2902

ON-SITE DISPOSAL FACILITY BORROW AREA STRATEGY REPORT

SOIL AND DISPOSAL FACILITY PROJECT

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EXECUTIVE SUMMARY

This Borrow Area Strategy Report (BASR) presents the updated strategy for developing, managing, and restoring the On-Site Disposal Facility (OSDF) borrow area. This updated strategy is based on information obtained during borrow activities for construction of clay liners and other components for OSDF Cells 1 through 3, and a revised estimate of the OSDF maximum size from nine to seven cells. This information and the revised size affect the estimated quantity of required borrow material. This report also outlines the incremental restoration strategy planned for the borrow area.

In this report, the required borrow material quantities are estimated based on construction of the OSDF with seven cells. The major borrow material quantities include: clay liner and cap material; ordinary borrow material for compacted fill, backfill, and vegetative soil cover; and topsoil. Borrow material sources were identified based on geotechnical investigations conducted during the initial design phase. The geotechnical investigations were used to characterize the material, estimate shrinkage/bulking and other factors, and determine available quantities of different materials (clay, silt, sand, etc.). In the initial design, and as proposed herein, the primary source for borrow material was proposed to be the brown till from the east side of the east field borrow area (EFBA). In accordance with the original design, the west side of the EFBA will continue to be reserved as a contingency borrow area. The brown till is a clay material overlying a gray till stratum. Only brown till will be used as clay liner and cap material. This decision was made during the initial design and was based on results of a test pad program that demonstrated the suitability of the brown till for use as clay liner and cap material in the OSDF liner and cover systems.

The clay liners for OSDF Cells 1, 2 and 3 were constructed during the 1997-1999 construction seasons. Material for the clay liner in Cell 1 and approximately 25 percent of the clay liner in Cell 2 was obtained from excavation within the OSDF footprint area. The remainder of the clay liner material for Cell 2 and Cell 3 was obtained from the east side of the EFBA. During initial borrow activities for the Cell 1 liner, more rock particles were encountered in the clay material than expected; these rocks were initially picked and removed by hand. However, this was inefficient and led to safety concerns. Therefore, during the remainder of Cell 1 and during Cell 2 and 3 clay liner construction, the borrow material was screened to remove the rock. Screening ensured the borrow material conformed to project requirements.

The screening process generated clayey rockfill material, which consisted of rock particles and clods that did not conform to the clay liner and cap requirements. In addition, more non-conforming material (i.e., material with high levels of organic material, sand, and silt and material that did not conform to technical specifications for clay liner and cap material) was encountered than expected when the clay liner material was excavated. As a result, a greater overall volume of borrow material was needed to provide the required quantities of clay liner and cap material than originally estimated.

This BASR presents a plan to obtain the required borrow material from the east side of the EFBA. Brown till will be used for the OSDF clay liners and caps, and will be excavated, screened, and stockpiled the year before it is scheduled for use to the extent possible. Both brown and gray till from the borrow area will be used for ordinary borrow material. The west side of the EFBA and an area north of the east side of the EFBA are reserved as contingency borrow areas.

The initial requirements and specific criteria for borrow area development and management were presented in the Design Criteria Package (DOE 1997a), Borrow Area Management and Restoration (BAMR) Plan (DOE 1997b), the OSDF Final Design Package, and OSDF Phase I and Phase II Certified-for-Construction (CFC) packages (DOE 1996a, 1997c. This BASR will be used to update the BAMR Plan, prepare future OSDF CFC packages, and serve as a general guide for future borrow area activities.

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LIST OF ACRONYMS AND ABBREVIATIONS

BAMR	Borrow Area Management and Restoration (Plan)
BASR	Borrow Area Strategy Report
bcy	bank cubic yard
CFC	Certified for Construction
DOE	U.S. Department of Energy
EFBA	East Field Borrow Area
FEMP	Fernald Environmental Management Project
FRL	final remediation level
GMA	Great Miami Aquifer
icy	in-place cubic yard
lbs/cf	pounds per cubic foot
OSDF	On-Site Disposal Facility
OU	Operable Unit
RI/FS	Remedial Investigation/Feasibility Study
SBF	Shrinkage/Bulking Factor
SER	South Entrance Road

GLOSSARY

Bank Cubic Yard (bcy) - A cubic yard of in-situ material in a natural condition.

Cell - One of the discrete disposal enclosures in the OSDF.

Clayey Rockfill - Non-conforming material generated during the clay screening process that does not pass through the screens. Consists primarily of soil clods and rock particles.

Clay liner and cap material – Brown till material that conforms to the performance requirements for clay liner (including intercell berm and clay wedge) and cap that are delineated in the technical specifications, based on conformance testing.

Conformance Testing - Geotechnical testing of screened material to determine if it meets the requirements for clay liner and cap material.

East Field Borrow Area (EFBA) - The southeast corner of the FEMP which was previously investigated and designated a borrow area. Consists of both an east side and a west side (i.e., eastern and western sides of the South Access Road, respectively). The east side of the EFBA is the primary borrow area described in this report. The west side of the EFBA is a contingency borrow area.

Fill Material – Brown or gray till material that will be used to construct the OSDF earthwork components, excluding the clay liner and clay cap.

Final Restoration – Final restoration in the borrow area consists of planting trees and final vegetation after borrow area excavation and interim restoration are completed in each subarea.

In-Place Cubic Yard (icy) – A cubic yard of material that is placed and compacted.

Interim Restoration – Interim restoration in the borrow area consists of final grading and establishing grass vegetation after borrow excavation is completed within each discrete subarea.

Liner Subgrade - Material located directly below the clay liner within the OSDF.

Non-Conforming Material – Non-conforming material does not conform to the performance requirements for clay liner and cap based on visual inspection, preconformance testing, or conformance testing. Non-conforming material may be used as ordinary borrow material if it meets the requirements of the technical specifications.

Non-Conforming Soil Factor – Percent of the total volume of material excavated in the borrow area that does not conform to the performance requirements of clay liner and cap material based on visual observation and/or preconformance testing.

Ordinary Borrow – Brown and/or gray till material suitable for compacted fill, backfill, and vegetative soil cover that meets requirements in the technical specifications. Excludes topsoil.

Pre-Conformance Testing - Geotechnical testing performed on material from the proposed borrow subarea prior to excavating. The CQC consultant will test the material to determine whether it will meet pre-conformance requirements for the clay liner and cap.

Pre-Conforming Material - Material that meets the pre-conformance testing requirements for the clay liner and cap.

Screened Material - Excavated material from borrow source that meets pre-conformance requirements and passes the screens.

Screener Reject Factor - Percent of the volume of material that is retained during the clay screening process. The factor is determined by dividing the volume of material that does not pass through the screens (i.e., clayey rockfill) by the total volume of material placed on the screens.

Shrinkage/Bulking Factor (SBF) – Percent of the average unit density (in lbs/cf) of material in the borrow area compared to the average unit density (in lbs/cf) in the OSDF.

Soil Factors – Percentages of material excavated (bcy) that impacts in-place volume (icy). Soil factors are specifically identified for shrinkage/bulking, screener reject, non-conforming soil, and wastage.

Subarea – Discrete area within the borrow area that will be developed during one construction season. The design limits of the subarea will be established in the CFC documents. The actual limits may be modified in the field based on actual conditions encountered; a subarea may be expanded to obtain sufficient quantities of clay liner and cap material if larger than anticipated quantities of non-conforming material are encountered.

Wastage Factor – Percent of the total volume of material excavated from the borrow area that may be wasted in material handling and will not be used for construction of the OSDF.

1.0 INTRODUCTION

Borrow material is required for constructing the On-Site Disposal Facility (OSDF) at the Fernald Environmental Management Project (FEMP). Initial borrow material estimates and a borrow area excavation strategy were prepared during the initial OSDF design and implemented during the 1997-1999 construction seasons. During these first three construction seasons, actual field data were obtained to verify, evaluate, and update the initial estimates. This report presents updated borrow material estimates for construction of the remaining four cell liner systems and seven cell cover systems, including revised estimates of required borrow material quantities, field data analyses obtained from the first three construction seasons, a summary of existing borrow area conditions, and an updated strategy to develop and restore the borrow area.

1.1 OBJECTIVE

The objective of this Borrow Area Strategy Report (BASR) is to present updated borrow quantity estimates and the strategy to develop, manage and restore the borrow area based on those estimates. This BASR will be used as a basis for updating the Borrow Area Management and Restoration (BAMR) Plan (DOE 1997b), preparing future OSDF Certified-for-Construction (CFC) package, and serving as a guide for future borrow activities.

1.2 GENERAL BORROW AREA STRATEGY

Borrow volume estimates for the remaining OSDF construction components presented in this report are based on the types of borrow required for the remaining four liner systems, and seven cover systems, the geotechnical analyses of on-site sources of the borrow, and field data obtained during construction. The three general types of required borrow material include:

- clay liner and cap material;
- ordinary borrow material; and
- topsoil.

Clay liner and cap material will be used in the liner and cover systems for each OSDF cell. Clay liner includes the material for the associated intercell berms and clay wedges.

Whenever possible, clay material will be excavated, screened and stockpiled one year before its placement in the OSDF to ensure it is available at the start of the construction season. This will minimize potential delays and ensure complete construction of a cell cap in one construction season. Clay cap

material will be required early in the construction of the OSDF cover system to allow time for placement of subsequent layers (i.e., biointrusion barrier, vegetative layer, etc.) later in the same construction season. Stockpiling materials will reduce impacts from adverse weather conditions; this will be critical during the years when both a clay liner and cap will be built. Stockpiling a year ahead of time will also provide time for adjustments if significant quantities of non-conforming material are encountered and the subarea must be expanded to obtain additional borrow material.

The OSDF Test Pad Program demonstrated that the brown till is suitable for clay liner and cap material in the OSDF if it meets the material and performance requirements in the technical specifications. During excavation for clay liner and cap material, non-conforming material will be encountered that cannot meet the material and performance requirements in the technical specifications and will not be suitable for use as clay liner and cap material. This non-conforming material may be used for ordinary borrow and/or topsoil if it meets the material requirements in the technical specifications.

Ordinary borrow material will be needed for backfill, compacted fill, and vegetative layer. This material will be used to backfill overexcavation of unsuitable subgrade, and construct berms at the perimeter of the OSDF cells, as well as to provide vegetative soil cover, fill for roads, and other compacted fill. This material must meet the technical specifications for backfill, compacted fill or vegetative layer. Ordinary borrow includes non-conforming clay material and may consist of either brown or gray till.

Topsoil from the borrow area will be used in the construction of the OSDF cover system. Topsoil will be stripped and stockpiled before excavating a new subarea in the borrow area, before clay liner and cap material are stockpiled on a subarea, and a new OSDF cell is constructed.

During initial OSDF design development, screening of borrow material was not considered. However, screening of borrow material was added during construction of the clay liner for Cell 1 to remove rock particles larger than two inches so the material would meet clay liner technical specifications. Screening was subsequently added as a requirement in the technical specifications (and used) for Cells 2 and 3 and will be specified for future cells. During borrow material screening, larger quantities of clayey rockfill (i.e., material that did not pass the screens) were generated than anticipated. As a result, additional borrow material volume must be excavated to obtain the necessary quantities of clay liner and cap material based on geotechnical testing results. Non-conforming material was also encountered during borrow material excavation. Borrow volume estimates for clayey rockfill and large quantities of

nonconforming material were not included in the original estimates because screening was not specified and quantities of non-conforming material was not expected to be significant. An updated estimate of total borrow volume is presented in this report and incorporated into the borrow area excavation and restoration strategy.

During construction of the first three cells, the majority of the required ordinary borrow material was obtained from the OSDF footprint area; the remainder was obtained from the OSDF borrow area. However, in the future, it is anticipated that ordinary borrow material will be obtained from the OSDF borrow area. This BASR is based on obtaining all required borrow material from the OSDF borrow area on the east side of the East Field Borrow Area (EFBA).

1.3 REPORT ORGANIZATION

Section 1 presents an introduction and overview of this report.

Section 2 summarizes existing conditions in the east side of the EFBA. This includes a description of the physical constraints in the area and the locations of the brown and gray till stratums.

Section 3 summarizes the estimated quantities of material required from the borrow area. This includes both estimated bank (i.e., in the borrow area) and in-place (i.e., in the OSDF) cubic yards as well as the factors that relate these two quantities.

Section 4 presents the conceptual borrow area development plan and the criteria that were used to develop the plan.

Section 5 presents restoration concept for the OSDF borrow area.

References are provided at the end of the report. Appendix A contains figures that present background and general information about the borrow area as well as conceptual excavation and restoration plans. Appendix B presents calculations, including volume estimates and field data from three previous construction seasons, the basis for estimating the soil factors, and calculations comparing original soil factors with actual data.

2.0 EXISTING CONDITIONS

The east side of the EFBA will be used as the source of OSDF borrow material. A geotechnical investigation of the area was performed during the Operable Unit (OU) 2 Remedial Investigation/ Feasibility Study (RI/FS) and the OSDF predesign investigation. The west side of the EFBA is designated as a contingency borrow area.

The east side of the EFBA is located in the southeast corner of the FEMP, as shown on Figure 2-1. It is bounded by the South Entrance Road (SER) to the west, the aesthetic barrier and Willey Road to the south, the Mid-Valley pipeline (and right-of-way) to the east, and the OSDF Borrow Area Sediment Basin to the northwest. The EFBA is not physically constrained on the eastern end of the north side; therefore, this area is a designated contingency borrow area. The northern limit of this contingency borrow area is south of the 24-inch diameter discharge line (i.e., GW-24) from the FEMP Advanced Wastewater Treatment Facility to the Great Miami River. Existing EFBA conditions (as of January 2000) are shown on Figure A-1 in Appendix A.

2.1 BACKGROUND INFORMATION

The EFBA was not disturbed by U.S. Department of Energy (DOE) material production operations. Except for the Trap Range, the area has been certified as below final remediation levels (FRLs). The Trap Range has been remediated and is expected to be certified to below FRLs by May 2000. Prior to construction activities (e.g., OSDF Borrow Area Sediment Basin construction, borrow excavation, Trap Range stabilization and excavation, etc.), the surface of the EFBA was covered with topsoil. The areas that have not been disturbed remain covered with topsoil. Generally, the subsurface material immediately below the topsoil consists of brown till to a depth of 10 to 20 feet. A gray till stratum is located below the brown till; the gray till ranges in thickness from 10 to 20 feet. The sand and gravel of the Great Miami Aquifer (GMA) are located beneath the gray till stratum. The estimated top of the gray till elevations and the estimated thicknesses (isopachs) of the gray till are shown on Figure A-2 in Appendix A.

The brown till was determined to be suitable for clay liner and cap during the OSDF test pad program. The gray till was not evaluated during the test pad program and therefore will not be used for clay liner and cap material; only brown till will be used for clay liner and cap material. Both brown and gray till will be used for ordinary borrow material.

