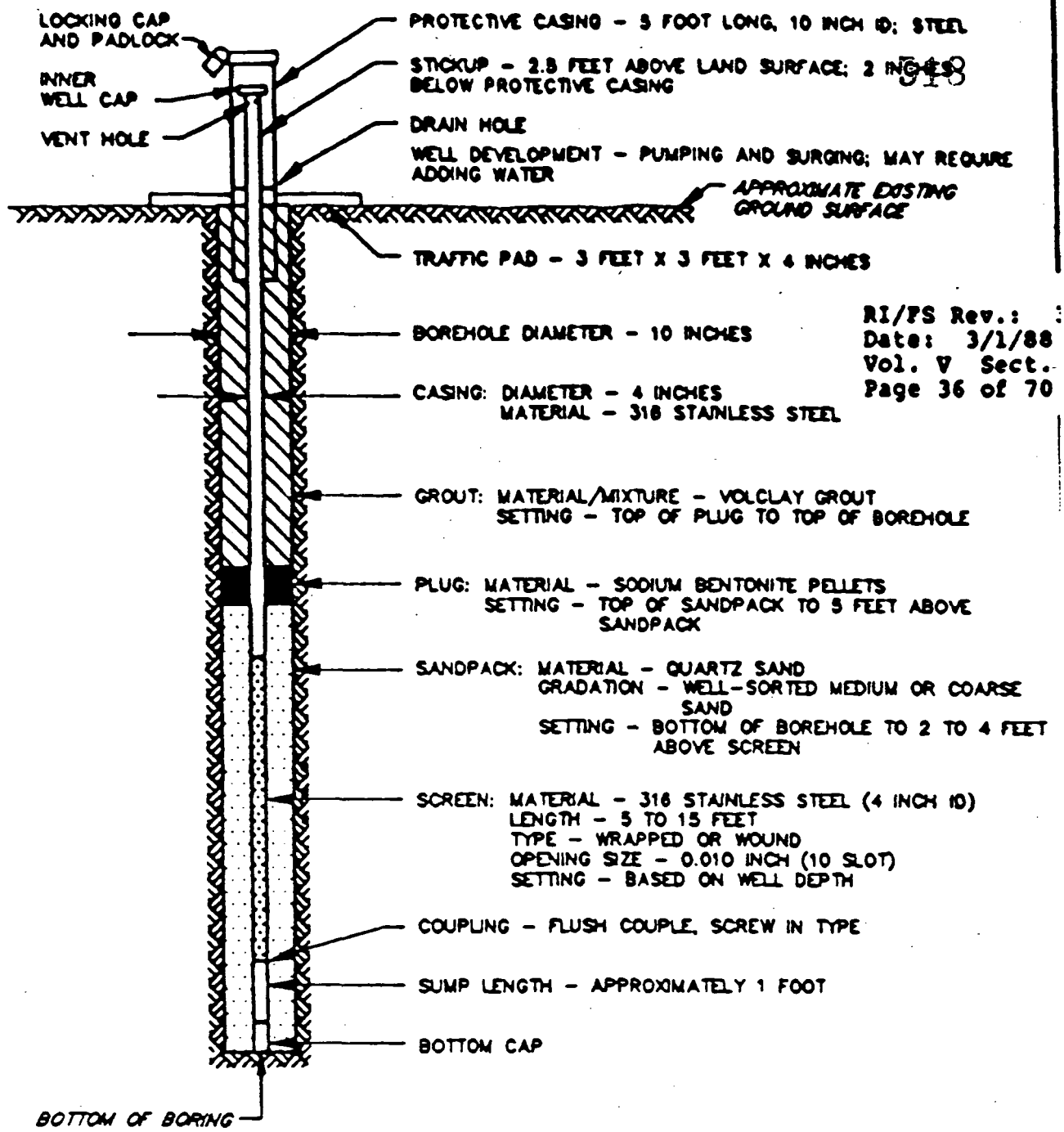

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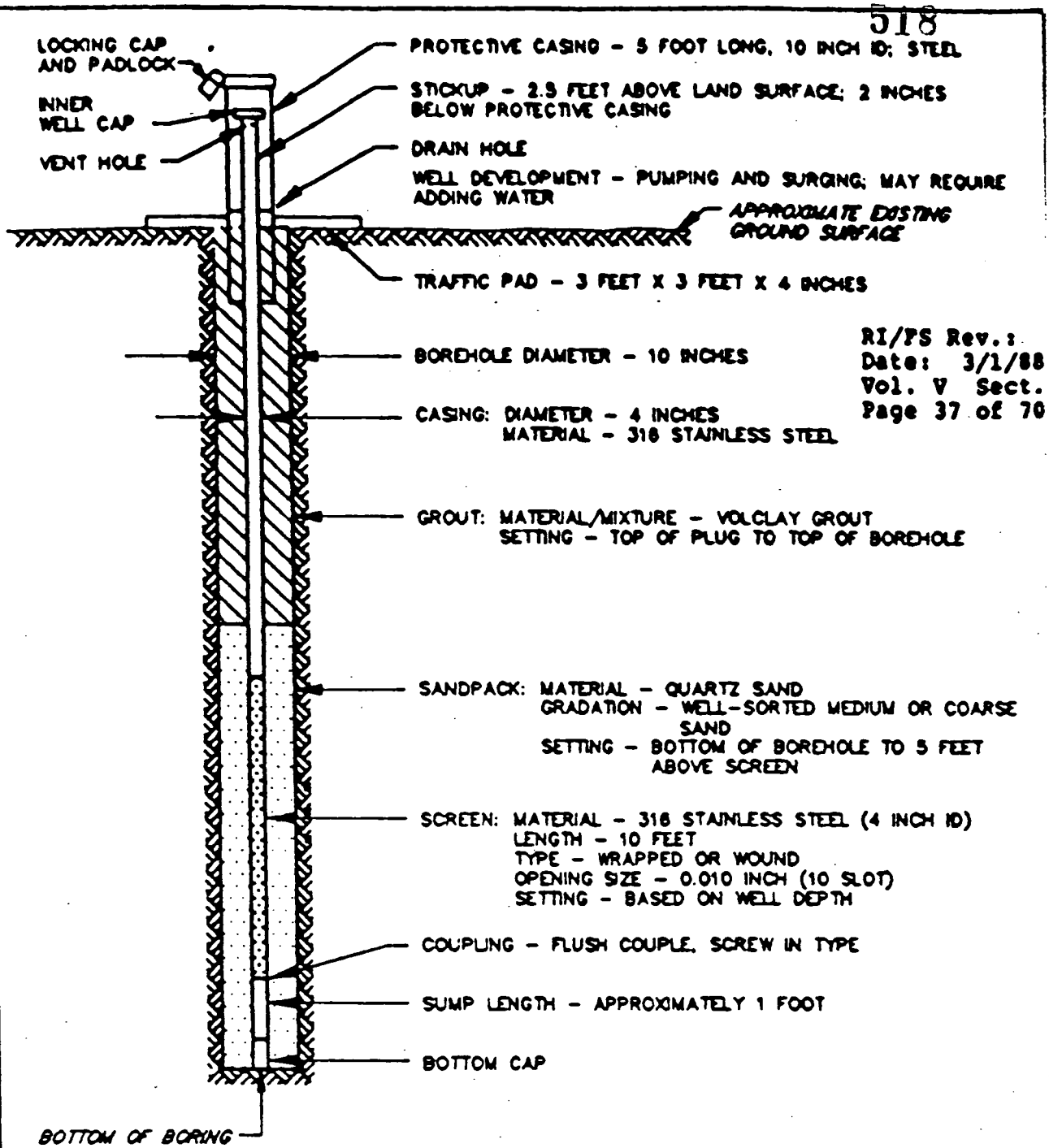
FIGURE D-8

SUMMARY OF SPECIFICATIONS FOR WELL COMPLETION
100- AND 200- SERIES WELLS



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DRAWN BY | R. Wilkin 1-18-88 | CHECKED BY | APPROVED BY | 3/25/88 | 3/25/88 | DRAWING NUMBER 303317-A17

FIGURE D-9

SUMMARY OF SPECIFICATIONS FOR WELL COMPLETION
300- AND 400- SERIES WELLS

- Three-inch diameter steel posts, each radially located four feet around each well, placed two feet below ground surface, concreted in place (optional), and having four feet minimum above ground surface.

