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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

AREA 2, PHASE I
SOUTHERN WASTE UNITS IMPLEMENTATION PLAN
FOR OPERABLE UNIT 2

OCTOBER 1997

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

2502-WP-0029
REVISION C
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ACRONYMS AND ABBREVIATIONS

A/E	Architect/Engineer
A1PI	Area 1, Phase I
A2PI	Area 2, Phase I
ACA	Amended Consent Agreement
ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	as low as reasonably achievable
APM	Area Project Manager
ARARs	applicable or relevant and appropriate requirements
ASL	analytical support level
ASCOC	area-specific contaminants of concern
AWAC	above waste acceptance criteria
AWWT	Advanced Wastewater Treatment (Facility)
BAT	best available technology
BWAC	below waste acceptance criteria
CAM	cost account manager
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIS	Characterization Investigation Study
CM	Construction Manager
COC	constituent of concern
COM	contract order monitor
CP	change proposal
CU	certification unit
DCN	design change notice
DOE	U.S. Department of Energy
DOE-FEMP	U.S. Department of Energy - Fernald Area Office
DOT	Department of Transportation
DQO	data quality objective
EC	Environmental Compliance
ECDC	Engineering/Construction Document Control
EDwg	Excavation Construction Drawing
EPA	U.S. Environmental Protection Agency
ESpec	Excavation Construction Specification
FAR	Federal Acquisition Requirements
FDF	Fluor Daniel Fernald, Inc.
FEMP	Fernald Environmental Management Project
FRLs	final remediation levels
FS	Feasibility Study
FTL	field tracking log
GIS	Geographic Information System
HPGe	high purity germanium detector
ICD	Interface Control Document
IEMP	Integrated Environmental Monitoring Program

ACRONYMS AND ABBREVIATIONS
(continued)

IFB	Invitation for Bid
IIMS	Integrated Information Management System
IMPTSAP	Impacted Materials Prototype Sampling and Analysis Plan
IMPP	Impacted Materials Placement Plan
IRDP	Integrated Remedial Design Package
MP	mobile and persistent
MTL	material tracking location
NPDES	National Pollutant Discharge Elimination System
NRRP	Natural Resource Restoration Plan
OEPA	Ohio Environmental Protection Agency
OSDF	On-Site Disposal Facility
OSHA	Occupational Safety and Health Administration
PEP	Project Execution Plan
PSHSRM	Project-Specific Health and Safety Requirements Matrix
PSP	Project-Specific Plan
PWID	Project Waste Identification and Disposition
QA	quality assurance
QAPP	SEP Quality Assurance Project Plan
QC	quality control
RA	remedial action
RCI	Request for Clarification of Information
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFP	request for proposal
RI	remedial investigation
ROD	Record of Decision
RSS	Radiological Scanning System
RTRAK	Real Time Radiation Tracking System
S&H	Safety and Health
SCEP	Soil Characterization and Excavation Project
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SED	Sitewide Environmental Database
SEP	Sitewide Excavation Plan
SFES	South Field Extraction System
SOP	Standard Operating Procedure
SPDwg	Site Preparation Construction Drawing
SPSpec	Site Preparation Technical Specification
SWIFTS	Sitewide Waste Information Forecasting and Tracking System
SWPPP	Stormwater Pollution Prevention Plan
SWRB	Stormwater Retention Basin
SWUs	Southern Waste Units
TCLP	Toxicity Characteristic Leaching Procedure

ACRONYMS AND ABBREVIATIONS
(continued)

WAC	waste acceptance criteria
WAO	Waste Acceptance Operations
WPRAP	Waste Pits Remedial Action Project
XRF	X-ray fluorescence
yd^3	cubic yards

EXECUTIVE SUMMARY

This Implementation Plan describes the specific activities the U.S. Department of Energy (DOE) intends to execute to remediate soils, perched groundwater, and debris in Area 2 Phase I (A2PI) at the Fernald Environmental Management Project (FEMP). The A2PI area consists of the Inactive Flyash Pile, South Field, and Active Flyash Pile, collectively known as the Southern Waste Units (SWUs) and part of Operable Unit 2, as well as adjacent peripheral areas that are part of Operable Unit 5.

This Implementation Plan describes the area-specific remedial design/remedial action process steps discussed in the Sitewide Excavation Plan (i.e., predesign investigations, remedial design, remedial action, precertification, and interim restoration activities). Certification and final restoration (including follow-on activities) will be conducted separately and are not included in this Implementation Plan. The guidelines provided in the Sitewide Excavation Plan (SEP) are detailed in this document for area- and project-specific conditions encountered in A2PI.

Remedial action in A2PI will be performed in two phases by separate contractors: site preparation and excavation. The site preparation phase will consist of all work necessary to prepare the site for excavation. This includes construction of a storm water management system to segregate runoff from A2PI from adjacent areas to prevent contamination and recontamination. The excavation phase will include excavation, treatment/disposition of impacted material, and interim restoration of A2PI. The excavation phase will be staged to address the most contaminated areas first and accommodate funding constraints. The current plan is to remediate the Inactive Flyash Pile in the first year of the excavation contract, the South Field and part of the Active Flyash Pile in the second year, and the remainder of the Active Flyash Pile in the third year. Seasonal protection for the winter shutdown period and temporary seeding for disturbed areas that sit idle for more than 45 days are included in both the site preparation and excavation contracts. Construction drawings and technical specifications have been prepared for each phase. The construction drawings and technical specifications for the excavation phase are included with this Implementation Plan in the Integrated Remedial Design Package.

The remedial action requirements described in the construction drawings and technical specifications were developed in accordance with the concepts described in this Implementation Plan, as guided by

the OSDF WAC Attainment Plan and the SEP. As the integrating document for the IRDP, the Implementation Plan provides a comprehensive description of planned remediation activities.

The history and use of the SWUs suggest that a wide variety of material and contamination levels will be encountered during remedial action activities. The location of much of this material cannot be identified prior to excavation. Therefore, an integrated approach to excavation and excavation control monitoring will be implemented to assure that special material and material with contamination levels above the waste acceptance criteria (WAC) for the On-Site Disposal Facility (OSDF) are identified, segregated, and properly dispositioned. This integrated approach includes both visual and radiological monitoring during excavation activities.

Material to be excavated from A2PI consists primarily of fill material that was placed into the SWUs during FEMP operations and material with contaminant levels above final remediation levels (FRLs). Excavation and remediation of A2PI is expected to generate approximately 337,000 cubic yards of impacted material. It is anticipated that approximately 335,000 cubic yards of this material will be hauled to and dispositioned in the OSDF, with the remainder dispositioned to a permitted off-site commercial disposal facility.

Material that is not acceptable for placement in the OSDF will be excavated from A2PI on a priority basis. Approximately 1,700 cubic yards (based on preliminary predesign data) of impacted material with total uranium concentrations above the OSDF WAC will be segregated and staged in the Operable Unit 1 Stockpile pending off-site shipment and disposal at a permitted commercial facility. An additional 100 cubic yards (based on preliminary predesign data) of lead-contaminated soil is considered mixed waste and will be excavated, containerized, and shipped off site for treatment and disposal. An estimated 200 cubic yards of certain special materials that are prohibited in the OSDF are anticipated and will also be shipped off site for disposal.

Site preparation activities began in August 1997, with issuance of the Notice to Proceed to the site preparation contractor, who mobilized to the site in September. To accommodate this schedule, a draft Site Preparation Plan was submitted to the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA) for review in July 1997. The provisions of that document,

along with EPA and OEPA comments, have been incorporated into the design drawings, technical specifications, and this Implementation Plan.

This Implementation Plan covers the remediation of all of A2PI, scheduled for completion in early 2002. The excavation contract, however, which will include placement of impacted material in the OSDF, is scheduled to end December 31, 2000. Another contract for operation and construction of the OSDF is scheduled to be awarded in early 2001. Therefore, the excavation contract period is necessary to avoid potential logistical and operational conflicts. Since the excavation contract will terminate before certification of the Active Flyash Pile, supplemental excavation that may be required to certify the Active Flyash Pile, as well as any associated interim grading and restoration, will be performed by another contractor. Final restoration may be performed in the future under separate contract, depending on the final land use selected for the area, and may involve more than one remediation area. The overall schedule is dependent upon federal funding, regulatory approval, and weather conditions.

1.0 INTRODUCTION

This Implementation Plan describes the activities the U.S. Department of Energy (DOE) intends to execute to remediate Area 2 Phase I (A2PI) at the Fernald Environmental Management Project (FEMP). It details how the general remediation strategies set forth in the Sitewide Excavation Plan [SEP (DOE 1997a)] will be applied to remediation of A2PI.

The FEMP site has been divided into eight areas for remediation of soil and at- and below-grade structures and debris. As shown on Figure 1-1, Location Map of Remediation Areas, the southwestern corner of the FEMP has been identified as Remediation Area 2. The remediation of this area has been separated into two phases to prioritize removal of material that presents the greatest risk to human health and the environment. This Implementation Plan addresses Phase I of Area 2 (Figure 1-2, Location Map of Area 2, Phase I), which consists of the Inactive Flyash Pile, the South Field, and the Active Flyash Pile, collectively known as the Southern Waste Units (SWUs), as well as adjacent peripheral areas that are part of Operable Unit 5. Therefore, the details provided are based on the selected remedies described in both the Operable Unit 2 and Operable Unit 5 Records of Decision [RODs (DOE 1995a, 1996a)].

The SWUs, the Solid Waste Landfill, and the Lime Sludge Ponds comprise the Operable Unit 2 waste units. For remediation purposes, the SWUs have been separated from the Solid Waste Landfill and the Lime Sludge Ponds because of priority of risk (i.e., the SWUs contribute greater risk to human health and the environment due to the magnitude of contamination and close proximity of this contamination to the Great Miami Aquifer), geographical location, activities scheduled for surrounding areas, and drainage patterns associated with excavation sequencing. The Lime Sludge Ponds will be remediated with Remediation Area 3, and the Solid Waste Landfill with Remediation Area 6.

All A2PI excavation activities will be performed in accordance with the A2PI Integrated Remedial Design Package (IRDP). The IRDP consists of the following area- and project-specific documents:

- Implementation Plan (this document)
- Construction Drawings (excavation phase)
- Technical Specifications (excavation phase).

The remedial action requirements described in the construction drawings and technical specifications were developed in accordance with the concepts described in this Implementation Plan, as guided by the SEP. As the integrating document for the IRDP, the Implementation Plan provides a comprehensive description of planned remediation activities. This will facilitate regulatory agency review and define the scope of work necessary to procure equipment, supplies, and services for implementation of remediation.

Remediation involves strategic planning, preparation of design packages (construction drawings and technical specifications), and detailed remedial action planning. As presented in the Amended Consent Agreement [ACA (EPA 1991)], this remediation process includes preparation of remedial action work plans to cover construction activities and the establishment of an enforceable remedial action schedule. The goals of remedial design and remedial action, and the intent of the ACA, will be addressed through sitewide excavation planning, development of IRDPs, development of the OSDF Impacted Materials Placement Plan [IMPP (DOE 1996b)] and the Waste Acceptance Criteria (WAC) Attainment Plan (DOE 1997b), coordination with other FEMP activities, and remediation/construction activities. This Implementation Plan, as part of the IRDP and in conjunction with the SEP and these documents, fulfills the ACA requirements.

1.1 SCOPE AND GENERAL APPROACH OF THE IMPLEMENTATION PLAN

As shown on Figure 1-1 of the SEP, the area-specific remedial design/remedial action (RD/RA) process involves several steps, including:

- Predesign investigations
- Remedial design
- Remedial action
- Precertification and certification
- Post remediation activities.

This Implementation Plan covers all of these steps except certification and final restoration and follow on post-remediation. As stated in the SEP, a Certification Design Letter will be prepared and submitted to the regulatory agencies following completion of the precertification process. This will provide a summary of the area-specific remediation completed, results of the precertification activities, and design of the certification sampling and analysis program. Following completion of certification activities and agency approval, interim restoration (Section 3.6) will be completed. Final restoration

and follow-on post remediation activities will take place following interim restoration and be guided on a sitewide basis by the final version of the Natural Resource Restoration Plan [NRRP (DOE 1997c)].

Remedial action in A2PI will be completed in two stages, under two separate contracts: site preparation and excavation. Since this work will be completed under separate contracts, the construction drawings and technical specifications portions of the IRDP are also divided into site preparation and excavation packages. To expedite site preparation activities, a draft Site Preparation Plan (DOE 1997d) and site preparation construction drawings and technical specifications were submitted to the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) for review in July 1997. The provisions of the draft Site Preparation Plan, along with EPA and OEPA comments, have been integrated into the design drawings, technical specifications, and this Implementation Plan. Only activities necessary to prepare the site for excavation will be performed during site preparation. Material excavated during construction of site preparation facilities will be temporarily stockpiled (Section 3.1.9), used in the construction of temporary facilities associated with site preparation, or, in the case of special materials (Section 3.3.2.5), segregated and dispositioned by site personnel (Section 3.3.3).

The excavation phase involves removal and disposition of impacted material, including that stockpiled during the site preparation phase. Impacted material, for the purposes of this Implementation Plan, consists of all material that was placed in the SWUs as fill material and all non-fill material with contaminant levels above the A2PI final remediation levels (FRLs) for the area-specific constituents of concern (ASCOCs) (Section 2.2). In addition, all sediment collected in ditches and retention basins and on erosion control measures will be considered impacted. Impacted material that does not meet the chemical/radiological WAC for the On-Site Disposal Facility (OSDF) will be shipped off site to a permitted commercial disposal facility for final disposition (Section 3.3.2.2 and 3.4.2.3). Impacted material that does not meet the OSDF physical WAC will be processed to achieve the WAC and dispositioned to the OSDF (Section 3.4.2.2). Impacted material that meets the OSDF chemical, radiological, and physical WAC will be hauled to that facility for disposition (Sections 3.3.2.2 and 3.4.2.1). Impacted material from potentially toxicity characteristic locations specified in the SEP that offer a reasonable site-specific potential for cost-effective treatment will be shipped off site to a permitted commercial disposal facility for treatment and final disposition (Section 3.3.2.2 and 3.4.3).

The extent of excavation (Section 2.4) is based on:

- 1952 topographical maps, which show ground level elevations after some disposal activities had taken place
- Soil boring data to supplement the 1952 topographical maps to determine the 1951 (pre-disposal) ground level elevations
- Computer modeling of FRL concentrations using RI/FS data supplemented by predesign investigation data (Section 2.1.2).

Excavation will be to the deeper of two levels: either to the original 1951 ground elevations that existed prior to initial waste placement, or to the FRLs, as defined in the Operable Unit 2 or 5 ROD, whichever is more stringent (Section 2.2). The final excavation extent will be based on actual field conditions, radiological field survey measurements, and physical sampling results.

This Implementation Plan provides the overall framework and strategy for performing the included remediation activities. These remedial action activities are described in more detail in the construction drawings and technical specifications. The specific methods, means, and procedures to accomplish the work will be proposed by the selected contractors and presented in Safe Work Plans subject to review and approval by the contractor selected to manage remediation at the FEMP for DOE. Currently, this contractor is Fluor Daniel Fernald (FDF).

This Implementation Plan consists of the following sections:

- Section 1.0 - Introduction, which summarizes the purpose and scope of this Implementation Plan and describes programmatic strategies and requirements for implementation of this remedial action project.
- Section 2.0 - Predesign Investigations, which describes the ASCOCs for A2PI, the surface and subsurface conditions of the SWUs, the nature and extent of contamination, and the anticipated excavation boundaries based on remedial investigation/feasibility study (RI/FS) data and other data collected to fill data gaps.
- Section 3.0 - Remedial Action Approach, which summarizes the approach that will be used to implement excavation (i.e., site preparation, soil excavation and segregation, excavation control monitoring, material handling and treatment, seasonal protection, interim restoration, and institutional controls).

- Section 4.0 - Project-Specific Environmental Controls and Monitoring, which discusses environmental controls and associated monitoring which will be initiated as part of the remediation of A2PI.

- Section 5.0 - Project-Specific Health and Safety Matrix, which summarizes project-specific health and safety requirements and procedures.

- Section 6.0 - Remedial Action Management Strategy, which discusses the strategy for managing remediation activities in A2PI.

1.2 BACKGROUND AND DESCRIPTION OF THE REMEDIATION AREA

This subsection provides a brief discussion of the remediation area, including a description of the waste units and a description of potential priority areas that may be encountered during remediation of A2PI.

1.2.1 Waste Units

As previously mentioned, the SWUs consist of the Inactive Flyash Pile, the South Field, and the Active Flyash Pile. The following is a brief discussion of each waste unit. Detailed descriptions are provided in the Operable Unit 2 RI (DOE 1995b) and FS (DOE 1995c) Reports.

1.2.1.1 Inactive Flyash Pile

The Inactive Flyash Pile is located approximately 2,000 feet southwest of the former production area (Figure 1-2, Location Map of Area 2, Phase I) and immediately west of the South Field. Although there is no well-defined boundary between the Inactive Flyash Pile and the South Field, the Inactive Flyash Pile area is estimated to be 3.4 acres.

Beginning in 1951, the Inactive Flyash Pile received flyash and bottom ash from the on-site coal-fired boiler plant. Materials such as building rubble, concrete, asphalt, rebar, and transite (presumed to contain asbestos) were also discarded in this area and are visible throughout the Inactive Flyash Pile and South Field. Until March 1990, drill cuttings from soil borings outside the former production and waste storage areas, including off-property wells, were disposed of in the Inactive Flyash Pile.

The Inactive Flyash Pile was not an engineered disposal site but was constructed by dumping material off the previously existing erosional terrace face adjacent to Paddys Run. Additional dumping occurred along a haul road constructed along a south-facing embankment, thereby creating a south-facing slope. The Inactive Flyash Pile is bounded on the west by a drainage ditch and a portion of Paddys Run, on the north by an

access road, on the south by the former running track/firing range facility, and on the east by the South Field. Once disposal activities were discontinued, portions of the southern part of the Inactive Flyash Pile were covered with soil/fill. A covering of trees and dense brush has grown over the Inactive Flyash Pile.

The Inactive Flyash Pile contains predominantly flyash with up to six feet of silty clay and clay cover in the southern half of the unit. The flyash overlies the till surface existing in 1951; therefore, the topography of the flyash fill/till interface is characterized by erosional features that were cut into the pre-existing till surface prior to 1951. Cross sections of these features are included in the Operable Unit 2 FS (DOE 1995c).

Glacial till is present beneath most of the Inactive Flyash Pile, but thins toward the western and southern boundaries of the unit. Soil borings conducted in the Inactive Flyash Pile area indicate that the thickness of the glacial till ranges from zero in the southernmost portion of the unit to approximately 27 feet on the northern side. The Great Miami Aquifer, consisting of glacial outwash deposits of sand and gravel, underlies the glacial till.

1.2.1.2 South Field

The South Field is located approximately 2,000 feet southwest of the former production area (Figure 1-2), adjacent to the Inactive Flyash Pile, and covers approximately 10 acres. A running track and firing range used by FEMP security personnel were also located in the South Field/Inactive Flyash Pile area. The South Field was not an engineered disposal site. It was used randomly, on an as-needed basis, resulting in a variable thickness of fill and nature of waste. The South Field was used until the mid-1960s as a disposal site for construction rubble and as a disposal area for soil excavated from the former production area. Soil, building rubble, concrete, asphalt, flyash, and rebar have been encountered during previous sampling activities. Transite panels, presumed to contain asbestos, have also been observed in the South Field area. As discussed in the Operable Unit 2 ROD (DOE 1995a), field investigations indicate process waste may also have been disposed of in the South Field.

An east-west access road borders the northern extent of the South Field. A north-south access road, which leads to the former running track/firing range facility, borders the eastern and southern extent of the South Field. The west side of the South Field borders the Inactive Flyash Pile and running track area. The western South Field border slopes to the west; a portion of the western slope was used as the backstop for the FEMP

security firing range for 35 years. The South Field was graded with a covering of clay fill and is now overgrown with grass, brush, and trees.

Boring log data indicate fill material of variable thickness is underlain by glacial till deposits in the South Field/Inactive Flyash Pile area. As with the Inactive Flyash Pile, the Great Miami Aquifer underlies the glacial till. The glacial till is composed primarily of silty clay interbedded with lenses of clay and silt, sandy clay, and sand and gravel. These more granular lithologies (i.e., sand and gravel) are discontinuous and often cannot be correlated laterally between soil borings.

The southern portions of the South Field and Inactive Flyash Pile overlie till ranging in thickness from 0-2 feet, indicating that fill materials at the southern end of the South Field and Inactive Flyash Pile lie directly upon the sand and gravel of the unsaturated Great Miami Aquifer, with a few feet of colluvial material separating them.

1.2.1.3 Active Flyash Pile

The Active Flyash Pile is located approximately 2,000 feet south of the former production area and east of the South Field (Figure 1-2). The Active Flyash Pile covers an area of approximately 2.2 acres.

The Active Flyash Pile is a steep-sided pile of flyash and boiler ash that has been built up since the mid-1960s with dumped and compacted flyash from the coal-fired boiler plant. The Active Flyash Pile is surrounded on the east and south by dense trees and brush, and on the north by a grass field. The Active Flyash Pile is bounded on the west by a gravel access road that separates it from the South Field. There is a ditch between the Active Flyash Pile and this road. To the north, east, and south, the Active Flyash Pile is bounded by an area that slopes toward the Storm Sewer Outfall Ditch. The Active Flyash Pile is uncovered, but wind barriers and crusting agents have been applied to mitigate wind erosion. Silt barriers and rock berms have been installed to control surface water erosion.

Soil boring data indicate that the Active Flyash Pile was constructed on glacial till materials ranging from less than 2 feet thick (south of the Active Flyash Pile) to 16 feet thick (north of the Active Flyash Pile).

1.2.1.4 Implications to Remediation Activities

The history and use of the SWUs suggest that a wide variety of material and associated contamination levels will be encountered during remedial action activities. Because of the heterogeneity of this material, the specific location of all above-WAC contamination areas and special materials could not be totally identified in the RI/FS or predesign investigations. Therefore, special procedures will be implemented to:

- Ensure that excavated material with contamination levels above the OSDF WAC is identified, segregated, and properly dispositioned (see Sections 3.3 and 3.4)
- Ensure that special material encountered during excavation activities is properly identified (Section 3.3.4), handled, and dispositioned (Section 3.4).

1.2.2 Excavation Priorities

Potential excavation priorities listed in the SEP include locations with contamination levels above the OSDF WAC, hazardous waste management units, underground storage tanks, potentially toxicity characteristic areas, and special materials. In terms of the A2PI remediation project, there are no hazardous waste management units or underground storage tanks. The following paragraphs describe the priorities that are applicable to the remediation of A2PI, including above-WAC material, potentially characteristically hazardous material, and special materials.

1.2.2.1 Locations with Contamination Above OSDF WAC

One area within the Inactive Flyash Pile has been identified as containing total uranium contamination in excess of the OSDF WAC. Four other areas in the SWUs area have been identified as potentially containing total uranium/technetium-99 levels in excess of the OSDF WAC. Predesign investigations (Section 2.1.2.2) have been completed to confirm and delineate the extent of contamination in these areas (Section 2.4.1).

1.2.2.2 Potentially Characteristically Hazardous Areas

The former firing range area within A2PI has been identified as containing soil that has the potential to exhibit the toxicity characteristic for lead (40 CFR 261.24). Predesign sampling (Section 2.1.2.3) has been performed to delineate the extent of this contamination (Section 2.4.2).

1.2.2.3 Special Materials

Special materials that have been identified in the SWUs include presumed asbestos containing material (PACM), miscellaneous debris, piping, and non-soil residues. Based on the history and use of the SWUs,

these and other types of special materials are expected in the Inactive Flyash Pile and South Field. See Sections 3.3.2.5 and 3.3.4 for further discussion.

1.3 SUMMARY OF REGULATORY DRIVERS

Several regulatory criteria and legal obligations provide the basis for remediation activities within A2PI. These include:

- Applicable or Relevant and Appropriate Requirements (ARARs) or To Be Considered Criteria (TBCs)
- Permits
- Natural Resources Trusteeship.

The pertinence of each of these to the remediation of A2PI is discussed in the following paragraphs.

1.3.1 ARARs and TBCs

The ARARs and TBCs for the A2PI remediation project are presented in the Design Criteria Package (Appendix A).

1.3.2 Permits

Storm water discharges from remediation of A2PI are covered under the existing National Pollution Discharge Elimination System (NPDES) permit (OEPA Permit Number 1IO00004*ED) through the implementation of the permit-required sitewide Storm Water Pollution Prevention Plan (RM-0039). Thus, no modifications to the permit are required as a result of the A2PI remedial action. The A2PI retention basin pumping activity (Section 3.1.7.6) will be acknowledged in the forthcoming 1997 NPDES permit renewal application.

1.3.3 Natural Resource Trusteeship

Two mechanisms drive protection of natural resources during remediation, the natural resource trusteeship process and the pertinent federal and state regulations. Both of these mechanisms have been incorporated into A2PI remedial design.

A conceptual restoration design for A2PI has been presented to the Natural Resource Trustees as part of the NRRP. The proposed restoration (Section 3.6) consists of expanded riparian habitat and restored upland woodlots. The final plan will be implemented after approval by the Natural Resource Trustees.

Regulatory drivers for the management of natural resources and associated monitoring are grouped into three areas: threatened and endangered species protection, wetlands/floodplain protection, and cultural resource management.

Threatened and Endangered Species

Based upon 1993-1994 updated threatened and endangered species surveys at the FEMP, DOE does not expect to encounter any federal- or state-listed threatened or endangered species or critical habitat in A2PI. Therefore, no additional threatened/endangered species surveys have been conducted or have been planned.

Wetlands/Floodplains

Jurisdictional wetlands and waters of the U.S. were delineated in the 1993 FEMP Wetland Delineation, officially approved by the U.S. Army Corps of Engineers on August 19, 1993. Based on a review of an overlay of the A2PI boundary on the 1993 FEMP Jurisdictional Wetland Delineation (Figure 1-3), no jurisdictional wetlands or waters of the U.S. are anticipated to be dredged and filled during excavation of the A2PI remediation area.

A portion of A2PI is located within the 100-year floodplain of Paddys Run. The floodplain elevations of Paddys Run reach the western slope of the Inactive Flyash Pile and the toe of the South Field slope [Site Preparation Construction Drawing (SPDwg) G0003]. Potential impacts will be minimized through the design and implementation of appropriate erosion and sedimentation controls (Section 3.1.7). Retention Basin 3 has been designed to retain runoff from a 10-year storm event; Retention Basins 1 and 2 have been designed to retain runoff from a 25-year storm event. All of the storm water retention basin berm elevations have been designed above the elevation of a 10-year flood event in Paddys Run and sandbags will be used to raise the top of berm elevation of Retention Basin 1 above the 25-year flood level of 539.1 [mean sea level (msl)] in Paddys Run (Section 3.1.7.6). No long-term impacts or changes in the elevation of the 100-year flood in Paddys Run are anticipated as a result of A2PI remediation activities. The A2PI remediation activities are authorized by Nationwide Permit #38 (Cleanup of Hazardous and Toxic Waste) under 33 CFR 330.1(c).

Cultural Resource Management

The SWUs have been designated as a disturbed area (DOE 1997e), which means that a Phase I archeological survey is not required, since it is unlikely that any cultural resources are present. All areas in A2PI surrounding the SWUs have been surveyed, and no historic properties have been identified. All cultural resource activities pertaining to A2PI will be conducted in accordance with both a programmatic agreement (DOE 1997e) and the inadvertent discovery of cultural resources provisions of the Native American Graves Protection and Repatriation Act List and 43 CFR Part 10.

In the event that cultural resources are discovered, project personnel will follow the procedures outlined in Appendix F.4.2 of the SEP, and FEMP procedure EP-0003, "Unexpected Discovery of Cultural Resources." In such cases, the DOE will consult with the appropriate parties pursuant to 36 CFR Part 800 to determine a course of action to avoid and minimize, to the extent practical, any adverse impacts. If human remains, associated or unassociated funerary objects, sacred objects, or objects of cultural patrimony are discovered, the appropriate Native American tribe(s) will be consulted. During the consultation, DOE will cease activity in the immediate area and make a reasonable attempt to secure the remains and/or objects. Work stoppages in the immediate area would likely last at least 30 days.

1.4 COMPONENTS OF THE REMEDY

As described in the Operable Unit 2 ROD, the remedy selected to provide protection of human health and the environment involves the excavation of all impacted materials, material processing (if necessary) to meet sizing and moisture criteria for the OSDF, disposal in the OSDF of that material which meets the OSDF WAC, and off-site disposal of excavated material exceeding the OSDF WAC. The components of the selected remedy, as presented in the Operable Unit 2 ROD and as applicable to A2PI, and the commitment to ensure these elements are met include the following:

- Establishment of OSDF WAC for the on-site disposal of Operable Unit 2 materials. The OSDF WAC have been established and are discussed in detail in the IMPP, and the WAC Attainment Plan.

- Excavation, transportation and off-site disposal of approximately 1,700 yd^3 of material with a total uranium concentration above the OSDF WAC. This material will be staged in the Operable Unit 1 Stockpile area prior to off-site shipment to a permitted commercial disposal facility (see Section 3.3 for additional details). Note that the volume has been revised based on predesign data (Section 2.1.2.2), but may increase through the identification of additional above-WAC areas using radiological monitoring (Section 3.3.4.1).

- Excavation, treatment, and off-site disposal of approximately 100 yd^3 of soil from the former South Field firing range as mixed waste if toxicity characteristic leachate procedure (TCLP) analyses indicate it is characteristically hazardous for lead. The remaining impacted material excavated from the former firing range will be managed per sitewide procedure EW-1019, "Management of At- and Below-Grade Impacted Material" (see Section 2.4.2 for further details). Note that the volume has been revised based on predesign data (Section 2.1.2.3).

- Excavation to the depth established by the Operable Unit 2 FS. Excavation will be performed in such a way as to minimize dilution of waste and keep exposure to humans as low as reasonably achievable (ALARA). Excavation includes removal of all fill material placed in the SWUs by former DOE operations as well as all soil and debris with contaminant levels above FRLs (see Section 3.3 for additional details).

- Segregation of debris (e.g., concrete, steel, and pallets) from Operable Unit 2 subunits that meets the OSDF chemical and radiological WAC and requires processing to meet OSDF physical WAC prior to disposal in the OSDF. Strategies for excavation, including segregation of debris, are presented in Sections 3.3 and 3.4.

- Transportation and on-site disposal of excavated material that meets the OSDF WAC. A discussion of transportation and disposition is presented in Section 3.3.3.

- Collection and treatment of construction water from the Operable Unit 2 subunits. Strategies for excavation, including collection and treatment of surface water, are presented in Section 3.1.7 and the Surface Water Management Plan (Appendix B).

- Certification (previously identified as verification in the Operable Unit 2 ROD selected remedy components) sampling and analysis in the excavated areas to confirm material with ASCOC levels above FRLs has been removed. As discussed in Section 7.2 of the SEP, a Certification Design Letter will detail the proposed certification activities. If results of the certification sampling and analysis indicate that contamination above FRLs remains, supplemental excavation and certification sampling and analysis will be performed. The certification program is discussed in Section 3.4 of the SEP.

- Restoration of Operable Unit 2 subunits following excavation and certification sampling and analysis. Restoration of the Operable Unit 2 subunits will include seeding and fencing, as appropriate. The extent of final restoration will depend on the end use of the area and the appropriate habitat. Information regarding the interim restoration of A2PI is included in Section 3.6. The final land use will be included in the final version of the NRRP.

- Institutional controls such as access restrictions and groundwater monitoring at the Operable Unit 2 subunits. During remediation, access to the A2PI area will be restricted through the use of barriers and warning/caution signs. Groundwater monitoring, as listed in the Operable Unit 2 ROD, will be implemented using wells designated for long-term groundwater monitoring. These wells (located north of the Inactive Flyash Pile, south of the South Field, and south and east of the Active Flyash Pile), as well as long-term sampling and monitoring strategies, are identified in the Integrated Environmental Monitoring Plan

[IEMP (DOE 1997f)]. Long-term institutional controls necessary to implement restoration goals under the site's selected remedy are presented in the NRRP.

- Maintenance of the remediated Operable Unit 2 subunit areas after restoration. Periodic checks will be made to assure stable slopes. Maintenance of the SWUs area will be conducted in accordance with the habitat and end use of the area.

1.5 LESSONS LEARNED

A lessons learned program has been implemented to apply knowledge accumulated during successive remedial efforts conducted under the SEP. Integration of lessons learned from past remedial activities [i.e., Area 1 Phase I (A1PI)] is imperative to ensure future remedial activities meet all requirements and achieve the highest possible levels of quality at the project level.

Lessons learned during the A1PI remediation project have been incorporated into the SEP. Therefore, by following the guidelines provided in the SEP, these same lessons learned have been incorporated into the A2PI remediation project. In addition to the implementation of the SEP, the Soil Characterization and Excavation Project (SCEP) has been reorganized to provide a single project manager with overall responsibility for the entire remedial effort in an area. This reorganization (Section 6.1) will ensure better control over all activities associated with the remediation of each area and facilitate the dissemination of key information among project personnel.

Because of the general complexity and site-specific nature of soil remediation activities, soil remediation at the FEMP will continue to evolve based on lessons learned during successive remedial efforts. Lessons learned will continue to be applied to future work efforts to ensure that the highest possible quality of work is attained.

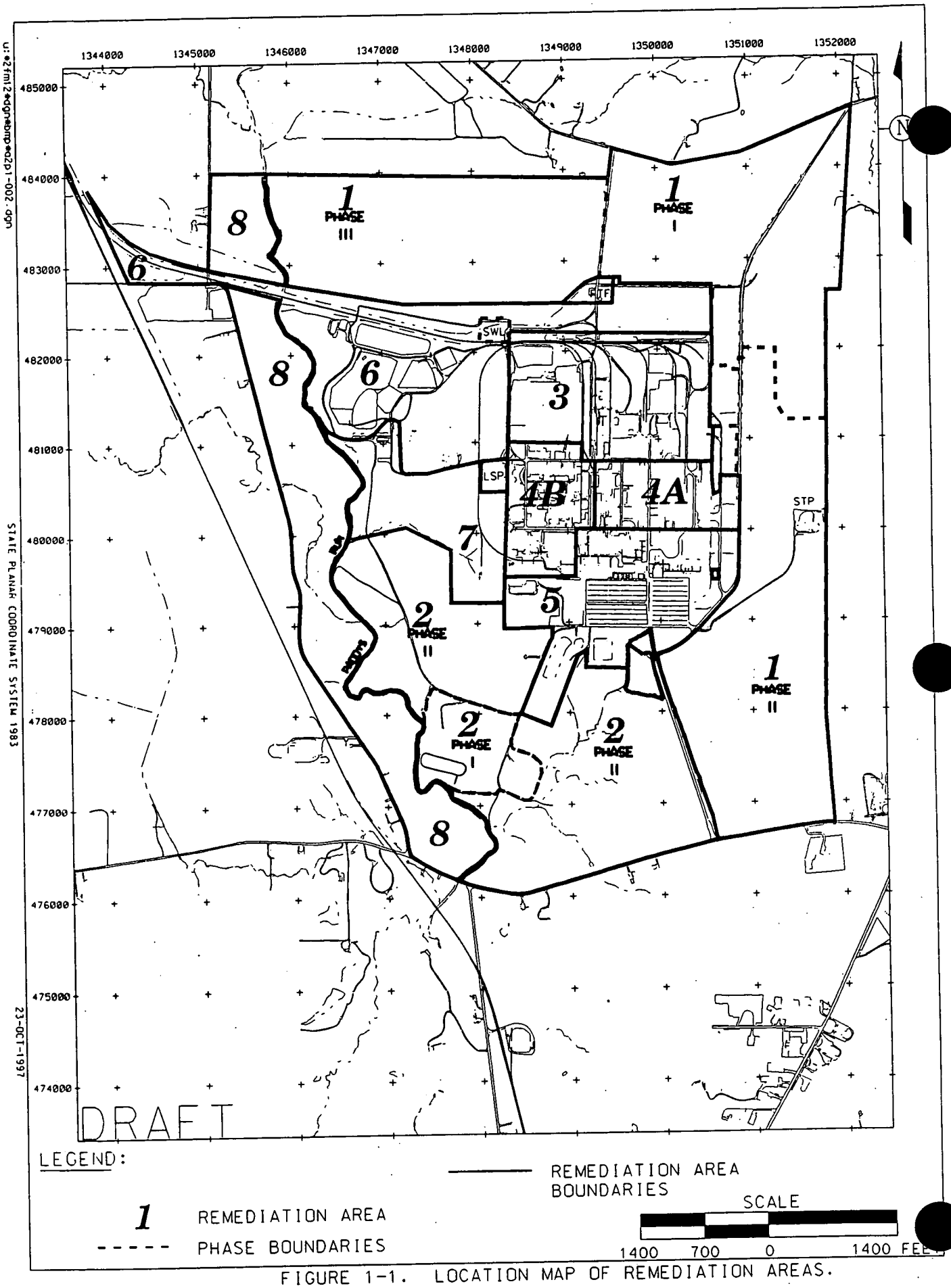

FIGURE 1-1. LOCATION MAP OF REMEDIATION AREAS.

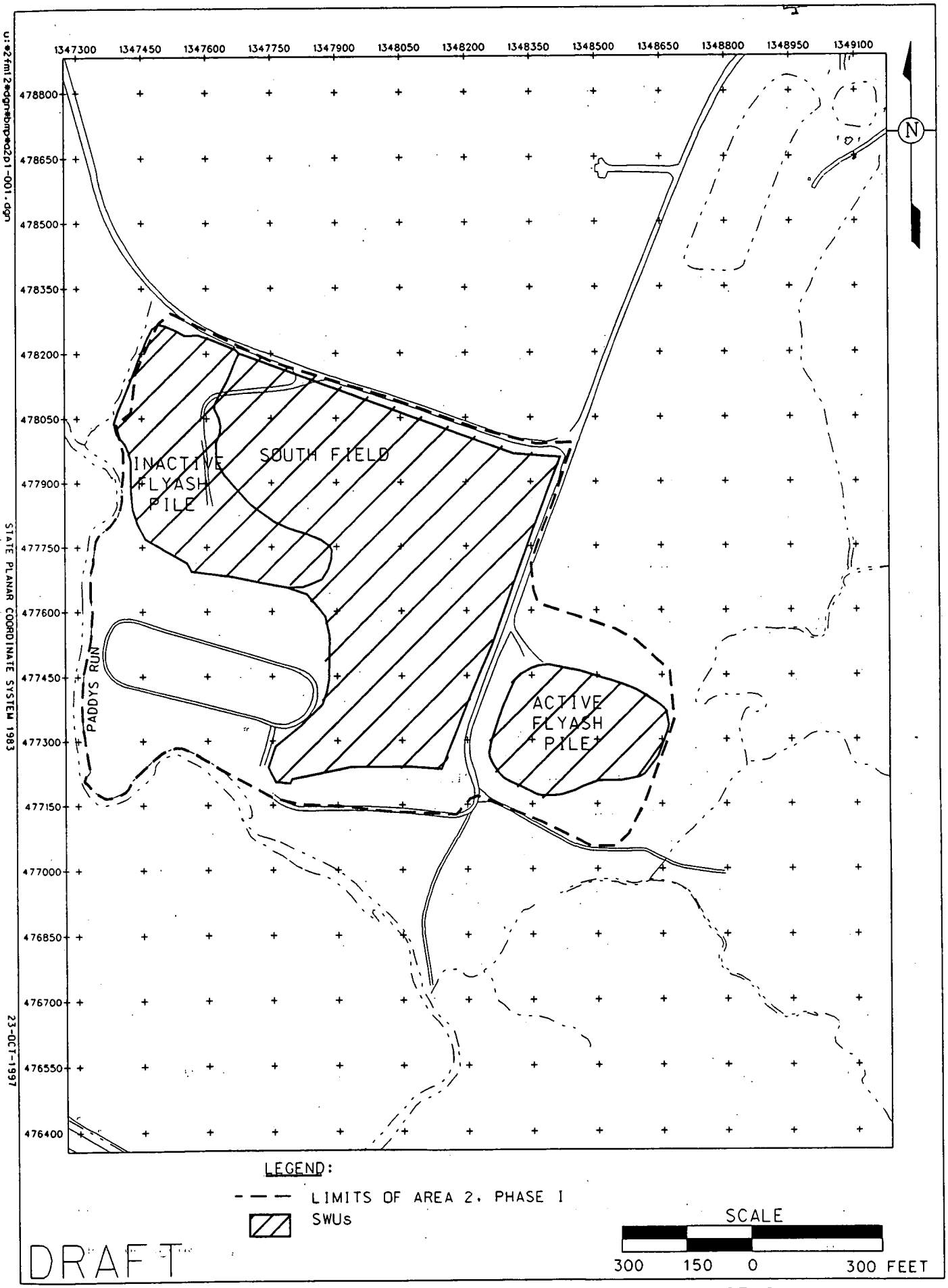

FIGURE 1-2. LOCATION MAP OF AREA 2, PHASE I

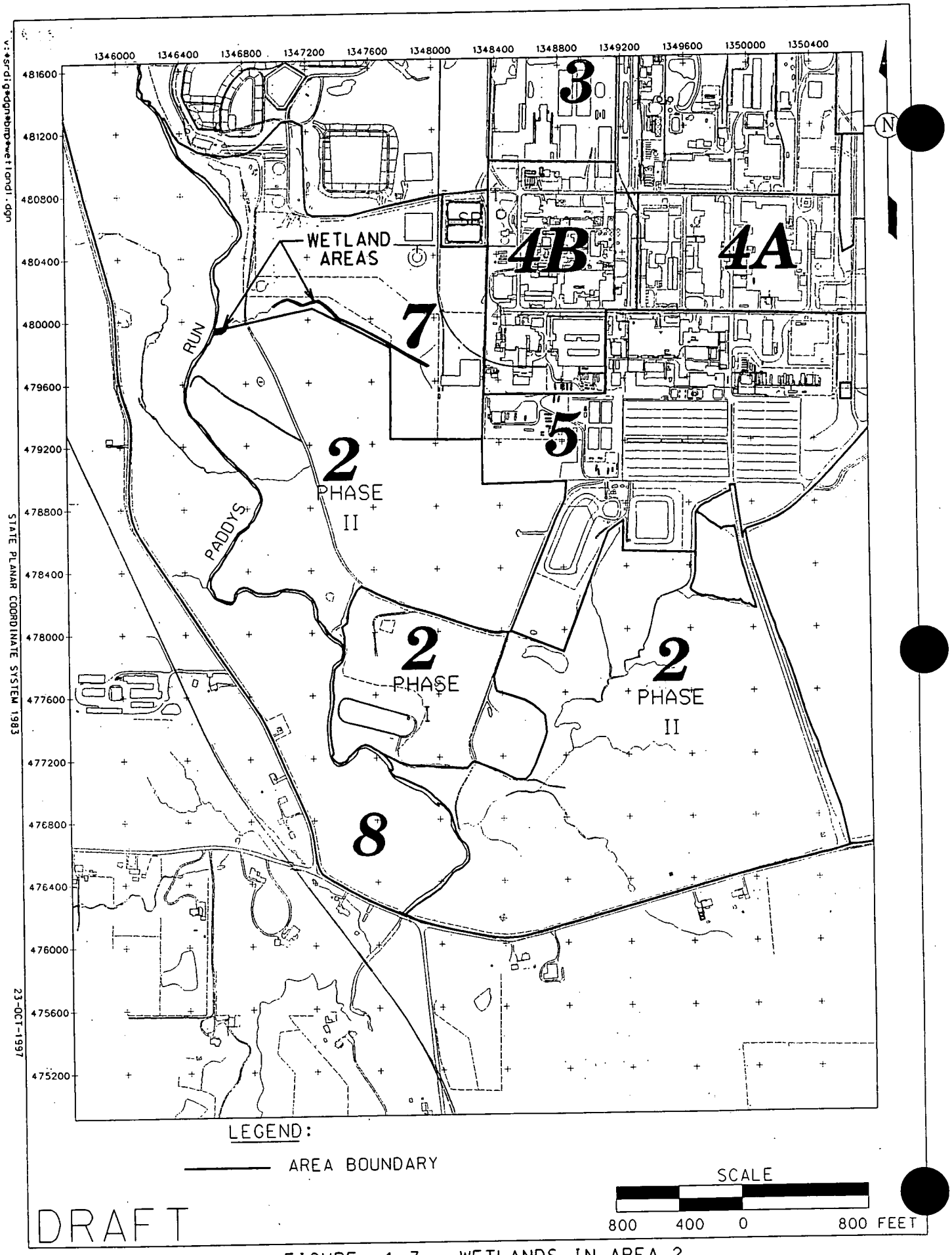

FIGURE 1-3. WETLANDS IN AREA 2

2.0 PREDESIGN INVESTIGATIONS

This section summarizes the investigations in A2PI that have been used in remedial design. These investigations include:

- The Operable Units 2 and 5 RI/FS activities
- Additional sampling and analyses to establish the presence of, and delineate the extent of, above-WAC contamination.

This information has been used to identify the ASCOCs for A2PI, describe the surface and subsurface conditions expected, and present the expected excavation boundaries.

2.1 SUMMARY OF RI/FS AND PREDESIGN INVESTIGATIONS

Predesign investigations that have been used to characterize A2PI include studies conducted as part of Operable Units 2 and 5 RI/FS studies and additional sampling and measurements that have been completed pursuant to RI/FS activities.

2.1.1 RI/FS Data Review

The nature and extent of radiological and chemical constituents within the SWUs are based on data collected during RI/FS field investigation activities. More detailed information regarding the extent and nature of contamination within the SWUs is available in Section 4.0 of the Operable Unit 2 RI Report (DOE 1995b). In addition, for the areas surrounding the SWUs, but still within the A2PI boundaries, details are provided in Section 4.0 of the Operable Unit 5 RI Report (DOE 1995d). The development and list of FRLs pertinent to Operable Units 2 and 5 are presented in the respective RODs (DOE 1995a and DOE 1996a).

Data gathered in the SWUs indicate that large volumes of solid waste and debris have been randomly deposited, along with small volumes of radiological and/or chemical wastes. The following paragraphs summarize the expected conditions in each of the SWUs.

Inactive Flyash Pile

In addition to flyash, other waste material, including sludge, clay drain tile, wood, nails, wire, transite, construction debris, and small amounts of organic waste, have been deposited in the Inactive Flyash

Pile. All materials except the flyash have above-background levels of radioactive contamination. The occurrence of uranium contamination in the perched groundwater under the Inactive Flyash Pile appears to be related to waste materials buried within or near the subunit. In addition, the Inactive Flyash Pile appears to be a source of uranium contamination for the Great Miami Aquifer beneath the central part of the subunit. Uranium is the only COC detected in the Great Miami Aquifer downgradient from the Inactive Flyash Pile.

There is an area within the Inactive Flyash Pile with total uranium concentrations in excess of the OSDF WAC. In addition, there are four other areas where uranium and/or technetium-99 levels in excess of the OSDF WAC are suspected. The presence and boundaries of this above-WAC material have been defined through predesign sampling activities (Section 2.1.2.2).

South Field

A wide range of waste materials has been encountered in the South Field, including concrete, steel pipe, sheet steel, wood, and clay tile. The level of contamination associated with some of this material suggests that it represents a potential source of radionuclides leaching into the groundwater. Some material at the former firing range contains potentially characteristically hazardous concentrations of lead. The boundaries of this lead contaminated material are being defined through predesign sampling (Section 2.1.2).

Active Flyash Pile

Field observations and historical documentation suggest that the Active Flyash Pile contains only flyash. Uranium-234, uranium-235/236, and uranium-238 were detected in the Great Miami Aquifer downgradient of the subunit, but, as discussed in Section 2.3.3, this is not believed to be associated with the Active Flyash Pile.

A2PI Area Surrounding SWUs

Review of the existing data suggests that most of the radiological and chemical contamination in A2PI outside of the SWUs is present in the surface soil. Uranium is the primary radiological contaminant. The inorganic constituents beryllium, cadmium, cyanide, lead, molybdenum, and silver have been detected at above-background levels. In general, the concentration of uranium decreases rapidly with depth.

2.1.2 Additional Sampling/Measurements

Three additional investigations have been conducted in A2PI pursuant to the RI/FS phase. These include:

- Sampling of site preparation areas
- Delineation of areas exceeding OSDF WAC
- Delineation of lead contaminated soil at the former firing range facility.

The purpose and results of each of these investigations are summarized in the following paragraphs.

2.1.2.1 Sampling of Site Preparation Areas

As described in Section 1.1, remedial action in A2PI will be conducted in two stages: site preparation and excavation. The purposes of the site preparation investigation (DOE 1997g) were to:

- Determine if impacted material being excavated in the site preparation areas (i.e., retention basins, stockpiles, utility corridors, ditches, support area, and equipment wash area) meet OSDF WAC

- Characterize soil within the limits of the three retention basins (Section 3.1.7.6) to determine its potential for reuse as nonimpacted backfill and/or grading material.

Preliminary results of this investigation (Appendix D) indicate that no impacted material in the site preparation areas exceeds OSDF total uranium WAC and that approximately 20,000 yd^3 of material from these areas has contamination levels below FRLs and can be stored in the nonimpacted stockpile (Section 3.1.9) pending reuse as clean backfill.

2.1.2.2 Delineation of Areas Exceeding OSDF WAC

Modeling of Operable Unit 2 RI/FS data indicates approximately 3,100 yd^3 of material in A2PI with total uranium contamination that exceeds the OSDF WAC of 1,030 mg/kg. In addition, results from the Characterization Investigation Study [CIS (Weston 1987)] indicate the presence of four locations with apparent contaminant levels in surface soil that exceed the OSDF WAC for total uranium, one of which also appears to exceed the OSDF WAC of 29.1 pCi/g for technetium-99.

An investigation (DOE 1997h) was performed to delineate the extent of known above-WAC contamination in A2PI, as well as determine the presence of other suspected or potential above-WAC

contamination in surface soil at locations outside of the site preparation areas that were previously identified (Section 1.2.2.1). Preliminary results (Appendix D) indicate that there is no surface soil at the five previously identified locations with contamination above the total uranium or technetium-99 WAC. These results also confirm the presence of above-WAC material at depth in the Inactive Flyash Pile. This area is located on the east side of the Inactive Flyash Pile adjacent to the South Field [Excavation Construction Drawing (EDwg G0006)] and it is situated directly on the sands and gravels of the Great Miami Aquifer. Based on this information, this area is approximately 40 feet wide and 120 feet long at a depth of 15-26 feet. The maximum total uranium concentration encountered in this location was 9,090 mg/kg. Based on 3-dimensional modeling of RI/FS and preliminary predesign data, the volume of this above-WAC material is estimated at 1700 yd^3. The revised volume and extent (Section 2.4.1) of this above-WAC contamination are reflected in the remedial design (EDwg G0006).

2.1.2.3 Delineation of Lead Contaminated Soil at the Former Firing Range Facility

Table 2-3 and accompanying Figure 1-5 of the SEP present a compilation of all areas where a reasonable potential exists for the presence of soil that is characteristically hazardous (see Section 2.1.1.3 of the SEP for additional discussion). As described in Section 2.1.1, one such area, the former firing range, exists within the A2PI remediation project area. This area was formerly used as a backstop for target practice by FEMP security personnel.

Results of the RI/FS investigations indicate a volume of approximately 300 yd^3 of lead contaminated soil at the former firing range facility. It was assumed in the Operable Unit 2 ROD that all of this material would be characteristically hazardous for lead and would be shipped off site for treatment and disposal.

The purposes of the lead delineation investigation (DOE 1997i) are to delineate the extent of lead contamination at the former firing range that exceeds the FRL (400 mg/kg) and make a preliminary determination of the RCRA status of this material. Preliminary results (Appendix D) indicate that the above-FRL area is approximately 20 feet wide and 45 feet long to a maximum depth of two feet. The maximum total lead concentration encountered was 1,573 mg/kg. Based on preliminary predesign data, the volume of above-FRL material is approximately 100 yd^3. It has been assumed that all of this material is characteristically hazardous for lead (i.e., leaches more than 5 mg/L of lead in the TCLP test) and will be handled as a mixed waste. The revised volume and extent of contamination are

reflected in the remedial design (EDwg G0008). An additional predesign investigation is being developed to better delineate the characteristically hazardous and above-FRL material. The results of this investigation will be submitted and the remedial design will be revised when the investigation is completed.

2.2 IDENTIFICATION OF EXCAVATION ASCOCS

The selected remedies for Operable Units 2 and 5 discuss the full suite of on-site COCs as well as their corresponding FRLs. Operable Unit 2 FRLs are the primary drivers for remediation in the SWUs. However, only three of these affect remedial design and excavation in A2PI. These include (Table 2-1):

- Total uranium, which drives design and excavation of above-WAC material in the Inactive Flyash Pile
- Lead, which drives design and excavation of the potentially characteristically hazardous and above-FRL material in the South Field
- Uranium-238, which drives design and excavation of above-FRL material in the remainder of A2PI.

These three are considered excavation ASCOCs because their combined extent bounds the extent of other COCs in A2PI. For these three, as indicated on Table 2-1, the more stringent (i.e., lower concentration) FRL between Operable Unit 2 and Operable Unit 5 has been selected. In the case of uranium-238, the most stringent FRL for the SWUs has been used (i.e., that for the South Field and Active Flyash Pile). As noted in Section 2.1.2.2, no above-FRL/WAC levels of technetium-99 were detected in A2PI. Based on this, technetium-99 is not considered an excavation ASCOC.

2.3 SUMMARY OF SURFACE AND SUBSURFACE CONDITIONS

Surface and subsurface conditions in A2PI are described in the following paragraphs in terms of surface coverage and drainage patterns, soil stratigraphy and geotechnical properties, the perched groundwater zone, at- and below-grade structures and debris, and groundwater monitoring wells.

2.3.1 Surface Coverage and Drainage Pattern

The SWUs cover approximately 15.6 acres within a total watershed area of 26.0 acres and have steep outslopes to the west, south, and southwest. The Inactive Flyash Pile and South Field outslopes are

heavily vegetated with trees and brush. Existing drainage consists of sheet flow and shallow concentrated flow that is generally uncontrolled before reaching Paddys Run. A portion of the Inactive Flyash Pile is situated adjacent to Paddys Run. A rock embankment was constructed under Removal Action 29 along a section of the eastern bank of Paddys Run to protect the Inactive Flyash Pile from stream erosion. A seepage control and collection system was constructed under Removal Action 31 to collect contaminated seepage from the Inactive Flyash Pile and South Field. The system pumps the collected seepage to the Advanced Wastewater Treatment Facility (AWWT) for treatment. Drainage area maps and calculations for A2PI are contained in the Surface Water Management Plan (Appendix B).

2.3.2 Soil Stratigraphy and Geotechnical Properties

The stratigraphy in the A2PI SWUs area consists of six classifications: flyash, fill, brown till, gray till, Great Miami Aquifer sand and gravel, and stratified glacial deposits. The depths and locations of these strata are given in Section 4.0 of the "Fly Ash Piles and South Field Waste Units Geotechnical Report" (Parsons 1996c). The geotechnical parameters summarized in the following paragraphs are taken from Section 5.0 of that same report.

The ash material in the Active and Inactive Flyash Piles is composed of mixed bottom ash and flyash and exhibits a wide range of moisture contents (from 16 to 52 percent). This suggests that some moisture conditioning of the material may be beneficial to facilitate handling and disposal. Earthen fill materials were generally classified as clays with varying amounts of gravel. Difficulties handling these earthen materials are not expected.

The brown and gray till have characteristics similar to soil and the stratified glacial deposits commonly contain zones of clay. Therefore, no significant difficulties in excavating, handling, and placing these materials are anticipated. Zones of saturated material may be encountered due to the presence of perched groundwater within the till, which may result in seepage into the excavation (Sections 3.1.7.4 and 3.3.2.6).

2.3.3 Perched Groundwater Zone

The perched groundwater at the Inactive Flyash Pile is located in saturated silty sand lenses within the till beneath the flyash, and in a saturated zone of flyash directly above the till. The till under the flyash

apparently slopes to the west, southwest, and south and truncates on the surface of the Great Miami Aquifer. This is believed to be the most significant mechanism to transport contamination from the SWUs to the Great Miami Aquifer.

Data suggest that perched groundwater in the northern portion of the Inactive Flyash Pile is flowing through waste materials containing uranium. This may be the source for uranium in the seepage.

Ten metals were detected at greater than background concentrations in the perched groundwater at the Inactive Flyash Pile. These include cobalt, nickel, and thallium, which were detected at elevated levels in the flyash. Uranium was also detected at elevated levels (up to 6700 g/L) in the same perched groundwater (DOE 1995b).

Total uranium was detected in all perched groundwater wells at the South Field. Perched groundwater north of the southeast corner of the South Field may be a source of recharge to the Great Miami Aquifer. The source of contamination in the perched groundwater beneath the Active Flyash Pile appears to be the South Field. A total of 22 constituents have been detected at above background levels in the Great Miami Aquifer beneath the SWUs (DOE 1995d).

2.3.4 At- and Below-Grade Structures and Debris

There are no known at- or below-grade structures present in the A2PI area. The SWUs were created by randomly placing material in undeveloped areas. Below-grade debris is anticipated, since the SWUs were used for uncontrolled dumping of various materials. Based on process knowledge and RI/FS data, it is known that a wide range of materials such as building rubble, construction debris, concrete, asphalt, clay pipe, wood, steel pipe, rebar, and transite is present in the Inactive Flyash Pile and South Field. The Active Flyash Pile is primarily composed of flyash and bottom ash, so the presence of other types of debris is not anticipated.

2.3.5 Groundwater Monitoring Wells

There are 37 groundwater monitoring wells in A2PI. Of these, 17 monitoring wells which will be encountered during excavation activities will be abandoned (plugged or removed) by FDF prior to the commencement of construction activities in the area. Fourteen groundwater monitoring wells and four extraction wells will remain and must be protected during construction activities. Wells remaining in

place and requiring protection are shown on the construction drawings (SPDwg G0003 and EDwg G0004). FDF will install the protection systems for these wells and the contractors will be responsible for any damage inflicted upon the wells. There is one groundwater monitoring well that was scheduled to be abandoned prior to excavation activities that is not completely abandoned. The excavation contractor will be responsible for removal of the well casings and concrete surrounding the casings to complete the abandonment process. Section 3.1.8 of this Implementation Plan provides additional details regarding the groundwater wells present in the A2PI area.

2.4 ANTICIPATED EXCAVATION BOUNDARIES

The anticipated boundaries of excavation in A2PI are defined in the following paragraphs in terms of addressing above-WAC material, potentially characteristically hazardous areas, and fill/above-FRL material.

2.4.1 Above-WAC Material

As described in Section 2.1.1 and confirmed during predesign investigations (Section 2.1.2.2), there is a volume of material with total uranium contamination in excess of the OSDF WAC (1,030 mg/kg) in the Inactive Flyash Pile. Based on the RI/FS and preliminary predesign information, there are approximately 1,700 yd^3 of this material (EDwg G0006). This material requires a specific excavation approach, which is presented in Section 3.3.2.2.

2.4.2 Potentially Characteristically Hazardous Areas

As described in Section 2.1.1 and confirmed during predesign investigations (2.1.2.3) there is lead contamination in the South Field. Based on RI/FS and preliminary predesign information, there are approximately 100 yd^3 of soil with lead contamination in excess of the FRL (400 mg/kg). This material is assumed to be characteristically hazardous and is therefore a mixed waste, which requires a specific remediation approach, which is presented in Section 3.3.2.2.

This material requires a specific remediation approach, which is presented in Section 3.3.2.2.

2.4.3 Fill/Above FRL Material

Operable Units 2 and 5 RI/FS data, predesign investigations (Section 2.1.2) and the South Field/Active Flyash Pile uranium-238 FRL (Section 2.2) were used to establish the extent of excavation of impacted

material in A2PI. Approximately 255,000 yd^3 of impacted material in A2PI exceed the total uranium FRL and meet the chemical/radiological WAC for the OSDF. An additional 80,000 yd^3 of excavation must be excavated to remove the remainder of all fill material and return the area to its original 1951 contours. After WAC attainment is demonstrated (Section 3.3.4.3), all of this material will be dispositioned to the OSDF. The footprint of this excavation covers nearly all of the SWUs and extends to the following depths:

- Site Preparation: Excavation of impacted (22,000 yd^3) and non-impacted (20,000 yd^3) material to construct site preparation facilities
- Inactive Flyash Pile: Existing grade level (msl elevation 570) in the northern and eastern portions, to approximately 30 feet deep (msl elevation 540) in the southern and western portions (EDwg G0005), a total of approximately 114,000 yd^3
- South Field: Existing grade level (msl elevation 563) in the northern portion, to approximately 20 feet deep (msl elevation 540) in the southern portion (EDwg G0007), a total of approximately 138,000 yd^3
- Active Flyash Pile: Existing grade level around the edges, to approximately 35 feet deep (msl elevation 555) in the south-central portion (EDwg G0007), a total of approximately 61,000 yd^3.

Backup calculations for these estimated earthwork volumes are provided in Appendix C. The excavation procedures to be used are discussed in Section 3.3.2.3.

TABLE 2-1

SUMMARY OF CONTAMINANTS PERTINENT TO EXCAVATION IN AREA 2, PHASE I

			Final Remediation Levels							
			Operable Unit 5 [b]		Operable Unit 2 [c]					
Constituent	Waste Acceptance Criteria for Soil and Sediment in the On-Site Disposal Facility [a]	Benchmark Toxicity Value	On-Property Soil	Sediment	Inactive Flyash Pile (over GMA)	Inactive Flyash Pile (> 16 ft natural soil)	South Field (over GMA)	South Field (> 16 ft natural soil)	Active Flyash Pile	FRLs Selected for use in SWUs
Uranium, total (mg/kg) (High K_L) [b]	1.03E+03	2.30E+02	8.20E+01	2.10E+02					2.80E+01	
Uranium, total (mg/kg) (Low K_L) [b]			2.00E+01		2.48E+01	2.48E+01	2.48E+01	2.48E+01		20[d]
Uranium-238 (pCi/g)	3.46E+02	1.20E+04			6.12E+00	3.22E+00	6.12E+00	3.22E+00	6.12E+00	3.22
Lead (mg/kg)		2.00E+02	4.00E+02				4.00E+02 [e]			400

Notes:
[a] From *Impacted Materials Placement Plan - On-Site Disposal Facility* (DOE 1996b).
[b] From Operable Unit 5 ROD (DOE 1996a).
[c] From Operable Unit 2 ROD (DOE 1995a).
[d] Listed because Operable Unit 2 FRLs were developed. The FRL for uranium-238 is more stringent and will be applied to all of A2PI.
[e] Only applies to the Firing Range.
ND = Not Detected

3.0 REMEDIAL ACTION APPROACH

This section presents the approach that will be used to remediate A2PI. The general approach is in accordance with "Excavation Approach B - Excavation in Waste Storage/Management Areas Outside the Former Production Area," described in Section 4.2 of the SEP (DOE 1997a). The performance requirements for implementing this approach are presented on the construction drawings and technical specifications for excavation activities included as part of the IRDP. As stated in Section 1.0, the construction drawings and technical specifications for site preparation activities have already been submitted. The drawings and specifications will become part of the Contract Documents, which will govern remediation activities performed by the construction contractors. Specific methods and procedures to perform the work will be detailed by the contractors in Safe Work Plans. As required by the contract documents, the Safe Work Plan for the site preparation and excavation contracts will include the following individual plans:

	Contract	
Component of Safe Work Plan	Site Preparation	Excavation
Material Documentation Work Plan	✓	✓
Traffic Control Plan	✓	✓
Dust Control Plan	✓	✓
Site Clearing Work Plan	✓	-
Excavation Work Plan	✓	✓
Impacted Material Work Plan	✓	-
Sheeting and Shoring Plan	✓	-
Quality Assurance/Inspection Program	✓	-
Water Management Plan	✓	-
Presumed Asbestos Containing Material Handling Plan	-	✓
Surface Water Management and Erosion/Sediment Control Plan	-	✓
Equipment Wash Plan	-	✓

The Safe Work Plans will be reviewed and approved by FDF before applicable remedial activities are implemented.

As described in Section 1.0, two contractors (the site preparation contractor and the excavation contractor) will perform the required remedial activities in a separate and sequential manner. The scope of work included in each of these contracts is described in the following subsections.

3.1 SITE PREPARATION

Site preparation activities consist of those tasks necessary to prepare the site for excavation. These activities will be performed by a construction contractor in accordance with the Site Preparation Contract Documents, which include the construction drawings and technical specifications. Site preparation activities will be completed before the initiation of excavation phase activities.

Impacted material excavated during site preparation activities will be stockpiled (Section 3.1.9) on the South Field and later dispositioned to the OSDF by the excavation contractor. Impacted material is expected to exhibit soil and soil-like characteristics and consist primarily of flyash and soil, with some building and construction debris. Material from installation of the retention basins (Section 3.1.7) determined to be non-impacted (Section 2.1.2.1) will be stockpiled (Section 3.1.9) within A2PI for potential future reuse as clean fill, or used to construct site preparation facilities.

Site preparation tasks include the following:

- Establishing site boundaries and access controls
- Surveying and site layout
- Establishing the support area
- Clearing
- Tie-in of utility hookups
- Installation of equipment wash facility
- Installation of surface water management system
- Installation of erosion and sediment controls
- Monitoring well abandonment/protection
- Construction/relocation of stockpiles.

3.1.1 Establishing Site Boundaries and Controls

The entire A2PI area will be classified as a radiological "soil contamination" area during site preparation activities, while existing posted areas within A2PI will be maintained. Initial preparation of

the A2PI area will include establishing the defined construction area in the field and posting appropriate signs at the boundaries (SPSpec 02100 and SPDwg G0005). The A2PI construction area will be defined by signs and construction fencing, which will also define the control boundary for the site. Gates will be installed at equipment access points.

3.1.2 Surveying and Site Layout

Project site survey control points (including baselines and temporary benchmarks) will be established in the field based on the coordinate system shown on the construction drawings (SPSpec 01050 and SPDwg G0004). In addition, all site preparation facilities, including the support area, ditches, retention basins, roads, equipment wash facility, utility lines, and other structures, will be located and staked.

3.1.3 Establishing the Support Area

A support area will be established at the northeastern edge of A2PI (SPDwg G0002) and outside the proposed excavation area. The area will include a radiological control point facility, field office, parking, laydown area, and other contractor facilities (SPDwg G0006). The radiological control point facility (SPSpec 13125) will consist of a trailer with radiological personnel monitoring equipment, an emergency shower, wash basins, and change-out room(s). All personnel will enter and exit the work area through this facility. The field office facility (SPSpec 13126) will consist of a trailer with office space and restrooms for construction management personnel.

3.1.4 Clearing

Clearing during A2PI site preparation activities will occur in two stages. Initial clearing will occur in those areas where site preparation activities will be performed, including:

- Retention basins
- Stockpiles
- Utility corridors
- Ditches
- Support area
- Equipment wash facility.

Initial clearing (SPSpec 02100) will consist of cutting all trees and brush in these areas to a height of one foot above grade, then chipping the material for use as on-site mulch during remediation. The

chips will be stored in the wood chip stockpile (Section 3.1.9) and periodically turned by the site preparation (SPSpec 02100) and excavation (ESpec 02150) contractors to prevent combustion. The stumps in the site preparation areas will then be ground in place (SPSpec 02205) and excavated with the surface soil for staging in the Impacted Material Stockpile (Section 3.1.9).

Final clearing will occur after surface water management facilities (Section 3.1.7) are constructed and functioning and consist of cutting and chipping all trees and brush in the remaining areas of A2PI to be disturbed during the subsequent excavation phase (SPSpec 02100). Stumps in these areas will remain in place and be ground and removed during the excavation phase (Section 3.3.2.1).

3.1.5 Tie-In of Utility Hookups

Existing electric and water service will be extended to the facilities associated with remediation of A2PI during the site preparation phase. This power will be extended from the substation near the Storm Water Retention Basin (SWRB) using power poles and overhead lines (SPDwg E0005). The electrical service will provide power to the support area, equipment wash facility, lift stations, as well as provide power for the South Field Extraction System. The power will be used for lighting, alarms, pumps, control systems, and other components.

Water service (SPSpec 02667) will be provided to the support area trailers, the equipment wash facility, and a yard hydrant (SPDwg N0003). This water will be provided by tapping into an existing 6-inch diameter drinking water line that parallels the road between the South Field and the Active Flyash Pile. Water will be used for drinking, showers, washing equipment, and dust control.

Pipelines (SPDwg N0002) will be necessary to transport water from the A2PI retention basins to the respective lift station (SPSpec 02668), and on to the SWRB (SPSpec 02669), as well as from the equipment wash facility, through the oil/sediment separator, to the existing seepage collection lift station (SPSpec 02668).

Trenches for underground utilities will be constructed and backfilled according to specification (SPSpec 02225). In general, trenches will be excavated to a depth below the bottom of the utility line, pipe bedding will be placed and compacted, the utility line will be installed, the remainder of the pipe bedding will be placed and compacted above the utility line, and the trench will be backfilled and

compacted. Impacted debris, including pipe, fencing, concrete, and conduits, that are removed during these activities will be handled according to established site procedures (Section 3.3.2.5). All soil and soil-like material will be returned to the trench pending final disposition during final restoration of the area.

3.1.6 Installation of Equipment Wash Facility

An equipment wash facility will be constructed during the site preparation phase at the point haul equipment from A2PI will access the dedicated Impacted Material Haul Road (SPDwgs G0002 and G0007). The equipment wash facility will be used by the excavation contractor to wash haul equipment (Section 3.3.3.2). The excavation contractor will be responsible for maintaining the haul road clear of mud, debris, and potentially impacted materials by washing the wheels and undercarriage of the haul equipment from A2PI accessing the haul road and routine cleaning of the haul road.

3.1.7 Installation of Surface Water Management System

A comprehensive surface water management system will be implemented to provide both management of storm water/perched groundwater and erosion and sedimentation control. Major components of the system will be constructed during the site preparation phase and maintained throughout the excavation phase. The types and sizes of the surface water management system components are summarized in the following paragraphs and detailed in the Surface Water Management Plan (Appendix B).

3.1.7.1 Overall Approach

Remediation activities and surface water management system practices will be performed to achieve the following general objectives:

- Prevent runoff from other areas from entering the project area
- Collect, control and provide sedimentation capacity for all runoff from disturbed areas
- Collect potentially contaminated runoff from support areas and potentially contaminated runoff/perched groundwater from excavation areas and treat it in existing FEMP treatment facilities
- Control storm water to prevent an increase in peak runoff.

The surface water management system will consist of the following (SPDwgs G0005 and N0002):

- Existing FEMP facilities
- Diversion ditches and related devices
- Excavation sumps
- Collection ditches
- Retention basins
- Other erosion and sediment control devices.

In general, the surface water management system has been designed to control, at a minimum, the runoff from a 10-year storm event. Certain components of the system, as described in the following paragraphs, have been designed for a 25-year storm.

3.1.7.2 Existing FEMP Facilities

Integral components of the surface water management system for A2PI include the SWRB and the AWWT facility. All water collected in the retention basins under the design conditions will be pumped to the SWRB for treatment at the AWWT facility.

3.1.7.3 Diversion Ditches and Related Devices

Runoff from uncertified areas upgradient and adjacent to A2PI (generally located north of A2PI) will be collected and diverted around A2PI and its associated surface water collection system. During remediation, this diversion will reduce the quantity of water requiring treatment. Following remediation, the diversion system will remain in place to prevent potential recontamination of A2PI.

Runoff from the forested area on the north side of the Inactive Flyash Pile and South Field is currently conveyed in a roadside ditch which flows to the west side of the Inactive Flyash Pile and into Paddys Run (SPDwg G0003). This ditch will be expanded during site preparation activities and direct runoff to a pipe culvert installed under the new Impacted Material Haul Road as part of the construction of the road (SPDwg G0005). This water will then flow into the existing catch basin and pipe system on the west side of the Inactive Flyash Pile, which currently conveys the flow to Paddys Run (SPDwg G0007). The existing pipe will be extended to convey this flow around the existing ditch (SPDwg G0008), which will be revised and used to convey runoff from the Inactive Flyash Pile to Retention Basin 1.

Runoff from upgradient areas north and east of the Active Flyash Pile will be collected in existing ditches and conveyed to the Storm Sewer Outfall Ditch (SSOD) (SPDwgs G0008 and G0005).

3.1.7.4 Excavation Sumps

As excavation is performed, active areas will be graded to drain to temporary collection sumps constructed by the excavation contractor within the excavation. The excavation contractor will install temporary excavation sumps in these collection points that will become part of the surface water management system. Since these sumps will be installed in the excavation phase, details regarding their design and construction are provided in Section 3.3.2.6.

3.1.7.5 Collection Ditches

Collection ditches will be constructed on the downgradient portions of the SWUs to collect potentially contaminated runoff from all the areas disturbed during excavation (SPDwg G0005). These ditches will convey the runoff to the A2PI retention basins (Section 3.1.7.6). A silt fence (SPSpec 02270) will be installed between the toe of the SWUs and the collection ditches to reduce sediment loading to the ditches and the retention basins. Where excavation for construction of the ditches extends into the Great Miami Aquifer (SPDwg G0012), a geomembrane liner (SPSpec 02713) will be placed in the bottom of the collection ditch. Runoff collection ditches D2 and D6, located on the perimeter of A2PI and adjacent to Paddys Run (SPDwg G0005), which discharge to Retention Basins 1 and 2, have been designed for a 25-year storm; other runoff collection ditches have been designed for a 10-year storm (see Appendix B for further details).

3.1.7.6 Retention Basins

Runoff from disturbed areas within A2PI will be collected in retention basins and pumped to the SWRB for treatment in the AWWT facility prior to discharge to the Great Miami River. The retention basins will be constructed south of, and adjacent to, the SWUs. These retention basins have been designed to comply with or exceed pertinent Ohio Department of Transportation and Ohio Department of Natural Resources guidelines. The basins will provide sediment and storm water storage (SPDwgs G0009, G0010, and G0011). Retention Basins 1 and 2 have been designed to store runoff from a 25-year, 24-hour storm event; Retention Basin 3, a 10-year, 24-hour storm event (see Appendix B for further details).

Since the excavation of these retention basins will extend into the Great Miami Aquifer, an infiltration barrier will be installed within the retention basins. This will consist of a one-foot thick layer of clay (SPSpec 02200) overlaid with a geomembrane liner (SPSpec 02713). The clay will be excavated from the designated OSDF sediment basin stockpile (SPDwg G0001) and hauled to A2PI by the site preparation contractor for use in the retention basins.

The outlet works for the retention basins will be a combination of a riser pipe and lift station. A riser pipe will be constructed within the storage area of each basin. The riser will have low level outlets and act as a filter for sediment. A discharge line will convey flow from the risers to a lift station near each retention basin. The lift stations will pump the water from the retention basins, through a common transfer line, to the SWRB.

The lift stations are designed to remove water from the retention basins within 72 hours. Pumping will be initiated when the water level in the lift station reaches a pre-established level and will continue until the water level returns to the low-level shutoff (SPDwg G0013).

The SWRB is designed for a 10-year, 24-hour storm event. When the SWRB's storage capacity is exceeded, flow bypasses around the AWWT and discharges directly to the Great Miami River. To reduce the risk of overflow from the SWUs retention basins into Paddys Run, A2PI Retention Basins 1 and 2 are designed with additional storage capacity. During periods when the SWRB is bypassing, the lift stations will continue to pump until the SWRB reaches its maximum capacity (i.e., the point of overflowing into the storm sewer outfall ditch, and subsequently into Paddys Run). When the SWRB reaches this level, the A2PI lift stations will be turned off. After the level in the SWRB drops below its freeboard capacity, the lift stations will be restarted. In this manner, there should be no direct discharge from Retention Basins 1 and 2 under design conditions.

To accommodate periods when the level in Paddys Run rises to a level near the top of the embankment for Retention Basin 1, sandbags will be used to increase the height of that embankment to an elevation of 541 msl. These sandbags will be in place before the excavation phase begins.

Accumulated sediment from the A2PI retention basins, ditches and erosion control measure will be monitored with field radiological survey equipment for attainment of OSDF radiological WAC and

dispositioned accordingly when the sediment depth reaches the sediment cleanout level indicated on the risers (SPDwgs G0013).

3.1.7.7 Other Erosion and Sediment Control Devices

Erosion and sedimentation control is a component of the surface water management system described in the Surface Water Management Plan (Appendix B) and the previous paragraphs. These controls are further detailed in the construction drawings (SPDwgs G0012 and G0013) and technical specifications (SPSpec 02270) and include:

- Silt fences
- Erosion control blankets
- Rock fill
- Silt berms/sediment barriers
- Temporary seeding
- Permanent seeding
- Crusting agents.

3.1.8 Monitoring Well Abandonment/Protection

Prior to contractor work in A2PI, FDF will abandon most of the monitoring wells within the excavation boundaries which exceed the depth of the proposed limit of excavation. General guidelines for abandoning wells are included in the SEP; general details regarding abandoning these wells are provided in the SCQ.

A total of 17 monitoring wells will be abandoned in the A2PI area (Table 3-1). The abandonment of one well (2945) which was scheduled to be abandoned by FDF will not be complete before the excavation phase begins and will have to be completed by the excavation contractor (Section 3.3.2.7). Monitoring wells remaining in the A2PI area for use in long-term monitoring programs are identified on the construction drawings and Table 3-1. FDF will install protection systems around these wells. It is the responsibility of both the site preparation and excavation contractors to ensure integrity of these wells is maintained by observing in place protection of the wells and preventing damage to the wells from any contractor activities (SPSpec 02100 and ESpec 02150).

3.1.9 Construction/Relocation of Stockpiles

The site preparation contractor will construct four new stockpiles and relocate one existing stockpile. The new stockpiles include:

- A woodchip stockpile, to be located north of the support area in the northeast corner of A2PI just west of the SWRB, near the meteorological tower (SPDwg G0002)

- An Impacted Material Stockpile (SPSpec 02205), to be located in the South Field, just west of the support area (SPDwg G0002). A geotextile fabric (SPSpec 02713) will be used to separate the stockpile material from the underlying soil (SPDwg G0005).