During OSDF design, DOE made a commitment to the stakeholders that a minimum of 12 feet of gray till will be maintained below the OSDF. Although this commitment does not apply to other areas of the FEMP, the borrow excavation concept presented in this report maintains a minimum of 12 feet of gray till in the borrow area. The excavation grading plan for the EFBA is shown on Figure A-3 in Appendix A. The thickness of the gray till stratum and proposed excavation depths are shown on Figure A-4; as indicated on the figure, no borrow area excavation will be performed in areas where the gray till is estimated to be less than 15 feet thick.

Material for the Cell 1 clay liner and approximately 25 percent of the material for the Cell 2 clay liner were obtained from the OSDF footprint area. During construction of the liner systems for Cells 1, 2 and 3, ordinary borrow was also obtained from excavation in the OSDF footprint area. Also, very little unsuitable subgrade material was encountered; therefore, no borrow was needed to backfill unsuitable subgrade excavations. The east side of the EFBA was used to obtain the clay liner material for Cells 2 and 3.

The strategy presented in this report is based on obtaining all required borrow material to construct the remaining four liner systems, seven cover systems, and other components for the remainder of the OSDF from the east side of the EFBA.

2.2 EXISTING CONDITIONS

The proposed strategy and borrow area evaluation presented in this report are based on mapping developed from aerial photography flown in January 2000; the topography is shown on Figure A-1 in Appendix A. As shown on Figure A-1, the OSDF Borrow Area Sediment Basin and previous excavations have disturbed the northwest and western areas of the east side of the EFBA. Excavations have been performed to construct the Sediment Basin, borrow excavation for the clay liners for Cells 2 and 3, and the Trap Range stabilization and excavation. This work was performed in accordance with the original BAMR Plan and initial design documents. There are also stockpiles within the area, including two topsoil stockpiles, clay stockpile 99-4, and clayey rockfill stockpiles. These stockpiles will be removed before excavation of the subareas on which they are located. These subareas are described in the excavation plan presented in Section 4 of this report.

The OSDF Borrow Area Sediment Basin is located in the northwest corner of the EFBA. During development and restoration, the east side of the EFBA will drain through this basin. The bottom of the

basin is at Elevation 567 feet, the bottom low level outlet is at Elevation 570 feet, and the primary spillway is at Elevation 575 feet. Because it is a wet basin, the bottom of the basin does not gravity drain below Elevation 570 feet; to avoid pumping and/or excavating wet material, no borrow excavation is proposed below Elevation 570 feet. There are low level outlets (perforations in the pipe riser) between Elevations 570 feet and 575 feet. After rainfall events, the basin will fill to Elevation 575 feet before activating the principal spillway; therefore, excavation between Elevations 570 feet and 575 feet may be impacted by rainfall. Excavation of the borrow material from these Elevations (570 feet to 575 feet) will increase the capacity of the basin. The basin will provide storage capacity to manage runoff from the areas that will be disturbed on the east side of the EFBA.

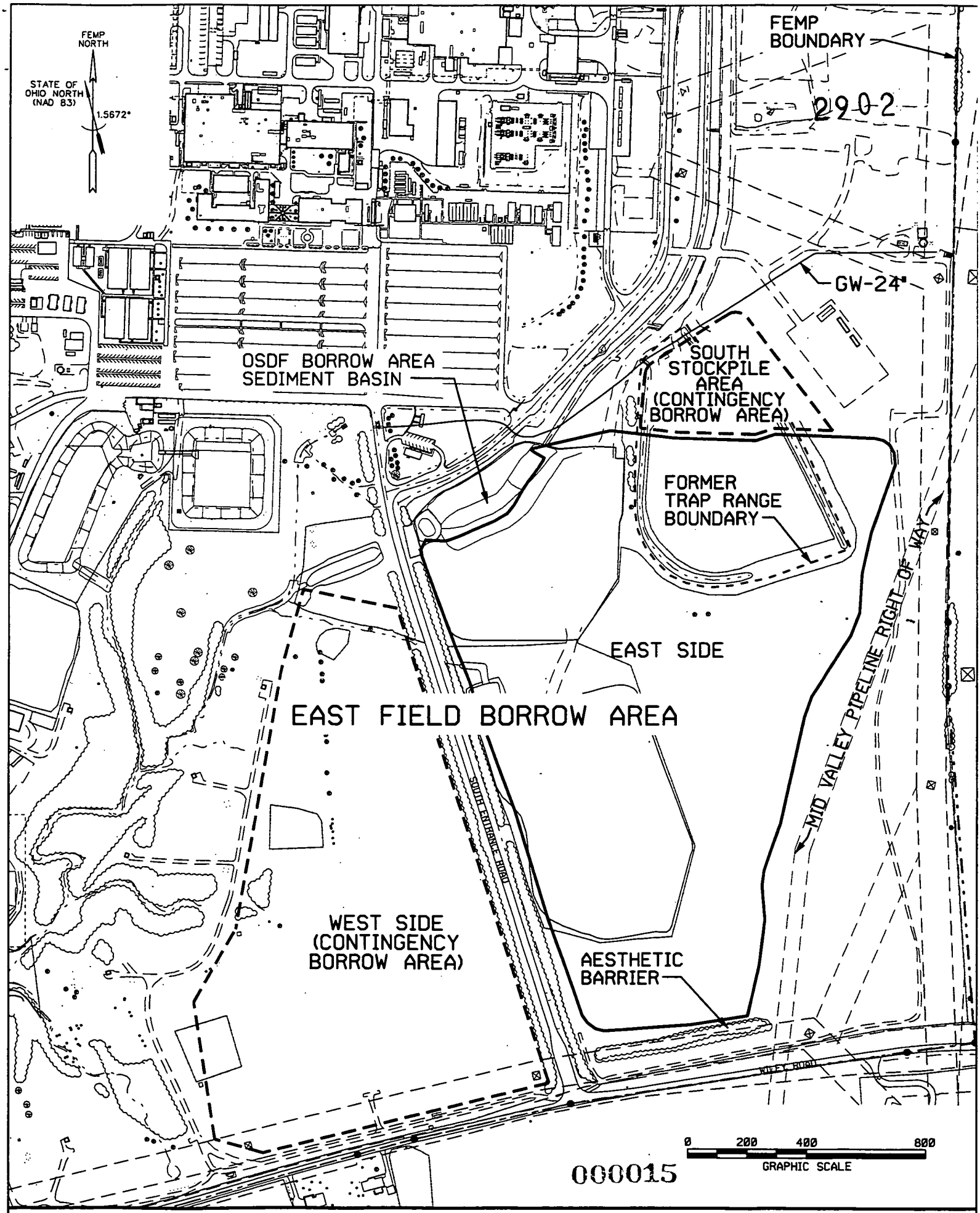

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FIGURE 2-1 EAST FIELD BORROW AREA LOCATION MAP

3.0 BORROW MATERIAL REQUIREMENTS

The borrow material quantity estimates are based on obtaining all clay liner and cap material, ordinary borrow material, and topsoil for future OSDF construction from the east side of the EFBA in calendar year 2000 and beyond.

3.1 BORROW MATERIAL REQUIREMENTS

Estimated in-place material quantities for various OSDF earthwork components are summarized on Table 3-1. The calculations supporting these estimated quantities are presented in Appendix B. The in-place estimated quantities and soil factors presented in this section were used to estimate required material quantities to be excavated from the east side of the EFBA.

3.2 SOIL FACTORS

Borrow material that is excavated from the borrow area may not be suitable for OSDF construction. Initial borrow area excavations demonstrated that a larger than anticipated volume of material must be excavated from the borrow area to provide the required quantity of material in the OSDF. Material in the borrow area is measured in bank cubic yards (bcy); material in the OSDF is measured as in-place cubic yards (icy). The major factors that affect the relationship between the two quantities include:

- shrinkage/bulking;
- screener reject;
- non-conforming soil; and
- wastage.

The above factors were evaluated based on geotechnical data, OSDF design documents, field data, and field observations. Sources of geotechnical data and design documents are listed in the reference section of this report. Field data and observations include:

- Earthwork and clay liner conformance and performance test results from construction of OSDF Cells 1 and 2;

- Field survey data for stockpiles of clayey rockfill (screener reject) materials, unsuitable soil from the OSDF and borrow area excavations from construction of OSDF Cell 1 and Cell 2; and

- Observations of excavation and screening operations during borrow and construction activities for Cells 1, 2, and 3.

Soil factors impacting quantities developed as part of this evaluation are discussed below.

- Shrinkage/Bulking Factor (SBF). The SBF in the design borrow volume calculations (reported in OSDF Final Design Calculation Package, DOE 1997a) was based on the Pre-Design Investigation and Site Selection Report for the On-Site Disposal Facility (DOE 1995), and the Geotechnical Data and Evaluation Report for East and South Field Borrow Areas (DOE 1996b). The SBF of 95.5 percent (95.5 bcy in the borrow area will bulk to 100 icy in the OSDF) was estimated in the OSDF Final Design Package (DOE 1997d). As described later in this section, this estimate is consistent with data available from borrow area excavations performed in 1999. This factor will be evaluated periodically, and adjusted as required, based on actual conditions encountered in the EFBA.

- Screener Reject Factor. Approximately 14 percent of the material placed on the screens will be rejected and classified as clayey rockfill. Because the clay liner and cap screening requirements were developed after preparation of the original design, screener reject was not considered during the original design. Calculations for the estimated screener reject factor are provided in Appendix B of this report. This factor will be evaluated periodically, and adjusted as required, based on actual conditions encountered in the EFBA.

- Non-Conforming Soil Factor. The non-conforming soil factor is estimated to be 12 percent. This soil will not be processed for consideration as clay liner and cap because of visual inspection and/or pre-conformance testing results. This estimate is based on the geotechnical investigation reports for the OSDF and EFBA, excavation of OSDF and EFBA during OSDF construction of Cells 1 and 2, and observations in the EFBA during excavation of clay material for the Cell 3 clay liner. Twelve percent is the weighted average of three areas excavated during previous construction seasons. These areas are the Cell 1 and the runon diversion ditch area; Cells 2 and 3 excavation area; and the north end of the EFBA. Non-conforming material was not expected to be a significant quantity in the original design and was not included in the original design. This weighted average calculation is provided in Appendix B to this report. During the 1999 construction season, higher silt and sand content and lower clay content were observed in the borrow material as the excavation proceeded from north to south. This trend may be an indication that the quantity of non-conforming material in the southern subareas may increase.

- Wastage Factor. The wastage factor for borrow volume wasted through spillage, erosion and/or handling from the OSDF excavation and the EFBA is estimated to be 2 percent based on the experience gained from the OSDF Cells 1, 2 and 3 construction. The wastage factor was not considered during the original design. This factor is included in the volume calculations presented in Appendix B of this BASR because of lessons learned in the past three construction seasons. This factor will be evaluated periodically, and adjusted as required, based on conditions encountered in the EFBA.

Table 3-2 presents a comparison summary of the soil factors considered in the OSDF Final Design to those resulting from this evaluation.

The original SBF of 95.5 percent is consistent with data collected from completed borrow area excavation and subsequent Cell 3 clay liner construction in the OSDF. Calculations supporting this conclusion are presented in Appendix B.

The initial calculations for the SBF were made during the original OSDF design and are presented in Section 15 of Volume IV of the OSDF Final Design Calculation Package (DOE 1997e). The SBF is the volume weighted average of the estimated in-place dry unit weight of the fill materials in the OSDF compared to *in situ* dry unit weight in the borrow area. The estimated in-place dry unit weights of the OSDF components were based on the following estimated standard proctor compaction:

- clay liner and cap - 97 percent;
- vegetative soil - 90 percent; and
- compacted fill - 95 percent.

The OSDF Borrow Area was used to provide material for the clay liner in Cell 2 and all of the material for the clay liner in Cell 3. To date, no material from the OSDF Borrow Area has been used for vegetative soil or compacted fill. Therefore, no actual field data regarding compacted fill or vegetative layer material from the Borrow Area are available to calculate the average component density and compare it to the original calculation.

The average dry density of the clay liner in Cell 3 is 119.1 pounds per cubic foot (lbs/cf); the average dry density of brown till in the borrow area is 122.0 lbs/cf. Based on these averages, the clay liner in Cell 3 is compacted to an average of 97.6 percent of the in situ unit weight in the OSDF Borrow Area. These calculations are presented in Appendix B. This is consistent with the estimated compaction of 97 percent for clay liner and cap component presented in the original calculations.

3.3 REQUIRED BORROW MATERIAL VOLUMES

The updated soil factors presented on Table 3-2 were used to estimate the required volume of borrow material (bcy) that must be excavated from the borrow area to provide the necessary in-place volumes (icy) presented in Table 3-1. The calculations that were made using these factors are presented in Appendix B. The impacts of these factors are discussed below.

- Clay liner and cap material. Based on the bulking, screener reject, non-conforming soil, and wastage factors, approximately 1.24 bcy of material must be excavated from the borrow area to produce 1 icy of clay liner or cap material in the OSDF. The non-conforming material will be stockpiled and may be used as ordinary borrow. The clayey rockfill generated by screening will be stockpiled within the excavation subarea and primarily used for interim restoration of the subarea.

- Ordinary borrow. Ordinary borrow will consist of material that meets the technical requirements for different materials and can be used for various components such as backfill for overexcavation of unsuitable subgrade, compacted fill for berms, vegetative layer, and other miscellaneous fill. To the extent possible, ordinary borrow will be obtained from the OSDF footprint area and supplemented with material from the EFBA. The amount of ordinary borrow that will not be able to be used is expected to be offset by the bulking component of the shrinkage/bulking factor; therefore, the factor for this material is estimated to be 1.0.

- Topsoil. Topsoil from the borrow area and the OSDF construction area will be stripped and stockpiled for later use in the OSDF cover system. No significant shrinkage and/or bulking is expected to occur. The estimated wastage factor for this material is 2 percent. Therefore, approximately 1.02 bcy of topsoil must be excavated to provide 1.0 icy in the OSDF.

The soil factors described above and presented on Table 3-2 were used to calculate the quantity of material that must be excavated from the borrow area to provide the in-place quantities presented in Table 3-1. As shown on Table 3-3, an estimated 902,000 bcy of material are to be excavated from the borrow area.

The proposed excavation grades for the eastern side of the EFBA are shown on Figure A-3 of this report. Excavation to these grades will produce approximately 917,000 bcy. This available volume exceeds the estimated required material volume of 902,000 bcy presented on Table 3-3. Therefore, there appears to be sufficient volume on the east side of the EFBA to complete construction of seven cells. This conclusion may change if actual field conditions are significantly different than those described in this report.

3.4 CONTINGENCY BORROW

The borrow volume estimates presented in this report are based on soil factors that may change based on conditions encountered in the field. For example, if significantly more non-conforming material is encountered than currently estimated, and/or an additional cell is required, additional borrow material may be required. Therefore, two contingency borrow areas have been identified and are shown on Figure 2-1.