Once the boring has been advanced to the desired depth, the well/piezometer will be constructed by the following procedure:

- Place the desired length of screen and casing inside the temporary casing.
- Place the sand pack in the annular space between the screen/casing and temporary casing.
- Withdraw the temporary casing slowly while placing sand pack material.
- After placing the sand pack to a level of at least two feet but not more than four feet above the screen, a five-foot-thick bentonite pellet layer (only for 100- and 200-series wells) is placed on top of the sand pack as the temporary casing continues to be withdrawn slowly. Periodic measurements will be made to check the uniform placement of the sand pack.
- The remaining annular space will be filled to the surface using Volclay grout.
- The temporary casing will be removed gradually as the backfill materials are placed in such a manner that the bottom of the temporary casing is kept below the top of the backfill material.
- The protective casing will be installed and concreted in place.
- A three-foot by three-foot by four-inch concrete apron will be installed around the protective casing.

D.3 MONITORING WELL DEVELOPMENT

The following procedure is presented for the proper development of monitoring wells and piezometers for ground water sampling purposes.

All field measurements and comments will be recorded on the appropriate data reporting form (Figure D-10). All lines on the form will be completed. The letter designation "NA" for not

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TASK 3.2

MONITORING WELL DEVELOPMENT

PAGE ___ OF ___

WELL NUMBER _____

DATE(S) OF WELL INSTALLATION _____

WELL DEVELOPMENT START DATE/TIME _____ COMPLETION DATE/TIME _____ 518

		BEFORE DEVELOPMENT	AFTER DEVELOPMENT
STATIC WATER LEVEL			
DEPTH OF OPEN HOLE			
CHANGES IN PHYSICAL CHARACTER OF WATER REMOVED	TURBIDITY		
	COLOR		
	PARTICULATES		
	ODOR		

TOTAL CALCULATED VOLUME OF WATER TO BE REMOVED (IN GALLONS) _____

TOTAL VOLUME OF WATER ACTUALLY REMOVED DURING DEVELOPMENT (GALLONS) _____

TYPE AND SIZE OF PUMP _____ TYPE AND SIZE OF BAILER _____

PHYSICAL CHARACTER OF REMOVED SEDIMENTS (LITHOLOGY AND GRAIN SIZE)

DESCRIPTION OF SURGE TECHNIQUES (IF USED)

METER CALIBRATION

pH TEMP	pH STD.	pH STD.	SPECIFIC CONDUCT.	uMHOS/CM	uMHOS/CM	TURBIDITY NTU	TURBIDITY NTU

METER MODEL/ SERIAL NO.	pH METER	SPECIFIC CONDUCTANCE METER	TURBIDITY METER	DISSOLVED OXYGEN METER

FIELD ENGINEER/GEOLOGIST _____ DATE _____

DRILLER/HELPER _____

CHECKED/VERIFIED BY _____ DATE _____

MAYDEV (2/88)

FIGURE D-10

DATE AND TIME SAMPLE COLLECTED	GALLONS OF WATER PURGED FROM WELL	TEMP.	SPECIFIC CONDUCTANCE	pH	DO	TURBIDITY	REMARKS

REMARKS/OBSERVATIONS

FIGURE D-10

(CONTINUED)

applicable or "NK" for not known will be used in all blank spaces. Also acceptable is a neat and precisely drawn arrow through applicable spaces from an "NA" or "NK." If some steps or procedures are not performed as described, the reason must be stated as completely as possible on the appropriate form or submitted as an attachment.

Monitoring well development will be performed as soon as possible after well installation, but no sooner than 48 hours after grouting is completed.