- Two non-impacted material stockpiles (SPSpec 02200), one to be located at the existing running track in the southwest corner of A2PI, and the other to be located northwest of the support area, in the north-central portion of A2PI (SPDwg G0002). A geotextile fabric and geomembrane liner (SPSpec 02713) will be used to separate the stockpile material from the underlying soil (SPDwg G0005).

The approximately 90 tons of material in the existing riprap stockpile, which is currently located at the site where Retention Basin 1 will be constructed, will be relocated just south of Retention Basin 1 (SPDwg G0005). The riprap stockpile is maintained for use in making repairs to the existing berm between Paddys Run and the Inactive Flyash Pile.

3.1.10 Installation of Treatment and Discharge Lines

Portions of the treatment and discharge lines that are associated with the groundwater recovery project and pass through A2PI will be installed during the site preparation phase. These lines will be installed in trenches that are common to those required for certain A2PI facilities. Since installation of these lines is not part of the remediation of A2PI, it is not discussed in this Implementation Plan.

3.2 AT- AND BELOW-GRADE STRUCTURE DEMOLITION

As stated in Section 2.3.4, there are no at- or below-grade structures present in the A2PI area, and therefore demolition issues are not relevant.

3.3 SOIL EXCAVATION AND SEGREGATION

Excavation activities will follow site preparation activities under a separate contract. A conceptual diagram of conditions following completion of site preparation activities is included as Figure 3-1, SWUs Prior to Excavation (May 1998). The excavation contractor will be responsible for:

- Excavating impacted material within A2PI

- Loading, hauling, and unloading impacted material that does not meet the OSDF WAC in temporary staging locations (i.e., the Operable Unit 1 Stockpile or the Special Materials Transfer Area) prior to offsite treatment and/or disposal

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- Containerizing and staging lead contaminated mixed waste in the Lead Contaminated Soil Container Transfer area

- Loading, hauling, and unloading impacted material that meets the WAC in the OSDF

As discussed in Section 1.0, impacted material, as used in this Implementation Plan, consists of all material that was placed in the SWUs as fill material and all non-fill material with contaminant levels above the FRLs. In addition, sediment collected in ditches and retention basins and on erosion control measures will be considered impacted. Nonimpacted material consists of natural soil exhibiting contaminant levels below the FRLs.

The limit of the design excavation depth was developed in accordance with the approach presented on Figure 3-2, Development of Excavation Design. As shown on that figure, the depth of excavation was developed by first determining:

- Original Ground - The original ground surface elevation was estimated by a review of 1952 topographic maps and soil boring data to determine the 1951 (pre-disposal) surface elevations

- FRL Model Line - The extent of contaminants above the FRLs was estimated by incorporating RI/FS and predesign data into a geostatistical model, which then provided an estimated surface of contaminant concentrations that are below FRLs.

The excavation design depth was then finalized by taking the deeper (lower) of the above lines and, when necessary, smoothing the contours to provide stable slopes. This excavation design depth is shown on the construction drawings and is the minimum excavation depth that will be achieved. Excavation control monitoring (Section 3.3.4), precertification sampling (Section 3.5), and certification sampling and analysis (Section 3.4 of the SEP) will determine the final excavation depth, which may exceed the design depth.

3.3.1 Excavation Sequence and Prioritization

The remedial action excavation will be performed in a phased manner consistent with the concepts presented in the SEP. The actual phasing and sequencing was developed based on:

- Contamination priorities. Excavation of impacted material in a given area with relatively high concentrations of contaminants (above WAC or characteristically hazardous) will be prioritized.

- Physical constraints. Excavation will be continuously monitored (Section 3.3.4) and must be performed at a pace that matches the limitations of the monitoring equipment and the ability of personnel to work safely within the area.

- Flow to OSDF. Excavation will be performed to support OSDF placement requirements and maintain the scheduled flow of material to achieve the target debris-to-soil ratio.

Based on the criteria presented above, contracting and funding requirements, and expected funding levels, the excavation period is scheduled to extend through three construction years, as follows:

- The first year will involve excavation of the Inactive Flyash Pile. It will consist of excavation of approximately 114,000 yd^3 of impacted material plus 1700 yd^3 of above-WAC material. This area was made a priority because of the impacted material with levels of total uranium that exceed the OSDF WAC (Section 2.4.1); this material is in close proximity to the Great Miami Aquifer. At the end of the first year (Figure 3-3, SWUs After First Year of Excavation [December 1998]), the Inactive Flyash Pile will be covered with a crusting agent (Section 3.3.5), since it will be too late in the season (Section 6.10) for seeding, followed by seeding in the spring of 1999.

- The second year of the excavation contract will involve removal and disposition of the Impacted Material Stockpile (in the South Field) generated during the site preparation phase, remediation of the entire South Field, and remediation of part of the Active Flyash Pile. An estimated 200,000 yd^3 of impacted material will be excavated during this phase (22,000 yd^3 from the stockpile, 138,000 yd^3 from the SF and 40,000 yd^3 from the Active Flyash Pile). The lead contaminated soil which is associated with the former firing range (an additional 100 yd^3) will be prioritized. Lead contaminated soil will be excavated, containerized, and staged in a designated area prior to off-site treatment and final disposition. At the end of the second year (Figure 3-4, SWUs After Second Year of Excavation [December 1999]), the South Field and disturbed portions of the Active Flyash Pile will be covered with a crusting agent (Section 3.3.5), since it will be too late in the season (Section 6.10) for seeding, followed by seeding in the spring of 2000.

- The third year will involve the removal and disposition of the remaining material in the Active Flyash Pile, an estimated 21,000 yd^3. At the end of this year (Figure 3-5, SWUs After Completion of Excavation [December 2000]), the newly disturbed areas of the Active Flyash Pile will be seeded (Section 3.3.5).

It is expected that the contractor will require at least two excavation crews throughout the contract period to meet the schedule constraints. Conceptually the implications of this are:

- In the Inactive Flyash Pile (year one), one crew will be working in the above-WAC area (Section 3.3.2.2) while the other excavates below-WAC material

(Section 3.3.2.3). Once all of the above-WAC material is removed, that crew would then excavate below-WAC material as well.

- In the South Field and Active Flyash Pile (year two), one crew will be working on the Impacted Material Stockpile while the other excavates other below-WAC material in the South Field. Once all of the Impacted Material Stockpile is dispositioned to the OSDF, that crew would excavate in the lead contaminated area (Section 3.3.2.2), then move on to other below-WAC material in the South Field, then both crews would move to the Active Flyash Pile.

- In the Active Flyash (year three), both crews will be excavating below-WAC material because of the limited time to complete the work (Section 6.10).

In all cases, if special materials (Section 3.3.2.5) or unexpected cultural resources (Section 1.3.3) are encountered, or if the crew is awaiting monitoring of a completed area (Sections 3.3.2.3 and 3.3.4.3), that crew will have to excavate in another location a safe distance from the non-excavation activities associated with these conditions (ESpec 02205). Thus, it is expected that at least three excavation areas may be open at any one time.

3.3.2 General Excavation Approach

During excavation, the A2PI area will be classified as a radiological "contamination" area. Excavation activities include the following:

- Grinding of stumps
- Prioritized excavation of impacted material
- Excavation of below-WAC material
- Excavation of debris
- Excavation of special materials
- Control of surface water
- Monitoring well abandonment/protection
- Transportation and disposition of impacted material
- Excavation control monitoring.

Each of these activities is discussed in detail in the following paragraphs. In addition, the excavation contractor will be responsible for placing soil and debris into Cells 1 and 2 of the OSDF, as well as construction of Cell 3. Requirements for these activities are included in the construction drawings and specifications for the OSDF Project.

3.3.2.1 Grinding of Stumps

All trees in areas to be excavated will be cut approximately one foot above the ground during the site preparation phase. All stumps located in areas that will be disturbed during site preparation (i.e., retention basins, stockpiles, utility corridors, ditches, support area, and equipment wash area) will be ground and chipped during site preparation. All other stumps will be ground in place and removed with the impacted material by the excavation contractor(ESpec 02205).

3.3.2.2 Prioritized Excavation

Impacted material that is known to exceed the OSDF WAC or that is RCRA characteristically hazardous will be excavated separately from material in the area that does meet the OSDF WAC. RI/FS and predesign sampling (Section 2.1.2) have been used to define the extent of impacted material that will be excavated in a priority manner (EDwg G0004). As these areas are excavated, the material will be segregated and handled separately and excavation control monitoring will be performed by FDF to ensure that the remaining material is below the OSDF WAC.

Above-WAC Material in the Inactive Flyash Pile

As discussed in Section 2.4.1, there are approximately 1,700 yd^3 of material in the Inactive Flyash Pile with total uranium contamination above the OSDF WAC of 1,030 mg/kg. The approach that will be used to excavate this above-WAC material is shown on Figures 3-6 and 3-7. Overburden material with contamination below OSDF WAC will be excavated (Figure 3-6, General Excavation on Top of Above-WAC Material) to the top of the above-WAC material. After the top of the above-WAC area is encountered, as determined by radiological field survey measurements (Section 3.3.4.1), excavation within the limits of this above-WAC material will be performed in four-foot lifts.

As shown on Figure 3-7, Above-WAC Excavation Approach, the side of the cut face of each lift will be scanned with field survey instruments (Section 3.3.4.1) to confirm that the limits of the above-WAC material do not extend laterally. If additional above-WAC material is detected, the lift will be expanded in the direction(s) indicated by the above-WAC measurement(s) until such material is removed.

After a lift is excavated in the above-WAC material, the adjacent below-WAC material will be excavated (Figure 3-7). For each lift, the above-WAC area will be left approximately one foot lower

than the surrounding area, and the surrounding area will be sloped away to facilitate control of surface water. Excavation will continue in this manner until, based on design data, the bottom of the above-WAC material is reached. Radiological field survey measurements (Section 3.3.4.1) will then be taken to demonstrate that all above-WAC material has been removed. Again, as needed, additional material will be excavated until all above-WAC material has been removed.

Above-WAC soil and soil-like material will be loaded into trucks and hauled to the Operable Unit 1 Stockpile. The loading area will be adjacent to the above-WAC area, toward the equipment wash facility, lined with a geomembrane, and sloped to drain into the above-WAC area (ESpec 02205). The location may be changed during excavation to facilitate loading. The contractor will be required to dump the material at the Operable Unit 1 Stockpile without contaminating the wheels of the haul equipment (ESpec 02205). The above-WAC material will be transported off site for final disposition (Section 3.4.2.3) at a permitted commercial disposal facility.

Lead Contaminated Soil in the South Field

As discussed in Section 2.4.2, there are approximately 100 yd^3 of material associated with the former firing range in the South Field with lead contamination above the FRL (400 mg/kg). This material is located on the west side of the South Field, at the base of a steep slope (EDwg G0008). The lead-contaminated soil is assumed to be characteristically hazardous and will be considered mixed waste. This material will be segregated and handled separately (Section 3.4.3). An additional investigation will be conducted (Section 2.1.2.3) to delineate the extent of the characteristically hazardous material.

Although not contaminated with lead, material at the top of the slope will be excavated (Section 3.3.2.3) and dispositioned to the OSDF. This excavation is required to keep material from sloughing down the slope, because of its steepness, and creating an unsafe condition. The mixed waste will then be excavated to the limits shown on the construction drawings (EDwg 60008). The approach that will be used to excavate this material is shown on Figure 3-8, Excavation of Lead Contaminated Soil. The mixed waste will be placed in containers and staged in the Lead Contaminated Soil Container Transfer Area (EDwg G0005) pending off-site shipment for treatment and disposal. Prior to closing the containers, samples will be collected to satisfy the requirements for waste acceptance at the permitted commercial off-site disposal facility.

Following excavation of the characteristically hazardous material, above-FRL material will be removed. After this excavation is completed, discreet samples will be collected for field x-ray fluorescence (XRF) analysis (Section 3.3.4.2), or the instrument will be used for in-situ analyses, to verify all of the above-lead-FRL material has been removed. As required by these measurements, supplemental excavation will then be performed. The above-FRL material will be hauled and unloaded in the OSDF.

3.3.2.3 Excavation of Below-WAC Material

Excavation of below-WAC material will typically take place in 3 ± 1-foot lifts (Figure 3-9, Typical Excavation Approach, and 3-10, Excavation Sequencing). This lift dimension is based on the approximately height of two passes with a typical excavator bucket. In addition to the specified lift height, the contractor will be required to excavate from an elevation higher than that of the material being excavated to assure that the face of the excavation is not obstructed and can be visually monitored. The combination of lift height, visual monitoring, and radiological survey monitoring will ensure that special materials and above-WAC gamma-emitting contamination are identified. Visual monitoring (Section 3.3.4.3) by FDF and contractor personnel will take place during this excavation to identify special materials. If special materials are identified, they will be handled in accordance with Section 3.3.2.5.

Upon completion of a lift in an approximately 100-foot-by-200-foot area, the contractor will provide at least a 50-ft. buffer zone (ESpec 02205) between the completed area and on-going excavation activities to allow radiological survey monitoring (Section 3.3.4.3) by FDF in the completed area. The purpose of this monitoring will be to identify above-WAC material. If any such material is identified, it will be handled in accordance with the procedures outlined in this subsection.

Upon completion of the excavation to the design depth, the entire area will be precertified (Section 3.5) to assure that the excavation depth is adequate to attain FRLs. As necessary, additional material will be excavated until the radiological surveying indicates that FRLs have been attained. The area will then be ready for certification (Section 3.4 of the SEP).

3.3.2.4 Excavation of Debris

Debris, such as reinforced concrete and structural steel, is anticipated to be encountered and removed from the A2PI area. Such material that exceeds the OSDF physical WAC will be excavated, processed to comply with physical sizing criteria discussed in the OSDF Impacted Material Placement Plan (1996b), and subsequently hauled to the OSDF for disposal. Processing of debris (Section 3.4.2.2) will occur with appropriate controls based on the processing method and area/material conditions. Debris that meets the OSDF physical WAC will be excavated with the surrounding soil and soil-like material and dispositioned to the OSDF.

3.3.2.5 Excavation of Special Materials

As described in the SEP, and used in this document, special materials include:

Friable PACM	Medical/infectious waste
Lead acid batteries	Pressurized containers
Piping/pumps	Tires
Nonpressurized containers	Uranium metal
Non-soil residues	Miscellaneous debris
Transformers/electrical equipment	

When these materials are encountered, the radiological level will first be determined by FDF Radiological Control Technicians (RCTs [Section 6.1.4]) for occupational health and safety considerations. Special material that cannot be handled by the contractor due to health and safety concerns will be handled completely by FDF. Under normal circumstances, these special materials will be identified, excavated, handled, and documented in accordance with the guidelines provided in Appendix F of the SEP and the requirements of the technical specifications (ESpecs 02205 and 02212). The excavation contractor will prepare procedures for special material handling and include these as part of the Safe Work Plan. Special materials will be placed in a safe configuration (i.e., container, plastic, etc.), as required, and temporarily staged in a Special Materials Transfer Area (to be located by the excavation contractor and approved by FDF - ESpec 02205) for later disposition by FDF Waste Management.

FDF Waste Acceptance Operations (WAO) will provide a field representative to observe all excavation activities (Section 6.1.3.6). This representative's primary function will be to assist with the

identification and handling of special materials, as well as documentation of the disposition of impacted material.

3.3.2.6 Control of Surface Water

Surface water will be controlled by the surface water management system constructed by the site preparation contractor (Section 3.1.7). The excavation contractor will use the surface water management facilities to support the excavation work. This will include monitoring and maintaining the retention basins, ditches and other facilities until all excavation is completed and the area is certified and turned over to FDF.

In addition to the surface water management components constructed by the site preparation contractor, the excavation contractor will construct interceptor ditches and excavation sumps to control surface water. Interceptor Ditch #1 will be constructed on the east side of the Inactive Flyash Pile (EDwg G0005). Since excavation of the Inactive Flyash Pile will occur in the first year of the contract and the South Field in the second year (Section 3.3.1). This ditch will prevent runoff from the South Field from cross-contaminating and recontaminating the Inactive Flyash Pile during and after remediation. Since this ditch is 12 feet deep at the down-stream end and constructed in fill material, there is a potential to encounter special and/or above-WAC material. Excavation control monitoring (Section 3.3.4.3) will be used during construction of the ditch. This monitoring may utilize HPGe equipment in locations inaccessible to the RSS/RTRAK.

Interceptor Ditches #2 and #3 will be constructed at the bottom of the terrace face which slopes to the sands and gravels of the Great Miami Aquifer (EDwg G0005 and G0007). These ditches will divert runoff from uncertified areas away from the exposed sands and gravels of the Great Miami Aquifer.

As excavation is performed, active areas will be graded to drain to collection points located within the excavation. Temporary excavation sumps (EDwg G0018) will be installed in these collection points to maintain a relatively dry work area, minimize the amount of runoff that may flow over the outslope of A2PI, and provide sediment capacity near the active area of excavation. Sediment storage capacity will be provided in each excavation sump below the intake for the pump. Water will be pumped out of the sumps and into the retention basins on an as-needed basis to keep the excavation area functional. Multiple excavation sumps may be used at the same time and will be continually moved as remediation

progresses to keep them in close proximity to the active excavation. Sumps in the above-WAC material that extend into the Great Miami Aquifer will be lined to minimize infiltration (ESpec 02205).

3.3.2.7 Monitoring Well Abandonment/Protection

As discussed in Section 3.1.8 and shown in Table 3-1, FDF will abandon most of the groundwater monitoring wells in A2PI which exceed the depth of the proposed excavation. One well (2945) has been partially abandoned by FDF, but the excavation contractor will be responsible for removal of the well to a depth below the design depth of excavation. Installation of this well was achieved using progressively smaller casing sizes ("telescoping") to ensure well integrity. Currently, the cross section contains a 4-inch diameter stainless steel casing within a 10-inch diameter stainless steel casing, which is within a 12-inch diameter stainless steel casing, which is within a 16-inch diameter stainless steel casing. Between each stainless steel casing is a 12-inch layer of concrete. The excavation contractor will be responsible for removal of the well casings and the concrete within the casings to a depth five feet below that of expected excavation (i.e., the casings will be cut off at 25 feet below present grade). The casings and concrete are to be removed in a manner so as not to compromise personnel safety; excavation removal strategy will be presented as part of the contractor's Safe Work Plan and is subject to FDF review and approval.

3.3.3 Transportation and Disposition of Impacted Material

Impacted material excavated from the A2PI area will be hauled to the OSDF (the majority of the material) or the Operable Unit 1 Stockpile (for above-WAC material), the Special Materials Transfer Area (for special materials), or the Lead Contaminated Soil Container Transfer Area. The majority of this movement will use the Impacted Material Haul Road. To minimize the amount of material tracked onto the Impacted Material Haul Road, equipment wash facilities (Section 3.3.3.2) will be installed at the SWUs for equipment leaving the SWUs, and at the OSDF for equipment leaving the OSDF. Lead-contaminated soil will be placed in containers and staged in the Lead Contaminated Container Soil Transfer Area (EDwg G0005), pending off-site shipment for treatment and disposal. Special materials will be staged in a Special Materials Transfer Area for disposition by FDF Waste Management. Measures will also be implemented to control the generation of dust during the hauling of material (Section 4.2.2).

3.3.3.1 Impacted Material Haul Road

The Impacted Material Haul Road (EDwg G0002) will begin at the northwest corner of A2PI and generally head in a northerly direction along the west side of the former production area, then turn east along the north side of the former production area and connect with the north end of the OSDF. The haul road is being constructed as part of initial construction activities associated with the OSDF. The haul road has been designed for standard highway H-20 loading and can accommodate off-road haul equipment up to a gross weight of approximately 53 tons. It will be operational prior to initiation of the excavation phase of remediation in A2PI. The haul road will be used to transport impacted material meeting the WAC to the OSDF for disposition, as well as material exceeding OSDF WAC to the Operable Unit 1 Stockpile.

During the excavation phase, the entire A2PI area, Impacted Material Haul Road, and OSDF will be classified as one radiological "contamination" area. Dust control measures and equipment washing procedures will minimize the spread of soil and contamination within the area. The OSDF equipment decontamination facility will be used to decontaminate equipment before it leaves radiologically controlled areas.

3.3.3.2 Equipment Wash Facility

As described in Section 3.1.6, an equipment wash facility will be constructed by the site preparation contractor in A2PI where haul equipment will access the new Impacted Material Haul Road. The excavation contractor will install the wash equipment at the facility and operate and maintain it during the excavation phase to meet the performance criteria established in the specifications (ESpec 02850). This equipment wash facility will be used to remove soil and debris from the equipment wheels and undercarriage to minimize the amount of material deposited on the haul road, thereby minimizing potential dust generation.

3.3.4 Excavation Control Monitoring

During remediation activities in A2PI, excavation- and disposition-focused monitoring will occur in regard to the following types of material:

- Material with contaminant levels exceeding the OSDF WAC
- Lead-contaminated soil
- Material with contaminant levels below the OSDF WAC.

An integrated approach to monitoring has been developed and is described in more detail in Appendix E. Since RI/FS data indicate there are no organic COCs in A2PI that affect design or excavation (Section 2.2) or that exceed the OSDF WAC, only organic monitoring associated with health and safety requirements will be performed.

3.3.4.1 Material with Contaminant Levels Exceeding the OSDF WAC

Excavation of the known above-WAC material in the Inactive Flyash Pile (Section 3.3.2.2), as well as other such material encountered during excavation (Section 3.3.4.3), will be monitored and controlled using radiological field survey measurements. The RI/FS data and results from the predesign investigations (Section 2.1.2) have delineated the extent of an area of above-WAC concentrations of uranium in the Inactive Flyash Pile (Section 2.4.1). This material will be excavated as described in Section 3.3.2.2 and shown on Figure 3-7. As detailed in Appendix E, the Radiological Scanning System (RSS) or high-purity germanium (HPGe) detector will be used to monitor the side of the cut face of each lift to verify that material exceeding the OSDF uranium WAC is not present. If necessary, additional material will be excavated until the sides of the excavation are confirmed to be below the OSDF total uranium WAC. Upon removal of all above-WAC material from that lift, the excavation/scanning process will iterate through successive lifts until the design depth is reached. The entire floor of the excavation will then be scanned with the Real Time Radiation Tracking System (RTRAK), RSS, or HPGe to verify that material exceeding the OSDF total uranium WAC has been removed. If above-WAC material is detected in the floor of the excavation at the design depth, additional material will be removed, as necessary, and the floor will be rescanned.

3.3.4.2 Lead-Contaminated Soil

Excavation of the lead-contaminated soil (Section 3.3.2.2) will be monitored using a portable XRF instrument. The RI/FS data and results from the predesign investigation (Section 2.1.2.3) have delineated the extent of soil that contains lead contamination above the FRL (Section 2.4.2). All of this material has been assumed to be characteristically hazardous, but an additional investigation will be conducted to delineate the extent of this material. This soil will be excavated, containerized, and staged pending off-site treatment and disposal (Section 3.3.2.2).

After the characteristically hazardous material has been removed, soil with lead contaminated above the FRL will be excavated. As detailed in Appendix E, discrete soil samples will be collected from within

the limits of the lead excavation and undergo XRF analysis via a portable field instrument to obtain preliminary verification that all above-lead-FRL soil has been removed. Alternatively, in-situ analyses may be performed. If the XRF screening indicates the presence of soil containing above-FRL concentrations of lead, additional excavation will take place and the XRF screening will be repeated. This step will be reiterated until the screening indicates the remaining soil is below the lead FRL.

After XRF screening indicates that all above-FRL soil has been removed, discrete samples will be collected from locations at the base of the lead excavation and sent to a laboratory for lead analysis. If laboratory results indicate that above-FRL material persists, additional material will be removed and the base of the footprint will be resampled for further laboratory analysis. In addition, radiological monitoring will be performed to confirm that all above-FRL radiological contamination has been removed. Upon confirmation that all above-FRL material has been excavated, the area will be ready for certification (Section 3.4 of the SEP).

3.3.4.3 Below-WAC Material

As stated in Section 3.3.2.3, excavation of below-WAC material will typically occur in lifts. As the face of a lift progresses across an area, two types of monitoring will take place (Figures 3-9 and 3-10). First, the face of the excavation will be visually monitored for special materials and changes in the appearance of the soil/material. If special materials are identified, they will be excavated and handled according to guidelines provided in Section 3.3.2.5 and detailed in the contractor's Safe Work Plan. A change in the appearance of the soil/material being excavated may indicate other unexpected conditions, and the contractor will coordinate with FDF CM and WAO field personnel (Section 6.6) to determine the required action, if any. As necessary, the contractor will stop work, or proceed in another area, until the issue is resolved.

In addition to visually monitoring the face of the excavation, radiological monitoring of the entire surface of each lift will be conducted, to the extent possible, with RSS/RTRAK or HPGe equipment to identify above-WAC uranium activity that may be present. If potentially above-WAC uranium activity is identified, additional material will be excavated, as necessary, to remove all above-WAC material (ESpec 02205). In cases where the radiological monitoring indicates the potential for extensive above-WAC contamination, either vertically or horizontally, physical samples and real-time analysis of collected cores may be utilized to delineate the extent of above-WAC material prior to excavation.

Following completion of excavation to the limits shown on the construction drawings (EDwgs G0005 and G0007), measurements will be taken to precertify (Section 3.5) the floor of the excavation for gamma-emitting radionuclides. If precertification criteria are not met, additional excavation will take place to remove the identified contamination. Excavation will cease when the floor of the excavation is shown to meet the precertification protocol for gamma-discernable radionuclides. The excavated surface will then be certified, as described in the Certification Design Letter (Section 7.2 of the SEP), which will be developed subsequent to excavation in each area.

3.3.5 Miscellaneous Excavation Requirements

During site preparation, impacted material will be temporarily placed into the South Field Impacted Material Stockpile (Section 3.1.9). This stockpile will be located in the South Field to prevent material from being removed from the SWUs during site preparation. It will contain approximately 22,000 yd^3 of impacted material excavated during site preparation activities. This stockpile will be excavated during the excavation phase and placed directly into the OSDF. As described in Section 2.1.2, WAC attainment sampling and analysis was performed on the impacted material prior to excavation. Therefore, excavation of this stockpile will not require radiological monitoring, although visual monitoring will be performed during excavation and loading.

Appropriate measures will be implemented to control the generation of dust. These measures include temporary seeding or application of a crusting agent in areas to be left idle for more than 45 days (ESpec 02275), and the use of water, dust suppressants, crusting agents, and other measures to control dust during actual excavation activities (Section 4.2.2).

All interim and final movements of impacted material will be documented as required by the contract documents (ESpecs 02212 and 02205). This data will be incorporated into the Integrated Information Management System (IIMS [Section 3.4 and 6.7]).

3.4 MATERIAL HANDLING AND TREATMENT

Excavation in A2PI will consist primarily of soil, flyash, and debris. Excavation of this material will be in accordance with the requirements contained in the project-specific technical specifications

(ESpec 02205) and shown on the construction drawings. Specific construction methods and procedures to achieve these requirements will be detailed in the excavation contractor's Safe Work Plan, (ESpec 02205).

3.4.1 General Requirements and Objectives

The technical specifications provide general requirements for the removal and handling of excavated material. Flow charts in Appendix F of the SEP provide general guidelines for the excavation and handling of special materials expected to be encountered in A2PI. Because most of the excavated impacted material will be placed in the OSDF, the OSDF Impacted Material Placement Plan is included as part of the contract documents.

During excavation, it is possible that unexpected conditions will be encountered that are not addressed through standard excavation specifications and guidelines. The combination of specifications and contractor Safe Work Plans establish procedures to be implemented in such cases, including moving excavation activities to another area to allow evaluation of the unexpected condition. This approach will minimize and/or prevent work stoppages/slowdowns and keep the excavation process moving forward.

3.4.2 WAC Attainment

Attainment of WAC involves both criteria for disposal in the OSDF as well as criteria for disposal in off-site facilities for material that does not meet the OSDF WAC.

3.4.2.1 Attainment of OSDF WAC

A key component of the OSDF WAC attainment program is the IIMS tracking system (Section 6.7), which maintains traceability of excavated impacted material to RI/FS, predesign, precertification, and supplementary WAC data.

The following actions will be performed to demonstrate compliance with the OSDF WAC:

- Assign OSDF-bound materials to material profiles
- Implement IIMS tracking requirements
- Segregate impacted materials according to OSDF Impacted Materials Placement Plan Categories 1 through 5 (DOE 1996b)

- Reduce size, fill void spaces, package (if required), and otherwise comply with physical OSDF WAC requirements
- Visually inspect the material to verify it meets physical OSDF WAC requirements
- Visually inspect the material to verify it does not include prohibited items
- Perform IIMS WAC attainment query in conjunction with manifest preparation, to verify material meets OSDF chemical/radiological WAC
- For OSDF Category 5 non-soil residues:
  - Complete a supplementary sampling program to assess type and level of contamination
  - Implement required actions

Material that does not meet the OSDF physical WAC will be processed and hauled to the OSDF for disposal. It is expected that, based on the types of material expected in the SWUs, the need for this segregation and processing will be minimal. Therefore, such required processing will take place at or near the area from which the material was excavated. Anticipated processing includes size reduction of concrete, pipe, and debris using excavation equipment. Before size reduction, pipe will be inspected to ensure that it contains no process material.

Processing of debris will be appropriately controlled based on the processing method and area/material conditions. Such controls, if required, may include water sprays, dust suppressants, or foam to reduce the generation of fugitive dust.

3.4.2.2 Special Material Not Meeting OSDF WAC

Management of special materials (Section 3.3.2.5) that do not meet the OSDF WAC will be coordinated with FDF Waste Management be in accordance with the SEP, WAC Attainment Plan, and "Management of At- and Below-Grade Impacted Material" (EW-1019). The following generator information will be provided to IIMS (Section 6.7) by the excavation contractor (ESpec 02212) for material not meeting the OSDF WAC:

- Estimated volume
- Material Tracking Location (MTL) of origin
- Visual description of material.

FDF Waste Management will be responsible for assuring off-site WAC are met prior to transportation of material to such off-site disposal facilities. Responsibilities for materials that fail the chemical/radiological OSDF WAC are listed below:

- Completion of waste profile
- Evaluation for treatment
- Identification of appropriate off-site disposition
- Receipt of approval from the receiving facility
- Packaging for shipment
- Certification for Department of Transportation (DOT) requirements
- Coordinating off-site shipment.

3.4.3 Lead Contaminated Material

Lead contaminated soil from the former firing range that is demonstrated to exceed RCRA toxicity characteristic limits will require treatment to comply with land disposal restrictions [LDRs (40 CFR 268)] before final disposition. Management of this soil will also be coordinated with FDF Waste Management. The same generator information (ESpec 02212) required for above-WAC material will be provided to IIMS by the excavation contractor. FDF Waste Management will be responsible for assuring off-site WAC are met prior to transportation.

3.5 PRECERTIFICATION EVALUATION AND SUPPLEMENTAL EXCAVATION

Precertification screening and analytical results will be used for a number of applications including, but not limited to, the following:

- Delineation of soil exceeding FRL concentrations
- Identification of soil with contamination levels above "hot spot" criterion (as defined in the SEP)
- Finalization of certification unit design.

Precertification sampling and analysis will be conducted for uranium following the excavation of impacted material to design elevations (Section 3.3). This sampling and analysis will employ field methods performed at the appropriate Analytical Support Level (ASL), as defined in the Sitewide CERCLA Quality Assurance Project Plan (SCQ). Total uranium concentrations will be assessed using the RTRAK, RSS, and HPGe equipment (see Appendix E). If precertification criteria are not met, additional material will be excavated, as required, to attain these criteria (ESpec 02205). Following

precertification activities, a formal certification program will be described in a Certification Design Letter (Section 7.2 of the SEP).

3.6 INTERIM RESTORATION

Following removal of impacted material from A2PI and certification of FRL attainment (Section 3.4 of the SEP), A2PI will be interimly restored consistent with expected natural resource restoration plans. The draft NRRP defines final restoration of A2PI as:

> "An expanded riparian habitat will be established in the downgradient areas of A2PI. The remaining slopes and upgradient areas will be restored to an upland forest that is typical of southwestern Ohio. These sections will require the application of topsoil and extensive revegetation. Some bank stabilization will also be required along various sections of Paddys Run."

Interim grading is not expected in A2PI since the excavation depth was designed to provide stable slopes and adequate drainage. As a temporary cover (ESpec 02275), the soil will be either treated with a crusting agent or mulched and hydro seeded (Section 3.3.1) with a quick-germinating seed mixture (ESpec 02900). After successful certification, runoff from A2PI will no longer require collection and treatment. Therefore, the sediment and geomembrane liners from the runoff collection channels and retention basins will be removed and placed into the OSDF. Surface water controls installed during construction along the perimeter of A2PI and left in place following construction will remain to prevent cross-contamination from upgradient areas.

Additionally, there will be a radiological downposting of the area from a "radiological contamination" area during excavation, to a "soil contamination" area following precertification, to a final radiological downposting and "certified" posting following certification.

3.7 INSTITUTIONAL CONTROLS

Institutional controls, such as fencing, posting of signs, and groundwater monitoring, are a key component of the Operable Units 2 and 5 selected remedies. Commitments to ensure the intent of the selected remedy is met are discussed in Section 1.3.

Access restriction to remediated areas is necessary to prevent cross-contamination during and following remediation. Access procedures for certified areas are contained in Access to Certified Area (CA)

(EP-0008). Institutional controls to restrict access to the remediated A2PI area include installing construction fencing around the area and posting the appropriate caution and warning signs. The construction fence will define the control boundary of the A2PI site. Gates will be installed at equipment access points.

The access restrictions will remain in place until the area is certified. Following the completion of remediation, during the final restoration phase, the institutional controls will be dictated by the NRRP.

Long-term groundwater monitoring will be conducted to determine the effectiveness of the remedy. The designated monitoring wells, as well as sampling methods and constituents, are presented in the IEMP.

TABLE 3-1

STATUS OF A2PI GROUNDWATER MONITORING WELLS

Well #	Location	Plans for Well
21190 (1016)	IFP	Plugged/abandoned by FDF
1045	AFP	Plugged/abandoned by FDF
1046	SF	Plugged/abandoned by FDF
1047	North of IFP	Plugged/abandoned by FDF
1048	AFP	To remain/Requires protection
1433	SF	To be plugged/abandoned by FDF
1711	IFP	To be plugged/abandoned by FDF
1941	SF	To be plugged/abandoned by FDF
1942	SF	Plugged/abandoned by FDF
1954	SF	Plugged/abandoned by FDF
2016	IFP	To remain/requires protection
2045	AFP	IEMP well: To remain/requires protection
2046	SF	IEMP well: To remain/requires lowering and protection
2047	North of IFP	Plugged/abandoned by FDF
2048	AFP	To remain/requires protection
2049	South of AFP	IEMP well: To remain/requires protection
2385	North of AFP	IEMP well: To remain/requires protection
2401	IFP	Plugged/abandoned by FDF
2943	SF	Plugged/abandoned by FDF
2944	SF	Plugged/abandoned by FDF
2945	SF	Removed by excavation subcontractor
2954	SF	Plugged/abandoned by FDF
2955	IFP	Plugged/abandoned by FDF
3016	IFP	Plugged/abandoned by FDF
3045	AFP	IEMP well: To remain/requires protection
3046	SF	IEMP well: To remain/requires lowering and protection
3049	South of AFP	IEMP well: To remain/requires protection
3385	North of AFP	IEMP well: To remain/requires protection
4016	IFP	To remain/requires protection
11032	North of SF	To remain/requires protection
21033	AFP	IEMP well: To remain/requires protection
21065	North of SF	To remain/requires protection
21191	South of SF	To remain/requires protection
31563	South of AFP	Extraction well: To remain/requires protection
31564	South of SF	Extraction well: To remain/requires protection
31565	IFP	Extraction well: To remain/requires protection
31566	AFP	Extraction well: To remain/requires protection

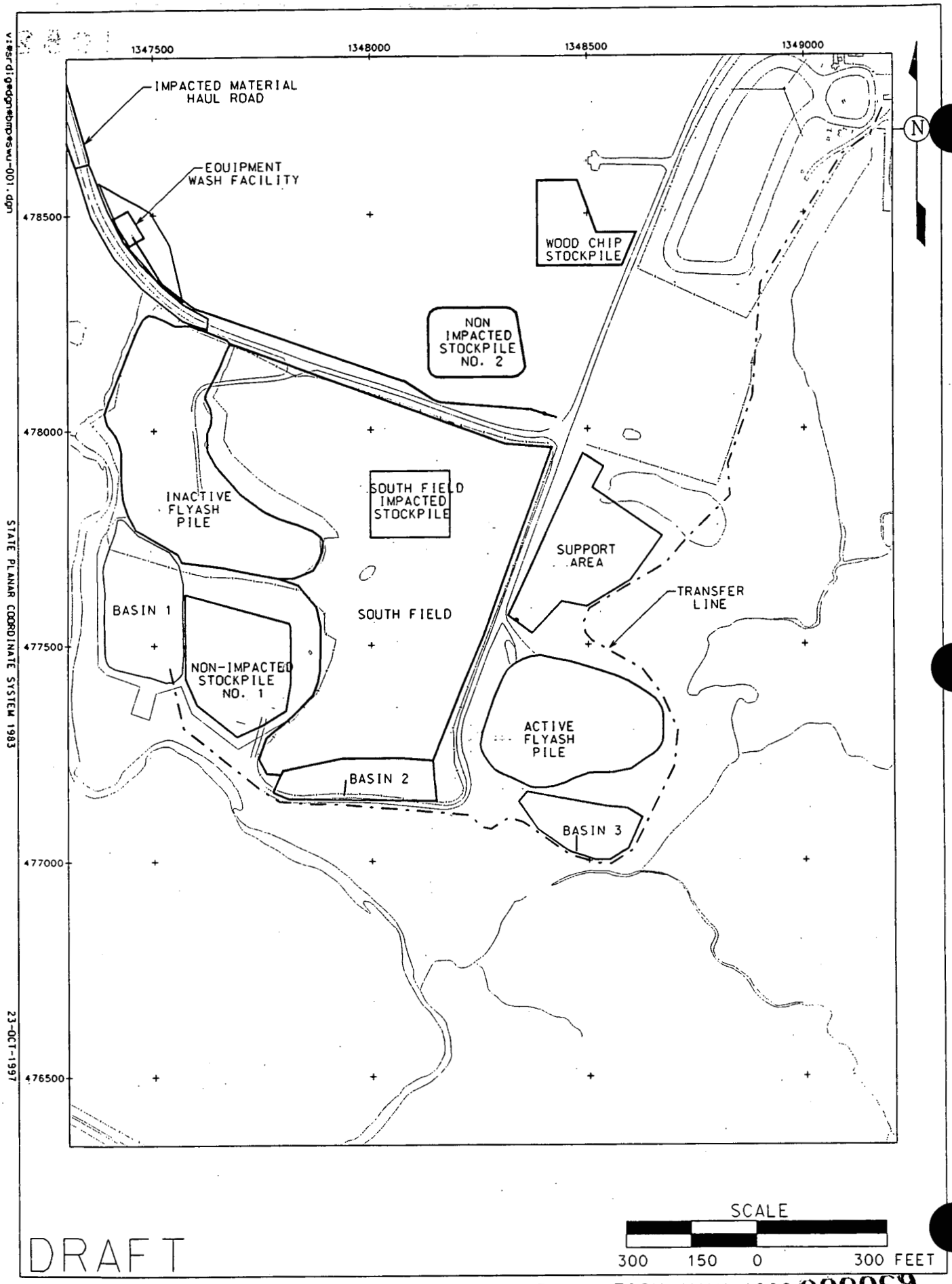
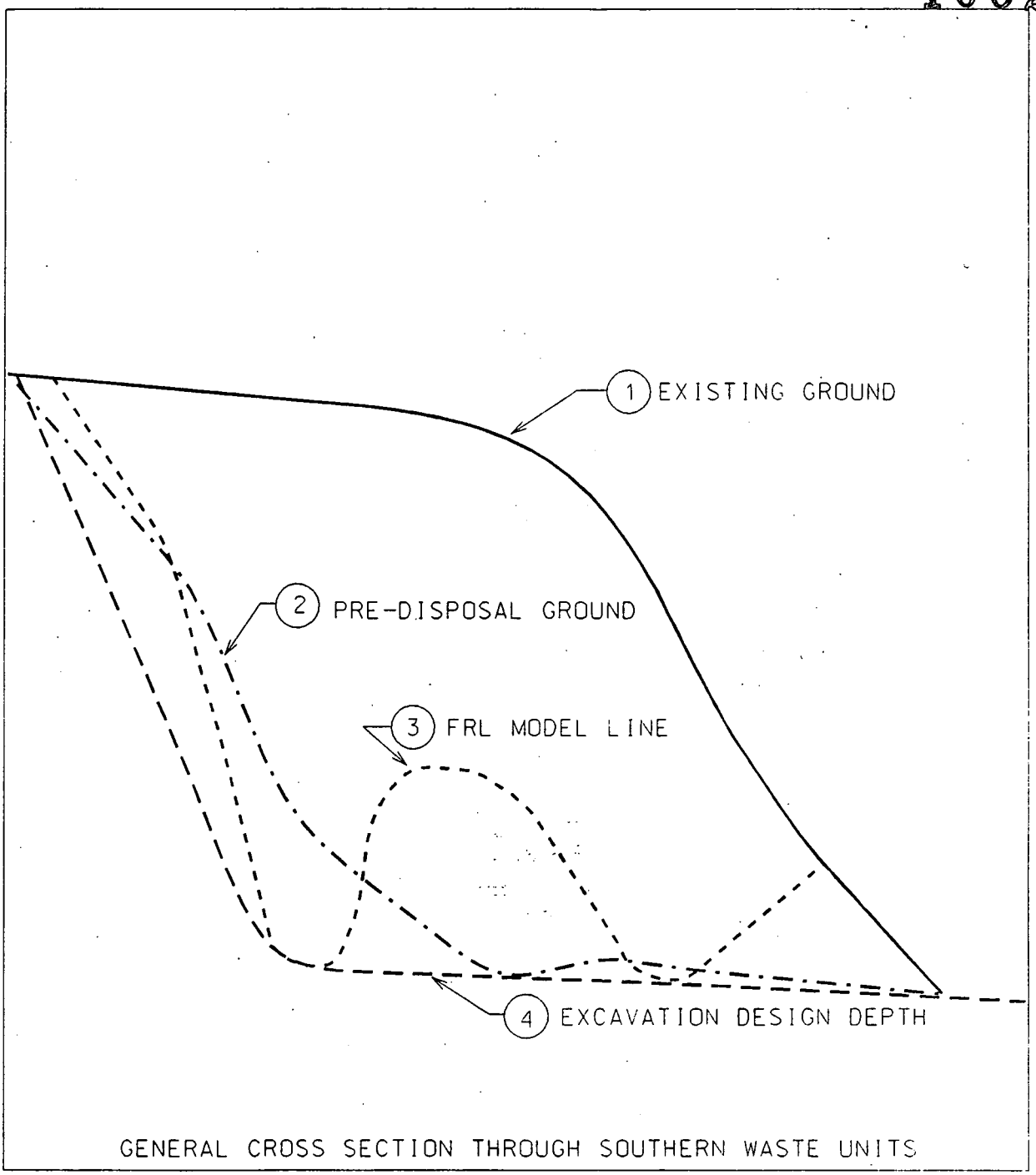


FIGURE 3-1. SWUs PRIOR TO EXCAVATION (MAY 1998



NOT TO SCALE

1. EXISTING GROUND (FROM 1992 AERIAL PHOTOGRAPHY).
2. PRE-DISPOSAL GROUND - (FROM 1952 TOPOGRAPHIC MAPPING AND BORING LOG INFORMATION).
3. FINAL REMEDATION LEVEL (FRL) MODEL LINE - (FROM ENVIRONMENTAL GEOSTATISICAL MODEL BASED ON RI/FS AND PREDESIGN DATA).
4. EXCAVATION DESIGN DEPTH - DEEPER OF (2) PRE-DISPOSAL GROUND, AND (3) FRL MODEL LINE WITH ADDITIONAL SMOOTHING TO DEVELOP STABLE GRADES.

FIGURE 3-2. DEVELOPMENT OF EXCAVATION DESIGN

c:*jrn/*d02-003.dgn
22-OCT-1991

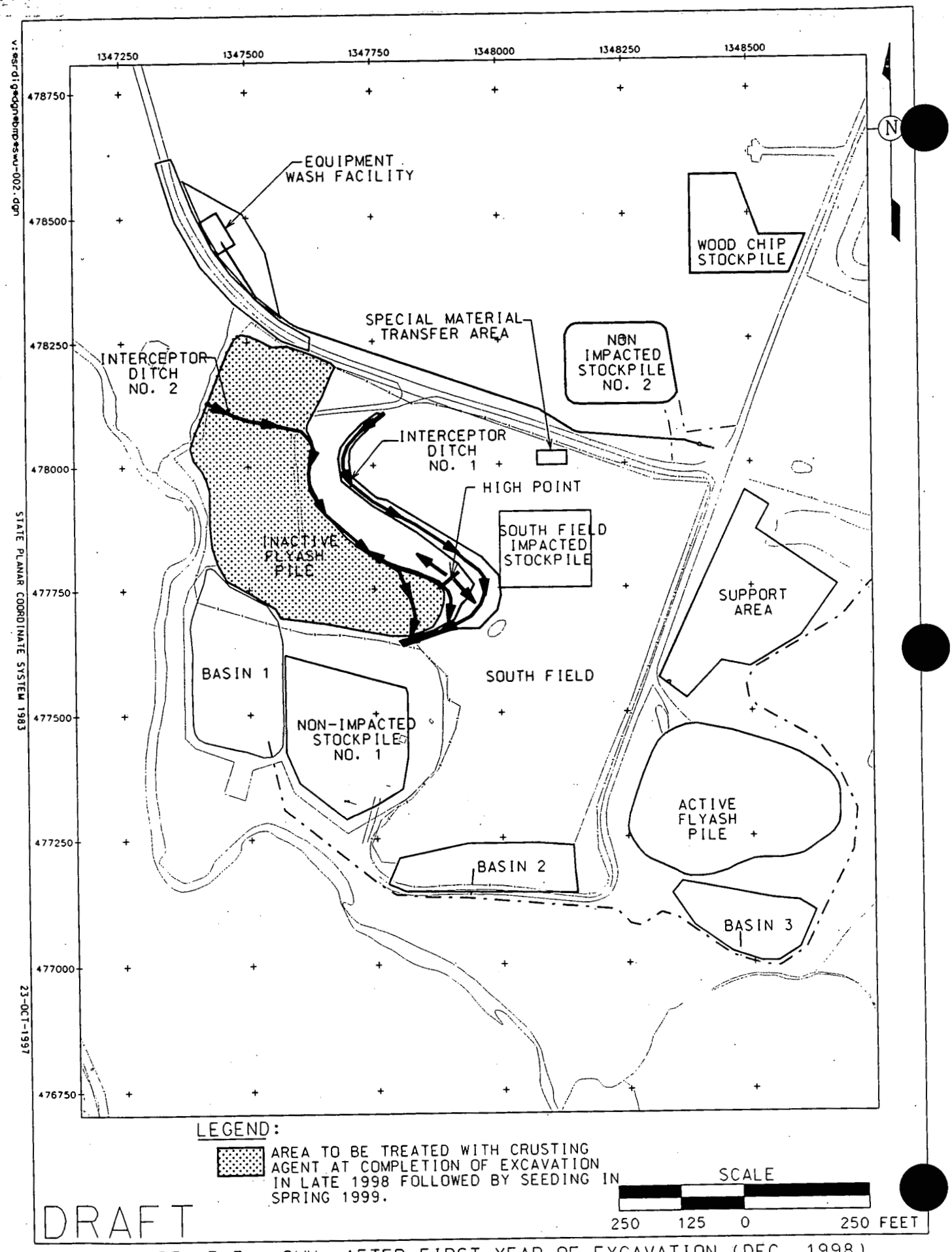
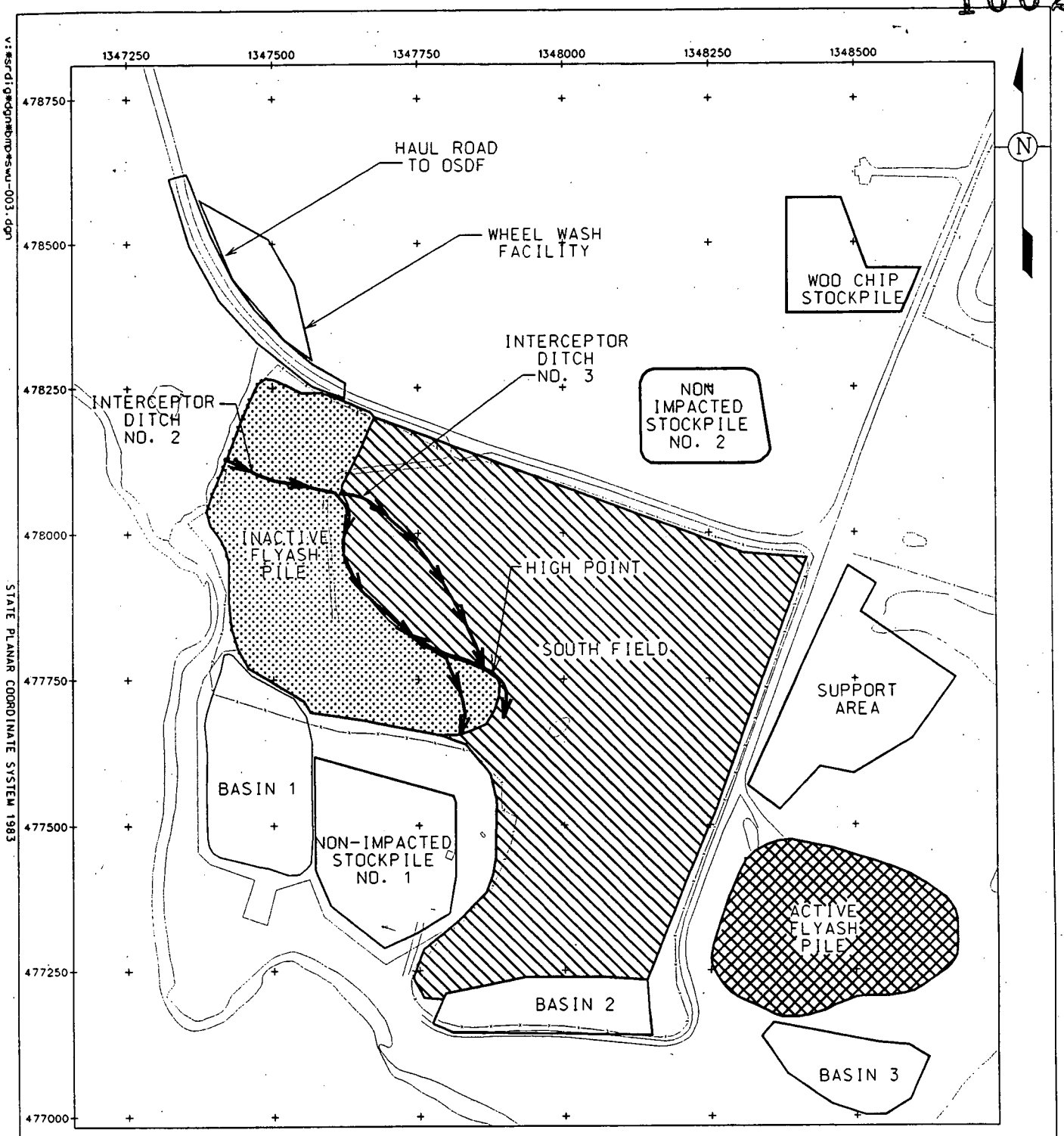


FIGURE 3-3. SWUs AFTER FIRST YEAR OF EXCAVATION (DEC. 1998)



v:\srdi\gdgn\bmdswu-003.dgn

STATE PLANAR COORDINATE SYSTEM 1983

23-OCT-1997

LEGEND:

- AREA PREVIOUSLY EXCAVATED AND VEGETATED.
- AREA TO BE TREATED WITH CRUSTING AGENT AT COMPLETION OF EXCAVATION IN LATE 1999 FOLLOWED BY SEEDING IN SPRING 2000.
- AREA TO BE TREATED WITH CRUSTING AGENT AT END OF EXCAVATION IN LATE 1999. EXCAVATION TO BE COMPLETED 2000.

SCALE

250 125 0 250 FEET

DRAFT

FIGURE 3-4. SWUs AFTER SECOND YEAR OF EXCAVATION (DEC. 1999)

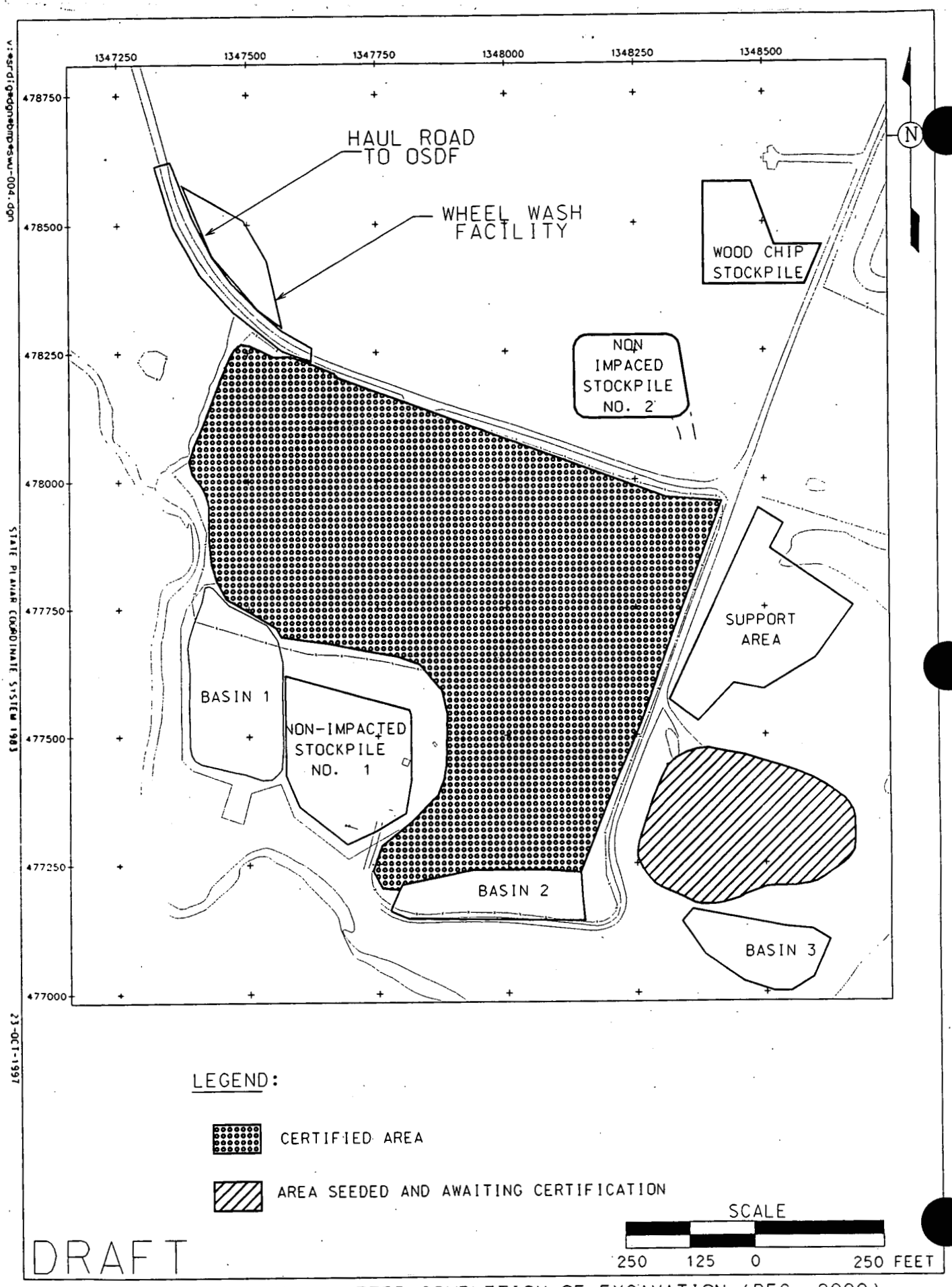


FIGURE 3-5. SWUs AFTER COMPLETION OF EXCAVATION (DEC. 2000)

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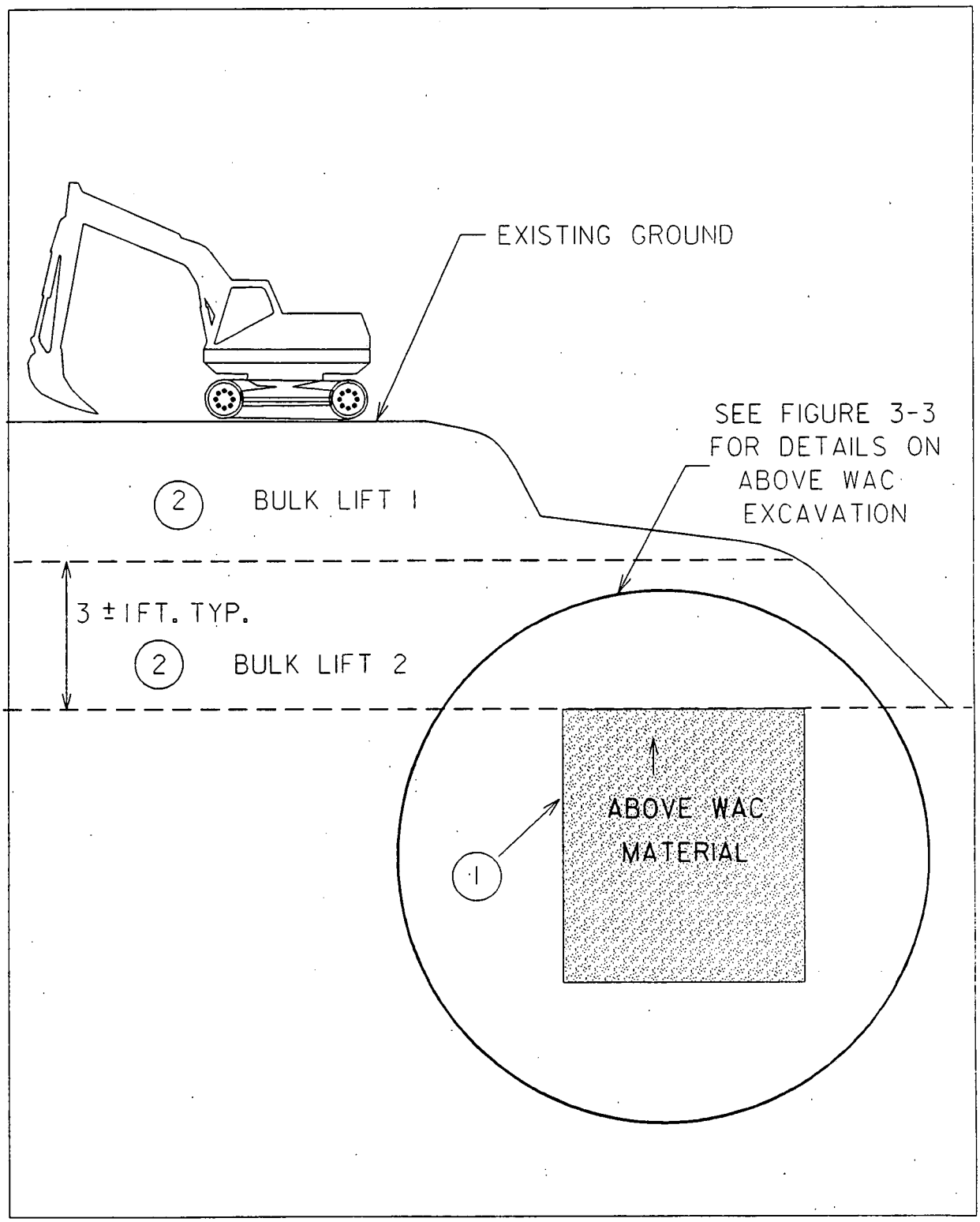
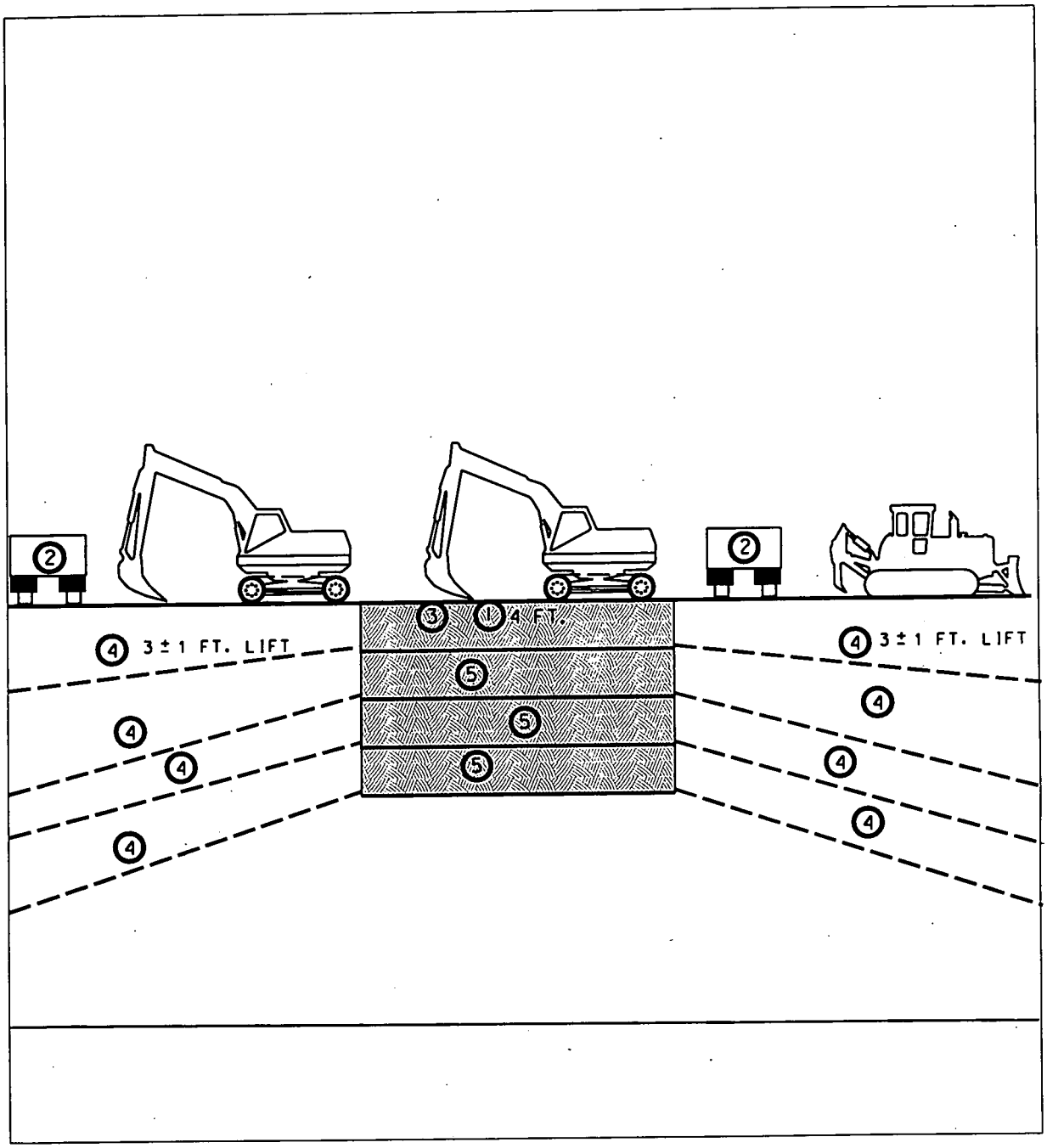


22-OCT-1997

① LIMIT OF ABOVE WAC MATERIAL SHALL BE DETERMINED BY RI/FS AND PRE-DESIGN SAMPLING DATA.

② BULK EXCAVATE MATERIAL TO OF TOP OF ABOVE WAC MATERIAL.

FIGURE 3-6. GENERAL EXCAVATION ON TOP OF ABOVE WAC MATERIAL



1. EXCAVATE ABOVE-WAC MATERIAL IN FOUR FOOT LIFTS
2. LOAD TRUCKS OUTSIDE OF ABOVE-WAC MATERIAL AREA.
3. FIELD SURVEY SIDES OF EACH LIFT IN ABOVE-WAC MATERIAL.
4. EXCAVATE 3 ± 1 FT. LIFT OUTSIDE ABOVE WAC MATERIAL AS PER FIGURE 3-8 AFTER EXCAVATION OF EACH 4 FT. LIFT IN ABOVE-WAC MATERIAL.
5. CONTINUE AND REPEAT STEPS 1 THROUGH 4 TO BOTTOM OF ABOVE-WAC MATERIAL.
6. FIELD SURVEY BOTTOM OF ABOVE-WAC MATERIAL. AND EXCAVATE ADDITIONAL LIFTS AS NECESSARY.

ABOVE WAC MATERIAL

FIGURE 3-7. ABOVE WAC EXCAVATION APPROACH

$$FILE$$
$$DATE$$

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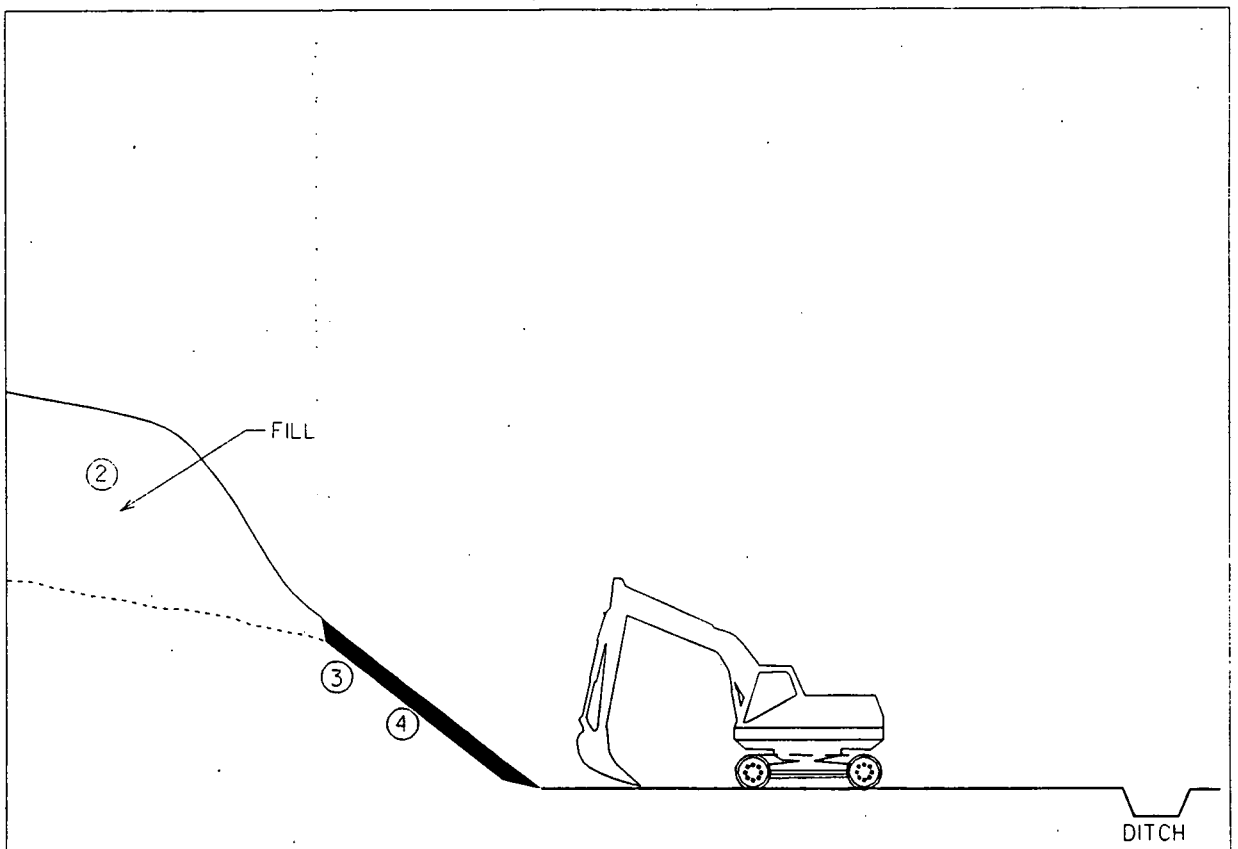
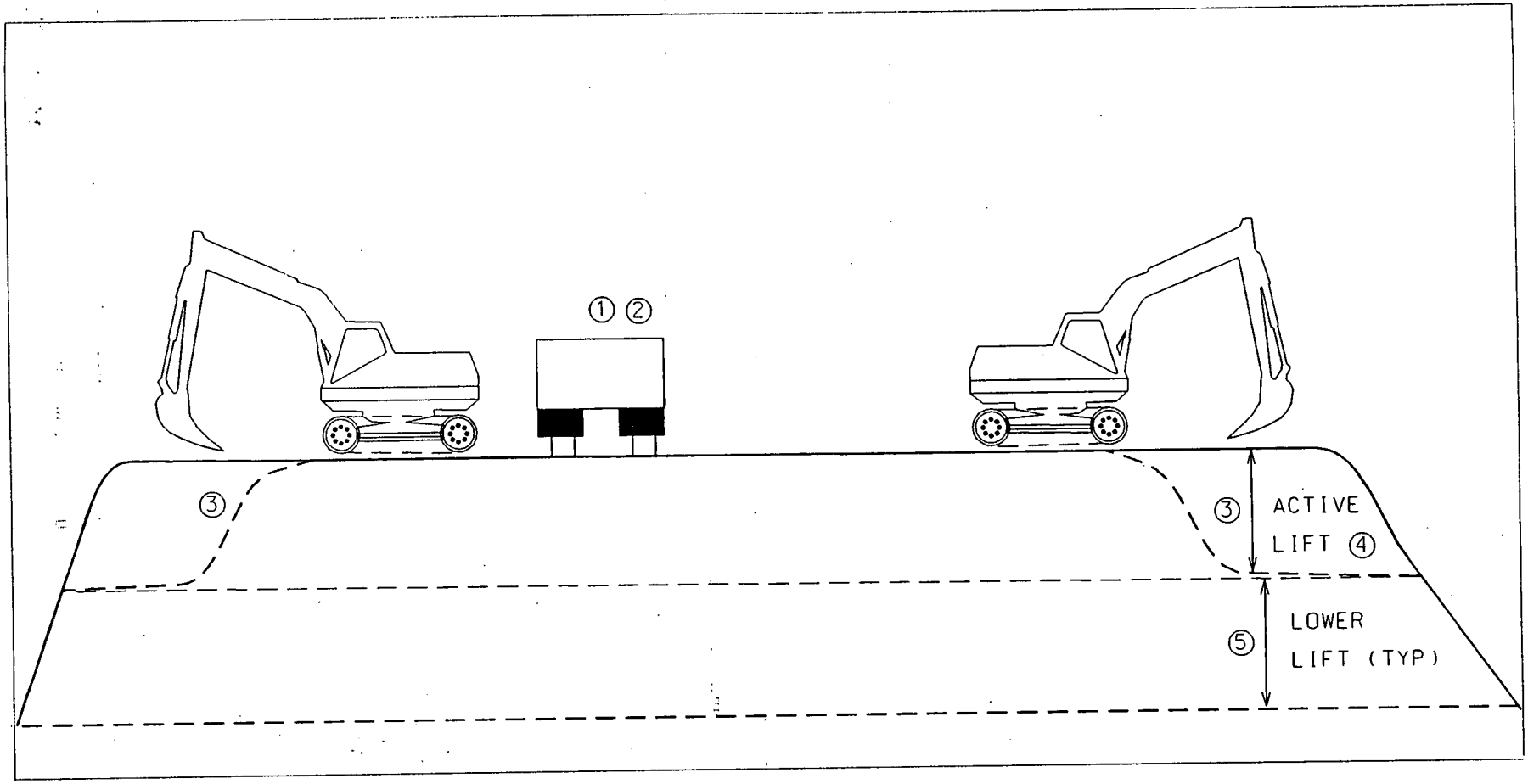


1. SURVEY AND STAKE LIMIT OF LEAD CONTAMINATED SOIL BASED ON PREDESIGN SAMPLING. (NOT SHOWN)
2. EXCAVATE IMPACTED MATERIAL ABOVE LEAD CONTAMINATED SOIL IN 3 ± 1FT. LIFTS.
3. EXCAVATE LEAD CONTAMINATED SOIL TO DEPTH SHOWN ON CONSTRUCTION DRAWINGS.
4. PERFORM CONFIRMATORY SAMPLING.
5. PERFORM SUPPLEMENTAL EXCAVATION AS NEEDED BASED ON CONFIRMATORY SAMPLING. (NOT SHOWN)

LEAD CONTAMINATED SOIL

22-OCT-1997

FIGURE 3-8. EXCAVATION OF LEAD CONTAMINATED SOIL



① MATERIAL SHALL BE LOADED DIRECTLY INTO TRUCKS.

② TRUCKS SHALL GO THROUGH EQUIPMENT WASH FACILITY BEFORE ENTERING HAUL ROAD TO OSDF.

③ VISUAL MONITORING AT ACTIVE EXCAVATION.

④ FIELD SURVEY FOR LOWER LIFTS SHALL BE PERFORMED IN ACTIVE LIFT BEHIND EXCAVATION.

⑤ EXCAVATE LOWER LIFT(S) AFTER FIELD SURVEY OF LIFT IS COMPLETE.

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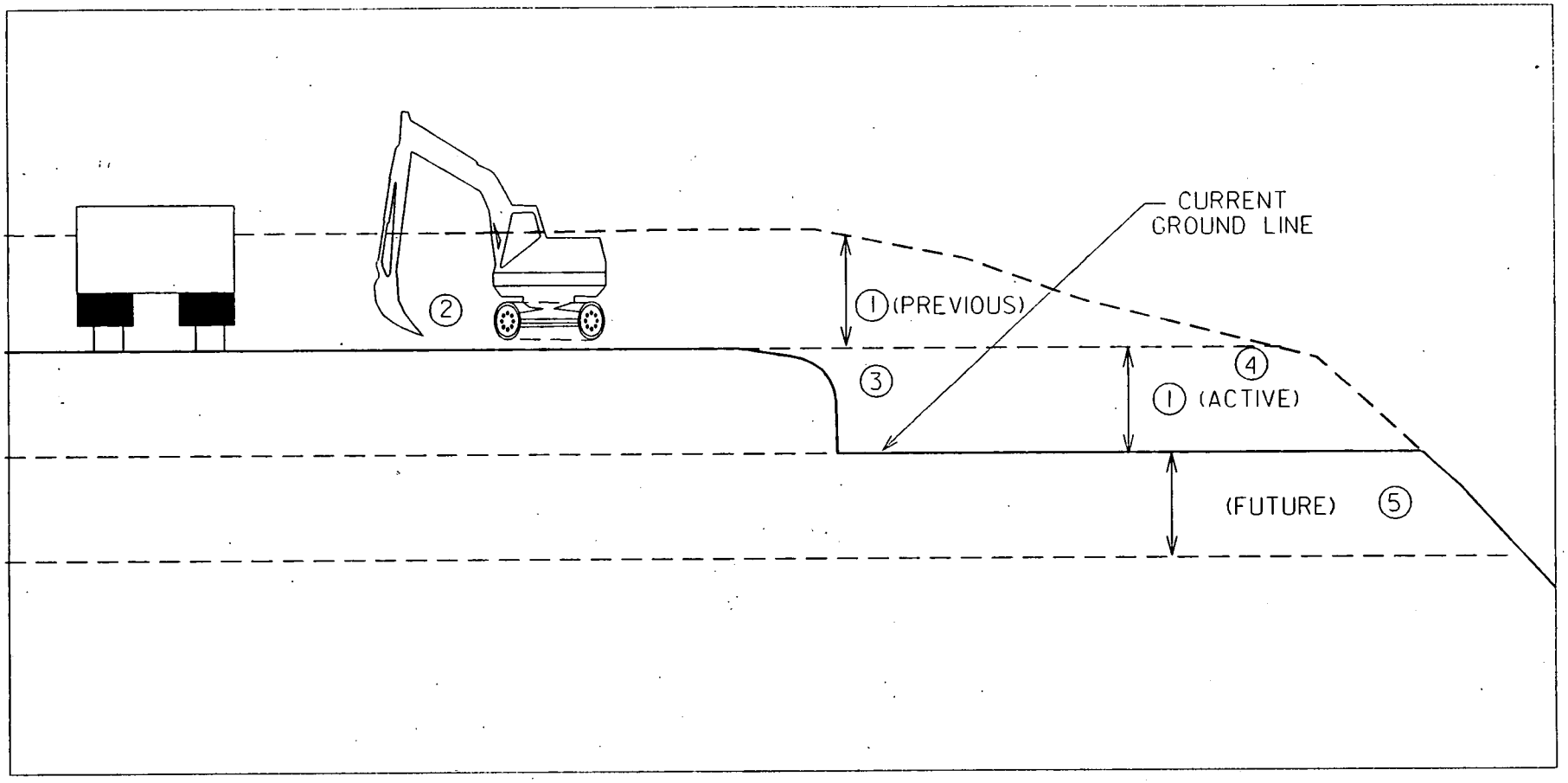
FIGURE 3-9. TYP L EXCAVATION APPROACH

000022



1. PERFORM EXCAVATION AFTER COMPLETION OF ABOVE WAC EXCAVATION. LIFTS SHALL BE 3 ± 1 FT DEEP.
2. ACTIVE EXCAVATION AND LOADING AREA.
3. VISUAL MONITORING AT ACTIVE EXCAVATION.
4. FIELD SURVEY OF FURURE LIFT (MINIMUM OF 50 FT. BEHIND ACTIVE EXCAVATION)
5. EXCAVATE FUTURE LIFT AFTER MONITORING IS COMPLETE ON ACTIVE LIFT.

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FIGURE 3-10. EXCAVATION SEQUENCING

4.0 PROJECT-SPECIFIC ENVIRONMENTAL CONTROLS AND MONITORING

This section defines the project-specific environmental controls and monitoring that will be performed as part of the remediation of A2PI, how the resulting information will be used by the project organization, and how it will be integrated with sitewide monitoring and reporting requirements. Control mechanisms and monitoring/inspection requirements are provided for impacts to natural resources, as well as environmental impacts through the air, surface water and groundwater pathways.