The two designated contingency borrow areas shown on Figure 2-1 are the footprint of the South Stockpile Area to the north of the proposed borrow area, and the west side of the EFBA. The designation of the west side of the EFBA as a contingency borrow area may be removed if a few years of excavation on the east side confirm the estimates in this report and indicate there is sufficient material on the east side to satisfy OSDF construction requirements. The South Stockpile Area will continue to be a designated contingency borrow area.

TABLE 3-1
ESTIMATED IN-PLACE VOLUMES OF BORROW MATERIAL FOR OSDF CONSTRUCTION
(for Calendar Year 2000 and beyond)

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Totals
1. Backfill for Unsuitable Subgrade	Complete	Complete	Complete	10,000	10,000	10,000	10,000	40,000
2. Compacted Fill	Complete	Complete	Complete	17,000	24,000	15,000	20,000	76,000
3. Miscellaneous Fill	Complete	Complete	Complete	11,000	5,000	5,000	5,000	26,000
4. Clay Liner	Complete	Complete	Complete	37,000	37,000	37,000	37,000	148,000
5. Clay Wedge	Complete	Complete	Complete	4,000	4,000	4,000	8,000	20,000
6. Contouring Layer	12,000	11,000	11,000	11,000	11,000	11,000	12,000	79,000
7. Clay Cap	26,000	24,000	24,000	24,000	24,000	24,000	26,000	172,000
8. Vegetative Cover Soil	36,000	27,000	27,000	27,000	27,000	27,000	36,000	207,000
9. Topsoil	8,000	7,000	7,000	7,000	7,000	7,000	8,000	51,000
Totals	82,000	69,000	69,000	148,000	149,000	140,000	162,000	819,000

Notes:
1. All volumes are in-place cubic yards (icy) as measured in-place in the OSDF.
2. See Appendix B for quantity calculations.

TABLE 3-2
COMPARISON OF ORIGINAL AND UPDATED SOIL FACTORS FOR REQUIRED BORROW VOLUME CALCULATIONS

Soil Factors	OSDF Final Design	Updated
1. Shrinkage/Bulking Factor	95.5%	95.5%
2. Screener Reject Factor	Not included	14%
3. Non-Conforming Soil Factor	Not included	12%
4. Wastage Factor	Not included	2%

TABLE 3-3
ESTIMATES OF BORROW REQUIRED TO OBTAIN IN-PLACE VOLUMES

OSDF Component	In-Place Volume (icy)	Factor	Borrow Volume (bcy)
1. Backfill for Unsuitable Subgrade (Cells 4-7)	40,000	1.0	40,000
2. Compacted Fill (Cells 4-7)	76,000	1.0	76,000
3. Miscellaneous Fill (Cells 4-7)	26,000	1.0	26,000
4. Clay Liner (Cells 4-7)	148,000	1.24	184,000[1]
5. Clay Wedge (Cells 4-7)	20,000	1.24	25,000[1]
6. Contouring Layer (Cells 1-7)	79,000	1.0	79,000
7. Clay Cap (Cells 1-7)	172,000	1.24	213,000[1]
8. Vegetative Soil Cover (Cells 1-7)	207,000	1.0	207,000
9. Topsoil (Cells 1-7)	51,000	1.02	52,000
Totals	819,000		902,000[1]

[1] Material that does not conform to the requirements for clay liner and cap may be suitable for ordinary borrow material and topsoil; this non-conforming quantity is estimated to be approximately 41,000 cubic yards (12 percent of Items 4, 5 and 7). Use of this non-conforming material as ordinary borrow material and topsoil will reduce the required borrow volume. If all of this material is suitable for ordinary borrow, the required borrow volume will be reduced from 902,000 cubic yards to 861,000 cubic yards.

4.0 BORROW AREA EXCAVATION

This section presents the general excavation strategy for the borrow area. This strategy will be further developed in the revised BAMR Plan and the future OSDF CFC documents. Implementation details will be presented in the Contractor's Borrow Area Management and Restoration Work Plan.

The borrow area will be developed in accordance with the following general criteria.

- Minimize area disturbed at any one time
- Reach final excavation grade and restore disturbed areas as soon as possible
- Perform interim restoration in an incremental manner
- Manage surface water and provide erosion and sediment controls.

In addition to the above, the Contractor will be required to:

- Manage stockpiles, and
- Maintain access to and from, within the borrow area.

The borrow area will be developed in discrete subareas; excavation in one subarea will be completed before excavation begins in the next subarea. General excavation requirements for development of the borrow area are described in Section 4.1. Excavation scheduling requirements are presented in Section 4.2, and general excavation steps within each subarea are presented in Section 4.3.

4.1 GENERAL EXCAVATION REQUIREMENTS

The general requirements for borrow area development are described below.

Minimize Area Disturbed at Any One Time. As the OSDF Borrow Area Sediment Basin is enlarged through excavation, it will have sufficient capacity to handle runoff from the east side of the EFBA. However, best management practices require that the amount of disturbed area be minimized at all times. This will be accomplished by:

- Performing interim restoration on each previously disturbed subarea after it has reached final excavation grade before beginning excavation in the next subarea. In any year, if the quantity of non-conforming material encountered is larger than the estimated quantities within the subarea, excavation may be extended into the next subarea before restoration of the previous subarea is initiated.

- Stripping topsoil just prior to beginning excavation in a new subarea.
- Excavating to final grade during one construction season.
- Performing interim restoration in each subarea after completing excavation during the same construction season, including extended subareas.

Reach Final Excavation Grades And Restore Disturbed Areas As Soon As Possible. Excavation will be performed to reach final excavation grade and interim restoration performed in each subarea in one construction season. Interim restoration will be performed in each subarea as soon as possible after excavation is completed. Once interim restoration is performed, the subarea will not be re-excavated for additional borrow material unless the borrow area needs are changed due to unforeseen conditions.

Manage Surface Water and Provide Erosion and Sediment Controls. Berms, grading, swales and other techniques will be used to divert water around the active excavation subarea in accordance with the BAMR Plan and technical specifications. Erosion and sediment control measures will be implemented in each borrow subarea. Runoff from disturbed and restored areas will be directed to the OSDF Borrow Area Sediment Basin.

Manage Stockpiles. During borrow area excavation, the following types of stockpiles will be required to effectively manage the borrow operation:

- Topsoil;
- Ordinary borrow (including non-conforming material);
- Clayey rockfill; and
- Clay liner and cap material.

Stockpiles will be managed in accordance with the requirements of the technical specifications. Stockpile stabilization techniques include grading to a stable configuration, sealing the surface, applying a crusting agent, and/or establishing vegetation. To effectively manage surface water, stockpiles will be located in areas that are the tributary to the OSDF Borrow Area Sediment Basin; the South Stockpile Area; and the east side of the EFBA drain to the OSDF Borrow Area Sediment Basin.

Topsoil and ordinary borrow material will be stockpiled in the South Stockpile Area northeast of the borrow area. They will be working stockpiles. Additional material will be added to them as borrow

excavation is performed. Material will be removed from them as it is needed for OSDF construction. Topsoil will be stripped from a subarea prior to the start of excavation within that subarea, and prior to placement of clay liner and cap material stockpiles in that subarea. During excavation for clay material, non-conforming material will be excavated and stockpiled in the South Stockpile Area as it is encountered.

Clayey rockfill will be stockpiled within the active excavation subarea as it is generated. This material will be used for interim restoration of each subarea, as described in Section 5.

Generally, placement of clay liner and cap stockpiles will be on subareas that will be excavated at least two years in the future. After screened clay liner and cap material is placed in these stockpiles, they will be graded to a stable configuration. If the stockpile is not expected to be used within 45 days, it will be sealed with heavy equipment as approved by the Construction Manager, and stabilized with a mulch binder in accordance with the technical specification requirements for crusting agent. Silt fence will be installed down gradient of the toe of the stockpiles to control sediment. The stockpiles will be located within the area that is tributary to the OSDF borrow sediment basin. The combination of grading to a stable configuration, sealing the surface, and stabilizing with a mulch binder crusting agent will provide protection from storm events. These methods will also help in maintaining the moisture content of the clay liner and cap material within the acceptable moisture content range. Silt fence and the OSDF Borrow Area Sediment Basin will provide additional sediment controls.

Maintain Access. A haul road from the active borrow area to the OSDF will be used during all phases of OSDF construction. During excavation of the first few subareas, a haul road will be located within the borrow area. During excavation of later subareas, the haul road will be located to the east of the EFBA between the top crest of the excavation slope and the Mid-Valley pipeline right-of-way. Relocating the haul road outside of the borrow area will allow the vegetation that will be planted during interim restoration to grow with minor disruption. The location of the corridor for this haul road is shown on Figure A-3 in Appendix A.

4.2 GENERAL EXCAVATION SCHEDULING REQUIREMENTS

Borrow excavation will be performed to meet OSDF construction requirements. Prior to borrow area excavation, the CQC consultant will conduct pre-conformance testing to evaluate the soils in the

specific area to be excavated. Pre-conformance testing will include geotechnical testing to determine if material can meet the pre-conformance requirements for clay liner and cap material before it is excavated. If pre-conformance testing indicates the borrow material meets pre-conformance requirements for liner and cap materials, it will be excavated, screened and stockpiled. After the screened material is stockpiled, the CQC consultant will perform conformance testing prior to use in the OSDF. Clay liner and cap material will (if possible) be excavated, screened and stockpiled during the construction season 1 year before it is scheduled for use in the OSDF. During the following construction season, the stockpiled clay liner and cap material will be excavated from the stockpile and transported to the OSDF.

Topsoil will be stripped and stockpiled prior to excavation of each subarea; it will then be excavated from the stockpiles as it is required for placement in the OSDF.

Some ordinary borrow material will be encountered as potential clay liner and cap material is excavated. This material will be identified and stockpiled in the South Stockpile Area. This material will be excavated from the stockpiles as it is needed. Ordinary borrow material may also be excavated and hauled directly to the OSDF.

A general borrow area development schedule is presented on Table 4-1. This schedule is based on the preliminary construction schedule as of October 1999. This schedule may change based on funding, impacted material quantities for each year, and other factors. Actual borrow area excavation will also be impacted based on field conditions. As shown on Table 4-1, the east side of the EFBA is proposed to be developed in eight subareas; each subarea will be excavated in one construction season. The subarea boundaries are shown on Figure A-5 in Appendix A. The limits of each subarea will be refined in the BAMR Plan and subsequent CFC documents. Actual limits will be determined in the field based on conditions encountered. The size of each subarea may be increased if additional excavation is required due to the larger than anticipated quantities of non-conforming material encountered.

4.3 GENERAL EXCAVATION STEPS

The borrow area will be developed as eight subareas. The material quantities in each subarea are shown in Table 4-2. The subareas are shown on Figure A-5. The actual sequence may vary based on funding and actual field conditions. The general excavation sequence is as follows.

- Begin excavation in Subarea 1. This includes the area that was excavated for borrow during the 1999 construction season.
- Continue excavation north to the OSDF Borrow Area Sediment Basin.
- Continue excavation eastward at north end of EFBA and then proceed south.
- Excavate to final grade in subareas as borrow excavation is performed.
- Expand and set subarea limits as necessary to obtain the required material quantities.
- Perform interim restoration in an incremental manner by completing interim restoration in one subarea before excavating the subsequent subarea.

A generalized sequence of construction within each subarea is as follows:

1. Perform pre-conformance testing in subarea to be excavated.
2. Stake limits for excavation for subarea.
3. Install perimeter construction fencing.
4. Install appropriate surface water, erosion and sediment control measures in accordance with the BAMR Plan and CFC documents.
5. Relocate existing stockpiles outside the active subarea.
6. Strip topsoil:
   - clear and grub as required;
   - stockpile topsoil outside borrow area in South Stockpile Area; and
   - construct berm at perimeter of subarea to be excavated.
7. Perform grading in the subarea to set up screening plant.
8. Set up screening plant.
9. Begin soil excavation and screening.

10. Excavate and segregate non-conforming material and stockpile outside borrow area in the South Stockpile Area.

11. Stockpile clayey rockfill material in current excavation subarea for use in interim restoration.

12. Stockpile clay liner and cap material in designated screened material stockpile areas.

13. Move screeners within subarea as required.

14. Complete screening of material.

15. Haul material as needed to the OSDF from active subarea.

16. Excavate to final grade to obtain material for ordinary borrow.

17. Complete hauling material to OSDF from subarea.

18. Perform interim restoration within subarea (see Section 5).

19. Continue borrow excavation in next subarea during the subsequent construction season.

TABLE 4-1
GENERAL BORROW AREA DEVELOPMENT SCHEDULE[1]

Borrow Area Subarea	Calendar Year	Process and Stockpile Clay – Components and Quantity (icy)[2]	General Scope of Major Borrow Activities
1	2000	L-4 and C-1 (67,000)	Relocate existing stockpiles of topsoil, clayey rockfill, and processed clay material, Process and stockpile clay material
2	2001	C-2 (24,000)	Haul and place previously stockpiled clay, Process and stockpile clay, Excavate and haul ordinary borrow and topsoil
3	2002	L-5 and C-3 (65,000)	Haul and place previously stockpiled clay, Process and stockpile clay, Excavate and place and haul ordinary borrow and topsoil
4	2003	L-6 and C-4 (65,000)	Haul and place previously stockpiled clay, Process and stockpile clay, Excavate and place haul ordinary borrow and topsoil
5	2004	C-5 (24,000)	Haul and place previously stockpiled clay, Process and stockpile clay, Excavate and place ordinary borrow and topsoil
6	2005	C-6 (24,000)	Haul and place previously stockpiled clay, Process and stockpile clay, Excavate and place ordinary borrow and topsoil
7	2006	None	Haul and place previously stockpiled clay, Excavate and place ordinary borrow and topsoil
8	2007	L-7 and C-7 (70,000)	TBD

Notes:
[1] The general sequence for borrow area development is based on a preliminary construction schedule and may change based on funding and impacted material placement quantities for each construction year
[2] Clay will be processed for clay liner (L) and clay cap (C) for separate cells as indicated (i.e., L-4 indicates the clay liner for Cell 4)

TABLE 4-2
BORROW AREA DEVELOPMENT BY SUBAREA
(quantities in thousands)

Borrow Area Subarea	Calendar Year	Clay Construction Activities		Clay Material		Ordinary Borrow and Topsoil		Total Borrow Excavation (bcy)	Total icy
		Process Clay	Haul and Place Clay	Excavate/ Process/ Stockpile	Place (icy)	Excavate (bcy)	Place (icy)		
1	2000	C-1, L-4	None	83 bcy 67 icy	0	0	0	83	0
2	2001	C-2	C-1, L-4	30 bcy 24 icy	67	94	94	124	161
3	2002	L-5, C-3	C-2	81 bcy 65 icy	24	45	45	126	69
4	2003	L-6, C-4	L-5, C-3	81 bcy 65 icy	65	84	84	165	149
5	2004	C-5	L-6, C-4	30 bcy 24 icy	65	75	75	105	140
6	2005	C-6	C-5	30 bcy 24 icy	24	45	45	75	69
7	2006	None	C-6	0 0	24	45	45	45	69
8	After 2006	L-7, C-7	L-7, C-7	88 bcy 71 icy	71	91	91	179	162
Totals				422 bcy 340 icy	340	479	479	902	819

Notes:
1. The general schedule for borrow area development is based on a preliminary construction schedule and may change based on funding and impacted material placement quantities for each construction year.
2. Clay construction activities include liner (L) and cap (C) for specific OSDF cells. Clay liner includes associated intercell berm and wedge.
3. See Tables 3-1 and 3-3 for basis of estimated quantities.