Well development equipment may include, but is not limited to, bailers, surge blocks, pumps, and hoses. Equipment and materials used for well development will be properly decontaminated the same way as drilling equipment, before and between each use. Decontamination will normally be high-pressure hot-water washing (steam cleaning) of equipment used to develop the well. However, if, during well development, the equipment becomes visibly contaminated, decontamination will be a high-pressure/hot-water wash, methanol wash followed by two separate deionized water rinses. In the case of visible inorganic contaminants (visibly contaminated with soil/sediment) decontamination will be high-pressure/ hot-water wash, dilute-hydrochloric-acid wash followed by two separate deionized water rinses. The internal mechanisms of pumps will be flushed using either dilute solutions of methanol and deionized water or dilute hydrochloric acid and deionized water when contaminants are visible. Development shall be continued with a sump and/or bottom discharge bailer, possibly supplemented with a surge block, until the well water is clear and sediment within the well is removed to the fullest extent practical. The natural hydraulic conductivity of the formation should have been restored and foreign sediment removed to provide turbid-free ground water samples. If the well continues to yield turbid ground water samples, the "Decision Chart for Turbid Ground-Water Samples" procedure described in the TEGD will be followed in an attempt to

achieve turbidity-free water. The recommended acceptance/ rejection value of five nephelometric turbidity units (NTU) is based on the need to minimize biochemical activity and possible interferences with ground water sample quality. As a minimum:

- For those wells where the boring was made without the use of drilling fluid water, remove five times the standing water volume in the well (well screen and casing plus saturated annulus). Should recharge be so slow that five volumes could not be removed in one day or the water remains discolored or contains greater than one percent particulates after this five volume removal, the hydrogeology task leader will direct an alternate procedure based on the judgment of the field geologist.

- For those wells where the boring was made or enlarged with the use of drilling fluid (water), remove five times the measured amount of total fluids lost while drilling plus five times the standing water volume as above. The same procedure also applies here as above for cases of slow recharge, discolored, or particulate-laden water.

- No water will be added to the well to assist development without prior approval. No dispersing agents, acids, or disinfectants will be used.

- During development, an effort will be made to remove the standing water from points near the bottom of the well screen as well as from the top of the water column.

- If problems are encountered during development, the task leader will be promptly notified by telephone.

- The volume of water collected for analysis will depend on the analytical needs of the project.

The following data will be recorded on the Monitoring Well Development form (Figure D-16) as part of development:

- Well designation (location ID);

- Date(s) of well installation;

- Date(s) and time of well development;

- Static water level before and after development;

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TASK 3.2

MONITORING WELL DEVELOPMENT

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WELL NUMBER _____

DATE(S) OF WELL INSTALLATION _____

WELL DEVELOPMENT START DATE/TIME _____ COMPLETION DATE/TIME _____

		BEFORE DEVELOPMENT	AFTER DEVELOPMENT
STATIC WATER LEVEL			
DEPTH OF OPEN HOLE			
CHANGES IN PHYSICAL CHARACTER OF WATER REMOVED	TURBIDITY		
	COLOR		
	PARTICULATES		
	ODOR		

TOTAL CALCULATED VOLUME OF WATER TO BE REMOVED (IN GALLONS) _____

TOTAL VOLUME OF WATER ACTUALLY REMOVED DURING DEVELOPMENT (GALLONS) _____

TYPE AND SIZE OF PUMP _____ TYPE AND SIZE OF BAILER _____

PHYSICAL CHARACTER OF REMOVED SEDIMENTS (LITHOLOGY AND GRAIN SIZE)

DESCRIPTION OF SURGE TECHNIQUES (IF USED)

METER CALIBRATION

pH TEMP	pH STD.	pH STD.	SPECIFIC CONDUCT.	uMHOS/CM	uMHOS/CM	TURBIDITY	
						NTU	NTU

METER MODEL/ SERIAL NO.	pH METER	SPECIFIC CONDUCTANCE METER	TURBIDITY METER	DISSOLVED OXYGEN METER

FIELD ENGINEER/GEOLOGIST _____ DATE _____

DRILLER/HELPER _____

CHECKED/VERIFIED BY _____ DATE _____

MWDEV (2/88)

FIGURE D-16

DATE AND TIME SAMPLE COLLECTED	GALLONS OF WATER PURGED FROM WELL	TEMP.	SPECIFIC CONDUCTANCE	pH	DO	TURBIDITY	REMARKS

REMARKS/OBSERVATIONS

FIGURE D-16

(CONTINUED)

- Quantity of water removed and time of removal;
- Depth of open hole inside the well before and after development;
- Physical character of the removed water, to include changes during development of turbidity, color, and odor;
- Physical character of removed sediments, to include lithology and grain size;
- Type and size/capacity of pump and/or bailer used;
- Description of surge techniques, if used; and
- Field characteristics of water removed including pH, specific conductance, temperature, and dissolved oxygen.