The IEMP provides a summary reporting link and a cumulative feedback function for the project-specific monitoring conducted by the individual remediation projects. This link will assist with interpretation of project-specific results from a sitewide perspective. It should be noted, however, that routine "process-adjustment" decisions, which will be made by the SCEP to react and respond to project-specific operating conditions and process-control objectives, will not be reported as part of the IEMP reporting cycles. Rather, these types of routine decisions will be maintained as part of the project organization's daily operations log and are considered to be a normal course of day-to-day practice to achieve project-specific operating objectives. Figure 5-1 of the SEP summarizes the FEMP sitewide and project-specific environmental monitoring and control mechanisms.

4.1 NATURAL RESOURCE IMPACTS

Impacts to natural resources include those associated with threatened and endangered species, cultural resources, and wetlands/floodplains. As stated in Section 1.3.3, the only expected natural resource-related area expected to be encountered during the remediation of A2PI is the 100-year floodplain of Paddys Run that reaches the Inactive Flyash Pile and the South Field. The following paragraphs describe the control mechanisms and monitoring that will be implemented in A2PI in regard to natural resource impacts.

4.1.1 Control Mechanisms

The SEP establishes a four component strategic control mechanism for natural resource impacts.

The first component, identification of unavoidable impacts to natural resources anticipated to result from remediation activities, has been addressed by the RODs for Operable Units 2 and 5

(DOE 1995a, 1996a). These RODs identified the unavoidable potential natural resource impacts anticipated to occur as a result of remediation activities relevant to A2PI to be initiated under the SEP.

The second component, avoidance of impacts to FEMP natural resources as practicable, has been controlled through planning and design. Sensitive natural resource areas have been delineated at the FEMP. These "Priority Natural Resource Areas" are illustrated in the Natural Resource Impact Monitoring Plan (briefly discussed below) and Figure 5-2 of the SEP. No Priority Natural Resource Areas are located within A2PI. All access points, laydown areas, etc., for the A2PI soil remediation project are outside Priority Natural Resource Areas. Potential impacts to other FEMP natural resources will be minimized through the incorporation of appropriate environmental control mechanisms as well. These are addressed in the subsequent, media-specific discussions.

The third component, monitoring to document the actual extent of impacts, is addressed in Section 4.1.2.

The fourth component, natural resource restoration, is briefly described in Section 1.3.3, and is the subject of the NRRP.

4.1.2 Monitoring

Monitoring of natural resource impacts associated with A2PI and other sitewide remedial activities will be conducted under the Natural Resources Impact Monitoring Plan (part of the IEMP). Descriptions of the objectives, regulatory drivers, monitoring, data evaluation, and reporting requirements for the program are provided therein. Sitewide monitoring of natural resource impacts will continue under the IEMP during A2PI soil remediation activities. Monitoring under that program will verify and document the actual extent of natural resource impacts anticipated by and identified in the RODs and will identify any unanticipated impacts to wetlands and floodplains associated with Paddys Run and its tributaries and threatened and endangered species habitat. The natural resource monitoring data collected from the FEMP will be updated in the NRRP as it is relevant to restoration.

4.2 AIR PATHWAY

This subsection presents the air pathway control and monitoring requirements for noise, fugitive emissions (visible dust), airborne radiological particulates and radon, and direct radiation during A2PI

soil remediation activities. Air pathway monitoring activities, to the maximum extent possible, will make use of both the existing FEMP occupational air monitoring program and the sitewide environmental monitoring program (described in Section 6.0 of the IEMP). Using existing monitoring programs will help ensure that project-specific data are of comparable quality and are beneficial in evaluating and reporting project-specific air pathway releases under the various regulatory drivers associated with these monitoring programs. Administrative and engineering control techniques, in accordance with the "Fugitive Dust Control Requirements" (RM-0047) developed from the FEMP fugitive dust control "best available technology" (BAT) determination, will be implemented during A2PI soil remediation activities including excavation, hauling, and placement of soils to mitigate potential emissions of fugitive dust and airborne radiological particulates.

4.2.1 Noise

4.2.1.1 Control Mechanisms

Noise control and abatement during the remediation of A2PI will include noise control devices (mufflers) on equipment and machinery, proper maintenance of equipment and machinery, and also may include rescheduling time periods in which heavy equipment is used in the field. Currently, only minimal remediation activities are anticipated to be performed after sunset.

To ensure that Occupational Safety and Health Administration (OSHA) and American Conference of Governmental and Industrial Hygienists (ACGIH) noise limits are met, an administrative action level below these limits has been specified in the project-specific health and safety plans (see Section 5.0). This administrative action level will be used to assess the need for hearing protection for field personnel in the areas of remediation activities, the need for maintenance of equipment and machinery, and the need for additional noise control and abatement.

4.2.1.2 Monitoring

Noise monitoring will be conducted to implement the A2PI project-specific health and safety requirements. Noise measurements will be made in the field by FDF health and safety personnel, using health and safety protocols for noise monitoring, to assess: whether administrative action levels are exceeded; the need for hearing protection; the need for maintenance of equipment and machinery; the need for additional noise control or abatement; and, compliance with OSHA and ACGIH occupational noise limits.

Components of noise monitoring will include establishing remediation area-specific background levels prior to the start of excavation activities, and occasional monitoring during implementation of remedial activities. If the environmental noise level falls within 5 dBA of the administrative action level (85 dBA, as specified in the health and safety requirements), health and safety personnel will contact the project field manager to begin appropriate corrective actions.

Field managers will be responsible for documenting noise monitoring in the field in accordance with the recordkeeping guidelines presented in Section 6.7, as well as for initiating noise abatement measures.

4.2.2 Fugitive Emissions

4.2.2.1 Control Mechanisms

Water, commercially available dust suppression agents, or other appropriate methods and work practices will be used proactively to reasonably minimize dust generation from A2PI soil remediation activities including soil excavation, handling, hauling, and placement. In general, the opportunity for dust generation will be minimized using work practices, including removing material from the undercarriage of equipment, sweeping haul roads, and covering the beds of haul equipment. Beyond that, water or other dust suppression agents will be applied in quantity sufficient to reasonably minimize dust generation, but limited so that they do not result in migration of the agent beyond work area boundaries, ponding, or disruption of other portions of work.

For excavation activities, dust control will be by progressive increments focused on making the material less dusty. The base mechanism is anticipated to be reliance on inherent moisture in the soil and soil-like material. If visible dust emissions occur during excavation, one or a combination of the following dust control methods are anticipated to be used:

- Apply water mist
- Add surfactants or other agents to the water mist
- Apply resins, crusting agents, or foams in lieu of water mist.

For soil handling, hauling, and placement activities, dust control will be focused on making the material to be transported unlikely to become airborne. The base mechanism is anticipated to be reliance on inherent moisture in the soil or soil-like materials, coupled with a 10-mile-per-hour speed

limit during hauling. In addition, the beds of all haul equipment will be required to be covered when transporting potentially dusty material. If visible dust emissions occur during handling, hauling, or placement, one or a combination of the following dust control methods are anticipated to be used:

- Change configuration of material (e.g., place less in the trucks)
- Apply water mist
- Add surfactants or other agents to the water mist
- Apply resins, crusting agents, or foams in lieu of water mist
- Reduce equipment speed.

Equipment wash facilities will be used at the point where equipment enters the Impacted Material Haul Road from A2PI or the OSDF. Clods, clumps, or visible deposits of soil or other materials that could readily become visible fugitive emissions from paved or treated unpaved roadways/parking areas will be promptly removed. Appropriate dust control mechanisms will be applied to reasonably minimize the generation of visible dust that may result from the removal process.

The number or type of dust suppression equipment in operation will not preclude stopping work if there is visible dust or excessive visible dust. Visible dust indicates the need to increase the level of dust control effort. Increasing levels of visible dust indicate a need to increase the level of dust control effort, including possible alteration, slowdown, or temporary suspension of the work activities generating the visible dust. The work activity(ies) observed to be generating the visible dust will be temporarily suspended if the visible dust exceeds the site-specific limit or Ohio standard [see "Fugitive Dust Control Requirements" (RM-0047)]. Dust controls will be increased and/or work practices will be modified to bring the fugitive emissions to a level below the limit/standard during dust-generating activities.

Personnel will be on-call during non-work periods seven days per week (including holidays) to respond to an "off-hours dust alert," which is defined as whenever FDF gives notification to the contractor that visible particulate emissions exceed six minutes during any 60-minute observation period. Site personnel will notify the contractor of such an alert and dust suppression will begin no more than three hours after such notification.

The contractor will develop a Dust Control Plan, as part of the Safe Work Plan, which will specify:

- A narrative description of how the contractor will implement the "Dust Control Plan," monitor for visible dust, progressively implement increased dust control or alter work activities when required, and maintain appropriate records of dust control activities
- A listing of methods to be used to suppress dust, and the associated frequency that routine dust suppression is to take place
- By method, the materials to be used to suppress dust — e.g., water, dust suppression agents, etc.
- By method, the specific types and quantities of equipment to be used to suppress dust
- A description of the notification process, including designation of personnel, that the contractor intends for SCEP personnel to utilize during non-work periods to notify the contractor of a "dust alert."

The contractor's "Dust Control Plan" will be reviewed against these criteria by FDF for adequacy. FDF approval of that plan is a prerequisite to authorization of earthmoving activities.

4.2.2.2 Monitoring

Project personnel will tour the areas of remediation activities at the start of the day and periodically during the day. Real-time observation of visible dust, in accordance with the criteria described in "Fugitive Dust Control Requirements" (RM-0047), will be used to assess fugitive dust emissions and progressively implement corrective measures.

Additionally, visual monitoring will be conducted in accordance with 40 CFR Part 60, Appendix A, Method 22, "Visual Determination of Fugitive Emissions from Material Sources and Smoke Emission from Flares." Furthermore, visual determination of opacity will be conducted on "project field activities" and "material handling/vehicle traffic on storage piles" [identified in the table in "Fugitive Dust Control Requirements" (RM-0047)]. That determination will be in accordance with 40 CFR Part 60, Appendix A, Method 9, "Visual Determination of Opacity of Emissions from Stationary Sources" (or an approved alternative method).

Field managers will be responsible for documenting visible emission monitoring in the field, in accordance with the recordkeeping guidelines defined in Section 6.7, as well as for initiating fugitive

dust abatement measures. Records of the following information for each work day (including off-hours dust-alert response, except as noted below) will be maintained for the A2PI soil remediation project:

- The date, weather conditions, and scheduled work activities (e.g., excavation, trenching, hauling, placement, compaction, loading, etc.)

- Records of opacity readings (if any) conducted that day in accordance with 40 CFR Part 60, Appendix A, Method 9, "Visual Determination of Opacity of Emissions from Stationary Sources" (or an approved alternative method) [NOTE: not required for off-hours dust alert responses]

- Time of off-hours dust alert notification given to the contractor, names of the individuals involved, FDF person providing notification, contractor employee notified, and contractor dust-alert responders, and time of initiation of dust suppression activity [NOTE: required only for days when such notification occurs]

- Identification of areas (or segments) where dust control was performed

- The manner or type of dust control activity(ies) applied by area

- Application rate of water or other dust suppression agents — at a minimum, tank truck load capacity and number of tankloads applied per area to which applied

- Identification of the party(ies) responsible for the dust control activity by area — at a minimum, name of the contractor.

4.2.3 Airborne Radiological Particulates

4.2.3.1 Control Mechanisms

All airborne radiological particulate emissions associated with A2PI soil remediation activities are anticipated to be from fugitive emissions. Control mechanisms for fugitive emissions are presented in the preceding subsection. No airborne radiological particulate control mechanisms beyond those provided by fugitive emission control are anticipated to be required for environmental or public safety concerns as a result of A2PI soil remediation activities.

4.2.3.2 Monitoring

Airborne radiological particulate emissions associated with A2PI soil remediation activities will be monitored via the sitewide airborne radiological particulate monitoring program presented in

Section 6.0 of the IEMP. The monitoring network encompasses all the current and expected diffuse and point sources at the FEMP site. The data collected under the sitewide airborne radiological particulate monitoring program will be used to assess the collective effect of concurrent remediation activities at the FEMP site under various regulatory drivers described in Section 6.0 of the IEMP.

No supplement or modification to the sitewide airborne radiological particulate monitoring program is anticipated to be required as a result of A2PI soil remediation activities. Monitoring stations already exist downwind (under the prevailing wind) of the A2PI soil remediation activities, and the monitoring frequency and analyses addressed by the program adequately address the COCs in the A2PI remediation area.

4.2.4 Radon

4.2.4.1 Control Mechanisms

Emission of radon from soil being remediated under the A2PI soil remediation project is not anticipated to be an environmental or public safety concern. Hence, no project-specific radon control mechanisms are anticipated to be required as a result of A2PI soil remediation activities.

4.2.4.2 Monitoring

Any potential radon emissions associated with A2PI soil remediation activities will be monitored via the sitewide radon monitoring program presented in Section 6.0 of the IEMP. No supplement or modification to that sitewide radon monitoring program is anticipated to be required as a result of A2PI soil remediation activities.

4.2.5 Direct Radiation

4.2.5.1 Control Mechanisms

No project-specific direct radiation control mechanisms beyond that provided by fugitive emissions control are anticipated to be required for environmental or public safety concerns as a result of A2PI soil remediation activities.

4.2.5.2 Monitoring

Environmental radiation levels associated with A2PI soil remediation activities will be monitored via the sitewide environmental direct radiation monitoring program presented in Section 6.0 of the IEMP.

No supplement or modification to that sitewide environmental direct radiation monitoring program is anticipated to be required as a result of A2PI soil remediation activities.

4.3 SURFACE WATER PATHWAY

4.3.1 Control Mechanisms

As a condition of its National Pollutant Discharge Elimination System (NPDES) Permit (OEPA Permit No. 1IO00004*ED), the FEMP was required to develop and implement a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP identifies potential sources of pollution associated with construction and industrial activities that may affect storm water quality at the FEMP and describes the practices that will be employed to reduce pollutants within these types of discharges. The SWPPP also contains provisions on the inspection programs which are being implemented to ensure that discharges of storm water associated with construction and industrial activities comply with the requirements of the FEMP NPDES Permit and the SWPPP.

A2PI is located outside the "storm water runoff controlled" former production area drainage basin; prior to these A2PI soil remediation activities, the A2PI area drains to NPDES-permitted storm water outfall *4004. Outside the FEMP's former production area drainage basin, storm water from construction activity is regulated as an industrial activity (if a certain magnitude of earth-moving activities is involved). A2PI soil remediation activities to be initiated under the SEP are a subset of construction activities. In accordance with both the SWPPP (under the FEMP's NPDES permit) and the SEP, erosion and sediment controls will be installed where appropriate to protect downgradient areas. These controls will be designed and installed in accordance with A2PI's Surface Water Management Plan to manage surface water run-on and runoff, minimize erosion, and control sedimentation in on-site surface waters such as Paddys Run.

The clearing and grading associated with the A2PI soil remediation activities will result in the generation of substantial quantities of downed trees and brush. During the site preparation phase of A2PI soil remediation activities, the majority of such material is anticipated to be handled by chipping (or shredding) and stockpiling near the meteorological data tower (see the site preparation package construction drawings) for potential use as mulch during future site restoration activities. During the excavation phase of A2PI soil remediation activities, the stumps and roots remaining from site preparation phase activities are anticipated to be managed by grinding them in place, then removing

them with the soil during excavation. Such management of chipped material is in accordance with the SEP; see Section 5.1.3 of the SEP for further discussion.

In accordance with the SWPPP and the SEP, an A2PI surface water management system will be constructed and operated to prevent runoff from contaminated and potentially contaminated areas from reaching areas downgradient from A2PI. Storm water runoff from such contaminated and potentially contaminated A2PI areas will be collected in retention basins and conveyed to the SWRB, where under normal (non-bypass) conditions, it is treated through the AWWT facility. For further discussion of A2PI surface water management, see Section 3.1.7, the A2PI Surface Water Management Plan, and the site preparation package construction drawings.

The FEMP drainage area map (Figure 2-1 of the SWPPP) has been revised to show changes in the drainage areas flowing to NPDES-permitted storm water outfall *4004 that result from the A2PI soil remediation activities. Revisions to the descriptions of the watershed basins currently provided in Section 4.0 of the SWPPP will be provided with the annual SWPPP update, along with a FEMP drainage area map (updated for changes from subsequent projects).

It is anticipated that the surface water management and sediment/erosion control systems for A2PI will remain in place until remediation of the area has been completed. They will be dismantled or reconfigured in phases (area-by-area) during interim and final restoration of A2PI. To the extent practical, surface water runoff from the area being worked will be conveyed via pumping or other appropriate mechanism to the adjacent area where the conveyance system is still intact. In accordance with the SWPPP and the SEP, once the A2PI area is certified clean, the pumps will be taken out of basins and the flow diverted to Paddys Run.

4.3.2 Inspection

Construction activity inspections mandated by the SWPPP will be conducted in the A2PI remediation area. Under the FEMP's construction activity inspection program, weekly inspections will be conducted within all construction areas at the site and after any rain events totaling 0.5 inch or more within a 24-hour period. Construction activity inspections are documented and maintained as part of the NPDES and SWPPP files at the facility.

Industrial activity inspections might also be conducted in the A2PI remediation area, if required under the SWPPP. The industrial activity inspection program covers both areas within and outside the former production area drainage basin. However, industrial activity inspections are not typically conducted in areas subject to the more frequent construction activity inspections. Under the FEMP's industrial activity inspection program, inspections are conducted in areas draining to the site's controlled storm sewer system (former production area drainage basin) and the uncontrolled watershed basins draining through NPDES permitted storm water outfalls *4003 through *4006. Industrial activity inspections are documented and maintained as part of the NPDES and SWPPP files at the facility.

Inspections conducted in the A2PI areas will ensure that:

- Erosion and sedimentation controls required under the A2PI Surface Water Management Plan and/or the contractor's work plan are in place and are well maintained
- Work practices and housekeeping activities are conducted in a manner that reduces the potential discharge of pollutants in association with storm water discharges from disturbed areas
- Corrective actions related to the establishment and/or maintenance of erosion and sedimentation control structures are documented and tracked to resolution
- Excessive erosion and/or siltation to Paddys Run or other off-property waterways is not occurring as a result of construction activities initiated under the A2PI soil remediation activities.

The SEP discusses potential project-specific storm water monitoring programs for soil remediation areas located outside the formerly storm-water-runoff-controlled production area drainage basin. The objectives of such a program would be to monitor performance of erosion and sedimentation control structures (e.g., sediment traps and basins) against their anticipated design efficiencies, and to determine whether the runoff presents an unacceptable impact to surface water quality or presents an unacceptable cross-media impact to the Great Miami Aquifer.

As previously described, the A2PI surface water management system captures all potentially contaminated storm water runoff within the A2PI area and directs it to the A2PI retention basins, which in turn convey the water to the SWRB and then to the AWWT (under design conditions). Potentially contaminated A2PI storm water runoff receives treatment before discharge to the receiving surface water, the SWRB and AWWT are monitored under IEMP-conducted NPDES permit monitoring, and

discharge from the non-controlled A2PI drainage areas flows to NPDES-permitted storm water outfall *4004 which also is monitored under IEMP-conducted NPDES monitoring. Because the objectives of the SEP-contemplated storm water monitoring program are met through other existing means no project-specific storm water monitoring program will be implemented for the A2PI soil remediation project.

4.4 GROUNDWATER PATHWAY

4.4.1 Control Mechanisms

The Great Miami Aquifer is an extensive aquifer located, in part, beneath the entire FEMP (including the A2PI area). Impacted perched water zones are known or reasonably expected to exist in the A2PI project area (see Section 2.3.3). Additional information on the Great Miami Aquifer in the A2PI area is provided in the Operable Unit 2 RI, and in the Operable Unit 5 RI. During remediation of A2PI, excavation will expose and extend into the unsaturated sands and gravels of the Great Miami Aquifer. Uncontrolled exposure of the Great Miami Aquifer in this manner may provide a pathway for contaminated and potentially contaminated water to infiltrate into the Great Miami Aquifer. Therefore, measures will be implemented to protect the Great Miami Aquifer during construction of surface water control facilities and when excavation of impacted material extends into and/or exposes the Great Miami Aquifer. These measures include the installation of geomembrane liners in ditches (Section 3.1.7.5) constructed into the unsaturated sands and gravels of the Great Miami Aquifer and infiltration barriers (e.g., clay and geomembrane) in all retention basins (Section 3.1.7.6). This approach will minimize infiltration into the Great Miami Aquifer through this pathway.

Measures will be implemented to minimize run on to exposed surfaces during excavation. Runon from upgradient areas will be diverted around the construction area. Runon diversion controls are discussed in Section 3.1.7.3.

Measures will also be implemented to minimize the potential for contaminated runoff to discharge into the Great Miami Aquifer during construction. As previously stated, the A2PI retention basins will be constructed with infiltration barriers. Retention basins are discussed in Section 3.1.7.6.

During excavation of the Inactive Flyash Pile and the South Field, cover soil including impacted material and glacial till will be removed and the sands and gravels of the Great Miami Aquifer will be

exposed. For these cases, interceptor ditches will be constructed to direct runoff from uncertified areas into the retention basins and around the exposed sands and gravels of the Great Miami Aquifer.

4.4.2 Monitoring

Groundwater in the Great Miami Aquifer in the A2PI area is impacted, and flows from approximately west-northwest to east-southeast. As determined during the Operable Unit 2 RI, Great Miami Aquifer concentrations of total uranium, the primary COC for the SWUs, ranged from approximately 1,820 parts per billion (ppb) down to 1.8 ppb. The hydraulic gradient for this area is approximately 0.0005.

The sitewide management strategy for monitoring groundwater during remedial activities is described in detail in Section 3.0 of the IEMP (DOE 1997f). Descriptions of the objectives, regulatory drivers, monitoring, data evaluation, and reporting requirements for the program are provided therein. Sitewide monitoring of groundwater will continue under the IEMP during A2PI soil remediation activities.

Twenty-one existing monitoring wells were selected under the IEMP to monitor the South Field Extraction area in 1997 and 1998 (Table 3-1 and EDwg G0004). For the most part, these existing monitoring wells are located along the Storm Sewer Outfall Ditch, although a few of the wells are located along the northern edge of the A2PI excavation area. All 21 wells are located outside or very close to the edge of the A2PI surface excavation area. Considering the spatial distribution of these existing wells and the dispersion of groundwater due to the gradient, the well configuration as it remains after preceding well abandonment activities (see Section 3.1.8 for discussion on monitoring well abandonment) will be adequate to identify (screen for) potential impacts to the regional aquifer during, or as a result of, A2PI remediation activities. The following paragraphs briefly present the groundwater monitoring program for these wells. The sampling will be conducted according to the requirements identified in the IEMP.

Groundwater monitoring will focus on FRL constituents that have been detected in the Great Miami Aquifer at concentrations above the established FRLs, and FRL constituents that are predicted to have a potential to migrate from the glacial overburden to the aquifer due to their mobility and persistence. In order to determine Great Miami Aquifer baseline conditions, the Great Miami Aquifer will be sampled

prior to A2PI site preparation excavation activities. Groundwater samples will be collected quarterly and analyzed for the five constituents categorized as mobile and persistent (MP), as well as detected in the Great Miami Aquifer at concentrations above the FRLs. These five constituents are in bold type in Table 4-1. A quarterly sampling frequency was selected so that seasonal concentration changes could be monitored. In addition to the quarterly sampling, groundwater samples will be collected annually and analyzed for the remaining 20 constituents identified in Table 4-1. A yearly sampling frequency was selected for these constituents because they are less mobile or not currently present in the aquifer above their respective FRLs. The full list of constituents (25 constituents) will be monitored initially and subsequent quarters will monitor the smaller list of constituents (five constituents).

In addition to the above sampling identified in the IEMP, four extraction wells will be sampled for total uranium during the initial sampling of the South Field Extraction System Monitoring Module in order to establish more comprehensive baseline conditions. The analytical requirements will be consistent with the IEMP, at ASL B. These four extraction wells, 31563, 31564, 31565, and 31566, are also located around the perimeter of, or within, the A2PI excavation area.

Data from this program will be used to assess the impact of remedial activities on the Great Miami Aquifer and will be provided in the IEMP reports. During implementation of A2PI soil remediation activities, the data will be evaluated in conjunction with Aquifer Restoration and Waste Water Project personnel to spot a trend or change in trend that could indicate a potential adverse impact to groundwater quality within the Great Miami Aquifer. The data will be carefully scrutinized in an effort to determine whether the soil remediation activities are adversely affecting the Great Miami Aquifer (e.g., vertical migration through the glacial overburden as a result of surface water infiltration), or whether other conditions (migration of existing plume, groundwater remediation activities) are the likely impacting factors. In the event that data indicate a potential adverse impact, an appropriate future course of action will be evaluated and implemented, considering the following:

- Is this area of the Great Miami Aquifer already planned for groundwater remediation? If not, should it be remediated (in accordance with the criteria in the OU5 ROD [DOE 1996a])?
- If the answer to either of the above is yes: Is Great Miami Aquifer groundwater remediation of this area already ongoing? If not, should Great Miami Aquifer groundwater remediation for the area be re-prioritized?

- After project-specific groundwater monitoring ceases as previously determined, should monitoring of those wells be continued under the IEMP?

- What modifications, if any, can be retrofitted to the A2PI soil remediation project to mitigate the situation?

- What modifications to approach can be implemented in subsequent soil remediation projects to further minimize potential adverse impacts to the Great Miami Aquifer from soil remediation activities?

TABLE 4-1
CONSTITUENTS WHICH WILL BE ANALYZED IN THE SOUTH FIELD EXTRACTION SYSTEM MONITORING WELLS

General Chemistry	Inorganic	Radionuclide	Organic
Fluoride	Antimony	**Neptunium-237**	Alpha-Chlordane
Nitrate/Nitrite	Arsenic	Strontium-90	Bromodichloromethane
	Boron	Technetium-99	Carbon Disulfide
	Cadmium	Thorium-228	1,2 Dichloroethane
	Total Chromium	Thorium-232	Trichloroethene
	Lead	**Total Uranium**	Vinyl Chloride
	Manganese		
	Mercury		
	Nickel		
	Selenium		
	Zinc		

Note: Constituents categorized as "MP" (shown in **Bold**) are analyzed quarterly. Other constituents are analyzed annually.

Source: Section 3.5.1.2 of the IEMP.

5.0 PROJECT-SPECIFIC HEALTH AND SAFETY

All DOE and FDF employees, visitors, vendors, and contractors are required to abide by the provisions of FDF-prepared applicable Project-Specific Health and Safety Requirements Matrices (PSHSRMs), FDF Work Permits, and the FDF-approved Safe Work Plan prepared by the contractor. Managers and supervisors are responsible for ensuring that PSHSRM requirements are met. All personnel have stop-work authority for imminent safety hazards resulting from noncompliance with the applicable health and safety practices.

All site preparation/excavation contractor activities conducted in support of this project are governed by the safety requirements specified in the remediation contract, which addresses environmental, occupational, industrial, and construction health and safety. In addition to the contract requirements, PSHSRMs, and permits, the contractors will comply with all federal, state, and local requirements (e.g., OSHA, ACGIH). Health and safety requirements and procedures for this Implementation Plan are governed by the A2PI PSHSRM, FDF Work Permits, and the overall strategy discussed in Section 6.0 of the SEP.

A project-specific occupational monitoring strategy will be developed by the FDF Safety and Health (S&H) department for the A2PI project. The contractors will incorporate their occupational exposure monitoring requirements into Section 3 of their FDF-approved Safe Work Plans. These strategies will address the COCs for the A2PI project area and will comply with all federal, state, and local requirements (e.g., OSHA, ACGIH).

In accordance with "Developing Project-Specific Health and Safety Requirements," FEMP-SH-0001, a PSHSRM will be developed for A2PI construction, excavation, and impacted material placement activities. The applicable PSHSRM will be included in the contract solicitation packages (IFB/RFP) and will provide the contractors with information related to the possible hazards and the safety requirements to execute each task. The contractor can develop their specific Safe Work Plans using this information. The PSHSRM may be revised after reviewing the contractor's Safe Work Plans, as tasks and/or associated hazards and mitigators are identified, added, or deleted. Upon specific request by the EPA, the DOE would submit the PSHSRM(s) for informational purposes only. The

PSHSRM(s), as well as the detailed Safe Work Plans, will be maintained at the project site, with controlled copies in the project document control files.

FDF will provide all radiological occupational monitoring for the contractor. FDF radiological control technicians will provide the necessary support for A2PI activities. The contractual radiological control requirements for the performance of A2PI work will be documented in FDF job-specific radiological work permits (RWPs). Personnel performing work that requires an RWP will be briefed on the specific hazards and requirements for the task prior to commencing work. FDF radiological control personnel will evaluate the data obtained from the monitoring to determine the effectiveness of the radiological controls and relay this information to the contractor.

6.0 REMEDIAL ACTION MANAGEMENT STRATEGY

This section describes the strategy for managing the remediation of A2PI, specifically the organizational structure, the process for selecting and managing the site preparation and excavation contractors, the strategy for managing impacted material, the record keeping and data management procedures that are in place and will be used, the quality assurance/quality control (QA/QC) process, the integration of project activities with other FEMP activities, and the schedule of activities.

6.1 ORGANIZATION AND RESPONSIBILITIES

The governing document for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions at the FEMP is the ACA (DOE 1991) between DOE and Region V of the EPA. As such, ultimate project management responsibility lies with those two entities. The DOE is the lead agency responsible for CERCLA activities at the FEMP. The DOE Fernald Area Office (DOE-FEMP) is the ultimate authority for ensuring the A2PI remedial action is performed in a manner that meets all project goals, standards, specifications, and requirements of the Operable Unit 2 ROD (DOE 1995a), the Operable Unit 5 ROD, and the A2PI IRDP. The OEPA has been granted regulatory authority over certain RCRA activities.

Within each agency, various organizations and offices have been delegated specific program responsibilities. The DOE-FEMP Operable Unit 5 Team Leader will provide the overall DOE programmatic direction for A2PI. The DOE-FEMP will conduct field oversight through technical leads responsible for construction, excavation/remediation, engineering, quality assurance and control, health and safety, and other pertinent aspects of the project.

The FDF SCEP will provide the overall project management and technical guidance to the A2PI Project Team. The A2PI Project Team will provide all of the necessary technical, regulatory, and administrative input required for the A2PI project, under the direction of the A2PI Area Project Manager (APM).

The A2PI project organization is shown in Figure 6-1. Each functional area contributes personnel resources to support the A2PI Project.

The A2PI project includes the following groups, as shown on Figure 6-1:

- Project Management
- Primary Technical Areas
- Functional Support.

The roles and responsibilities for these groups within SCEP are presented below.

6.1.1 Project Management

A2PI project management includes the SCEP Project Director, APM, Deputy APM, and project support and administration. Except for positions specific to the SCEP, some of the personnel roles and responsibilities listed below are explained in detail in FEMP procedures.

It is important to note, as described in the following paragraphs, that various groups will have lead responsibilities during certain portions of the project. This does not reduce project management's overall responsibility to provide direction, guidance, and oversight.

The roles and responsibilities of points of interface between other FEMP projects and A2PI are discussed in Section 6.9. These points of contact with other projects will be critical to the progress and success of the project.

6.1.1.1 SCEP Project Director

The SCEP Project Director reports directly to the Vice President of the Soil and Water Projects Division. The Project Director provides guidance and a point of interface for all of the APMs, and serves as the primary contact for the SCEP with the DOE and the regulatory agencies.

6.1.1.2 Area Project Manager

The APM oversees and manages the project and has overall responsibility to complete the project scope within budget and schedule parameters. Specific responsibilities of the APM include:

- Providing administrative and technical direction
- Providing project staffing through SCEP
- Serving as a DOE and regulatory interface for the A2PI Project

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- Scheduling and general coordination
- Monitoring performance (scope, schedule, and budget)
- Monitoring and ensuring that Performance Objective Criteria (POC) milestones are completed.

6.1.1.3 Deputy Area Project Manager

The Deputy APM assists the APM as required and plays a major role in coordination within the project and with other projects/divisions. Specific responsibilities include:

- Coordinating technical issues with functional area leads
- Coordinating A2PI on a technical basis with other FEMP projects
- Serving as an alternate contact with the DOE and the regulatory agencies.

6.1.1.4 Project Support and Administration

Project Support and Administration coordinates and produces all A2PI documents. Specific responsibilities that are pertinent to the project include:

- Interfacing with Engineering/Construction Document Control (ECDC)
- Managing project documents
- Managing project document reviews, including the review/comment/response process.

6.1.1.5 Project Controls

The Project Controls group provides the APM with cost and schedule information for all accounts within the project. Specific responsibilities include:

- Ensuring cost and schedule requirements are defined, planned, and monitored against an integrated baseline so that performance can be measured and reported consistent with overall commitments, budgets and available funding
- Establishing and maintaining cost, schedule, and technical baselines through the issuance of change proposals
- Collecting monthly status reports to evaluate current trends which may result in forecast variances from the established baselines
- Assisting A2PI Control Account Managers (CAMs) and other project personnel in the various administrative duties associated with establishing the baselines and forecasts, as well as ensuring that all charges are directed to the proper accounts as defined in the baselines

- Working with sitewide training coordinators to ensure that individuals assigned to the project are in compliance with established training procedures and guidelines

- Working with division and site commitment trackers to ensure that all project commitments are entered into the tracking systems and that responsible personnel are kept informed of the requirements of each commitment

- Providing adequate documentation of commitment completion to sitewide and division trackers.

6.1.2 Primary Technical Areas

The primary technical areas for A2PI are:

- Engineering and Design
- Construction
- Characterization.

Each primary technical area will receive support from the functional support groups. Engineering and construction will be supported by contractors.

6.1.2.1 Engineering

Engineering, under the lead of the Project Engineer, provides technical expertise for engineering and design throughout the project. Engineering is responsible to the A2PI APM for developing project-specific designs and associated documentation and design modifications. An Architect/Engineer (A/E) Subcontractor will perform design, engineering and construction phase services (Title I/II and III) for A2PI. Engineering will serve as the primary contact and liaison with the A/E, work with the A/E on a day-to-day basis to address project technical issues, review the A/E's designs and work products, and evaluate the A/E's services. During construction, Engineering processes all Requests for Clarification of Information (RCIs) and Design Change Notices (DCNs). Specific responsibilities include:

- Reviewing and approving all engineering documents submitted by the A/E and construction contractors, as required by contract documents

- Developing responses to RCIs

- Developing DCNs

- Instructing the A/E when to revise construction drawings/technical specifications

- Reviewing and approving "As-Built Drawings" supplied by the Construction contractors at the completion of field work
- Reviewing and approving RCIs and DCNs
- Verifying that all contractual work has been performed by the A/E
- Verifying that all regulatory commitments are completed and approved.

6.1.2.2 Construction

Construction, under the lead of the CM, will be the lead organization during remedial action, including managing the construction contractors. The CM has a construction coordinator, a construction field engineer, and a construction contracts manager on staff to support these activities. During remedial design, construction will provide input and constructability reviews. Specific responsibilities include:

- Coordinating daily work activities in the field and providing technical direction to the construction contractors within the scope of the contract
- Coordinating day-to-day management of the A2PI field operations labor force
- Coordinating with/directing the Contractor
- Performing contract administration
- Reviewing and approving any modifications or changes to the contract documents
- Approving contract submittals.

Separate construction contractors provide remedial action/construction services during the site preparation and excavation phases. The contractors shall be qualified to perform all aspects of work required to successfully perform the site preparation and/or excavation of A2PI. In accordance with the contract documents, the contractors shall be registered/permitted in accordance with applicable local, state, and federal requirements and shall demonstrate significant prior related experience.

The contractors report contractually to the CM. They coordinate daily work activities with, and take technical direction from, the CM within the contract scope. The contractors are responsible for all equipment, materials, and activities relating to the project. The contractors are also responsible for scheduling and coordinating work with lower-tier contractors to complete the project within the schedule approved by the CM. The contractors are responsible for updating all construction drawings

for any deviations from the original plans and specifications on a daily basis and will prepare as-built drawings.

The contractors are represented on site by field representatives, who shall be qualified individuals who are capable of supervising the performance of all tasks associated with A2PI activities. They are responsible for coordinating and supervising the contractors' work in A2PI. At a minimum, the contractors' field representatives will be responsible for the following:

- Implementing a safety program in accordance with the contract documents
- Discussing and interpreting all elements of the A2PI design and informing the CM of any discrepancies between the plans and specifications and the field conditions
- Recommending changes or modifications to the project specifications for approval by the CM
- Distributing all documentation required by the project specifications in a timely manner
- Attending all project coordination meetings
- Scheduling all phases of the applicable A2PI activities
- Maintaining a daily log of all A2PI activities and assisting the CM in reviewing and approving submittals, as necessary
- Implementing and verifying all QC procedures required of the contractor and/or contractor's lower-tier contractors
- Submitting proposed alternative materials or methods to the CM for approval prior to acquisition and use
- Coordinating all technical requirements with the CM.

6.1.2.3 Characterization

The Characterization Manager will coordinate field measurements, sample collection, laboratory analysis, and data management associated with the characterization of waste materials and soil in A2PI.

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These responsibilities include:

- Developing project-specific plans (PSPs) and coordinating sampling and analysis to support predesign
- Evaluating and reporting data and providing associated recommendations and documentation
- Reporting precertification and certification sampling/measurements.

6.1.3 Functional Support

The A2PI Project will require support from internal SCEP functional areas. These functional areas will support remediation under the guidance of the lead organization and/or the APM. Generally, the lead technical group will manage the functional support staff. To the extent possible, functional support will be provided by personnel dedicated to the SCEP.

6.1.3.1 Safety and Health

S&H support during the project will include:

- Preparing all S&H documents for the project (including a Safety Assessment and S&H matrix)
- Reviewing project documents as they are prepared for compliance with S&H requirements
- Implementing the A2PI Project-Specific Health and Safety Plan (PSHSP)
- Assuring that contractors follow safe work practices.

The S&H representative has stop-work authority if unsafe work practices go uncorrected. Any employee of FDF or a contractor can stop work if he or she feels that the work situation is unsafe.

6.1.3.2 Radiological Control

Radiological Control support during the project will include:

- Preparing all required radiological control documents for the project (including radiological ALARA)
- Reviewing project documents as they are prepared for compliance for radiological requirements.

6.1.3.3 Environmental Compliance

Environmental Compliance (EC) support during the project will include:

- Preparing all required EC documents for the project, including the ARARs crosswalk, and environmental ALARA
- Reviewing project documents as they are prepared for EC requirements
- Coordinating with internal and external groups, including regulatory agencies, regarding regulatory matters
- Providing oversight to ensure compliance with environmental requirements.

6.1.3.4 Quality Assurance

The Quality Assurance (QA) representative will report to the A2PI APM and will be responsible for developing and implementing QA plans for the project. The primary responsibility of the QA representative is oversight of QA/QC activities during design, sampling, waste disposition, and construction excavation tasks. The QA representative will monitor and provide support to the project to ensure compliance with FEMP requirements and procedures. QA for A2PI will be performed in accordance with quality program elements identified in the FEMP Quality Assurance Program (RM-0012), the Sitewide CERCLA Quality Assurance Project Plan (SCQ; FD-1000), and the SEP Quality Assurance Project Plan. The QA representative has stop-work authority if quality concerns go unresolved.

6.1.3.5 Sampling

Sampling personnel are responsible for providing input on PSPs, collecting field data, and performing data management for all sampling activities related to A2PI, except for environmental monitoring sampling.

The individual sampling tasks are defined in PSPs prepared by the A2PI Characterization Manager, with the technical and writing assistance of Sampling personnel.

Environmental monitoring sampling is not performed by A2PI Sampling. Environmental monitoring sampling is covered under the IEMP and will be performed by Environmental Monitoring personnel.

6.1.3.6 Waste Disposition

Waste disposition support will be provided by a representative from the WAO. Support will include preparation of Project Waste Identification and Disposition (PWID) forms; definition of Material Tracking Locations (MTLs); technical direction and oversight for waste stream segregation and management; preparation of Field Tracking Logs (FTLs) and OSDF Manifests; preparation of waste stream profiles; and coordination with the CM, SCEP Characterization, and Waste Management and Technologies for handling and disposition of waste streams.

6.1.3.7 Natural Resources

Natural Resources personnel will be responsible for assessing the natural resources within the A2PI project area and assessing potential damages for consideration during the design and planning stages of the project. Natural resources personnel will not monitor natural resources impacts. Monitoring is covered under the IEMP and will be performed by Environmental Monitoring personnel.

Natural resources personnel will also be responsible for planning and implementing interim and final restoration of the A2PI area as described in the NRRP.

6.1.3.8 Cultural Resources

Cultural Resources will be responsible for handling unexpected discoveries of cultural resources during site preparation and excavation in A2PI.

6.1.4 Coordination of Excavation Site Activities

Several non-excavation activities will be on-going at each active excavation site. Because of the potential safety hazards associated with construction, these activities must be properly coordinated and supervised. Such activities include:

- Visual Observation
- WAC Attainment Monitoring
- Radiological Occupational Monitoring
- Asbestos Monitoring
- Material Documentation
- Occupational Health & Safety Monitoring
- Construction Monitoring
- Surveying
- Visual Dust Monitoring
- Environmental Monitoring
- Safety Inspections

The following paragraphs describe each of these activities, the personnel involved, and the time requirement for their involvement. In addition to these responsibilities, the contractor is expected to have one full-time equipment operator, the equivalent of one full-time truck driver, and a part-time supervisor at each active excavation area.

Visual Observation

The active face of excavation in below-WAC areas will be visually monitored (Section 3.3.4.3) on a continual basis to identify special materials encountered during excavation. This monitoring will be performed by FDF personnel (Section 6.1.3.6) and the excavation contractor.

WAC Attainment Monitoring

After completion of a lift in a discrete excavation area (normally 100-foot-by-200-foot), WAC attainment monitoring (Section 3.3.4.3) will be performed using RSS/RTRAK or HPGe equipment to identify above-WAC material. FDF sampling (Section 6.1.3.5) will perform this function under the general direction of the A2PI Characterization Manager. One person is required to operate each RSS/RTRAK unit and should normally take two to four hours to collect the data in the discrete area. The processing of this data is expected to take up to 48 hours. Upon completion of the data processing. The A2PI Characterization Manager will notify the CM of the results.

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If above-WAC material is identified, its presence will be confirmed and the horizontal and vertical extent determined using HPGe measurements and/or physical samples. FDF sampling (Section 6.1.3.5) will perform these functions under the general direction of the A2PI Characterization Manager. The following personnel are required for these activities:

Measurement Method:	HPGe	Physical Samples
Personnel Required:	2 operators per unit	2 geoprobe operators 2 technicians 1 geologist 1 documentation person

Radiological Occupational Monitoring

Radiological Control (Section 6.1.3.2) will have one full-time RCT in the field to monitor (Section 6.4.4) for general radiological levels, RWP compliance, and changes in material affecting the classification of the area (such as elevating it from a contamination area to a high contamination area), and to scan special materials if any are encountered.

Asbestos Monitoring

An "asbestos competent person" will be in the field full-time to monitor excavations for Presumed Asbestos Containing Material (PACM). The contractor will be required to perform this function, however, FDF will also monitor this activity. With proper training, this responsibility may be included with "visual observation" responsibilities.

Material Documentation

A full-time FDF representative will complete paperwork to document the transfer of material from the SWUs to the OSDF. This will include OSDF manifests and FTLs. All trucks hauling to the OSDF from A2PI must leave with an OSDF manifest. The FTL will include tracking by MTL. The FDF representative will use verbal information from contractor personnel to document movements between MTLs. These responsibilities may be included with "visual observation" responsibilities.

Occupational Health and Safety

The contractor will be responsible to monitor the work area for occupational health and safety concerns. This will include occupational dust, compliance with the Safe Work Plan, chemical

exposure, other hazards, and changes in field conditions affecting worker safety. FDF S&H (Section 6.1.3.1) will periodically observe health and safety conditions at the active excavation area.

Construction Monitoring

FDF construction (Section 6.1.2.2) will monitor (Section 6.4.2) the work for compliance with the contract documents and direct the actual work. This will be accomplished by one full-time person in A2PI and other personnel on a periodic, part-time basis.

Surveying

The Contractor will have a two- to three-person survey crew in the field to provide construction control and to monitor the excavation as the basis for progress payments. FDF may also perform limited surveying to check construction progress.

Visual Dust Monitoring

The contractor will have the primary responsibility to monitor for dust. However, FDF will also monitor the area for compliance with the BAT dust policy requirements.

Environmental Monitoring

Environmental monitoring will be done on a regular basis by FDF. This will include weekly inspections of surface water control facilities and inspections of surface water control facilities after every major rain event to satisfy IEMP requirements.

Safety Inspections

FDF S&H (Section 6.1.3.1) will perform weekly safety inspections (Section 6.4.3) of the work area with the contractor. This activity can be coordinated with occupational health and safety monitoring.

6.1.4.2 Typical Field Team

The typical field team at each excavation will consist of one RCT (radiological occupational monitoring), one FDF representative (visual observation and material documentation) and two construction personnel. However, it is possible that 12 or more people (six conducting radiological surveys with HPGe equipment or taking physical samples, one performing occupational health and safety monitoring and a health and safety inspection, one performing environmental and dust control

monitoring, one performing construction monitoring, and three construction personnel) could be near an active excavation site at any one time. However, only personnel required for actual construction activities will be allowed within 50 feet of the active excavation.

6.1.4.3 Management of Field Personnel

Such a potentially large group of personnel at a single excavation site at any given time creates logistical and safety concerns. Therefore, the responsibility for the management and coordination of all field personnel and activities has been assigned to the CM (Section 6.1.2.2). All personnel needing access to the excavation site will sign in with the CM before entering the excavation area and sign out upon leaving the area. In this way, the CM can control the number of people in a given area, as well as know how many people are in the construction area in the event of an emergency.

6.2 CONFIGURATION MANAGEMENT

Configuration Management will be implemented throughout the A2PI Project. Configuration Management is the management process by which the technical baseline for projects are identified, graded, tracked, and controlled. Configuration Management establishes consistency among the design requirements, physical configuration, and technical documentation, and will ensure this consistency is maintained throughout construction and operation. Configuration Management also ensures the systematic evaluation, coordination, disposition, documentation, implementation, and verification of all changes, and their impact on cost, schedule, and technical baselines. Site procedure CM-0001, "Configuration Management," will be used as the Configuration Management guideline throughout the A2PI Project.

Procedure ED-12-4015, Performance Grading, has been used and this project has been assigned Performance Grade 5, using the graded approach for systems, structures, and components, based on the importance of their function of hazard mitigation and safety. Performance Grade 5 will primarily require documentation control.

6.3 CONTRACTOR PROCUREMENT AND AWARD STRATEGY

Procurement and contract awards for all activities to support and implement the A2PI remediation project will generally be performed through fixed price/unit price contracts. The FDF acquisition system follows requirements of the Federal Acquisition Requirements (FARs) and is designed to ensure

adequate and effective competition among prospective bidders/proposers. The site preparation contractor was procured through an Invitation for Bid (IFB) process. The excavation contractor will be procured through an RFP.

Minimum qualifications are established in the pre-qualification phase in order to be considered for the competitive bid process. Those firms not meeting the minimum qualifications are not considered. The IFB/RFP solicitation package is prepared during the design process by the FDF Construction Engineer with input from Engineering, Health and Safety, QA/QC, Procurement personnel, and other applicable disciplines. The solicitation package is made up of several parts, including technical specifications and construction drawings, the PSHSRM and training requirements, QA/QC requirements, and the statement of work. Sealed bids/proposals are required to be submitted by potential contractors at a specified place, date, and time.

Following the pre-award survey and the determination that the bidder/proposer is both responsive and responsible, the FDF Contract Administrator recommends and makes the final award. The IFB/RFP solicitation package dictates how many days after award or Notice to Proceed that contractor performance begins and ends.

6.3.1 IFB for Site Preparation

Because the site preparation work is well defined, the contractor was selected based on responses to the IFB. The site preparation procurement process has been completed. The solicitation package was issued as an IFB on June 24, 1997; the pre-bid meeting for potential bidders was held July 8, 1997. Sealed bids from five bidders were received and opened on July 28, 1997. The contract was awarded to Kelchner Environmental on August 6, 1997. Construction was initiated the last week of August 1997, with issuance of the Notice to Proceed. The contractor mobilized to the site on September 3, 1997.

6.3.2 RFP for Excavation

The remedial action excavation for the SWUs will be combined with Phase II construction of the OSDF. Therefore, the plan and specifications for the SWUs excavation will be combined with the plans and specifications for the OSDF and presented to prospective contractors in one combined Request for Proposal (RFP). The RFP approach was selected in order to allow prospective contractors

flexibility to propose innovative and alternative methods of performing the work. Combining A2PI excavation and OSDF construction under one contract will reduce coordination issues.

The A2PI excavation/OSDF construction RFP is scheduled to be sent to prospective offerers in early November 1997. A contract will be awarded in early 1998 and actual construction will begin in June 1998.

6.3.3 Equipment and Material Procurement

The majority of the standard support equipment and materials for the A2PI project will be procured by the contractor performing the remediation during the site preparation phase. Procurement of equipment and material will be in accordance with design specification requirements consistent with the submittal schedule included in the subcontract, pending FDF approval. Vendor data will be submitted by the contractor for applicable Project Team Management (contractor's field representative, CM) review to ensure design and specification requirements are met. Responsibility for maintenance and repair of procured equipment and material lies with the contractor until final acceptance and turnover to FDF on behalf of the DOE.

6.4 CONTRACTOR MANAGEMENT

FDF will directly oversee the contractor performing remediation work and will be responsible for construction management during the work. Construction management includes, but is not limited to, conducting status meetings, daily work surveillance and inspections, and daily safety tours and oversight of the project. The CM will ensure that safety concerns are brought to the attention of the FDF S&H Officer and the responsible contractor(s) who will correct these concerns. FDF is responsible for implementing the A2PI remedial action project in accordance with DOE direction.

6.4.1 Status Meetings

Upon the award of the contracts, the CM will conduct regularly scheduled status meetings. These meetings are to ensure orderly and timely completion of the work and to provide coordination and communication between all parties involved. Attendees will include the CM, the APM, Engineering, Health and Safety, QA, contractor representative(s), and others, as warranted. The meetings will address action item status, project progress, planning, schedule status, safety items, quality, environmental protection, and problem resolution.

In addition to the status meetings, the contractor(s) will be required to submit a daily report (or log) to the CM. The contractor's daily report will cover the previous day's work status and identify any safety or quality problems encountered and a description of work performed. In addition to the contractor-generated daily report, the CM will also generate a daily report. Both reports will be maintained in the FDF project file.

6.4.2 Surveillance and Inspection

The contractors have first line responsibility to inspect work and correct any deficiencies. In addition to the generation and review of daily reports throughout excavation in the A2PI area, inspection and surveillance of the contractor's work will be conducted by FDF with support from the contractor's field representative. The surveillance and inspections will provide independent checks that the design is being properly implemented and contract requirements are being satisfied. Quality control inspection will also occur in accordance with the contractor's Construction Quality Assurance Plan and design requirements. If a deficiency is noted, the contractor will be notified immediately in order to implement the necessary corrective action(s) as soon as possible. The contractor's failure to satisfactorily correct a deficiency will constitute cause to issue a cure order/notice to stop work.

6.4.3 Health and Safety Oversight

A S&H representative will be assigned to the A2PI project. While all contractor personnel are responsible for following all safety requirements identified in the PSHSRM and subsequent Safe Work Plans, as appropriate, the A2PI Project Team personnel will perform periodic surveillance during the A2PI remedial action project to monitor compliance. Although all project personnel have stop work authority for imminent safety hazards, the S&H representative will have stop-work authority in the event of threat to worker and/or public safety until the proper corrective follow up actions are taken. The S&H representative assigned to the field project will be the single point of contact for all safety, industrial hygiene, fire protection, and radiological issues or concerns, and will direct those concerns to the CM for resolution/implementation.

6.4.4 Radiological Monitoring and Oversight

To ensure occupational radiological compliance, FDF RCTs will be assigned to the A2PI project. The assigned RCTs will perform the necessary radiological monitoring and oversight to provide documentation demonstrating project compliance with regulatory occupational exposure control

requirements. The PSHSRM will be the basis for the required project radiological monitoring and will identify controls (engineering or administrative) to ensure personnel radiological safety as well as industrial/occupational safety.

6.5 IMPACTED MATERIAL MANAGEMENT

Impacted material management protocols described below will be implemented in conformance with "Management of At- and Below-Grade Impacted Material" (EW-1019). This procedure provides for the programmatic segregation and characterization of wastes to ensure that only material that meets the OSDF WAC is disposed on site. This procedure adheres to the requirements set forth in the SEP, OSDF WAC Attainment Plan, and the OSDF Impacted Material Placement Plan.

6.5.1 Waste Planning

The impacted material waste streams anticipated to be generated during remediation of the SWUs are shown in Table 6-1, Impacted Material Waste Streams. This information will be incorporated into a PWID form prior to field implementation of each project phase. Each waste stream will be associated in the PWID with at least one source MTL. The MTLs are based on data from kriging models that are developed for designing project excavations. A material documentation drawing which identifies MTLs is included in the design packages (SPDwg G0022, EDwg G0019).

The PWID will govern disposition of waste streams throughout project execution. Compliance with the PWID during project activities will be documented by completing FTLs for interim movements (e.g., stock piling, backfilling, transfer to containers), and by completing manifests for OSDF disposition. Requirements for documentation of waste streams using FTLs and manifests are included in contract technical specifications (ESpec 02212). Waste stream information, including but not limited to PWIDs, MTLs, FTLs, manifests, and supporting data, will be tracked in the IIMS database.

6.5.2 Waste Stream Excavation

Waste streams within each MTL will be segregated as they are excavated, in accordance with the protocols indicated in Table 6-2, Material Segregation Protocols.

Waste disposition staff will support construction during waste excavation activities by conducting the following activities:

- Providing technical direction and oversight for identifying, segregating, and managing impacted material waste streams
- Preparing FTLs/manifests for transfer of material between MTLs, including but not limited to, stockpiles and the OSDF
- Preparing waste stream profiles for material dispositioned to stockpiles or the OSDF
- Tracking waste streams in IIMS
- Preparing weekly inventory reports for staged material
- Conducting weekly audits of staged material for inventory security and erosion controls.

6.5.3 Waste Stream Staging, Treatment, and Disposal

Each of the anticipated waste streams identified in Table 6-1 will require interim management as well as final disposition. In some cases, interim management will be limited to integration between field and office to ensure that manifests are prepared and sufficiently backed by electronic data in IIMS to support direct disposition to the OSDF upon excavation of impacted material. In other cases, interim management will be more complex, requiring staging the material in a stockpile or container for sampling and analysis, or simply to await scheduling for on- or off-site disposition.

Typically, only final disposition can be clearly defined for a waste stream prior to project implementation. Most interim management requirements are subject to project conditions such as availability of OSDF capacity for a specific waste matrix (e.g., soil versus debris) and the quality of excavated material for construction purposes. Consequently, only anticipated stockpile and container staging, and the anticipated final disposition of waste streams, are recorded in the original PWID. Any additional management approaches that are implemented during project execution are documented by updating the PWID.

The following outline identifies all possible interim and final disposition options that may be used during a project. Requirements are identified in Section 7 of EW-1019.

- Bulk waste stream management for on-site disposition: Waste streams that meet the OSDF chemical, radiological, and physical WAC (Section 7.5 of EW-1019)

  - Project-specific stockpiles
  - Sitewide stockpiles
  - Cut-and-fill working stockpiles
  - Back fill
  - OSDF - from project area
  - OSDF - from a stockpile

- Bulk waste stream management for off-site disposition: Waste streams that exceed the OSDF chemical or radiological WAC, and can be managed bulk (Section 7.6 of EW-1019)

  - Project-specific stockpiles
  - OU1 stockpile

- Containerized waste streams that are dispositioned on-site: (Section 7.8 of EW-1019)

  - Interim container staging pending characterization
  - Bulked prior to OSDF disposition

- Containerized waste streams that are dispositioned off-site (Section 7.7 of EW-1019)

  - Materials that exceed the OSDF WAC and cannot be managed bulk
  - Transferred to WPM for off-site disposition in container system.

FTLs/manifests will be used in all cases for tracking material that will be dispositioned to the OSDF. Information that supports WAC determinations will be retrievable through IIMS using either the FTL (interim staging) or manifest (OSDF disposition) form numbers. This information will be available for review by WAO.

The FTLs also will be used to track above-OSDF-WAC containerized materials from the project area. However, subsequent management of the material will be conducted under existing site waste management procedures, with tracking conducted in the Sitewide Waste Information Forecasting and Tracking System (SWIFTS) database.

Stockpile management protocols (Section 3.1.9) will include administrative controls (posting and boundary delineation) that ensure only suitable material is staged at the stockpile locations. Silt fencing and either vegetative or crusting agent covers will be installed to control erosion and runoff. When

stockpiles are in use, dust controls will include daily compaction and application of water mist for visible dust.

6.6 CONTINGENCY MANAGEMENT

The potentially contaminated or hazardous materials identified in Table 6-3, Protocols for Special Material, will require special handling and controls if encountered during soil excavation activities, due to potential health and safety concerns.

Figures F.5-2 through F.5-12 in the SEP provide additional information regarding protocols for managing special materials. As indicated in Table 6-1, some special materials may meet the OSDF WAC, while others will require off-site shipment. The SCEP Waste Disposition Support Services will provide assistance to Construction for field decisions related to management and disposition of special materials, and, if applicable, will arrange for movement of materials to the appropriate FEMP staging and handling areas for characterization, treatment evaluation, and final disposition arrangements.

6.7 RECORD KEEPING AND DATA MANAGEMENT

Record keeping and data management for the A2PI Project will be in accordance with Section 3.6 of the SEP. The primary documents that will be generated during A2PI remediation activities and the files in which they will be maintained are identified in Table 6-4, A2PI Records.

6.8 QA/QC AND REGULATORY AUDIT

The A2PI project activities will be assessed to verify compliance to program requirements specified in the A2PI Implementation Plan. This will include audits, surveillances and inspections commensurate to the scope of assessment and level of verification with respect to field tasks, subcontract execution and programmatic implementation of driver documents. Quality assurance programmatic drivers are considered to be the DOE approved FDF Quality Assurance Plan (RM-0012), the EPA approved SCQ, and the draft SEP Appendix E, SEP Quality Assurance Project Plan (QAPP).

The applicable quality requirements will be specified in all planning documents defining project activities. This includes Data Quality Objectives (DQOs) and PSPs that serve as planning and field instructions for environmental radiological field survey measurements and physical sampling to support project data collection. Additionally, the engineering design packages will include the necessary QC to

assure conformance to design specifications. Part 9 of the design packages describes appropriate QA requirements. A Construction QA plan will be submitted by construction contractors for SCEP QA approval. Other documents that require QA review and concurrence are procedures, purchase requisitions and the Project Execution Plan (PEP).

The SCEP QA lead will coordinate project QA/QC oversight through audits, surveillances, inspections, vendor surveys, and other internal assessments needed to verify quality related to IRDP activities. External assessments from FDF will also be coordinated with the SCEP QA lead. The contractor will be responsible for field inspections, nonconformance identification, and corrective action that is documented and reflected in a controlled manner through DCNs.

The DOE-FEMP and EPA/OEPA have ready access to IRDP field activities, planning documents, and databases as necessary to assess and verify IRDP implementation. The OEPA has FEMP oversight responsibility for NPDES, RCRA, dust and noise control, groundwater, monitoring, radiological pathways, and related split-sampling programs.

All FDF procurement requisitions are reviewed and signed by SCEP QA. The A2PI QA representative will identify materials receipt inspection requirements and when vendor source inspections are necessary. Nonconforming items will be tagged and dispositioned as unacceptable until corrective measures are determined.

6.9 INTEGRATION OF A2PI EXCAVATION WITH OTHER FEMP ACTIVITIES

The A2PI Project is related to, and must be integrated with, other projects (external to the SCEP) at the FEMP. The major projects that will impact A2PI and their relationship to A2PI are as follows:

- OSDF. Impacted material (soil, fill material, flyash, ground stumps, debris, etc.) will be excavated from A2PI. Most of this material is expected to meet the OSDF WAC and will be hauled to, and placed in, the OSDF, where it will be placed in ratios defined in the Impacted Material Placement Plan with available debris from the former production area. The excavation phase of A2PI remediation will be integrated into one contract package with Phase II of the OSDF. Excavation, loading, hauling, unloading, and subsequent placement of impacted material in the OSDF will be performed by one construction contractor.

- Waste Pits Remedial Action Project (WPRAP). Material excavated from A2PI that is above the OSDF WAC will be sent off site for disposal through WPRAP. Above-

WAC material will be hauled to, and unloaded at, the Operable Unit 1 Stockpile by the excavation contractor.

- Waste Management. Special materials and lead-contaminated soil from the SWUs will be managed by FDF Waste Management. The excavation contractor will coordinate the transfer with Waste Management through the CM.

- Impacted Material Haul Road - Haul equipment transporting material from the A2PI area to the OSDF and the Operable Unit 1 Stockpile will use the Impacted Material Haul Road. Prior to accessing the Haul Road, the haul equipment will be routed through the A2PI equipment wash facility. The equipment wash facility will be located adjacent to the Impacted Material Haul Road near the Inactive Flyash Pile area. Haul equipment returning from the OSDF and the Operable Unit 1 stockpile to the A2PI area will also use the Impacted Material Haul Road. At certain designated crossings, Operable Unit 1 activities and Operable Unit 4 activities will also necessitate accessing the Impacted Material Haul Road.

- AWWT and Water Projects. Part of the South Field Extraction System (SFES) will be built in the area of the SWUs. Part of the SFES will be put in by the site preparation contractor. Access to groundwater extraction wells during A2PI remediation activities will be provided. Also, water from the three A2PI retention basins will be pumped to the SWRB.

- Storm Water Retention Basin (SWRB) - Contaminated and potentially contaminated storm water runoff collected from the A2PI excavation activities will be pumped from the A2PI retention basins to the SWRB.

- Site Utilities - Electrical power will be required for lighting, alarms, pumps, and controls. FDF will route all electric power for contractor tie-ins. Potable water will be obtained by the contractor from the site public water supply line.

6.10 SCHEDULE

In accordance with the ACA, this Implementation Plan identifies A2PI remedial action project-specific milestones subject to enforceable deadlines by the EPA. A conceptual schedule is provided on Figure 6-2. This schedule is based on current funding assumptions and the overall site remediation schedule.

Site preparation work was initiated in August 1997, with award of the contract and issuance of the Notice to Proceed. The contractor mobilized to the site in September 1997. On-site excavation activities are expected to be initiated June 1, 1998. The excavation contract is expected to end on December 31, 2000. This is necessary because the Area 3 remediation contract award is scheduled for

that time. That contract, as will the A2PI excavation contract, will include placement of material in the OSDF. Therefore, to avoid conflicts, the A2PI excavation contract will have to be terminated.

As shown in Figure 6-2, this is before certification of the Active Flyash Pile. Therefore, any supplemental excavation or interim restoration (Section 3.6) in the Active Flyash Pile or Retention Basin 3 required as part of, and subsequent to, the certification will be provided by the Area 3 contractor.

TABLE 6-1

IMPACTED MATERIAL WASTE STREAMS

Waste Stream	Source Location	OSDF WAC Status	Final Disposition	Est. Vol. (Yd^3)
Lead-contaminated Soil	South Field Firing Range	AWAC[a]	Off-site bulk shipment by truck to PCDF[b], pending sample results	100
Fly Ash/Soil	Inactive Fly Ash Pile	AWAC	Staged in OU1 Stockpile for off-site rail shipment to PCDF	1,700
OSDF Category 1 Impacted Material	Inactive Fly Ash Pile	BWAC[c]	OSDF[d]	97,000
OSDF Category 1 Impacted Material	Active Fly Ash Pile	BWAC	OSDF	61,000
OSDF Category 1 Impacted Material	South Field	BWAC	OSDF	117,000
OSDF Category 1 Impacted Material	Impacted Stockpile on South Field	BWAC	OSDF	22,000
Wood Chips	All Areas	BWAC	On-site reuse	1,000
OSDF Category 2 Debris	All Areas	BWAC	OSDF	37,000
OSDF Category 3 Debris	All Areas	BWAC	OSDF	250 [f]
OSDF Category 5 Material	All Areas	BWAC	OSDF	200 [f]
Prohibited Items	All Areas	AWAC	Off-site containerized shipment by truck to NTS[e] or PCDF	100 [f]
Special materials	All Areas	AWAC	Off-site containerized shipment by truck to NTS or PCDF	100 [f]
Special materials (Various OSDF Categories)	All Areas	BWAC	OSDF	100 [f]

[a] AWAC = Above OSDF Waste Acceptance Criteria
[b] PCDF = Permitted Commercial Disposal Facility
[c] BWAC = Below OSDF Waste Acceptance Criteria
[d] OSDF = On-Site Disposal Facility
[e] NTS = Nevada Test Site
[f] Assumed value to reflect expectation of encountering such material

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TABLE 6-2

MATERIAL SEGREGATION PROTOCOLS

Material Type	Segregation Protocols
AWAC Special Material	See Table 1 of EW-1019 for list of special materials.
BWAC Special Material	See Table 1 of EW-1019 for list of special materials.
Prohibited Items	See Table 2 of EW-1019 for list of prohibited items.
AWAC Soil	See Table 4 of EW-1019 for chemical and radio nuclides of concern, and Table 3 of EW-1019 for prohibited constituents of concern. Note that Table 3 prohibitions apply only to areas defined in the OU2 and OU5 RODs as potentially RCRA characteristic.
AWAC Debris	AWAC debris that is not classified as special material or prohibited items, requires physical sizing or processing to meet the OSDF WAC.
BWAC Material	Segregate in accordance with OSDF waste stream categories in Table 5 of EW-1019.

AWAC = Above OSDF Waste Acceptance Criteria.
BWAC = Below OSDF Waste Acceptance Criteria

TABLE 6-3

PROTOCOLS FOR SPECIAL MATERIALS

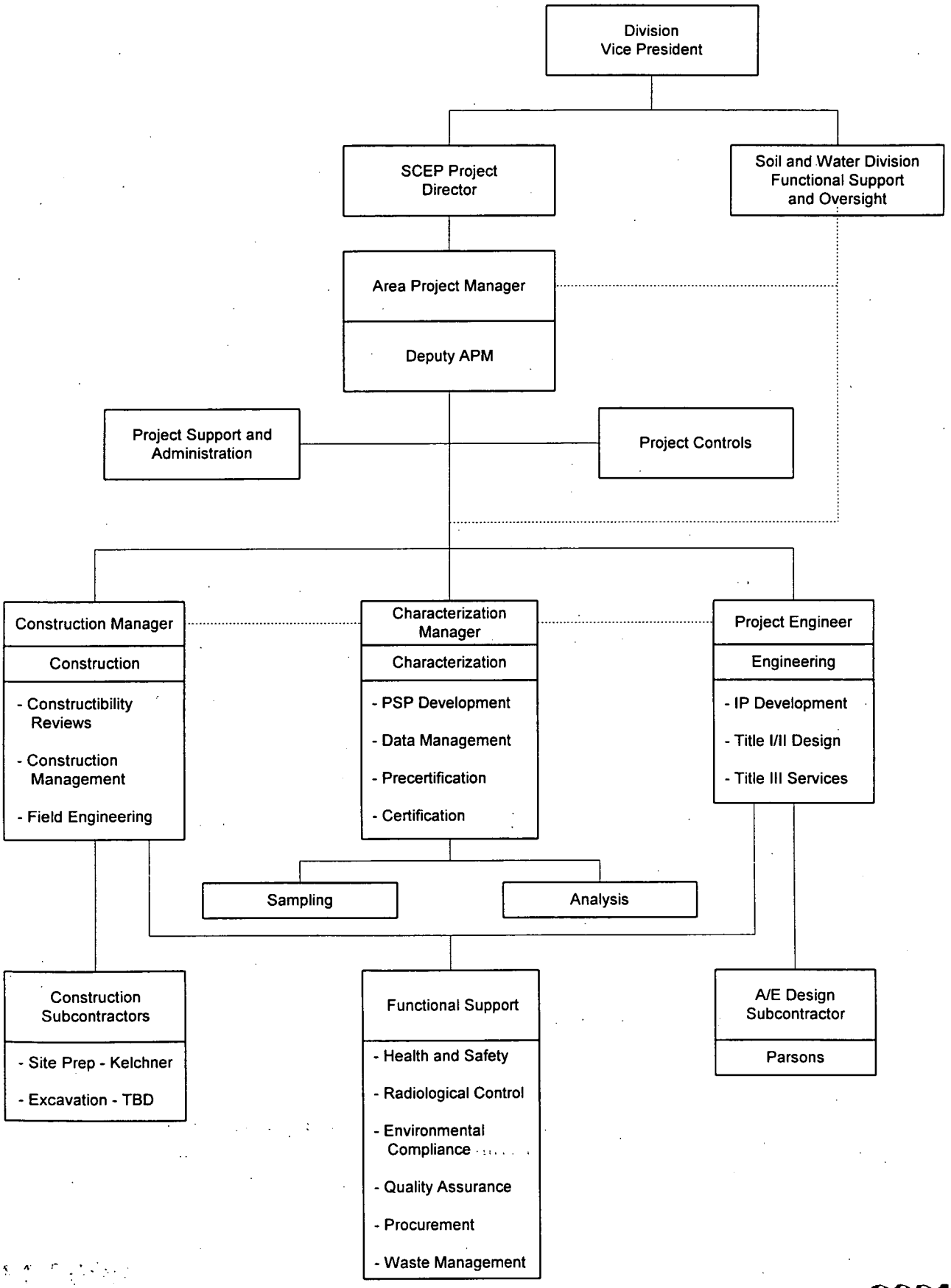
SPECIAL MATERIAL	EXAMPLES	PROTOCOLS
Asbestos/Presumed Asbestos Containing Material (PACM)	Transite panels, floor tile, feeder cable, piping insulation	General: Unprotected ACM may not be staged in the excavation area. If delays are expected prior to OSDF disposition, containerize and transport to interim storage. Wrapped pipe: Size reduce, double bag or equivalent for OSDF Category 3 or 5. Pipe may be split axially or radially. Transite sheets: Band and manage as OSDF Category 3. Other ACM that meets OSDF Category 5: Double bag ACM that does not meet OSDF WAC: Containerize and transport to interim storage for off-site evaluation. Note: OSDF Category 5 is evaluated on a case-by-case basis. A Request For Disposal (RFD) is required.
Non-pressurized Containers	Intact drums, metal and wood boxes, cans	Intact containers: Visually inspect for leaks and indication of contents. Overpack or repack leaking containers prior to movement from area of discovery. If safety considerations allow, open container and record description of contents on Visual Inspection Form. Transport to interim storage for further evaluation. Empty containers: Crush or size reduce and manage as OSDF Category 2.
Pressurized Containers	Aerosol cans, Freon containers, gas cylinders, propane tanks, fire extinguishers	General: Handle intact containers as though they contain material. Evaluate container integrity. Intact containers: Overpack and move to FEMP interim storage area for evaluation. If container is to be dispositioned in OSDF, it must be punctured, crushed or cut so that the interior is open to the atmosphere. Breached containers: Evaluate for OSDF Categories 2, 3 and 5. Category 5 is evaluated on a case-by-case basis and requires a RFD.
Piping and sumps	Drain lines, sewer lines, process piping, floor sumps	General: Elevate one end of exposed pipe, cut, and empty flowable material into a container. Transport containers to interim storage for evaluation. Process piping: Cap and remove pipe after emptying. Evaluate piping for OSDF Category 2. Containerize any piping that requires off-site disposition. General piping: Cap and remove pipe after emptying. Manage as OSDF Category 2. Sumps: Remove after emptying. Mange as OSDF Category 2. Note: MEF/SWIFTS research is required prior to trenching activities.
Non-soil Residues	Green salt, black oxide, sump cake	Field screen to determine radionuclide content. Segregate uranium-bearing residues, containerize, and transport to interim storage for evaluation. Stockpile non-uranium residues and evaluate for OSDF Category 1 or 5. Category 5 requires a RFD.
Transformers	Electrical equipment	General: Segregate and evaluate to determine if contains fluids. Empty transformers: Manage as OSDF Category 2, 3, or 5. Fill void spaces greater than 1 cf. with flowable, cohesionless material or a quick set grout. Category 5 requires an RFD. Transformers containing fluids: Drain fluids into a container and transport to interim storage. Evaluate fluids for off-site disposition. Manage emptied transformer as described above.
Lead Acid Batteries		Segregate, containerize and transport to interim storage for evaluation.
Uranium Metal	Derbies, ingots, billets, irregularly shaped scrap	Segregate, containerize, and transport to interim storage area for off-site evaluation. Will either be classified as nuclear material and sold, or classified as a waste and disposed off site.
Medical/Infectious Waste	Syringes, vials	Evaluate on case-by-case basis for OSDF Category 5 (requires a RFD). Containerize and move to interim storage if field operations do not allow timely completion of this evaluation. Medical/infectious waste not meeting OSDF requirements will be containerized and transported to interim storage for off-site evaluation.
Miscellaneous Debris	Oil/air filters, radiators, cable/wire, tools; heavy equipment, office materials, documents	Evaluate on case-by-case basis for OSDF Category 5 (requires a RFD). Containerize and move to interim storage if field operations do not allow timely completion of this evaluation. Miscellaneous debris not meeting OSDF requirements will be containerized and transported to interim storage for off-site evaluation.
Tires	Tires from miscellaneous equipment	Containerize and transport to interim storage for off-site evaluation.