000031

5.0 RESTORATION CONCEPT

Restoration will consist of two major steps, interim and final. Interim restoration will be performed within each subarea during each construction season after borrow excavation is completed within that subarea. In any year, if the quantity of non-conforming material encountered is larger than the estimated quantities within the subarea, excavation may be extended into the next subarea before restoration of the previous subarea is initiated. Interim restoration in any year must also include extended subareas. Final restoration will be performed after borrow excavation and interim restoration are completed in the entire borrow area.

During borrow excavation, the base of each subarea will be generally graded to a flat, gently sloping plane (e.g., 0.25 to 1.25 percent). A 6 horizontal to 1 vertical (6H:1V) outer excavation slope will be constructed at the borrow area boundary, as shown on Figure A-5 in Appendix A.

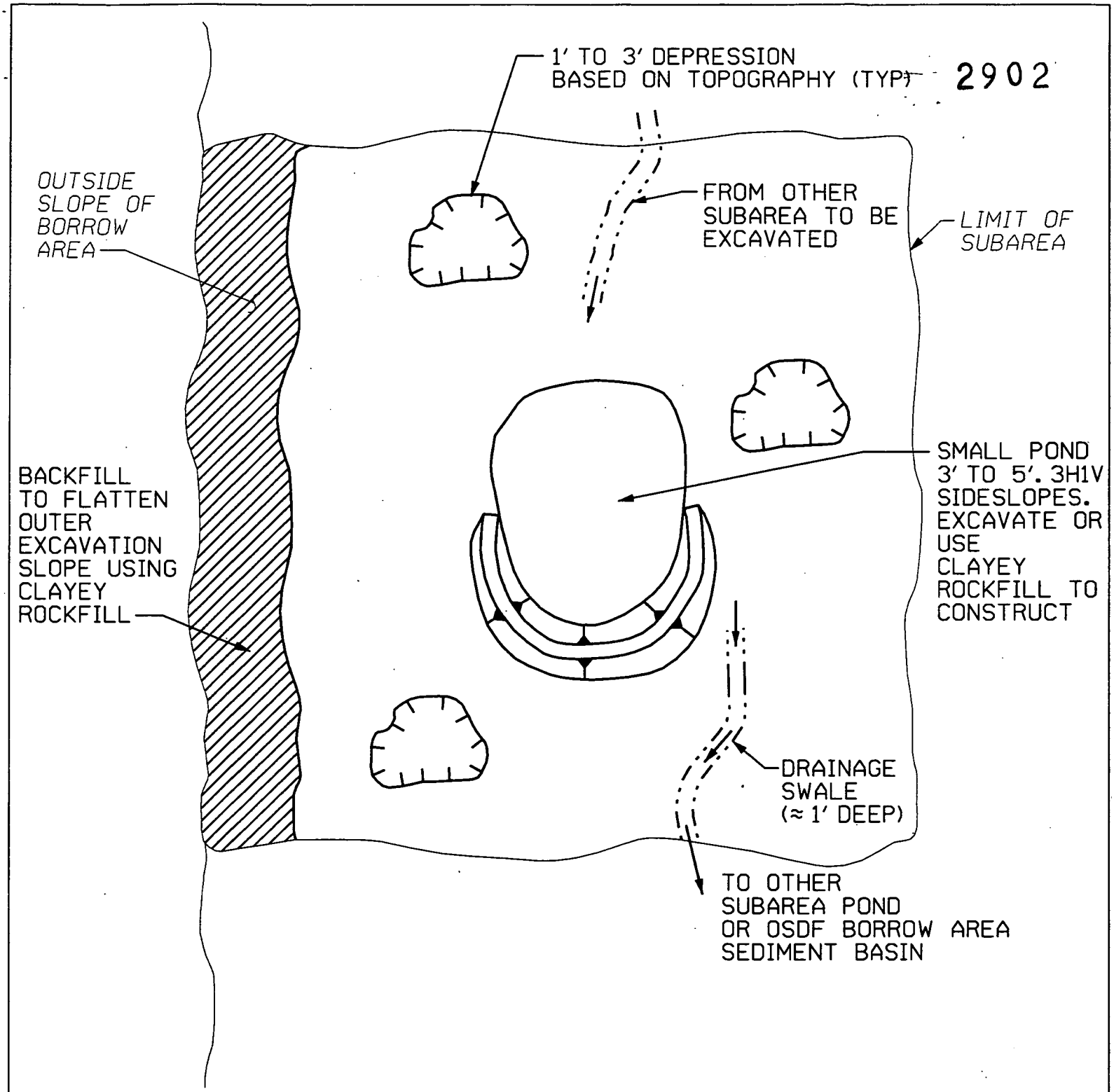
Although interim restoration will vary in each subarea, it will typically include grading for construction of a small pond, some depressions, and a drainage swale. The typical interim restoration grading for each subarea is shown on Figure 5-1 and will include the following:

- Spreading clayey rockfill material to flatten outer excavation slopes;
- Constructing a small pond by excavation and/or dike construction (with clayey rockfill);
- Excavating a drainage swale through the subarea;
- Excavating small depressions within the subarea; and
- Other grading and earthwork based on subarea-specific conditions.

After interim restoration grading is completed, seeding will be performed to establish vegetation, which will consist of upland and wet prairie mixes. After the interim restoration is completed, the borrow area will be a combination of upland and wet prairie.

Final restoration is expected to consist primarily of planting trees and final vegetation at the perimeter of the borrow area. Only minor regrading will be performed during final restoration.

A conceptual restoration plan for the eight OSDF borrow area subareas is presented on Figure A-6 in Appendix A. The exact grading and configuration of each subarea will be determined in the field based on the quantity of clayey rockfill that is available for restoration and on actual field conditions. For example, the outer excavation slope of the borrow area will be reduced and regraded based on the quantity of material that is available; the slopes may be reduced to 10H:1V if sufficient quantities of clayey rockfill are available. The outer excavation slope will be graded to a gently rolling grade to mimic natural conditions as much as possible.



NOTES:

1. SIZE OF FEATURES WILL VARY BASED ON QUANTITIES OF MATERIAL AND TOPOGRAPHY.
2. FILL FOR WATER FEATURES SHALL BE COMPACTED.
3. SEE FIGURE A-6 FOR PLAN TO IMPLEMENT THIS GRADING WITHIN THE OSDF BORROW AREA.

000034

FIGURE 5-1
TYPICAL INTERIM RESTORATION GRADING
NTS

figures.dgn

REFERENCES

U.S. Department of Energy, 1995, "Pre-Design Investigation and Site Selection Report for the On-Site Disposal Facility," Revision 0, DOE, Fernald Environmental Management Project, Cincinnati, OH.

U.S. Department of Energy, 1996a, "On-Site Disposal Facility - Phase I Construction Package, Certified-for-Construction," Revision 0, DOE, Fernald Environmental Project, Cincinnati, OH.

U.S. Department of Energy, 1996b, "Geotechnical Data and Evaluation Report for East and South Field Borrow Areas," Revision 0, DOE, Fernald Environmental Management Project, Cincinnati, OH.

U.S. Department of Energy, 1997a, "OSDF Design Criteria Package," Revision 0, DOE, Fernald Environmental Management Project, Cincinnati, OH.

U.S. Department of Energy, 1997b, "Borrow Area Management and Restoration Plan," Revision 0, DOE, Fernald Environmental Management Project, Cincinnati, OH.

U.S. Department of Energy, 1997c, "On-Site Disposal Facility - Phase II Construction Package, Certified-for-Construction," Revision 0, DOE, Fernald Environmental Project, Cincinnati, OH

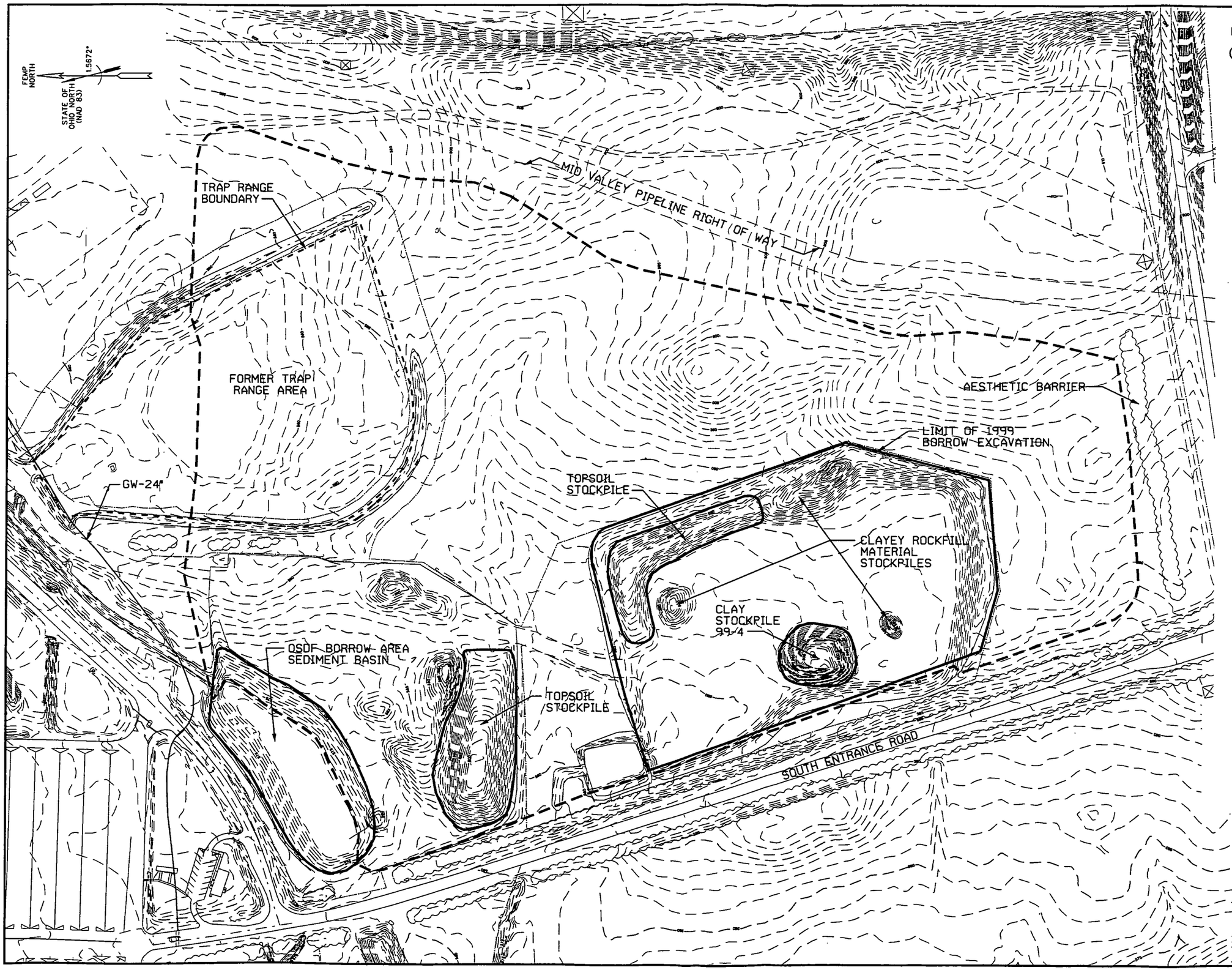
U.S. Department of Energy, 1997d, "OSDF Final Design Construction Drawings, Technical Specifications, and Support Plans," Revision 0, DOE, Fernald Environmental Management Project, Cincinnati, OH.

U.S. Department of Energy, 1997e, "OSDF Final Design Calculation Package, Volumes I and IV," Revision 0, DOE, Fernald Environmental Management Project, Cincinnati, OH.

APPENDIX A

BORROW AREA FIGURES

Figure A-1	Existing Conditions Plan
Figure A-2	Top of Gray Till and Gray Till Isopachs
Figure A-3	Excavation Grading Plan
Figure A-4	Grading Plan with Gray Till Excavation Information
Figure A-5	Borrow Area Excavation Subareas
Figure A-6	Conceptual Borrow Area Interim Restoration Plan



NOTES:

① EXISTING SURFACE CONTOURS FROM AERIAL PHOTOGRAPHY FLOWN JANUARY, 2000.