APPENDIX E

E.1 GROUND WATER SAMPLING TECHNIQUES

The primary consideration in ground water sampling is to obtain a representative sample of the ground water body. To safeguard against collecting nonrepresentative stagnant water from a well or piezometer, the following guidelines and techniques should be observed during sample withdrawal:

- As a general rule, all monitoring wells will be pumped or bailed prior to collecting a sample. Evacuation of at 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 E-1) will be completed. For instance, samples for HSL volatile organic compounds, pH, specific conductance, and temperature will be collected first. Parameters which are not sensitive to pH or volatilization should 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 ground water 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 (gpm) 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 as specified below.

- If drawdown is significant, the submersible pump will be lowered during purging to keep the pump five to ten feet below the water level in the casing and the pumping rate will

DATE						
TIME						
PAGE ___ OF ___						
PAGE						

FERNALD RI/FS

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 E-1

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 visibly 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.

  - As described above, the equipment shall be thoroughly rinsed with two deionized water rinses to remove traces of hydrochloric acid, detergent, and methanol (acetone may be substituted for methanol if volatile organic compounds are not being determined).

  - 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.

- Existing wells with limited access will be sampled from the pump discharge.

- 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 using blue ice or other approved, sealed cooling materials.

- Samples will be properly labeled and chain-of-custody records, water quality field collection report (Figure E-1), sample collection log, and laboratory request for analysis forms will be properly filled out.

E.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 should 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. 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.

  - 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, a chain-of-custody record, a laboratory request for analysis form, and a sample label 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 during shipment, sealed, and transported to the laboratory.

. Acid and Base-Neutral Extractable Compounds and Pesticides/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.

- 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, a chain-of-custody record, a laboratory request for analysis form, and a sample label 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 during shipment, sealed, and transported to the laboratory.

- Dissolved Metals

  - When it is desired to determine concentrations of dissolved metals in a water system, the sample should be filtered in the field, as soon as possible after collection, through 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 should 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 is 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, a chain-of-custody record, a laboratory request for analysis form, and a sample label will be completed in the field. All of these forms, except for the sample collection log, will accompany the sample to the laboratory.

- General Chemistry Parameters

  - Sample bottles will be either polyethylene or glass and will contain the appropriate chemical preservatives. Sample bottle closures will be plastic with 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.

  - 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 an ice chest filled with blue ice and maintained at approximately 4 degrees Celsius.

- Samples will be properly labeled and sample collection logs, chain-of-custody records, and laboratory request for analysis form will be properly completed.

• Radionuclide Parameters

- In general, samples for radionuclide analyses can be collected in the same manner as samples for other chemical analyses.

- Flush sample lines 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.)

- Floating debris and bottom sediments will be avoided when sampling surface waters. Avoid suspended sediments when sampling ground water.

- The pump or Teflon bailer will be decontaminated in accordance with the procedures in Appendix D, Ground Water Sampling Techniques, to minimize contamination of subsequent samples.

- Water samples will be filtered in the field through an 0.45-micron membrane filter as soon as possible after sample collection when dissolved radionuclides are to be determined. Containers without preservative will be used to initially collect samples prior to filtration. Transfer samples 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 and chain-of-custody records, sample collection logs, and laboratory request for analysis forms will be properly completed.

E.1.2 WATER LEVEL MEASUREMENTS

The following procedures should be followed for collecting water level data from wells:

- Obtain permission from owner to measure water level in well if required off site.

- In the case of domestic wells, ask the owner not to use water for short time so pump does not activate and affect water level. Make sure water level is stable.

- Remove well cap if an access hole is not available. (Be sure not to take water-level measurements in the riser pipe from the pump discharge line.)