TABLE 6-4

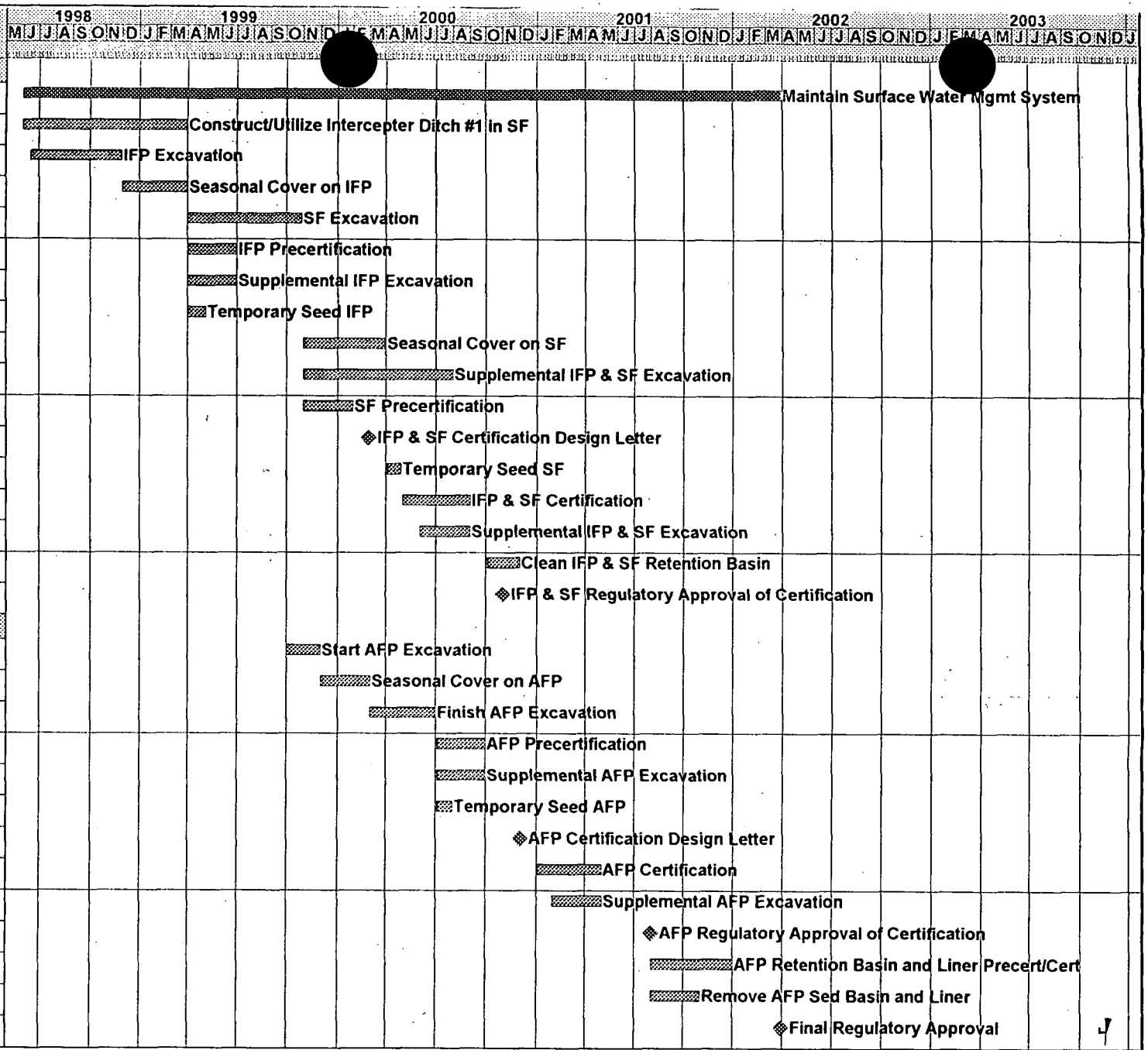
AREA 2, PHASE I RECORDS

Document	File
Construction drawings and associated field logs	• IIMS GIS Component • Engineering/Construction Document Control
Miscellaneous Field Logs	• Engineering/Construction Document Control
Manifest-type Documents	• IIMS SWIFTS Component • Engineering/Construction Document Control
Containerized Impacted Material Documents	• IIMS SWIFTS Component • Site Operating Record
Analytical Data and Associated Field Logs	• IIMS SED Component • Engineering/Construction Document Control

Figure 6-1
Area 2, Phase I Project Organization



Activity Description	Early start	Early finish
IFP & SF EXCAVATION & PRECERT/CERT		
Maintain Surface Water Mgmt	01JUN98*	29MAR02
Construct/Utilize Intercepter	01JUN98	31MAR99
IFP Excavation	15JUN98*	30NOV98
Seasonal Cover on IFP	01DEC98	31MAR99
SF Excavation	01APR99*	29OCT99
IFP Precertification	01APR99	30JUN99
Supplemental IFP Excavation	01APR99	30JUN99
Temporary Seed IFP	01APR99	03MAY99
Seasonal Cover on SF	01NOV99	31MAR00
Supplemental IFP & SF	01NOV99	01AUG00
SF Precertification	01NOV99	31JAN00
IFP & SF Certification Design		28FEB00*
Temporary Seed SF	03APR00	28APR00
IFP & SF Certification	01MAY00	01SEP00
Supplemental IFP & SF	01JUN00	01SEP00
Clean IFP & SF Retention Basin	02OCT00*	30NOV00
IFP & SF Regulatory Approval		31OCT00*
AFP EXCAVATION & PRECERT/CERT		
Start AFP Excavation	01OCT99*	30NOV99
Seasonal Cover on AFP	01DEC99	29FEB00
Finish AFP Excavation	01MAR00	30JUN00
AFP Precertification	03JUL00	29SEP00
Supplemental AFP Excavation	03JUL00	29SEP00
Temporary Seed AFP	03JUL00	31JUL00
AFP Certification Design Letter		30NOV00*
AFP Certification	01JAN01*	30APR01
Supplemental AFP Excavation	01FEB01*	30APR01
AFP Regulatory Approval of		31JUL01*
AFP Retention Basin and Liner	01AUG01	31DEC01
Remove AFP Sed Basin and	01AUG01	31OCT01
Final Regulatory Approval		29MAR02*



Project Start	02FEB98	Early Bar
Project Finish	29MAR02	Progress Bar
Data Date	02FEB98	Critical Activity
Plot Date	23OCT97	

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A2P1

Sheet 1 of 1

FIGURE 6-2

A2P1 EXCAVATION/CERTIFICATION

IMPLEMENTATION PLAN

FERNALD

Environmental Management Project

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A

Design Criteria Package for Area 2, Phase I Southern Waste Units Remedial Action Project Design and Construction

20400-DC-0001

Project Order 165

October 1997
Revision 1

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FDF Subcontract No. 2-21487

PARSONS

25 Merchant Street
Cincinnati, Ohio 45246

Design Criteria Package
for
Area 2, Phase I
Southern Waste Units
Remedial Action Project
Design and Construction
Revision 1

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LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACGIH	American Conference of Governmental Industrial Hygienists
AFP	Active Flyash Pile
ALARA	As Low As Reasonably Achievable
ASCE	American Society of Civil Engineers
ANSI	American National Standards Institute
ARAR	Applicable or Relevant and Appropriate Requirement
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWWT	Advanced Wastewater Treatment (Facility)
CFC	Certified for Construction
CFR	Code of Federal Regulations
cy	cubic yards
DCP	Design Criteria Package
DOE	United States Department of Energy
EPA	Environmental Protection Agency
FDF	Fluor Daniel Fernald, Inc.
FEMP	Fernald Environmental Management Project
FRL	Final Remediation Level
FS	Feasibility Study
GMA	Great Miami Aquifer
gpm	gallons per minute
HDPE	High Density Polyethylene
IFP	Inactive Flyash Pile
ISC3	Industrial Source Complex Version 3
μg	micrograms
m	meter
MSS	Manufacturers Standardization Society
NEMA	National Electrical Manufacturers Association
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OSDF	On-Site Disposal Facility
OU	Operable Unit
PACM	Presumed Asbestos Containing Materials
PCDF	Permitted Commercial Disposal Facility

PSHSP	Project-Specific Health and Safety Plan
psi	pounds per square inch
rem	roentgens-equivalent man
RI	Remedial Investigation
SCS	Soil Conservation Service
SF	South Field
SFES	South Field Extraction System
SFVH	South Field Valve House
S/RID	Standards/Requirements Identification Document
SSC	Structure, System, and Component
SWMP	Surface Water Management Plan
SWRB	Stormwater Retention Basin
~~SWU~~	~~Southern Waste Unit~~
TBC	To Be Considered
TWA	Time-Weighted Average
UBC	Uniform Building Code
WAC	Waste Acceptance Criteria

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SECTION 1

PROJECT DESCRIPTION

The Fernald Environmental Management Project (FEMP) is a 1,050-acre facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The FEMP facility contains low-level radioactive, solid, and hazardous wastes. Much of the impacted material is to be disposed of in an On-Site Disposal Facility (OSDF) as delineated in the Operable Units Records of Decision. It is anticipated that approximately 2.5 million cubic yards (cy) of material will be removed from the FEMP operable units during the remediation activities and will be placed in the OSDF for permanent disposition. The impacted material that has been approved for placement in the OSDF from the Operable Unit (OU) 2 ~~Southern Waste Units (SWU)~~ Area 2, Phase I consists of approximately ~~345,000~~ 346,500 cy of soil (in situ), debris, fly ash, sludge, and solid waste. In addition, approximately 3,000 cy of material will be transported to the OU-1 Stockpile Area pending shipment to an off-site permitted commercial disposal facility (PCDF). Approximately ~~100~~ 300 cy of lead-contaminated soil will be excavated and shipped offsite for treatment and disposal.

This Design Criteria Package (DCP) addresses the issues and concerns for design and construction of the ~~OU-2 SWU~~ Area 2, Phase I Remedial Action Project. The DCP is developed consistent with the requirements in the draft Functional Requirements Document prepared by Fluor Daniel Fernald, Inc. (FDF), the Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) requirements prepared by FDF and listed in Appendix A, appropriate United States Department of Energy (DOE) regulations and orders, United States Environmental Protection Agency (EPA) directives, and FDF Standards/ Requirements Identification Documents (S/RIDs).

This DCP will serve as the basis for Title I, II, and III design services for design and construction of the ~~SWU~~ Area 2, Phase I Remedial Action Project.

This DCP was prepared consistent with the outline provided in the FEMP Engineering Procedure Number 12-4003, *Design Criteria Package*, Revision 0.

1.1 Project Scope

PARSONS will provide Title I/II engineering services to prepare Certified for Construction (CFC) design packages for the ~~OU-2 SWU~~ Area 2, Phase I. Separate Site Preparation and Excavation packages will be prepared for the ~~SWUs~~ Area 2, Phase I which include the following:

- South Field (SF)
- Inactive Flyash Pile (IFP)
- Active Flyash Pile (AFP)

Title III services will be provided during construction of the ~~SWU~~ Area 2, Phase I Remedial Action Project.

1.2 Description of Alternative Selected

The selected remedy for the OU-2 ~~SWU~~ Area 2, Phase I includes excavation of all impacted material with contaminants of concern above the established OU-2 Remedial Investigation (RI)/Feasibility Study (FS) final remediation levels (FRLs) or all fill material, whichever extends deeper. For the remediation of the ~~SWU~~ Area 2, Phase I areas, this includes excavating down to the original grade or deeper if indicated by the RI/FS FRLs. In addition to excavation, the remediation process will include material processing for specified size requirements, moisture control, and on-site disposal in the OSDF. Excavated impacted material that exceeds the radiological waste acceptance criteria (WAC) of the OSDF will be segregated and transported to the OU-1 Stockpile Area. This material will be packaged and shipped by FDF to a PCDF. It is estimated that approximately ~~345,000~~ 346,500 cy of in situ impacted material will meet the OSDF WAC and thus be disposed of on-site. Approximately 3,000 cy of material may not meet the WAC for the OSDF and will be disposed of off-site at a PCDF. Additionally, approximately ~~100~~ 300 cy of soil containing lead will be removed from the former firing range and packaged for shipment to a PCDF. This material will be staged within the ~~SWU~~ Area 2, Phase I project site prior to shipment.

1.3 General Description of the Project Components

1.3.1 Excavation

After site preparation, excavation will be performed in a phased manner by area. The general phases will be IFP, SF, and AFP. Within each area priority material that exceeds the OSDF WAC (i.e., above WAC and lead contaminated soil), will be excavated first and segregated as it is encountered. Material that meets the OSDF WAC will be transported to the OSDF for disposal. ~~Contaminated~~ Impacted material will be removed and the underlying substrate monitored for contaminant levels. As the ~~SWU~~ Area 2, Phase I area is remediated it will be graded to provide for positive drainage and seeded for erosion control.

1.3.2 Stormwater Controls

Stormwater runon will be controlled by constructing diversion ditches upslope of excavations. Runoff from within the excavated areas will be collected and controlled. The excavated areas within the ~~SWUs~~ Area 2, Phase I will serve as collection sumps for stormwater control. Retention basins will be designed

to store the 10-year, 24-hour storm event with sediment level at the required cleanout volume. The sediment cleanout level shall be based on 27-cubic yards of sediment storage per acre of drainage area. Additional detail is provided in Section 2.3 and describes use of 25-year, 24-hour storm event criteria for some stormwater controls. At the ~~SWUs~~ Area 2, Phase I, the potentially contaminated water from the retention basins will be pumped via a common pipeline to the FEMP Stormwater Retention Basin (SWRB). Retention basins will be designed to dewatere~~d~~ the 10-year storm within approximately 72 hours. All stormwater is to be routed so that it can be sent to the SWRB. Water from the SWRB is then sent to the Advanced Waste Water Treatment (AWWT) Facility for treatment.

A Surface Water Management Plan (SWMP) ~~will be~~ has been prepared for the ~~SWU~~ Area 2, Phase I Remedial Action Project and ~~will~~ include~~s~~ construction and post-construction controls for surface water runon and runoff.

1.3.3 Pipeline

Stormwater piping from the retention basins lift station to the SWRB will be double-walled. High Density Polyethylene (HDPE) pipe will be used for piping located below grade. This pipe will be buried a minimum of 3.5 feet to prevent freezing. Cleanouts will be placed at critical low points to assist in cleanout if the lines should become clogged. ~~Pressure relief~~ Air release valves will be installed at high points.

1.3.4 ~~Wheel~~ Equipment Wash Facility

~~A Wheel~~ An Equipment Wash Facility will be required prior to accessing the Haul Road at the ~~SWU~~ Area 2, Phase I excavation areas. The ~~wheel wash pad~~ Equipment Wash Facility will be constructed with a collection sump to collect potentially contaminated water so it can be sent to the AWWT for treatment. A flow rate of ~~10~~ 15 gpm is assumed. Potable water will be used. Wash water pressure ~~will~~ may be increased with a commercially available pressure washing unit. The ~~Wheel Wash Facility~~ Equipment Wash Facility will be used for gross decontamination by removing loose contaminants from vehicle tires and undercarriages. Water supply for the wash facility will be from the 6-inch diameter public water supply line that serves the FEMP. A backflow prevention system will be installed at the tie-in point.

1.3.5 Radiological Control Point Facility Trailer

Support facilities (trailers) will be provided at the ~~SWU~~ Area 2, Phase I access point. A radiological control trailer and an office trailer (for FDF use) will be provided. The radiological control trailer will be used as the normal ingress and egress point for the contamination areas and will include personnel contamination monitoring and radiological access control equipment, lockers, change-out areas, sinks and emergency showers. The office trailer will be provided with lavatory facilities (sink and toilet). Water supply for the trailers will be from the 6-inch diameter public water supply line that serves the FEMP.

~~Waste~~ Sanitary water will be collected in holding tanks and periodically removed by the ~~sub~~contractor and handled in accordance with site water treatment requirements. Sanitary facilities consisting of portable toilets located outside of contamination areas at the ~~SWU~~ Area 2, Phase I area, will also be provided.

1.3.6 Electrical Power

Electrical power will be provided at the ~~SWU~~ Area 2, Phase I areas for services to the trailers, stormwater excavation pumping, ~~wheel~~ equipment wash facility, lighting and other loads. In the ~~SWU~~ Area 2, Phase I area, a 13.2 kV aerial circuit will be extended from the primary of substation N18-1 to serve local 13.2 Kv - 480 V pole mounted transformer banks for the required loads. For these areas, a starter rack type service will be installed adjacent to the equipment requiring electrical power. Pumps associated with the remediation will be 480 V, 3 phase with local starters.

1.3.7 Surface Water Management Plan

A SWMP ~~shall be~~ has been prepared for the ~~SWU~~ Area 2, Phase I area. The plan ~~shall~~ addresses how surface water will be controlled, stormwater management, erosion and sediment control measures, implementation, and maintenance of the control measures.

1.3.8 Systems Plan

A Systems Plan ~~will be~~ has been developed for each system with mechanical or electrical components which ~~will~~ includes instructions for safe operations and maintenance.

1.3.9 Title III Services

Title III services will be provided during the construction of the ~~SWU~~ Area 2, Phase I Remedial Action Project. These services include attendance at construction meetings, preparation of observation reports, and review of site preparation and excavation ~~sub~~contractor submittals including Vendor Data Submittals, Requests for Clarification of Information, and Design Change Notices.

1.4 Assumptions/Clarifications

1) Retention basins for the ~~SWU~~ Area 2, Phase I will be designed to store either the 25-year, 24-hour storm event or the 10-year, 24-hour storm event (see Section 2.3) with sediment level at the required cleanout volume. The sediment cleanout level shall be based on 27-cubic yards of sediment storage per acre of drainage area. Ditches and culverts will also be designed using a 10-year frequency storm. Ditches and culverts located between the construction area and Paddys Run will be designed for the 25-year, 24-hour storm.

2) FDF will be responsible for compliance with stormwater management and wetlands issues, including all National Pollutant Discharge Elimination System requirements and permits. FDF will provide guidance on stormwater and wetland compliance.

3) The Project-Specific Health and Safety Plan (PSHSP) will be prepared by FDF.

4) The construction ~~sub~~contractor will remove and handle impacted material as shown on the design documents.

5) FDF will prepare and implement any sampling and analysis plans to characterize soil, guide excavation, and determine compliance with clean-up levels.

6) Air monitoring will be provided by FDF in accordance with ARARs.

7) Heat tracing will be provided on all aboveground piping where adequate slope for drainage cannot be achieved.

8) Double-walled pipe will be required for stormwater runoff transferred from the ~~SWUs~~ Area 2, Phase I.

9) Leak detection will not be required for stormwater runoff/transfer piping.

10) Above-grade vegetation will be cut, chipped, and either stockpiled in locations shown on the construction documents or hauled to the OSDF.

11) Geomembrane liners will be used in the non-impacted stockpiles. Geomembrane liners and soil infiltration barriers will be used in retention basins. A clay or clay-like soil, obtained from the OSDF Sediment Basin stockpile, will be used for the infiltration barrier material in retention basins and ditches where the Great Miami Aquifer (GMA) will be exposed due to excavation.

12) The personnel monitoring trailer requirements will be specified by FDF. Drawings and specifications on the personnel monitoring trailer will be provided by PARSONS.

13) The FDF office trailer requirements will be specified by FDF. Drawings and specifications (meeting Ohio Department of Transportation Type C field office trailer requirements) for the FDF office trailer will be provided by PARSONS.

14) The contractor will be required to provide his own office trailer and a pole will be designated for the power supply.

15) Structures, systems, and components (SSCs) are classified as PC-2 for Natural Phenomena Hazards design.

1.5 Project Interfaces

The ~~SWU~~ Area 2, Phase I requires interfacing with existing systems and procedures. The existing physical interfaces include:

1) Site access and haul roads
2) Site utilities and storm drains
3) OU-1 Stockpile Area
4) AWWT Facility
5) OSDF and off-site disposal
6) SWRB
7) OU-5 South Field Extraction System
8) Miscellaneous material stockpiles

1.5.1 Site Access and Haul Roads

Traffic plan shall be included in the bid documents to illustrate to the ~~sub~~contractor the site access and support area access, the haul route to the OSDF, above WAC OU-1 Stockpile Area, other stockpiles to be cleared, and the vehicle decontamination location.

1.5.2 Site Utilities and Storm Drains

The ~~SWU~~ Area 2, Phase I will tie into the 6-inch public water line which serves the FEMP with potable water for the ~~wheel wash pad~~ Equipment Wash Facility, emergency shower in the access control trailer, lavatory facilities in the office trailer, and for ~~the~~ water spray for the AFP. The ~~sub~~contractor shall supply a temporary storage tank at the AFP as direct application from the 6-inch public water supply line will not be permitted. Electrical power will be required at the ~~wheel wash pad~~ Equipment Wash Facility, ~~SWU~~ Area 2, Phase I support area, and the stormwater lift stations. See 1.3.6 for description. The existing east seepage control lift station and effluent line are to be removed during excavation. The west seepage control lift station shall pump water from the ~~wheel wash pad~~ Equipment Wash Facility.

Between the SF area and the AFP is a utility corridor that contains the FEMP's water and gas supply along with groundwater lines for the South Plume Remediation.

1.5.3 OU-1 Stockpile Area

Impacted materials above the OSDF radiological WAC will be transported to an OU-1 Stockpile Area for off-site disposal. The contractor will be responsible for maintaining and controlling the stockpile and for unloading the impacted materials in a manner to prevent contamination of the vehicle tires and undercarriages.

1.5.4 Advanced Wastewater Treatment

All Area 2, Phase I stormwater for storms up to the design storm will be collected ~~will be processed by and routed to~~ the AWWT for treatment. The ~~SWU~~ Area 2, Phase I stormwater will be routed to retention basins within Area 1, Phase II and then transferred to the ~~will be routed through the~~ FEMP's SWRB from where it is then transferred to the AWWT. Effluent from the AWWT discharges to the Great Miami River. The flow from the Area 2, Phase I retention basins will be limited to 600 gpm and will be pumped directly to the SWRB.

1.5.5 OSDF and Off-Site Disposal

An OSDF will be constructed (~~by others~~ not as a part of this project) to dispose of low level impacted material and waste fill. The Area 2, Phase I ~~sub~~contractor will be responsible to ensure that the impacted material meets all OSDF physical WAC including size and moisture content. Impacted material or other material that does not conform to the OSDF radiological WAC will be segregated and queued in areas designated by FDF (above WAC OU-1 Stockpile Area, special materials transfer area, and lead contaminated soil transfer area) for further processing for off-site disposal.

~~1.5.6 Stormwater Retention Basin~~

~~Stormwater from the SWU will be routed to the SWRB. The flow from the SWU will be limited to 600 gpm and will be pumped directly from the SWU stormwater retention basins.~~

1.5.~~7~~6 South Field Extraction System (SFES)

The OU-5 SFES project has wells, underground lines, and a valve house (SFVH) in the general area of the ~~SWU~~ Area 2, Phase I. The soil stockpile east of basin number 1 will require that the treatment and discharge lines from extraction well 13 (EW-13) and the power supply to EW-13 ~~be relocated~~ shown on CFC drawings be revised prior to their installation. The ~~SWU~~ Area 2, Phase I work will require the gravel road between the AFP and SF be closed. This will cut off clean access to the SFVH, EW-13, 14, 15, and 16. EW-15 and 17 will be given access from the ~~SWU~~ Area 2, Phase I support area. A new

access road (~~by others~~ not as a part of this project) will need to be provided and built for the SFVH, EW-13, 14, and 16 by OU-5.

1.5.~~8~~7 Miscellaneous Material Stockpiles

A series of Remedial Action~~s~~ and other stockpiles have been identified for removal and cleanup as part of the ~~SWU~~ Area 2, Phase I project work. These stockpiles will be identified on the traffic routing plan and controls provided for cleanup of the stockpiles.

1.6 Remediation Schedules

Construction activities for the ~~SWU~~ Area 2, Phase I will be divided into two bid packages, site preparation and excavation. Site Preparation, which started in summer of 1997, shall include the stormwater and erosion control measures, infrastructure improvements, and clearing. The Excavation package will include the excavation of the impacted material (remediation grading), interim restoration grading, and vegetative stabilization, and is anticipated to start in the spring of 1998. The start of remediation grading activities is contingent upon completion of the Haul Road to the OSDF and the ability of the OSDF to accept material from ~~the SWU~~ Area 2, Phase I.

SECTION 2

DESIGN BASIS

2.1 Functional Requirements

The functional requirements for the ~~SWU~~ Area 2, Phase I Remedial Action Project will be in accordance with the Functional Requirements Document prepared by FDF for this project.

2.2 Design Criteria

State and local building codes will be followed unless they conflict with DOE Order 6430.1A, in which case the most conservative will apply. Title I, II, and III work will be performed in compliance with pertinent S/RIDs as identified in the FDF *Policies and Requirements Manual*. Pertinent S/RIDs for this project are those requirements in the following S/RIDs contained in PARSONS Generic Requirements List forwarded to FDF on April 19, 1996 (PARSONS ID# 27:000:041:0132-96).

1) S/RID No. 2, Engineering Design
2) S/RID No. 3, Emergency Preparedness and Management
3) S/RID No. 5, Environmental Protection
4) S/RID No. 6, Fire Protection
5) S/RID No. 8, Management Systems
6) S/RID No. 9, Nuclear and Systems Safety
7) S/RID No. 10, Occupational Safety and Health
8) S/RID No. 12, Packaging and Transportation
9) S/RID No. 14, Radiological Protection
10) S/RID No. 15, Security
11) S/RID No. 17, Environmental Restoration and Waste Management

2.2.1 Regulations, Codes, Standards, Orders, Manuals, and Guides

This section presents the general regulations, codes, standards, and orders that are to be followed for the design of the ~~SWU~~ Area 2, Phase I Remedial Action Project other than ARARs/TBCs. This information is organized by engineering discipline. Pertinent ARARs/TBCs developed by FDF are listed in Appendix A.

Civil

1) American Association of State Highway and Transportation Officials (AASHTO), GDHS-90, "Policy on Geometric Design of Highways and Streets," 1990, by AASHTO.

2) American Society of Civil Engineers (ASCE), Manual 37, "Design and Construction of Sanitary and Storm Sewers," ASCE.

3) American Water Works Association (AWWA) C 906-90 Polyethylene Pressure Pipe and Fittings, 4 Inch through 63 Inch for Water Distribution.

4) AWWA, C 600-93 Installation of Ductile-Iron Water Mains and Their Appurtenances.

5) FEMP Stormwater Pollution Prevention Plan for Construction Activities.

6) North American Datum of 1983.

7) North American Vertical Datum of 1929.

8) Ohio Department of Transportation (ODOT), Location and Design Manual, Volume II, Drainage Design.

9) ODOT, Construction and Material Specifications, January 1995.

10) Ohio Department of Natural Resources (ODNR), "Rainwater and Land Development, Ohio's Standard for Stormwater Management, Land Development, and Urban Stream Protection," 2nd ed., 1996.

11) Soil Conservation Service (SCS), Soil Survey of Hamilton County, Ohio.

~~12) SCS, Soil Survey of Butler County, Ohio.~~

~~13~~12) SCS, "TR-55 Urban Hydrology for Small Watersheds," Technical Release 55, SCS.

~~14~~13) TM 5 814-2, "Sanitary and Industrial Wastewater Collection - Pumping Stations and Force Mains," U.S. Dept. of Army.

~~15~~14) AASHTO HS-20, Traffic Loadings Across Force Mains.

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Cost Estimating

1) FEMP, PCS-002, Cost Estimating.

2) DOE Office of Infrastructure Acquisition (FM-50), "Cost Estimating Guide, Cost Guide, Volume 6."

Electrical

1) American Bearing Manufacturers Association (ABMA) 9-90 Load Ratings and Fatigue Life for Ball Bearings.

2) ABMA 11-90 Load Ratings and Fatigue Life for Roller Bearings.

3) American National Standards Institute (ANSI) C80.1-90 Rigid Steel Conduit-Zinc Coated.

4) ANSI C2-97 National Electrical Safety Code.

5) ANSI C29.2-92 Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type.

6) ANSI C29.4-89 Wet-Process Porcelain Insulators - Strain Type.

7) ANSI C29.5-84 Wet-Process Porcelain Insulators - Low and Medium Voltage Types.

8) ANSI C29.7-83 Wet-Process Porcelain Insulators - High Voltage Line-Post Type.

9) ANSI C37.30-89 Definitions and Requirements for High-Voltage Air Switches, Insulators, and Bus Supports.

10) ANSI C62.1-89 Gapped Silicon-Carbide Surge Arresters for AC Power Circuits

11) ANSI C62.11-87 Metal-Oxide Surge Arresters for AC Power Circuits

12) ANSI C82.4-85 Ballasts for High Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).

13) ANSI C135.1-79 Galvanized Steel Bolts and Nuts for Overhead Line Construction.

14) ANSI C135.22-88 Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction.

15) ANSI O5.1-92 Wood Poles Specifications and Dimensions.

16) American Society for Testing and Materials (ASTM) A36/A36M-96 Standard Specification for Carbon Structural Steel.

17) ASTM A475-95 Standard Specification for Zinc-Coated Steel Wire Strand.

18) ASTM A675/A675M Steel Bars, Carbon, Rev. A-90 Hot-Wrought, Special Quality, Mechanical Properties.

19) ASTM B231-90 Concentric-Lay- Stranded Aluminum 1350 Conductors.

20) ASTM B232-92 Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR).

21) American Wood-Preservers Association (AWPA):

22) AWPA C4-89 Poles - Pressure Process.

23) AWPA C25-89 Standard for the Preservative Treatment of Crossarms by the Pressure Process.

24) International Electrical Testing Association (NETA) NETA ATS-95 Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

25) Institute of Electrical and Electronics Engineers (IEEE) 48-90 Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

26) IEEE 112-91 Standard Test Procedure for Polyphase Induction Motors and Generators.

27) National Electrical Manufacturers Association (NEMA) AB 1-93 Molded Case Circuit Breakers and Molded Case Switches.

28) NEMA ICS 1-93 Industrial Control and Systems General Requirements.

29) NEMA ICS 2-93 Industrial Control and System Controllers, Contractors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.

30) NEMA ICS 4-93 Industrial Control and Systems Terminal Blocks.

31) NEMA ICS 6-93 Industrial Control and Systems Enclosures.

32) NEMA LA 1-92 Surge Arresters.

33) NEMA MG 1-93 Motors and Generators.

34) NEMA MG 13-84 Frame Assignments for AC Integral-Horsepower Induction Motors.

35) NEMA OS 1-89 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

36) NEMA PB 1-90 Panelboards.

37) NEMA PB 1.1-91 General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

38) NEMA ST 20-92 Dry Type Transformers for General Applications.

39) NEMA TC 3-90 PVC Fittings for Use with Rigid PVC Conduit and Tubing.

40) NEMA TC 6-90 PVC and ABS Plastic Utilities Duct for Underground Installation.

41) NEMA WC 7-88 Cross-Linked-Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

42) NEMA WC 8-88 Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

43) NEMA WD 1-83 General Requirements for Wiring Devices.

44) NEMA WD 6-88 Wiring Devices - Dimensional Requirements.

45) NEMA 250-91 Enclosures for Electrical Equipment (1,000 Volts Maximum).

46) National Fire Protection Association (NFPA) 70 National Electrical Code, 1996 Edition.

47) NFPA 101-94 Code for Safety to Life from Fire in Buildings and Structures.

48) Underwriters Laboratories, Inc. (UL) Electrical Construction Materials Directory-95.

49) UL 360-86 UL Standard for Safety Liquid-Tight Flexible Steel Conduit.

50) UL 486A-91 UL Standard for Safety Wire Connectors and Soldering Lugs for Use with Copper Conductors.

51) UL 510-94 UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

52) UL 854-96 Service-Entrance Cables.

53) UL 870-95 UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.

54) UL 467-93 UL Standard for Safety Grounding and Bonding Equipment.

55) UL 96-94 UL Standard for Safety Lightning Protection Components.

Environmental Safety and Health

1) 29 Code of Federal Regulations (CFR) 1910, "Occupational Safety and Health Standards."

2) 29 CFR 1926, "Safety and Health Regulations for Construction."

3) 10 CFR 835, "Occupational Radiation Protection" (this is the promulgation of DOE Order 5480.11).

4) DOE Order 5480.10, "Contractor Industrial Hygiene Program."

5) DOE/EH-0256T, Radiological Control Manual.

6) DOE-EM-STD-5502-94, "Hazard Baseline Documentation."

7) DOE-STD-1088-95, DOE Standard "Fire Protection for Relocatable Structures," June 1995.

8) RM-0016, Management Plan FDF Policies and Requirements Manual.

9) RM-0020, Radiological Control Requirements Manual

10) RM-0021, Safety Performance Requirements Manual.

Geotechnical

1) American Society for Testing and Materials (ASTM) D2216, Laboratory Determination of Water (Moisture) Content of Soil and Rock.

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2) ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.

3) ASTM D4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

4) ASTM D698, Laboratory Compaction Characteristics of Soil Using Standard Effort.

5) ASTM D5084, Measurement of Hydraulic Conductivity of Saturated Porous Material Using a Flexible Wall Permeameter.

6) ASTM D5321, Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic Friction by Direct Shear Method.

Material Handling

1) ANSI B30.10-87, Hooks

2) DOE/ID-10500, Hoisting and Rigging Manual

3) Ohio Administrative Code (OAC) 3745-20-05, Standards for Asbestos Waste Handling

Mechanical Process/Piping

1) American Society of Mechanical Engineers (ASME) B31.3, Chemical Plant and Refinery Piping.

2) American Society for Non-Destructive Testing (ASNT) SNT-TC-1A, Recommended Practices.

3) ASTM A36, Standard Specifications for Carbon Structural Steel.

4) ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

5) ASTM A105/A105M Revision B, Standard Specification for Carbon Steel Forgings for Piping Applications.

6) ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

7) ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Material for High Temperature Service.

8) ASTM A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

9) ASTM C552, Standard Specification for Cellular Glass Thermal Insulation.

10) American Welding Society D1.1, Structural Welding Code, Steel.

11) Manufacturers Standardization Society (MSS) SP-58, Pipe Hangers and Support-Materials, Design, and Manufacture.

12) MSS SP-69, Pipe Hangers and Support-Selection and Application.

13) MSS SP-89, Pipe Hangers and Support-Fabrication and Installation Practices.

Mechanical Utilities

1) Ohio Plumbing Code, 1995.

Structural

1) ASCE 7-95, Minimum Design Loads for Buildings and Other Structures.

2) DOE Order 5480.28, "Natural Phenomena Hazards Mitigation."

3) DOE-STD-1020-94, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities."

4) Ohio Basic Building Code, 1995.

5) Uniform Building Code, 1994.

2.3 Discipline Criteria

2.3.1 Civil and Site Development

General

The emphasis of the civil design will relate to site preparation required to support construction activities; site preparation of the ~~SWU~~ Area 2, Phase I; control of stormwater; sending potentially contaminated and

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contaminated water to treatment; excavation of impacted material; sediment control; and interim restoration grading and stabilization.

Site Preparation

The ~~SWUs~~ Area 2, Phase I excavation area will have a radiological control point facility trailer and FDF office trailer to support the construction activities. The contractor will provide his own construction trailer. The trailers will require utilities in order to function. A public water source is available for the trailers and ~~wheel~~ equipment wash facility ~~at the SWUs~~ in the A2PI area. The ~~sub~~contractor is to provide a storage tank at the ~~wheel~~ equipment wash facility, if necessary, and the yard hydrant north of the AFP. PARSONS will design electrical power to the trailers, pumps, and all fire and evacuation alarm services (as required). New roads or drives will also be required to serve the trailers and construction activities as well as access to OU-5 SFES activities. The design of these improvements shall ~~meet~~ use the requirements specified in DOE Order 6430.1A, Division 2 as guidance. The locations for the roads, trailers, utilities, as well as access control and security issues will be coordinated with FDF. ~~OU-2~~

Clearing

Clearing is required for the ~~SWU~~ Area 2, Phase I areas because they are moderately to heavily wooded. Trees, bushes, and high grass will need to be removed from the areas that require excavation. The vegetation will be chipped and transferred to a designated stockpile area. The Site Preparation Package for the ~~SWU~~ Area 2, Phase I shall specify that the ~~sub~~contractor will clear the entire ~~SWU~~ Area 2, Phase I area but will only grind stumps at the retention basins and areas to be excavated during site preparation. The excavation package will specify the contractor grind remaining stumps as necessary. This is to limit the area that has been cleared at any one time to limit the amount of erosion and sedimentation from exposed/disturbed areas.

Stormwater Controls

One of the major design issues is how stormwater is controlled, both during and after construction. Stormwater runon needs to be minimized to the extent practical, since stormwater that contacts potentially contaminated areas must also be considered contaminated and be treated prior to leaving the site. This will be accomplished primarily by diversion dikes, culverts, ditches, and similar drainage controls upstream of the contaminated areas being excavated. Stormwater controls at the ~~SWU~~ Area 2, Phase I areas will focus on preventing runon from adjacent areas and preventing runoff from the excavation area from reaching existing drainage systems. Other perimeter erosion and sediment control measures will be used to control erosion and limit sediment from leaving the work area. Sediment and erosion control measures will follow ODNR, ODOT, SCS, and FEMP standards. Runoff controls will be designed consistent with the ODNR "Rainwater and Land Development Manual". Overall surface water

consistent with the ODNR "Rainwater and Land Development Manual". Overall surface water management in Area 2 Phase I, including all stormwater controls, will be described in a separate SWMP.

Retention Basins

The ~~SWU~~ Area 2, Phase I will have three retention basins to collect runoff as well as any water pumped from the excavation areas. Basins 1 and 2 will be sized to store a minimum of the 25-year, 24-hour storm event with a sediment load. Basin 3 will be sized to store a minimum of the 10-year, 24-hour storm event with a sediment load. The sediment load is the amount of sediment allowed prior to cleanout. This ~~is~~ must at least equal to 27 cy per watershed acre. Since each basin is expected to be excavated into the soils of the GMA, an infiltration barrier will be used to limit infiltration. Each basin will have a perforated riser which will drain to a lift station. Each lift station will discharge into a common HDPE transfer line which will empty into the sluice gate between the east and west basins of the SWRB. The combined flow from the three lift stations shall not exceed 600 gpm.

Once the ~~SWU~~ Area 2, Phase I area is certified below FRLs, interim restoration activities will be completed that will be consistent with the final overall site reclamation and regrading plan.

Excavation

Excavation of impacted material will be accomplished through a controlled excavation process. Within their respective areas prioritized excavation (above WAC material and lead contaminated soil) will be performed first. Impacted material that meets the OSDF WAC will be transported to the OSDF. Pockets of impacted material exceeding the WAC will be excavated and transported to the OU-1 Stockpile Area as they are encountered. Each of the excavated areas will serve as the initial sump for stormwater control. The sequence of excavation needs to consider the stormwater control and floodplain issues.

Stabilization and Landscaping

During excavation of the waste units, interim seeding with a quick-germinating seed mixture or other temporary stabilization measures, such as crusting agents, will be applied within seven days to limit erosion of excavated areas not expected to be worked for a period of 45 days or more. The final configuration of the sites will be graded to blend in with the adjacent topography.

Maximum slopes during initial excavation/grading will be determined by slope stability calculations and may be exceeded only with the approval of the FDF Construction Manager. The maximum slope after final grading shall be 2 horizontal to 1 vertical. Flatter slopes shall be used where feasible to provide a slope that is easier to maintain. Once final excavation has occurred, seed and mulch will be applied according to ODOT standards. No other landscaping or improvements are planned as part of this project.

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Pipeline

The stormwater transfer line will be double-walled for the ~~SWU~~ Area 2, Phase I. Stormwater piping will be buried a minimum of 3.5 feet to prevent freezing. Underground force mains shall be protected at all road crossings from AASHTO HS-20 traffic loadings. The minimum force main velocity shall be 3.0 feet per second to resuspend solids that may have settled during quiescent periods. Aboveground piping that has positive drainage will not need to be heat traced. A minimum slope of 1/4 inch per foot fall is assumed to provide adequate positive drainage. Draining the fluid back through the pump is not recommended, so additional valving and piping will be required. Cleanouts and air release valves along the transfer line shall be provided and shall also be double walled.

Leak Detection System/High Level Alarm

A leak detection system is not required. The high level alarm shall detect liquid levels above a maximum setpoint in the lift stations. The setpoint shall have sufficient freeboard to provide response time for maintenance personnel to repair the station. The setpoint must be located high enough above the normal maximum liquid level to prevent turbulence in the wet well from falsely activating the high water alarm. The setpoint shall be no more than 6 feet above the invert of the inlet per OAC 3745-27-08.

Site Preparation

1) Support Area: The ~~SWU~~ Area 2, Phase I will require an area for a radiological control point facility trailer, FDF office trailer, ~~sub~~contractor and other support trailers (as necessary), and parking. The support areas for ~~SWU~~ Area 2, Phase I will be gravel.

2) Roads: Roads shall be crowned with a transverse slope of 2 percent. Longitudinal slopes shall be between 1 and 6 percent. Roads shall comply with AASHTO GDHS-90.

3) Dust control will be required for activities within a contaminated area. Dust control procedures will be provided by the ~~sub~~contractor as required by ODOT or as directed by FDF. Air particulate emission requirements are listed in the ARARs in Appendix A.

   The ~~sub~~contractor will apply water or a dust suppressant using tanks with a suitable sprinkling device to control dust within the project area for all activities involving the potential for generating airborne emissions.

4) Access Control: The type, size, and location of fences and gates will be determined in conjunction with FDF.

5) Stormwater diversion in the area north of the SF and the AFP will discharge to the existing channel adjacent to the north side of the AFP. This channel has some major erosion problems at its confluence with the SWRB outfall channel. The erosion problems will require repair.

Utilities

The locations of existing utilities are available on FEMP Grid Utilities drawings. Major utilities include the Cincinnati Gas and Electric-supplied 6-inch gas line, the FEMP's public water supply line, South Plume groundwater extraction line, electrical lines, SF leachate collector, pump, and force main, all of which are in the gravel road between the SF and the AFP. Due to site conditions, utility relocation will be avoided if possible. Potable and process water will be obtained from the 6-inch public water supply line for the ~~SWU~~ Area 2, Phase I. A back-flow preventer will be installed at a tie-in to the water supply line for non-potable use.

Civil Design Drawings and Specifications

The following approximate number of design drawings and specifications will be included in the CFC Design Packages:

Table 2-1 - Civil Drawings

Drawing	Qty. ~~SWU~~ A2,PI DP Site Prep	Qty. ~~SWU~~ A2,PI DP EXCAV
Title Sheet	1	1
Index of Sheets	1	1
Legend and Symbols	1	1
Master Site/Utility Plan	1	1
Existing Conditions Plans	1	1
Traffic Plan	1	1
Benchmark and Baseline Location Plan	1	1
Grading Plans-		
Site Preparation/Drainage Control	1	

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Table 2-1 - Civil Drawings (Continued)

Drawing	Qty. ~~SWU~~ A2,P1 DP Site Prep	Qty. ~~SWU~~ A2,P1 DP EXCAV
Above WAC/Initial Excavation		1
Lead Contamination		1
Excavation/Remediation		1
~~Restoration~~		~~1~~
Utility Removal and Demolition Plan		1
Cross-Sections		8
Enlargement Retention Basin	3	
Plan and Profiles - Transfer Line	3	
Details	3	1
Erosion and Sediment Control	2	1
Site Plan Wheel Wash Area Paddys Run Area Support Area	3	
Wheel Wash Pad- Plan and Details	1	
Wheel Wash Effluent Line Profile and Details	1 1	
Material Documentation Plan	1	1
TOTAL	26	~~23~~ 22

DP - Design Package
SP - Site Preparation Package
EXCAV - Excavation Package

Table 2-2 - Division 1, 2, and 3 Specifications

(1)	Specification	~~SWU~~ A2,P1 SP	~~SWU~~ A2,P1 EXCAV
01050	Surveying	x	x
01123	Separation and Packaging of Presumed Asbestos Containing Materials (PACM)		x
01450	Material Documentation	x	x
02100	Site Preparation	x	
02200	Non Impacted Material Earthwork	x	
02205	Impacted Material Excavation and Handling	x	x
02206	Restoration		x
02225	Trenching and Backfill	x	x
02270	Erosion and Sediment Control	x	x
02300	Boring and Jacking		
02506	Aggregate Surface	x	
02510	Asphaltic Concrete Paving	x	
02667	Drinking Water Lines	x	
02668	Transfer Line	x	
02669	Discharge and Treatment Lines	x	
02713	Goemembrane Liner	x	
02720	Site Drainage and Water Management	x	x
02831	Chain Link Fences	x	
02900	Soil Preparation and Seeding	x	x
02999	Miscellaneous and Specialty Items	x	
03001	Concrete	x	

NOTE (1): Specification no. shown is for the Site Preparation Package. For the Excavation Package the specification no. will be revised so that it can be used in conjunction with similar specifications in an OSDF package.

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Calculations

The following calculations will be provided:

1) System total dynamic head
2) Earthwork
3) Stormwater (runon and runoff) management
4) Storm drainage
5) Water lines

2.3.2 Electrical

General

Electrical power will be provided to the ~~SWU~~ Area 2, Phase I support area and lift stations. Three- and single-phase power will be obtained from an existing substation and routed to the support area and lift stations via an overhead electrical distribution system supported by wood poles, crossarms and porcelain type insulators. Step-down transformers required shall be pole-mounted.

Freeze Protection

As required, electrical freeze protection will be provided for aboveground (and underground for depths less than 3.5 feet) piping and other features (e.g., pumps, valves, etc.) where sloped drainage (i.e., 1/4-inch drop per foot of run) is inadequate.

Electrical Design Drawings and Specifications

The following approximate number of design drawings and specifications will be included in the CFC Design Packages:

Table 2-3 - Electrical Drawings

Drawing	Qty. ~~SWU~~ A2,PI SP	Qty. ~~SWU~~ A2,PI EXCAV
Symbols and Legend	1	
Single Line	3	
Power Plan	1	
Elementary Diagrams	1	
Panel Schedules	1	
Details	6	
Conduit/Cable Schedules	1	
TOTALS	14	

SP - Site Preparation Package

EXCAV - Excavation Package

Table 2-4 - Electrical Specifications

	Specifications	Qty. ~~SWU~~ A2,PI SP	Qty. ~~SWU~~ A2,PI EXCAV
15170	Motors	x	
16050	Basic Electrical Materials and Methods	x	
16118	Underground Ductbanks	x	
16121	Medium Voltage Cables	x	
16170	Grounding and Bonding	x	
16311	Primary Switchgear	x	
16370	Overhead Power Distribution	x	
16462	Dry-Type Transformer/ Panelboards	x	
16470	Panelboards	x	
16500	Lighting	x	
16855	Heating Cables	x	

2.3.3 Environmental Safety and Health Requirements

The subsections below describe worker health and safety, radiation exposure control, and other regulatory requirements. All of the requirements provided are derived from pertinent S/RIDs identified in the *Management Plan, FDF Policies and Requirements Manual (RM-0016)*, and PARSONS Generic Requirements List.

Worker Health and Safety

Several health-and-safety-related requirements for this project are provided below. This subsection complements the PSHSP (to be prepared by FDF) and is not to be considered a replacement or summary of the Health and Safety Plan.

~~Waste unit~~ A2, P1 excavation activities will take place in ~~controlled~~ contaminated areas; therefore, workers shall be required to have Hazardous Waste Operations and Emergency Response training in accordance with 29 CFR 1910.120.

Site clearing activities shall be done in accordance with 29 CFR 1926.604. Equipment used in site clearing activities shall also meet this requirement.

Material handling equipment shall meet the requirements of 29 CFR 1926.602. These requirements address seat belts, brakes, rollover protection, audible alarms, and scissor points.

Workers may be required to enter excavated trenches to relocate or remove utilities. This type of work will be minimized to the maximum extent possible. Excavations shall be maintained in accordance with 29 CFR 1926, Subpart P.

Measures shall be identified and implemented which comply with American Conference of Governmental Industrial Hygienists (ACGIH) and FDF requirements to prevent heat stress during warm weather. Heat stress hazards are more serious for activities where special protective clothing and equipment are required.

Valves, switches, and like devices shall be designed to accept a FDF Facility Owner's lock shank to provide a means for energy control.

Worker Exposure

~~1) Radiological: Internal exposure is the primary concern for this project. Radiologically contaminated soil and waste unit material will become airborne during earth moving activities in contaminated areas. 10 CFR 835.1002 requires that airborne radioactive material be controlled and that the inhalation of such material by workers be kept to levels that are As Low As Reasonably Achievable (ALARA). The Nearfield Box Model and/or the Industrial Source Complex Version 3 (ISC3) will be used as necessary to model dispersion of airborne contaminated soil generated during excavation activities. A dense gas dispersion model (DEGADIS) may be used to model radon dispersion.~~

~~To control airborne emissions from soil, conventional dust suppression methods, as discussed in Subsection 2.3.1 of this DCP, shall be used. Eating, drinking, and smoking shall not be allowed in radiologically controlled areas. The need for respirators will be specified in the PSHSP and/or the Radiation Work Permit, when it is prepared.~~

~~External exposure is a secondary concern for this project. Waste materials of varying concentrations are expected and may require modeling of external dose components with Microshield 4.0. 10 CFR 835.1002 requires that personnel exposure to external sources of radiation be controlled to an average of 1 rem per year, or ALARA. The need for modeling of external dose components will be assessed based on a review of sample data provided in the *Feasibility Study Report for Operable Unit 2* (DOE 1995) during preliminary design.~~

1) Radiological: Site radiological control documents and procedures implement 10 CFR 835 requirements. The radiological control requirements applicable to the project will be incorporated into project documents to maintain worker exposures below regulatory limits and ALARA.

Internal exposure is the primary occupational exposure concern for this project. Waste unit material will become airborne during earth-moving activities within the project Contamination Areas. To control airborne emissions from soil, conventional dust suppression methods, as discussed in Subsection 2.3.1 of this DCP, Shall be used. The radiological control and PPE requirements (including respiratory protection requirements) will be specified in the PSHSP and Matrix and in the Radiological Work Permit.

External exposure is a secondary occupational exposure concern for this project. Waste materials of varying concentrations are expected within the waste units. External sources of radiation will be identified through the performance of field radiological surveys and controlled through compliance with site and project radiological control requirements.

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2) Asbestos: The *Feasibility Study Report for Operable Unit 2* indicates that asbestos is presumed to be present in the ~~SWU~~ Area 2, Phase I. Asbestos emissions from the ~~SWU~~ Area 2, Phase I will be modeled during design to estimate worker exposure. Modeling will be performed using ISC3. Per 29 CFR 1910.1001, the Permissible Exposure Limits for asbestos are:

(1) Time-Weighted Average (TWA) of 0.1 fiber per cubic centimeter of air as an 8-hour TWA

(2) Excursion limit of 1.0 fiber per cubic centimeter of air as averaged over a sampling period of 30 minutes

Exposure monitoring shall be required that is representative of the 8-hour TWA and 30-minute short-term exposures of each employee. FDF shall establish appropriate action levels and monitoring of workers per Appendix A of 29 CFR 1910.1001.

3) Particulates, Gases, and Vapors: Remedial activities will have the potential to generate various particulates, gases, and vapors. Where necessary, exposure monitoring will be provided to ensure that worker exposures are properly controlled within Occupational Safety and Health Administration (29 CFR 1910 and 1926) and ACGIH limits. Specific control measures and Personal Protective Equipment will be identified in the PSHSP to be developed by FDF.

The excavation of the IFP and the AFP will generate particulate emissions that may exceed regulatory requirements for airborne particulates. Particulates are regulated under OAC 3745-17-02. This requirement states that the level of the primary and secondary 24-hour ambient air quality standards for total suspended particulates is 150 $\mu g/m^3$, 24-hour average concentrations. The level of the primary and secondary annual standards for total suspended particulates is 50 $\mu g/m^3$, annual arithmetic mean. Also, the emission rates provided in OAC 3745-17-11 apply (see Appendix A for values). Particulate emissions from excavation of the piles will be modeled using ISC3.

Applicable or Relevant and Appropriate Requirements

The ARARs for this project have been prepared by FDF and are provided in Appendix A of this DCP. The table provides a requirement summary and implementation strategy for each ARAR. The implementation strategy references applicable sections of this DCP where appropriate.

2.3.4 Geotechnical

General

The nature, level, and extent of contamination at the ~~OU-2~~ Area 2, Phase I waste units and the clean-up levels defined in the OU-2 Record of Decision provide the bases for establishing the extent, boundaries,

and approach for the excavation required for the design. Data regarding the nature, level, and extent of radiological contamination at the OU-2 Waste Units is summarized in the *Remedial Investigation Report for Operable Unit 2*, the *Feasibility Study Report for Operable Unit 2*, and in associated electronic data bases maintained and provided by FDF.

Geotechnical data that provide the bases for the remedial design are summarized in the above RI/FS documents as supplemented by data summarized in the following geotechnical report:

Active Flyash Pile, Inactive Flyash Pile and South Field Waste Units

Flyash Piles and South Field Waste Units Geotechnical Report, Revision 0, April 1996

The emphasis of geotechnical design will relate to support for excavation planning and slope stability analyses. An Intergraph Geologic Information System computer platform will be used to assist in developing the civil excavation plan for the ~~SWUs~~ Area 2, Phase I. The platform will be used to evaluate contaminant data provided by FDF. Slope stability analyses will use XSTABL slope stability software and will consider temporary slopes during excavation and permanent slopes established in the final grading plan.

Calculations

1) Slope stability

2.3.5 Material Handling

General

The design will describe methods for waste excavation or retrieval, size reduction, and segregation into separate waste streams. Packaging and transportation requirements will be established for on- and off-site disposal for the various waste streams, including low-level radioactive, hazardous, and mixed waste. The method for separation, handling, and packaging of Presumed Asbestos Containing Materials (PACM) and lead will be addressed in separate technical specifications. Material Handling will develop these specifications with input from Environmental Safety and Health. Asbestos encountered during this remedial action must be prepared for disposal in accordance with the requirements of OAC 3745-20-05 (Standards for Asbestos Waste Handling) and the Impacted Material Placement Plan for the OSDF.

Impacted material that is to be placed within the OSDF must satisfy OSDF WAC for moisture content and size.

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Equipment

1) Mobile size reduction equipment may include chipper, grinder, shredder, shear, and baler

2) Excavation equipment may include front-end loaders, backhoe, hydraulic crane, and track dozers

3) Transportation equipment may include covered or uncovered dump trucks, stake-bed trucks, forklift, flatbed semi trucks, and tank trucks

Testing

Lifting devices shall be tested in accordance with DOE/ID-10500 Hoisting and Rigging Manual.

Material Handling Specifications

Separation, packaging, and transportation of impacted materials and asbestos containing material are part of the Division ~~1 and~~ 2 specifications. Refer to Section 2.3.1, Table 2-2.

2.3.6 Mechanical Process/Piping

General

Storage and transfer systems shall meet the requirements of DOE Order 6430.1A. Design shall emphasize the use of multiple barriers to restrict the movement of wastewater which has the potential for human contact or reducing groundwater quality.

Retention basin lift stations will be equipped with a submersible pump on a guide system to minimize the need to enter the lift station. A check valve will be used to prevent backflow through the pump. Fill controls will regulate the pump operation. Mechanical Process is responsible for the specifications of pumps, above-ground pipe, pipe supports, and insulation.

Equipment

Confinement systems shall meet the criteria in DOE Order 6430.1A, Paragraphs 1300-7 and 1323-5 Radioactive Liquid Waste Facility. Pumps shall be provided to transfer ~~SWU~~ Area 2, Phase I retention basin contents in a common transfer line at a total rate of 600 gpm (maximum) to the SWRB.

~~Wheel~~ Equipment Wash Facility

~~A wheel~~ An equipment wash facility will be located near the Haul Road exit of the ~~SWU~~ Area 2, Phase I. This facility is intended to be used to remove bulk solids from haul vehicles by high-pressure spray. Collected wash water from the ~~SWU~~ equipment wash facility will be piped to the existing seepage lift station.

Process and Potable Water

~~SWU~~ Area 2, Phase I process water will be obtained from the existing 6-inch public water supply line. A back-flow preventer will be placed at the tie-in to the supply line for the ~~wheel~~ equipment wash and support area hydrants. Potable water supply will be obtained from the existing 6-inch public water supply line for the personnel monitoring trailer. Below grade piping will be HDPE.

Stormwater Piping

~~Single-walled and~~ Double-walled HDPE pipe will be used for below grade stormwater transfer piping. No leakage monitoring will be provided to detect leakage into the space between the inner and outer pipes.

Testing

Except for the buried systems (HDPE), pipe and pipe systems testing shall conform to the requirements set forth in ASME B31.3 and ASNT SNT-TC-1A.

Heat Tracing and Insulation

Electrical heat tracing and insulation will be provided for above-grade piping, fittings, valves, and equipment that are subject to freezing temperatures and for below-grade piping less than a frost depth of ~~3~~ 3.5 feet, as required. Insulation requirements shall be in accordance with the applicable ASTM insulation and sheeting specifications.

Pipe Supports

Pipe supports shall be spaced in accordance with ASME B31.3 and PARSONS' span table. Pipe hanger material, design, manufacture, selection, application, fabrication, and installation shall be in accordance with MSS SP-58, SP-69, and SP-89. Auxiliary steel supports shall be in accordance with ASTM A-36 and A-576.

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Welding/Joining

Welding shall be in accordance with ASME B31.3 and American Welding Society D1.1. HDPE pipe material shall be joined/fused per manufacturer's instructions.

Materials

Corrosion, abrasion resistance, and ease of decontamination shall be considered when selecting pipe, fittings, valves, and equipment items.

Mechanical Process/Piping Design Drawings and Specifications

Table 2-5 lists the approximate number of design drawings that will be included in the CFC Package.

Table 2-5 - Mechanical Process/Piping Drawings

Drawing	Qty. ~~SWU~~ A2,PI SP	Qty. ~~SWU~~ A2,PI EXCAV
P&ID - Symbols and Legend Sheet	1	1
P&ID - Wastewater Collection and Transfer	1	1
P&ID - Drinking Water System	1	
TOTAL	3	2

Table 2-6 lists the approximate number of specifications that will be included in the CFC Package.

Table 2-6 - Division 15 Specifications

	Specification	Qty. ~~SWU~~ A2,PI SP	Qty. ~~SWU~~ A2,PI EXCAV
15060	Piping, Fittings, Valves, and Accessories	x	
15090	Piping Supports and Anchors	x	
15160	Pumps	x	
~~15161~~	~~Pressure Washer~~		~~x~~
15170	Motors	x	
15250	Insulation	x	

SP - Site Preparation Package EXCAV - Excavation Package

Calculations

The following calculations will be provided:

1) Pipeline sizing
2) Pump sizing

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2.3.7 Mechanical Utilities

General

A radiological control point facility will be established at the egress point of the ~~SWU~~ Area 2, Phase I excavation. Lockers and change-out area will be provided. An emergency shower will also be provided at the ~~SWU~~ Area 2, Phase I radiological control point trailer. Shower and sink wash water will be collected in a tank and will be periodically removed by the ~~sub~~contractor. The FDF office trailer will have lavatory facilities and will have a tank for collection of wastewater. Utility water will be supplied to the trailers by connection to the 6-inch public water supply line ~~at the~~ ~~SWU~~ in Area 2, Phase I. Portable sanitary facilities will be used at all of the waste units and will be serviced periodically by the ~~sub~~contractor.

Piping

Utility piping for the personnel trailers will be constructed of copper tubing and will comply with ASTM B88. Outside aboveground piping will be heat traced and insulated.

2.3.8 Structural

General

The design and evaluation of Structure, System, and Components (SSCs) due to wind, earthquake, and flood shall be in accordance with DOE Order 6430.1A and DOE-STD-1020 for PC-2 type structures. SSCs for ~~the~~ ~~SWU~~ Area 2, Phase I include guys, miscellaneous steel supports, and concrete foundations.

Dead Loads

Dead loads are all loads that remain permanently in place, including weights of all permanent materials, equipment, piping, self-weights, and provisions for future loads, if required. The unit weights of materials and assemblies may be based on sources or data from manufacturers' drawings and catalogs, and Table C3-1A of ASCE 7-95.

Live Loads

Live loads shall include all loads resulting from use of the SSCs. Live loads may act in any direction. Impact loads, moving loads, and operating loads shall be considered as part of live loads. Live loads for structures shall not be less than the minimum uniform or concentrated loads stipulated in ASCE 7-95.

Wind Loads

Wind loads design criteria presented in this section shall be based on the requirements of DOE Order 6430.1A, DOE-STD-1020, and ASCE 7-95. The Ohio Basic Building Code Exposure "C" shall be used for all wind load calculations.

Tornado Loads

Tornado loads are not applicable and will not be considered given that the SSCs are assumed PC-2, that most piping will be located underground, and construction/excavation operation will cease during rain/stormy weather.

Seismic Design and Evaluation

The seismic criteria for the design and evaluation of SSCs shall be based on procedures detailed in Subsection 2.3.1 of DOE-STD-1020, PC-2, and Uniform Building Code (UBC) Section 1628. The earthquake response shall be evaluated in accordance with procedures given in UBC Section 1627.8 using the static force method. The capacities will be evaluated using the strength design or allowable stress design method. Story drift limitations shall be per UBC Section 1628.8. Nonbuilding structures shall meet the requirements of UBC Section 1632. Lateral forces on elements of structures and nonstructural components supported by structures shall be in accordance with UBC Section 1630.

Other Loads

Load criteria not specified above shall be in accordance with DOE Order 6430.1A, paragraph 0111-2.8, "Other Loads for Buildings and Other Structures."

Other Structural Material/Design Requirements

Design requirements for structural materials and design are as follows:

1) Concrete: Concrete material, design, and construction shall be per American Concrete Institute 318-89. Minimum concrete strength at 28 days shall be 3,000 psi for foundations and 4,000 psi for slabs.

2) Reinforcement: Deformed billet steel shall conform to ASTM A615, Grade 60.

3) Grout: High strength, nonshrink grout shall be 1 inch minimum thickness.

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4) Structural Steel: Design, details, fabrication, and erection of structural steel shall conform to the UBC and the American Institute of Steel Construction Manual, Ninth Edition. The material for structural steel shapes and plates shall conform to ASTM A36. All structural steel shall be painted or galvanized. Primary connection bolts shall be high-strength ASTM A325 with hardened nut and washer. Secondary connections may be made with A307 bolts, nuts, and washers.

5) Field Connections: Connections may be bolted or welded using E70XX electrodes.

6) Foundations/Slabs: The provisions of UBC Chapter 18 shall govern the design of foundations. Footings will be placed in the upper natural soils or properly compacted fill. Foundations and slabs will be designed for an allowable soil bearing pressure based on available geotechnical data or pressure or presumptive values. The bottoms of footings will be placed a minimum of 3 feet below adjacent final grade for frost protection.

Structural Design Drawings and Specifications

Drawings

The structural design drawings are included with the civil list, Table 2-1.

Specifications

Division 3 specifications are with the civil list, Table 2-2.

Calculations

The following calculations will be provided:

1) Foundations/slabs
2) Structural steel/pipe supports
3) Guy wire supports

SECTION 3

REFERENCES

This DCP is based on the following documents:

1) FERMCO, September 1994. FEMP Engineering Procedure, Document No. 12-4003, Design Criteria Package. Fernald, Ohio: FERMCO.

2) FERMCO, February 16, 1996. *Policies and Requirements Manual.* Fernald: FERMCO.

3) FERMCO, September 30, 1994. Document No. RM-0012, *Quality Assurance Program, Revision 3.* Fernald: FERMCO.

4) FERMCO, February 28, 1996. *Site Procedures Manuals*, Volumes 1 - 12. Fernald: FERMCO.

5) Project Order 165, Revision 0, *Operable Unit 2 Waste Units Remediation Statement of Work*, December 7, 1995.

6) United States Department of Energy, 1987/1992. DOE Order 4700.1, "Project Management System."

7) U.S. Department of Energy, 1989. DOE Order 6430.1A, "General Design Criteria."

8) U.S. Department of Energy, 1995a, *Final Remedial Investigation for Operable Unit 2, FEMP. Fernald, OH, Remedial Investigation, Feasibility Study*, U.S. DOE Fernald Office, Fernald, OH.

9) U.S. Department of Energy, 1995a, *Final Feasibility Study Report for Operable Unit 2, FEMP, Fernald OH, Remedial Investigation, Feasibility Study*, U.S. DOE Fernald Office, Fernald, OH.

10) U.S. Department of Energy, 1995a, *Final Record of Decision for Remedial Actions at Operable Unit 2, FEMP, Fernald, OH*, U.S. DOE Fernald Office, Fernald OH.

11) U.S. Department of Energy, 1995, *Draft Remedial Design Work Plan for Remedial Actions at Operable Unit 2, FEMP, Fernald, OH*, U.S. DOE Fernald Office, Fernald OH.

APPENDIX A

ARARs AND TBCs FOR AREA 2, PHASE I

Appendix A has been prepared by FDF and identifies design and implementation-related ARARs and TBCs for the A2PI (a.k.a. ~~SWU~~ Area 2, Phase I Remediation Project). Compliance with these ARARs/TBCs is addressed therein. See the Sitewide Excavation Plan and the Implementation Plan for further discussion.

TABLE A-1

GROUPINGS OF ARARs AND TBCs USED IN TABLE A-2

FOR REMEDIATION AREA 2 PHASE I

Presentation Group	Topical Subdivision(s)	Page
Natural and Cultural Resources	Threatened and Endangered Species Protection	A-2
	Archeological, Historic, and Cultural Resource Protection	A-3
Air Pathway	Noise Pollution Control	A-7
	Air Emissions	A-7
Surface Water Pathway	Wetlands/Floodplain Protection	A-16
	Discharge to Surface Water	A-23
Groundwater Pathway	Groundwater Protection	A-27
	Wells - Construction	A-27
	Wells - Abandonment	A-27
Soil Remediation	Radionuclide Concentrations	A-28
	Lead Concentration	A-31
	PCB Concentration	A-32
	Certification of Cleanup	A-32
Impacted Material Management	Definitions and General Facility Standards	A-34
	Management of Low-level Radioactive Waste Material	A-48
	Management of Hazardous Remediation Waste	A-48
	Management of PCB-tainted Material	A-55
Post-Closure	Description of Post-closure Care	A-57
	Modifications to Post-closure Care Plan or Period	A-59
	Property Use Restrictions	A-59
	Post-closure Notice/Survey Plat	A-61
	Deed Notation	A-61

TABLE A-2

PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
NATURAL & CULTURAL RESOURCES						
	THREATENED & ENDANGERED SPECIES PROTECTION					
Procedures for Implementing the National Environmental Policy Act 40 CFR §6.302(h) 10 CFR Part 1021 Endangered Species Act 16 U.S.C. §1531, et seq. Endangered and Threatened Wildlife and Plants 50 CFR §17.21, §17.31, §17.61, §17.71, and §17.94 Interagency Cooperation-Endangered Species Act 50 CFR §402.01	All federal agencies must ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of the constituent elements essential to the conservation of a listed species within a defined critical habitat. Additional requirements apply if it is determined that a proposed activity could adversely affect these species or their habitat.	Appl	Appl	Appl	Findings of 1993-94 updated surveys at the FEMP property: • Populations of the state-listed threatened Sloan's crayfish (*Orconectes sloanii*) are located in sections of Paddy's Run. • Good habitat for the federally-listed endangered Indiana bat (*Myotis sodalis*) exists along Paddy's Run and the storm sewer outfall ditch. • Suitable habitat exists in limited areas for the federal-listed endangered running buffalo clover (*Trifolium stoloniferum*), and only in the northern woodlot for the state-listed threatened spring corralroot (*Corallorhiza wisteriana*). • Marginal habitat for the state-listed endangered cave salamander (*Eurycea lucifuga*) exists in a very limited single area. • Neither habitat nor populations were located for the state-listed endangered mountain bindweed (*Polygonum cilinode*) and slender fingergrass (*Digitaria filiformis*).	Addressed in Section 5.1 of the Sitewide Excavation Plan, and will be addressed in the IEMP's Natural Resource Impact Monitoring Plan (NRIMP); however, DOE does not expect to encounter any federal- or state-listed threatened or endangered species or critical habitat in the Remediation Area 2 Phase I areas to be addressed by this remediation project; no additional surveys conducted or planned.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
THREATENED & ENDANGERED SPECIES PROTECTION, continued						
Interagency Cooperation-Endangered Species Act 50 CFR §402.12(a), (b)	A biological assessment shall evaluate the potential effects of the action on listed and proposed critical habitat and determine whether any such species or habitat are likely to be adversely affected by the action and is used in determining whether formal consultation or a conference is necessary. These procedures are required for federal actions that are "major construction activities."	Appl	Appl	Appl	No critical habitat is present on the Fernald property. Updated surveys of the FEMP property in 1993 found marginal habitat for the state-listed endangered cave salamander (*Eurycea lucifuga*) exists in a very limited single area.	See preceding.
Endangered Species Regulations ORC 1531.25	No person shall take or possess any native species of wild animal, or any eggs or offspring thereof, that is endangered with state-wide extinction.	Appl	Appl	Appl	Updated surveys of the FEMP property in 1993-94 found populations of the state-listed threatened Sloan's crayfish (*Orconectes sloanii*) in sections of Paddy's Run.	See preceding.
Endangered Species Regulations ORC 1518.02 OAC 1501:18-1	No person shall root-up, injure, destroy, remove, or carry away on or from public highways, public property, or waters of the state, or on or from the property of another, without the written permission of the owner, lessee, or other person entitled to possession, any endangered plant listed in OAC 1501:18-1.	Appl	Appl	Appl	Surveys of the FEMP property in 1994 did not locate populations of the following plants: the federal-listed endangered running buffalo clover (*Trifolium stoloniferum*); the state-listed endangered mountain bindweed (*Polygonum cilinode*) and slender fingergrass (*Digitaria filiformis*); and the state-listed threatened spring corralroot (*Corallorhiza wisteriana*).	See preceding.
ARCHAEOLOGICAL, HISTORIC AND CULTURAL RESOURCE PROTECTION						
Antiquities Act of 1906 16 U.S.C. §431	No person may appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity situated or controlled by the Government of the United States without an applicable permit. Identification and preservation of cultural resources on federal lands is required, including natural landmarks.	Appl	Appl	Appl	Proposed areas of disturbance will be surveyed and consultation will occur between DOE, the Advisory Council on Historic Preservation and the State of Ohio Historic Preservation Office (OHPO) as agreed upon in the Programmatic Agreements (later entries).	Section F.4.2 of the Sitewide Excavation Plan
Historic Sites Preservation Act 16 U.S.C. §461-467		✓	Appl	Appl		

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	ARCHAEOLOGICAL, HISTORIC AND CULTURAL RESOURCE PROTECTION, continued					
Archaeological Resources Protection Act 16 U.S.C. § 470aa-470ll Procedures for Implementing the National Environmental Policy Act 40 CFR §6.301(c) Protection of Archaeological Resources 43 CFR §7.4(a)	Whenever any Federal agency finds, or is notified, in writing, by an appropriate historical or archaeological authority, that its activities in connection with any Federal construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific prehistorical, historical, or archaeological data, such agency shall notify the Secretary of the Interior, in writing, and shall provide the Secretary with appropriate information concerning the project, program, or activity. No person may excavate, remove, damage, or otherwise alter or deface or attempt to excavate, remove, damage, or otherwise alter or deface any archaeological resource located on public lands unless such activity is pursuant to a permit. If an EPA activity may cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeological data, the responsible official or the secretary of the Interior is authorized to undertake data recovery and preservation activities.	Appl	Appl	Appl	See preceding.	See preceding.
National Historic Preservation Act (NHPA) 16 U.S.C. §470 Protection of Historic Properties 36 CFR Part 800 Procedures for Implementing the National Environmental Policy Act 40 CFR §6.301(a), (b)	A federal agency (DOE) must take into account the effect of an undertaking on historic properties and accord the Advisory Council on Historic Preservation a reasonable opportunity to comment. Historic properties are defined as any prehistoric or historic district, building, site, structure, or object included in or eligible for inclusion in the National Register of Historic Places. This term includes artifacts, records, and persons released to and located within such properties. Historic properties that are to be substantially altered or demolished must be recorded for future use and reference. The purpose of this Act is not only to protect those properties listed in or eligible for the National Register of Historic Places, but also those properties that have not been listed or formally determined eligible for the listings. The heads of all Federal agencies shall assume responsibility for the preservation of historic properties which are owned or controlled by such agency. Prior to any Federal undertaking which may directly and adversely affect any National Historic Landmark, the head of the responsible agency shall, to the extent possible, minimize the harm to such landmark.	Appl	Appl	Appl	See preceding.	See preceding.
Archaeological and Historic Preservation Act 16 U.S.C. §469	Upon discovery that a project may cause the irreparable loss, destruction, significant scientific finding, prehistorical finding, or loss of historical or archaeological data, DOE must notify the Dept. of the Interior in writing and provide appropriate information concerning the project. DOE must, with possible assistance from the OHPO, undertake recovery, protection, and preservation of the data.	√	Appl	Appl	See preceding.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	ARCHAEOLOGICAL, HISTORIC AND CULTURAL RESOURCE PROTECTION, continued					
Executive Order 11593, Protection and Enhancement of Cultural Environment 3 CFR Part 54	An inventory of a site with potential historic places is required for eligibility in the National Register of Historic Places.	✓	Appl	Appl	See preceding and following entries.	See preceding.
Programmatic Agreement Regarding Archaeological Investigations at the Fernald Environmental Management Project (March 6, 1997)	Annual report packages, the first of which must be submitted on July 1,1997, must be submitted to the Ohio Historic Preservation Office (OHPO) and the Advisory Council on Historic Preservation (the Advisory Council) containing the following information: 1 list of all response actions and associated activities initiated within the year reported on; 2. map showing locations of above response actions/ associated activities; 3. list of response actions/associated activities conducted in previously surveyed (archeological survey) areas; 4. a list of surveys which identified no eligible historic properties; 5. a list of eligible historic properties that were avoided when implementing response actions and/or associated activities; 6. a list of Phase I-III reports generated; and 7. a map of locations of areas identified in item 6 and all properties identified. DOE-FEMP must also submit any and all Phase I reports generated within the last year, and not previously submitted, with the annual report. By September 2, 1997 (within 180 days of the signing of the Programmatic Agreement), submit to the OHPO and the Advisory Council a literature search, examination of aerial photographs, and use of a predictive model for all disturbed and/or contaminated areas of the FEMP (as defined in the Agreement). The predictive model is to utilize existing archeological data from the FEMP and surrounding area to determine the likelihood of additional archeological sites within the contaminated/disturbed areas and the spatial distribution, physical characteristics, and uses.	✓	✓	✓	The Southern Waste Units (Remediation Area 2 Phase I) area has been designated in this programmatic agreement as a disturbed area, which means that no Phase I survey is required. All areas in Remediation Area 2 Phase I surrounding the Southern Waste Units have been surveyed, and no historic properties have been identified. Unexpected discoveries will be addressed accordingly (see Section F.4.2 of the SEP). Draft reports are under preparation for submission to the OHPO and the Advisory Council. Once finalized, the reports will be available to the public in the Public Environmental Information Center and archived as appropriate.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
ARCHAEOLOGICAL, HISTORIC AND CULTURAL RESOURCE PROTECTION, continued						
Native American Graves Protection and Repatriation Act 25 U.S.C. §3001 et seq.	Identification and preservation of cultural resources on federal lands is required, including natural landmarks. DOE must consult with appropriate Indian tribes before the intentional excavation or removal after an inadvertent discovery of Native American cultural items including human remains and objects of cultural significance.	Appl	Appl	Appl	DOE will consult with likely culturally affiliated tribes to determine the excavation, treatment, analysis and preparation of any extra reviews, associated funerary objects, unassociated funerary objects, sacred objects, or objects of cultural patrimony. Consultation will be coordinated with NHPA compliance when possible.	See preceding.
43 CFR Part 10	Provides for the return of human remains and cultural objects from Native American graves to affiliated tribes.	Appl	✓	✓		
American Indian Religious Freedom Act 42 U.S.C. §1996	Provides for tribal access by native peoples to grave sites and sites of cultural, symbolic, or religious significance.	Appl	Appl	Appl	See preceding.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
AIR PATHWAY						
	NOISE POLLUTION CONTROL					
Noise Control Act, as amended 42 U.S.C. §4901, *et seq.* Noise Pollution and Abatement Act 42 U.S.C. §7641	The public must be protected from noises that jeopardize health and welfare.	Appl	Appl	R&A	Appropriate engineering controls and best management practices will be implemented so that nuisance noise from vehicles and equipment will be reduced to the maximum practicable extent during conduct of the actions.	Section 5.1.2.1 of the Sitewide Excavation Plan
	AIR EMISSIONS					
Solid Waste and Infectious Waste Regulations, Authorized, Limited, and Prohibited Solid Waste Disposal Methods OAC 3745-27-05 ORC 3734.03	Open dumping of solid waste is prohibited [OAC 3745-27-05(C)]. Solid waste disposal by means of open burning, as defined in OAC 3745-19, is permitted only as provided therein [OAC 3745-27-05(B)].	Appl	Appl	Appl		Addressed through the description of the selected remedy in the OU2 ROD (Section 9.0), OU5 ROD (Section 9.0), and OU3 ROD (Section 8.0)
Criteria for Classification of Solid Waste Disposal Facilities and Practices, Air 40 CFR §257.3-7]	Open burning of residential, commercial, institutional or industrial solid waste is prohibited. This requirement does not apply to infrequent burning of agricultural wastes in the field, silvicultural wastes for forest management purposes, land-clearing debris, diseased trees, debris from emergency clean-up operations, and ordnance [40 CFR §257.3-7].	✓	✓	Appl		
Open Burning Standards, Open Burning in Unrestricted Areas OAC 3745-19-04®	Open burning is allowed for the following purposes [OAC 3745-19-04(C)]: • Recognized horticultural, silvicultural, range, or wildlife management practices [OAC 3745-19-04(C)(5)]. • Disposal of land clearing waste if the following conditions are met [OAC 3745-19-04(C)(4)]: - The fire is set only when atmospheric conditions will readily dissipate contaminants; - The fire does not create a visibility hazard on roadways, railroad tracks, or air fields; - The fire is located at a point on the premises no less than 1000 feet from any inhabited building not located on said premises.	✓	✓	Appl		

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
General Provisions on Air Pollution Control, Air Pollution Nuisances Prohibited OAC 3745-15-07 ORC 3704.01-.05	Measures shall be taken to adopt and maintain a program for the prevention, control, and abatement of air pollution in order to protect and enhance the quality of the state's air resource so as to promote the public health, welfare, and economic vitality of the people of the state. The emission or escape into open air from any source whatsoever of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors and combinations of the above in such a manner or in such amounts as to endanger the health, safety, and welfare of the public, or to cause unreasonable injury or damage to property shall be declared to be a public nuisance. It is unlawful for any person to cause, permit, or maintain any such public nuisance.	Appl	Appl	Appl	Only fugitive dust (dirt, flyash, bottom ash) is anticipated from this soil remedial action project. Air pollution nuisance prohibitions will be met by employing best management practices for control of fugitive dust.	FEMP Fugitive Dust Control BAT Determination, Fugitive Dust Control Requirements (RM-0047), and Section 5.1.2 of the Sitewide Excavation Plan
ORC 3734.02(I)	No owner or operator of a hazardous waste facility, in the operation of the facility, shall cause, permit, or allow the emission therefrom of any particulate matter, dust, fumes, gas, mist, smoke, vapor, or odorous substances that, in the opinion of the Director [of Environmental Protection, a.k.a., the Director of the OEPA], unreasonably interferes with comfortable enjoyment of life or property by persons living or working in the vicinity of the facility, or that is injurious to public health. Any such action is hereby declared to be a public nuisance.	√	√	R&A		
Particulate Matter Standards, Non-Degradation Policy OAC 3745-17-05	The significant and avoidable deterioration of air quality in any part of the area where presently existing air quality is better than the particulate ambient air quality standards in OAC 3745-17-02 (described above) shall be prohibited.	Appl	Appl	√	Appropriate control measures will be applied to all construction grading, excavation, loading/unloading and material management activities to reduce fugitive emissions. Also see preceding entry.	FEMP Fugitive Dust Control BAT Determination, Fugitive Dust Control Requirements (RM-0047), and Section 5.1.2.2 of the Sitewide Excavation Plan
Particulate Matter Standards, Control of Visible Particulate Emissions from Stationary Sources OAC 3745-17-07(A)(1)(a)	Visible particulate emissions from any point source shall not exceed 20 percent opacity, as a six-minute average, but shall not exceed 60 percent opacity, as a six-minute average, at any time. Transient exceedance limits are included in this regulation.	Appl	Appl	Appl	All point sources associated with a remedial action project (i.e., sludge dewatering, etc.) will employ best available emissions control technologies to mitigate particulate emissions.	As necessary, monitoring requirements will be addressed in the appropriate IRDP.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
Particulate Matter Standards, Control of Visible Particulate Emissions from Stationary Sources OAC 3745-17-07(B)(1)	Visible particulate emissions from any fugitive dust source shall not exceed 20 percent opacity, as a three-minute average.	✓	✓	✓	Appropriate control measures will be applied to all construction grading, excavation, loading/unloading and material management activities to reduce fugitive emissions.	See preceding.
Particulate Matter Standards, Control of Visible Particulate Emissions from Stationary Sources OAC 3745-17-07 (B)(4), (5), (6)	There shall be no visible particulate emissions from any paved roadway or paved parking area except for a period of time not to exceed six minutes during any 60-minute observation period. There shall be no visible particulate emissions from any unpaved roadway or unpaved parking area except for a period of time not to exceed 13 minutes during any 60-minute observation period. There shall be no visible particulate emissions from any material storage piles except for a period of time not to exceed 13 minutes during any 60-minute observation period.	Appl	R&A	✓	Appropriate control measures will be applied to all construction grading, excavation, loading/unloading and material management activities to reduce fugitive emissions.	FEMP Fugitive Dust Control BAT Determination, Fugitive Dust Control Requirements (RM-0047), and Section 5.1.2.2 of the Sitewide Excavation Plan
Particulate Matter Standards, Restriction of Emission of Fugitive Dust OAC 3745-17-08(B)	No person shall cause or permit any fugitive dust source to be operated; or any materials to be handled, transported, or stored; or a building (or its appurtenances) or a road to be used, constructed, altered, repaired, or demolished without taking or installing reasonably available control measures to prevent fugitive dust from becoming airborne. Such reasonably available control measures shall include, but are not limited to, one or more of the following which are appropriate to minimize or eliminate visible particulate emissions of fugitive dust. • The use of water or other suitable dust suppression chemicals for the control of fugitive dust from the demolition of existing buildings or structures, construction operations, the grading of roads, or the clearing of land; or • The periodic application of asphalt, oil, water, or other suitable dust suppression chemicals on dirt or gravel roads and parking lots, and any other surfaces that may cause emissions of fugitive dust.	Appl	R&A	Appl	This requirement is applicable only to certain cities in Butler and Hamilton Counties. Appropriate control measures will be applied to all construction grading, excavation, loading/unloading and material management activities to reduce fugitive emissions.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
Particulate Matter Standards, Restrictions on Particulate Emissions from Industrial Processes OAC 3745-17-11	The following are restrictions for particulates from any operation, process, or activity which releases or may release particulate emissions into the ambient air. These limits are based on the weight of material being processed. Process Weight at Maximum Capacity (lb/hr) — Allowable Particulate Emission Rate (lb/hr) 100 — 0.551 200 — 0.877 400 — 1.40 600 — 1.83 800 — 2.22 1000 — 2.58 *These limits do not apply to generation of fugitive dust* subject to OAC 3745-17-08 (listed above).	Appl		R&A	All point sources associated with a remedial action project (i.e., sludge dewatering, etc.) will employ best available emissions control technologies to mitigate particulate emissions.	See preceding.
Permit to Install New Sources of Pollution OAC 3745-31-05 (A)(3)	The installation or modification and operation of an air contaminant source, solid waste disposal facility, water pollution source, disposal system, land application of sludge, or public water system, must employ the best available technology. The terms used in the above are defined in OAC 3745-15-01, unless otherwise defined in OAC 3745-31-01.	R&A	Appl	R&A	Appropriate control measures will be applied to all construction grading, excavation, loading/unloading and material management activities to reduce fugitive emissions. All point sources associated with a remedial action project (i.e., sludge dewatering, etc.) will employ best available emissions control technologies to mitigate particulate emissions.	FEMP Fugitive Dust Control BAT Determination, Fugitive Dust Control Requirements (RM-0047), and Section 5.1.2.2 of the Sitewide Excavation Plan

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
Standards of Performance for New Stationary Sources, Subpart OOO—Standards of Performance for Nonmetallic Mineral Processing Plants 40 CFR §60.672(a), (d), (e)	No owner or operator shall cause to be discharged into the atmosphere from a crusher any emissions which: • Contain particulate matter in excess of 0.05 grams per dry cubic meter at standard conditions (g/dscm); and • Exhibit greater than 7 percent opacity Truck dumping of nonmetallic minerals into any crusher is exempt from these requirements.	R&A	✓		It is not anticipated that a crusher will be used during this remedial action project. All point sources associated with a remedial action project (i.e., sludge dewatering, etc.) will employ best available emissions control technologies to mitigate particulate emissions.	See preceding.
	AIR EMISSIONS, continued					
40 CFR Part 61, Subpart M-National Emission Standard for Asbestos, Standard for Waste Disposal for Manufacturing, Fabrication, Demolition, Renovation, and Spraying Operation 40 CFR §61.150	(a) Discharge no visible emissions to the outside air during the collection, processing, packaging, or transporting of any asbestos-containing waste material, or use one of the emission control methods specified in paragraphs (a)(1) through (4) of this section: (1) Adequately wet asbestos-containing material. After wetting, seal all asbestos-containing waste material in leak-tight containers while wet; or, put materials that will not fit into containers without additional breaking into leak-tight wrapping. Label the containers or wrapped materials in accordance with 29 CFR 1910.1001(j)(2) or 1926.58(k)(2)(iii). ... (4) Use an alternative emission control and waste treatment method that has received prior approval from the Administrator. (5) As applied to demolition and renovation, the requirements above under paragraph (a) of this section do not apply to Category I non-friable ACM waste and Category II non-friable ACM waste that did not become crumbled, pulverized, or reduced to powder.	✓	✓	Appl		See preceding, and following sections of the Sitewide Excavation Plan: 2.5.8 Special Materials 3.3.2.2 Special Materials F.4.1.1 Asbestos

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
Asbestos Emission Control, Standard for Active Asbestos Disposal Sites OAC 3745-20-06(A)&(B) [40 CFR Part 61, Subpart M-National Emission Standard for Asbestos, Standard for Active Waste Disposal Sites, 40 CFR §61.154]	(A) Each owner or operator of an active asbestos waste disposal site shall cause or permit no visible emissions [of asbestos] to the outside air; or shall comply with the requirements of paragraph (B) of this rule. (B) Rather than meet the no visible emissions requirement of paragraph (A) of this rule, each owner or operator of an active asbestos waste disposal site shall comply with the following: (1) There shall be no visible emissions from asbestos-containing waste materials during the on-site transportation, transfer, deposition or compacting operations. (2) Deposition and burial operations shall be conducted in a manner which prevents handling by equipment or persons that causes asbestos-containing waste materials to be broken-up or dispersed before the materials are buried. (3) As soon as practicable after deposition of the asbestos-containing waste materials but no later than at the end of each operating day, the asbestos-containing waste material deposited at the site during the operating day shall be buried with at least twelve inches of compacted nonasbestos-containing material. Alternatively, any owner or operator of an active asbestos waste disposal site may apply for approval of the Director [of Environmental Protection, a.k.a. Director of the OEPA] to utilize alternative control measures to bind dust, control wind erosion or convert [friable] asbestos to non-friable forms. (4) During the unloading, deposition, burial, and initial compaction of asbestos-containing materials, the owner or operator of the active [asbestos] waste disposal site shall establish a restricted area adequate to deter the unauthorized entry of the general public and any unauthorized personnel from any location within one hundred feet of the operations, and shall display the following information on a sign not less than twenty by fourteen inches, so that it is visible before entering the restricted area: ASBESTOS DUST HAZARD Do Not Remain In Area Unless Your Work Requires It Breathing Asbestos Dust Is Hazardous To Your Health	√	√	Appl	Pertinent to the management of asbestos-containing materials. Also note that requirements from paragraphs (A) and (B) which are pertinent to disposal of asbestos-containing materials, are included in the OSDF Impacted Materials Placement Plan.. NOTE: The sizing & language for warning signs under (B)(4) at left conflicts with that required by OSHA under 29 CFR §1926.1101(k)(7). The FEMP will follow the OSHA requirements. Sign language: DANGER ASBESTOS CANCER & LUNG DISEASE HAZARD AUTHORIZED PERSONNEL ONLY OSHA does not impose a minimum sign size.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
Asbestos Emission Control, Standard for Inactive Asbestos Disposal Sites OAC 3745-20-07® [40 CFR Part 61, Subpart M-National Emission Standard for Asbestos, Standard for Inactive Waste Disposal Sites, for Asbestos Mills and Manufacturing and Fabricating Operations 40 CFR §61.151]	The owner or operator may use an alternate control method that has received prior approval of the Director [of Environmental Protection, a.k.a. Director of the OEPA] rather than comply with the requirements of paragraph (A) [emissions and cover requirements] or (B) [posting and access control requirements] of this rule.	✓	✓	Appl	These requirements for inactive asbestos waste disposal sites are very similar to those for active asbestos waste disposal sites under OAC 3745-20-06 (preceding entry). During soil remediation activities under this remedial action project, the requirements for active asbestos disposal sites (preceding entry) will be followed while managing friable asbestos-containing material. Also note that requirements pertinent to disposal of asbestos-containing materials under paragraphs (A) and (C) of OAC 3745-20-07 are included in the OSDF Impacted Materials Placement Plan.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
Asbestos Emission Control, Standard for Inactive Asbestos Disposal Sites OAC 3745-20-07(D) [40 CFR Part 61, Subpart M-National Emission Standard for Asbestos, Standard for Inactive Waste Disposal Sites for Asbestos Mills and Manufacturing and Fabricating Operations, 40 CFR §61.151(d)]	Each owner or operator of an inactive asbestos waste disposal site shall notify the Director [of Environmental Protection, a.k.a. the Director of the OEPA] in writing prior to disturbing or removing any asbestos-containing waste material. The notice shall contain:	✓	✓	✓	Submission of the project-specific IRDPs to OEPA constitute this notification.	
	• the reason for disturbing the waste,					The reason for disturbing the material is documented in the OU2, OU5 and OU3 RODs.
	• the procedures to be used to control emissions,					FEMP Fugitive Dust Control BAT Determination, Fugitive Dust Control Requirements (RM-0047), the OSDF Impacted Materials Placement Plan, and following sections of the Sitewide Excavation Plan: 2.5.8 Special Materials 3.3.2.2 Special Materials 5.1.2.2 Fugitive Emissions F.4.1.1 Asbestos
	• the duration of the operation, and				Project schedules contained in project-specific IRDPs.	
	• the location of the final disposal site.					The OSDF, unless the OSDF WAC is not met; else, an off-site permitted/licensed disposal facility.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	AIR EMISSIONS, continued					
National Emission Standards for Hazardous Air Pollutants, Subpart H—National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities, 40 CFR §61.90, §61.91 and §61.92 - .97 [Radiation Protection of the Public and the Environment DOE Order 5400.5 Chapter II (1)(b)]	Emissions of radionuclides (except radon-220 and radon-222) to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr. To determine compliance with the standard, radionuclide emissions shall be determined and effective dose equivalent values to members of the public calculated using EPA-approved sampling procedures, computer models CAP-88 or AIRDOS-PC, or other procedures for which EPA has granted prior approval.	Appl	Appl	Appl		Section 6 of the Integrated Environmental Monitoring Plan (IEMP) and the following sections of the Sitewide Excavation Plan: 5.1.2.3 Airborne Radiological Particulates 5.1.2.4 Radon 5.1.2.5 Direct Radiation
National Emission Standards for Hazardous Air Pollutants, Subpart Q—National Emission Standards for Radon Emissions From Department of Energy Facilities 40 CFR §61.190, §61.192	No source at a DOE facility shall emit more than 20 pCi/m^2/sec of radon-222 as an average for the entire source into the air.	Appl	Appl	R&A	The existing distribution of contaminants within the site soils attains compliance with this requirement. Will be addressed sitewide as necessary by the Integrated Environmental Monitoring Plan (IEMP).	