2902

LEGEND:

- - - - LIMIT OF BORROW AREA

— — — — EXISTING SURFACE CONTOURS

0 50 100 200 400

GRAPHIC SCALE

FIGURE A-1
ON-SITE DISPOSAL FACILITY
EAST FIELD BORROW AREA

EXISTING CONDITIONS PLAN

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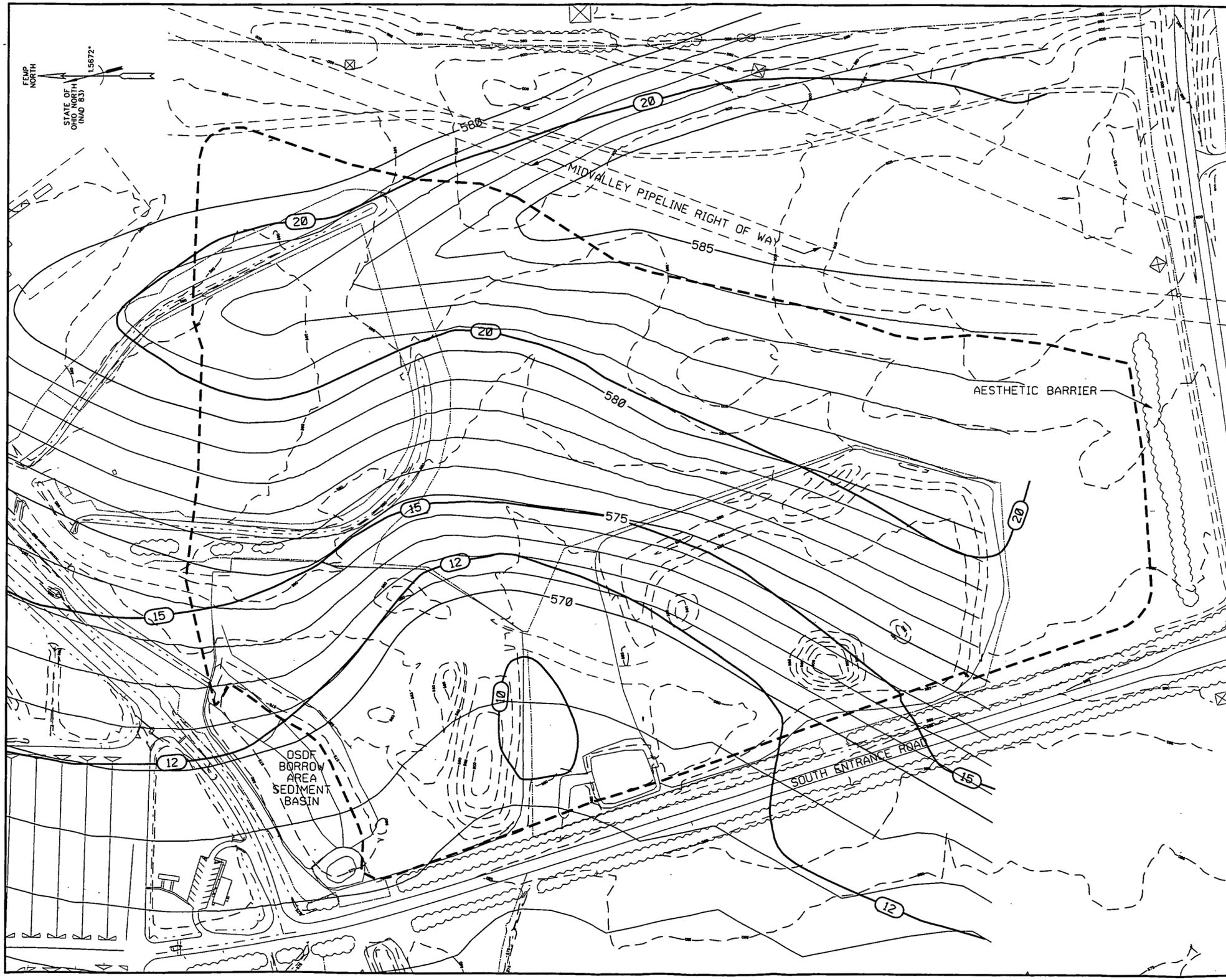

NOTES:

1. EXISTING SURFACE CONTOURS FROM AERIAL PHOTOGRAPHY FLOWN JANUARY, 2000.
2. TOP OF GRAY TILL CONTOURS AND GRAY TILL ISOPACHS OBTAINED FROM FIGURES 3-3 AND 3-4 OF THE 'PREDESIGN INVESTIGATION AND SITE SELECTION REPORT FOR THE ON-SITE DISPOSAL FACILITY, FERNALD ENVIRONMENTAL MANAGEMENT PROJECT', U.S. DEPARTMENT OF ENERGY, JULY 1995.

2902

LEGEND:

- LIMIT OF BORROW AREA
- EXISTING SURFACE CONTOURS
- CONTOURS OF BROWN TILL/GRAY TILL INTERFACE (TOP OF GRAY TILL)
- (12) GRAY TILL ISOPACH (THICKNESS OF GRAY TILL)

0 50 100 200 400
GRAPHIC SCALE

FIGURE A-2
ON-SITE DISPOSAL FACILITY
EAST FIELD BORROW AREA

TOP OF GRAY TILL AND
GRAY TILL ISOPACHS

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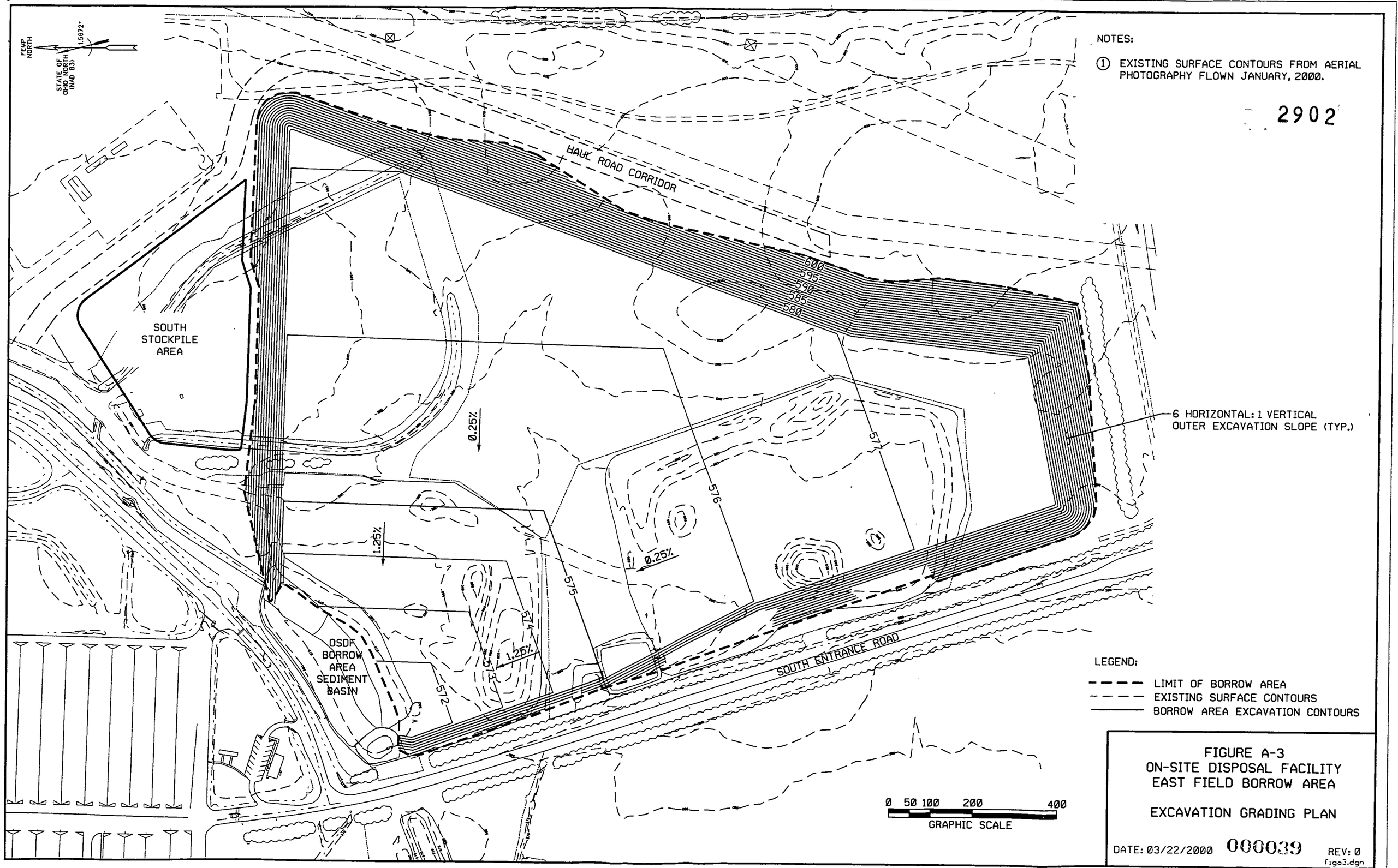
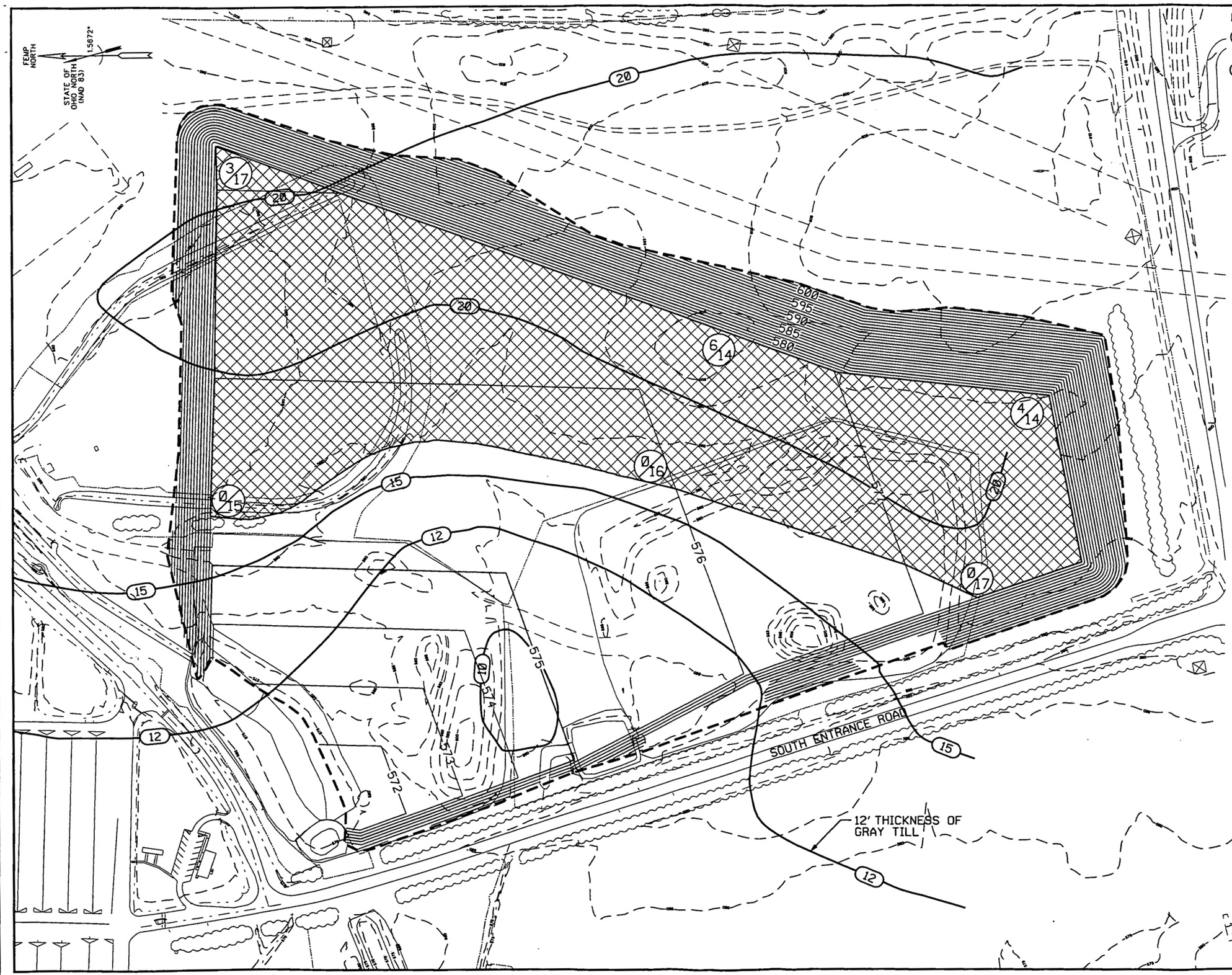

FEMP NORTH
1.5672°
STATE OF OHIO NORTH (NAD 83)
NOTES:
① EXISTING SURFACE CONTOURS FROM AERIAL PHOTOGRAPHY FLOWN JANUARY, 2000.
2902
HAUL ROAD CORRIDOR
600
595
590
585
580
SOUTH STOCKPILE AREA
0.25%
1.25%
576
575
574
573
572
OSDF BORROW AREA SEDIMENT BASIN
SOUTH ENTRANCE ROAD
6 HORIZONTAL: 1 VERTICAL OUTER EXCAVATION SLOPE (TYP.)
LEGEND:
LIMIT OF BORROW AREA
EXISTING SURFACE CONTOURS
BORROW AREA EXCAVATION CONTOURS
0 50 100 200 400
GRAPHIC SCALE
FIGURE A-3
ON-SITE DISPOSAL FACILITY
EAST FIELD BORROW AREA
EXCAVATION GRADING PLAN
DATE: 03/22/2000
000039
REV: 0
fig03.dgn



NOTES:

1. EXISTING SURFACE CONTOURS FROM AERIAL PHOTOGRAPHY FLOWN JANUARY, 2000.
2. DEPTH OF EXCAVATION INTO GRAY TILL AND DEPTH OF GRAY TILL REMAINING BASED ON INFORMATION PRESENTED ON FIGURES 3-3 AND 3-4 OF THE "PREDESIGN INVESTIGATION AND SITE SELECTION REPORT FOR THE ON-SITE DISPOSAL FACILITY, FERNALD ENVIRONMENTAL MANAGEMENT PROJECT", U.S. DEPARTMENT OF ENERGY, JULY 1995.