- Lower M-scope probe until water is reached (this will be indicated by a buzzer, meter needle deflection, or light); raise probe above the water level and slightly shake; then lower again and recheck. Be careful not to get tangled with electrical wiring from pump, if present.

- Note depth to water to 0.01 foot from the measuring point, i.e., top of casing, top of sanitary seal.

- Enter water level and measuring point in log with date and time or on Figure E-2, Piezometer Data Sheet.

- Replace cover on well.

E.2 FIELD ANALYTICAL PROCEDURES FOR GROUND WATER 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 E-1). 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. Ground water field measurements may also be taken in

FERNALD
RI/FS

PIEZOMETER DATA SHEET

PAGE ____ OF ____
PAGE

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 E-2

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situ (downhole) to avoid changes which might occur if the sample is removed from the well.

E.2.1 TEMPERATURE

Scope and Application

The temperature of surface and ground water 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 are 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 measured in two-degree intervals is used.

Measurement Practices

- Temperature readings should be taken immediately after sample collection on unpreserved samples.
- Readings should be taken until two identical values are obtained.
- The average readings for each sample will be documented immediately on field measurement or collection forms.

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.

E.2.2 pH

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; and
  - pH 10.0.
- A metal-cased direct-reading thermocouple with a normal range of zero to 50 degrees Celsius 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.

E.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.

Apparatus

- Conductivity cell or probe;
- Conductivity meter; and
- 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 field measurement form.

- 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.

E.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 surface and ground water 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; and
- A metal-cased, direct-reading thermocouple with a normal range of zero to 50 degrees Celsius 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 field measurement form (Water Quality Field Collection Report, Figure E-1).
- 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.

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
CIS	Characterization Investigation Study
DOE	U.S. Department of Energy
EP	Extraction Procedure
EPA	Environmental Protection Agency
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
ft/day	Feet per day
ft/ft	Foot per foot
GQAPO	Groundwater Quality Assessment Program Outline
gpd/ft	Gallons per day per foot
GPR	Ground Penetrating Radar
HSL	Hazardous Substances List
MSL	Mean Sea Level
MW	Monitoring Well
OS	Offsite
PCB	Polychlorinated Biphenyl
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
SC	Specific Conductance
SW-2	Southwestern Ohio Water Company - Collector No. 2
T*	T-statistic
T_c	T-statistic (comparison)

T_m	T-statistic (monitoring)
T_b	T-statistic (background)
TEGD	Technical Enforcement Guidance Document
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TP	Test Pit
U.S. EPA	United States Environmental Protection Agency
W_b	Weighting factor (background)
W_m	Weighting factor (monitoring)
WMCO	Westinghouse Materials Company of Ohio

REFERENCES

(1) WMCO, RCRA Part A Permit Application for the FMPC, Revision No. 4, dated September 21, 1987.

(2) WMCO, FMPC Response to Items B - B5 of RCRA Section (FFCA), dated October 16, 1987 (Revised: January 23, 1987).

(3) WMCO, FMPC Response to Items A.1 of RCRA Section (FFCA), dated August 17, 1986 (Revised: January 21, 1987).

(4) Dames & Moore, RCRA Groundwater Monitoring Report - 1987, Volume 5 - Round 5, dated November, 1987.

(5) U.S. EPA, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD), OSWER-9950.1, dated 1986.

(6) Dames & Moore, RCRA Groundwater Monitoring Report - 1987, Volume 3 - Round 3, dated March, 1987.

(7) Davis, S. N. and DeWiest, R. J., Hydrogeology, John Wiley & Sons, New York, 1966.

(8) ASI, Work Plan - Remedial Investigation and Feasibility Study, FMPC, Revision 3, dated March 1988.

(9) Dames & Moore, Groundwater Study - Task C Report, dated July, 1985.

(10) Roy F. Weston, Inc., Characterization Investigation Study, Volume 1: Geophysical Survey, dated September 1987.

(11) WMCO, Groundwater Quality Assessment Program Plan For Waste Pit No. 4, dated November 1987.

(12) ASI, Quality Assurance Project Plan - Remedial Investigation and Feasibility Study, FMPC, Revision 3, dated March 1, 1988.