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
SURFACE WATER PATHWAY						
	WETLANDS/FLOODPLAIN PROTECTION					
Executive Order 11990, Protection of Wetlands	Federal agencies are required to take action to avoid adversely impacting wetlands wherever possible, to minimize wetland destruction, and to preserve the values of wetlands.	Appl	Appl		Floodplain and wetland impacts associated with soil remediation activities will be minimized and avoided to the maximum extent practicable. Projects with unavoidable impacts will be undertaken in accordance with 33 CFR Parts 323 and 330. Based on a review of an overlay of the Remediation Area 2 Phase I boundary on the FEMP Jurisdictional Wetland Delineation (Drwg. 75X-5500-G-00372), no jurisdictional wetlands or waters of the U.S. are anticipated to be dredged and filled during excavation of the remediation area.	Approximately 35.9 acres of jurisdictional wetlands and 8.9 acres of waters of the United States were identified on the FEMP property as a result of the 1993 Jurisdictional Wetlands & Waters of the U.S. (1993 FEMP Wetland Delineation). The U.S. Army Corps of Engineers officially approved the delineation on August 19, 1993. See also: Appendix H of the OU2 FS Report; Appendix J of the OU5 FS Report, and Appendix J of OU3 RI/FS. The Natural Resources Restoration Plan (NRRP); also, operable unit closure reports must include NEPA compliance, as per following sections of the Sitewide Excavation Plan: 1.4.2 Related Documents 7.3 Certification Report 7.4 Other Related Future Documents

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	WETLANDS/FLOODPLAIN PROTECTION, continued					
Procedure for Implementing the National Environmental Policy Act 40 CFR §6.302(a)	Federal agencies conducting certain activities must avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands, and avoid support of new construction in wetlands when a practicable alternative exists.	Appl	Appl		See preceding.	See preceding.
Executive Order 11988, Floodplain Management Procedures for Implementing the National Environmental Policy Act 40 CFR §6.302(b)	Federal agencies must evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain.	Appl	Appl		Remediation is needed, and can not be avoided. Nationwide Permit # 38 (subsequent entry) authorizes such remedial activity in a floodplain. The floodplain will not be developed as a result of this federal agency action. A portion of Remediation Area 2 Phase I is located within the 100-year floodplain of Paddy's Run. Impacts to the floodplain were addressed in a Floodplain/Wetland Assessment included in Appendix H of the OU2 FS Report (March 1995). Consistent with the fiindings of that assessment, temporary floodplain impacts in the form of increased stormwater runoff and/or siltation have the potential to occur during site preparatiuon activities. These potential impacts will be minimized through the design and implementation of appropriate erosion and sedimentation controls (see Section 5.1.3 of the Sitewide Excavation Plan). All three Area 2 Phase I stormwater retention basins will be designed to at least retain runoff from a 10-year storm event; basins 1 and 2 will be designed to retain runoff from a 25-year storm event. Stormwater retention basin berm elevations will be designed above the elevation of a 10-year flood event. No long term impacts or changes in the pool elevation of the 100-year flood are anticipated.	An updated floodplain determination was conducted in October 1992 for Paddy's Run using the U.S. Army Corps of Engineers' standard HEC2 water surface profile analysis program. The 100-year flood elevations reach the western slope of the Inactive Flyash Pile and the toe of the South Field slope.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	WETLANDS/FLOODPLAIN PROTECTION, continued					
DOE Compliance with Floodplain/ Wetlands Environmental Review Requirements 10 CFR §1022.3(a), 3(b)(1), 3(b)(2), 3(b)(3), 3(b)(5), 3(b)(6), 3(c), 3(d), 3(e)	DOE shall exercise leadership and take action to: • Avoid to the extent possible the long- and short-term adverse impacts associated with the destruction of wetlands and the occupancy and modification of floodplains and wetlands, and avoid direct and indirect support of floodplain and wetland development wherever there is a practicable alternative. • Incorporate floodplain management goals and wetlands protection considerations into its planning, regulatory, and decision-making processes and shall to the extent practicable: - Reduce the hazard and risk of flood loss. - Minimize the impact of floods on human safety, health, and welfare. - Restore and preserve natural and beneficial values served by the floodplain. - Minimize the destruction, loss, or degradation of wetlands. - Preserve and enhance the natural and beneficial values of wetlands. • Undertake a careful evaluation of the potential effects of any DOE action taken in a floodplain and any new construction undertaken by DOE in wetlands not located in a floodplain. • Identify, evaluate, and as appropriate, implement alternative actions which may avoid or mitigate adverse floodplain/wetlands impacts. • Provide opportunity for early public review of any plans or proposals for actions in floodplains and new construction in wetlands.	Appl	Appl	Appl	10 CFR Part 1022 is the DOE implementing regulation for Executive Orders 11988 and 11990 (see corresponding preceding entries).	Remediation decisions included avoidance to/ minimization of wetlands impacts. See: Appendix H of the OU2 FS Report; Appendix J of the OU5 FS Report, and Appendix J of OU3 RI/FS. Also, see preceding entries.
DOE Compliance with Floodplain/ Wetlands Environmental Review Requirements 10 CFR §1022.5(b), (h)	This part shall apply to all proposed floodplain/wetlands actions, including those sponsored jointly with other agencies, where practicable alternatives to the proposed actions are still available. The policies and procedures of this part which are applicable to floodplain actions shall apply to all proposed actions which occur in a wetlands located in a floodplain.	Appl	Appl	Appl	See preceding entries.	See preceding entries.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	WETLANDS/FLOODPLAIN PROTECTION, continued					
DOE Compliance with Floodplain/ Wetlands Environmental Review Requirements 10 CFR §1022.11 (a), (b), (c)	Concurrent with its review of a proposed action to determine appropriate NEPA requirements, DOE shall determine applicability of the floodplain management and wetlands protection requirements of this part. In making a floodplain determination, DOE shall utilize the Flood Insurance Rate Maps (FIRMs) or the Flood Hazard Boundary Maps (FHBMs) prepared by the Federal Insurance Administration of the Department of Housing and Urban Development to determine if a proposed action is located in the base or critical action floodplain, as appropriate. For a proposed action in an area of predominately federal or state land holdings where FIRM or FHBM maps are not available, information shall be sought from the land administering agency (e.g., Bureau of Land Management, Soil Conservation Service, etc.) or from agencies with floodplain analysis expertise.	Appl	Appl		See preceding entries.	See preceding entries.
DOE Compliance with Floodplain/ Wetlands Assessments 10 CFR §1022.12(a)	If DOE determines, pursuant to 10 CFR §§ 1022.5 and 1022.11, that this part is applicable to the proposed action, DOE shall prepare a floodplain/wetlands assessment, according to the requirements in this section (10 CFR §1022.12).	Appl	Appl		See preceding entries.	See preceding entries.
DOE Compliance with Floodplain/ Wetlands Environmental Review Requirements 10 CFR §1022.15(a)	If DOE finds that no practicable alternative to locating in the floodplain/wetland is available, consistent with the policy set forth in Executive Order 11988, DOE shall, before taking action, design, or modify its action in order to minimize potential harm to or within the floodplain or wetland.	Appl	Appl		See preceding entries.	See preceding entries.
Federal Water Pollution Control Act (a.k.a., Clean Water Act) General Regulatory Policies 33 CFR §323.3	Permits will be required for the discharge of dredged or fill material into waters of the United States including wetlands. Certain discharges specified in 33 CFR Part 330 are permitted by that regulation (nationwide permits). If a discharge of dredged or fill material is not permitted by 33 CFR Part 330 (Nationwide Permits), an individual section 404 permit will be required for the discharge of dredged or fill material into waters of the United States. Discharges of dredged or fill material into waters of the United States done by or on behalf of any Federal agency, other than the Corps of Engineers, are subject to the authorization procedures of these regulations. Remedial actions involving the discharge of dredge and fill material into these areas shall meet the substantive requirements of this section and 40 CFR Part 230.	Appl	 Appl		See preceding entry for Executive Order 11990 (first Floodplain/Wetland Protection entry).	See preceding entries.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	WETLANDS/FLOODPLAIN PROTECTION, continued					
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Nationwide Permit (NWP) Program 33 CFR Part 330	The U.S. Army Corps of Engineers has authorized certain categories of activities involving the discharge of dredged and fill material into wetlands and waters of the United States under the NWP program. Activities involving the discharge of dredged and fill material will be conducted in accordance with the substantive requirements of applicable NWPs as required. Discharges not authorized by NWP will be conducted in accordance with the substantive requirements of 33 CFR Part 323 and 40 CFR Part 230.	✓	Appl	R&A	See preceding entries.	Following sections of the Sitewide Excavation Plan: 3.3.1 Implementation of Construction, Excavation, and Material Handling Activities 5.1.1 Natural Resource Impacts 5.1.3 Surface Water Pathway
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Nationwide Permit Program 33 U.S.C. §1341(a)(1), (d) 33 CFR §330.1(c)	An activity is authorized under an Nationwide Permit (NWP) only if that activity and the permittee satisfy all of the individual NWP's terms and conditions. Potentially applicable NWPs include: • Nationwide Permit #38 — Cleanup of Hazardous and Toxic Waste - This permit authorizes specific activities required to affect the containment, stabilization or removal of hazardous or toxic waste materials that are performed, ordered, or sponsored by a government agency with established legal or regulatory authority provided the permittee notifies the district engineer. - For discharges in special aquatic sites, including wetlands, the notification must include a delineation of affected special aquatic sites, including wetlands. - This nationwide permit does not authorize the establishment of new disposal sites or the expansion of existing sites used for the disposal of hazardous or toxic waste. • Nationwide Permit #26 — Headwaters and Isolated Waters Discharges - The discharge does not cause the loss of more than 10 acres of waters of the United States. - The permittee notifies the district engineer if the discharge would cause the loss of waters of the United States greater than one acre. - For discharges in special aquatic sites, including wetlands, the notification must also include a delineation of affected special aquatic sites, including wetlands. - The discharge, including all attendant features, both temporary and permanent, is part of a single and complete project.	Appl	Appl	R&A	See preceding entries for Executive Orders 11990 (Protection of Wetlands) and 11988 (Floodplain Management).	January 17, 1992 letter from Donald R. Schregardus, Director of the OEPA, to the U.S. Army Corps of Engineers, "401 Certification — Grant," the OEPA conditionally certified that projects authorized by NWP #s 38 and 26 will comply with the applicable provisions of the Federal Water Pollution Control Act.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	WETLANDS/FLOODPLAIN PROTECTION, continued					
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Nationwide Permit Program Section B(26) to Appendix A of 33 CFR Part 330	Discharges of dredged or fill material into headwaters and isolated waters [under Nationwide Permit # 26] are approved provided: • The discharge does not cause the loss of more than 10 acres of waters of the United States. • The permittee notifies the district engineer if the discharge would cause the loss of waters of the United States greater than one acre. • For discharges in special aquatic sites, including wetlands, the notification must also include a delineation of affected special aquatic sites, including wetlands. • The discharge, including all attendant features, both temporary and permanent, is part of a single and complete project.	✓	✓	✓	See preceding and following entries.	See preceding and following entries.
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Nationwide Permit Program 33 CFR §330.4 (c)(1) Ohio Section 401 State Water Quality Certifications OAC 3745-32-02	Section 401 State Water Quality Certification pursuant to Section 401 of the Clean Water Act, or waiver thereof, is required to prior to issuance or reissuance of individual or nationwide permits authorizing (dredge and fill) activities which may result in a discharge into waters of the United States. State Water Quality Certification is granted provided: 1. The discharge does not prevent or interfere with the attainment or maintenance of applicable water quality standards; and 2. The discharge does not result in a violation of any applicable provisions of the Federal Water Pollution Control Act (a.k.a., Clean Water Act).	Appl	Appl		See preceding and following entries.	January 17, 1992 letter from Donald R. Schregardus, Director of the OEPA, to the U.S. Army Corps of Engineers, "401 Certification – Grant," the OEPA conditionally certified that projects authorized by the NWP #s 38 and 26 (see previous entry) will comply with the applicable provisions of the Federal Water Pollution Control Act.
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Nationwide Permit Program Section C of Appendix A to 33 CFR Part 330	In addition to the General Conditions, the following [Section 404 only] conditions apply only to activities that involve the discharge of dredge or fill material and must by followed in order for authorization of the nationwide permits to be valid: • No discharge of dredged or fill material may consist of unsuitable material (e.g., trash, debris, car bodies, etc.). And material discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act). • Discharges of dredged or fill material into waters of the United States must be minimized or avoided to the maximum extent practicable at the project site, unless the District Engineer has approved a compensation mitigation plan for the specific regulated activity.	✓	✓		See preceding entries.	The Natural Resources Restoration Plan (NRRP)

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	WETLANDS/FLOODPLAIN PROTECTION, continued					
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Nationwide Permit Program Section C of Appendix A to 33 CFR Part 330	Factors that the District Engineer will consider when determining the acceptability of appropriate and practicable mitigation include, but are not limited to: • To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of overall project purposes. • To the extent appropriate, permittees should consider mitigation banking and other forms of mitigation including contribution to wetland trust funds, which contribute to the restoration, creation, replacement, enhancement, or preservation of wetlands. • Furthermore, examples of mitigation that may be appropriate and practicable include but are not limited to: reducing the size of the project; establishing buffer zones to protect aquatic resource values; and replacing the loss of aquatic resource values by creating, restoring, and enhancing similar functions and values. In addition, mitigation must address impacts and cannot be used to offset the acreage of wetland losses that would occur in order to meet the acreage limits of some of the nationwide permits.	√	√		See preceding entries.	The Natural Resources Restoration Plan (NRRP)
Federal Water Pollution Control Act (a.k.a., Clean Water Act) §404 (33 U.S.C. §1344) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, Subpart B—Compliance With the Guidelines, Restrictions on Discharge 40 CFR §230.10	No discharge of dredged or fill material shall be permitted: • If there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as, the alternative does not have other significant adverse environmental consequences. • Unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem. No discharge of dredged or fill material shall be permitted if it: • Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable state water quality standard. • Violates any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act. • Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, or results in likelihood of the destruction or adverse modification or a habitat which is determined to be a critical habitat under the Endangered Species Act of 1973, as amended.	Appl	√	√	See preceding entries.	Appendix H of the OU2 FS Report; Appendix J of the OU5 FS Report, and Appendix J of OU3 RI/FS.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DISCHARGE TO SURFACE WATER					
Pollution to Waters of the State ORC 6111.04	No person shall cause pollution or place or cause to be placed any sewage, industrial waste, or other wastes in a location where they cause pollution of any waters of the state. No person to whom a permit has been issued shall place or discharge, or cause to be placed or discharged, in any waters of the state any sewage, industrial waste, or other wastes in excess of the permissive discharges specified under such existing permit without first receiving a permit from the Director to do so. Pollution to waters of the state is prohibited.	Appl	Appl	R&A		FEMP Site NPDES Permit Number 1IO00004*ED, the FEMP Stormwater Pollution Prevention Plan (RM-0039), Section 4 of the Integrated Environmental Monitoring Plan (IEMP), and the following section of the Sitewide Excavation Plan: 5.1.3 Surface Water Pathway
Compliance with Ohio Water Pollution Control Requirements ORC 6111.07(A), (C)	Failure to comply with water pollution control requirements is prohibited.	√	Appl	Appl		See preceding.
Water Quality Standards, Criteria Applicable to All Waters OAC 3745-1-04	To every extent practical and possible, all surface waters of the State of Ohio shall be free from: • Suspended solids or other substances that enter the waters as a result of human activity that will form putrescent or otherwise objectionable sludge deposits • Floating debris, oil, scum and other floating materials entering the waters as a result of human activity in amounts sufficient to be unsightly or cause degradation • Materials entering the waters as a result of human activity producing color, odor or other conditions in such a degree as to create a nuisance • Substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone • Nutrients entering the waters in concentrations that create nuisance growths of aquatic weeds or algae	√	R&A	R&A		See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DISCHARGE TO SURFACE WATER, continued					
Water Quality Standards, Antidegradation Policy OAC 3745-1-05(A)&(B)	(A) Existing instream water uses as defined in OAC 3745-1-07 [subsequent entry] shall be maintained and protected. No further water quality degradation which would interfere with or become injurious to designated uses is allowable. (B) Waters in which existing water quality is better than the criteria prescribed in these rules and exceeds those levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water shall be maintained and protected. ... Degradation of water quality shall not interfere or become injurious to existing or planned uses, and the Director shall require that ... feasible management or regulatory programs pursuant to Section 208 and 303 of the Act [Clean Water Act], 33 U.S.C. Sections 1288 and 1313, be applied to nonpoint sources.	√	√	Appl	Soil remedial action projects will ensure that existing instream water uses of the Great Miami River and Paddy's Run will be maintained as health protective.	See preceding.
Water Quality Standards, Great Miami River OAC 3745-1-21	Paddy's Run and the Great Miami River are designated as: • Warm water aquatic life habitat • Agricultural and industrial water supply • Primary contact recreation The Great Miami River between Ross Road (RM 95.7) to Taylorsville Dam (RM 92.6) is a state resource water, and RM 130 and 118 are public water supplies.	Appl	Appl	Appl	Discharges to the Great Miami River and Paddy's Run must not cause a violation of applicable numeric or narrative water quality standards for these designations. The FEMP effluent discharge pipe, located at River Mile (RM) 24.73 on the Great Miami River, is downstream of the state resource waters and public water supplies.	See preceding.
National Pollutant Discharge Elimination System 40 CFR §122.26(a)(l)(ii), 40 CFR §122.26(b)(14)(v), (x)	A discharge composed entirely of storm water associated with industrial activity is required to obtain a NPDES permit. These categories of facilities are considered to be engaging in "industrial activity": • Landfills, land application sites, and open dumps that receive or have received any industrial wastes (waste that is received from any of the facilities described under this subsection), including those that are subject to regulation under Subtitle D of RCRA; and • Construction activities including clearing, grading, and excavation that disturbs five acres or more of total land area.	Appl	Appl	Appl	Discharges of stormwater associated with industrial and/or construction activities are regulated in accordance with the existing FEMP NPDES Permit, and the FEMP Stormwater Pollution Prevention Plan.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DISCHARGE TO SURFACE WATER, continued					
Ohio NPDES Permits, Ohio NPDES Permits Required OAC 3745-33-02(A)	No person may discharge any pollutant or cause, permit, or allow a discharge of any pollutant [from a point source] without applying for and obtaining an Ohio NPDES permit in accordance w with the requirements of this Chapter, 3745-33.	✓	✓	✓	See preceding and following entries.	FEMP Site NPDES Permit (Ohio EPA Number 1IO00004*ED), and the FEMP Stormwater Pollution Prevention Plan (RM-0039).
Ohio NPDES General Permits, Ohio NPDES Permit Required OAC 3745-38-02(A)	No person may discharge any pollutant or cause, permit, or allow a discharge of any pollutant from a point source without either applying for and obtaining an Ohio NPDES permit in accordance w with the requirements of Chapter 3745-33 of the Administrative Code [preceding entry], ... or have authorization to discharge under an Ohio NPDES general permit in accordance with the requirements of this chapter [3745-38]. **NOTE:** In September 1992, the FEMP applied for an individual stormwater permit to cover its industrial stormwater discharges to Paddy's Run. On the basis of the information provided in the original FEMP Stormwater Permit Application , Ohio EPA has chosen to regulate FEMP site industrial stormwater discharges under the individual permit process (OAC 3745-33, preceding entry), by incorporating stormwater monitoring requirements at Paddy's Run into the NPDES Permit. The site NPDES permit also addresses discharges of stormwater associated with construction activities by requiring a Stormwater Pollution Prevention Plan that defines the manner in which these discharges will be managed.	✓	✓	✓	In accordance with the note at left, the general permitting process described in OAC 3745-38 is not applicable to the FEMP site stormwater discharges. Rather, these are regulated within the context of the existing FEMP NPDES Permit (Ohio EPA Number 1IO00004*ED) and the FEMP Stormwater Pollution Prevention Plan (RM-0039), both of which derive their regulatory basis from OAC 3745-33 (preceding entry).	See preceding entries.
Rules and Regulations of the Hamilton County Soil and Water Conservation District Governing Earthwork for Unincorporated Hamilton County, Ohio	Temporary and/or permanent erosion and sediment control features and devices shall be designed and constructed in general accordance with the State of Ohio Temporary Erosion Control Specifications. *Exempted* from these requirements are: • *any public work performed by or under control of any governmental agency*, provided such operations do not cause instability of any adjacent or contiguous property and substantially equivalent sediment control policies are applied [3.10 E]. • *operations involving process and stockpiling of soils or rock materials where controlled by other regulations*, provided such operations do not cause instability of any adjacent or contiguous property [3.10 H].	✓	TBC	TBC		FEMP Site NPDES Permit (OEPA Number 1IO00004*ED), and the FEMP Stormwater Pollution Prevention Plan (RM-0039), and the following sections of the Sitewide Excavation Plan: 5.1.3 Surface Water Pathway App F Implementation of Construction

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DISCHARGE TO SURFACE WATER, continued					
Federal Water Pollution Control Act (a.k.a., Clean Water Act) Subpart K—Best Management Practices (BMP) Programs 40 CFR §125.104	BMP programs shall be developed in accordance with good engineering practices and: 1) Be documented in narrative form and include any necessary plot plans, drawings or maps; 2) Establish specific objectives for the control of toxic and hazardous pollutants: (a) Each facility component or system shall be examined for its potential for causing a release of significant amounts of toxic or hazardous pollutants to waters of the United States due to equipment failure, improper operation, natural phenomena such as rain or snowfall, etc. (b) Where experience indicates a reasonable potential for equipment failure (e.g., a tank overflow or leakage), natural condition (e.g., precipitation), or other circumstances to result in significant amounts of toxic or hazardous pollutants reaching surface waters, the program should include a prediction of the direction, rate of flow and total quantity of toxic or hazardous pollutants which could be discharged from the facility as a result of each condition or circumstance; 3) Establish specific BMPs to meet the objectives identified in (2) above, addressing each component or system capable of causing a release of significant amounts of toxic or hazardous pollutants to the waters of the United States.		Appl	R&A	BMP requirements will be met by implementing FEMP's BMP Plan. The BMP Plan will be progressively updated to accommodate changing site activities during the conduct of CERCLA remedial actions.	Addressed as part of the selected remedy described in the OU5 ROD. Also see preceding entries.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
GROUNDWATER PATHWAY						
GROUNDWATER PROTECTION						
Safe Drinking Water Act 42 U.S.C. §1424(e)	All Federal financially assisted projects constructed in the area of a sole source aquifer and its principal recharge zone will be subject to EPA's review to insure that these projects are designed and constructed so that they do not create a significant hazard to public health.	Appl	Appl	Appl	A notice in 53 FR 15876 (May 4, 1988) designated the Buried Valley Aquifer System of the Great Miami/ Little Miami River Basins of southwestern Ohio as a sole or principal source of drinking water. The Fernald site is located above this aquifer.	EPA and OEPA review of project submittals
WELLS – CONSTRUCTION						
Water Well Standards, Pumping Wells OAC 3745-9-08(C)	Pumps may only be primed with potable water.		Appl		Pertains to all well pumps that require priming.	The Sitewide CERCLA Quality Assurance Project Plan (SCQ), the Integrated Environmental Monitoring Plan (IEMP), and the individual project-specific plans for sampling.
Water Well Standards, Monitoring Well Maintenance and Modification OAC 3745-9-09(A) through (C), and (E) through (G)	Monitoring wells must be maintained or modified to avoid cross-contamination of groundwater.		Appl		Pertains to all groundwater wells and piezometers.	The Sitewide CERCLA Quality Assurance Project Plan (SCQ), the Integrated Environmental Monitoring Plan (IEMP), and the following section of the Sitewide Excavation Plan: F.6.3 Monitoring Well Preservation
WELLS – ABANDONMENT						
Water Well Standards, Abandonment of Test Holes and Wells OAC 3745-9-10	Upon completion of testing, a test hole shall be either completely filled with grout or such other material as will prevent contaminants from entering groundwater. If a well [or similar device] containing walls is not being used for obtaining groundwater or for determining the quality, quantity, or level of groundwater, it shall be completely filled with grout or other similar material as will prevent contaminants from entering groundwater, or maintained in strict accordance with all applicable requirements of OAC 3745-9-09.		Appl	Appl	After they are no longer needed, wells, peizometers and lysimeters are to be properly plugged and abandoned in accordance with these requirements.	The Sitewide CERCLA Quality Assurance Project Plan (SCQ), the Integrated Environmental Monitoring Plan (IEMP), and the following section of the Sitewide Excavation Plan: F.6.1 Plugging and Abandonment F.6.2 Monitoring Well Excavation

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
SOIL REMEDIATION						
	RADIONUCLIDE CONCENTRATIONS					
Radiation Protection of the Public and the Environment DOE Order 5400.5 Chapter I (4) and Chapter II (2)	An "as low as reasonably achievable (ALARA)" process is to be used in planning and carrying out all DOE activities that have the potential to cause radiation exposure to the public. ALARA requires judgement with respect to what is reasonably achievable. Factors that relate to societal, technological, economic, and other public policy considerations shall be evaluated to the extent practicable. Factors to be considered, at a minimum, include: • Maximum dose to members of the public; • Collective dose to the population; • Alternative processes, such as alternative treatment of discharge streams, operating methods, or controls; • Doses for each process alternative; • Cost for each of the technological alternatives; • Examination of the changes in cost among alternatives; and • Changes in societal impact associated with process alternatives (e.g., differential doses from various pathways). Except for meeting requirements of NEPA, qualitative analyses are acceptable, in most instances, for ALARA judgements, especially when the potential doses are well below the dose limit. The bases for these judgements should be documented. More detailed analyses should be considered if the decision might result in doses that approach the limit.	TBC	TBC		In addition to the evaluations conducted as part of the CERCLA selection of remedy process (the short- and long-term risk assessments of the Comprehensive Remedial Action Risk Evaluation (CRARE) within the feasibility studies (FSs)), documentation of "equivalent evaluations" for environmental ALARA are performed in accordance with the "FEMP Environmental ALARA Plan" and retained as part of the site and project records.	Addressed through the approved selected remedy in the RODs. An ALARA goal is set in the OU5 ROD for the total uranium FRL.
10 CFR Part 834 (PROPOSED)			TBC			

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	RADIONUCLIDE CONCENTRATIONS, continued					
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Subpart B— Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites 40 CFR §192.12(a) Subpart C— Implementation 40 CFR §192.20	Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials, the concentration of radium-226 in land averaged over any area of 100 m^2 shall not exceed the background level by more than: • 5 pCi/g averaged over the first 15 cm of soil below the surface, and • 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface. Compliance with this requirement should be shown through measurements performed within the accuracy of currently available types of field and laboratory instruments in conjunction with reasonable survey and sampling procedures.	R&A	R&A	R&A	Met through the selection of FRLs based on risk assessment, followed by certification of cleanup.	The selected remedy in the OU2 and OU5 RODs established more stringent clean-up levels for radium-226 of 1.7 pCi/g, as opposed to 5.0 pCi/g above background.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Subpart C— Implementation 40 CFR §192.21(f) and §192.22(b)	Where radionuclides other than radium-226 and its decay product are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials, remedial actions shall, in addition to satisfying the standards of Subpart A in 40 CFR §192.02 and Subpart B in 40 CFR §192.12 (both listed above), reduce other residual radioactivity to levels that are ALARA.	R&A	R&A	R&A		The approved selected remedy in the OU5 ROD set an ALARA goal for the total uranium FRL.
Postclosure Standards for Uranium and Thorium Mill Tailings, Subpart D— Standards for the Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended 40 CFR §192.32 (b)(2)	The requirements for the management of uranium byproduct materials after closure of a disposal area [40 CFR §192.32(b)(1)] shall not apply to any portion of a disposal site which contains a concentration of radium-226 in land, averaged over areas of 100 m^2, which, as a result of uranium byproduct material, does not exceed the background level by more than the limits specified in 40 CFR §192.12(a) (see above).	R&A	R&A	R&A		See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	RADIONUCLIDE CONCENTRATIONS, continued					
Management of Thorium Mill Tailings, Subpart E— Standards for the Management of Thorium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended 40 CFR §192.40 - §192.42	The following are requirements for the management of thorium byproduct materials: • The provisions for the management of uranium byproduct material (40 CFR §192.32) shall apply to thorium byproduct material and: - Provisions applicable to the element uranium shall also apply to the element thorium - Provisions applicable to radon-222 shall also apply to radon-220 - Provisions applicable to radium-226 shall also apply to radium-228 With the concurrence of EPA, alternative provisions may be substituted for any of the above requirements provided the alternative provisions will provide at least an equivalent level of protection for human health and environment.	R&A	R&A	R&A		See preceding.
Radiation Protection of the Public and the Environment, DOE Order 5400.5 Chapter IV (4)(a)	Guidelines for residual concentrations of radionuclides other than thorium and radium shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these derivations are given in DOE/CH-8901. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2.	TBC				Considered in the development of the selected remedy in the OU2 and OU5 RODs.
Radiation Protection of the Public and the Environment, DOE Order 5400.5 Chapter IV (4)(a)(1) 10 CFR Part 834 (PROPOSED)	If the average residual concentration of radionuclides in any surface or below- surface area less than or equal to 25 m^2 exceeds the limit or guideline by a factor of $(100/A)^{0.5}$ [where A is the area (in square meters) of the region in which the concentrations are elevated], limits for "hot spots" shall also be developed and applied. Procedures for calculating these hot spots limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit in the soil, irrespective of the average concentration in the soil.	TBC	TBC			Considered in the development of the selected remedy in the OU2 and OU5 RODs.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	RADIONUCLIDE CONCENTRATIONS, continued					
Radiation Protection of the Public and the Environment, DOE Order 5400.5 Chapter IV (4)(a)(2)(3) 10 CFR Part 834 (PROPOSED)	The generic guidelines for residual concentrations of radium-226, radium-228, thorium-230, and thorium-232 are: • 5 pCi/g, averaged over the first 15 cm of soil below the surface; and • 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface. These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If both thorium-230 and radium-226, or both thorium-232 and radium-228, are present and not in secular equilibrium, the appropriate guideline is applied as a limit for the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that either the dose for the mixture will not exceed the basic dose limit or the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1. Explicit formulas for calculating residual concentrations guidelines for mixtures are given in DOE/CH-8901.	TBC	TBC		Included as it is more restrictive than the federal standard in 40 CFR §192, .02, .12(a), .20, .21(f), .22(b), .32(b)(2), .40-.42.	Considered in the development of the selected remedy in the OU2 and OU5 RODs.
Guidelines for Residual Radioactive Material—Surface Contamination DOE Order 5400.5 Chapter IV (4)(d) 10 CFR Part 834 (PROPOSED)	These generic surface contamination guidelines are applicable to existing structures and equipment. These guidelines are generally consistent with standards of the NRC (1982) and functionally equivalent to Section 4, "Decontamination for Release for Unrestricted Use," of Regulatory Guide 1.86, but apply to nonreactor facilities. These limits apply to both interior equipment and building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in paragraph IV (6)(a) are applicable to the resulting contamination in the ground.		TBC		Will be used for any process facility building or structures built and/or used for the remedial action, including the AWWT, soil staging, etc.	The operable unit closure reports identified in Section 7.4 of the Sitewide Excavation Plan.
	LEAD CONCENTRATION					
Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, OSWER Directive # 9355.4-12 (July 14, 1994)	EPA recommends using 400 ppm soil lead as a screening level for lead in soil for residential scenarios at CERCLA sites and at RCRA Corrective Action sites. Residential areas with soil lead below 400 ppm generally require no further action. Site-specific preliminary remediation goals (PRGs) at CERCLA sites and media cleanup standards at RCRA corrective action facilities for residential land use are described.	TBC	TBC			The selected remedy in the OU2 and OU5 RODs established this value as the lead FRL.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	PCB CONCENTRATION					
Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, And Use Prohibitions, Subpart A— Applicability, Definitions 40 CFR §761.3	PCB materials which appear at concentrations less than 50 ppm are excluded from the PCB disposal requirements in this regulation.	R&A	√	R&A	Operable Unit 2 does not contain PCB materials which have a concentration greater than 50 ppm.	Following sections of the Sitewide Excavation Plan: 2.5.8 Special Materials 3.3.2.2 Special Materials F.4.1 Materials Which Require Special Handling
Subpart G— PCB Spill Cleanup Policy, Requirements for PCB Spill Cleanup 40 CFR §761.125(c)	PCBs at a concentration of greater than 50 ppm are subject to TSCA decontamination requirements in 40 CFR §761.120(b). Soil in restricted access areas contaminated by a PCB spill shall be cleaned to 25 ppm PCBs by weight [40 CFR §761.125(c)(3)(v)]. At such times as restricted access areas (other than outdoor electrical substations) are converted to another use, the spill site shall be cleaned up to the non-restricted access area requirements of 40 CFR §761.125(c)(4)(v). Soils in non-restricted access areas contaminated by a PCB spill shall be cleaned to 10 ppm PCBs by weight, provided that the soil is excavated to a minimum depth of 10 inches. The excavated soil will be replaced with clean soil (i.e., containing less than 1 ppm PCBs by weight), and the spill site will be restored (e.g., replacement of turf) [40 CFR §761.125(c)(4)(v)].		TBC	TBC	Soil containing PCBs will be excavated as necessary to attain FRLs; soil concentrations are expected to be less than 50 ppm by weight.	The OU5 ROD established FRLs for the PCBs Arochlor-1254 and Arochlor-1260 as 0.13 mg/kg (ppm by weight).
Subpart G— PCB Spill Cleanup Policy, Sampling Requirements 40 CFR §761.130	Criteria that the EPA uses to determine the adequacy of the cleanup of spills resulting from the release of regulated PCB materials at concentrations of ≥50 ppm by weight. Applies to spills which occur after May 4, 1987.			TBC	Applies to spills of regulated PCB materials (i.e., those that have a concentration ≥50 ppm by weight) that occurred after May 4, 1987.	See preceding.
	CERTIFICATION OF CLEANUP					
Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media EPA 230/02-89-042 NTIS PB89-234959 February 1989	This EPA guidance document describes methods for testing whether soil chemical concentrations at a site are statistically below a cleanup standard or ARAR. If it can be reasonably concluded that the remaining soil or treated soil at a site has concentrations that are statistically less than relevant cleanup standards then the site can be judged protective of human health and the environment.	TBC	√			Following sections of the Sitewide Excavation Plan: 2.2.2 Certifying FRL Attainment 3.4 Certification App G Certification Design [illegible]le

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	CERTIFICATION OF CLEANUP, continued					
RCRA/CERCLA Integrated Closure Director's Final Findings and Orders (June 4, 1996) Section V.4 in lieu of Closure and Post-Closure Under Interim Standards Certification of Closure OAC 3745-66-15	For the HWMUs identified in Attachment A of these Orders, the Respondent ... are hereby exempted from complying with OAC rule 3745-66-15 provided that they submit Remedial Action Reports for the HWMUs contained in operable units 1, 3, and 5 within sixty (60) days from completion of remedial activities at each operable unit, which is determined by the U.S. EPA, in accordance with CERCLA. These Remedial Action Reports shall certify that the HWMUs contained in operable units 1 and 3 have been closed, and that the environmental media in operable unit 5 has been managed, in accordance with the final remedies contained in the Records of Decision and in accordance with the Director's closure performance standards. Attachment C [of these Orders] summarizes the documents that will be provided during remediation process. These CERCLA documents contain the substantive requirements of the RCRA and Ohio hazardous waste closure regulations.		✓	✓	Pertinent to closures of HWMUs listed in preceding entries (from Table 2-1 of the Sitewide Excavation Plan, derived from the DF&O's Attachment A) during the CERCLA soil remediation activities.	Following sections of the Sitewide Excavation Plan: 3.4.6 Certification Report 7.3 Certification Report 7.4 Other Related Future Documents

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
IMPACTED MATERIAL MANAGEMENT						
	DEFINITIONS & GENERAL FACILITY STANDARDS					
Resource, Conservation, and Recovery Act 42 U.S.C. §6903 (27)	Solid waste means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities, but does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954.	Appl	✓	✓		Following sections of the Sitewide Excavation Plan: 3.0 General Implementation Approach App F Implementation of Construction
Solid Waste and Infectious Waste Regulations, Definitions OAC 3745-27-01 (B)(40)	Solid wastes means such unwanted residual solid or semisolid material as results from industrial, commercial, agricultural, and community operations, *excluding earth or material from construction, mining, or demolition operations, or other waste materials of the type that would normally be included in demolition debris, nontoxic flyash, spent nontoxic foundry sand, and slag and other substances that are not harmful or inimical to public health,* and includes, but is not limited to, garbage, tires, combustible and noncombustible material, street dirt, and debris. Solid waste does not include any material that is an infectious waste or a hazardous waste. For the purpose of this definition, "semisolid material" does not contain liquids which can be readily released under normal climatic conditions, as determined by method 9095 (paint filter liquids test) in SW-846: "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods".	Appl	✓	✓		See preceding.
Solid Waste and Infectious Waste Regulations, Definitions OAC 3745-27-01 (B)(15) OAC 3745-27-30 (A), (E), (H) ORC 3734.021 (A)(1)(c), (d)	Infectious waste is defined by nine categories of waste including human blood specimens and blood products, sharp wastes used in the treatment or inoculation of human beings, and any other waste materials generated in the diagnosis, treatment, or immunization of human beings. A generator who places all sharp infectious wastes and all unused hypodermic needles, syringes, and scalpel blades into a "SHARPS" container before they are transported and who generates less than 50 lbs. of infectious wastes each month and does not hold a certificate of registration as a generator of infectious wastes may transport and dispose of infectious wastes in the same manner as solid wastes. Treated infectious wastes can be transported and disposed in the same manner as noninfectious waste. Infectious waste that is also radioactive shall be managed in accordance with applicable Ohio Department of Health and U.S. Nuclear Regulatory Commission regulations.	Appl	✓			See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Identification and Listing of Hazardous Waste, Definition of Hazardous Waste OAC 3745-51-03(A) [Identification and Listing of Hazardous Waste, Subpart A—General, Definition of Hazardous Waste 40 CFR §261.3(a)]	A solid waste is a hazardous waste, if: (1) it is not excluded from regulation as a hazardous waste under OAC 3745-51-04(B) [40 CFR §261.4(b)]; and (2)(a) it exhibits any of the characteristics of hazardous waste identified in OAC 3745-51-20 to 3745-51-24, with certain exceptions noted therein; or (2)(b) it is listed as hazardous waste in OAC 3745-51-31 to 3745-51-33 [40 CFR §§ 261.30 - 261.35]; or (2)(c) it is a mixture of solid and hazardous wastes; (2)(d) it is a mixture of hazardous wastes as defined in OAC 3745-51-03(A)(2)(a) to 3745-51-03(A)(2)(c) [three previous bullets in this entry] and source material, special nuclear material, or by product material, as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq., or other radionuclides. However, only the hazardous components of the mixture are subject to regulation for purposes of this [OAC 3745-51] chapter.	Appl	✓	✓		See preceding.
Identification and Listing of Hazardous Waste, Exclusions OAC 3745-51-04(B)(4) [Identification and Listing of Hazardous Waste, Subpart A—General, Exclusions 40 CFR §261.4(b)(4)]	The following are not hazardous wastes: fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste generated primarily from the combustion of coal or other fossil fuels.	Appl	✓	✓		See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Identification and Listing of Hazardous Wastes, Requirements for Recyclable Materials OAC 3745-51-06(A)(3) [40 CFR §261.6]	The following recyclable materials are not subject to regulation under rules 3745-50-40 to 3745-50-62 or Chapters 3745-52 to 3745-57 and 3745-65 to 3745-69 of the Ohio Administrative Code [Parts 262 through 266 or 268, 270, or 124 of 40 CFR], and are not subject to the notification requirements of Chapter 3734 of the Ohio Revised Code [Section 3010 of RCRA]: (b) used batteries (or used battery cells) returned to a battery manufacturer for regeneration; (c) used oil that exhibits one or more of the characteristics of hazardous waste but is recycled in some other manner than being burned for energy recovery; (d) scrap metal.	√	√	Appl	Pertinent to remediation generated materials. Recycling of remediation generated materials may be conducted.	Operable Unit 3 Integrated RD/RA Work Plan
Termination of Operating Licenses for Nuclear Reactors Section C.4 Decontamination for Release for Unrestricted Use U.S. Nuclear Regulatory Commission Regulatory Guide 1.86 (June 1974)	A reasonable effort shall be made to eliminate residual surface radiological contamination and to achieve the acceptable surface contamination levels stated in this guide.	√	√	TBC	Pertinent to releasing to off-site any potentially radiologically-contaminated materials. Radiation surveys will be performed prior to releasing any potentially radiologically- contaminated materials off-site to demonstrate compliance with the surface contamination levels stated in this guide.	Operable Unit 1 Design Criteria Package
Identification and Listing of Hazardous Waste, Subpart A—General, Definition of Hazardous Waste 40 CFR §261.3	Debris means solid material exceeding a 60-mm particle size that is intended for disposal and that is a manufactured object, plant or animal matter, or natural geologic material.	√	Appl	Appl	Applicable to hazardous debris that will be disposed of off-site.	Operable Unit 1 Design Criteria Package, and following sections of the Sitewide Excavation Plan: 1.3.2.4 Remediation Debris 2.5.10 Off-Site Shipments F.5.2 Off-Site Disp

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Land Disposal Restrictions, Subpart A—General, Definitions Applicable to This Part 40 CFR §268.2	Hazardous debris means debris that contains a listed hazardous waste, or that exhibits a characteristic of hazardous waste.	√	Appl	Appl	"contains a listed hazardous waste" portion is not applicable to on-property disposal within a CAMU under the CAMU Rule as invoked under the OU5 ROD.	See preceding.
Hazardous Waste Regulations Contained-In Policy 58 FR 48092 (September 14, 1993) Proposed rule. 58 FR 59976 (November 12, 1993) Notice to extend comment. 59 FR 10778 (March 8, 1993) Clarification, partial withdrawal.	Hazardous soil means soil that contains RCRA hazardous waste(s) listed in Subpart D of 40 CFR Part 261, or that exhibits one or more of the characteristics of a hazardous waste as defined in Subpart C of 40 CFR Part 261. This proposed rule recommends contained-in determinations for hazardous debris, hazardous soil and other environmental media. Any person may petition the Regional Administrator to exclude, under 261.3(f)(2) or 261.3(g) of this chapter, hazardous debris and hazardous soil or other environmental media, including but not limited to groundwater, surface water, and sediment, from regulation as hazardous waste. The petition for a contained-in determination must include information sufficient to demonstrate that specific constituent concentrations in the hazardous debris, hazardous soil, or other environmental media to be excluded do not pose a hazard to human health and the environment at that site. (Such a petition is not necessary for remedial actions conducted pursuant to RCRA or CERCLA authorities provided that a similar determination is made by the Regional Administrator based on substantially equivalent information including public notice and comment requirements).		TBC	TBC	Will be considered for managing treated soil that is contaminated with RCRA waste.	Addressed in the selected remedy in the OU5 ROD. Following sections of the Sitewide Excavation Plan: 3.3 Remedial Action App F Implementation of Construction
Ohio Petroleum Contaminated Soil Policy OEPA Policy PP.01-03-200	The basis of the "contained in" policy is that environmental media, such as soil or groundwater, are not considered to be waste material. Because they are not a solid waste, the mixture rule, as set forth in OAC 3745-51-03, does not apply when they become contaminated with a listed hazardous waste but only contains the waste. The result of this policy is that if the waste constituents can be removed, the soil is no longer considered to contain a hazardous waste. Therefore, since soil is not a waste material it does not have to be de-listed in order for it to be used for its intended purpose. However, as long as the soil contains the waste material, it must be managed as a hazardous waste. If this concept is applied to petroleum-contaminated soil, the soil containing a petroleum hydrocarbon would not need to be managed as a solid waste if the contaminants were removed.	TBC	TBC		Allows for treated/ clean soil to be used as backfill. Thus, all soil below FRLs can be backfilled as clean soil.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Hazardous Waste Management System: General, Subpart B—Definitions 40 CFR §260.10	Remediation waste means all solid and hazardous waste, and all media (including groundwater, surface water, soils, and sediments) and debris, which contain listed hazardous wastes or which themselves exhibit a hazardous waste characteristic, that are managed for the purpose of implementing corrective action requirements under 40 CFR §264.101 and RCRA section 3008(h). For a given facility, remediation wastes may originate only from within the facility boundary, but may include waste managed in implementing RCRA sections 3004(v) or 3008(h) for releases beyond the facility boundary.	R&A	√	√	Under the Consent Agreement as amended in 1991 (a.k.a., the ACA), remediation at the FEMP is conducted under the authorities of CERCLA as well as RCRA sections 3004(v) and 3008(h).	Following secctions of the Sitewide Excavation Plan: 1.3.2.1 Soil and Sediment 1.3.2.6 Corrective Action Management Unit Rule 3.3.4.1 WAC Attainment
CERCLA Compliance with Other Laws Manual Section 2.7	Placement/disposal of waste does not occur under the following circumstances: • waste is consolidated within a unit (including an area of contamination that can be viewed as a single unit); • waste is capped in place, including grading prior to capping; • waste is treated in situ; and • waste is processed within the unit in order to improve its structural stability for closure or for movement of equipment over the area.	TBC	√	TBC	See following entry on the Corrective Action Management Unit.	See following entry.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Corrective Action Management Unit Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart S- 40 CFR §264.552 (58 FR 865829, February 16, 1993)	For the purpose of implementing remedies under Sec. 264.101 or RCRA Section 3008(h), the EPA Regional Administrator may designate an area at the facility as a corrective action management unit (CAMU). One or more CAMUs may be designated at a facility under the following conditions: 1) Emplacement of remediation wastes into or within a CAMU does not constitute land disposal of hazardous wastes. 2) Consolidation or emplacement of remediation wastes into or within a CAMU does not constitute creation of a unit subject to minimum technology requirements. 3) The CAMU shall facilitate the implementation of reliable, effective, protective, and cost-effective remedies. 4) Waste management activities associated with the CAMU shall not create unacceptable risks to humans or to the environment resulting from exposure to the wastes. 5) The CAMU shall include uncontaminated areas of the facility only if including such areas for the purpose of managing remediation waste is more protective than management of such wastes at contaminated areas of the facility. 6) Areas within the CAMU, where wastes remain in place after closure of the CAMU, shall be managed and contained so as to minimize future releases, to the extent practicable. 7) The CAMU shall expedite the timing of remedial activity implementation, when appropriate and applicable. 8) The CAMU shall enable the use, when appropriate, of treatment technologies (including innovative technologies) to enhance the long-term effectiveness of remedial actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU. 9) The CAMU shall, to the extent practicable, minimize the land area of the facility upon which wastes will remain in place after closure of the CAMU. The owner/operator shall provide sufficient information to enable the Regional Administrator to designate a CAMU in accordance with the criteria in Sec. 264.552. Note: RCRA regulated units (HWMUs) within a CAMU are fully subject to RCRA closure regulations.	R&A	Appl	R&A	Per the selected remedy in the OU5 ROD: • the FEMP site (bounded by its property boundaries) is designated as a CAMU; • consolidation or management of on-site remediation wastes into or within the CAMU does not constitute creation of a unit subject to minimum technology requirements (MTRs) [OAC 3745-68-101 and 40 CFR §265.301(a)] and does not invoke land disposal restrictions (LDRs)[OAC 3745-59 and 40 CFR§§268.40 through .44].	Section 9.1.8 of the OU5 ROD.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Generator Standards, Hazardous Waste Determination OAC 3745-52-11(A) through (F) [Standards Applicable to Generators of Hazardous Waste, Subpart A—General, Hazardous Waste Determination 40 CFR §262.11]	A person who generates a solid waste must determine if that waste is a hazardous waste using the following method: 1) First determine if the waste is excluded from regulation (not a solid waste) under OAC 3745-51-04 (40 CFR §261.4).	√	R&A	R&A		Section 3.3.2 of the Sitewide Excavation Plan.
	2) If the waste is not excluded from regulation, then determine if the waste is listed as a waste ("listed waste") in OAC 3745-51-30 to 3745-51-33 (Subpart D of 40 CFR Part 261).				Not pertinent for on-site disposal because of the CAMU rule (see preceding entry); pertinent for off-site treatment or disposal.	See preceding entry, and following sections of the Sitewide Excavation Plan: 2.5.10 Off-Site Shipments F.5.2 Off-Site Disposal
	3) For purposes of complying with OAC 3745-59 (40 CFR Part 268), or if the waste is not a "listed waste" per step 2 above, then determine if the waste is a "characteristic waste" as identified in OAC 3745-51-20 through 3745-51-24 (Subpart C of 40 CFR Part 261), by either (a) testing the waste using appropriate methods, or (b) applying knowledge of the hazardous characteristic of the waste in light of the materials or processes used ("process knowledge").				Per the RODs, pertinent only to the following areas: In OU2: approx. 300 cubic yards of lead-containing soil in the South Field Firing Range. In OU5: 1) Abandoned sump west of Pilot Plant; 2) Area between KC-2 Warehouse and RR tracks; 3) Trap Range; 4) Paddy's Run streambank fill materials west of OU4's Silos 1-4; 5) Scrap Metal Pile area; and 6) Area north of maintenance building.	Sections 7.4 (@ p. 7-5), 9.1 (@ p. 9-2), and 10.2.2 (@ p. 10-4) of the OU2 ROD; Section 9.1.1 (@ p. 9-6) and Table 9-1 of the OU5 ROD

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Interim [Status Hazardous Waste Facility] Standards —General Provisions, General Provisions OAC 3745-65-13 through -16 [Interim Status Hazardous Waste Facility Standards, Subpart B—General Facility Standards 40 CFR §§265.13 through .16]	Owners/operators of a facility must obtain chemical and physical analyses of a representative sample of each hazardous or nonhazardous waste to be treated, stored or disposed of at the facility prior to treatment, storage or disposal. At a minimum, the analysis must contain all the information which must be known to treat, store or dispose of the waste, and may include using existing published or documented data on the waste or on waste generated from similar processes ("process knowledge") [OAC 3745-65-13].	√	R&A	R&A	Pertinent to management of hazardous waste.	Following sections of the Sitewide Excavation Plan: 3.3.2 Impacted Materials ,Handling and Tracking 4.0 Location-Specific Excavation Approaches F.5 Excavated Material Management
	The facility owner/operator must prevent the unknowing entry, and minimize the possibility of unauthorized entry, to the active portion of the facility unless certain conditions apply [OAC 3745-65-14].				Controls which limit access to the FEMP will remain in place throughout remediation activities.	F.2.1 Establishing Excavation Boundaries and Access Controls
	The facility operator must maintain and inspect all monitoring equipment, safety and emergency equipment, security devices, and operating and structural equipment that are important to preventing human health hazards. The frequency of inspection may vary by item, and should be based on the rate of possible deterioration of the equipment/item and the probability of an environmental or human health incident if the deterioration, malfunction, or operator error goes undetected [OAC 3745-65-15]. The facility operator must train personnel for procedures relevant to the positions in which they are employed [OAC 3745-65-16].					F.8 Remediation Maintenance Activities
Hazardous Waste Facility Environmental Impact ORC 3734.05(D)(6)(c)	A hazardous waste facility installation and operation permit shall not be approved unless it is proven that the facility represents the minimum adverse environmental impact, considering the state of available technology, the nature and economics of various alternatives and other pertinent considerations	√	Appl	√	**NOTE:** Incorrectly cited in RODs as OAC 3745.05(D)(6)(c).	Appendix H of OU2 FS, Appendix J of OU5 FS, and Appendix J of OU3 RI/FS.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Hazardous Waste Facility Minimum Risk ORC 3734.05(D)(6)(d)	A hazardous waste facility installation and operation permit shall not be approved unless it is proven that the facility represents the minimum risk of all the following: 1) contamination of groundwater and surface water; 2) fires or explosions from treatment, storage, or disposal methods; 3) accidents during transportation; 4) impact to public health and safety; 5) air pollution; and 6) soil contamination.	√	Appl	√	NOTE: Incorrectly cited in RODs as OAC 3745.05(D)(6)(d).	OU2, OU5, and OU3 FS Reports and RODs. Also, see preceding.
Interim [Status Hazardous Waste Facility] Standards—General Provisions, Preparedness and Prevention OAC 3745-65-31 through -35, and -37 [Interim Status Hazardous Waste Facility Standards, Subpart C—Preparedness and Prevention 40 CFR §§265.31 through .35, and .37]	TSD facility operators must design, construct, maintain and operate facilities to minimize the possibility of fire, explosion or any unplanned sudden or non-sudden release of hazardous waste to air, soil, or surface water which might threaten human health or the environment.	√	R&A	R&A		See two preceding entries. For waste that is dispositioned for off-site disposal, see the Operable Unit 1 Design Criteria Package.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Interim [Status Hazardous Waste Facility] Standards—General Provisions, Contingency Plan and Emergency Procedures OAC 3745-65-51, -52, -55 and -56 [Interim Status Hazardous Waste Facility Standards, Subpart D—Contingency Plan and Emergency Procedures 40 CFR §265.51, .52, .55 and .56]	Each facility operator must have a contingency plan designed to minimize hazards to human health and the environment due to fires, explosions, or any unplanned releases of hazardous waste constituents to air, soil or surface/groundwater.	✓	R&A	R&A	Pertinent to on-site facilities that treat, store, or dispose of hazardous waste.	FEMP Emergency Plan (PL-3020); all HWMUs identified in Table 2-1 of the Sitewide Excavation Plan (and the subset identified previously in this table) are addressed in Section G: Contingency Plan of the RCRA Part B Permit Application. Also, see three preceding entries. For waste that is dispositioned for off-site disposal, see the Operable Unit 1 Design Criteria Package.
Hazardous Waste Incinerators [and Miscellaneous Units], Environmental Performance Standards OAC 3745-57-91 and -92 [Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart X—Miscellaneous Units, 40 CFR §§264.601 through .603]	Prevention of any release that may have adverse effects on human health or the environment includes, but is not limited to: A. Migration of waste constituents in the groundwater or subsurface environment. B. Migration of waste constituents in surface water, or wetlands or on the soil surface. C. Migration of waste constituents in the air. Monitoring, tests, analytical data, inspections, response, and reporting procedures and frequencies must ensure compliance with pertinent portions of the OAC.	✓	R&A	✓	Pertinent to on-site facilities that treat, store, or dispose of hazardous waste in miscellaneous units unless the CAMU Rule is applied.	See preceding.

TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Radioactive Waste Management DOE Order 5820.2A Chapter III (3)(d)	Low-level waste shall be characterized with sufficient accuracy to permit proper segregation, treatment, storage, and disposal. This characterization shall ensure that, upon generation after processing, the actual physical and chemical characteristics and major radionuclide content are recorded and known during all stages of the waste management process. Waste characterization data shall be recorded on a waste manifest and shall include: • the physical and chemical characteristics of the waste; • volume of the waste (total of waste and any solidification or absorbent media); • weight of the waste (total of waste and any solidification or absorbent media); • major radionuclides and their concentrations; and • packaging date, package weight, and external volume.	TBC	√	TBC	The CERCLA RI/FS process established the nature and extent of contamination at the FEMP. During excavation, monitoring will be performed in accordance with of the Sitewide Excavation Plan and individual IRDPs, and results will be documented in order to determine if impacted material meets the OSDF WACs or offsite WACs. These sources of characterization information (RI/FS sampling, pre-design investigations, FRL attainment, WAC attainment) will provide the required manifest information.	Addressed throughout the CERCLA RI/FS and selection of remedy process, culminated in the OU2, OU5 and OU3 RODs; OSDF Impacted Materials Placement Plan; following section of the Sitewide Excavation Plan: 3.3.2 Impacted Materials Handling and Tracking

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Waste Treatment DOE Order 5820.2A Chapter III (3)(f)	Waste treatment techniques such as incineration, shredding, and compaction to reduce volume and provide more stable waste forms shall be implemented as necessary to meet performance requirements. Use of waste treatment techniques to increase the life of the disposal facility and improve the long-term facility performance, by improved site stability and reduction of infiltrating water, is required to the extent it is cost effective. The development of large scale waste treatment facilities shall be supported by the appropriate National Environmental Policy Act documentation. Operation of waste treatment facilities shall be supported by adequate documentation.	TBC	TBC	TBC	Based upon CERCLA RI/FS data, the majority of the impacted material from OU2, OU5 & OU3 will meet the OSDF WACs and thus the performance objectives of the OSDF & DOE Order 5820.2A without treatment. This has been demonstrated through the modeling performed in the FSs to establish the OSDF WACs. Two categories of impacted materials may need to be treated before disposal. Characteristically hazardous materials from seven areas will be quantified & treated to the extent necessary to remove the characteristic(s) that cause them to be regulated as hazardous. Physical sizing & treatment as per the OSDF Impacted Material Placement Plan will be conducted as needed on debris for proper waste placement and stability within the OSDF. Some physical treatment may also be necessary for the sludge from the OU2 Lime Sludge Ponds to decrease the moisture content before placement into the OSDF.	Addressed throughout the CERCLA RI/FS and selection of remedy process, culminated in the OU2, OU5 and OU3 RODs; OSDF Impacted Materials Placement Plan; following sections of the Sitewide Excavation Plan: 1.3.2.7 RCRA Characteristic Waste Disposal 2.1.1.3 Characteristically Hazardous Waste 3.3.2 Impacted Materials Handling and Tracking F.5 Excavated Material Management

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Radioactive Waste Management DOE Order 5820.2A Chapter III (3)(g)	The volume of waste and number of shipments of low-level wastes shall be minimized and the shipments will be conducted based on plans developed by field organizations. Generators shall provide an annual forecast in the third quarter of the fiscal year to the field organizations managing the off-site disposal facility to which the waste is to be shipped. Generators must receive advance approval from the receiving facility and shall certify prior to shipment that waste meets the receiving facility waste acceptance criteria. The certification program shall be auditable and able to withstand independent review.	TBC	TBC	TBC	The volume of impacted material to be disposed onsite in the OSDF will be minimized through a number of programs. First, extensive sampling has been performed during the CERCLA RI/FS process and the extent of excavation has been established using this data. Combined with the sampling/monitoring that will be performed during excavation in accordance with Section 3.3 of the Sitewide Excavation Plan and individual IRDPs, this will confirm that only impacted materials are excavated and sent to disposal. Compliance with the FEMP Pollution Prevention and Waste Minimization Awareness Plan will minimize the amount of low-level waste (i.e., equipment and personal protective equipment) generated during remediation.	FEMP Pollution Prevention and Waste Minimization Awareness Plan; also see preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DEFINITIONS & GENERAL FACILITY STANDARDS, continued					
Control of Residual Radioactive Material DOE Order 5400.5 Chapter IV (6)(b) 10 CFR Part 834 (PROPOSED)	Interim storage must provide: 1) Control and stabilization features shall be designed to provide, to the extent reasonably achievable, an effective life of 50 years with a minimum life of at least 25 years. 2) Controls shall be designed such that radon-222 concentrations in the atmosphere above facility surfaces or openings in addition to background levels, will not exceed: (a) 100 pCi/L at any given point; (b) An annual average concentration of 30 pCi/L over the facility site; and (c) An annual average concentration of 3 pCi/L at or above any location outside the facility site. (d) Flux rates from the storage of radon producing wastes shall not exceed 20 pCi/m^2/sec, as required by 40 CFR Part 61.	✓	TBC		The selected remedies are for a permanent remedy, not for interim storage; any short-term management of impacted material to be employed is to facilitate the permanent remedy.	Addressed through the approved selected remedy in the OU2 and OU5 RODs, associated remedial design documents (i.e., IRDPs).
	3) Controls shall be designed such that concentrations of radionuclides in the groundwater and quantities of residual radioactive material will not exceed applicable federal or state standards.					Section 5.0 of the Sitewide Excavation Plan, for environmental controls to be implemented during remediation.
	4) Access to a property and use of on-site material contaminated by residual radioactive material should be controlled through appropriate administrative and physical controls such as those described in 40 CFR Part 192. These control features should be designed to provide, to the extent reasonable, an effective life of at least 25 years.					Section 3.0 and Appendix F of the Sitewide Excavation Plan and IRDPs, for access controls to be implemented during remediation.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF LOW-LEVEL RADIOACTIVE MATERIAL					
Low-level Radioactive Waste Generation DOE Order 5820.2A Chapter III (3)(c)	Technical and administrative controls shall be directed to reducing the gross volume of waste generated and/or the amount of radioactivity requiring disposal. Waste reduction efforts shall include consideration of process modification, process optimization, materials substitution, and decontamination. All DOE low-level waste generators shall establish auditable programs to assure that the amount of low-level waste generated and/or shipped for disposal is minimized. Each DOE low-level waste generator shall separate uncontaminated waste from low-level waste to facilitate cost-effective treatment and disposal. Each DOE low-level waste generator preparing a design for a new process or process change shall incorporate principles into the design that will minimize the generation of low-level waste.	TBC	TBC	TBC	Implementation of the FEMP Pollution Prevention and Waste Minimization Awareness Plan will confirm that all newly generated waste is minimized during remediation. Additionally, excavation controls such as rapid test methodology and additional laboratory sampling will be implemented to confirm that only impacted material with contamination that is potentially above the FRLs is being excavated and sent to disposal. Physical sampling of the impacted materials and/or rapid test method methodology will also confirm that only material that exceeds the OSDF WAC is sent offsite for disposal.	Addressed throughout the CERCLA RI/FS and selection of remedy process, culminated in the OU2, OU5 and OU3 RODs; also, FEMP Pollution Prevention and Waste Minimization Awareness Plan.
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE					
Identification and Listing of Hazardous Waste, Residues of Hazardous Waste in Empty Containers OAC 3745-51-07(A) &(B) [Identification and Listing of Hazardous Waste, Subpart A—General, Residues of Hazardous Waste in Empty Containers 40 CFR §261.7]	Any hazardous waste remaining in either an empty container or an inner liner removed from an empty container is not subject to regulation under 40 CFR Parts 261 through 265 (RCRA requirements). A container is empty if: 1) All wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container (e.g., pouring, pumping, and aspirating); and 2) No more than 2.5 cm (1 inch) of residue remains on bottom of the container or inner liner; or 3) No more than 3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 110 gal. in size, or no more than 0.3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 110 gal. in size.	√	R&A	Appl	Pertinent when containerizing: soil contaminated by RCRA waste; any treatment residues exhibiting RCRA characteristics including advanced wastewater treatment (AWWT) sludges and soil decontamination residues.	Following sections of the Sitewide Excavation Plan: 2.5.8 Special Materials 3.3.2.2 Special Materials App F Implementation of Construction

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued					
Closure and Post-Closure Under Interim Standards, Condition of Containers OAC 3745-66-71 Compatibility of Containers OAC 3745-66-72 Management of Containers OAC 3745-66-73 Inspections OAC 3745-66-74 Special Requirements for Ignitable or Reactive Waste OAC 3745-66-76 Special Requirements for Incompatible Wastes OAC 3745-66-77 [Interim Status Standards, Subpart I—Use & Management of Containers, 40 CFR §§265.171 through .174, .176 and .177]	If a container holding hazardous waste is not in good condition (e.g., severe rusting, apparent structural defects) or begins to leak, the owner or operator must transfer the hazardous waste from this container to a container that is in good condition or manage the waste in some other way that complies with this requirement.	√	R&A	Appl	Pertinent to handling containers holding environmental media contaminated with RCRA waste.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued					
[New Facilities] Corrective Action, Closure and Post-Closure Requirements Containment OAC 3745-55-75 [Interim Status Hazardous Waste Facility Standards, Subpart I—Use & Management of Containers 40 CFR §§265.175(a) through (c)]	A containment system for RCRA container storage areas must be designed and operated to provide: 1) A sufficiently impervious base, which is sloped to collect any leaking liquids. 2) Sufficient capacity to contain liquids. 3) Prevention of run-on into the containment system. 4) A sump to prevent overflow of the collection system. Storage areas for containers holding only wastes that do not contain free liquids need not have a containment system, provided that: 1) The storage area is sloped or is otherwise designed and operated to drain and remove liquid resulting from precipitation, or 2) The containers are elevated or are otherwise protected from contact with accumulated liquid.	√	R&A	Appl	Pertinent to handling soil contaminated with RCRA listed or characteristic hazardous waste. A Part B Permit Application for RCRA storage has been submitted to the OEPA.	See preceding.
[New Facilities] Surface Impoundments, Waste Piles, and Tanks [Waste Piles] Design and Operating Requirements OAC 3745-56-51(A) through (F)	A waste pile used to store or treat hazardous waste must have: 1) A liner that is designed, constructed, and installed to prevent any migration of waste out of the pile into the adjacent subsurface soil or groundwater or surface water at any time during the active life (including the closure period) of the waste pile, and 2) A leachate collection and removal system immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the pile.	√	R&A	√	Pertinent to on-site hazardous waste piles used for longer than 90 days unless the CAMU Rule is applied.	Addressed through remedial design documents (IRDPs).
	The owner/operator must design, construct, operate, and maintain a run-on control system capable of preventing flow onto the active portion of the pile during peak discharge from at least a 25-yr storm and manage a runoff management system to collect and control at least the water volume resulting from a 24-hr, 25-yr storm.	√	R&A	√		
	If the pile contains any particulate matter which may be subject to wind dispersal, the owner or operator must cover or otherwise manage the pile to control wind dispersal.	√	R&A	√		FEMP Fugitive Dust Control BAT Determination, Fugitive Dust Control Requirements (RM-0047), and Section 5.1.2.2 and Appendix F of the Sitewide Excavation Plan

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued					
Monitoring and Inspection OAC 3745-56-54(A) and (B)	During construction or installation, liners and cover systems must be inspected for uniformity, damage, and imperfections.	√	R&A	√		
	Collection and holding facilities associated with run-on and runoff control system must be inspected weekly and be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system.	√	R&A	√		FEMP Stormwater Pollution Prevention Plan (RM-0039), and Appendix F of the Sitewide Excavation Plan
Special Requirements for Ignitable or Reactive Waste OAC 3745-56-56(A) and (B) Special Requirements for Incompatible Wastes OAC 3745-56-57(A), (B) and (C) [Subpart L—Waste Piles, 40 CFR §§264.251 through .259]	Ignitable, reactive, or incompatible waste must not be added to a waste pile, unless specified in OAC 3745-56-56(A) and (B) or 57(A), (B) and (C).	√	R&A	√	The CERCLA RIs did not find evidence of ignitive or reactive material on-site. Impacted and non-impacted materials management will be segregated and managed in separate piles, based upon intended disposition (waste acceptance criteria).	Following sections of the Sitewide Excavation Plan: 3.3.2 Impacted Materials Handling and Tracking 4.0 Location-Specific Excavation Approaches F.5 Excavated Material Management
Temporary Units Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart S- 40 CFR §264.553 (a), (b) (58 FR 865829, February 16, 1993)	For temporary tanks and container storage areas used for treatment or storage of remediation wastes during remedial activities, the Regional Administrator may determine that a design, operating, or closure standard applicable to such units may be replaced by alternative requirements which are protective of human health and the environment. Any temporary unit to which alternative requirements are applied shall be: • located within the facility boundary; and • used solely for treatment or storage of remediation wastes.	R&A	√	R&A	Pertinent to short-term management/storage of impacted materials during the CERCLA soil remediation activities.	Appendix F of the Sitewide Excavation Plan

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued					
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart DD—Containment Building 40 CFR §§264.1100 through .1102 57 FR 37194 (August 18, 1992)	The owner or operator is not subject to the definition of land disposal in RCRA Section 3004(k) provided that the unit: 1) Is a completely enclosed, self-supporting structure that is designed and constructed of synthetic materials of sufficient strength and thickness to support themselves, the waste contents, and any personnel and heavy equipment that operate within the unit, and to prevent failure due to pressure gradients, settlement, compression, or uplift, physical contact with the hazardous wastes to which they are exposed, climatic conditions, and the stresses of daily operation, including the movement of heavy equipment within the unit and contact of such equipment with containment walls; 2) Has a primary barrier for management of solids, in addition to a liquid collection system and secondary containment for management of liquids. 3) Has controls sufficient to prevent fugitive dust emissions to meet the no visible emission standard in Sec. 264.1101(c)(1)(iv); and 4) Is designed and operated to ensure containment and prevent the tracking of materials from the unit by personnel or equipment. At closure, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components, contaminated subsoil, and structures and equipment contaminated with waste and leachate, and handle them as a hazardous waste.	✓	R&A	R&A	Pertinent to excavated RCRA hazardous soil and sediment that may require short-term management/ storage during the CERCLA soil remediation activities. NO CONTAINMENT BUILDINGS ARE ANTICIPATED.	Following sections of the Sitewide Excavation Plan: 3.3.2 Impacted Materials Handling and Tracking 4.0 Location-Specific Excavation Approaches F.5 Excavated Material Management