2902

LEGEND:

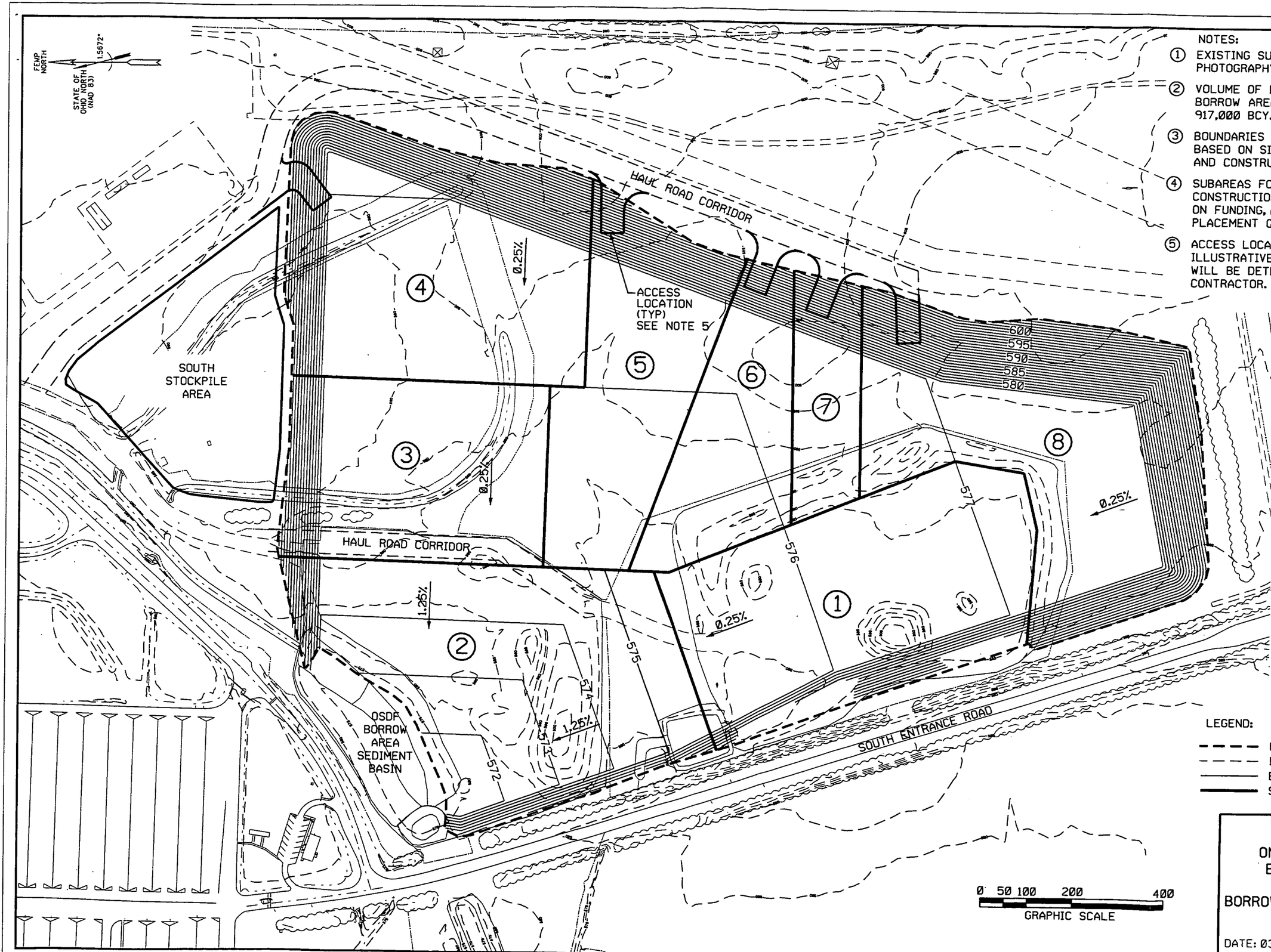
- LIMIT OF BORROW AREA
- EXISTING SURFACE CONTOURS
- BORROW AREA EXCAVATION CONTOURS
- AREAS WHERE BORROW EXCAVATION EXTENDS INTO GRAY TILL
- 6/14 DEPTH OF EXCAVATION INTO GRAY TILL/DEPTH OF REMAINING GRAY TILL

0 50 100 200 400
GRAPHIC SCALE

FIGURE A-4
ON-SITE DISPOSAL FACILITY
EAST FIELD BORROW AREA

GRADING PLAN WITH
GRAY TILL EXCAVATION
INFORMATION

DATE: 03/22/2000 000040 REV: 0
fige4.dgn



NOTES:

1. EXISTING SURFACE CONTOURS FROM AERIAL PHOTOGRAPHY FLOWN JANUARY, 2000.
2. VOLUME OF BORROW MATERIAL WITHIN LIMIT OF BORROW AREA EXCAVATION IS APPROXIMATELY 917,000 BCY.
3. BOUNDARIES BETWEEN SUBAREAS WILL VARY BASED ON SIDE SLOPES, ACTUAL FIELD CONDITIONS, AND CONSTRUCTION SCHEDULE.
4. SUBAREAS FOR EXCAVATION BASED ON PRELIMINARY CONSTRUCTION SCHEDULE AND MAY CHANGE BASED ON FUNDING, AND ACTUAL IMPACTED MATERIAL PLACEMENT QUANTITIES.
5. ACCESS LOCATIONS ARE SHOWN FOR GENERAL ILLUSTRATIVE PURPOSES ONLY. ACTUAL LOCATIONS WILL BE DETERMINED IN THE FIELD BY THE CONTRACTOR.

2902

SUBAREA	APPROX. BORROW MATERIAL VOLUME (BCY)
1	89,000
2	130,000
3	120,000
4	165,000
5	105,000
6	75,000
7	45,000
8	188,000
TOTAL	917,000

LEGEND:

- LIMIT OF BORROW AREA
- EXISTING SURFACE CONTOURS
- BORROW AREA EXCAVATION CONTOURS
- SUBAREA BOUNDARY

FIGURE A-5
ON-SITE DISPOSAL FACILITY
EAST FIELD BORROW AREA

BORROW AREA EXCAVATION SUBAREAS

000041

DATE: 03/22/2000

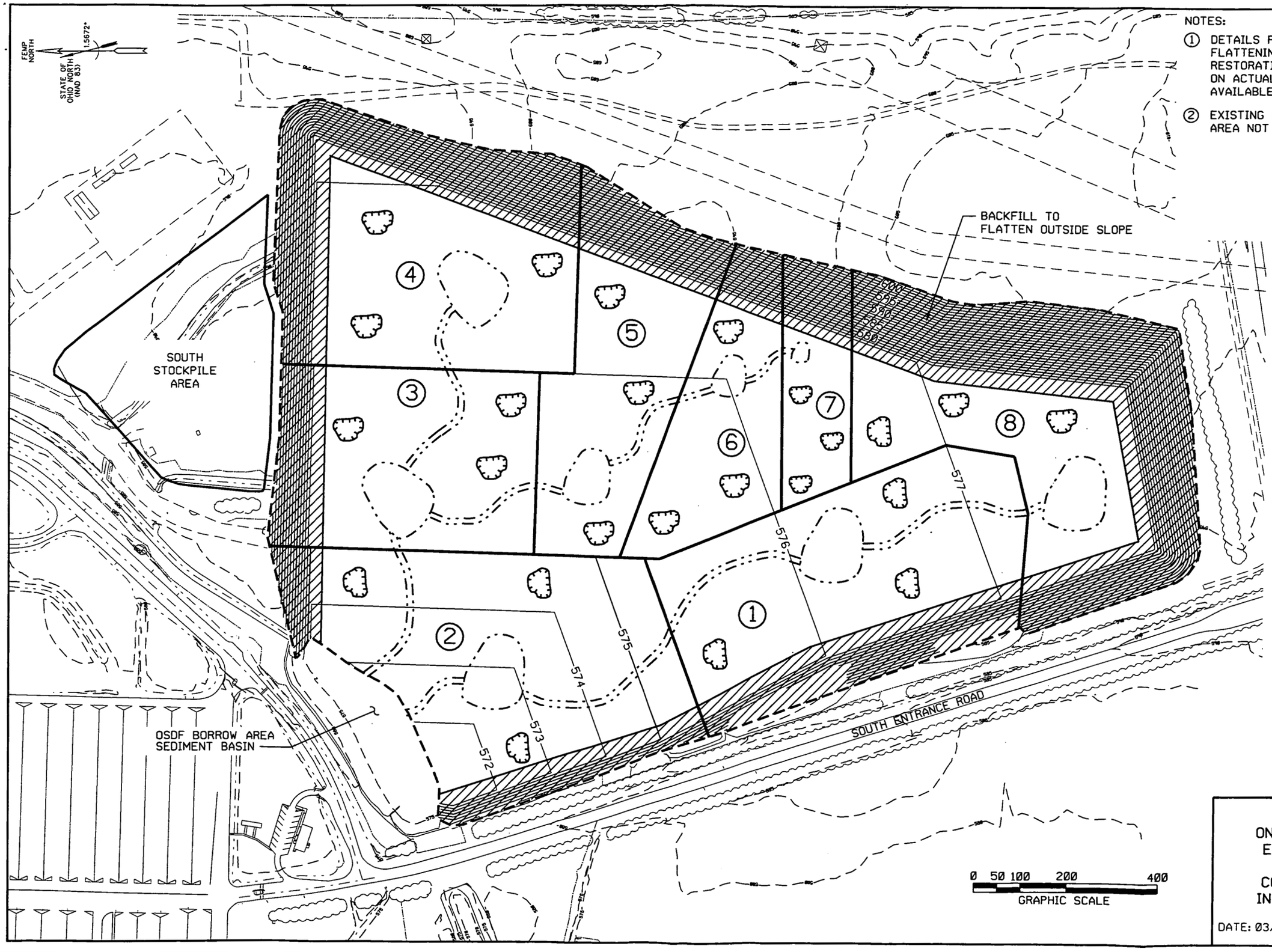
REV: 0

fig05.dgn

NOTES:

1. DETAILS REGARDING SMALL POND CONSTUCTION, FLATTENING OUTSIDE SLOPE AND OTHER RESTORATION GRADING WILL VARY DEPENDING ON ACTUAL QUANTITIES OF CLAYEY ROCKFILL AVAILABLE WITHIN THE SUBAREA.
2. EXISTING CONTOURS WITHIN LIMIT OF BORROW AREA NOT SHOWN FOR CLARITY.

2902



LEGEND:

- LIMIT OF BORROW AREA
- SUBAREA BOUNDARY
- DEPRESSION (TYP)
- SUBAREA DESIGNATION
- GENERAL FLOW DIRECTION
- SMALL POND
- OUTSIDE SLOPE TO BE FLATTENED WITH CLAYEY ROCKFILL
- SWALE
- EXISTING SURFACE CONTOURS
- BORROW AREA EXCAVATION CONTOURS

FIGURE A-6
ON-SITE DISPOSAL FACILITY
EAST FIELD BORROW AREA

CONCEPTUAL BORROW AREA
INTERIM RESTORATION PLAN

DATE: 03/22/2000

000042

REV: 0

fig06.dgn

APPENDIX B

CALCULATIONS

FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

ENGINEERING CALCULATION

PROJECT NUMBER:	
BY: A.P. KLIMEK	DATE: 11/14/99
CHECKED BY: J. BLANKEMEYER	DATE: 4/3/00
PAGE 1 OF 4	
SUBJECT:	REVISED:

2902

ESTIMATE QUANTITIES OF BORROW FOR OSDF

1. BACKFILL FOR UNSUITABLE SUBGRADE OVER EXCAVATION

ESTIMATE ONLY - ASSUME 10,000 ICY PER CELL.
CONSERVATIVE - VERY LITTLE IN CELLS 1, 2 AND 3.

2. COMPACTED FILL

COMPACTED FILL WILL BE REQUIRED TO CONSTRUCT SIDE BERMS AT OSDF. IT WILL VARY FROM CELL TO CELL. MATERIAL WAS OBTAINED FROM OSDF FOOTPRINT AREA FOR CELLS 1, 2 AND 3. SEE SUMMARY SHT (3 OF 4) FOR OSDF CALCS. ASSUME ALL MATERIAL WILL NEED TO COME FROM BORROW AREA:

- CELL 4 - 17,000 ICY
- CELL 5 - 24,000 ICY
- CELL 6 - 15,000 ICY
- CELL 7 - 20,000 ICY - (USE ESTIMATE FOR LAST CELL)

3. MISCELLANEOUS FILL

ESTIMATE ONLY - ASSUME 5000 ICY FOR EACH CELL EXCEPT CELL 4: ADD 6000 ICY TO BACKFILL PART OF SEDIMENT BASIN FOR PERMANENT LCS AS PART OF CELL 4

4. CLAY LINER

SEE ATTACHED SUMMARY SHT (SHEET 3 OF 4)
USE 37,000 ICY / CELL (INCLUDES INTER CELL BERM)

5. CLAY WEDGE

SEE ATTACHED CALCULATION SHEET (SHEET 4 OF 4)
USE 4000 ICY (4 to 6) USE 8,000 ICY FOR CELL 7

000044

6. CONTOURING LAYER

SEE ATTACHED SUMMARY SHT (SHEET 3 OF 4)
USE 11,000 ICY FOR CELLS 2 to 6, ADD 1000 ICY FOR FIRST (CELL 1) AND LAST CELL - 13,000 ICY

FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

ENGINEERING CALCULATION

PROJECT NUMBER:	
BY: A P. KUMPEK	DATE: 11/14/99
CHECKED BY: J. BLANKENMEYER	DATE: 4/3/00
PAGE 2 OF 4	
SUBJECT:	REVISED:

7. COMPACTED CLAY CAP

SEE ATTACHED SUMMARY SHT (SHT 3 OF 4)

USE 26,000 ICY FOR FIRST AND LAST CELL (1 AND 7)

USE 24,000 ICY FOR OTHER CELLS (2 to 6)

8. VEGETATIVE SOIL COVER

SEE ATTACHED SUMMARY SHT (SHT 3 OF 4)

USE 36,000 ICY FOR FIRST AND LAST CELL (1 AND 7)

USE 27,000 ICY FOR OTHER CELLS (2 to 6)

9. TOPSOIL

SEE ATTACHED SUMMARY SHT (SHT 3 OF 4)

USE 8000 ICY FOR FIRST AND LAST CELL (1 AND 7)

USE 7000 ICY FOR OTHER CELLS (2 to 6)

Paul J. Sabatini

TABLE 2. SUMMARY OF REQUIRED EARTHWORK QUANTITIES

Cell No.	Compacted Clay Liner (cy)	LDS Drainage Layer (cy)	LCS Drainage Layer (cy)	Protective Soil Layer (impacted) (cy)	Protective Soil Layer (non-impacted) (cy)	Compacted Clay Cap (cy)	Cover Drainage Layer (cy)	Biointrusion Barrier (cy)	Choke Layer (cy)	Granular Filter (cy)	Vegetative Soil Layer (cy)	Topsoil (cy)	Seasonal Cover (cy)	Compacted Fill (cy)	(outlining LAYER (cy))
	#4 OD	OS	OS	IMP	BA	#7 BA	OS	OS	OS	OS	#8 BA	#9 BA	IMP	#2 BA	#6
1	41,900	11,500	14,109	7,692	1,201	26,179	18,922	39,881	3,171	8,467	36,358	8,467	3,593	16,246	11,207
2	36,866	10,697	13,306	6,889	1,201	23,704	14,371	35,689	2,907	6,749	26,575	6,749	3,593	6,254	10,874
3	36,866	10,697	13,306	6,889	1,201	23,704	14,371	35,689	2,907	6,749	26,575	6,749	3,593	14,755	10,874
4	36,866	10,697	13,306	6,889	1,201	23,704	14,371	35,689	2,907	6,749	26,575	6,749	3,593	16,847	10,874
5	36,866	10,697	13,306	6,889	1,201	23,704	14,371	35,689	2,907	6,749	26,575	6,749	3,593	23,882	10,874
6	36,866	10,697	13,306	6,889	1,201	23,704	14,371	35,689	2,907	6,749	26,575	6,749	3,593	15,244	10,874
7	36,866	10,697	13,306	6,889	1,201	23,704	14,371	35,689	2,907	6,749	26,575	6,749	3,593	11,264	10,874
8	34,135	9,907	12,357	7,459	-	26,179	18,922	39,881	3,171	8,467	36,358	8,467	-	19,945	11,207
TOTAL	297,231	85,589	106,302	56,485	8,407	194,582	124,070	293,896	23,784	57,428	232,166	57,428	25,151	124,437	87,658
TOTAL (9 cells)	334,097	96,286	119,608	63,374	9,608	218,286	138,441	329,585	26,691	64,177	258,741	64,177	28,744	137,071	98,532

Total riprap = 26,574 cy

REF: FROM VOLUME II OF OSDF FINAL CALCULATION PACKAGE BY GEOSYNTEC MAY '97, REV 0, APP. H.