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued					
Procedures for Planning and Implementing Offsite Response Actions ("The CERCLA Offsite Rule") 40 CFR §300.400	Materials from remediation of a CERCLA site ("CERCLA waste") may only be transferred to offsite facilities that are in compliance with Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), or other applicable federal and state requirements. Only U.S. EPA has the authority to determine whether the facility in question meets the acceptability criteria and is acceptable for receiving CERCLA waste from offsite. A determination of acceptability for a potential receiving facility is to be made in advance (prior to initiating transportation offsite, and optimally prior to making offsite treatment/ storage/disposal contract arrangements). Materials covered under this rule ("CERCLA waste") are any hazardous substance, pollutant, or contaminant as defined under CERCLA sections 101(14) and 101(33). Samples of waste sent to a laboratory for characterization are exempt from the rule, as are certain treatability study waste. The receiving facility must meet compliance and release criteria presented therein. Facility is defined as the receiving unit(s) that directly stores, treats, or disposes of the CERCLA waste. Non-receiving units at the facility need not be in compliance in order for the U.S. EPA to determine that the receiving unit meets acceptance criteria. U.S. EPA may deem a facility acceptable even if certain minor violations have occurred at the facility. If a facility does not meet the criteria for receiving CERCLA wastes, the rule presents notification, determination, appeal/review and reinstatement procedures.	✓	✓	Appl	Pertinent to preparation of materials for off-site disposition.	Operable Unit I Design Criteria Package, and following sections of the Sitewide Excavation Plan: 2.5.10 , Off-Site Shipments F.5.2 Off-Site Disposal
[Hazardous Waste] Generator Standards OAC 3745-52-20 through -23, and -30 through -33 [40 CFR §§262.20 through .23, and .30 through .33]	Before transporting hazardous waste or offering hazardous waste for transportation off-site ("pre-transport"), for either treatment or disposal, general requirements for the generator, require a manifest [OAC 3745-52-20 through -23], in accordance with the requirements specified therein. Pre-transport requirements also include appropriate packaging [OAC 3745-52-30], labeling [OAC 3745-52-31], marking [OAC 3745-52-32], and placarding [OAC 3745-52-33], in accordance with the requirements specified therein.	✓	Appl	Appl	Pertinent to preparation of RCRA hazardous waste for off-site treatment and/or disposal.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued					
Implementation of the United Nations Recommendations, International Maritime Dangerous Goods Code, and the International Civil Aviation Organization's Technical Instructions 59 FR 67390 (December 29, 1994) as amended by 60 FR 26796 (May 18, 1995)	These rules (final rule was effective October 1, 1995) comprehensively revise the Hazardous Materials Regulations (HMR), 49 CFR Parts 171-173, 177, and 178, with respect to hazard communication, classification, and packaging requirements based on United Nations recommendations.	√	√	Appl	These Hazardous Materials Regulations are requirements embedded in both the state (OAC) and federal (CFR) regulations in both the generator standards (preceding entry) and the transporter standards (subsequent entry).	See preceding generator standards entry and subsequent transporter standards entry.
[Hazardous Waste] Land Disposal Restrictions OAC 3745-59 [Land Disposal Restrictions, Subpart D—Treatment Standards 40 CFR §§268.40 through .44]	A restricted hazardous waste may be land disposed only if: 1) An extract of the waste or of the treatment residue of the waste does not exceed the value shown in 40 CFR §268.41. 2) It is treated using a technology specified in 40 CFR §268.42(a) or an equivalent treatment method. 3) The constituent concentrations in the waste or treatment residue of the waste do not exceed the value shown in 40 CFR §268.43.	√	Appl	Appl	Not applicable to on-property disposal within a CAMU under the CAMU Rule as invoked under the OU5 ROD. Applicable to those RCRA hazardous wastes that will be disposed of off-site.	See three preceding entries.
Land Disposal Restrictions, Subpart D—Treatment Standards, Treatment Standards Expressed as Concentrations in Waste Extract 40 CFR §268.41	The maximum concentration of lead (5.0 mg/L) may not be exceeded whether it is the extract of a waste or waste treatment residual.	R&A	Appl		Not applicable to on-property disposal within a CAMU under the CAMU Rule as invoked under the OU5 ROD. Applicable to those RCRA hazardous wastes that will be disposed of off-site.	See four preceding entries.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
MANAGEMENT OF HAZARDOUS REMEDIATION WASTE, continued						
Land Disposal Restrictions, Subpart D—Treatment Standards, Contaminated Debris 40 CFR §268.45	Hazardous debris must be treated before land disposal unless the EPA determines that the debris is no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standard for the waste contaminating the debris. Provided the debris does not exhibit a RCRA characteristic it is not subject to regulation under 40 CFR 260, 261 to 266, 268, or 270 if: 1) The hazardous debris has been treated using one of the required extraction or destruction technologies specified in 40 CFR §268.45; or 2) The debris, considering the extent of contamination, is determined to no longer be contaminated with hazardous waste.	√	Appl	Appl	Not applicable to on-property disposal within a CAMU under the CAMU Rule as invoked under the OU5 ROD. Applicable to those RCRA hazardous wastes that will be disposed of off-site.	See five preceding entries.
[Hazardous Waste] Transporter Standards OAC 3745-53-20 through -22, -30 and -31 [40 CFR §§263.20 through .22, .30 and .31]	General requirements for the transporter during transportation of hazardous waste for off-site treatment and/or disposal require acceptance and handling of hazardous waste and use of the manifest system [OAC 3745-53-20], compliance with the manifest [OAC 3745-53-21], and recordkeeping [OAC 3745-53-22], in accordance with the requirements specified therein. Appropriate response actions must be taken for any hazardous waste discharge during transportation [OAC 3745-53-30 and -31], in accordance with the requirements specified therein.	√	Appl	Appl	Pertinent to transportation of RCRA hazardous wastes for off-site treatment and/or disposal.	See six preceding entries.
MANAGEMENT OF PCB-TAINTED MATERIAL						
Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, And Use Prohibitions, Subpart D—Storage and Disposal, Disposal Requirements 40 CFR §761.60(a)(4)	Any nonliquid PCBs at concentrations 50 ppm or greater in the form of contaminated soil, rags, or other debris shall be disposed of in an incinerator which complies with 40 CFR §761.70, or in a chemical waste landfill which complies with 40 CFR §761.75.		Appl	Appl	Pertinent if soil or other material containing PCBs above 50 ppm is excavated. PCBs were detected in soil beneath the Fire Training Facility.	Following sections of the Sitewide Excavation Plan: 3.3.2 Impacted Materials Handling and Tracking 4.0 Location-Specific Excavation Approaches F.5 Excavated Material Management

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MANAGEMENT OF PCB-TAINTED MATERIAL, continued					
Subpart D—[PCB] Storage and Disposal, Disposal Requirements 40 CFR §761.60(e)	Any person who is required to incinerate PCBs or PCB items under this subpart and who can demonstrate that an alternate method of destroying PCBs or PCB items can achieve a level of performance equivalent to the requirements under 40 CFR §761.70 may submit a written request to either the Regional Administrator or the Director, Exposure Evaluation Division, for an exemption from the incineration requirements of 40 CFR §§ 761.70 or 761.60. The applicant must show that the alternate method of destroying PCBs will not present an unreasonable risk of injury to health or the environment.		Appl	Appl	Pertinent only if PCB contaminated soil is greater than 50 ppm and is treated on-property using a method besides incineration. DOE neither currently anticipates any such material nor on-property treatment for any such material under the soil remediation projects.	See preceding entry, plus following sections of the Sitewide Excavation Plan: 2.5.10 Off-Site Shipments F.5.2 Off-Site Disposal
Subpart D—[PCB] Storage and Disposal, Storage for Disposal 40 CFR §761.65	This section applies to the design of storage areas to be used for later disposal of PCBs at concentrations of 50 ppm or greater.		Appl	Appl	Pertinent to storage of PCB-contaminated material at 50 ppm or greater. DOE does not currently anticipate any such material under the soil remediation projects.	See two preceding entries.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
POST-CLOSURE						
	DESCRIPTION OF POST-CLOSURE CARE					
[New Facilities Hazardous Waste] Surface Impoundments, Waste Piles, and Tanks, [Waste Piles] Post-Closure OAC 3745-56-58(B) [Subpart L—Waste Piles, 40 CFR §§264.251 through .259]	If, after removing or decontaminating all residues and making all reasonable effort to effect removal or decontamination of contaminated components, subsoil, structures and equipment, the owner/operator finds that not all contaminated subsoil can be practically removed or decontaminated, he must close the unit/facility and perform post-closure care in accordance with OAC 3745-57-10. **NOTE:** If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	R&A		Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	Currently addressed in the OSDF Post-closure Care and Inspection Plan (20100-PL-010, which notes in its Prologue that it can be revised at a later date to expand the scope of coverage to encompass the entire FEMP site as needed. Will also be addressed in the Certification Report and Remedial Action Report — see following sections of the Sitewide Excavation Plan: 1.4.2 Related Documents 3.4.6 Certification Report 7.3 Certification Report 7.4 Other Related Future Documents
[New Facilities Hazardous Waste] Incinerators [and Miscellaneous Units], [Miscellaneous Units] Environmental Performance Standards OAC 3745-57-93 [Subpart X—Miscellaneous Units, 40 CFR §§264.601 through .603]	If a treatment or storage miscellaneous unit has contaminated soil or groundwater that cannot be completely removed or decontaminated during closure, the unit must also meet the requirements of OAC 3745-57-91 during the post-closure care period. The post-closure plan under OAC 3745-55-18 must specify the procedures that will be used to satisfy this requirement. A miscellaneous unit that is a disposal unit must be maintained in a manner that complies with OAC 3745-57-91 during the post-closure care period. **NOTE:** If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	R&A		Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	DESCRIPTION OF POST-CLOSURE CARE, continued					
Closure and Post-Closure Under Interim Standards, Post-closure Care and Use of Property OAC 3745-66-17(A) [40 CFR §265.117(a)(2)]	Post-closure care of hazardous waste management units must begin after completion of closure of the unit and continue for 30 years after that date unless shortened by the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection] in accordance with OAC 3745-66-18(G) (40 CFR §117(a)(2)). NOTE: If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	Appl		NOTE: Identified in the OU5 ROD as applicable only to existing hazardous waste management units (HWMUs); also cited in RCRA/CERCLA Integrated Closure DF&O @ V.1. Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	See preceding.
Closure and Post-Closure Under Interim Standards, Post-closure Care and Use of Property OAC 3745-66-17(A)(1) [40 CFR §265.117(a)(1)]	Post-closure care...must consist of at least the following: • monitoring and reporting; and • maintenance and monitoring of waste containment systems. NOTE: If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	✓	✓	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1. Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	See preceding.
Closure and Post-Closure Under Interim Standards, Post-closure Plan; Amendment of Plan OAC 3745-66-18(A)&(C)	The owner of a hazardous waste disposal unit shall have a written post-closure plan, which shall identify the activities that will be carried on after closure of each unit and the frequency of those activities, and include at least: • a description of the planned monitoring activities and frequencies at which they will be performed; • a description of the planned maintenance activities and frequencies at which they will be performed, to ensure (a) the integrity of the cap and final cover or other containment systems, and (b) the functioning of the monitoring equipment; and • the name, address and telephone number of the person or office to contact about the hazardous waste disposal unit or facility during the post-closure period. NOTE: If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	✓	✓	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1. Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	MODIFICATIONS TO POST-CLOSURE CARE PLAN OR PERIOD					
Closure and Post-Closure Under Interim Standards, Post-closure Plan; Amendment of Plan OAC 3745-66-18(D)	The owner may amend the post-closure plan any time during the active life of the facility or during the post-closure period. **NOTE:** If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	✓	✓	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1. Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	Currently addressed in the OSDF Post-closure Care and Inspection Plan (20100-PL-010), which notes in its Prologue that it can be revised at a later date to expand the scope of coverage to encompass the entire FEMP site as needed.
Closure and Post-Closure Under Interim Standards, Post-closure Plan; Amendment of Plan OAC 3745-66-18(G)	The post-closure plan and length of the post-closure period may be modified any time prior to the end of the post-closure care period. A modification of the post-closure plan may include, where appropriate, the temporary suspension rather than permanent deletion of one or more post-closure care requirements. At the end of the specified period of suspension, the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection] would then determine whether the requirements should be permanently discontinued or reinstated to prevent threats to human health and the environment. **NOTE:** If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	✓	✓	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1. Only pertinent to those units where risk-based FRLs are not met. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	See preceding.
	PROPERTY USE RESTRICTIONS					
Closure and Post-Closure Under Interim Standards, Post-closure Care and Use of Property OAC 3745-66-17® [40 CFR §265.117(c)]	Post-closure use of property on or in which hazardous waste remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other component of the containment system, or the function of the facility's monitoring systems, unless the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection] approves otherwise. **NOTE:** If clean (or risk-based) closure is performed, then post-closure care is not required.	✓	Appl	✓	**NOTE:** Identified in the OU5 ROD as applicable only to existing hazardous waste management units (HWMUs); also cited in RCRA/CERCLA Integrated Closure DF&O @ V.1. DOE intends, and anticipates being able, to clean (risk-based) close all identified HWMUs.	Currently addressed in the OSDF Post-closure Care and Inspection Plan (20100-PL-010, which notes in its Prologue that it can be revised at a later date to expand the scope of coverage to encompass the entire FEMP site as needed.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings Subpart A— 40 CFR §192.02(a)	Controls of residual radioactive materials from inactive uranium processing sites shall be designed to be effective for up to 1,000 years, to the extent reasonably achievable, and in any case, for at least 200 years, and provide protection of groundwater.	R&A	R&A		Most pertinent to the design and closure of the On-Site Disposal Facility.	Addressed by selected remedies of OU2 and OU5 RODs in establishment of FRLs.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	PROPERTY USE RESTRICTIONS, continued					
Long-Term Management of Residual Radioactive Material DOE Order 5400.5 Chapter IV (6)(d) 10 CFR Part 834 (PROPOSED)	Controls of residual radioactive materials from inactive uranium processing sites shall be designed to be effective for up to 1,000 years, to the extent reasonably achievable, and in any case, for at least 200 years, and provide protection of groundwater.		TBC			Addressed by selected remedies of OU2 and OU5 RODs in establishment of FRLs.
	For long-term management of uranium, thorium, and their decay products, access to a property and use of on-site materials contaminated by residual radioactive material should be controlled through appropriate administrative and physical controls such as those described in 40 CFR 192. These controls should be designed to be effective to the extent reasonable for at least 200 years.	TBC	TBC			
Control of Residual Radioactive Material Above the Guidelines DOE Order 5400.5 Chapter IV (6)	Residual radioactive material with concentrations above the generic guidelines (see chemical-specific requirements) shall be managed in accordance with Chapter II, Requirements for Radiation Protection of the Public and the Environment, and operational and control requirements.	TBC	√			See preceding.
Supplemental Limits and Exceptions for Residual Radioactive Material DOE Order 5400.5 Chapter IV (7)	If special specific property circumstances indicate that the concentration guidelines or authorized limits are not appropriate, supplemental limits or an exception may be requested to those guidelines or limits.	TBC	√			See preceding.
Release of Property DOE Order 5400.5 Chapter II (5)	Real property (land and structures), personal property, materials, and equipment shall be released if the concentration of radioactivity is within the limits of residual radioactive contamination.	TBC	√			See preceding.

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TABLE A-2 (Continued)
PERTINENT ARARs AND TBCs FOR REMEDIATION AREA 2 PHASE I

Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	Remarks	Cross-Reference
	POST-CLOSURE NOTICE/SURVEY PLAT					
Closure and Post-Closure Under Interim Standards, Survey Plat OAC 3745-66-16	The owner shall submit -- to the local zoning authority, or the authority with jurisdiction over local land use, and to the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection] -- a survey plat, prepared and certified by a professional land surveyor, indicating the location and dimensions of landfill cells or other hazardous waste disposal units with respect to permanently surveyed benchmarks. The plat must contain a note, prominently displayed, which states the owner's obligation to restrict disturbance of the hazardous waste disposal unit in accordance with OAC 3745-66-17(C).	√	√	√	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1.	Currently addressed in the OSDF Post-closure Care and Inspection Plan (20100-PL-010), which notes in its Prologue that it can be revised at a later date to expand the scope of coverage to encompass the entire FEMP site as needed.
Closure and Post-Closure Under Interim Standards, Post-closure Notices OAC 3745-66-19(A)	The owner shall submit -- to the local zoning authority, or the authority with jurisdiction over local land use, and to the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection] -- a record of the type, location, and quantity of hazardous waste disposed of within each cell or disposal unit of the facility.	√	√	√	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1.	See preceding.
	DEED NOTATION					
Closure and Post-Closure Under Interim Standards, Post-closure Notices OAC 3745-66-19(B)	The owner shall record, in accordance with state law, a notation on the deed of the facility property, or on some other instrument which is normally examined during title search, that will notify in perpetuity the potential purchasers of the property that: • the land has been used to manage hazardous wastes; • its use is restricted under the Ohio Administrative Code closure and post-closure rules; and • a survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each cell or hazardous waste unit of the facility as required by OAC 3745-66-16 and OAC 3745-66-19(A) have been filed with the local zoning authority or the authority with jurisdiction over local land use and the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection].	√	√	√	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1.	Currently addressed in the OSDF Post-closure Care and Inspection Plan (20100-PL-010), which notes in its Prologue that it can be revised at a later date to expand the scope of coverage to encompass the entire FEMP site as needed. Will also be addressed in the NRRP.
Closure and Post-Closure Under Interim Standards, Post-closure Notices OAC 3745-66-19®	If the owner or any subsequent owner of the land upon which a hazardous waste disposal unit was located wishes to remove hazardous wastes and hazardous waste residues in satisfaction of the criteria in OAC 3745-66-17(C), the owner may request that the Director [of the OEPA, a.k.a. the Ohio Director of Environmental Protection] approve either: • the removal of the notation on the deed to the facility property or other instrument normally examined during title search; or • the addition of a notation to the deed or instrument indicating the removal of the hazardous waste.	√	√	√	Cited in the RCRA/CERCLA Integrated Closure DF&O @ V.1.	See preceding.

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B

Surface Water Management Plan for Area 2, Phase I Southern Waste Units Remedial Action Project Subcontract No. FSC607

October 1997
Revision 2

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FDF Project No. 20400

PARSONS

25 Merchant Street
Cincinnati, Ohio 45246

Surface Water Management Plan
for
Area 2, Phase I
Southern Waste Units
Remedial Action Project

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APPENDICES

A Calculations

B Drainage Area Maps

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D Additional Sketches of Paddys Run Area

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LIST OF ACRONYMS AND ABBREVIATIONS

A2P1	Area 2, Phase 1
AFP	Active Flyash Pile
AWWT	Advanced Wastewater Treatment (Facility)
cfs	cubic feet per second
DOE	United States Department of Energy
FEMP	Fernald Environmental Management Project
FDF	Fluor Daniel Fernald, Inc.
FRL	Final Remediation Level
GMA	Great Miami Aquifer
gpm	gallons per minute
HDPE	High Density Polyethylene
IFP	Inactive Flyash Pile
NPDES	National Pollutant Discharge Elimination System
ODNR	Ohio Department of Natural Resources
OSDF	On-Site Disposal Facility
SF	South Field
SWMP	Surface Water Management Plan
SWPPP	Stormwater Pollution Prevention Plan
SWRB	Stormwater Retention Basin
SWUs	Southern Waste Units
WAC	Waste Acceptance Criteria
WURP	Waste Units Remediation Project

EXECUTIVE SUMMARY

This Surface Water Management Plan (SWMP) addresses surface water management of the Southern Waste Units (SWUs) during remediation. This SWMP addresses erosion and sedimentation, stormwater runoff, and other surface water issues at the SWUs.

The SWUs consist of the South Field (SF), the Inactive Flyash Pile (IFP), and the Active Flyash Pile (AFP) areas. The remediation of the SWUs involve the removal of approximately 340,000 bank cubic yards of impacted material consisting of soil, debris (fill), and flyash. The SWUs remediation project will be performed in two phases- 1) Site Preparation, and 2) Excavation. The site preparation phase of the SWUs Project is scheduled to begin in the summer of 1997. The excavation phase of the SWUs Project is scheduled to begin in Spring, 1998. The excavation phase is scheduled to require three construction seasons.

Three retention basins (Nos. 1, 2, and 3) will be constructed in the SWUs area to manage surface water during remediation. The retention basins will be lined with one foot of compacted clay overlain by a geomembrane liner. The non-impacted soil stockpiles and selected collection ditches will be lined with a geomembrane liner. Both sediment and stormwater storage capacity will be provided in the retention basins. A minimum of 27 cubic yards/watershed acre of storage capacity in each basin will be provided for sediment storage. Stormwater storage capacity has been provided above the sediment storage capacity level to store the runoff from a 25-year, 24-hour storm for basins 1 and 2 and to store the runoff from a 10-year, 24-hour storm for basin 3. Stormwater collected in the basins will discharge through riser pipes and gravity flow to lift stations located adjacent to each of the retention basins. From the lift stations, collected runoff will be pumped through a common double-walled pipe to the Stormwater Retention Basin (SWRB), and subsequently conveyed to the Advanced Wastewater Treatment (AWWT) facility for treatment prior to discharge to the Great Miami River.

The overall operation of the surface water management system was planned and designed to minimize the generation of contaminated runoff and to collect potentially contaminated surface water prior to discharge. Run-on control ditches will be constructed prior to remediation to prevent water from upgradient areas from flowing across the construction area. These run-on control ditches will remain after remediation to prevent potential recontamination. Runoff from disturbed areas will drain to collection ditches which will route the runoff to the retention basins. These basins provide temporary storage while allowing for additional sediment removal prior to runoff being conveyed to the SWRB and AWWT. Excavation of the SWU with the highest known levels of contamination (IFP) was prioritized; it will be excavated first. Within the IFP and other areas, excavation will be performed to minimize potential cross-contamination.

Upon completion of remediation/excavation activities the site will be graded to drain and graded to approximate original (1952) topographical conditions, where possible.

SECTION 1

INTRODUCTION AND PROJECT DESCRIPTION

1.1 Introduction

The Fernald Environmental Management Project (FEMP) is a 1,050-acre facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The FEMP contains low-level radioactive, solid, and hazardous wastes. The Operable Unit 2 Waste Units Remediation Project (WURP) consists of the following waste units:

- Active Flyash Pile (AFP)
- Inactive Flyash Pile (IFP)
- South Field (SF)
- Lime Sludge Ponds (LSPs)
- Solid Waste Landfill (SWL).

The SF, IFP, and the AFP are collectively known as the Southern Waste Units (SWUs). The LSPs and SWL have been separated from the SWUs due primarily to remedial action schedule; it was determined that since the IFP contributes a greater source of contamination to the Great Miami Aquifer (GMA), the SWUs remediation was of high priority. Therefore, the LSPs and SWL will be addressed separately from the SWUs.

This SWMP addresses surface water management during remediation of the SWUs. The SWUs project will involve excavation and removal of approximately 340,000 bank cubic yards of impacted material from the SWUs. Impacted material consists of all material placed in the area by previous United States Department of Energy (DOE) operations and includes soil, debris (fill), and flyash. Impacted material also includes material with contamination levels above the final remediation level (FRL). Most of the impacted material will be placed in the OSDF. In addition, approximately 1,690 cubic yards of material will be transported to the Above-WAC Queue Area pending shipment to an off-site permitted commercial disposal facility. Approximately 100 cubic yards of lead-contaminated soil will be excavated and shipped offsite for treatment and disposal.

1.2 Purpose

The FEMP is operating under a National Pollutant Discharge Elimination System (NPDES) Permit which requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP). This SWPPP became effective May 1, 1996. Section 6 of the SWPPP addresses discharges related to

construction activities. The measures outlined in the SWMP and details shown on the Construction Drawings and specifications will be implemented to effectively manage stormwater and limit the amount of erosion and the release of sediment that will occur during the remediation of the SWUs.

Stormwater, erosion and sediment control measures are also required to minimize release of radiological contaminants. This SWMP has been prepared as a guide to minimize construction-related impacts on water quality from erosion and sedimentation, and minimize the spread of contamination during remediation of the SWUs. During remediation, Fluor Daniel Fernald, Inc. (FDF) will perform required NPDES monitoring at the permitted stormwater outfalls and comply with all applicable Federal, State, DOE, and FEMP requirements.

1.3 Scope

This SWMP provides the following information:

- Background discussion of the scope of the SWUs project,
- Description of the SWUs proposed surface water management system for the Southern Waste Units Remediation Project,
- Description of proposed general and area-specific erosion and sediment control measures,
- Description of the type and frequency of maintenance activities required to support the control measures.

The SWMP addresses stormwater management, erosion prevention, sediment control, hydrologic and hydraulic loading, physical site characteristics that impact the selection and implementation of control measures, and references to established design criteria. Supporting engineering data and calculations are attached as Appendix A.

1.4 Construction Drawings and Specifications

The construction within the SWUs will be accomplished in 2 phases; The site preparation phase and the excavation phase. Construction Drawings and specifications from both phases are incorporated herein by reference. They will be a part of the contract bid documents for that phase of remediation of the SWUs. The site preparation phase construction will address the stormwater and erosion control measures herein discussed (including the retention basins and ditches), the support area, equipment wash area, transfer line and all other items required to remove impacted material from the SWUs. The excavation

phase construction will address the removal of impacted material from the SWUs and the subsequent disposition of that material.

SECTION 2

SURFACE WATER MANAGEMENT SYSTEM

2.1 Overall Approach

The principal objectives of surface water management in the SWUs are to prevent or minimize stormwater runon to the work areas and to control water and runoff which has come into contact with contamination and/or impacted material. Runon from upgradient areas will be prevented (via diversion ditches and berms) from flowing into the construction area; this will minimize the generation of contaminated stormwater and sediment. Runon control ditches will be designed to handle the 10-year, 24-hour storm event except for ditch 2, ditch 6, and interceptor ditches 1-3, all of which will be designed to handle the 25-year, 24-hour storm event. Surface water in the SWUs project will be treated as potentially contaminated and will be collected in ditches and conveyed to three retention basins. Water from the retention basins will then be pumped to the SWRB and subsequently to the AWWT facility for treatment. The design for basins 1 and 2 used in stormwater controls are based on a 25-year, 24-hour storm event and a 10-year, 24-hour storm event for basin 3. Water that enters the excavations during construction will be collected in excavation sumps and handled as described in this plan.

The SWUs consist of the IFP, SF, and the AFP areas and cover approximately 15.8 acres within a total watershed area of 26.0 acres. The SWUs have steep outslopes to the west, south, and southwest. The IFP and SF outslopes are heavily vegetated with trees and brush. Existing drainage consists of sheet flow and shallow concentrated flow that is generally uncontrolled before reaching Paddys Run. A portion of the IFP is situated adjacent to Paddys Run. A rock embankment was constructed under Removal Action 29 along a section of the eastern bank of Paddys Run to protect the IFP from stream erosion.

Because of the proximity of the SWUs to Paddys Run and the nature of the remediation activities, a surface water management system will be used during remediation. Some components of the surface water control system will remain in operation through restoration of the SWUs area. The surface water management system will include diversion ditches and berms to prevent runon from entering the remediation areas, and excavation sumps, collection ditches, retention basins, lift stations, and transfer lines to control runoff. Existing drainage patterns and facilities will be utilized for stormwater management, wherever possible, by implementing improvements to convey design flows and incorporating erosion control materials and revegetation to limit erosion along drainage paths. Where necessary, new ditches or diversion berms will be constructed to redirect existing drainage paths away from the construction area.

See Figure 2-1 for the overall operation of the surface water management system.

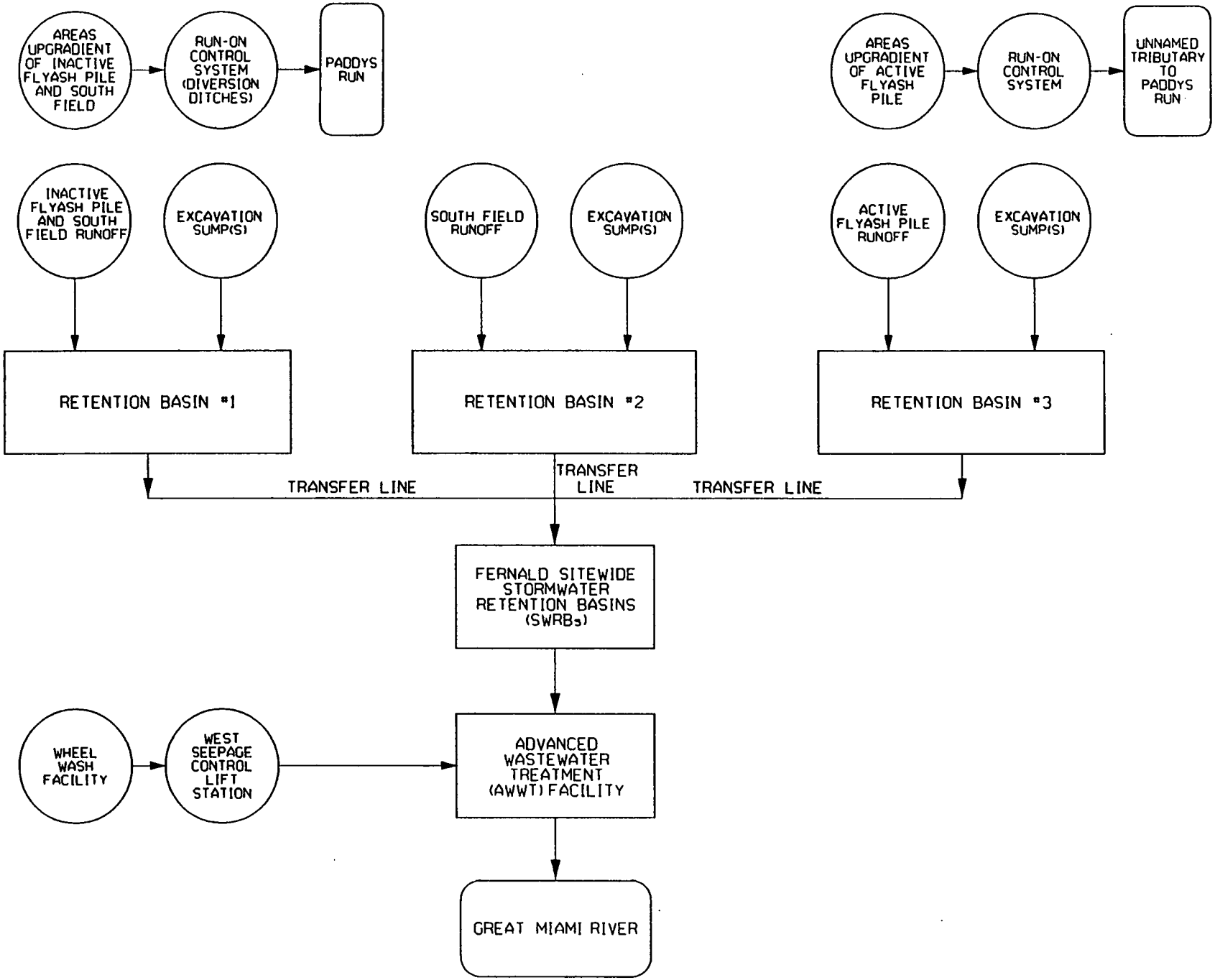

FIGURE 2-1. SURFACE WATER MANAGEMENT SYSTEM FOR SOUTHERN WASTE UNITS

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2.2 Specific System Components

Specific components of the surface water management system are shown in Figure 2-1 and are described below. See the Construction Drawings and technical specifications for detailed design information concerning stormwater controls. See Appendix A for design calculations. Drainage area maps are presented in Appendix B.

2.2.1 Diversion Ditches and Related Devices

Runon from upgradient areas will be collected and diverted around the excavation area. Runon will be handled by diversion ditches and other components generally located north of the SWUs.

A ditch (designated as D-12 on the Construction Drawings) north of the existing road that runs along the northern edge of the IFP and SF will be constructed to intercept runon and convey this water westward to a new pipe under the road and into an existing catch basin. This catch basin is located at the northwest corner of the IFP, and has an 18-inch corrugated polyethylene pipe which conveys this runon to an existing drainage way, approximately 300 feet north of the existing National Pollution Discharge Elimination System (NPDES) Discharge Point No. *4004 at Paddys Run. An earthen berm will be constructed around the existing catch basin to collect potential runon water from the south side of the road and prevent potentially contaminated runoff from entering the system. The existing 18-inch pipe will be extended to discharge at the existing NPDES Discharge Point No. *4004. Impacted runoff will be diverted away from NPDES Discharge Point No. *4004 and into the retention basins.

During the base bid and interim grading activities interceptor ditches 1-3 will be constructed to intercept runoff and prevent drainage from flowing onto the sands and gravels of the Greater Miami Aquifer (GMA).

An earthen berm will be constructed across a low area (topographically) north of the AFP to ensure that runon water will not enter the AFP remediation area.

The runon control components of the surface water management system will remain in place after restoration to prevent runon from uncertified areas upgradient from potentially contaminating the restored areas of the SWUs.

2.2.2 Excavation Sumps

As remediation is performed, active areas of excavation will be graded to drain to collection points located within the excavation area to the extent practical. Temporary excavation sumps will be excavated at these collection points to temporarily hold the stormwater. Water will be pumped out of the sumps

and into retention basins on an as-needed basis to keep the excavation area functional. Multiple sumps/pumps may be used for dewatering of the excavation area and will be moved as the excavation of the work face progresses.

2.2.3 Collection Ditches and Related Devices

Collection ditches will be constructed around the perimeter of the remediation/construction areas to collect and convey stormwater runoff to the SWUs retention basins. Where possible, the channel slopes will follow the existing topography to minimize excavation. The ditches will be trapezoidal (flat bottom) or triangular in shape depending on anticipated flow rates and site constraints. Ditches will be lined to prevent channel erosion with either erosion control blanket or dumped rock depending on the design flow velocities, see Summary of Ditch Performance, Sheet B34, Appendix A. Collection and interceptor ditches excavated into the sand and gravels of the GMA will be lined with a geomembrane liner.

2.2.4 Retention Basins

The SWUs project area is divided into three major drainage areas (P1, P2, and P3 as shown in Appendix B) based on existing topography. Three retention basins (one per drainage area) will be constructed to retain potentially contaminated stormwater runoff. Non-impacted soil removed during basin construction will be placed in non-impacted soil stockpile areas (stockpile #1 and stockpile #2 as indicated on the Construction Drawings). Material in the non-impacted soil stockpile areas will be left in place for possible future use. The retention basins will be graded to prevent retention of water during the restoration phase of the project.

Each retention basin will have a lift station which will pump runoff to the SWRB. The lift station will consist of a manhole, pump, and related piping/wiring/etc., and will be located adjacent to each basin. A high density, polyethylene (HDPE) riser/intake structure will be constructed inside the basin to feed the lift station. The riser will be designed with three hooded orifices sized to prevent starvation of the pump. The top of the riser will have a cap-type perforated lid. Construction details for the lift station and riser/intake structure are shown on the Construction Drawings.

Overflow outlets will be provided for all three basins. The overflow outlets will consist of open, trapezoidal channels with invert elevations above the top of the riser pipe and below the top elevation of the basin embankment. The overflow outlets for basins 1 and 2 will not discharge unless the 25-year, 24-hour storm is exceeded. The overflow outlet for basin 3 will not discharge unless the 10-year, 24-hour storm is exceeded. However, all three basins are located in the 100-year floodplain (see Evaluation of the Potential Peak Stages in Paddys Run During Storm Events at Cross Sections Close to the Proposed Retention Basin No. 1, and additional cross sections, Appendix C & Appendix D). Under certain

circumstances, the SWRB will bypass the AWWT and discharge directly to the Great Miami River (in accordance with the OU5 ROD, Sections 9.1.4 and 9.1.5: Treatment of Discharges). During these periods of stormwater bypass, the outlet pumps from the Area 2, Phase I retention basins will continue to pump until the SWRB reaches its capacity below the freeboard level. When the SWRB reaches its capacity, the outlet pumps from the Area 2 Phase I retention basins will be turned off and the water will be stored in these basins, which will be designed for 25-year or 10-year storm. After a sufficient amount of water from the SWRB has been bypassed and the water level is below the freeboard level, the outlet pumps at the Area 2, Phase I retention basins will resume operations and pump the water to the SWRB.

After remediation and restoration is completed, retention basins 1 and 2 will be graded to prevent the retention of water. For retention basins 1 & 2 the lift station pumps and geomembrane liners will be removed. The compacted clay subgrade will remain. Retention basin 3 will remain in operation. Material removed from the basins will be hauled to the OSDF.

The retention basins and respective drainage areas are described as follows:

2.2.4.1 Retention Basin 1

The proposed (developed conditions) P1 watershed is approximately 15.2 acres in size and contains the IFP and a portion of the SF and non-impacted soil stockpile area #1. Runoff will be collected and conveyed to Retention Basin 1 (see Construction Drawings and calculations) via collection ditches D1, D2 (D2A & D2B), D3, and D4. Retention Basin 1 will be located south of the IFP and SF and will cover approximately 1.5 acres of surface area. This basin is designed to retain the runoff volume from a 25-year, 24-hour storm event without discharge to the environment. A lift station with a 400 gallons per minute (gpm) pump system will be installed to pump collected runoff to the SWRB. Anticipated dewatering time for a 25-year, 24-hour storm event is approximately 72 hours. A 20-foot wide, open trapezoidal channel will be constructed to provide positive drainage for overflow occurring from storm events in excess of the 25-year, 24-hour storm or during sufficiently large sequential rain events.

Basin 1 will be constructed almost entirely by excavation with only a minimal amount of fill used for berms. Because Basin 1 is located within the GMA, the bottom and side slopes of the basin will be lined with one foot of compacted clay and a geomembrane liner.

2.2.4.2 Retention Basin 2

The proposed (developed conditions) P2 watershed is approximately 6.0 acres in size and contains the SF, the remainder of the non-impacted soil stockpile area #1, and all of non-impacted soil stockpile area #2. Runoff will be collected and conveyed to Basin 2 through collection ditches D5, D6, D7, and D8 (D8A & D8B). Basin 2 will be located south of the SF and will cover approximately 0.5 acre of surface

area. This basin is designed to retain the runoff volume from a 25-year, 24-hour storm event without discharge to the environment. A lift station with a 100 gpm pump system will be provided to pump collected runoff to the SWRB. Anticipated dewatering time for a 25-year, 24-hour storm event is approximately 72 hours. A 15-foot wide, open trapezoidal channel will be constructed to provide positive drainage for overflow occurring from storm events in excess of the 25-year, 24-hour storm.

Basin 2 will be constructed by excavation. Because this basin is located within the GMA, the bottom and side slopes of the basin will be lined with one foot of compacted clay and a geomembrane liner.

2.2.4.3 Retention Basin 3

The proposed (developed conditions) P3 watershed is approximately 4.8 acres in size and contains the AFP. Runoff will be collected and conveyed to Basin 3 through collection ditches D9, D10 (D10A & D10B) and D11. Basin 3 will be located south of the AFP and will cover approximately 0.4 acre of surface area. This basin is designed to retain the runoff volume from a 10-year, 24-hour storm event without discharge to the environment. A lift station with a 100 gpm pump system will be provided to pump collected runoff to the SWRB. Anticipated dewatering time for a 10-year, 24-hour storm event is approximately 72 hours. A 15-foot wide, open trapezoidal channel will be constructed to provide positive drainage for overflow occurring from storm events in excess of the 10-year, 24-hour storm.

Basin 3 will be constructed by excavation. Because this basin is located within the GMA, the bottom and side slopes of the basin will be lined with one foot of compacted clay and a geomembrane liner.

2.2.5 Transfer Line

A double-walled, HDPE pipe will be installed to convey runoff collected in the retention basins to the SWRB. The main transfer line begins at the lift station at Basin 1 and proceeds in an eastward direction where the lift stations for Basins 2 and 3 discharge into the transfer line. From Basin 3 the transfer line runs northward, east of the AFP, until reaching the termination point at the SWRB diversion box (see Construction Drawings). Cleanouts will be provided at strategic low points along the run of pipe. Air relief valves will be provided at strategic high points.

2.2.6 SWRB and AWWT

The SWRB will receive all water pumped from the Area 2, Phase 1 (A2P1) retention basins. Under normal conditions, the SWRB is pumped to the AWWT facility for treatment and discharge, consistent with the NPDES and OU-5 ROD requirements.

2.2.7 Equipment Wash Facility

An equipment wash facility will be constructed north of the IFP. It will be used to remove mud and debris from the wheels and undercarriage of haul vehicles prior to using the haul road. Water from the equipment wash facility will gravity flow via underground pipe through an oil-water separator to the west seepage control lift station and be pumped to the AWWT.

2.3 OVERALL SYSTEM OPERATION

A major goal of the surface water management system is to prevent potentially contaminated surface water from being discharged to the environment prior to treatment. Initial management will be provided by constructing diversion ditches and berms at strategic locations to prevent surface water runon from entering the area of the SWUs that will be remediated. Runoff from the A2P1 area that will be remediated will be managed through a series of excavation sumps and collection ditches, which collect and convey runoff from the remediation areas to three retention basins.

The retention basins will provide temporary storage for runoff and pre-treatment of the water by providing detention time for sediments to settle out. Lift stations are provided to transfer runoff stored in the basins to the SWRB through a double-walled, HDPE transfer line. At the SWRB the potentially contaminated runoff is stored until it can be treated at the AWWT. During high flow conditions when the SWRB is at full capacity, the pumps at the retention basin lift stations will be shut off until adequate drawdown at the SWRB.

At the AWWT facility the water will be treated as required prior to being released to the Great Miami River.

SECTION 3

STORMWATER MANAGEMENT

Stormwater management as described in this Surface Water Management Plan addresses the peak runoff that discharges (and will discharge) from the A2P1 area during existing, construction/remediation, and restoration conditions. The goal of stormwater management is to prevent a significant increase in the peak runoff during remediation and restoration activities.

The A2P1 project site is currently vegetated and consists of sheet flow and shallow concentrated flow in the upper watershed areas, leading to concentrated flows in drainage ways around the area. All stormwater from the SWUs project site presently flows into Paddys Run. Prior to the start of remediation a surface water management system will be implemented to prevent runon to the site, and collect and convey runoff from the site for storm events up to the 25-year, 24-hour storm for Retention Basins 1 & 2, ditches 2 & 6, and interceptor ditches 1-3. Retention Basin 3 and the remaining ditches will collect and convey runoff from the site for storm events up to the 10-year, 24-hour storm. Since runoff from the site will be pumped to the SWRB, the peak runoff from the area to Paddys Run will be reduced during remediation/excavation.

After remediation the area will be restored to the approximate original topography. Land use after remediation will be undeveloped with a vegetated cover. Based on an undeveloped land use scenario, the peak and total amount of runoff from the SWUs after remediation can be expected to be similar to the conditions that existed in 1952.

SECTION 4

EROSION AND SEDIMENT CONTROL MEASURES

4.1 Overall Concept

Soil conservation practices, combining vegetative and structural measures, have been incorporated in construction documents to mitigate soil erosion damage, off-site sediment migration, and water pollution from erosion. Many of these measures will be long-term in nature and will become part of the completed construction project (i.e., grading, and permanent seeding). Other measures will be temporary and will be removed by the excavation Contractor at the completion of excavation and interim restoration. The selection of erosion and sediment control measures was based on several general principles including the following:

- minimization of erosion through project design,
- incorporation of temporary and permanent erosion control measures,
- removal of sediment prior to discharge.

Erosion and sediment control measures incorporated into the A2P1 project incorporate applicable State, Federal, DOE, and FEMP requirements. The FEMP standards for erosion and sediment control follow the Ohio Department of Natural Resources (ODNR) and United States Soil Conservation Service standards for construction and materials. Vegetative stabilization, silt fencing, and ditch protection will be implemented in accordance with Ohio Department of Transportation Construction and Material Specifications and the Location and Design Manual, Volume Two, Drainage. A generalized description of proposed erosion and sediment control measures is presented in this section. Construction details for erosion and sediment control measures are included in the Construction Drawings and technical specifications.

4.2 Specific Components

There are two types of erosion and sediment control measures: temporary and long-term measures. Temporary measures include silt fencing, crusting agents, stabilization measures (vegetation, matting, dumped rock), and sediment storage capacity within retention basins. Long-term measures include design features such as grading, vegetation, and dumped rock. Both temporary and long-term measures are discussed below.

4.2.1 Silt Fencing

Silt fencing will be used to intercept sheet flow, retain sediments, and disperse flow prior to runoff reaching the collection ditches. Prior to clearing, grading, and excavation activities, silt fencing will be installed along downgradient perimeters to prevent migration of sediment eroded from exposed areas. Silt fencing will consist of a woven filter fabric attached to wooden posts. Silt fencing will be constructed so that the toe of the filter fabric is securely buried to prevent water from undercutting the fence. Silt fencing will be installed in accordance with details presented on the drawings and in accordance with manufacturers recommendations. The locations presented on the Construction Drawings for the project areas are considered the minimum necessary during construction. Intermediate silt fencing may be used by the Contractor to control and slow down flows in active excavation areas. The Contractor shall install breaks and overlaps in the silt fencing to allow vehicle access to the construction areas.

Inspection of silt fence shall occur at regular intervals as outlined in Section 6.

4.2.2 Temporary Stabilization

As a result of phased construction, portions of the project areas may be left in intermediate/incomplete conditions. Intermediate areas may include rough graded areas awaiting final grading. Intermediate areas where activities will not resume for a period of 45 consecutive days or greater shall be stabilized (e.g., seeded with a quick germinating seed mixture, covered with a layer of straw mulch, or application of a crusting agent) within 7 days. Temporary measures will help to stabilize exposed soil and limit erosion. As construction progresses, temporary vegetation, straw mulch, or the crusting agent will be left in place until final seeding or until construction resumes.

4.2.3 Retention Basins

Although the primary purpose of the retention basins is to collect and hold runoff for treatment, the basins also provide an additional measure of sediment control. Runoff is detained in the retention basins until pumped to the SWRB. Because the rate of pumping to the SWRB is less than 1 cubic feet per second (cfs) (one cfs is 448.8 gallons per minute), which is small compared to discharges from standard outlet structures (usually several cfs), the retention basins provide a large detention storage time for sediments to settle out.

To account for the sediment removal capability of the retention basins, the basins have been designed with sediment storage capacities in excess of the 27 cubic yards per watershed acre as recommended in the ODNR's "Rainwater and Land Development Manual". For storm routing purposes, the sediment storage volume was assumed as dead storage (i.e., at full sediment capacity) and was not included in the basin

volume computations. The designed versus required sediment storage capacity for each basin is given below:

Retention Basin 1

Watershed Area = 15.2 Acres
Sediment Storage Required = 0.25 Acre-Feet
Sediment Storage as Designed = 0.38 Acre-Feet

Retention Basin 2

Watershed Area = 6.0 Acres
Sediment Storage Required = 0.10 Acre-Feet
Sediment Storage as Designed = 0.11 Acre-Feet

Retention Basin 3

Watershed Area = 4.8 Acres
Sediment Storage Required = 0.08 Acre-Feet
Sediment Storage as Designed = 0.10 Acre-Feet

4.2.4 Grading and Design Features

Grading design features incorporated into the remedial design to control erosion include runon controls, limiting steep slopes, routing runoff to surface water collection ditches, limiting discharge and flow velocities in the collection ditches to the extent practical, and lining collection ditches with erosion control blankets or dumped rock as required to maintain non-erosive velocities. A sediment barrier, comprised of a geotextile fabric tube filled with crushed rock, is used to slow velocities in critical areas in ditches with geomembrane liners.

4.2.5 Vegetation

Subsequent to final remediation of the A2P1 area, a revegetation program will be implemented to establish a permanent variety of vegetation. The vegetation layer (turf type grass) will reduce erosion, enhance evapotranspiration of water, and improve the quality of water leaving the area. The project area will be seeded in stages as remediation is completed. In addition to seeding with a permanent variety of grass seed, mulch will be placed on graded slopes to prevent erosion during turf establishment. As an aid to turf establishment, seeded areas will be fertilized with a starter fertilizer as described in the technical specifications.

4.2.6 Dumped Rock

Where added erosion protection is necessary for protection from excessive velocities, diversion ditches will be lined with dumped rock. Also, the existing drainageway north of the AFP, and where the unnamed tributary discharges into Paddys Run just west of the IFP, will be lined with dumped rock. Dumped rock will be placed in these locations to prevent further erosion as shown on the Construction Drawings.

4.3 Design Criteria and Standards

The criteria used to design the various components of the surface water management plan are described below.

- Retention basins 1 and 2 are designed to retain the runoff from a 25-year, 24-hour storm event without discharge to the environment. Retention Basin 3 is designed to retain the runoff from a 10-year, 24-hour storm event without discharge to the environment.

- Retention basins are designed with a sediment storage capacity which exceeds the recommended 27 cubic yards per watershed acre.

- Pump rates at the lift stations are designed to convey accumulated water from the design storm event in approximately 72 hours.

- Runon and diversion and collection ditches (drainage ditches) and culverts are designed based on a 10-year, 24-hour storm frequency, except ditches 2 and 6, and interceptor ditches 1-3, which are designed based on a 25-year, 24-hour storm frequency, see Summary of Ditch Performance, Sheet B34, Appendix A.

Various standards and good engineering practices were used in the technical portion of the design. See calculations in Appendix A for a listing and discussion of the standards and practices used.

SECTION 5

IMPLEMENTATION

Because of the large expanse of area that will be impacted by remediation, relatively steep slopes, and close proximity to Paddys Run, intensive erosion control measures will be required to minimize erosion and maximize the capture of sediment. In conjunction with stormwater management measures, silt fencing will be installed along perimeter downslope areas (along contours) and drainage ditches, where necessary, prior to the beginning of excavation activities.

Once excavation of impacted material and contaminated soil begins, erosion and sediment control measures will be integrated with stormwater management measures. Runoff from the active working face will either be gravity drained to collection ditches and basins, or collected in excavation sumps and pumped to collection ditches or directly to the retention basins. Initiation of the surface water management system will commence during site preparation and remain in operation until the final phase of Area 2, Phase 1 soil remediation is complete. Runoff from all areas will be routed to the retention basins until the areas are certified below FRLs and all upslope soils are stabilized with vegetation. The Contractors will be required to periodically remove sediments from silt fences, drainage ditches, and retention basins to maintain desired performance. Sediment removed from silt fences, drainage ditches, and basins will be managed as impacted material and disposed of in the OSDF, in accordance with the technical specifications.

Areas in which work will not occur for 45 days will be stabilized within 7 days (see Site Preparation Technical Specification Section 02270. Vegetation standards, specifically percent grass coverage, are discussed in Site Preparation Technical Specification Section 02900). Areas will also be stabilized to the extent practical prior to winter shutdown.

5.1 General Construction Practices

In general, it is advantageous to disturb only as much area as necessary to accommodate construction needs. Limiting the extent of grading and excavation will minimize disturbed areas subject to erosion at any given time. However, disturbed areas may be expanded to separate work areas and provide more room to work for safety reasons. The construction phasing ultimately incorporated into the work plan is dependent on several factors including the following:

- Contractor's management strategies,
- construction conditions,
- seasonal and weather conditions.

The following construction practices will be followed as a general rule.

- All erosion and sediment control measures are to be installed prior to or as the first step in excavation.

- Disturbed/exposed areas will be excavated as quickly as practical. Disturbed areas which will remain unworked for 45 consecutive days or greater will be stabilized with a temporary vegetative cover or other measures, such as mulching, within 7 days.

- All erosion and sediment control measures shall be maintained and/or modified as approved by FDF in accordance with regulatory criteria during construction to comply with this plan.

- Potential cross-contamination from vehicle traffic will be prevented by stabilization of entry/exit routes, equipment washing, and monitoring vehicles exiting the work zone.

5.2 Construction Sequencing

The following sections discuss the general erosion control sequencing plan (during site preparation) and the excavation sequencing plan.

5.2.1 General Erosion Control Sequencing Plan (During Site Preparation)

Step 1. Establish site boundaries and access controls.

Step 2. Install silt fence and diversion ditches in locations indicated on the Construction Drawings.

Step 3. Strip the surface (if not certified below FRLs by FDF) from areas designated for retention basin construction and stockpile the material within the boundaries of the impacted material stockpile within the SF to be field located as noted on the Construction Drawings.

Step 4. Complete excavation of retention basins to lines and grades shown on the plans. Prior to excavation (to the extent practical), FDF will determine whether material to be excavated is below FRLs. During excavation FDF may perform additional monitoring with real-time instruments. Soil suspected to be impacted (not below FRLs) will be placed in Impacted Material Stockpile shown on the Construction Drawings. Other soil

will be placed in the Non-Impacted Material Stockpile Areas as shown on the Construction Drawings.

Step 5. Install risers, barrels, lift stations, and transfer lines for the retention basins as shown on the Construction Drawings.

Step 6. Install compacted clay subgrade and geomembrane liner in the retention basins.

Step 7. Divert flow into the retention basins by constructing collection ditches.

Step 8. Construct equipment wash facility and associated devices.

5.2.2 Excavation Sequencing Plan for Impacted Material Excavation

Step 1. Establish site boundaries and access controls.

Step 2. Establish erosion, siltation, and surface water controls in locations indicated on the plans and as shown in the details. Confirm that all erosion and sediment controls are in place and all runoff from potentially contaminated and disturbed areas flows to the retention basins.

Step 3. Clear remaining trees and vegetation. Stumps will be ground in place and excavated with surface soil removal.

Step 4. Excavate impacted material to the limits indicated on the Construction Drawings.

Step 5 Excavate construction sumps near working face to collect runoff.

Step 6 As excavation progresses, relocate sumps as required.

Step 7. When excavation is completed in a discrete area, certification samples will be collected (by FDF).

Step 8. Upon certification that soils remaining in the remediation area meet FRLs, interim restoration shall be performed.

Step 9. Apply seed and mulch to all disturbed areas.

Step 10. Install temporary erosion and sedimentation controls for decommissioning of retention basins.

Step 11. Upon verification that the excavation meets FRLs and has an established stand of vegetation, accumulated sediments, compacted clay subgrade, and the geomembrane liner shall be removed from the retention basins 1 and 2.

Step 12. Remove temporary erosion and sedimentation controls following completion of final grading activities and after the excavation areas have an established stand of vegetation. Seed and mulch any areas disturbed by this activity.

SECTION 6

SEDIMENT CONTROL MAINTENANCE AND MONITORING

6.1 Monitoring and Inspection

The erosion and sediment controls identified in this SWMP will be monitored by a qualified representative of the Contractor and FDF every 7 calendar days or within 24 hours of a precipitation event of 0.5 inches or greater during the construction phase of the project. Inspections will include areas under excavation, unstabilized exposed areas, erosion control measures, and locations where vehicles enter/exit the project area. Where portions of the project area have been completed and permanent erosion control measures have been implemented, inspection will be conducted at least once every month until the entire project area is completely stabilized. All inspections will be conducted and documented in accordance with the SWPPP.

Disturbed areas and areas used for storage of materials that are exposed to the elements will be inspected for evidence of, or for the potential of, pollutants entering local drainage systems. Locations where vehicles exit the A2P1 area will be inspected for evidence of off-site tracking of contaminated soil or impacted material.

If the inspections indicate that control measures are not adequate or effective, modifications to the control measure will be implemented immediately by the Contractor. A report summarizing the scope of the inspection, name of the inspector, inspection date, observations relating to the implementation of this plan, and necessary corrective action measures (if any) will be made and retained in the FDF project files to demonstrate compliance. The reports will either identify any areas of noncompliance with this plan, or contain a certification that control measures are effective and in compliance with this plan.

6.2 Maintenance

Erosion and sediment controls will be maintained in good operating condition until the A2P1 area has been completely stabilized and the soils remaining in the A2P1 area are certified to meet FRLs. Specific maintenance procedures will address silt fencing, drainage ditches, retention basins, and the equipment wash facility.

6.2.1 Silt Fencing

As sediment collects along the silt fences, the fences will be cleaned to maintain desired removal performance and prevent structural failure of the fence. During site preparation the sediment will be

removed by the Contractor and managed as impacted material and placed in the impacted material stockpile for subsequent placement into the OSDF. During excavation, the sediment will be removed by the Contractor and placed into the OSDF. The perimeter silt fencing will remain in place until excavation activities in the area are completed and vegetative cover or other erosion control measures are adequately established.

6.2.2 Drainage Ditches

The Contractor will be required to periodically remove sediment from the drainage ditches to maintain conveyance. Sediment removed from ditches during site preparation will be managed as impacted material and placed in the impacted material stockpile for subsequent placement into the OSDF. During excavation, the sediment will be removed by the Contractor and placed into the OSDF.

6.2.3 Retention Basins

The Contractor will be required to periodically remove sediment from the retention basins to maintain desired sediment storage capacity. Sediment removed from basins during site preparation will be managed as impacted material and placed in the impacted material stockpile for subsequent placement into the OSDF. During excavation, the sediment will be removed by the Contractor and placed into the OSDF.

6.2.4 Equipment Wash Facility

Sediments will be removed from the trench and oil/water separator as required. During site preparation, sediments removed from the Equipment Wash Facility will be managed as impacted material and placed in the OSDF. During excavation, the sediment will be removed by the Contractor and placed into the OSDF.

APPENDIX A

CALCULATIONS

PARSONS
ERA PROJECT

DESIGN CALCULATIONS INDEX

Discipline CIVIL Project Order No. 165 OU No. 2

CALCULATION NO.	SUBJECT	COMPUTER GENERATED (Y/N)	ORIGINATING AUTHOR	CHECKED BY	REV. NO./ DATE
15-01	STORMWATER MANAGEMENT	BOTH	T. BROWN	B. PARTON	0/ 5/22/97
15-01	STORMWATER MANAGEMENT	BOTH	T. BROWN	B. PARTON	1/ 8/15/97
15-01	STORMWATER MANAGEMENT	BOTH	T. BROWN	B. PARTON	2/ 10/10/97

APPROVED Franklin M. Partch DATE 10/10/97
Technical Lead

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- Basis Sheet . . . . . 2-4 of 12
- Computer Calculation Summary Sheet . . . . . 5-7 of 12
- Results . . . . . 8 of 12
- Computer 9-12

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  - Channel FlowWorksheet A7
  - Runoff Curve Number Data A8
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Attachment D
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Attachment F
Calculation 15-01, PO139, Design of Seepage
Collection & Removal of Sediment

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 10/10/97

Sheet 1 of 12

Proj. Order No. 165 Calculation No. 15-01

Project Title SOUTHERN WASTE UNITS

Calculation Subject STORMWATER MANAGEMENT Date Verified/Checked 10/10/97

STATUS: PRELIMINARY ____ FINAL X SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

1) Determine size of three retention basins required to collect and retain runoff from the 25 yr-24 hr precipitation event (Basins 1 & 2) and the 10 yr-24 hr precipitation event (Basin 3).

2) Determine size of collection ditches and culverts required to convey a 10-yr storm event to the retention basins. Due to the close proximity to Paddys Run, Ditch 2 & Ditch 6 will also be evaluated for the 25-yr storm event.

SUMMARY OF CONCLUSIONS

1) The basins, as shown on Dwg. 92X-5900-G-00282 are of sufficient size to collect runoff from the 10 yr-24 hr (Basin 3), or 25 yr-24 hr (Basins 1 & 2) storm event as required.

2) Ditches and culverts shown on Dwg. 92X-5900-G-00282, Dwg. 92X-5900-G-00283, and 92X-5900-G-00453 are of sufficient size to convey the 10-yr or 25-yr storm event, as required, to the basins.

Originator's Signature and Date: 10/10/97

CHECKING METHOD

1. Review ____
2. Alternate Calculation ____

Checker's Signature and Date: Franklin M. Potter 10/10/97

Lead Discipline Engineer's Signature and Date: Franklin M. Potter 10/10/97

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date

PARSONS
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ENGINEERING CALCULATIONS BASIS SHEET

Revision No. 2
Sheet 2 of 12

Proj. Order No. 165 Calculation No. 15-01

Project Title Southern Waste Units

Calculation Subject Stormwater Management Date Verified/Checked 10/10/97

Prepared By: T. Brown TJB Checked/Verified By: Frank Porter Jr

Date 10/10/97

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

Data Sources

1. PARSONS DWGs. (used to create drainage area maps)
2. Haestad Methods. 1989. Quick TR-55™ *Urban Hydrology for Small Watersheds*
3. Haestad Methods. 1989. Pond-2™ *Detention Pond Analysis*
4. Haestad Methods. 1995. Flow Master™ v 5.13
5. U.S. Weather Bureau. *Rainfall Frequency Atlas of the United States*
6. Soil Conservation Service. *Soil Survey of Hamilton County, Ohio*. August 1982
7. ODOT. *Location and Design Manual, Vol. 2, Drainage Design*
8. FHWA. *Hydraulic Design of Highway Culverts*. HDS No. 5. 1985
9. Brater, E.F., & King, H.W., *"Handbook of Hydraulics"*, 6th ed., 1976, McGraw-Hill

CODES

Applicable sections of the Ohio Department of Natural Resources *Rainwater and Land Development Manual*

ASSUMPTIONS

1. Retention basins: The retention basins will be in place and operational prior to excavation. Therefore, the contributing watershed areas prior to, and during excavation were examined to identify the worst-case for storm volumes.

ENGINEERING CALCULATIONS
BASIS SHEET
SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS (continued)

2. Ditches and Culverts: Both existing and proposed conditions were evaluated, with the one producing the highest flow rates used in design.
3. The Rainfall Intensity-Frequency-Duration Curve for the Fernald area has the shortest duration equal to 10 minutes. The time of concentrations (t_c) computed for drainage areas P1, P2, and P3 were less than 10 minutes. Since the drainage areas for ditches are smaller than basin drainage areas (and subsequent t_c's for ditches less than those for basins), calculations for t_c for ditch and culvert drainage areas were not performed (except for Ditch-12, and Culvert-4). Instead, the smallest duration (10 min.) from the Rainfall Intensity-Frequency-Duration Curve were used to calculate rainfall intensities. For Ditch-12 and Culvert-4, t_c's were calculated using SCS methodologies due to the relatively large, flat drainage areas.
4. Ditches were designed based on uniform flow.
5. The existing ditches and 24" dia. culvert at the proposed wheel wash area were designed under Calculation No. 15-02, for PO158 (Haulroad Upgrade Project), and is included for information as an attachment to this calculation.
6. The existing catch basin and 18" corrugated HDPE storm drain located west of the Inactive Flyash Pile was designed under Calculation No. 15-01, for PO139 (Design of Seepage Collection & Removal of Sediment), and is included for information as an attachment to this calculation.
7. The Contingency Stockpile Area (Stockpile #2), located north-northwest of ditch-12, may or may not be utilized, depending on the amount of excess soil. Therefore, ditches 8A, 8B, and Basin 2 were designed assuming that this stockpile area would be utilized.
8. Dumped Rock Fill will be used in ditches that do not have a geomembrane liner where velocities are greater than 4.0 fps for erosion control blanket lining. ODOT Type "C" dumped rock fill will be used due to the small geometrical shape of the ditches.

9. Ditches 2B, 3-7, and 9 will have a geomembrane liner. Where velocity checks are used, flow depths will be determined using a broad-crested weir analysis.

PARSONS
ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 165 Job Number: 7663-0165-11112-141

Computer Code: OTR-55 Version: 5.46

Code Verification Status: REV 0, Nov 1992

Description of Program: Developes runoff hydrographs per SCS TR-55, Determines peak flows per Modified Rational Method

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To determine volume of runoff produced by 10-yr, 24-hr storm event, Retention Basins will be sized to accommodate these volumes.

To determine peak flows for design of ditches and culverts.

Run Performed By: T. Brown

Date/Time of Run: various, see computer printouts

Computer Time of Run: n/a

Input Filename: See attached list on Sheets 8-11

Output Filename: See attached list on Sheets 8-11

Files Saved to Diskname: p:\engdata\c&sdata\po165\swu\swcalc Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown JB Date: 10/10/97

Checked By: Frank Porter Jr Date: 10/10/97

Approved By: Date:

5 of 6 of 12

PARSONS
ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 165 Job Number: 7663-0165-11112-141

Computer Code: Flow Master Version: 5.13

Code Verification Status: Rev 0, Feb. 1997

Description of Program: Computes solutions to uniform flow open channel hydraulic problems

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: Used to evaluate and select drainage channel geometry and acceptable lining material.

Run Performed By: T. Brown

Date/Time of Run: various, see computer print-outs

Computer Time of Run: n/a

Input Filename: See attached list on Sheets 8-11

Output Filename: See attached list on Sheets 8-11

Files Saved to Diskname: p:engdata\c&sdata\po165\swu\swcalc Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TJB Date: 10/10/97

Checked By: [signature] Date: 10/10/97

Approved By: Date:

12/92 ENG095

000267

PARSONS
ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 165 Job Number: 7663-0165-11112-141

Computer Code: POND -2 Version: 5.17

Code Verification Status: REV 0, NOV 1992

Description of Program: Computes solution for routing inflow hydrograph generated by OTR-55 and generates an outflow hydrograph using level-pool routing techniques

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: Used to size retention basins to ensure no discharge for 10-year, 24-hour storm event.

Run Performed By: T. Brown

Date/Time of Run: various, see computer print-outs

Computer Time of Run: n/a

Input Filename: See attached list on Sheets 8-11

Output Filename: See attached list on Sheets 8-11

Files Saved to Diskname: p:\engdata\c&sdata\po165\swu\swcalc Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TB Date: 10/10/97

Checked By: Frank Pulsa Jr Date: 10/10/97

Approved By: Date:

RESULTS:

The results from the routing of the 25-year, 24-hour storm event through retention basins 1 & 2 are as follows:

RETENTION BASIN 1

Q_{25} =	88 CFS
Initial Storage (Assumed full of sediment) =	0.36 Ac-Ft
Overflow Elev. =	538.5
Water Surface Elev. (WSE_{25}) =	537.87
Q_{25} Discharge =	0 CFS

RETENTION BASIN 2

Q_{25} =	34 CFS
Initial Storage (Assumed full of sediment) =	0.11 Ac-Ft
Overflow Elev. =	537.0
Water Surface Elev. (WSE_{25}) =	536.63
Q_{25} Discharge =	0 CFS

The results from the routing of the 10-year, 24-hour storm event through retention basin 3 are as follows:

RETENTION BASIN 3

Q_{10} =	21 CFS
Initial Storage (Assumed full of sediment) =	0.10 Ac-Ft
Overflow Elev. =	540.0
Water Surface Elev. (WSE_{10}) =	539.89
Q_{10} Discharge =	0 CFS

The retention basins do not discharge during the design storm events and are acceptable.

The diversion ditches and culverts were designed to accommodate a 10-year storm event.
The results for diversion ditches and culverts are included within the body of the calculations.

SHT 9-12 1062

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c4p.mod
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eng095ep.2
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swu.fm2
swu.idf
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swu1.fm2
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ATTACHMENT A, RETENTION BASINS

Methodology

This calculation is performed by examining the existing and proposed conditions to identify the "worst case" for storm volumes.

The existing drainage area for each basin is computed using the existing topography. The proposed drainage area for each basin is computed on the final grading plan. Time of concentrations are determined using sheet flow, shallow concentrated flow, and channel flow as required by the drainage characteristics of each drainage area. See Drainage Area Map in Appendix B of the Surface Water Management Plan. A weighted curve number is developed for each drainage area based on soil types and conditions within the drainage area. The proposed inflow hydrographs are then developed using SCS Technical Release No. 55 (TR-55) and the computer program Quick TR-55. Retention Basins No. 1 & 2 will use the 25 yr - 24 hr storm as the design storm event. Retention Basin No. 3 will use the 10 yr - 24 hr storm as the design storm event. The drainage areas for each basin under existing and proposed conditions are as follows:

	EXISTING	PROPOSED
Basin 1	14.33 AC	15.23 AC
Basin 2	7.04 AC	6.1 AC
Basin 3	4.78 AC	4.78 AC

By inspection, The worst-case volume condition for basin 1 and basin 3 will occur during proposed conditions due to the size of the drainage areas and the use of higher curve numbers for disturbed conditions. However, for basin 2 it is not apparent which condition will generate the largest storm runoff volume. Therefore, runoff hydrographs will be generated for each condition and routed through the storage volume estimate routine of the Pond-2 computer program. The condition which produces the largest estimated storage volume will be used as the worst-case and will be routed through the basin.

Stage-storage information is developed from the grading plans for each basin. This information is entered into the Pond-2 computer program. Since the basins retain the design storm instead of regulating outflow, an outflow rating table is not required. Also, the pumping rate at the lifts stations (400 gallons per minute at basin 1, and 100 gpm at basins 2 & 3) was not considered when routing the design storm event.

The inflow hydrographs are then routed through the basins using level-pool reservoir routing techniques found in the Pond-2 computer program. Maximum water surface elevations due to storage of the entire storm volume are evaluated to ensure that adequate volume is provided to contain the design storm events.

Variables used in development of the inflow hydrographs are taken from TR-55. Variable definitions, values used, and reference location within TR-55 are defined.

Time of Concentration

Time of concentration is comprised of travel times from sheet flow, shallow concentrated flow, and channel flow components. Each component is described as follows:

Sheet Flow (Equation 3-3)

$$T_t = \frac{0.007\,(n \times L)^{0.8}}{(P_2)^{0.5}\, s^{0.4}}$$

where:

T_t = Travel time (hrs)
n = Manning's roughness coefficient. Use following values from Table 3-1, Page 3-3 for n:

n = 0.011 for bare soil conditions,
n = 0.13 for range conditons (vegetated)

P_2 = 2 yr - 24 hr rainfall (in.). The 2 yr - 24 hr rainfall is used in the SCS equation for sheet flow for any storm frequency. For the Fernald Area use 3.0 inches (Reference 5)
L = Flow Length (ft)
s = Land slope (ft/ft)

Shallow Concentrated Flow (Page 3-1)

$$T_t = L / 3600 \times V$$

where:

T_t = Travel time (hrs)
L = Flow Length (ft)
3600 is conversion factor from seconds to hours
V = Average velocity (ft/s) taken from Figure 3-1

Channel Flow (Page 3-3)

$$T_t = L / 3600 \times V$$

T_t = Travel time (hrs)
L = Flow Length (ft)
3600 is conversion factor from seconds to hours
V = Average channel velocity taken from equation 3-4

Runoff Curve Number

A weighted curve number is derived for watershed areas based on the soil type, hydrologic soil group, cover type, and treatment. The soil types in the area and the hydrologic soil groupings are based on soil surveys of the area (Reference 6, see Attachment E). The cover types and treatment (i.e., proposed-bare soil conditions, or existing-wooded conditons) are based on the expected conditions to be encountered during the project. Curve numbers are assigned based on the Curve Number Tables 2-2a, 2-2b, and 2-2c.

SHT A4

RETENTION BASIN 1

Quick TR-55 Ver.5.46 S/N:
Executed: 10:05:30 08-19-1997 c:\po165tk\P1.TCT

RETENTION BASIN - 1

Tc COMPUTATIONS FOR: P1

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description	BARE		
Manning's roughness coeff., n		0.0110	
Flow length, L (total < or = 300)	ft	280.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0210	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.05	= 0.05

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	240.0	
Watercourse slope, s	ft/ft	0.1120	
$Avg.V = Csf * (s)^{0.5}$	ft/s	5.3996	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	10.00	
Wetted perimeter, Pw	ft	12.47	
Hydraulic radius, r = a/Pw	ft	0.802	
Channel slope, s	ft/ft	0.0080	
Manning's roughness coeff., n		0.0400	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.8758	
Flow length, L	ft	305	
T = L / (3600*V)	hrs	0.03	= 0.03

::

TOTAL TIME (hrs) 0.09

USE 0.1 hrs

SHT A6

Quick TR-55 Ver.5.46 S/N:
Executed: 10:05:30 08-19-1997 c:\po165tk\P1.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN - 1

Subarea descr.	Tc or Tt	Time (hrs)
P1	Tc	0.09

USE 0.1 hrs

P1 WATERSHED, CHANNEL FLOW
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	P1 WATERSHED, CHANNEL FLOW
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Depth	1.00	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	8.00	ft

Results		
Discharge	28.68	cfs
Flow Area	10.00	ft^2
Wetted Perimeter	12.47	ft
Top Width	12.00	ft
Critical Depth	0.69	ft
Critical Slope	0.028706	ft/ft
Velocity	2.87	ft/s
Velocity Head	0.13	ft
Specific Energy	1.13	ft
Froude Number	0.55	
Flow is subcritical.		

Notes:

THIS ANALYSIS WAS TO DETERMINE THE FLOW AREA, WETTED PERIMETER, AND HYDRAULIC RADIUS OF D-3 FLOWING 1 FT. DEEP.

RESULTS USED TO DETERMINE TRAVEL TIME FOR CHANNEL FLOW COMPONENT OF TIME OF CONCENTRATION OF P1 DRAINAGE AREA.

SHT A8

Quick TR-55 Ver.5.46 S/N:
Executed: 10:15:12 08-19-1997

RETENTION BASIN 1
59% HoA, 20% HeF, 10% MaB,
10% Gn, 1% Gravel Road

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN
HoA, (C): FALLOW, BARE SOIL	8.97	91
MaB, (C): FALLOW, BARE SOIL	1.52	91
HeF, (B): FALLOW, BARE SOIL	3.04	86
Gn, (B): FALLOW, BARE SOIL	1.55	86
Gravel Road	0.15	91
COMPOSITE AREA --->	15.23	89.5 ~~(89)~~

::

(90)

000281

SHTA9 1062

Quick TR-55 Ver.5.46 S/N:
Executed: 10:15:12 08-19-1997

RETENTION BASIN 1
59% HoA, 20% HeF, 10% MaB,
10% Gn, 1% Gravel Road

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
	15.23	~~89~~ USE 90

SEE PREVIOUS SHEET

SHT A10

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
P1	15.23	90.0	0.10	0.00	4.80	3.68	.05	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 15.23 acres or 0.02380 sq.mi
Peak discharge = 88 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P1	0.10	0.00	**	**	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P1	88	12.1
Composite Watershed	88	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P1	2	3	5	29	57	88	55	19	13
Total (cfs)	2	3	5	29	57	88	55	19	13

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P1	11	9	8	7	6	5	4	4	4
Total (cfs)	11	9	8	7	6	5	4	4	4

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P1	3	3	3	3	2	2	2	2	2
Total (cfs)	3	3	3	3	2	2	2	2	2

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P1	2	1	1	1	0
Total (cfs)	2	1	1	1	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	2	14.8	3
11.1	2	14.9	3
11.2	3	15.0	3
11.3	3	15.1	3
11.4	4	15.2	3
11.5	4	15.3	2
11.6	5	15.4	2
11.7	13	15.5	2
11.8	21	15.6	2
11.9	29	15.7	2
12.0	57	15.8	2
12.1	88	15.9	2
12.2	55	16.0	2
12.3	19	16.1	2
12.4	13	16.2	2
12.5	11	16.3	2
12.6	9	16.4	2
12.7	8	16.5	2
12.8	7	16.6	2
12.9	6	16.7	2
13.0	6	16.8	2
13.1	5	16.9	2
13.2	5	17.0	2
13.3	4	17.1	2
13.4	4	17.2	2
13.5	4	17.3	2
13.6	4	17.4	2
13.7	4	17.5	2
13.8	4	17.6	2
13.9	3	17.7	2
14.0	3	17.8	2
14.1	3	17.9	2
14.2	3	18.0	2
14.3	3	18.1	2
14.4	3	18.2	2
14.5	3	18.3	2

SMA14

14.6	3	18.4	2
14.7	3	18.5	2

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	1	22.4	1
18.7	1	22.5	1
18.8	1	22.6	1
18.9	1	22.7	1
19.0	1	22.8	1
19.1	1	22.9	1
19.2	1	23.0	1
19.3	1	23.1	1
19.4	1	23.2	1
19.5	1	23.3	1
19.6	1	23.4	1
19.7	1	23.5	1
19.8	1	23.6	1
19.9	1	23.7	1
20.0	1	23.8	1
20.1	1	23.9	1
20.2	1	24.0	1
20.3	1	24.1	0
20.4	1	24.2	0
20.5	1	24.3	0
20.6	1	24.4	0
20.7	1	24.5	0
20.8	1	24.6	0
20.9	1	24.7	0
21.0	1	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0
21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

SHT A16

POND-2 Version: 5.17
S/N:

RETENTION BASIN NO. 1

CALCULATED 08-19-1997 10:23:58
DISK FILE: c:\po165tk\SW1 .VOL

Planimeter scale: 1 inch = 40 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
531.40	0.00	0.00	0.00	0.00	0.00
532.00	5.27	0.19	0.19	0.04	0.04
533.00	16.74	0.61	1.15	0.38	0.42
534.00	23.83	0.88	2.22	0.74	1.16
535.00	25.38	0.93	2.71	0.90	2.07
536.00	26.97	0.99	2.88	0.96	3.03
537.00	28.60	1.05	3.06	1.02	4.05
538.00	31.45	1.16	3.31	1.10	5.15
539.00	35.20	1.29	3.67	1.22	6.38
540.00	36.27	1.33	3.94	1.31	7.69

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

532.90	-----	0.56	1.09	0.33	0.36
538.50	-----	1.22	3.57	0.59	5.75

* Incremental volume computed by the Conic Method for Reservoir Volumes.

SHT A12 1002


```
*************************
*                       *
*   RETENTION BASIN 1   *
* 25 YR - 24 HR STORM   *
* PROPOSED CONDITIONS   *
*                       *
*                       *
*************************
```

Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Rating Table file: c:\po165tk\SW1 .PND

----INITIAL CONDITIONS----
Elevation = 532.90 ft — MAX. SEDIMENT CLEANOUT ELEV.
Outflow = 0.00 cfs
Storage = 0.36 ac-ft — MAX. SEDIMENT STORAGE VOLUME

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
531.40	0.0	0.000
532.00	0.0	0.040
532.90	0.0	0.360
533.00	0.0	0.420
534.00	0.0	1.160
535.00	0.0	2.070
536.00	0.0	3.030
537.00	0.0	4.050
538.00	0.0	5.150
538.50	0.0	5.750
539.00	0.0	6.380
540.00	0.0	7.690

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
9.7	9.7
87.1	87.1
101.6	101.6
280.7	280.7
500.9	500.9
733.3	733.3
980.1	980.1
1246.3	1246.3
1391.5	1391.5
1544.0	1544.0
1861.0	1861.0

Time increment (t) = 0.100 hrs.