CELL 8 QUANTITIES USED FOR CELL 7 IN BASR APK - 11/30/99

ALL QUANTITIES IN ICY (WITHIN OSDF) APK - 11/30/99

QUANT.XLS

APK ~~Page 20 of 32~~ 11/19/99 ~~Pat Gam~~ 2/1/00 3/9

OD DGP 2 APR 96 PJS 30 OCT 96 2902 2:53 PM

000046

4/L

(c) DEVELOP CROSS SECTIONS FOR CELL 2-3 INTERCELL BERM USING GIVEN CONTROL POINTS.

SEE ATTACHED FOR CROSS SECTIONS.

VOLUME OF BERM =

AVG. OF END AREAS * LENGTH OF BERM IN PLAN
PLANIMETERED

LENGTH OF BERM = 675'

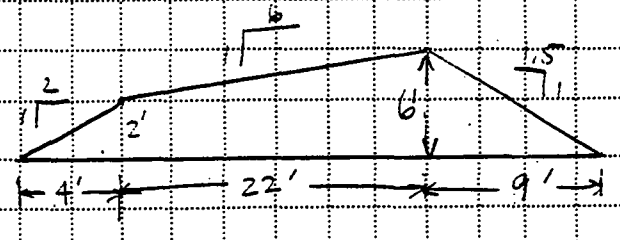
#5

$$\text{VOL} = \left(\frac{27.49 + 81.60}{2}\right) in^2 \left(\frac{10^2 ft^2}{in^2}\right)(675 ft)\left(\frac{cy}{27 ft^3}\right) = 7386 \text{ cy}$$

(d) DETERMINE VOLUME OF WEDGE FROM DIMENSIONS SCALED FROM PHASE II DWG

LENGTH OF BERM = 430'

OF BERMS = 2



AREA = 4 sf + 88 sf + 27 sf = 119 sf

$$\text{VOL} = 119 sf (430 ft)(2) / \frac{27 ft^3}{cy} = 3790 \text{ cy}$$

SAY 4,000 ICY APK 11/13/99
USE DOUBLE OR 8,000 ICY FOR CELL 7

(e) Total Clay Vol. =

$$\frac{234,350 sf (3 ft)}{27} - \frac{(12,135 sf)(3 ft)}{27} + 7386 \text{ cy} + 3790 =$$

41,902 cy

000047

FERNALD
ENVIRONMENTAL RESTORATION
MANAGEMENT CORPORATION

ENGINEERING CALCULATION

PROJECT NUMBER: 20100	
BY: A.P. KLIMEK	DATE: 11/16/99
CHECKED BY: J. BLANKENSHIP	DATE: 4/3/00
PAGE 1 OF 7	
REVISED:	

SUBJECT:

2902

ESTIMATE SOIL FACTORS FOR BORROW MATERIAL.

1. SOIL SWELL FACTOR. USE 0.955 AS PRESENTED IN OSOF FINAL DESIGN CALCULATIONS SEE SHT 3 OF 7, ATTACHED. (FROM FINAL DESIGN CALCS) ✓

2. SCREENER REJECT FACTOR.
USE 14%, SEE ATTACHED SHTS 4, 5 AND 6

14% IS REASONABLE BASED ON CELL 3 EXPERIENCE

3. UNSUITABLE SOIL FACTOR
USE 12% SEE ATTACHED SHT 7 OF 7

12% IS REASONABLE BASED ON CELL 3 EXPERIENCE

4. WASTAGE FACTOR - USE 2% (ESTIMATE - NO CALCS)

000048

BY: RICK HEATH

CHECKED/REVISED: A.P.KLIMEK 11/16/99

CUMULATIVE SOIL FACTORS

Find - Cumulative soil factors needed to convert from compacted in-place cubic yards to bank cubic yards to be borrowed

Given - Soil factors for clay compaction and OSDF Final Design Calculation Package Vol IV

1.0 ICY compacted glacial till = 0.955 BCY Borrow Soil (SHT 3 OF 7)

1.14 BCY unscreened borrow soil = 1.0 BCY screened soil (SHTS 4, 5 AND 6)

1.12 BCY total borrow soil = 1.0 BCY suitable borrow soil (SHT 7 OF 7)

1.02 BCY total borrow soil = 1.0 BCY delivered to cell (ESTIMATE ONLY, NO CALCS)

Find - Compacted Clay Liner (CCL) cumulative factor

$$\frac{\text{1 ICY Compacted Clay Liner}}{\text{1 ICY CCL}} * \frac{\text{0.955 BCY Borrow}}{\text{1ICY CCL}} * \frac{\text{1.14 BCY unscreened}}{\text{1 BCY screened}} * \frac{\text{1.12 BCY unsuitable}}{\text{1 BCY suitable}} * \frac{\text{1.02 BCY total}}{\text{1 BCY delivered}} = \frac{\text{1.244 BCY Borrow}}{\text{1 ICY CCL}}$$

USE 1.24 APK

Find - ~~Compacted Fill~~ ORDINARY BORROW APK cumulative factor

$$\frac{\text{1 ICY Compacted Fill}}{\text{1 ICY Compacted Fill}} * \frac{\text{0.955 BCY Borrow}}{\text{1BCY Delivered}} * \frac{\text{~~1.12~~ 1.03 BCY unsuitable}}{\text{1 BCY suitable}} * \frac{\text{1.02 BCY total}}{\text{1 BCY delivered}} = \frac{\text{~~1.09~~ 1.003 BCY Total Borrow}}{\text{1 ICY Compacted Fill}}$$

ASSUME THAT ONLY 1/4 OF MATERIAL THAT IS UNSUITABLE FOR CLAY LINER WILL BE UNSUITABLE FOR ORDINARY BORROW. ADK 11/16/99

USE 1.00 APK 11/16/99

contingency volume is provided for the following reasons: (i) construction of a ninth OSDF contingency cell if disposal volumes are larger than anticipated; (ii) to backfill to subgrade elevations beneath the footprint of the OSDF in the event that additional excavation of impacted material is necessary; and (iii) if insufficient volumes of suitable impacted material are available to complete the construction of a component of the liner or cover system.

CONCLUSIONS

* The shrinkage/bulk factor for the brown till is calculated to be 0.955 (i.e., 0.955 ft^3 of in situ brown till material is required to construct 1.000 ft^3 of compacted material). This implies the bank/unbulked brown till will undergo a net increase in volume of approximately 4.7 percent once compacted in-place as part of the OSDF liner/cover system.

The required bank/unbulked volume was calculated to be 433,567 yd^3 for the Borrow Area. There is 590,834 yd^3 of material available in the Borrow Area, an excess of 157,267 yd^3 of material for use in constructing specific earthwork components of the OSDF. This excess corresponds to a 19.5% contingency volume; this exceeds the minimum required contingency of ~~10%~~. 17.5% ✓ KW

AD, DGP 2 APRIL 96

REF/SOURCE: "FINAL DESIGN CALCULATION PACKAGE, OSDF VOL IV OF IV", BY GEOSYNTEC, MAY 1997

APK 11/16/99

FERNALD
ENVIRONMENTAL RESTORATION
MANAGEMENT CORPORATION

ENGINEERING CALCULATION

PROJECT NUMBER:	
BY: Y. AFSHAR	DATE: 12/14/98
CHECKED BY: REH	DATE: 12/29/98
PAGE 1 OF 2	
SUBJECT: Clay Screening Reject Factor	REVISED: DARKENED APK 11/16/99 CLARIFIED APK 11/16/99

CALCULATE REJECT FACTOR (%) FOR BORROW MATERIAL FOR CONSTRUCTION OF THE OSDF.

GIVEN:

- CLAY VOL REQUIRED FOR EACH CELL = 39,426 (ICY) x 0.955
  = 37,652 BCY

SOURCES OF CLAY USED FOR CONSTRUCTION OF CELL 2:

1. CELL FOOT PRINT
   BANK VOLUME = 32,810 BCY

2. EAST BORROW AREA (EFBA)
   VOLUME OF REJECT MATERIAL = 2055 CY

APK 11/16/99 VOL. OF REJECT FROM FOOT PRINT AREA - UNKNOWN
VOL. OF BORROW FROM EFBA - UNKNOWN

SOLUTION:

(VOL FROM CELL FOOT PRINT - REJEC) +

(VOL FROM EAST BORROW AREA - REJECT) = 37,652 BCY

ASSUMING REJECTION FACTOR = X%
VOLUM FROM EAST BORROW AREA = y

∴ REJECT FROM EAST BORROW AREA = xy = 2055 CY
ASSUMING A 20% BULKING FACTOR

$xy = (0.8)(2055) = 1644$ BCY $\quad y = \frac{1644}{x}$ --- I

$(32,810 - 32,810x) + (y - xy) = 37,652$ --- II

$(32,810 - 32,810x) + \left(\frac{1644}{x} - \frac{1644}{x}x\right) = 37,652$

FERNALD
ENVIRONMENTAL RESTORATION
MANAGEMENT CORPORATION

ENGINEERING CALCULATION

PROJECT NUMBER:	
BY: Y. AFSHAR	DATE: 12/10/99
CHECKED BY: REH	DATE: 2/29/98
PAGE 2 OF 2	
SUBJECT:	REVISED: DARKENED 11/16/99

$$-32810 - 32810X + \frac{1644}{X} - 1644 - 37652 = 0$$

$$X\left(32810X - \frac{1644}{X} + 6486\right) = 0 \quad (x)$$

2902

$$\underset{a}{32810}X^2 + \underset{b}{6486}X - \underset{c}{1644} = 0$$

$$X = \frac{-b \pm \sqrt{(b^2) + 4ac}}{2a} \quad \text{(QUADRATIC EQUATION)}$$

$$X = \frac{-6486 \pm \sqrt{(6486)^2 - 4(32810)(-1644)}}{2(32810)}$$

$$X = \frac{-6486 \pm 16{,}057}{65620}$$

$$X = \frac{9{,}571}{65620} = 0.145 \approx 14\%$$

DARKENED BY
APK 11/16/99

BY: R. HEATH

CHECK OF REJECT FACTOR CALCULATION

ALL VOLUMES IN BANK CUBIC YARDS

			Y	1541	X
TOTAL INTO CELL 2	BORROW FROM FP	FR BORROW - REJECT	EFBA INTO CELL2	EFBA SPOIL	REJECT FACTOR
37652	32810	30185.200	7466.800	645.132	0.080
37652	32810	29529.000	8123.000	893.530	0.100
37652	32810	28872.800	8779.200	1179.924	0.120
37652	32810	28216.600	9435.400	1505.890	0.140
37652	32810	28183.790	9468.210	1523.255	0.141
37652	32810	28150.980	9501.020	1540.723	0.142

THIS WAS AN INDEPENDENT CHECK ASSUMING BCY REJECT OF 1541CY

APK 11/17/99

BY: RICK HEATH

CHECKED
REVISED: A.P. KLIMEK 11/16/99

UNSUITABLE SOIL FACTORS

Find - Percent of soil excavated from OSDF footprint and EFBA that is not suitable for use as clay liner.

2902

Method - From Cell 1 & 2 liner construction experience estimate quantity of soil rejected or diverted to other purposes beside compacted clay liner.

(1) North and West ditch and Cell 1 excavation was 14' deep
Gray till intermixed with sand seam = 4' thick over bottom 60% of excavation

$$\frac{4}{14} * 0.6 = 17.1\% \text{ unsuitable}$$

(2) Cell 2 & 3 excavation was ≈ 7' deep
Silts and sands comprised ≈ ½' thick over 1/3 of excavation

$$\frac{0.5'}{7'} * 0.3 = 2.1\% \text{ unsuitable}$$

(3) Borrow area east of SER was 95% suitable, 5% unsuitable
Borrow area west of SER was 10% suitable, 90% unsuitable

EAST ~~West~~ APK side volume was ≈ 55,000 BCY E
WEST ~~East~~ APK side volume was ≈ 9,000 BCY E

$$\frac{\overset{W}{0.90} * \overset{W}{9{,}000} + \overset{E}{0.05} * \overset{E}{55{,}000}}{64{,}000} = 16.9\% \text{ unsuitable}$$

APK 11/16/99
SER - SOUTH ENTRANCE ROAD. EXCAVATION WAS FOR OSDF BORROW AREA SED. BASIN (~~EAST OF SER~~) AND OUTFALL DITCH (~~WEST OF~~ SER). MOST OF ~~MATERIAL~~ ON WEST SIDE WAS UNSUITABLE

Each area contained approximately the same borrow volume.

Average unsuitable soil from the 3 areas = 17.1 + 2.1 + 16.9) /3 = 12.1%

Say 12% unsuitable for each BCY excavated

This factor will change as new borrow areas are excavated and more information becomes available.

12% UNSUITABLE IS REASONABLE BASED ON CELL 3 EXCAVATION IN BORROW AREA

G:\Engineering\HEATH\Borrow Area Study\soilfactors.wpd 3/24/99 9:50 AM

FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

ENGINEERING CALCULATION

PROJECT NUMBER:	
BY: A.P. KLIMEK	DATE: 01/10/00
CHECKED BY: J. BLANKEMEYER	DATE: 04/03/00
PAGE 1 OF 3	
SUBJECT:	REVISED:

SHRINKAGE/BULKING FACTOR SBF 2902

COMPARE IN-PLACE DENSITY OF IN-SITU BROWN TILL IN OSDF BORROW AREA TO DENSITY OF THE CLAY LINER IN CELL 3.