SHT A18

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	2.00	-----	87.1	87.1	0.00	532.90
11.100	2.00	4.0	91.1	91.1	0.00	532.93
11.200	3.00	5.0	96.1	96.1	0.00	532.96
11.300	3.00	6.0	102.1	102.1	0.00	533.00
11.400	4.00	7.0	109.1	109.1	0.00	533.04
11.500	4.00	8.0	117.1	117.1	0.00	533.09
11.600	5.00	9.0	126.1	126.1	0.00	533.14
11.700	13.00	18.0	144.1	144.1	0.00	533.24
11.800	21.00	34.0	178.1	178.1	0.00	533.43
11.900	29.00	50.0	228.1	228.1	0.00	533.71
12.000	57.00	86.0	314.1	314.1	0.00	534.15
12.100	88.00	145.0	459.1	459.1	0.00	534.81
12.200	55.00	143.0	602.1	602.1	0.00	535.44
12.300	19.00	74.0	676.1	676.1	0.00	535.75
12.400	13.00	32.0	708.1	708.1	0.00	535.89
12.500	11.00	24.0	732.1	732.1	0.00	536.00
12.600	9.00	20.0	752.1	752.1	0.00	536.08
12.700	8.00	17.0	769.1	769.1	0.00	536.15
12.800	7.00	15.0	784.1	784.1	0.00	536.21
12.900	6.00	13.0	797.1	797.1	0.00	536.26
13.000	6.00	12.0	809.1	809.1	0.00	536.31
13.100	6.00	12.0	821.1	821.1	0.00	536.36
13.200	5.00	11.0	832.1	832.1	0.00	536.40
13.300	4.00	9.0	841.1	841.1	0.00	536.44
13.400	4.00	8.0	849.1	849.1	0.00	536.47
13.500	4.00	8.0	857.1	857.1	0.00	536.50
13.600	4.00	8.0	865.1	865.1	0.00	536.53
13.700	4.00	8.0	873.1	873.1	0.00	536.57
13.800	4.00	8.0	881.1	881.1	0.00	536.60
13.900	4.00	8.0	889.1	889.1	0.00	536.63
14.000	3.00	7.0	896.1	896.1	0.00	536.66
14.100	3.00	6.0	902.1	902.1	0.00	536.68
14.200	3.00	6.0	908.1	908.1	0.00	536.71
14.300	3.00	6.0	914.1	914.1	0.00	536.73
14.400	3.00	6.0	920.1	920.1	0.00	536.76
14.500	3.00	6.0	926.1	926.1	0.00	536.78
14.600	3.00	6.0	932.1	932.1	0.00	536.81
14.700	3.00	6.0	938.1	938.1	0.00	536.83
14.800	3.00	6.0	944.1	944.1	0.00	536.85
14.900	3.00	6.0	950.1	950.1	0.00	536.88
15.000	3.00	6.0	956.1	956.1	0.00	536.90
15.100	3.00	6.0	962.1	962.1	0.00	536.93
15.200	3.00	6.0	968.1	968.1	0.00	536.95
15.300	2.00	5.0	973.1	973.1	0.00	536.97
15.400	2.00	4.0	977.1	977.1	0.00	536.99

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	2.00	4.0	981.1	981.1	0.00	537.00
15.600	2.00	4.0	985.1	985.1	0.00	537.02
15.700	2.00	4.0	989.1	989.1	0.00	537.03
15.800	2.00	4.0	993.1	993.1	0.00	537.05
15.900	2.00	4.0	997.1	997.1	0.00	537.06
16.000	2.00	4.0	1001.1	1001.1	0.00	537.08
16.100	2.00	4.0	1005.1	1005.1	0.00	537.09
16.200	2.00	4.0	1009.1	1009.1	0.00	537.11
16.300	2.00	4.0	1013.1	1013.1	0.00	537.12
16.400	2.00	4.0	1017.1	1017.1	0.00	537.14
16.500	2.00	4.0	1021.1	1021.1	0.00	537.15
16.600	2.00	4.0	1025.1	1025.1	0.00	537.17
16.700	2.00	4.0	1029.1	1029.1	0.00	537.18
16.800	2.00	4.0	1033.1	1033.1	0.00	537.20
16.900	2.00	4.0	1037.1	1037.1	0.00	537.21
17.000	2.00	4.0	1041.1	1041.1	0.00	537.23
17.100	2.00	4.0	1045.1	1045.1	0.00	537.24
17.200	2.00	4.0	1049.1	1049.1	0.00	537.26
17.300	2.00	4.0	1053.1	1053.1	0.00	537.27
17.400	2.00	4.0	1057.1	1057.1	0.00	537.29
17.500	2.00	4.0	1061.1	1061.1	0.00	537.30
17.600	2.00	4.0	1065.1	1065.1	0.00	537.32
17.700	2.00	4.0	1069.1	1069.1	0.00	537.33
17.800	2.00	4.0	1073.1	1073.1	0.00	537.35
17.900	2.00	4.0	1077.1	1077.1	0.00	537.36
18.000	2.00	4.0	1081.1	1081.1	0.00	537.38
18.100	2.00	4.0	1085.1	1085.1	0.00	537.39
18.200	2.00	4.0	1089.1	1089.1	0.00	537.41
18.300	2.00	4.0	1093.1	1093.1	0.00	537.42
18.400	2.00	4.0	1097.1	1097.1	0.00	537.44
18.500	2.00	4.0	1101.1	1101.1	0.00	537.45
18.600	1.00	3.0	1104.1	1104.1	0.00	537.47
18.700	1.00	2.0	1106.1	1106.1	0.00	537.47
18.800	1.00	2.0	1108.1	1108.1	0.00	537.48
18.900	1.00	2.0	1110.1	1110.1	0.00	537.49
19.000	1.00	2.0	1112.1	1112.1	0.00	537.50
19.100	1.00	2.0	1114.1	1114.1	0.00	537.50
19.200	1.00	2.0	1116.1	1116.1	0.00	537.51
19.300	1.00	2.0	1118.1	1118.1	0.00	537.52
19.400	1.00	2.0	1120.1	1120.1	0.00	537.53
19.500	1.00	2.0	1122.1	1122.1	0.00	537.53
19.600	1.00	2.0	1124.1	1124.1	0.00	537.54
19.700	1.00	2.0	1126.1	1126.1	0.00	537.55
19.800	1.00	2.0	1128.1	1128.1	0.00	537.56
19.900	1.00	2.0	1130.1	1130.1	0.00	537.56
20.000	1.00	2.0	1132.1	1132.1	0.00	537.57

SHT A20

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	1.00	2.0	1134.1	1134.1	0.00	537.58
20.200	1.00	2.0	1136.1	1136.1	0.00	537.59
20.300	1.00	2.0	1138.1	1138.1	0.00	537.59
20.400	1.00	2.0	1140.1	1140.1	0.00	537.60
20.500	1.00	2.0	1142.1	1142.1	0.00	537.61
20.600	1.00	2.0	1144.1	1144.1	0.00	537.62
20.700	1.00	2.0	1146.1	1146.1	0.00	537.62
20.800	1.00	2.0	1148.1	1148.1	0.00	537.63
20.900	1.00	2.0	1150.1	1150.1	0.00	537.64
21.000	1.00	2.0	1152.1	1152.1	0.00	537.65
21.100	1.00	2.0	1154.1	1154.1	0.00	537.65
21.200	1.00	2.0	1156.1	1156.1	0.00	537.66
21.300	1.00	2.0	1158.1	1158.1	0.00	537.67
21.400	1.00	2.0	1160.1	1160.1	0.00	537.68
21.500	1.00	2.0	1162.1	1162.1	0.00	537.68
21.600	1.00	2.0	1164.1	1164.1	0.00	537.69
21.700	1.00	2.0	1166.1	1166.1	0.00	537.70
21.800	1.00	2.0	1168.1	1168.1	0.00	537.71
21.900	1.00	2.0	1170.1	1170.1	0.00	537.71
22.000	1.00	2.0	1172.1	1172.1	0.00	537.72
22.100	1.00	2.0	1174.1	1174.1	0.00	537.73
22.200	1.00	2.0	1176.1	1176.1	0.00	537.74
22.300	1.00	2.0	1178.1	1178.1	0.00	537.74
22.400	1.00	2.0	1180.1	1180.1	0.00	537.75
22.500	1.00	2.0	1182.1	1182.1	0.00	537.76
22.600	1.00	2.0	1184.1	1184.1	0.00	537.77
22.700	1.00	2.0	1186.1	1186.1	0.00	537.77
22.800	1.00	2.0	1188.1	1188.1	0.00	537.78
22.900	1.00	2.0	1190.1	1190.1	0.00	537.79
23.000	1.00	2.0	1192.1	1192.1	0.00	537.80
23.100	1.00	2.0	1194.1	1194.1	0.00	537.80
23.200	1.00	2.0	1196.1	1196.1	0.00	537.81
23.300	1.00	2.0	1198.1	1198.1	0.00	537.82
23.400	1.00	2.0	1200.1	1200.1	0.00	537.83
23.500	1.00	2.0	1202.1	1202.1	0.00	537.83
23.600	1.00	2.0	1204.1	1204.1	0.00	537.84
23.700	1.00	2.0	1206.1	1206.1	0.00	537.85
23.800	1.00	2.0	1208.1	1208.1	0.00	537.86
23.900	1.00	2.0	1210.1	1210.1	0.00	537.86
24.000	0.00	1.0	1211.1	1211.1	0.00	537.87
24.100	0.00	0.0	1211.1	1211.1	0.00	537.87
24.200	0.00	0.0	1211.1	1211.1	0.00	537.87
24.300	0.00	0.0	1211.1	1211.1	0.00	537.87
24.400	0.00	0.0	1211.1	1211.1	0.00	537.87
24.500	0.00	0.0	1211.1	1211.1	0.00	537.87
24.600	0.00	0.0	1211.1	1211.1	0.00	537.87

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
24.700	0.00
24.800	0.00
24.900	0.00
25.000	0.00
25.100	0.00
25.200	0.00
25.300	0.00
25.400	0.00
25.500	0.00
25.600	0.00
25.700	0.00
25.800	0.00
25.900	0.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87
0.0	1211.1	1211.1	0.00	537.87

SHTA22

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

Starting Pond W.S. Elevation = 532.90 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 88.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 537.87 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.36 ac-ft
Peak Storage From Storm = 4.64 ac-ft

Total Storage in Pond = 5.00 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

PEAK ELEV 537.87 < OVERFLOW ELEV 538.5

∴ BASIN IS ACCEPTABLE

SHT A23 1002

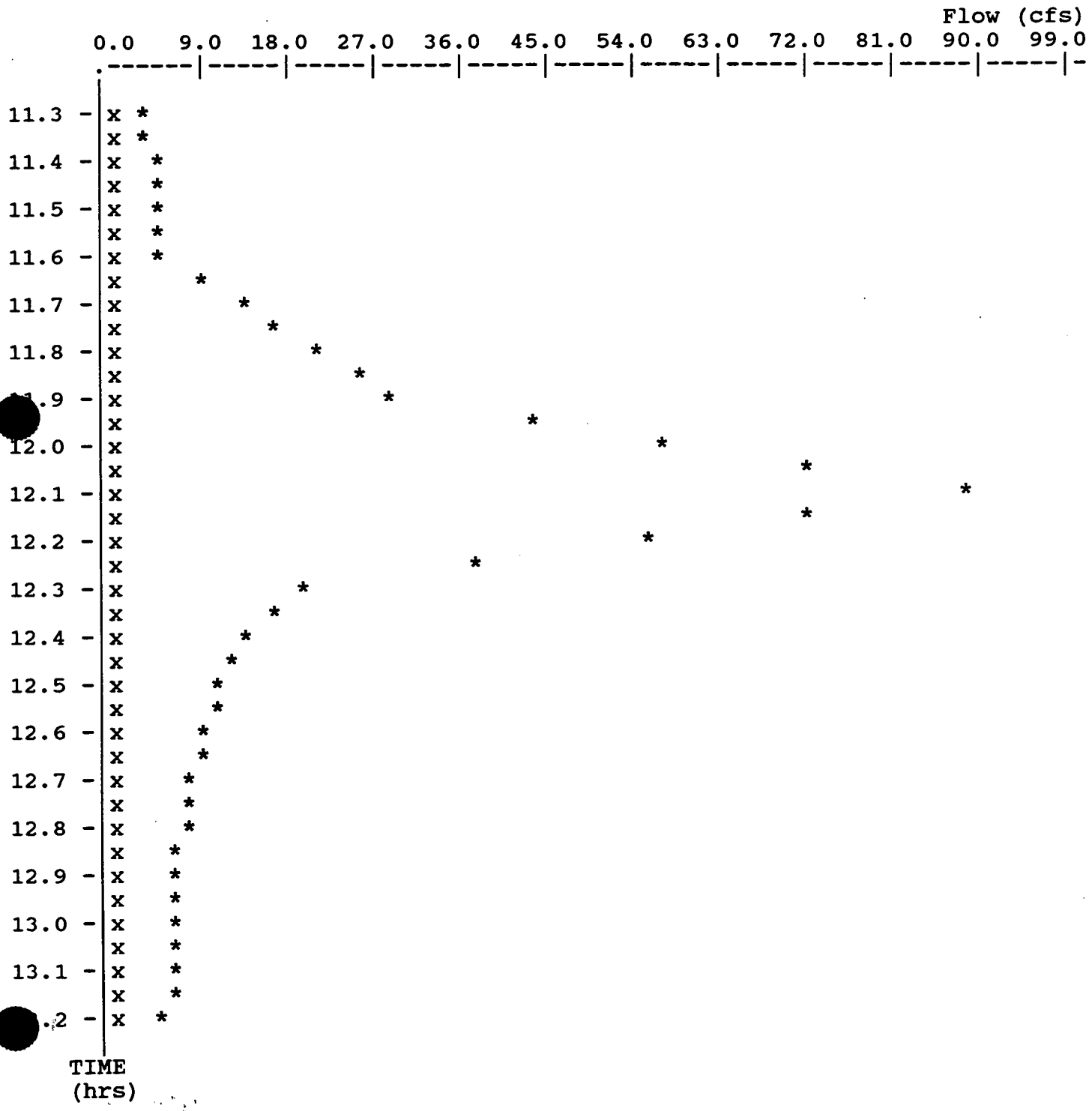
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.17 S/N:

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

EXECUTED: 08-19-1997
10:26:34

Peak Inflow = 88.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 537.87 ft



SHTA24

```
*  File:   c:\po165tk\P1-25    .HYD    Qmax =     88.0 cfs
x  File:   c:\po165tk\SW1      .HYD    Qmax =      0.0 cfs
```

SHT A 25

1062

RETENTION BASIN 2

SHT A26

```
Quick TR-55 Ver.5.46    S/N:
Executed: 10:33:15   08-19-1997    c:\po165tk\P2E.TCT

                         RETENTION BASIN 2
                        EXISTING CONDITIONS


                   Tc COMPUTATIONS FOR: P2

SHEET FLOW (Applicable to Tc only)
    Segment ID                                     1
    Surface description                       RANGE
    Manning's roughness coeff., n                  0.1300
    Flow length, L (total < or = 300)       ft     266.0
    Two-yr 24-hr rainfall, P2               in     3.000
    Land slope, s                        ft/ft     0.0450
                          0.8
         .007 * (n*L)
    T =  -------------                     hrs      0.24          =  0.24
            0.5    0.4
          P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                    2
    Surface (paved or unpaved)?                   Unpaved
    Flow length, L                          ft     160.0
    Watercourse slope, s                 ft/ft     0.0970

                               0.5
    Avg.V =   Csf *   (s)                 ft/s    5.0251
    where:    Unpaved Csf = 16.1345
              Paved   Csf = 20.3282

    T = L / (3600*V)                       hrs      0.01          =  0.01


CHANNEL FLOW
    Segment ID                                     3
    Cross Sectional Flow Area, a          sq.ft     1.48 <- FROM DITCH
    Wetted perimeter, Pw                    ft      3.85 <- 8B CALC.
    Hydraulic radius, r = a/Pw              ft     0.384
    Channel slope, s                     ft/ft     0.1000
    Manning's roughness coeff., n                  0.0600

                        2/3    1/2
          1.49   *  r    *  s
    V =   --------------------            ft/s    4.1518
                    n

    Flow length, L                          ft       280

    T = L / (3600*V)                       hrs      0.02          =  0.02
:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)           0.27
```

000299

SHA27

1062

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:15 08-19-1997 c:\po165tk\P2E.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN 2
EXISTING CONDITIONS

Subarea descr.	Tc or Tt	Time (hrs)
P2	Tc	0.27

SHT A28

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:45 08-19-1997

RETENTION BASIN 2, EXISTING CONDITIONS
HoA 51.0%, Gn 36.9%, HeF 6.4%,
GRAVEL ROAD 3.0%,
MaC2 2.7%

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
HoA (C): BRUSH, FAIR	2.43	70	
HoA (C): FALLOW, BARE SOIL	1.16	91	
Gn (B): BRUSH, FAIR	1.00	56	
Gn (B): FALLOW, BARE SOIL	1.60	86	
HeF, (B): BRUSH, FAIR	0.45	56	
MaC2, (C): BRUSH, FAIR	0.19	70	
GRAVEL ROAD	0.21	91	
COMPOSITE AREA --->	7.04	74.8	(75)

::

SHT A29

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:45 08-19-1997

1062

RETENTION BASIN 2, EXISTING CONDITIONS
HoA 51.0%, Gn 36.9%, HeF 6.4%,
GRAVEL ROAD 3.0%,
MaC2 2.7%

RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
	7.04	75

SRT A30

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
P2	7.04	75.0	0.30	0.00	4.80	2.29	I.14	.14

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 7.04 acres or 0.01100 sq.mi
Peak discharge = 17 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P2	0.27	0.00	0.30	0.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P2	17	12.3
Composite Watershed	17	12.3

SHTA32

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P2	0	1	1	2	5	10	16	17	12
Total (cfs)	0	1	1	2	5	10	16	17	12

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P2	7	5	4	3	2	2	2	1	1
Total (cfs)	7	5	4	3	2	2	2	1	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P2	1	1	1	1	1	1	1	1	1
Total (cfs)	1	1	1	1	1	1	1	1	1

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P2	1	0	0	0	0
Total (cfs)	1	0	0	0	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	1
11.1	0	14.9	1
11.2	1	15.0	1
11.3	1	15.1	1
11.4	1	15.2	1
11.5	1	15.3	1
11.6	1	15.4	1
11.7	1	15.5	1
11.8	2	15.6	1
11.9	2	15.7	1
12.0	5	15.8	1
12.1	10	15.9	1
12.2	16	16.0	1
12.3	17	16.1	1
12.4	12	16.2	1
12.5	7	16.3	1
12.6	5	16.4	1
12.7	4	16.5	1
12.8	3	16.6	1
12.9	2	16.7	1
13.0	2	16.8	1
13.1	2	16.9	1
13.2	2	17.0	1
13.3	2	17.1	1
13.4	2	17.2	1
13.5	2	17.3	1
13.6	1	17.4	1
13.7	1	17.5	1
13.8	1	17.6	1
13.9	1	17.7	1
14.0	1	17.8	1
14.1	1	17.9	1
14.2	1	18.0	1
14.3	1	18.1	1
14.4	1	18.2	1
14.5	1	18.3	1

SHT A34

14.6	1	18.4	1
14.7	1	18.5	1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	0	22.4	0
18.7	0	22.5	0
18.8	0	22.6	0
18.9	0	22.7	0
19.0	0	22.8	0
19.1	0	22.9	0
19.2	0	23.0	0
19.3	0	23.1	0
19.4	0	23.2	0
19.5	0	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

SHTA36

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:26 08-19-1997 c:\po165tk\P2.TCT

RETENTION BASIN 2
PROPOSED CONDITIONS

Tc COMPUTATIONS FOR: P2

SHEET FLOW (Applicable to Tc only)

Segment ID		1			
Surface description		BARE			
Manning's roughness coeff., n		0.0110			
Flow length, L (total < or = 300)	ft	250.0			
Two-yr 24-hr rainfall, P2	in	3.000			
Land slope, s	ft/ft	0.0280			
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.04		=	0.04

SHALLOW CONCENTRATED FLOW

Segment ID		2	3		
Surface (paved or unpaved)?		Unpaved	Unpaved		
Flow length, L	ft	210.0	220.0		
Watercourse slope, s	ft/ft	0.1190	0.0100		
$Avg.V = Csf * (s)^{0.5}$	ft/s	5.5658	1.6135		
where: Unpaved Csf = 16.1345					
Paved Csf = 20.3282					
T = L / (3600*V)	hrs	0.01	+ 0.04	=	0.05

CHANNEL FLOW

Segment ID		N/A			
Cross Sectional Flow Area, a	sq.ft	0.00			
Wetted perimeter, Pw	ft	0.00			
Hydraulic radius, r = a/Pw	ft	0.000			
Channel slope, s	ft/ft	0.0000			
Manning's roughness coeff., n		0.0000			
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000			
Flow length, L	ft	0			
T = L / (3600*V)	hrs	0.00		=	0.00

::

TOTAL TIME (hrs) 0.09

000309

use 0.1 hrs

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:26 08-19-1997 c:\po165tk\P2.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN 2
PROPOSED CONDITIONS

Subarea descr.	Tc or Tt	Time (hrs)
P2	Tc	0.09

USE 0.1 hrs

SHT A38

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:54 08-19-1997

RETENTION BASIN 2, PROPOSED CONDITIONS
HoA 49.5%, Gn 38.1%, HeF 6.6%,
GRAVEL ROAD 3.5%,
MaC2 2.3%

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
HoA (C): FALLOW, BARE SOIL	3.00	91	
Gn (B): FALLOW, BARE SOIL	2.31	86	
HeF, (B): FALLOW, BARE SOIL	0.40	86	
MaC2, (C): FALLOW, BARE SOIL	0.14	91	
GRAVEL ROAD	0.21	91	
COMPOSITE AREA --->	6.06	88.8	(89)

::

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:54 08-19-1997

RETENTION BASIN 2, PROPOSED CONDITIONS
HoA 49.5%, Gn 38.1%, HeF 6.6%,
GRAVEL ROAD 3.5%,
MaC2 2.3%

RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
	6.06	89

SHT A40

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
P2	6.06	89.0	0.10	0.00	4.80	3.58	I.05 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 6.06 acres or 0.00947 sq.mi
Peak discharge = 34 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P2	0.10	0.00	**	**	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P2	34	12.1
Composite Watershed	34	12.1

SHT A42

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P2	1	1	2	11	22	34	21	7	5
Total (cfs)	1	1	2	11	22	34	21	7	5

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P2	4	4	3	3	2	2	2	2	1
Total (cfs)	4	4	3	3	2	2	2	2	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P2	1	1	1	1	1	1	1	1	1
Total (cfs)	1	1	1	1	1	1	1	1	1

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P2	1	1	0	0	0
Total (cfs)	1	1	0	0	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	1	14.8	1
11.1	1	14.9	1
11.2	1	15.0	1
11.3	1	15.1	1
11.4	1	15.2	1
11.5	2	15.3	1
11.6	2	15.4	1
11.7	5	15.5	1
11.8	8	15.6	1
11.9	11	15.7	1
12.0	22	15.8	1
12.1	34	15.9	1
12.2	21	16.0	1
12.3	7	16.1	1
12.4	5	16.2	1
12.5	4	16.3	1
12.6	4	16.4	1
12.7	3	16.5	1
12.8	3	16.6	1
12.9	2	16.7	1
13.0	2	16.8	1
13.1	2	16.9	1
13.2	2	17.0	1
13.3	2	17.1	1
13.4	2	17.2	1
13.5	2	17.3	1
13.6	2	17.4	1
13.7	1	17.5	1
13.8	1	17.6	1
13.9	1	17.7	1
14.0	1	17.8	1
14.1	1	17.9	1
14.2	1	18.0	1
14.3	1	18.1	1
14.4	1	18.2	1
14.5	1	18.3	1

SHT A44

14.6	1	18.4	1
14.7	1	18.5	1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	1	22.4	0
18.7	1	22.5	0
18.8	1	22.6	0
18.9	1	22.7	0
19.0	1	22.8	0
19.1	1	22.9	0
19.2	1	23.0	0
19.3	1	23.1	0
19.4	1	23.2	0
19.5	1	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

SHT A46

POND-2 Version: 5.17 S/N:

>>>>> OUTFLOW HYDROGRAPH ESTIMATOR <<<<<

Inflow Hydrograph: c:\po165tk\P2E-25 .HYD
Qpeak = 17.0 cfs

Estimated Outflow: c:\po165tk\ESTIMATE.EST
Qpeak = 0.0 cfs

Approximate Storage Volume
(computed from t= 11.00 to 25.90 hrs)

1.3 acre-ft

POND-2 Version: 5.17 S/N:

>>>>> OUTFLOW HYDROGRAPH ESTIMATOR <<<<<

Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Qpeak = 34.0 cfs

Estimated Outflow: c:\po165tk\ESTIMATE.EST
Qpeak = 0.0 cfs

Approximate Storage Volume
(computed from t= 11.00 to 25.90 hrs)

1.7 acre-ft

NOTE: VOLUME ESTIMATE FOR EXISTING CONDITIONS = 1.3 AC.-FT (PREVIOUS SHEET)

VOLUME ESTIMATE FOR PROPOSED CONDITIONS = 1.7 AC-FT

USE PROPOSED CONDITIONS
FOR ROUTING

SHT A48

POND-2 Version: 5.17
S/N:

RETENTION BASIN 2
W/3:1 SIDE SLOPES

CALCULATED 08-19-1997 11:11:30
DISK FILE: c:\po165tk\SW2-T1 .VOL

Planimeter scale: 1 inch = 10 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
528.70	0.00	0.00	0.00	0.00	0.00
529.00	25.38	0.06	0.06	0.01	0.01
530.00	42.26	0.10	0.23	0.08	0.08
531.00	62.78	0.14	0.36	0.12	0.20
532.00	83.00	0.19	0.50	0.17	0.37
533.00	104.32	0.24	0.64	0.21	0.58
534.00	127.21	0.29	0.80	0.27	0.85
535.00	154.79	0.36	0.97	0.32	1.17
536.00	185.99	0.43	1.17	0.39	1.56
537.00	215.38	0.49	1.38	0.46	2.02

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

530.30	-----	0.11	0.31	0.03	0.11

* Incremental volume computed by the Conic Method for Reservoir Volumes.

SKT A49 & V.U2

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

```
**********************
*                    *
*   STORM BASIN NO. 2 *
*   W/3:1 SIDE SLOPES *
*                    *
*                    *
*                    *
**********************
```

Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Rating Table file: c:\po165tk\SW2-T1 .PND

----INITIAL CONDITIONS----
Elevation = 530.30 ft —— MAX. SEDIMENT CLEANOUT ELEV
Outflow = 0.00 cfs
Storage = 0.11 ac-ft —— MAX. SEDIMENT STORAGE VOLUME

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + O (cfs)
528.70	0.0	0.000	0.0	0.0
529.00	0.0	0.010	2.4	2.4
530.00	0.0	0.080	19.4	19.4
530.30	0.0	0.110	26.6	26.6
531.00	0.0	0.200	48.4	48.4
532.00	0.0	0.370	89.5	89.5
533.00	0.0	0.580	140.4	140.4
534.00	0.0	0.850	205.7	205.7
535.00	0.0	1.170	283.1	283.1
536.00	0.0	1.560	377.5	377.5
537.00	0.0	2.020	488.8	488.8

Time increment (t) = 0.100 hrs.

SHT A50

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	1.00	-----	26.6	26.6	0.00	530.30
11.100	1.00	2.0	28.6	28.6	0.00	530.36
11.200	1.00	2.0	30.6	30.6	0.00	530.43
11.300	1.00	2.0	32.6	32.6	0.00	530.49
11.400	1.00	2.0	34.6	34.6	0.00	530.56
11.500	2.00	3.0	37.6	37.6	0.00	530.65
11.600	2.00	4.0	41.6	41.6	0.00	530.78
11.700	5.00	7.0	48.6	48.6	0.00	531.01
11.800	8.00	13.0	61.6	61.6	0.00	531.32
11.900	11.00	19.0	80.6	80.6	0.00	531.78
12.000	22.00	33.0	113.6	113.6	0.00	532.47
12.100	34.00	56.0	169.6	169.6	0.00	533.45
12.200	21.00	55.0	224.6	224.6	0.00	534.24
12.300	7.00	28.0	252.6	252.6	0.00	534.61
12.400	5.00	12.0	264.6	264.6	0.00	534.76
12.500	4.00	9.0	273.6	273.6	0.00	534.88
12.600	4.00	8.0	281.6	281.6	0.00	534.98
12.700	3.00	7.0	288.6	288.6	0.00	535.06
12.800	3.00	6.0	294.6	294.6	0.00	535.12
12.900	2.00	5.0	299.6	299.6	0.00	535.17
13.000	2.00	4.0	303.6	303.6	0.00	535.22
13.100	2.00	4.0	307.6	307.6	0.00	535.26
13.200	2.00	4.0	311.6	311.6	0.00	535.30
13.300	2.00	4.0	315.6	315.6	0.00	535.34
13.400	2.00	4.0	319.6	319.6	0.00	535.39
13.500	2.00	4.0	323.6	323.6	0.00	535.43
13.600	2.00	4.0	327.6	327.6	0.00	535.47
13.700	2.00	4.0	331.6	331.6	0.00	535.51
13.800	1.00	3.0	334.6	334.6	0.00	535.55
13.900	1.00	2.0	336.6	336.6	0.00	535.57
14.000	1.00	2.0	338.6	338.6	0.00	535.59
14.100	1.00	2.0	340.6	340.6	0.00	535.61
14.200	1.00	2.0	342.6	342.6	0.00	535.63
14.300	1.00	2.0	344.6	344.6	0.00	535.65
14.400	1.00	2.0	346.6	346.6	0.00	535.67
14.500	1.00	2.0	348.6	348.6	0.00	535.69
14.600	1.00	2.0	350.6	350.6	0.00	535.71
14.700	1.00	2.0	352.6	352.6	0.00	535.74
14.800	1.00	2.0	354.6	354.6	0.00	535.76
14.900	1.00	2.0	356.6	356.6	0.00	535.78
15.000	1.00	2.0	358.6	358.6	0.00	535.80
15.100	1.00	2.0	360.6	360.6	0.00	535.82
15.200	1.00	2.0	362.6	362.6	0.00	535.84
15.300	1.00	2.0	364.6	364.6	0.00	535.86
15.400	1.00	2.0	366.6	366.6	0.00	535.88

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	1.00	2.0	368.6	368.6	0.00	535.91
15.600	1.00	2.0	370.6	370.6	0.00	535.93
15.700	1.00	2.0	372.6	372.6	0.00	535.95
15.800	1.00	2.0	374.6	374.6	0.00	535.97
15.900	1.00	2.0	376.6	376.6	0.00	535.99
16.000	1.00	2.0	378.6	378.6	0.00	536.01
16.100	1.00	2.0	380.6	380.6	0.00	536.03
16.200	1.00	2.0	382.6	382.6	0.00	536.05
16.300	1.00	2.0	384.6	384.6	0.00	536.06
16.400	1.00	2.0	386.6	386.6	0.00	536.08
16.500	1.00	2.0	388.6	388.6	0.00	536.10
16.600	1.00	2.0	390.6	390.6	0.00	536.12
16.700	1.00	2.0	392.6	392.6	0.00	536.14
16.800	1.00	2.0	394.6	394.6	0.00	536.15
16.900	1.00	2.0	396.6	396.6	0.00	536.17
17.000	1.00	2.0	398.6	398.6	0.00	536.19
17.100	1.00	2.0	400.6	400.6	0.00	536.21
17.200	1.00	2.0	402.6	402.6	0.00	536.23
17.300	1.00	2.0	404.6	404.6	0.00	536.24
17.400	1.00	2.0	406.6	406.6	0.00	536.26
17.500	1.00	2.0	408.6	408.6	0.00	536.28
17.600	1.00	2.0	410.6	410.6	0.00	536.30
17.700	1.00	2.0	412.6	412.6	0.00	536.32
17.800	1.00	2.0	414.6	414.6	0.00	536.33
17.900	1.00	2.0	416.6	416.6	0.00	536.35
18.000	1.00	2.0	418.6	418.6	0.00	536.37
18.100	1.00	2.0	420.6	420.6	0.00	536.39
18.200	1.00	2.0	422.6	422.6	0.00	536.41
18.300	1.00	2.0	424.6	424.6	0.00	536.42
18.400	1.00	2.0	426.6	426.6	0.00	536.44
18.500	1.00	2.0	428.6	428.6	0.00	536.46
18.600	1.00	2.0	430.6	430.6	0.00	536.48
18.700	1.00	2.0	432.6	432.6	0.00	536.49
18.800	1.00	2.0	434.6	434.6	0.00	536.51
18.900	1.00	2.0	436.6	436.6	0.00	536.53
19.000	1.00	2.0	438.6	438.6	0.00	536.55
19.100	1.00	2.0	440.6	440.6	0.00	536.57
19.200	1.00	2.0	442.6	442.6	0.00	536.58
19.300	1.00	2.0	444.6	444.6	0.00	536.60
19.400	1.00	2.0	446.6	446.6	0.00	536.62
19.500	0.00	1.0	447.6	447.6	0.00	536.63
19.600	0.00	0.0	447.6	447.6	0.00	536.63
19.700	0.00	0.0	447.6	447.6	0.00	536.63
19.800	0.00	0.0	447.6	447.6	0.00	536.63
19.900	0.00	0.0	447.6	447.6	0.00	536.63
20.000	0.00	0.0	447.6	447.6	0.00	536.63

SHT A52

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	0.00	0.0	447.6	447.6	0.00	536.63
20.200	0.00	0.0	447.6	447.6	0.00	536.63
20.300	0.00	0.0	447.6	447.6	0.00	536.63
20.400	0.00	0.0	447.6	447.6	0.00	536.63
20.500	0.00	0.0	447.6	447.6	0.00	536.63
20.600	0.00	0.0	447.6	447.6	0.00	536.63
20.700	0.00	0.0	447.6	447.6	0.00	536.63
20.800	0.00	0.0	447.6	447.6	0.00	536.63
20.900	0.00	0.0	447.6	447.6	0.00	536.63
21.000	0.00	0.0	447.6	447.6	0.00	536.63
21.100	0.00	0.0	447.6	447.6	0.00	536.63
21.200	0.00	0.0	447.6	447.6	0.00	536.63
21.300	0.00	0.0	447.6	447.6	0.00	536.63
21.400	0.00	0.0	447.6	447.6	0.00	536.63
21.500	0.00	0.0	447.6	447.6	0.00	536.63
21.600	0.00	0.0	447.6	447.6	0.00	536.63
21.700	0.00	0.0	447.6	447.6	0.00	536.63
21.800	0.00	0.0	447.6	447.6	0.00	536.63
21.900	0.00	0.0	447.6	447.6	0.00	536.63
22.000	0.00	0.0	447.6	447.6	0.00	536.63
22.100	0.00	0.0	447.6	447.6	0.00	536.63
22.200	0.00	0.0	447.6	447.6	0.00	536.63
22.300	0.00	0.0	447.6	447.6	0.00	536.63
22.400	0.00	0.0	447.6	447.6	0.00	536.63
22.500	0.00	0.0	447.6	447.6	0.00	536.63
22.600	0.00	0.0	447.6	447.6	0.00	536.63
22.700	0.00	0.0	447.6	447.6	0.00	536.63
22.800	0.00	0.0	447.6	447.6	0.00	536.63
22.900	0.00	0.0	447.6	447.6	0.00	536.63
23.000	0.00	0.0	447.6	447.6	0.00	536.63
23.100	0.00	0.0	447.6	447.6	0.00	536.63
23.200	0.00	0.0	447.6	447.6	0.00	536.63
23.300	0.00	0.0	447.6	447.6	0.00	536.63
23.400	0.00	0.0	447.6	447.6	0.00	536.63
23.500	0.00	0.0	447.6	447.6	0.00	536.63
23.600	0.00	0.0	447.6	447.6	0.00	536.63
23.700	0.00	0.0	447.6	447.6	0.00	536.63
23.800	0.00	0.0	447.6	447.6	0.00	536.63
23.900	0.00	0.0	447.6	447.6	0.00	536.63
24.000	0.00	0.0	447.6	447.6	0.00	536.63
24.100	0.00	0.0	447.6	447.6	0.00	536.63
24.200	0.00	0.0	447.6	447.6	0.00	536.63
24.300	0.00	0.0	447.6	447.6	0.00	536.63
24.400	0.00	0.0	447.6	447.6	0.00	536.63
24.500	0.00	0.0	447.6	447.6	0.00	536.63
24.600	0.00	0.0	447.6	447.6	0.00	536.63

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	447.6	447.6	0.00	536.63
24.800	0.00	0.0	447.6	447.6	0.00	536.63
24.900	0.00	0.0	447.6	447.6	0.00	536.63
25.000	0.00	0.0	447.6	447.6	0.00	536.63
25.100	0.00	0.0	447.6	447.6	0.00	536.63
25.200	0.00	0.0	447.6	447.6	0.00	536.63
25.300	0.00	0.0	447.6	447.6	0.00	536.63
25.400	0.00	0.0	447.6	447.6	0.00	536.63
25.500	0.00	0.0	447.6	447.6	0.00	536.63
25.600	0.00	0.0	447.6	447.6	0.00	536.63
25.700	0.00	0.0	447.6	447.6	0.00	536.63
25.800	0.00	0.0	447.6	447.6	0.00	536.63
25.900	0.00	0.0	447.6	447.6	0.00	536.63

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

Starting Pond W.S. Elevation = 530.30 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 34.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 536.63 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.11 ac-ft
Peak Storage From Storm = 1.74 ac-ft

Total Storage in Pond = 1.85 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

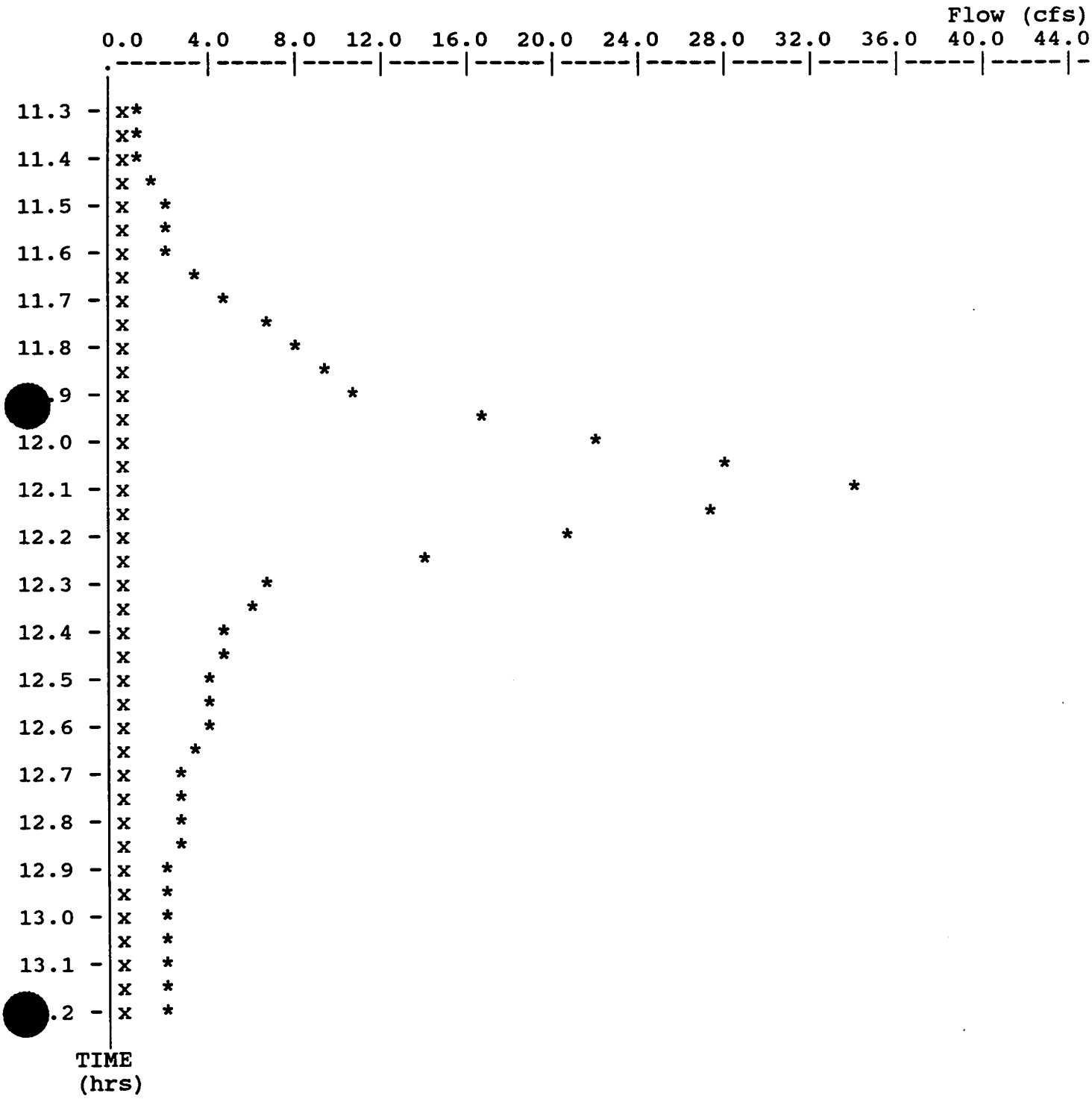
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.17 S/N:

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

EXECUTED: 08-19-1997
11:12:44

Peak Inflow = 34.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 536.63 ft



```
*  File:  c:\po165tk\P2-25    .HYD   Qmax =    34.0 cfs
x  File:  c:\po165tk\SW2-T1   .HYD   Qmax =     0.0 cfs
```

SHT A56

RETENTION BASIN 3

SHT A58

```
Quick TR-55 Ver.5.46   S/N:
Executed: 11:20:38   08-19-1997     c:\po165tk\P3.TCT

                              RETENTION BASIN 3


                      Tc COMPUTATIONS FOR: P3

SHEET FLOW (Applicable to Tc only)
    Segment ID                                     1
    Surface description                      BARE SOIL
    Manning's roughness coeff., n                 0.0110
    Flow length, L (total < or = 300)     ft      222.0
    Two-yr 24-hr rainfall, P2             in      3.000
    Land slope, s                       ft/ft     0.0810
                         0.8
         .007 * (n*L)
    T = --------------                   hrs       0.02              =  0.02
            0.5     0.4
          P2    *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                     2
    Surface (paved or unpaved)?                  Unpaved
    Flow length, L                        ft      145.0
    Watercourse slope, s                ft/ft     0.0760

                             0.5
    Avg.V =  Csf *  (s)                 ft/s      4.4480
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                     hrs       0.01              =  0.01


CHANNEL FLOW
    Segment ID                                    N/A
    Cross Sectional Flow Area, a        sq.ft      0.00
    Wetted perimeter, Pw                  ft       0.00
    Hydraulic radius, r = a/Pw            ft      0.000
    Channel slope, s                    ft/ft     0.0000
    Manning's roughness coeff., n                 0.0000

                        2/3    1/2
         1.49   *   r    *   s
    V = --------------------            ft/s      0.0000
                    n

    Flow length, L                        ft           0

    T = L / (3600*V)                     hrs       0.00              =  0.00

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                                 TOTAL TIME (hrs)     0.03
```

000331

USE 0.1 hrs

SHT A59 1062

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:38 08-19-1997 c:\po165tk\P3.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN 3

Subarea descr.	Tc or Tt	Time (hrs)
P3	Tc	0.03

USE 0.1 hrs

SHT A60

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:53 08-19-1997

RETENTION BASIN 3
HoA 35%, MoE2 30%, Gn 15%, HeF 11.6%
GRAVEL SURFACE = 8.4%%
ASSUMED ANY VEG AREA AS BARE

RUNOFF CURVE NUMBER DATA

::

Composite Area: P3

SURFACE DESCRIPTION	AREA (acres)	CN	
HoA, (C): FALLOW, BARE SOIL	1.67	91	
MoE2, (B): FALLOW, BARE SOIL	1.43	86	
Gn, (B): FALLOW, BARE SOIL	0.72	86	
HeF, (B): FALLOW, BARE SOIL	0.56	86	
GRAVEL ROAD	0.40	91	
COMPOSITE AREA --->	4.78	88.2	(88)

::

SHT A61 1062

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:53 08-19-1997

RETENTION BASIN 3
HoA 35%, MoE2 30%, Gn 15%, HeF 11.6%
GRAVEL SURFACE = 8.4%%
ASSUMED ANY VEG AREA AS BARE

RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
P3	4.78	88

SHT A52

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
P3	4.78	88.0	0.10	0.00	4.10	2.82	I.07 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 4.78 acres or 0.00747 sq.mi
Peak discharge = 21 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P3	0.10	0.00	**	**	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P3	21	12.1
Composite Watershed	21	12.1

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P3	1	1	1	7	14	21	13	5	3
Total (cfs)	1	1	1	7	14	21	13	5	3

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P3	3	2	2	2	1	1	1	1	1
Total (cfs)	3	2	2	2	1	1	1	1	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P3	1	1	1	1	1	0	0	0	0
Total (cfs)	1	1	1	1	1	0	0	0	0

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P3	0	0	0	0	0
Total (cfs)	0	0	0	0	0

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	1	14.8	1
11.1	1	14.9	1
11.2	1	15.0	1
11.3	1	15.1	1
11.4	1	15.2	1
11.5	1	15.3	1
11.6	1	15.4	1
11.7	3	15.5	1
11.8	5	15.6	1
11.9	7	15.7	1
12.0	14	15.8	0
12.1	21	15.9	0
12.2	13	16.0	0
12.3	5	16.1	0
12.4	3	16.2	0
12.5	3	16.3	0
12.6	2	16.4	0
12.7	2	16.5	0
12.8	2	16.6	0
12.9	1	16.7	0
13.0	1	16.8	0
13.1	1	16.9	0
13.2	1	17.0	0
13.3	1	17.1	0
13.4	1	17.2	0
13.5	1	17.3	0
13.6	1	17.4	0
13.7	1	17.5	0
13.8	1	17.6	0
13.9	1	17.7	0
14.0	1	17.8	0
14.1	1	17.9	0
14.2	1	18.0	0
14.3	1	18.1	0
14.4	1	18.2	0
14.5	1	18.3	0

SHT A60

14.6	1	18.4	0
14.7	1	18.5	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	0	22.4	0
18.7	0	22.5	0
18.8	0	22.6	0
18.9	0	22.7	0
19.0	0	22.8	0
19.1	0	22.9	0
19.2	0	23.0	0
19.3	0	23.1	0
19.4	0	23.2	0
19.5	0	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

POND-2 Version: 5.17
S/N:

SHT A68

RETENTION BASIN 3
W/3:1 SIDE SLOPES
1' DEEPER

CALCULATED 08-19-1997 13:16:51
DISK FILE: c:\po165tk\SW3-T1 .VOL

Planimeter scale: 1 inch = 10 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
532.50	0.00	0.00	0.00	0.00	0.00
533.00	26.52	0.06	0.06	0.01	0.01
534.00	36.29	0.08	0.22	0.07	0.08
535.00	47.04	0.11	0.29	0.10	0.18
536.00	58.73	0.13	0.36	0.12	0.30
537.00	71.40	0.16	0.45	0.15	0.45
538.00	85.08	0.20	0.54	0.18	0.63
539.00	99.71	0.23	0.64	0.21	0.84
540.00	117.39	0.27	0.75	0.25	1.09
541.00	131.90	0.30	0.86	0.29	1.37

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

540.10	-----	0.27	0.81	0.03	1.11
540.20	-----	0.28	0.82	0.05	1.14
540.30	-----	0.28	0.82	0.08	1.17
540.40	-----	0.28	0.83	0.11	1.20
540.50	-----	0.29	0.83	0.14	1.23
540.60	-----	0.29	0.84	0.17	1.26
540.70	-----	0.29	0.84	0.20	1.28
540.80	-----	0.30	0.85	0.23	1.31
540.90	-----	0.30	0.85	0.26	1.34

* Incremental volume computed by the Conic Method for Reservoir Volumes.

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51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*****************************
*                           *
* STORM WATER BASIN NO. 3   *
*                           *
*                           *
*                           *
*                           *
*****************************
```

Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Rating Table file: c:\po165tk\SW3-T1 .PND

----INITIAL CONDITIONS----
Elevation = 534.20 ft — MAX. SEDIMENT CLEANOUT ELEV.
Outflow = 0.00 cfs
Storage = 0.10 ac-ft — MAX. SEDIMENT STORAGE

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + O (cfs)
532.50	0.0	0.000	0.0	0.0
533.00	0.0	0.010	2.4	2.4
534.00	0.0	0.080	19.4	19.4
535.00	0.0	0.180	43.6	43.6
536.00	0.0	0.300	72.6	72.6
537.00	0.0	0.450	108.9	108.9
538.00	0.0	0.630	152.5	152.5
539.00	0.0	0.840	203.3	203.3
540.00	0.0	1.090	263.8	263.8
540.10	3.2	1.110	268.6	271.8
540.20	6.5	1.140	275.9	282.4
540.30	9.7	1.170	283.1	292.8
540.40	13.0	1.200	290.4	303.4
540.50	16.2	1.230	297.7	313.9
540.60	22.1	1.260	304.9	327.0
540.70	29.6	1.280	309.8	339.4
540.80	37.8	1.310	317.0	354.8
540.90	46.8	1.340	324.3	371.1
541.00	56.5	1.370	331.5	388.0

Time increment (t) = 0.100 hrs.

SHT A 70

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	1.00	-----	24.2	24.2	0.00	534.20
11.100	1.00	2.0	26.2	26.2	0.00	534.28
11.200	1.00	2.0	28.2	28.2	0.00	534.37
11.300	1.00	2.0	30.2	30.2	0.00	534.45
11.400	1.00	2.0	32.2	32.2	0.00	534.53
11.500	1.00	2.0	34.2	34.2	0.00	534.61
11.600	1.00	2.0	36.2	36.2	0.00	534.70
11.700	3.00	4.0	40.2	40.2	0.00	534.86
11.800	5.00	8.0	48.2	48.2	0.00	535.16
11.900	7.00	12.0	60.2	60.2	0.00	535.57
12.000	14.00	21.0	81.2	81.2	0.00	536.24
12.100	21.00	35.0	116.2	116.2	0.00	537.17
12.200	13.00	34.0	150.2	150.2	0.00	537.95
12.300	5.00	18.0	168.2	168.2	0.00	538.31
12.400	3.00	8.0	176.2	176.2	0.00	538.47
12.500	3.00	6.0	182.2	182.2	0.00	538.59
12.600	2.00	5.0	187.2	187.2	0.00	538.68
12.700	2.00	4.0	191.2	191.2	0.00	538.76
12.800	2.00	4.0	195.2	195.2	0.00	538.84
12.900	2.00	4.0	199.2	199.2	0.00	538.92
13.000	1.00	3.0	202.2	202.2	0.00	538.98
13.100	1.00	2.0	204.2	204.2	0.00	539.02
13.200	1.00	2.0	206.2	206.2	0.00	539.05
13.300	1.00	2.0	208.2	208.2	0.00	539.08
13.400	1.00	2.0	210.2	210.2	0.00	539.11
13.500	1.00	2.0	212.2	212.2	0.00	539.15
13.600	1.00	2.0	214.2	214.2	0.00	539.18
13.700	1.00	2.0	216.2	216.2	0.00	539.21
13.800	1.00	2.0	218.2	218.2	0.00	539.25
13.900	1.00	2.0	220.2	220.2	0.00	539.28
14.000	1.00	2.0	222.2	222.2	0.00	539.31
14.100	1.00	2.0	224.2	224.2	0.00	539.35
14.200	1.00	2.0	226.2	226.2	0.00	539.38
14.300	1.00	2.0	228.2	228.2	0.00	539.41
14.400	1.00	2.0	230.2	230.2	0.00	539.44
14.500	1.00	2.0	232.2	232.2	0.00	539.48
14.600	1.00	2.0	234.2	234.2	0.00	539.51
14.700	1.00	2.0	236.2	236.2	0.00	539.54
14.800	1.00	2.0	238.2	238.2	0.00	539.58
14.900	1.00	2.0	240.2	240.2	0.00	539.61
15.000	1.00	2.0	242.2	242.2	0.00	539.64
15.100	1.00	2.0	244.2	244.2	0.00	539.68
15.200	1.00	2.0	246.2	246.2	0.00	539.71
15.300	1.00	2.0	248.2	248.2	0.00	539.74
15.400	1.00	2.0	250.2	250.2	0.00	539.78

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	1.00	2.0	252.2	252.2	0.00	539.81
15.600	1.00	2.0	254.2	254.2	0.00	539.84
15.700	1.00	2.0	256.2	256.2	0.00	539.87
15.800	0.00	1.0	257.2	257.2	0.00	539.89
15.900	0.00	0.0	257.2	257.2	0.00	539.89
16.000	0.00	0.0	257.2	257.2	0.00	539.89
16.100	0.00	0.0	257.2	257.2	0.00	539.89
16.200	0.00	0.0	257.2	257.2	0.00	539.89
16.300	0.00	0.0	257.2	257.2	0.00	539.89
16.400	0.00	0.0	257.2	257.2	0.00	539.89
16.500	0.00	0.0	257.2	257.2	0.00	539.89
16.600	0.00	0.0	257.2	257.2	0.00	539.89
16.700	0.00	0.0	257.2	257.2	0.00	539.89
16.800	0.00	0.0	257.2	257.2	0.00	539.89
16.900	0.00	0.0	257.2	257.2	0.00	539.89
17.000	0.00	0.0	257.2	257.2	0.00	539.89
17.100	0.00	0.0	257.2	257.2	0.00	539.89
17.200	0.00	0.0	257.2	257.2	0.00	539.89
17.300	0.00	0.0	257.2	257.2	0.00	539.89
17.400	0.00	0.0	257.2	257.2	0.00	539.89
17.500	0.00	0.0	257.2	257.2	0.00	539.89
17.600	0.00	0.0	257.2	257.2	0.00	539.89
17.700	0.00	0.0	257.2	257.2	0.00	539.89
17.800	0.00	0.0	257.2	257.2	0.00	539.89
17.900	0.00	0.0	257.2	257.2	0.00	539.89
18.000	0.00	0.0	257.2	257.2	0.00	539.89
18.100	0.00	0.0	257.2	257.2	0.00	539.89
18.200	0.00	0.0	257.2	257.2	0.00	539.89
18.300	0.00	0.0	257.2	257.2	0.00	539.89
18.400	0.00	0.0	257.2	257.2	0.00	539.89
18.500	0.00	0.0	257.2	257.2	0.00	539.89
18.600	0.00	0.0	257.2	257.2	0.00	539.89
18.700	0.00	0.0	257.2	257.2	0.00	539.89
18.800	0.00	0.0	257.2	257.2	0.00	539.89
18.900	0.00	0.0	257.2	257.2	0.00	539.89
19.000	0.00	0.0	257.2	257.2	0.00	539.89
19.100	0.00	0.0	257.2	257.2	0.00	539.89
19.200	0.00	0.0	257.2	257.2	0.00	539.89
19.300	0.00	0.0	257.2	257.2	0.00	539.89
19.400	0.00	0.0	257.2	257.2	0.00	539.89
19.500	0.00	0.0	257.2	257.2	0.00	539.89
19.600	0.00	0.0	257.2	257.2	0.00	539.89
19.700	0.00	0.0	257.2	257.2	0.00	539.89
19.800	0.00	0.0	257.2	257.2	0.00	539.89
19.900	0.00	0.0	257.2	257.2	0.00	539.89
20.000	0.00	0.0	257.2	257.2	0.00	539.89

SHT A72

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	0.00	0.0	257.2	257.2	0.00	539.89
20.200	0.00	0.0	257.2	257.2	0.00	539.89
20.300	0.00	0.0	257.2	257.2	0.00	539.89
20.400	0.00	0.0	257.2	257.2	0.00	539.89
20.500	0.00	0.0	257.2	257.2	0.00	539.89
20.600	0.00	0.0	257.2	257.2	0.00	539.89
20.700	0.00	0.0	257.2	257.2	0.00	539.89
20.800	0.00	0.0	257.2	257.2	0.00	539.89
20.900	0.00	0.0	257.2	257.2	0.00	539.89
21.000	0.00	0.0	257.2	257.2	0.00	539.89
21.100	0.00	0.0	257.2	257.2	0.00	539.89
21.200	0.00	0.0	257.2	257.2	0.00	539.89
21.300	0.00	0.0	257.2	257.2	0.00	539.89
21.400	0.00	0.0	257.2	257.2	0.00	539.89
21.500	0.00	0.0	257.2	257.2	0.00	539.89
21.600	0.00	0.0	257.2	257.2	0.00	539.89
21.700	0.00	0.0	257.2	257.2	0.00	539.89
21.800	0.00	0.0	257.2	257.2	0.00	539.89
21.900	0.00	0.0	257.2	257.2	0.00	539.89
22.000	0.00	0.0	257.2	257.2	0.00	539.89
22.100	0.00	0.0	257.2	257.2	0.00	539.89
22.200	0.00	0.0	257.2	257.2	0.00	539.89
22.300	0.00	0.0	257.2	257.2	0.00	539.89
22.400	0.00	0.0	257.2	257.2	0.00	539.89
22.500	0.00	0.0	257.2	257.2	0.00	539.89
22.600	0.00	0.0	257.2	257.2	0.00	539.89
22.700	0.00	0.0	257.2	257.2	0.00	539.89
22.800	0.00	0.0	257.2	257.2	0.00	539.89
22.900	0.00	0.0	257.2	257.2	0.00	539.89
23.000	0.00	0.0	257.2	257.2	0.00	539.89
23.100	0.00	0.0	257.2	257.2	0.00	539.89
23.200	0.00	0.0	257.2	257.2	0.00	539.89
23.300	0.00	0.0	257.2	257.2	0.00	539.89
23.400	0.00	0.0	257.2	257.2	0.00	539.89
23.500	0.00	0.0	257.2	257.2	0.00	539.89
23.600	0.00	0.0	257.2	257.2	0.00	539.89
23.700	0.00	0.0	257.2	257.2	0.00	539.89
23.800	0.00	0.0	257.2	257.2	0.00	539.89
23.900	0.00	0.0	257.2	257.2	0.00	539.89
24.000	0.00	0.0	257.2	257.2	0.00	539.89
24.100	0.00	0.0	257.2	257.2	0.00	539.89
24.200	0.00	0.0	257.2	257.2	0.00	539.89
24.300	0.00	0.0	257.2	257.2	0.00	539.89
24.400	0.00	0.0	257.2	257.2	0.00	539.89
24.500	0.00	0.0	257.2	257.2	0.00	539.89
24.600	0.00	0.0	257.2	257.2	0.00	539.89

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	257.2	257.2	0.00	539.89
24.800	0.00	0.0	257.2	257.2	0.00	539.89
24.900	0.00	0.0	257.2	257.2	0.00	539.89
25.000	0.00	0.0	257.2	257.2	0.00	539.89
25.100	0.00	0.0	257.2	257.2	0.00	539.89
25.200	0.00	0.0	257.2	257.2	0.00	539.89
25.300	0.00	0.0	257.2	257.2	0.00	539.89
25.400	0.00	0.0	257.2	257.2	0.00	539.89
25.500	0.00	0.0	257.2	257.2	0.00	539.89
25.600	0.00	0.0	257.2	257.2	0.00	539.89
25.700	0.00	0.0	257.2	257.2	0.00	539.89
25.800	0.00	0.0	257.2	257.2	0.00	539.89
25.900	0.00	0.0	257.2	257.2	0.00	539.89

SHT A74

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

Starting Pond W.S. Elevation = 534.20 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 21.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 539.89 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.10 ac-ft
Peak Storage From Storm = 0.96 ac-ft

Total Storage in Pond = 1.06 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

PEAK ELEV = 539.89 < OVERFLOW OUTLET ELEV 540.0

∴ BASIN IS ACCEPTABLE

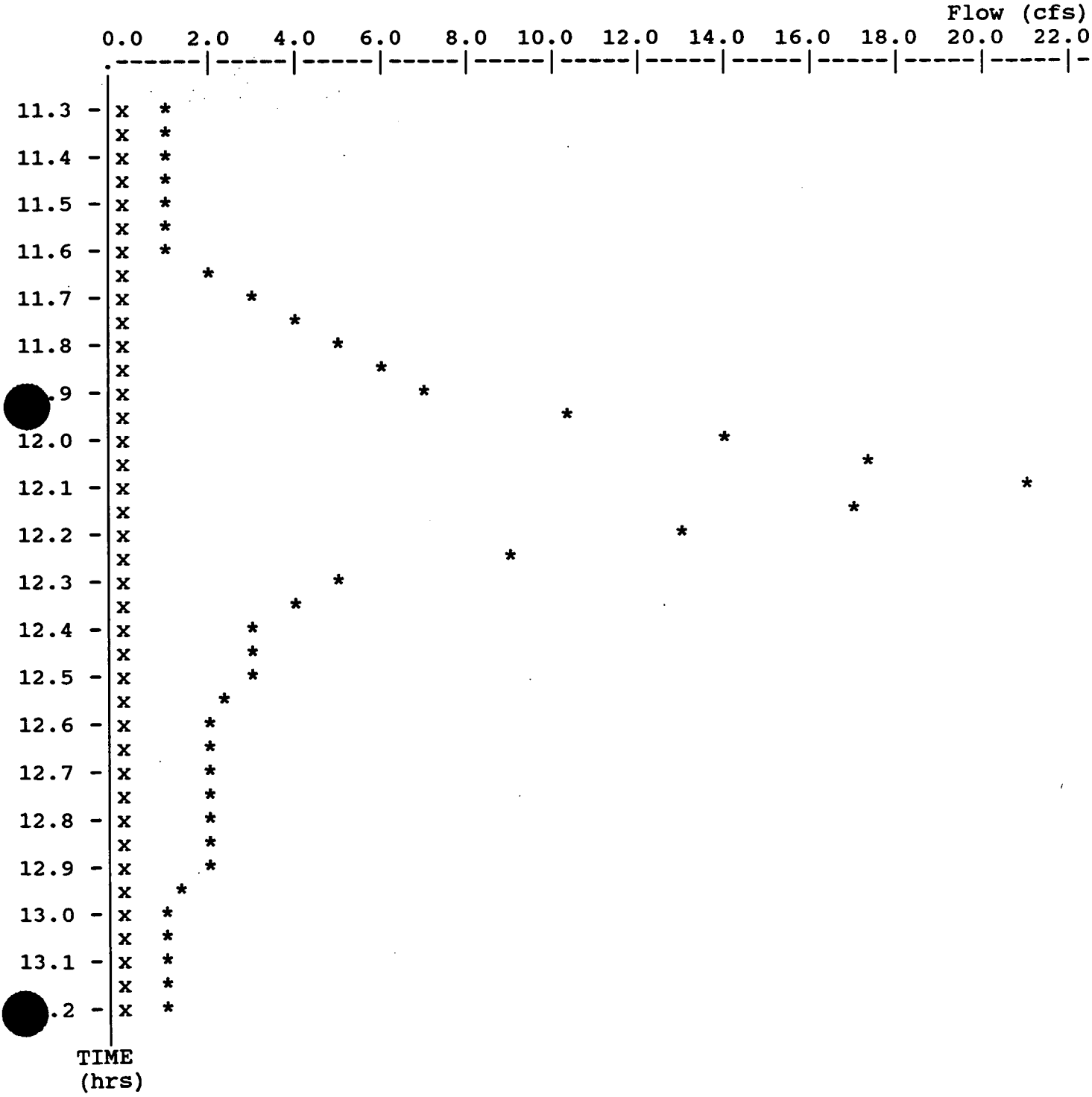
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.17 S/N:

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

EXECUTED: 08-19-1997
13:19:51

Peak Inflow = 21.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 539.89 ft



SHTA76