OSDF BORROW AREA - ESTIMATE IN-SITU DENSITY
REF: "GEOTECHNICAL DATA AND EVALUATION REPORT FOR EAST AND SOUTH FIELD BORROW AREAS" JUNE 1996, BY PARSONS

ESTIMATE IN-SITU DENSITY OF CLAY IN BORROW AREA (SEE ATTACHED FIGURE 2-3 AND TABLE 4-3)

BORING NO	SAMPLE NO.	DEPTH (FT)	WET DENSITY (lbs/CF)	DRY DENSITY (lbs/CF)
148	410573	7.5/9.5	135.7	114.8
152	410282	12.5/14.5	146.3	131.2
153	410287	5.0/7.0	143.6	127.0
1745	3250-(AVE)	6.0/9.0	137.6	119.2
1748	3251-(AVE)	9.0/12.0	142.7	129.4
201	(AVE) G2-201/4/2	7.5/9.5 2.5/4.5	130.0	111.2
202	G2-202/4(AVE)	7.5/9.5	141.0	123.6
203	G2-203/8	7.5/9.5	138.6	118.8
204	G2-204/4	7.5/9.5	139.2	122.0
205	G2-205/2	2.5/4.5	138.3	129.2
206	AVE G2-206 2/4/6	2.5→14.5	135.8	121.0
	Σ =		1528.8	1342.4
		AVE =	139.0 lbs/FT³	122.0 lbs/CF

AVE DENSITY OF CLAY LINER IN CELL 3 - 136.2 lbs/CF (W) 119.1 lbs/CF (D)

98% 97.6%

000055

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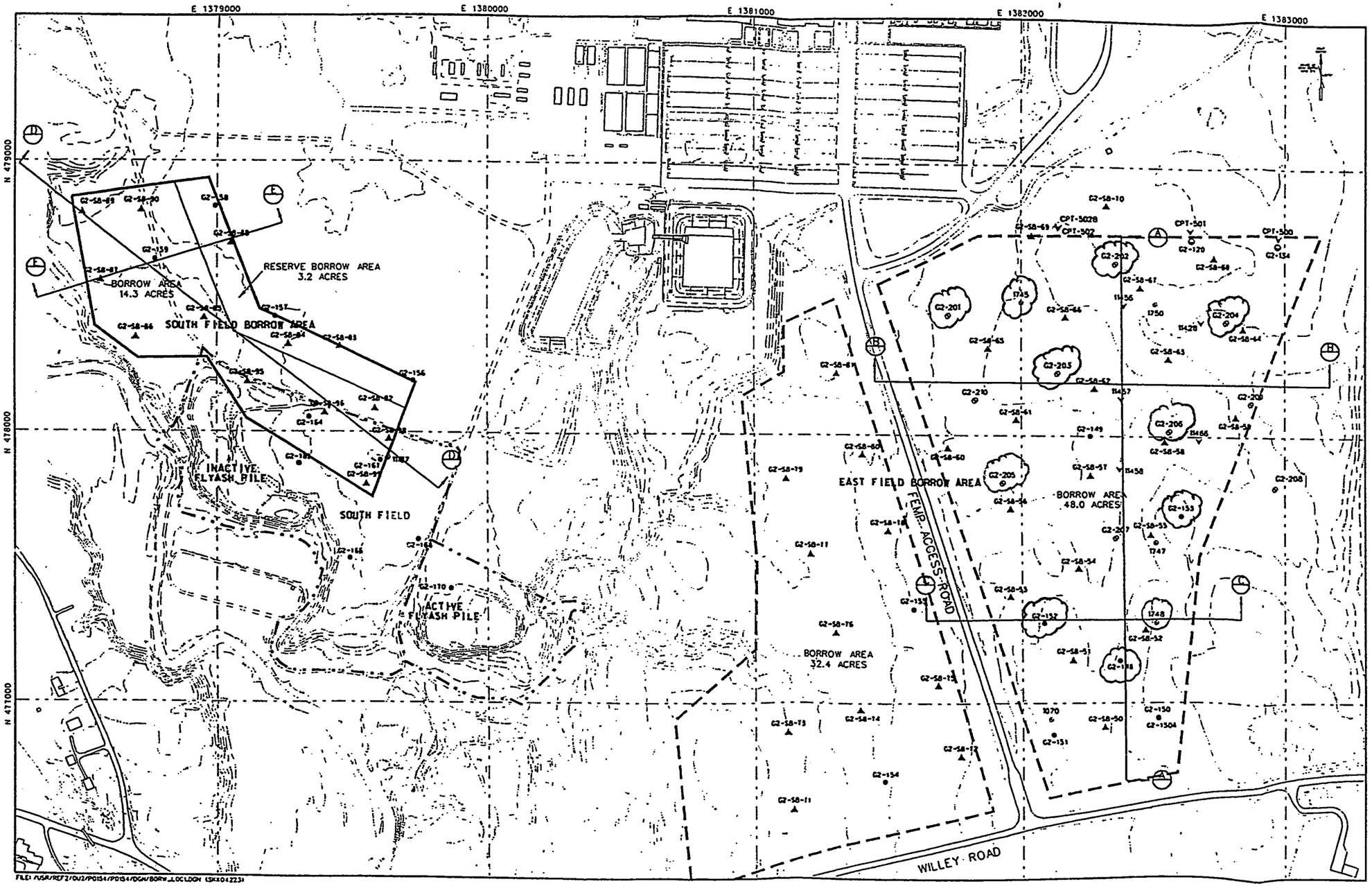
2902



Contour Values in Feet Above Mean Sea Level

LEGEND

G2-170	PO-154 Geotechnical Test Boring
G2-58-105	PO-154 Shallow Boring
11187	OU-2 RI Phase 2 Geotechnical Boring
G2-120	PO-140 Geotechnical Test Boring
11457	Phase II Disposal Facility Pre-Design CPT Sounding
CPT-500	Phase III Disposal Facility Design CPT Sounding
1745	RI Disposal Facility Geotechnical Test Boring
G2-203	PO-101 Geotechnical Test Boring
	Surface Contour
	Road
	Boundary of East Field Borrow Area
	Boundary of South Field Borrow Area
	Boundary of Waste Unit
	Cross Section Lines

SCALE

BORINGS USED TO ESTIMATE AVERAGE IN-SITU DENSITY

Location Map for Geotechnical Borings and Cone Penetrometer Soundings at the East and South Field Borrow Areas

000056

Figure 2-3 - Location Map for Geotechnical Test Boring and Cone Penetration Soundings at East and South Field Borrow Areas

Table 4-3 - Summary of Unit Weight and Percent Saturation, Undisturbed Samples

On-Site Location	Boring No.	Sample No.	Sample Type	Top Depth (feet)	Bottom Depth (feet)	Color (from field log)	General Stratum	USCS Group Name	USCS Group Symbol	Specimen ID	Test Type	Moisture Content Specimen (%)	Moisture Content Average (%)	Wet Density Specimen (pcf)	Wet Density Average (pcf)	Dry Density Specimen (pcf)	Dry Density Average (pcf)	Percent Saturation Specimen (%)	Percent Saturation Average (%)	Specific Gravity	Data Source
EFBA	G2-148	410573	DEN	7.5	9.5	Yellowish Brown	Brown Till	Lean Clay with Sand	CL	410573A Stage 1	CU-Stg	18.2		135.7		114.8		100		2.75	PO 154
EFBA	G2-150A	410256	DEN	15.0	17.0	Gray	Gray Till	Sandy Lean Clay	CL	410256 A	UU	14.7		142.7		124.4		100		2.65	PO 154
EFBA	G2-152	410282	ST	12.5	14.5	Olive Brown	Brown Till	Silty, Clayey Sand with Gravel	SC-SM	410282A Stage 1	CU-Stg	11.5		146.3		131.2		100		2.73	PO 154
EFBA	G2-153	410287	ST	5.0	7.0	Light Olive Brown	Brown Till	Sandy Lean Clay	CL	410287	UU	13.1		143.6		127.0		100		2.74	PO 154
EFBA	G2-154	410171	ST	10.0	12.0	Brown / Greenish Gray	Gray Till	Sandy Lean Clay	CL	410171 B	UU	11.4		142.5		128.0		96		2.72	PO 154
EFBA	G2-155	410175	ST	7.5	9.5	Light Olive Brown	Brown Till	Sandy Lean Clay	CL	410175 A	UU	12.2		143.5		127.8		100		2.73	PO 154
SFBA	G2-156	410131	ST	7.5	9.5	Yellowish Brown	Brown Till	Lean Clay	CL	410131 A	CU	21.6		132.3		108.8		100		2.72	PO 154
										410131 B	CU	23.1		130.9		106.4		100		2.72	PO 154
										410131 C	CU	24.6		128.7		103.3		100		2.72	PO 154
													23.1		130.6		106.2		100		Average
SFBA	G2-157	410140	ST	7.5	9.5	Greenish Gray	Gray Till	Lean Clay	CL	410140	UU	23.5		133.0		107.7		100		2.69	PO 154
EFBA	1745	3250	ST	6.0	9.0	Yellowish Brown	Brown Till	Silty Clay with Sand	CL-ML		CU	17.9		138.3		117.3		100		2.80	Nutting
											CU	14.4		140.8		123.1		100		2.80	Nutting
											CU	14.1		143.4		125.7		100		2.80	Nutting
											CON_s	15.8		134.3		116.0		87		2.80	Nutting
											P_c	15.1		131.0		113.8		86		2.80	Nutting
													15.5		137.6		119.2		95		Average
EFBA	1748	3251	ST	9.0	12.0	Brown	Brown Till	Clayey Gravel with Sand	GC		CU	9.7		143.6		134.9		100		2.79	Nutting
											CU	11.2		146.2		131.5		100		2.79	Nutting
											CU	12.0		144.6		129.1		100		2.79	Nutting
											CON_s	11.1		136.8		123.1		75		2.79	Nutting
											P_c	11.1		142.4		128.2		96		2.79	Nutting
													11.0		142.7		129.4		94		Average
EFBA	1747	3252	ST	12.0	14.5	Yellowish Brown	Gray Till	Clayey Gravel with Sand	GC		CU	13.4		142.2		125.4		100		2.74	Nutting
											CU	13.6		143.5		126.3		100		2.74	Nutting
											CU	12.4		143.9		128.0		100		2.74	Nutting
											CON_s	13.7		134.5		118.3		84		2.74	Nutting
											P_c	21.4		138.8		114.3		100		2.74	Nutting
													14.9		140.6		122.5		97		Average
EFBA	G2-201	G2-201 / 4	ST	7.5	9.5	Yellowish Brown	Brown Till	Lean Clay	CL	4A	UW	15.5		136.5		118.2		96		2.73	PO 101
EFBA	G2-201	G2-201 / 2	ST	2.5	4.5	Dark Yellowish Brown	Brown Till	Lean Clay	CL	2A	CU	20.4		130.2	130	108.5		99		2.70	PO 101
										2B	CU	17.7		120.9		102.8	111.2	75		2.70	PO 101
										2C	CU	18.2		119.4		101.1		74		2.70	PO 101
													18.8		123.5		104.1		83		Average
EFBA	G2-201	G2-201 / 10	ST	22.5	24.5	Dark Gray	Gray Till	Sandy Lean Clay	CL	10A	CU	12.6		143.7		127.6		100		2.75	PO 101
										10B	CU	13.0		143.4		126.9		100		2.75	PO 101
										10C	CU	13.8		142.4		125.2		100		2.75	PO 101
													13.1		143.2		126.6		100		Average
EFBA	G2-202	G2-202 / 4	ST	7.5	9.5	Yellowish Brown	Brown Till	Sandy Lean Clay	CL	4A	CU	14.2		139.6		122.3		98		2.81	PO 101
										4B	CU	14.1		142.4		124.8		92		2.81	PO 101
													14.2		141.0		123.6		95		Average
EFBA	G2-203	G2-203 / 8	ST	17.5	19.5	Yellowish Brown	Brown Till	Sandy Lean Clay	CL	8B	P	16.7		138.6		118.8		100		2.74	PO 101
EFBA	G2-203	G2-203 / 10	ST	22.5	24.5	Dark Gray	Gray Till	Sandy Lean Clay	CL	10A	CON_s	14.0		139.5		122.4		93		2.79	PO 101
EFBA	G2-204	G2-204 / 4	ST	7.5	9.5	Yellowish Brown	Brown Till	Sandy Lean Clay	CL	4A	CON_s	14.2		139.2		122.0		96		2.74	PO 101
EFBA	G2-204	G2-204 / 6	ST	12.5	14.5	Dark Gray	Gray Till	Lean Clay with Sand	CL	6C	CU	12.5		142.9		127.0		100		2.76	PO 101
										6B	CU	12.9		144.0		127.6		100		2.76	PO 101
										6A	CU	12.7		145.9		129.5		97		2.76	PO 101
													12.7		144.3		128.0		99		Average
EFBA	G2-204	G2-204 / 10	ST	22.5	24.5	Dark Gray	Gray Till	Sandy Lean Clay	CL	10B	P	12.1		144.3		128.7		96		2.78	PO 101
EFBA	G2-205	G2-205 / 2	ST	2.5	4.5	Dark Yellowish Brown	Brown Till	Lean Clay	CL	2B	P	11.3		138.3		124.2		87		2.68	PO 101
EFBA	G2-205	G2-205 / 8	ST	17.5	19.5	Dark Gray	Gray Till	Sandy Lean Clay	CL	8A	CU	12.6		144.4		128.2		100		2.77	PO 101
										8B	CU	13.0		143.1		126.6		99		2.77	PO 101
										8C	CU	12.2		143.3		127.7		95		2.77	PO 101
													12.6		143.6		127.5		98		Average
EFBA	G2-206	G2-206 / 2	ST	2.5	4.5	Yellowish Brown	Brown Till	Lean Clay with Sand	CL	2A	CON_s	11.4		122.8		110.2		56		2.76	PO 101
EFBA	G2-206	G2-206 / 4	ST	7.5	9.5	Yellowish Brown	Brown Till	Sandy Lean Clay	CL	4A	P	13.7		138.5		121.8		92		2.75	PO 101
EFBA	G2-206	G2-206 / 6	ST	12.5	14.5	Yellowish Brown	Brown Till	Lean Clay with Sand	CL	6A	UW	11.5		146.0		130.9		100		2.76	PO 101
EFBA	G2-206	G2-206 / 10	ST	22.5	24.5	Dark Gray	Gray Till	Sandy Lean Clay	CL	10A	CU	12.7		144.4		128.1		100		2.73	PO 101
EFBA	G2-134	405140	DEN	12.0	14.0	Dark Greenish Gray	Gray Till	Sandy Lean Clay	CL	405140A	UU	12.6		143.7		127.6		100		2.72	PO 140

Notes:

1. On-Site Location:
   - EFBA East Field Borrow Area
   - SFBA South Field Borrow Area
2. Sample Type:
   - ST Shelby Tube Sample (ASTM D 1587)
   - DEN Denison Core Barrel Sample
3. Test Type:
   - CON_s Consolidation with time readings, (ASTM D 2435), specimen at saturated conditions
   - CU Triaxial Shear, Consolidated, Undrained with Pore Pressure Measurements (ASTM D 4767), Three Points
   - CU-Stg Triaxial Shear, Consolidated, Undrained with Pore Pressure Measurements (ASTM D 4767), Staged Test
   - P Triaxial, Back-Pressure, Permeability (ASTM D 5084)
   - P_c Rigid Wall, Constant Head Permeability (ASTM D 2434)
   - UU Triaxial Shear, Unconsolidated, Undrained ASTM D 2850
   - UW Unit Weight (ASTM D 2937)
4. Data Source:
   - Nutting H.C. Nutting Technical Report 5.1A, Engineering Evaluation Report for On-Site Disposal, U.S. DOE Fernald Field Office, June 1993 (H.C. Nutting Laboratory Data).
   - PO 101 On-Site Disposal Cell Pre-Design Activities Engineering Report, PARSONS Project Order 101, April 1994.
   - PO 140 Geotechnical Investigation On-Site Disposal Facility, Soil Investigation Data Report, PARSONS Project Order 140, December 1995.
   - PO 154 East and South Field Borrow Areas Geotechnical Investigation, Geotechnical Laboratory Data Report, PARSONS Project Order 154, March, 1996.