```
*  File:  c:\po165tk\P3-10    .HYD   Qmax =    21.0 cfs
x  File:  c:\po165tk\SW3-T1   .HYD   Qmax =     0.0 cfs
```

ATTACHMENT B, DITCHES

Methodology

This calculation is performed using the "worst case" scenario for peak flows. Each ditch was evaluated under existing conditions (after construction of ditches and basins, but before remediation activities begin), and proposed conditions (after remediation activities have been completed).

The Modified Rational Method (Reference 2) was used to determine peak flows for the 10 year and 25 year (Ditches 2 & 6 only) frequency storm events. After drainage areas (existing and proposed) were calculated for each ditch, a weighted runoff coefficient (C) was determined based on land use area and type. A rainfall intensity was selected based on the shortest duration (duration = 10 min for all ditches except ditch 12) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

Ditch 12 has a large, relatively flat drainage area (see last assumption on this page). SCS procedures were used to find the time of concentration (duration) for the ditch 12 drainage area. The rainfall intensity was selected based on the time of concentration (duration) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

With the peak flows known for both existing and proposed conditions, the highest peak flow was selected for design. Ditches were designed based on the uniform flow theory using Manning's equation. In most cases ditch slopes varied. In one instance the bottom width varied. In order to evaluate ditch design and performance of ditch lining, the worst case flow conditions for velocity and flow depth were considered for the three types of ditch lining (i.e. erosion control blanket, dumped rock fill, or exposed geomembrane liner). The Flow Master computer program was used to evaluate the effects of the varying components on the performance of the ditch (Reference 4).

Ditch sections 2A and 2B, and ditch sections 2C and 2D are all the same ditch. Ditch sections 2A and 2B will be constructed to accommodate existing conditions. The section of ditch labeled 2A has channel slopes of approximately 10% and will be lined with riprap (dumped rock fill). The section of ditch labeled 2B has flat channel slopes (approx. 0.8%), and will be lined with erosion control blanket.

Ditch section 2C under proposed condtiions is the same section as 2A under existing conditions. Since ditch section 2C under proposed conditions has less flow than section 2A under existing condtiions, section 2C will not be modified.

Ditch section 2D will replace ditch section 2B during grading activities. This ditch section will have a flat channel slope (approx 0.7%) with a varying left-side slope.

Ditch 12 will be designed assuming that an existing culvert located east of the drainage area (see Proposed Conditions, Sheet 2 of 2 drainage area map) becomes

clogged and forces additional water into the normal drainage area for Ditch 12.

Ditches 13 & 14 and the existing 24" culvert at the wheel wash area were originally designed under Calculation No. 15-02, PO158 (Haul Road Upgrade Project). These ditches were relocated eastward to accommodate construction of the Wheel Wash Facility. The total drainage area or land use did not change. Therefore, the design geometry proposed for these ditches under PO158 will be used on this project. New calculations are not provided.

Two types of ditch lining were evaluated for most ditches; vegetated using erosion control blankets, and dumped rock fill. Ditches 2B, 3-7, and 9 will have an exposed geomembrane liner. Roughness coefficients for the erosion control blanket and dumped rock fill were selected from Reference 7, and are as follows:

Erosion Control Blankets $n = 0.04$
Riprap $n = 0.06$

Maximum flow velocity for using erosion control blankets as a lining material was established at 4.0 feet per second (Reference 7).

Roughness coefficient for the exposed geomembrane liner was derived from values typically used for polyethylene pipe:

Geomembrane liner $n = 0.009$

In addition to the ditches described above, three interceptor ditches (Interceptor Ditch 1, 2, & 3) will be constructed during various phases of remediation to prevent runon to the exposed GMA (See Construction Drawings 92X-5900-G-00286, G-00333, and G-00413). Interceptor ditch 1 will have both erosion control blanket lining and dumped rock lining. Interceptor ditches 2 & 3 will have a geomembrane lining.

Calculations are included on the following pages.

SHT B3

1062

TABLE 1
DRAINAGE AREA AND PEAK FLOW SUMMARY

DITCH	EXISTING CONDITIONS		PROPOSED CONDITIONS	
	DRAINAGE AREA (AC)	FLOW (CFS)	DRAINAGE AREA (AC)	FLOW (CFS)
10 YEAR STORM FREQUENCY				
DITCH - 1	1.57	3.88	0.54	2.18
DITCH - 2A	3.45	8.18	N/A	N/A
DITCH - 2B	3.45	8.18	N/A	N/A
DITCH - 2C	N/A	N/A	1.82	6.09
DITCH - 2D	N/A	N/A	3.54	12.65
DITCH - 3	8.40	19.31	6.63	25.33
DITCH - 4	0.69	2.67	0.69	2.67
DITCH - 5	0.62	2.37	0.62	2.37
DITCH - 6	0.47	1.79	0.47	1.79
DITCH - 7	1.76	5.90	2.04	7.87
DITCH - 8A	1.80	5.88	1.45	5.56
DITCH - 8B	3.21	9.21	1.82	7.02
DITCH - 9	3.31	11.50	3.42	13.22
DITCH - 10 (A & B)	0.41	1.34	0.27	0.88
DITCH - 11	1.17	4.28	0.85	3.24
DITCH - 12	7.52	8.91	7.52	8.91
DITCH - 13	DESIGNED UNDER PO158, HAUL ROAD UPGRADE			
DITCH - 14	DESIGNED UNDER PO158, HAUL ROAD UPGRADE			
DITCH - 15	0.20	1.0	0.2	1.0
25 YEAR STORM FREQUENCY				
DITCH - 2A	3.45	10.06	N/A	N/A
DITCH - 2B	3.45	10.06	N/A	N/A
DITCH - 2C	N/A	N/A	1.82	7.49
DITCH - 2D	N/A	N/A	3.54	15.56
INTERCEPTOR DITCH - 1A	N/A	N/A	2.65	12.43
INTERCEPTOR DITCH - 1B	N/A	N/A	4.27	20.03
INTERCEPTOR DITCH - 2	N/A	N/A	2.10	9.85
INTERCEPTOR DITCH - 3	N/A	N/A	2.88	13.51

SHT B4

Quick TR-55 Ver.5.46 S/N:
Executed: 15:18:48 10-27-1996

DITCH-1
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	1.46						
GRAVEL RD	0.900	0.11						
			10.00	0.454	0.454	5.450	1.57	3.88

SHT B5

Quick TR-55 Ver.5.46 S/N:
Executed: 14:50:44 10-27-1996

1062

DITCH-1
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, S>4:1	0.700	0.43						
GRAVEL RD	0.900	0.11						
			10.00	0.741	0.741	5.450	0.54	2.18

SHT B6

Quick TR-55 Ver.5.46 S/N:
Executed: 06:37:27 02-04-1997

DITCH-2A
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	5.450	3.45	8.18

000355

SHB7
1062

Quick TR-55 Ver.5.46 S/N:
Executed: 14:09:34 07-21-1997

DITCH-2A
DRAINAGE AREA P1
EXISTING CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	6.700	3.45	10.06

SHT B8

Quick TR-55 Ver.5.46 S/N:
Executed: 06:38:22 02-04-1997

DITCH-2B
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	5.450	3.45	8.18

SHT B9 1062

Quick TR-55 Ver.5.46 S/N:
Executed: 14:10:15 07-21-1997

DITCH-2B
DRAINAGE AREA P1
EXISTING CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	6.700	3.45	10.06

SHT B10

Quick TR-55 Ver.5.46 S/N:
Executed: 06:43:08 02-04-1997

DITCH-2C
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, >4:1	0.700	0.82						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.614	0.614	5.450	1.82	6.0

SHT B11
1062

Quick TR-55 Ver.5.46 S/N:
Executed: 14:11:45 07-21-1997

DITCH-2C
DRAINAGE AREA P1
PROPOSED CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.82						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.614	0.614	6.700	1.82	7.49

SHT B12

Quick TR-55 Ver.5.46 S/N:
Executed: 06:43:50 02-04-1997

DITCH-2D
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, >4:1	0.700	2.54						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.656	0.656	5.450	3.54	12.6

000361

Quick TR-55 Ver.5.46 S/N:
Executed: 16:54:32 08-19-1997

SHT B13
1062

DITCH-2D
DRAINAGE AREA P1
PROPOSED CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, >4:1	0.700	2.54						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.656	0.656	6.700	3.54	15.56

SHT B14

Quick TR-55 Ver.5.46 S/N:
Executed: 15:56:04 10-27-1996

DITCH-3
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. S>4:1	0.420	8.37						
GRAVEL ROAD	0.900	0.03						
			10.00	0.422	0.422	5.450	8.40	19.31

000363

SHT B15

Quick TR-55 Ver.5.46 S/N:
Executed: 15:00:44 01-22-1997

1062

DITCH-3
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	6.60						
GRAVEL ROAD	0.900	0.03						
			10.00	0.701	0.701	5.450	6.63	25.33

SHT B16

Quick TR-55 Ver.5.46 S/N:
Executed: 15:07:33 04-26-1997

DITCH-4
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1 GRAVEL ROAD	0.700	0.66						
	0.900	0.03						
			10.00	0.709	0.709	5.450	0.69	2.67

SHT B17

L-1062

Quick TR-55 Ver.5.46 S/N:
Executed: 15:06:30 04-26-1997

DITCH-4
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.66						
GRAVEL ROAD	0.900	0.03						
			10.00	0.709	0.709	5.450	0.69	2.67

SHT B18

Quick TR-55 Ver.5.46 S/N:
Executed: 14:15:21 04-28-1997

DITCH-5
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.62						
			10.00	0.700	0.700	5.450	0.62	2.37

Quick TR-55 Ver.5.46 S/N:
Executed: 14:16:50 04-28-1997

DITCH-5
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.62						
			10.00	0.700	0.700	5.450	0.62	2.37

SHT B20

Quick TR-55 Ver.5.46 S/N:
Executed: 14:18:30 04-28-1997

DITCH-6
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	5.450	0.47	1.79

Quick TR-55 Ver.5.46 S/N:
Executed: 14:19:02 04-28-1997

DITCH-6
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	5.450	0.47	1.79

B22

Quick TR-55 Ver.5.46 S/N:
Executed: 17:07:06 08-19-1997

DITCH-6
DRAINAGE AREA P2
EXISTING CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	6.700	0.47	2.20

B23 1002

Quick TR-55 Ver.5.46 S/N:
Executed: 17:07:40 08-19-1997

DITCH-6
DRAINAGE AREA P2
PROPOSED CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
`C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	6.700	0.47	2.20

000372

SHT B24

Quick TR-55 Ver.5.46 S/N:
Executed: 16:06:06 04-29-1997

DITCH-7
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	0.59						
BARE,>4:1	0.700	1.09						
GRAVEL RD	0.900	0.08						
			10.00	0.615	0.615	5.450	1.76	5.90

SHT 12802

Quick TR-55 Ver.5.46 S/N:
Executed: 07:34:14 04-29-1997

DITCH-7
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	1.96						
GRAVEL RD	0.900	0.08						
			10.00	0.708	0.708	5.450	2.04	7.87

SHT B26

Quick TR-55 Ver.5.46 S/N:
Executed: 10:46:30 04-30-1997

DITCH-8A
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.10						
VEG, FAIR	0.420	0.67						
GRAVEL RD	0.900	0.03						
			10.00	0.599	0.599	5.450	1.80	5.88

SHT B27

1062

Quick TR-55 Ver.5.46 S/N:
Executed: 14:47:00 04-29-1997

DITCH-8A
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.42						
GRAVEL RD	0.900	0.03						
			10.00	0.704	0.704	5.450	1.45	5.56

SHT B28

Quick TR-55 Ver.5.46 S/N:
Executed: 10:46:56 04-30-1997

DITCH-8B
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.10						
VEG, FAIR	0.420	2.04						
GRAVEL RD	0.900	0.07						
			10.00	0.526	0.526	5.450	3.21	9.21

SHT B29
1062

Quick TR-55 Ver.5.46 S/N:
Executed: 14:48:13 04-29-1997

DITCH-8B
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.75						
GRAVEL RD	0.900	0.07						
			10.00	0.708	0.708	5.450	1.82	7.02

SHT B30

Quick TR-55 Ver.5.46 S/N:
Executed: 16:47:01 01-20-1997

DITCH-9
DRAINAGE AREA P3
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	2.63						
BARE	0.700	0.40						
GRAVEL RD	0.900	0.28						
			10.00	0.637	0.637	5.450	3.31	11.50

Quick TR-55 Ver.5.46 S/N:
Executed: 16:47:37 01-20-1997

DITCH-9
DRAINAGE AREA P3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	2.89						
GRAVEL RD	0.900	0.28						
VEG, POOR	0.600	0.25						
			10.00	0.709	0.709	5.450	3.42	13.22

SHT B32

Quick TR-55 Ver.5.46 S/N:
Executed: 09:27:01 11-24-1996

DITCH-10 (10A AND 10B)
DRAINAGE AREA P3
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.41						
			10.00	0.600	0.600	5.450	0.41	1.34

SHT B33

1062

Quick TR-55 Ver.5.46 S/N:
Executed: 09:27:45 11-24-1996

DITCH-10 (10A AND 10B)
DRAINAGE AREA P3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.27						
			10.00	0.600	0.600	5.450	0.27	0.88

SHT B34

Quick TR-55 Ver.5.46 S/N:
Executed: 16:49:52 01-20-1997

DITCH-11
DRAINAGE AREA P3
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.89						
GRAVEL	0.900	0.28						
			10.00	0.672	0.672	5.450	1.17	4.28

SHT B35

Quick TR-55 Ver.5.46 S/N:
Executed: 16:49:22 01-20-1997

1062

DITCH-11
DRAINAGE AREA P3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.57						
GRAVEL	0.900	0.28						
			10.00	0.699	0.699	5.450	0.85	3.24

SHT B36

Quick TR-55 Ver.5.46 S/N:
Executed: 14:03:23 02-04-1997

DITCH-12
EXISTING/PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
WOODS	0.300	6.32						
VEG, FAIR	0.420	1.00						
GRAVEL ROAD	0.900	0.20						
			20.40	0.332	0.332	3.570	7.52	8.91

000385

SHT B37

Quick TR-55 Ver.5.46 S/N:
Executed: 14:02:25 02-04-1997 c:\po165d\D12P.TCT

1062

DITCH 12

Tc COMPUTATIONS FOR: DITCH 12

SHEET FLOW (Applicable to Tc only)

Segment ID		1
Surface description		WOODS, LT
Manning's roughness coeff., n		0.4000
Flow length, L (total < or = 300)	ft	122.0
Two-yr 24-hr rainfall, P2	in	3.000
Land slope, s	ft/ft	0.0500

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.30 = 0.30

SHALLOW CONCENTRATED FLOW

Segment ID		
Surface (paved or unpaved)?		
Flow length, L	ft	0.0
Watercourse slope, s	ft/ft	0.0000

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 0.0000

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.00 = 0.00

CHANNEL FLOW

Segment ID		2
Cross Sectional Flow Area, a	sq.ft	7.50
Wetted perimeter, Pw	ft	8.71
Hydraulic radius, r = a/Pw	ft	0.861
Channel slope, s	ft/ft	0.0130
Manning's roughness coeff., n		0.0400

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 3.8441

Flow length, L ft 485

T = L / (3600*V) hrs 0.04 = 0.04

::

TOTAL TIME (hrs) 0.34

000386

SHT B38

Quick TR-55 Ver.5.46 S/N:
Executed: 14:02:25 02-04-1997 c:\po165d\D12P.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

DITCH 12

Subarea descr.	Tc or Tt	Time (hrs)
DITCH 12	Tc	0.34

SHT B39

1062

TIME OF CONCENTRATION, DITCH 12
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	TIME OF CONC., DITCH 12
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.013000	ft/ft
Depth	1.50	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft

Results		
Discharge	28.76	cfs
Flow Area	7.50	ft^2
Wetted Perimeter	8.71	ft
Top Width	8.00	ft
Critical Depth	1.25	ft
Critical Slope	0.027917	ft/ft
Velocity	3.83	ft/s
Velocity Head	0.23	ft
Specific Energy	1.73	ft
Froude Number	0.70	
Flow is subcritical.		

SHT B40

DITCHES 13 & 14 DESIGNED UNDER PO158, HAUL ROAD UPGRADE PROJECT

SHT B41

Quick TR-55 Ver.5.46 S/N:
Executed: 09:39:59 06-10-1997

1062

DITCH 15
EXISTING AND PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
GRAVEL	0.900	0.20						
			10.00	0.900	0.900	5.450	0.20	0.98

000390

SNT B41A

Quick TR-55 Ver.5.46 S/N:
Executed: 13:49:28 09-28-1997

INTERCEPTOR DITCH 1A
V-DITCH GEOMETRY
BASE BID GRADING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	2.65						
			10.00	0.700	0.700	6.700	2.65	12.43

SHT B41B

Quick TR-55 Ver.5.46 S/N:
Executed: 13:54:34 09-28-1997

1062

INTERCEPTOR DITCH 1B
FLAT BOTTOM GEOMETRY
BASE BID GRADING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	4.27						
			10.00	0.700	0.700	6.700	4.27	20.03

SHT B41C

Quick TR-55 Ver.5.46 S/N:
Executed: 14:14:12 09-28-1997

INTERCEPTOR DITCH 2

BASE BID GRADING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	2.10						
			10.00	0.700	0.700	6.700	2.10	9.85

SHT. B41D

Quick TR-55 Ver.5.46 S/N:
Executed: 13:58:54 09-28-1997

1062

INTERCEPTOR DITCH 3

INTERIM GRADING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	2.88						
			10.00	0.700	0.700	6.700	2.88	13.51

000394

TABLE 2

SUMMARY OF DITCH PERFORMANCE

DITCH	Q (CFS)	SLOPE		VELOCITY		FLOW DEPTH		COMMENTS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
10 YR STORM EVENT								
DITCH - 1	3.88	0.5	2.6	1.6	3.0	0.8	1.1	EROSION CONTROL BLANKET
DITCH - 2A	8.18	10.0	10.0	4.5	4.5	1.0	1.0	DUMPED ROCK FILL
DITCH - 2B	8.18	0.8	0.8	7.2	7.2	0.8	0.8	GEOMEMBRANE LINER
DITCH - 2C	6.09 CFS < 8.18 CFS UNDER EXISTING CONDITIONS, USE SAME AS D-2B							
DITCH - 2D	12.65	0.7	0.7	1.3	2.3	0.6	1.4	EROSION CONTROL BLANKET
DITCH - 3	25.33	0.7	0.7	7.0	8.1	0.4	0.6	GEOMEMBRANE LINER
DITCH - 4	2.67	0.9	0.9	4.9	4.9	0.2	0.2	GEOMEMBRANE LINER
DITCH - 5	2.37	1.5	1.5	5.7	5.7	0.2	0.2	GEOMEMBRANE LINER
DITCH - 6	1.79	1.4	1.4	5.1	5.1	0.2	0.2	GEOMEMBRANE LINER
DITCH - 7	7.87	1.1	2.9	7.5	10.4	0.3	• D_n = 0.4 • D_u = 1.6	GEOMEMBRANE LINER
DITCH - 8A	5.88	0.8	0.8	2.2	2.2	1.2	1.2	EROSION CONTROL BLANKET
DITCH - 8B	9.21	10.0	10.0	4.6	4.6	1.0	1.0	DUMPED ROCK FILL
DITCH - 9	13.22	1.1	6.7	7.8	14.1	0.2	• D_n = 0.4 • D_u = 1.7	GEOMEMBRANE LINER
DITCH - 10A	1.34	4.3	4.3	2.8	2.8	0.5	0.5	EROSION CONTROL BLANKET
DITCH - 10B	1.34	20.0	20.0	3.7	3.7	0.4	0.4	DUMPED ROCK FILL
DITCH - 11	4.28	2.6	4.0	3.1	3.6	0.8	• D_n = 0.8 • D_u = 1.7	EROSION CONTROL BLANKET
DITCH - 12	8.91	0.8	1.4	2.4	2.9	0.8	1.0	EROSION CONTROL BLANKET
DITCHES - 13 & 14	DITCH DESIGNED UNDER PO158, HAUL ROAD UPGRADE							EROSION CONTROL BLANKET
DITCH - 15	1.0	2.5	3.0	2.1	2.3	0.5	0.5	EROSION CONTROL BLANKET
25 YR STORM EVENT								
DITCH - 2A	10.1	10.0	10.0	4.7	4.7	1.0	1.0	DUMPED ROCK FILL
DITCH - 2B	10.1	0.8	0.8	7.6	7.6	0.8	0.8	GEOMEMBRANE LINER
DITCH - 2D	12.65	0.7	0.7	1.3	2.3	0.6	1.4	EROSION CONTROL BLANKET
DITCH - 6	2.20	1.4	1.4	5.4	5.4	0.2	0.2	GEOMEMBRANE LINER
INTERCEPTOR DITCH - 1A	12.43	0.8	0.8	2.6	2.6	1.6	1.6	EROSION CONTROL BLANKET
INTERCEPTOR DITCH - 1B	20.03	2.3	20.0	3.1	6.6	0.6	1.1	DUMPED ROCK FILL
INTERCEPTOR DITCH - 2	9.85	0.5	13.0	6.0	18.8	0.2	0.5	GEOMEMBRANE LINER
INTERCEPTOR DITCH - 3	13.51	0.9	0.9	8.2	8.2	0.5	0.5	GEOMEMBRANE LINER

Normal flow depth • D_u = Flow depth upstream of velocity check

000395

SAT 842

SHT B43

1062

DITCH-1 (D1)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-1 (D1)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.005000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	3.88	cfs

Results		
Depth	1.09	ft
Flow Area	2.38	ft^2
Wetted Perimeter	4.88	ft
Top Width	4.37	ft
Critical Depth	0.75	ft
Critical Slope	0.037554	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.13	ft
Froude Number	0.39	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 on slopes from 0.5% to 3.6% (See Rating Table).

Use Erosion Control Blanket for channel lining

000396

SHT B44

DITCH-1 (D1)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-1 (D1)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	3.88 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020
Channel Slope	0.005000	0.026000	0.021000 ft/ft

Rating Table

Channel Slope (ft/ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.005000	0.040	1.09	1.63
0.005000	0.060	1.27	1.20
0.026000	0.040	0.80	3.02
0.026000	0.060	0.93	2.23

000397

SHT B45

DITCH 2A, EXISTING CONDITIONS
Worksheet for Triangular Channel

1 of 2

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2A, EXISTING CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	8.18	cfs

Results		
Depth	0.82	ft
Flow Area	1.36	ft^2
Wetted Perimeter	3.68	ft
Top Width	3.29	ft
Critical Depth	1.01	ft
Critical Slope	0.033997	ft/ft
Velocity	6.03	ft/s
Velocity Head	0.57	ft
Specific Energy	1.39	ft
Froude Number	1.66	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04, Not acceptable

Use Riprap for channel lining on steep section

000398

SHT 846

DITCH 2A, EXISTING CONDITIONS
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2A, EXISTING CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	8.18 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.82	6.03
0.060	0.96	4.45

SHT B47

1062

DITCH 2A-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2A-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	10.10	cfs

Results		
Depth	1.04	ft
Flow Area	2.15	ft^2
Wetted Perimeter	4.64	ft
Top Width	4.15	ft
Critical Depth	1.10	ft
Critical Slope	0.074376	ft/ft
Velocity	4.69	ft/s
Velocity Head	0.34	ft
Specific Energy	1.38	ft
Froude Number	1.15	
Flow is supercritical.		

SHT B48

DITCH 2B, EXISTING CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2B, EXISTING CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	8.18	cfs

Results		
Depth	0.76	ft
Flow Area	1.14	ft^2
Wetted Perimeter	3.38	ft
Top Width	3.02	ft
Critical Depth	1.01	ft
Critical Slope	0.001721	ft/ft
Velocity	7.16	ft/s
Velocity Head	0.80	ft
Specific Energy	1.55	ft
Froude Number	2.05	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 8.2 fps: OK

000401

SHT B49

1062

DITCH 2B-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2B-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	10.10	cfs

Results		
Depth	0.82	ft
Flow Area	1.34	ft^2
Wetted Perimeter	3.66	ft
Top Width	3.27	ft
Critical Depth	1.10	ft
Critical Slope	0.001673	ft/ft
Velocity	7.55	ft/s
Velocity Head	0.89	ft
Specific Energy	1.70	ft
Froude Number	2.08	
Flow is supercritical.		

000402

SHT B50

DITCH 2C, PROPOSED CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	8.18	cfs

Results		
Depth	0.82	ft
Flow Area	1.36	ft^2
Wetted Perimeter	3.68	ft
Top Width	3.29	ft
Critical Depth	1.01	ft
Critical Slope	0.033997	ft/ft
Velocity	6.03	ft/s
Velocity Head	0.57	ft
Specific Energy	1.39	ft
Froude Number	1.66	
Flow is supercritical.		

Notes:

This is same ditch with same discharge as ditch 2A under existing conditions.

000403

SHT B51

DITCH 2C, PROPOSED CONDITIONS
Rating Table for Triangular Channel

1062

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	8.18 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.82	6.03
0.060	0.96	4.45

000404

SHT B52

DITCH 2C-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	7.49	cfs

Results		
Depth	0.80	ft
Flow Area	1.27	ft^2
Wetted Perimeter	3.56	ft
Top Width	3.19	ft
Critical Depth	0.97	ft
Critical Slope	0.034401	ft/ft
Velocity	5.90	ft/s
Velocity Head	0.54	ft
Specific Energy	1.34	ft
Froude Number	1.65	
Flow is supercritical.		

000405

SHT B53

1062

DITCH 2C-25
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	7.49 cfs

Input Data			
	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.80	5.90
0.060	0.93	4.36

000406

SHT B54

DITCH 2D, PROPOSED CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D, PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	12.70	cfs

Results		
Depth	1.35	ft
Flow Area	5.51	ft^2
Wetted Perimeter	8.62	ft
Top Width	8.13	ft
Critical Depth	1.02	ft
Critical Slope	0.031514	ft/ft
Velocity	2.31	ft/s
Velocity Head	0.08	ft
Specific Energy	1.44	ft
Froude Number	0.49	
Flow is subcritical.		

Notes:

DITCH 2D WITH VARYING LEFT SIDE SLOPE.

TWO CRITERIA FOR ACCEPTANCE:
1.COMPARE LEFT SIDE SLOPE WITH FLOW DEPTH TO ENSURE FREEBOARD,
2. COMPARE VELOCITY TO ENSURE THAT
V < 4.0 FPS FOR EROSION CONTROL BLANKET.

OK FOR BOTH

000407

SHT B 55

1062

DITCH 2D, PROPOSED CONDITIONS
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D, PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.040
Channel Slope	0.007000 ft/ft
Right Side Slope	2.000000 H : V
Discharge	12.70 cfs

Input Data	Minimum	Maximum	Increment
Left Side Slope	4.000000	60.000000	2.000000 H : V

Rating Table

Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
4.000000	1.35	2.31
6.000000	1.21	2.17
8.000000	1.11	2.06
10.000000	1.04	1.97
12.000000	0.98	1.90
14.000000	0.93	1.84
16.000000	0.89	1.79
18.000000	0.85	1.75
20.000000	0.82	1.71
22.000000	0.80	1.67
24.000000	0.77	1.64
26.000000	0.75	1.61
28.000000	0.73	1.58
30.000000	0.71	1.56
32.000000	0.70	1.53
34.000000	0.68	1.51
36.000000	0.67	1.49
38.000000	0.66	1.47
40.000000	0.64	1.46
42.000000	0.63	1.44
44.000000	0.62	1.42
46.000000	0.61	1.41
48.000000	0.60	1.39

000408

SHT B56

DITCH 2D, PROPOSED CONDITIONS
Rating Table for Triangular Channel

Rating Table		
Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
50.000000	0.59	1.38
52.000000	0.59	1.37
54.000000	0.58	1.36
56.000000	0.57	1.34
58.000000	0.56	1.33
60.000000	0.56	1.32

000409

SHT 657

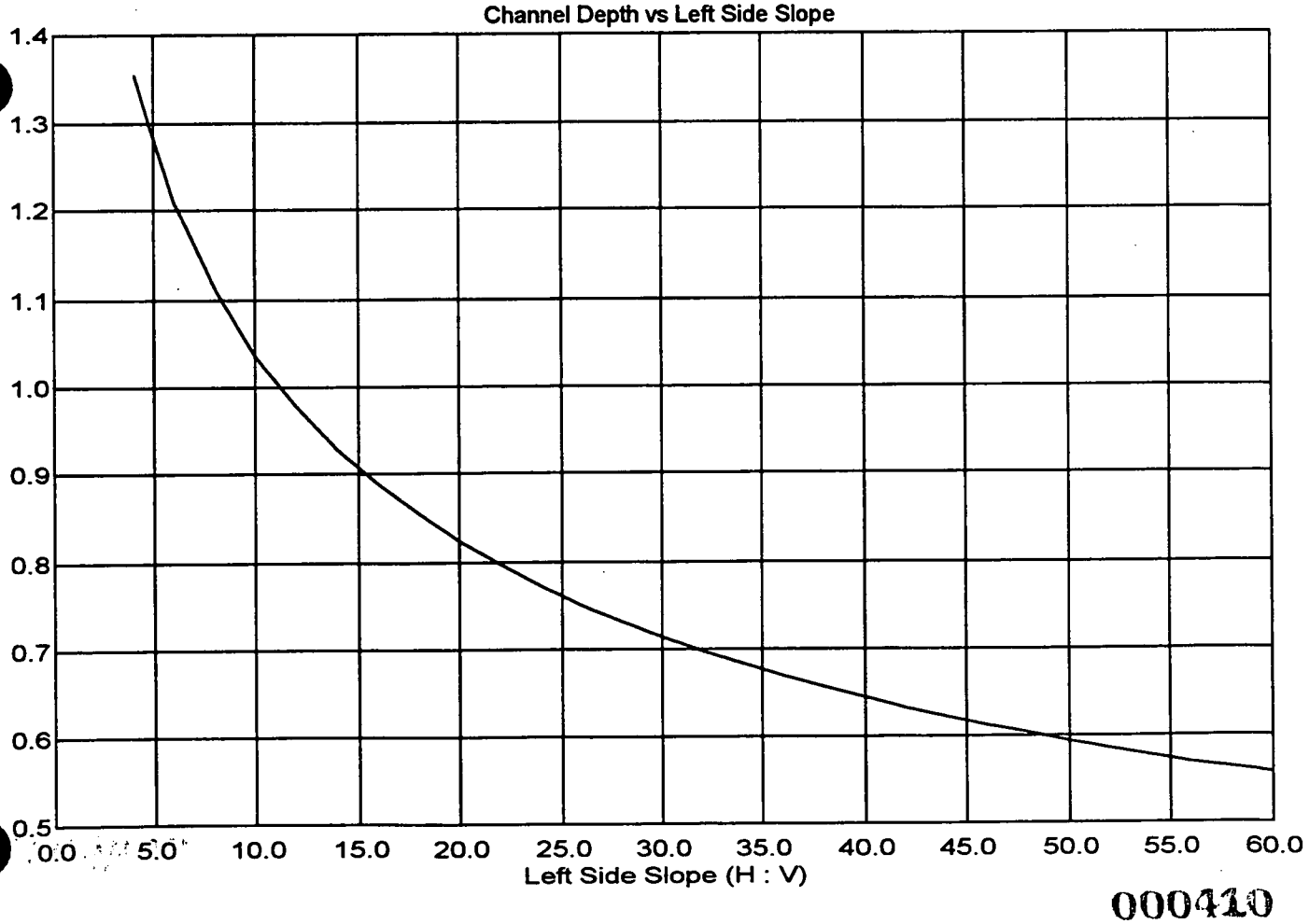
1062

DITCH 2D, PROPOSED CONDITIONS
Plotted Curves for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D, PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000 ft/ft	
Right Side Slope	2.000000 H : V	
Discharge	12.70	cfs

Input Data			
	Minimum	Maximum	Increment
Left Side Slope	4.000000	60.000000	2.000000 H : V



000410

SHT B58

DITCH 2D-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	12.65	cfs

Results		
Depth	1.35	ft
Flow Area	5.49	ft^2
Wetted Perimeter	8.60	ft
Top Width	8.12	ft
Critical Depth	1.02	ft
Critical Slope	0.031530	ft/ft
Velocity	2.30	ft/s
Velocity Head	0.08	ft
Specific Energy	1.44	ft
Froude Number	0.49	
Flow is subcritical.		

Notes:

DITCH 2D-25 WITH VARYING LEFT SIDE SLOPES

TWO CRITERIA FOR ACCEPTANCE:
1. COMPARE LEFT SIDE SLOPE WITH FLOW DEPTH TO ENSURE FREEBOARD,
2. COMPARE VELOCITY TO ENSURE THAT V < 4,0 FPS FOR EROSION CONTROL BLANKET

OK FOR BOTH

000411

SHT B 59V 02

DITCH 2D-25
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000	ft/ft
Right Side Slope	2.000000	H : V
Discharge	12.65	cfs

Input Data			
	Minimum	Maximum	Increment
Left Side Slope	4.000000	60.000000	2.000000 H : V

Rating Table

Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
4.000000	1.35	2.30
6.000000	1.21	2.16
8.000000	1.11	2.06
10.000000	1.03	1.97
12.000000	0.98	1.90
14.000000	0.93	1.84
16.000000	0.89	1.79
18.000000	0.85	1.74
20.000000	0.82	1.70
22.000000	0.79	1.67
24.000000	0.77	1.64
26.000000	0.75	1.61
28.000000	0.73	1.58
30.000000	0.71	1.55
32.000000	0.70	1.53
34.000000	0.68	1.51
36.000000	0.67	1.49
38.000000	0.66	1.47
40.000000	0.64	1.45
42.000000	0.63	1.44
44.000000	0.62	1.42
46.000000	0.61	1.41
48.000000	0.60	1.39

SAT 860

DITCH 2D-25
Rating Table for Triangular Channel

Rating Table		
Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
50.000000	0.59	1.38
52.000000	0.59	1.37
54.000000	0.58	1.35
56.000000	0.57	1.34
58.000000	0.56	1.33
60.000000	0.56	1.32

000413

SHT B61

1062

DITCH-3 (D3)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-3 (D3)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.006700	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	4.00	ft
Discharge	25.33	cfs

Results		
Depth	0.60	ft
Flow Area	3.12	ft^2
Wetted Perimeter	6.68	ft
Top Width	6.40	ft
Critical Depth	0.92	ft
Critical Slope	0.001432	ft/ft
Velocity	8.13	ft/s
Velocity Head	1.03	ft
Specific Energy	1.63	ft
Froude Number	2.05	
Flow is supercritical.		

Notes:

NOTE: 4' WIDE DITCH SECTION DOES NOT GET TOTAL "Q"

GEOMEMBRANE LINER

V = 8.1 fps: OK

000414

SHT B62

DITCH-3 (D3)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-3 (D3)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Channel Slope	0.006700	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	25.33	cfs

Input Data			
	Minimum	Maximum	Increment
Bottom Width	4.00	8.00	4.00 ft

Rating Table		
Bottom Width (ft)	Depth (ft)	Velocity (ft/s)
4.00	0.60	8.13
8.00	0.41	6.96

000415

SHT B63

1062

DITCH-4 (D4)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-4 (D4)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.008600	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.67	cfs

Results		
Depth	0.22	ft
Flow Area	0.54	ft^2
Wetted Perimeter	2.99	ft
Top Width	2.89	ft
Critical Depth	0.34	ft
Critical Slope	0.001943	ft/ft
Velocity	4.91	ft/s
Velocity Head	0.37	ft
Specific Energy	0.60	ft
Froude Number	2.00	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 4.91 fps: OK

000416

SHT B64

DITCH-5 (D5)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-5 (D5)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.015000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.37	cfs

Results		
Depth	0.18	ft
Flow Area	0.42	ft^2
Wetted Perimeter	2.79	ft
Top Width	2.71	ft
Critical Depth	0.32	ft
Critical Slope	0.001977	ft/ft
Velocity	5.69	ft/s
Velocity Head	0.50	ft
Specific Energy	0.68	ft
Froude Number	2.56	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 5.7 fps: OK

000417

SHT B65

DITCH-6 (D6)
Worksheet for Trapezoidal Channel

1062

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-6 (D6)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.014000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	1.79	cfs

Results		
Depth	0.15	ft
Flow Area	0.35	ft^2
Wetted Perimeter	2.69	ft
Top Width	2.61	ft
Critical Depth	0.27	ft
Critical Slope	0.002064	ft/ft
Velocity	5.06	ft/s
Velocity Head	0.40	ft
Specific Energy	0.55	ft
Froude Number	2.42	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 5.1 fps: OK

000418

SHT B66

DITCH 6-25
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 6-25
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.014000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.20	cfs

Results		
Depth	0.17	ft
Flow Area	0.41	ft^2
Wetted Perimeter	2.77	ft
Top Width	2.69	ft
Critical Depth	0.30	ft
Critical Slope	0.002000	ft/ft
Velocity	5.42	ft/s
Velocity Head	0.46	ft
Specific Energy	0.63	ft
Froude Number	2.46	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 5.4 fps: OK

000419

SHT E67

1062

DITCH-7 (D7)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-7 (D7)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.011000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	7.87	cfs

Results		
Depth	0.38	ft
Flow Area	1.05	ft^2
Wetted Perimeter	3.70	ft
Top Width	3.52	ft
Critical Depth	0.63	ft
Critical Slope	0.001671	ft/ft
Velocity	7.48	ft/s
Velocity Head	0.87	ft
Specific Energy	1.25	ft
Froude Number	2.41	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

Vmin = 7.5 fps @ S = 1.1% - OK
Vmax = 10.4 fps @ S = 2.9% - USE VELOCITY CHECK

000420

SHT B68

DITCH-7 (D7)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-7 (D7)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	2.00	ft
Discharge	7.87	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.011000	0.028600	0.017600 ft/ft

Rating Table		
Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.011000	0.38	7.48
0.028600	0.29	10.43

NORMAL DEPTH

FOR FLOW DEPTH UPSTREAM OF VELOCITY CHECK, USE BROAD-CRESTED WEIR

$Q = CLH^{3/2}$ where $C = 2.61$ (REFERENCE 9 for $h = 0.4$)

$L = 6'$

$$H = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{7.87}{2.61 \times 6}\right)^{2/3} = 0.63 \text{ ft}$$

FLOW DEPTH = 1.0 ft (velocity check h) + 0.63 ft = **1.63 ft**

000421

SHT E69

1062

DITCH-8A (D8A)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-8A (D8A)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000001	H : V
Right Side Slope	2.000000	H : V
Discharge	5.88	cfs

Results		
Depth	1.17	ft
Flow Area	2.73	ft^2
Wetted Perimeter	5.22	ft
Top Width	4.67	ft
Critical Depth	0.88	ft
Critical Slope	0.035527	ft/ft
Velocity	2.16	ft/s
Velocity Head	0.07	ft
Specific Energy	1.24	ft
Froude Number	0.50	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for slope = 0.8% - OK

Use Erosion Control Blanket for channel lining

000422

SHT B70

DITCH-8B (D8B)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-8B (D8B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	9.21	cfs

Results		
Depth	0.86	ft
Flow Area	1.48	ft^2
Wetted Perimeter	3.85	ft
Top Width	3.44	ft
Critical Depth	1.06	ft
Critical Slope	0.033465	ft/ft
Velocity	6.22	ft/s
Velocity Head	0.60	ft
Specific Energy	1.46	ft
Froude Number	1.67	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04, Not acceptable

Use Riprap for channel lining

000423

SAT B71

1062

DITCH 8B (D8B)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-8B (D8B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	9.21 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.86	6.22
0.060	1.00	4.59

000424

SHT B72

DITCH-9 (D9)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-9 (D9)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.011000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	4.00	ft
Discharge	13.22	cfs

Results		
Depth	0.36	ft
Flow Area	1.69	ft^2
Wetted Perimeter	5.61	ft
Top Width	5.44	ft
Critical Depth	0.62	ft
Critical Slope	0.001573	ft/ft
Velocity	7.80	ft/s
Velocity Head	0.95	ft
Specific Energy	1.30	ft
Froude Number	2.46	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

Vmin = 7.8 fps @ S = 1.1% - OK

Vmax = 14.1fps @ S = 6.7% - USE VELOCITY CHECK

000425

SHT B73

1062

DITCH-9 (D9)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-9 (D9)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	4.00	ft
Discharge	13.22	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.011000	0.066700	0.055700 ft/ft

Rating Table

Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.011000	0.36	7.80
0.066700	0.21	14.08

NORMAL DEPTH

FOR FLOW DEPTH UPSTREAM OF VELOCITY CHECK, USE BROAD-CRESTED WEIR

$Q = CLH^{3/2}$ WHERE $C = 2.61$ (REFERENCE 9, TABLE 5-3)

$L = 8$ ft

$$H = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{13.22}{2.61 \times 8}\right)^{2/3} = 0.74 \text{ ft}$$

FLOW DEPTH = 1.0 ft (velocity check ht) + 0.74 ft = **1.74 ft**

000426

SHT B74

DITCH-10A (D10A)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10A (D10A)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.043000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.34	cfs

Results		
Depth	0.49	ft
Flow Area	0.48	ft^2
Wetted Perimeter	2.19	ft
Top Width	1.96	ft
Critical Depth	0.49	ft
Critical Slope	0.043270	ft/ft
Velocity	2.80	ft/s
Velocity Head	0.12	ft
Specific Energy	0.61	ft
Froude Number	1.00	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 on 4.3% slope, OK

Use Erosion Control Blanket for channel lining

000427

SHT 875
1 of 2

DITCH-10A (D10A)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10A (D10A)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.043000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	1.34 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.49	2.80
0.060	0.57	2.06

000428

SHT B76

DITCH-10B (D10B)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10B (D10B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.200000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.34	cfs

Results		
Depth	0.43	ft
Flow Area	0.36	ft^2
Wetted Perimeter	1.91	ft
Top Width	1.71	ft
Critical Depth	0.49	ft
Critical Slope	0.097364	ft/ft
Velocity	3.67	ft/s
Velocity Head	0.21	ft
Specific Energy	0.64	ft
Froude Number	1.40	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04 on steeper slopes,
(See Rating Table), Not acceptable

Use Riprap for channel lining

000429

SHT B77

1062

DITCH-10B (D10B)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10B (D10B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.200000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	1.34 cfs

Input Data			
	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.37	4.98
0.060	0.43	3.67

000430

SHT B78

DITCH-11 (D11)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-11
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.026000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	4.28	cfs

Results		
Depth	0.83	ft
Flow Area	1.38	ft^2
Wetted Perimeter	3.72	ft
Top Width	3.33	ft
Critical Depth	0.78	ft
Critical Slope	0.037065	ft/ft
Velocity	3.10	ft/s
Velocity Head	0.15	ft
Specific Energy	0.98	ft
Froude Number	0.85	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 on slopes from 2.6% to 4.0% (See Rating Table) OK

Use Erosion Control Blanket for channel lining

000431

SHT B79

1062

DITCH-11 (D11)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-11
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

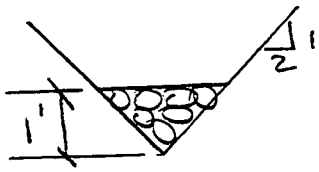
Constant Data	
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	4.28 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020
Channel Slope	0.026000	0.040000	0.014000 ft/ft

Rating Table

Channel Slope (ft/ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.026000	0.040	0.83	3.10
0.026000	0.060	0.97	2.28
0.040000	0.040	0.77	3.64
0.040000	0.060	0.89	2.69

NORMAL DEPTH



FOR FLOW DEPTH UPSTREAM OF CHECK DAM, USE BROAD-CRESTED WEIR

$Q = CLH^{3/2}$ WHERE $C = 2.61$ (REFERENCE 9, TABLE 5-3)

$L = 4$ ft

$$H = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{4.28\text{cfs}}{2.61 \times 4}\right)^{2/3} = 0.55 \text{ ft}$$

FLOW DEPTH = 1.0 ft (CHECK DAM) + 0.55 ft = 1.55 ft

000432

SHT 3 80

DITCH 12 (REVISED)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 12 (REVISED)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	8.90	cfs

Results		
Depth	0.96	ft
Flow Area	3.77	ft^2
Wetted Perimeter	6.30	ft
Top Width	5.85	ft
Critical Depth	0.68	ft
Critical Slope	0.032473	ft/ft
Velocity	2.36	ft/s
Velocity Head	0.09	ft
Specific Energy	1.05	ft
Froude Number	0.52	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 OK

Use Erosion Control Blanket for channel lining.

000433

SHT B81

1062

DITCH 12 (REVISED)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 12 (REVISED)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	2.00	ft
Discharge	8.90	cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	0.008000	0.014000	0.006000 ft/ft

Rating Table		
Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.008000	0.96	2.36
0.014000	0.84	2.90

SHT B82

DITCH - 15
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH - 15
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.025000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.00	cfs

Results		
Depth	0.49	ft
Flow Area	0.47	ft^2
Wetted Perimeter	2.17	ft
Top Width	1.94	ft
Critical Depth	0.43	ft
Critical Slope	0.044992	ft/ft
Velocity	2.12	ft/s
Velocity Head	0.07	ft
Specific Energy	0.56	ft
Froude Number	0.76	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04: OK

Use Erosion Control Blanket for Channel Lining

000435

SAT B81062

DITCH - 15
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH - 15
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Discharge	1.00	cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	0.025000	0.030000	0.005000 ft/ft

Rating Table		
Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.025000	0.49	2.12
0.030000	0.47	2.27

000436

SHT B84

INTERCEPTOR DITCH 1A
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	INTERCEPTOR DITCH 1A
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	12.43	cfs

Results		
Depth	1.55	ft
Flow Area	4.78	ft^2
Wetted Perimeter	6.92	ft
Top Width	6.19	ft
Critical Depth	1.19	ft
Critical Slope	0.032153	ft/ft
Velocity	2.60	ft/s
Velocity Head	0.10	ft
Specific Energy	1.65	ft
Froude Number	0.52	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04; OK

Use Erosion Control Blanket

000437

SHT 685

1062

INTERCEPTOR DITCH 1B
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	INTERCEPTOR DITCH 1B
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.200000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	4.00	ft
Discharge	20.03	cfs

Results		
Depth	0.59	ft
Flow Area	3.04	ft^2
Wetted Perimeter	6.63	ft
Top Width	6.35	ft
Critical Depth	0.80	ft
Critical Slope	0.065788	ft/ft
Velocity	6.59	ft/s
Velocity Head	0.67	ft
Specific Energy	1.26	ft
Froude Number	1.68	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04

Use Dumped Rock Fill for lining.

000438

SHT B 86

INTERCEPTOR DITCH 1B
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	INTERCEPTOR DITCH 1B
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	4.00	ft
Discharge	20.03	cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020
Channel Slope	0.023000	0.200000	0.177000 ft/ft

Rating Table

Channel Slope (ft/ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.023000	0.040	0.85	4.11
0.023000	0.060	1.06	3.08
0.200000	0.040	0.47	8.69
0.200000	0.060	0.59	6.59

000439

SHT B87

INTERCEPTOR DITCH 2
Worksheet for Trapezoidal Channel

1062

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	INTERCEPTOR DITCH 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.130000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	9.85	cfs

Results		
Depth	0.22	ft
Flow Area	0.52	ft^2
Wetted Perimeter	2.97	ft
Top Width	2.86	ft
Critical Depth	0.71	ft
Critical Slope	0.001622	ft/ft
Velocity	18.77	ft/s
Velocity Head	5.47	ft
Specific Energy	5.69	ft
Froude Number	7.73	
Flow is supercritical.		

Notes:

Geomembrane Liner

000440

SHT B88

INTERCEPTOR DITCH 2
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	INTERCEPTOR DITCH 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	2.00	ft
Discharge	9.85	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.005000	0.130000	0.125000 ft/ft

Rating Table

Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.005000	0.53	6.04
0.130000	0.22	18.77

000441

SHT B89

1062

INTERCEPTOR DITCH 3
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	INTERCEPTOR DITCH 3
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.009000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	13.51	cfs

Results		
Depth	0.54	ft
Flow Area	1.66	ft^2
Wetted Perimeter	4.41	ft
Top Width	4.15	ft
Critical Depth	0.85	ft
Critical Slope	0.001557	ft/ft
Velocity	8.16	ft/s
Velocity Head	1.03	ft
Specific Energy	1.57	ft
Froude Number	2.28	
Flow is supercritical.		

Notes:

Geomembrane Liner

000442

ATTACHMENT C, CULVERTS

Methodology

This calculation is performed using the "worst case" scenario for peak flows. Each culvert was evaluated under existing conditions (after construction of ditches and basins, but before remediation activities begin), and proposed conditions (after remediation activities have been completed).

The Modified Rational Method (Reference 2) was used to determine peak flows for the 10 year frequency storm event. After drainage areas (existing and proposed) were calculated for each culvert, a weighted runoff coefficient (C) was determined based on land use area and type. A rainfall intensity was selected based on the shortest duration (duration = 10 min for all culverts except culvert 4) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

Culvert 4 has a large, relatively flat drainage area. SCS procedures were used to find the time of concentration (duration) for the culvert 4 drainage area. The rainfall intensity was selected based on the time of concentration (duration) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

Calculations are included on the following pages.

SHT C2

Quick TR-55 Ver.5.46 S/N:
Executed: 15:17:59 01-20-1997

CULVERT 1

EXISTING/PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.60						
GRAVEL	0.900	0.90						
			10.00	0.820	0.820	5.450	1.50	6.70

PROJECT: Southern Waste Units
Culvert - 1

STATION: _____

SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____

REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

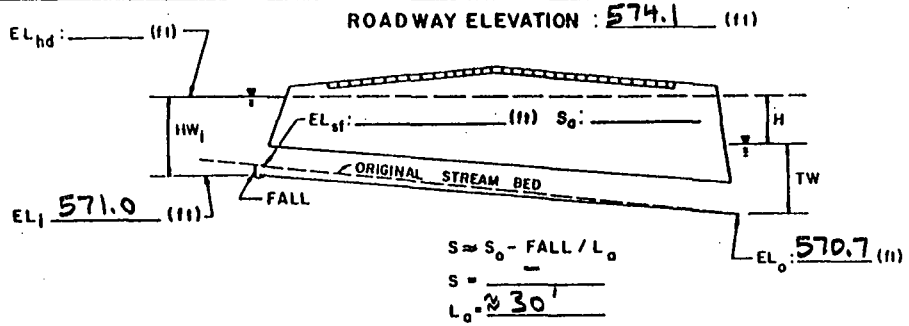
SEE ADD'L. SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	6.7	*

ROADWAY ELEVATION: 574.1 (ft)



$S \approx S_o - FALL / L_o$

$S = \_\_$

$L_o = \approx 30'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ CMP	6.7	6.7	1.8	2.25	-	573.3	0.5	1.0	1.1	1.1	0.9	2.2	574.0	574.0	-	OUTLET CONTROL TOO HIGH
TRY 18" Φ CMP	6.7	6.7	1.13	1.70	-	572.7	0.5	0.95	1.2	1.2	0.9	0.85	572.8	572.8	—	OUTLET CONTROL OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION: * ASSUME OUTLET DRAINAGEWAY FLOWING 0.5' DEEP

PROJECTING ENDS ∴ $K_e = 0.9$

CULVERT BARREL SELECTED:

SIZE: 18" Φ

SHAPE: ROUND

MATERIAL: CMP n 0.024

ENTRANCE: PROJECTING

240

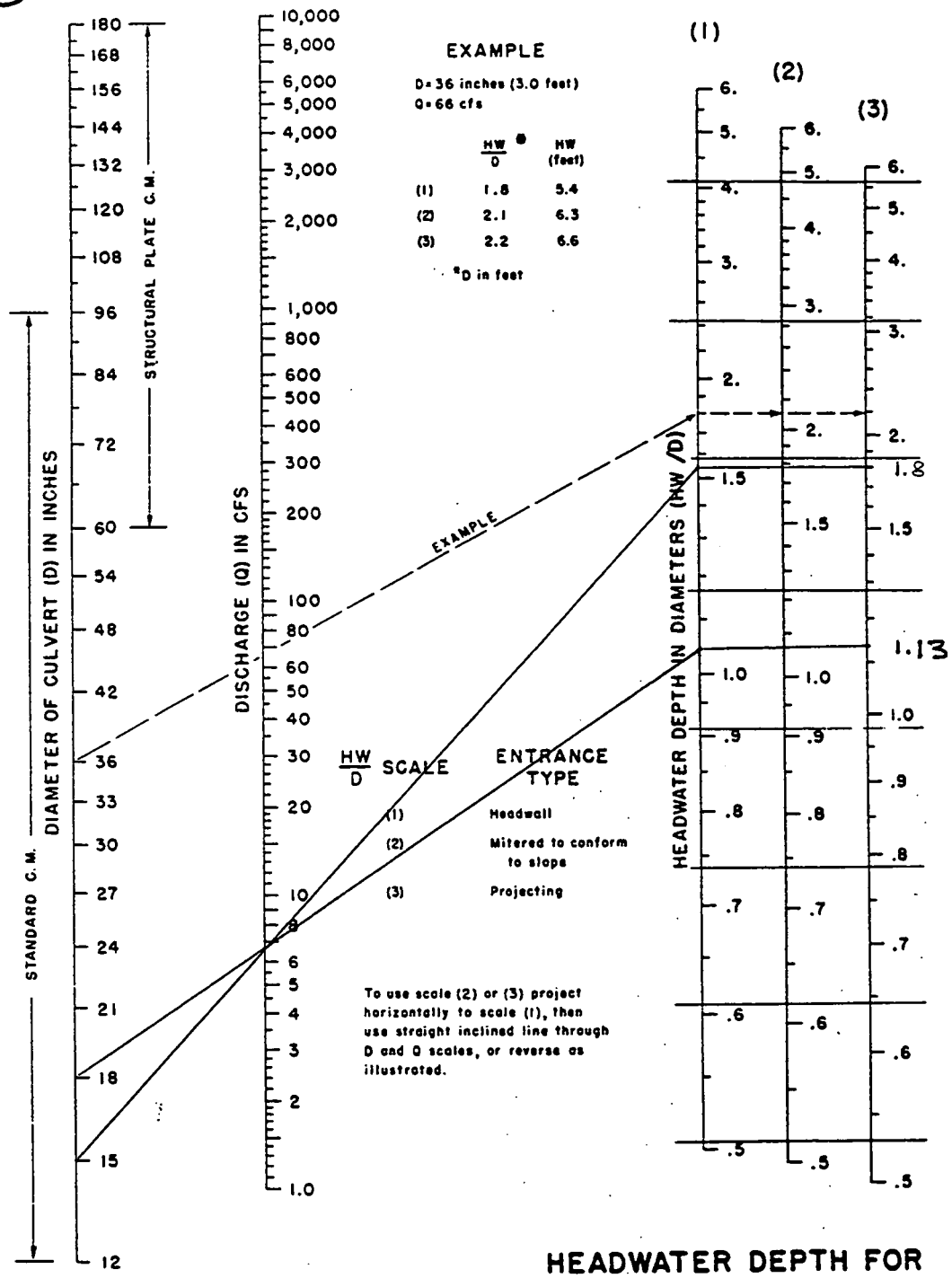
000445

SHT C3

1062

SHT C4

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

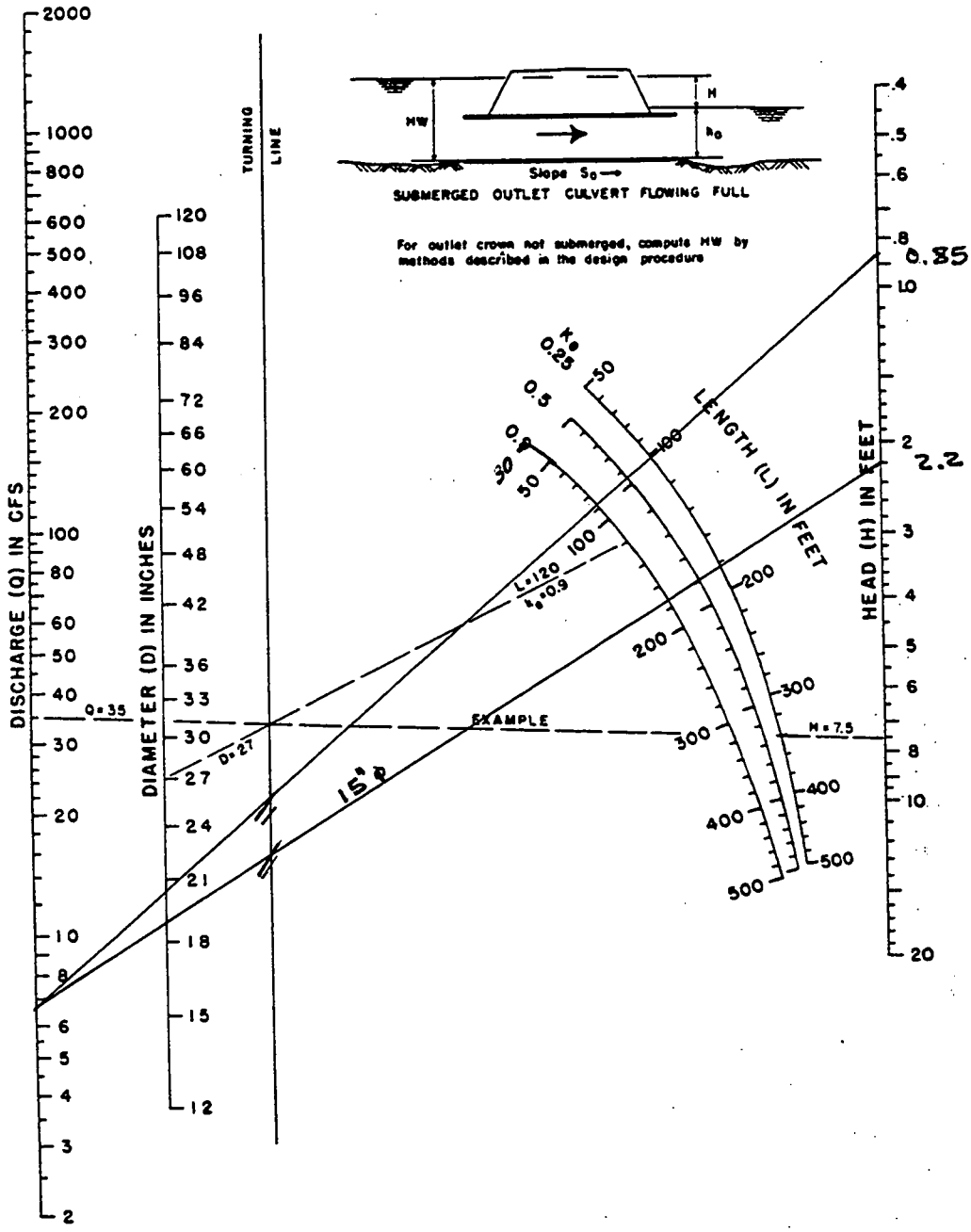
BUREAU OF PUBLIC ROADS JAN. 1963

000446

SHT C5

1062

CHART 6



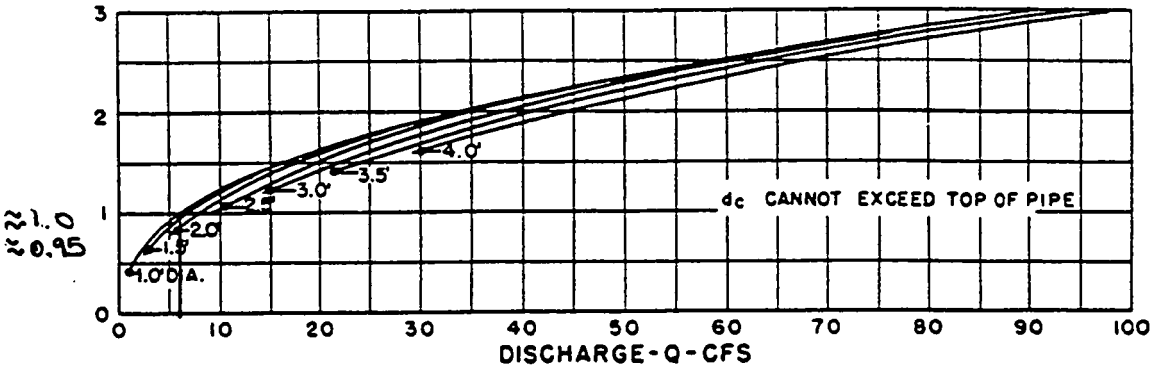
HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL n = 0.024

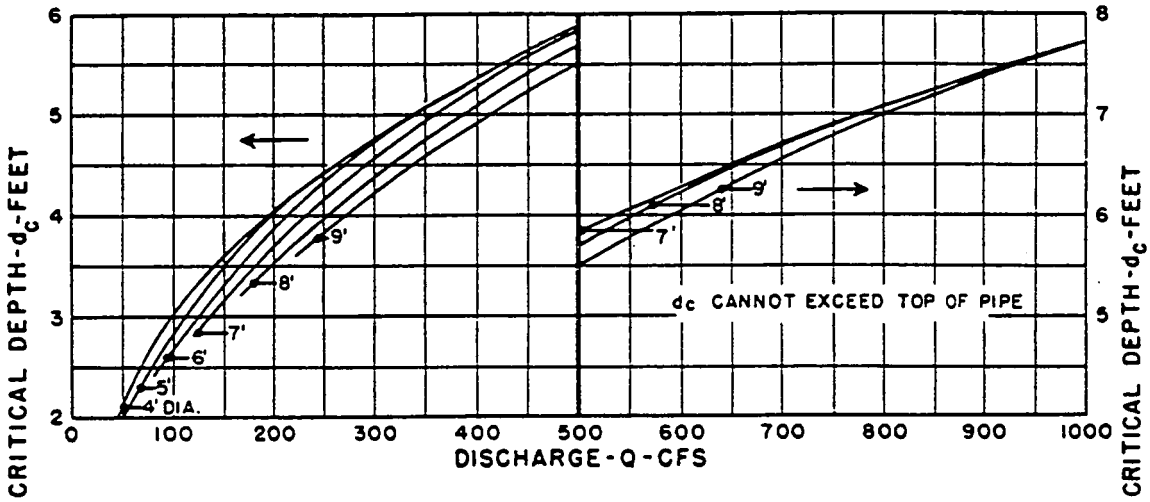
BUREAU OF PUBLIC ROADS JAN. 1963

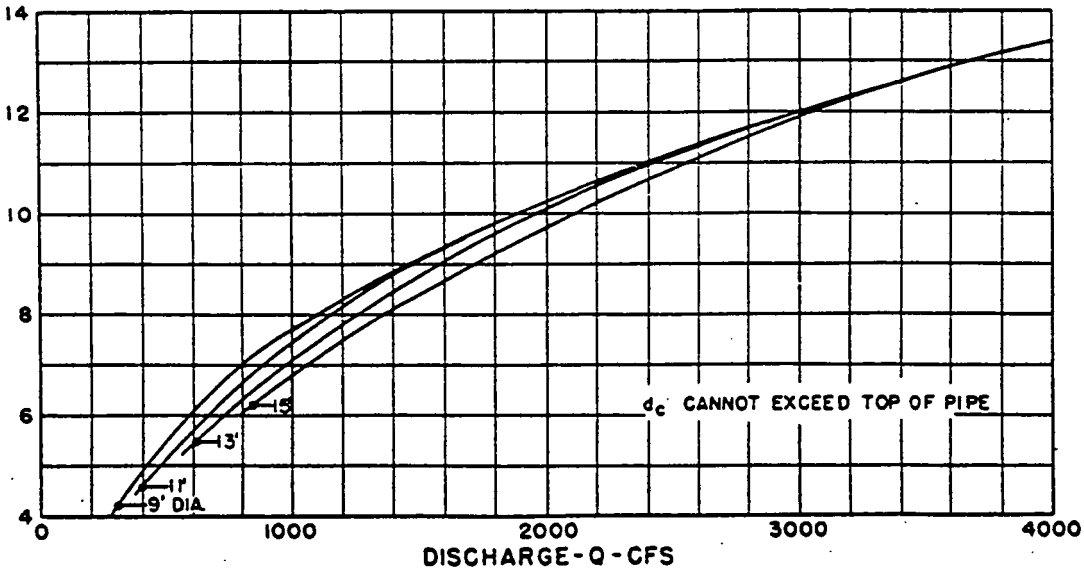
000447

SHT C6

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000448

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

SHT C8

Quick TR-55 Ver.5.46 S/N:
Executed: 16:48:53 01-20-1997

CULVERT 2
USE SAME AS D11
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.89						
GRAVEL	0.900	0.28						
			10.00	0.672	0.672	5.450	1.17	4.28

SHT C9

Quick TR-55 Ver.5.46 S/N:
Executed: 16:48:20 01-20-1997

1062

CULVERT 2
USE SAME AS D11
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.57						
GRAVEL	0.900	0.28						
			10.00	0.699	0.699	5.450	0.85	3.24

PROJECT: SOUTHERN WASTE UNITS
CULVERT-2

STATION: _____
SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

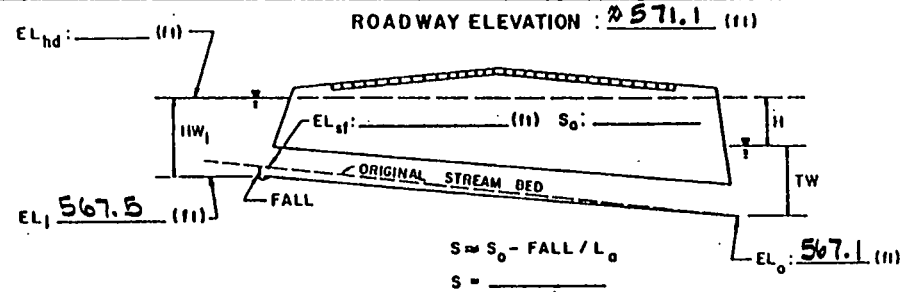
SEE ADD'L. SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	4.3	*

ROADWAY ELEVATION: ≈ 571.1 (ft)



$S \approx S_o - FALL / L_o$
$S =$ _____
$L_o \approx 40'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	h_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ CMP	4.3	4.3	1.12	1.4	—	568.9	0.8	0.8	1.03	1.03	0.9	0.9	569.0	569.0	—	OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION: * ASSUME OUTLET FLOWING FULL, FROM D-11 CALC, DEPTH FOR n = 0.04 DITCH = 0.77' ⇒ USE TW = 0.8'

PROJECTING ENDS ∴ $K_e = 0.9$

CULVERT BARREL SELECTED:

SIZE: 15" Φ
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

240

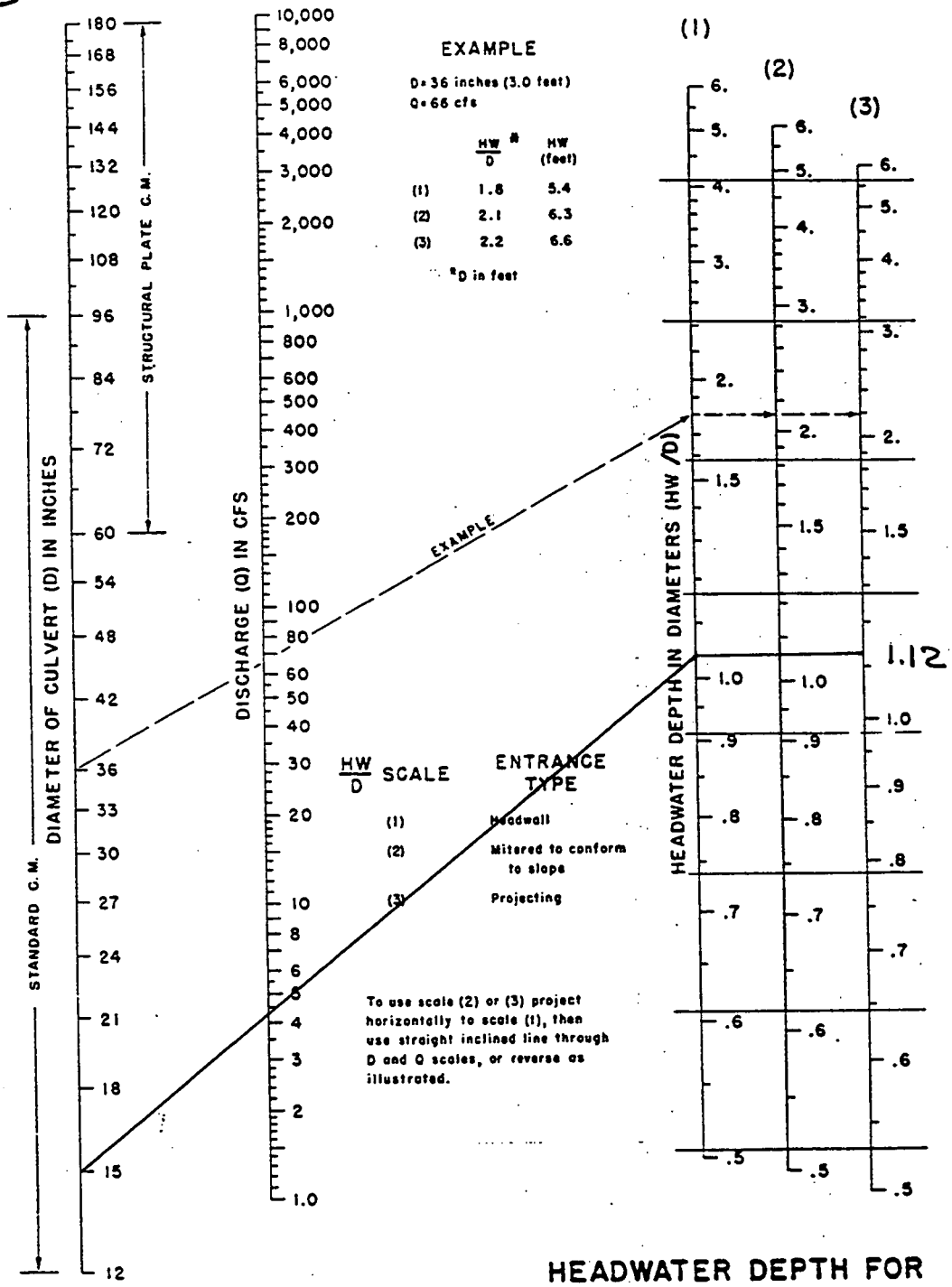
000452

SHT C10

SHT C11

1062

CHART 2



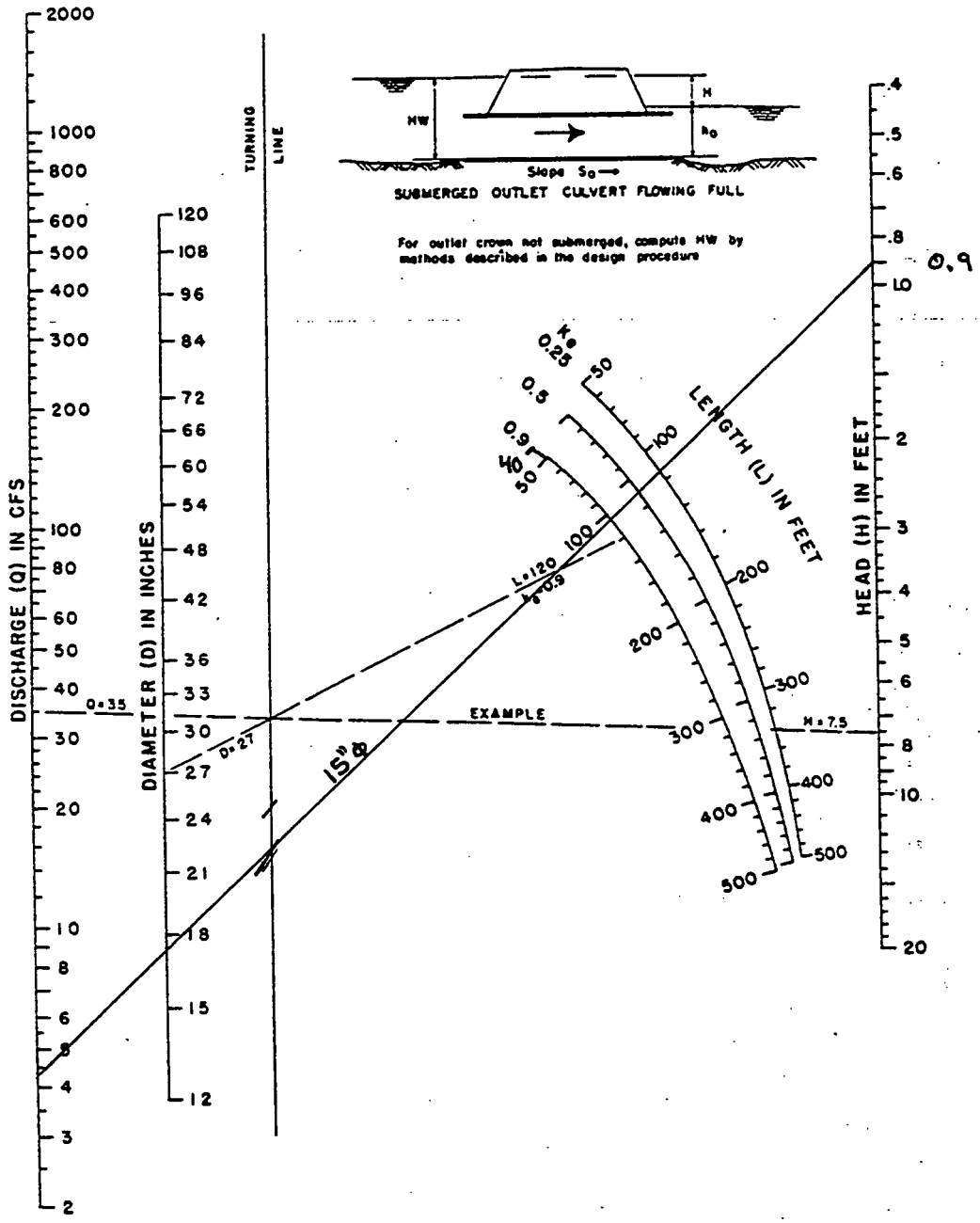
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000453

SHT C12

CHART 6

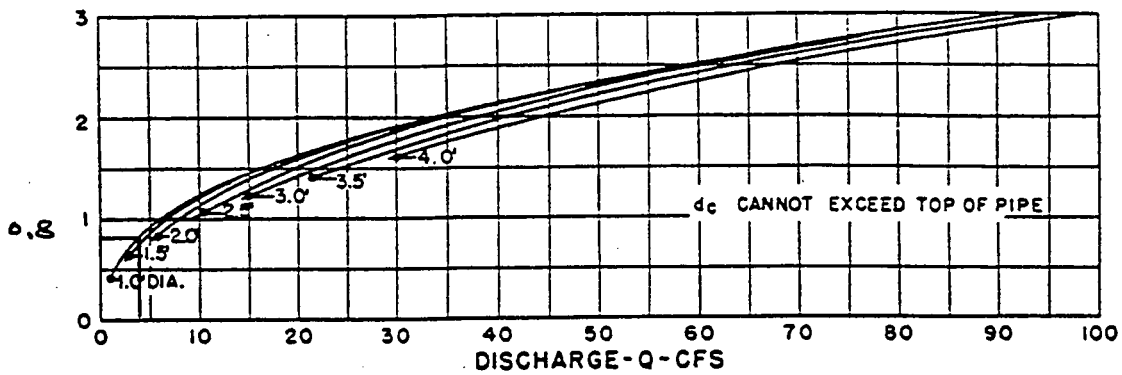


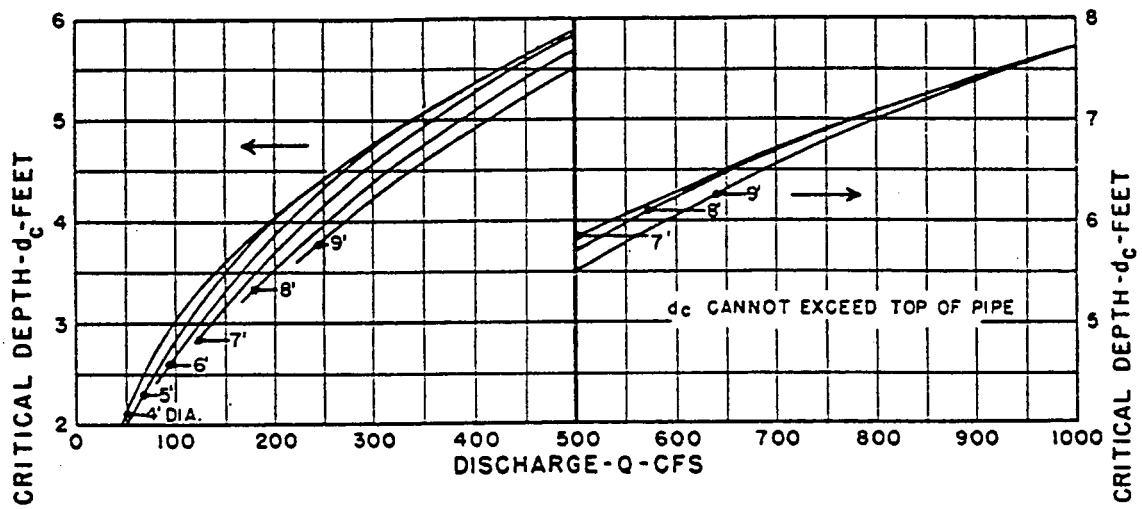
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

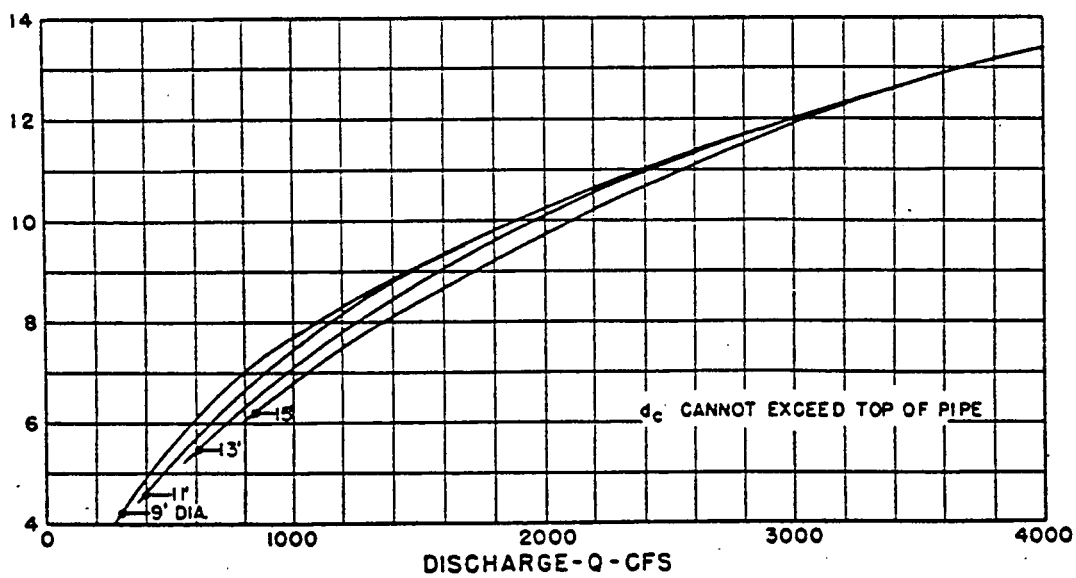
BUREAU OF PUBLIC ROADS JAN. 1963

000454

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

SHT C14

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000456

SKT C15

1062

Quick TR-55 Ver.5.46 S/N:
Executed: 14:39:46 04-28-1997

DITCH-5 & 6 COMBINED
CULVERT 3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	1.09						
			10.00	0.700	0.700	5.450	1.09	4.16

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 3

STATION: N/A
SHEET — OF —

CULVERT DESIGN FORM

DESIGNER / DATE: ____ / ____
REVIEWER / DATE: ____ / ____

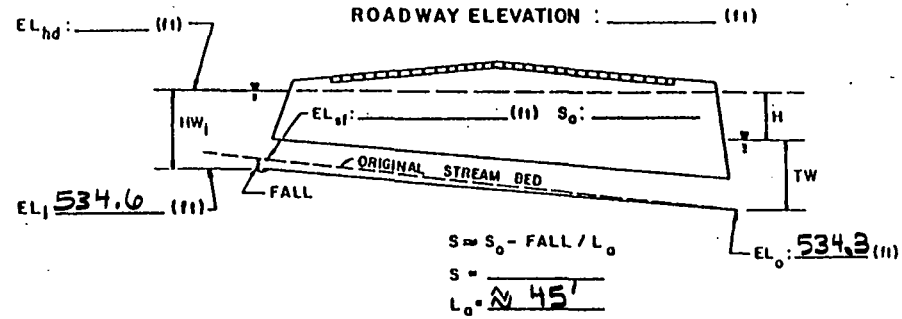
HYDROLOGICAL DATA

SEE ADD'L. SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	4.2	*



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ CMP	4.2	4.2	1.1	1.38	—	536.0	0.8	0.8	1.03	1.03	0.9	0.82	536.15	536.15	—	OUTLET CONTROL

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW /D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION: * ASSUME D-7 FLOWING FULL. FROM D-7 CALC, DEPTH = 0.8 FT

PROJECTING, K_e = 0.9

CULVERT BARREL SELECTED:

SIZE: 15"
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

240

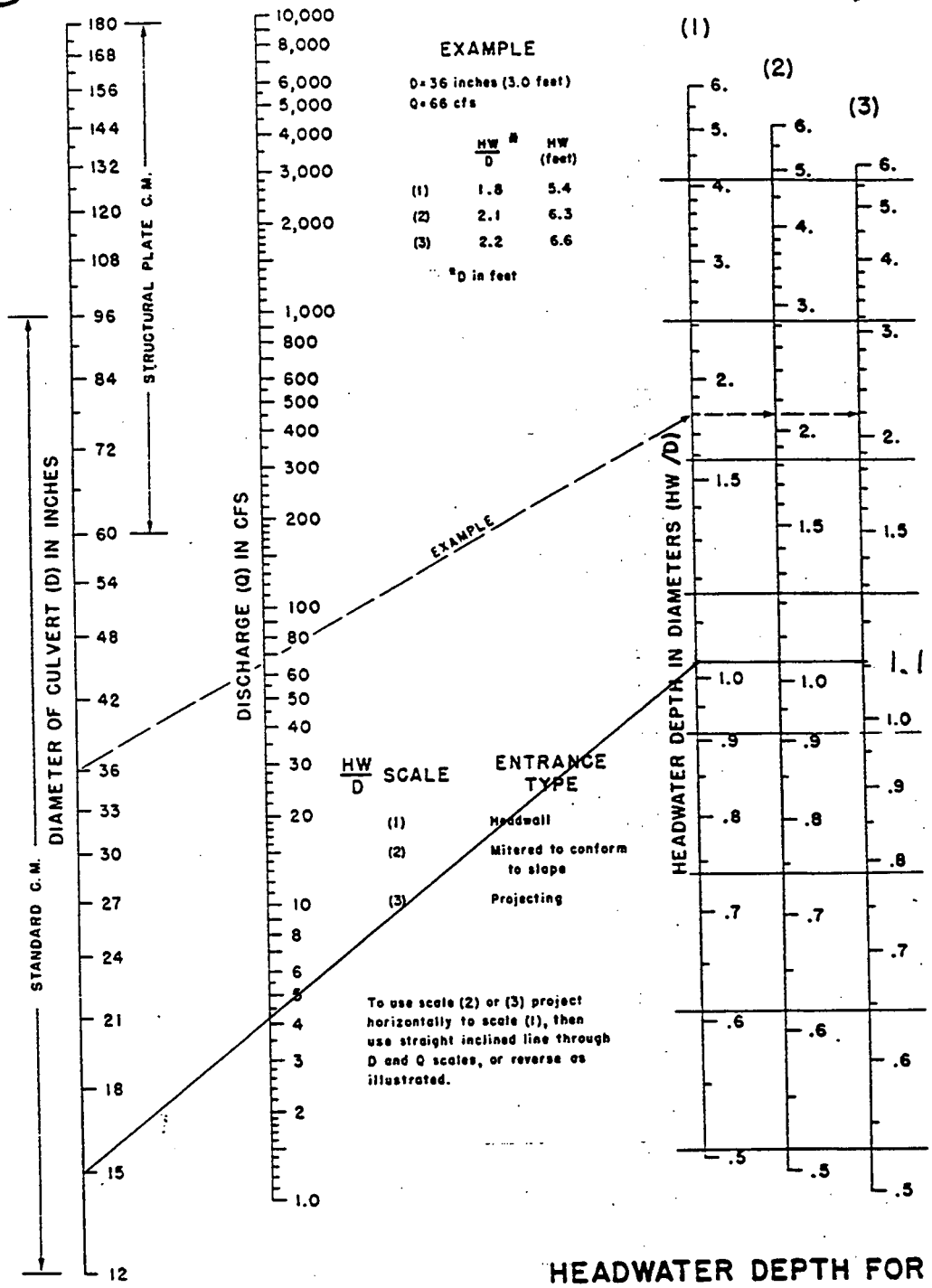
SHT C16

000053

SHT C17

1002

CHART 2



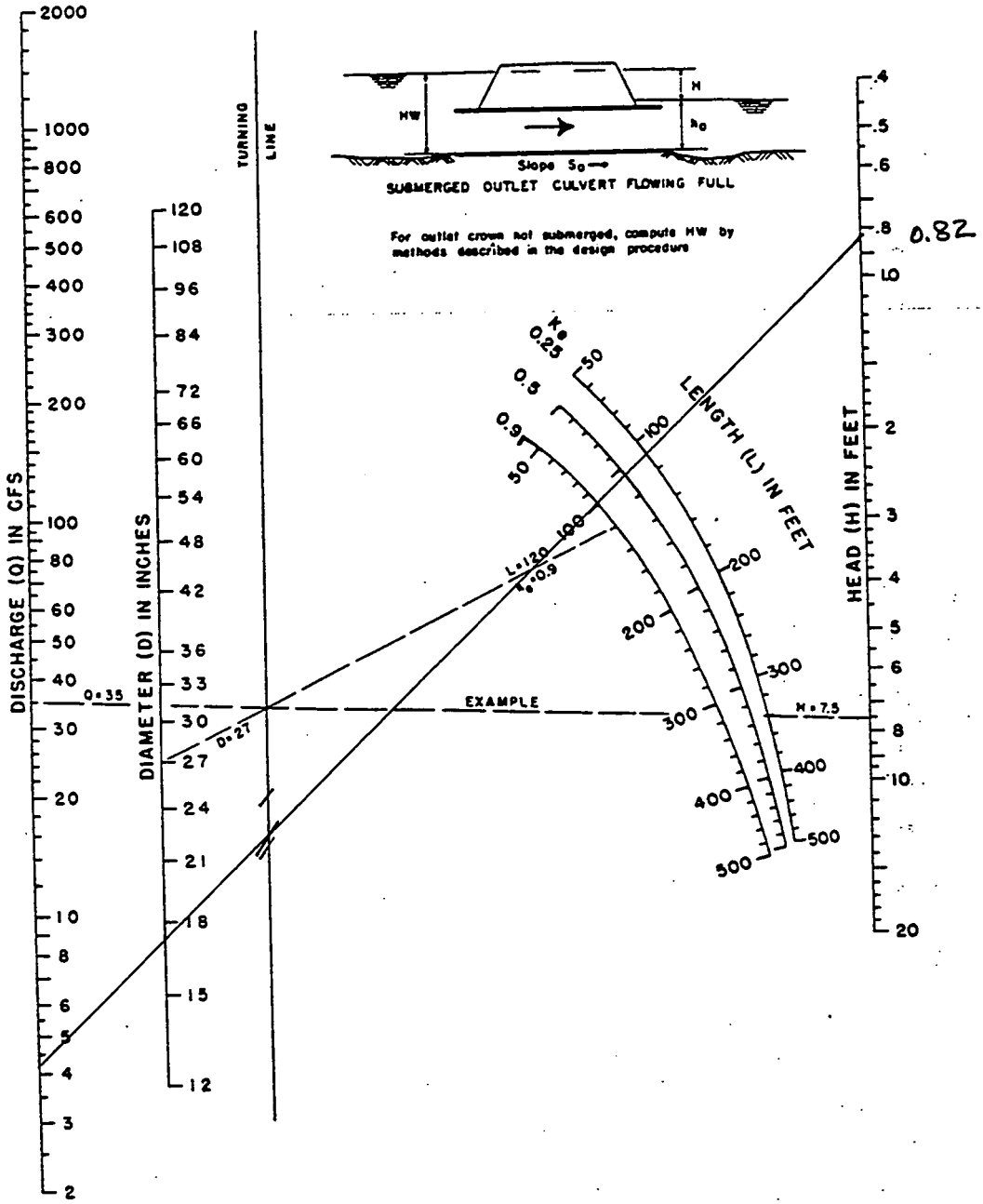
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000459

SHT C18

CHART 6



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

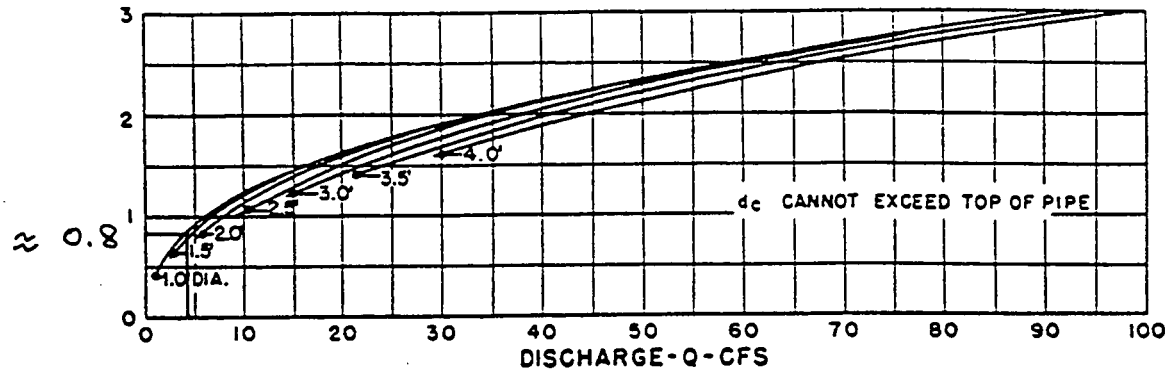
BUREAU OF PUBLIC ROADS JAN. 1963

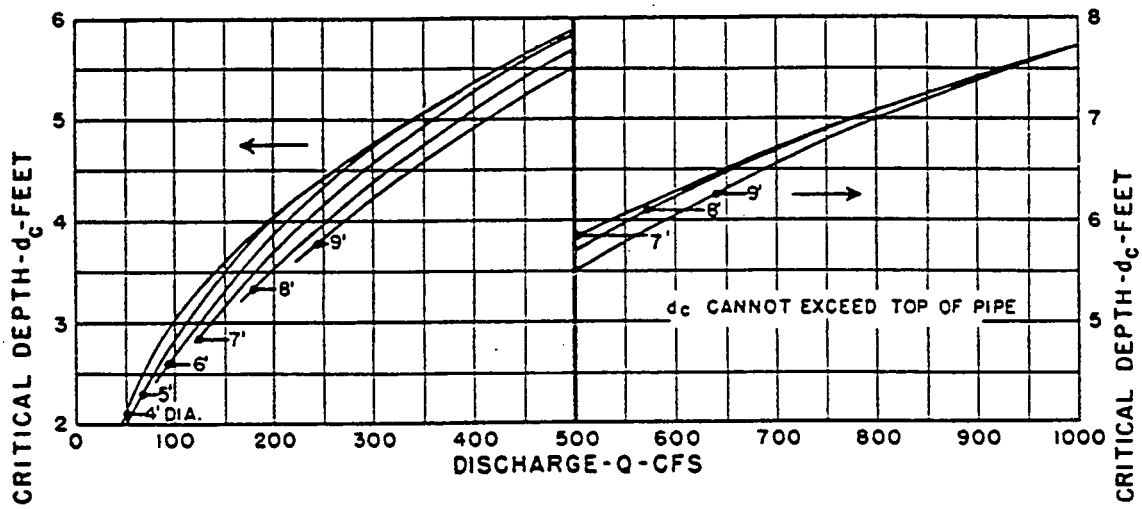
000460

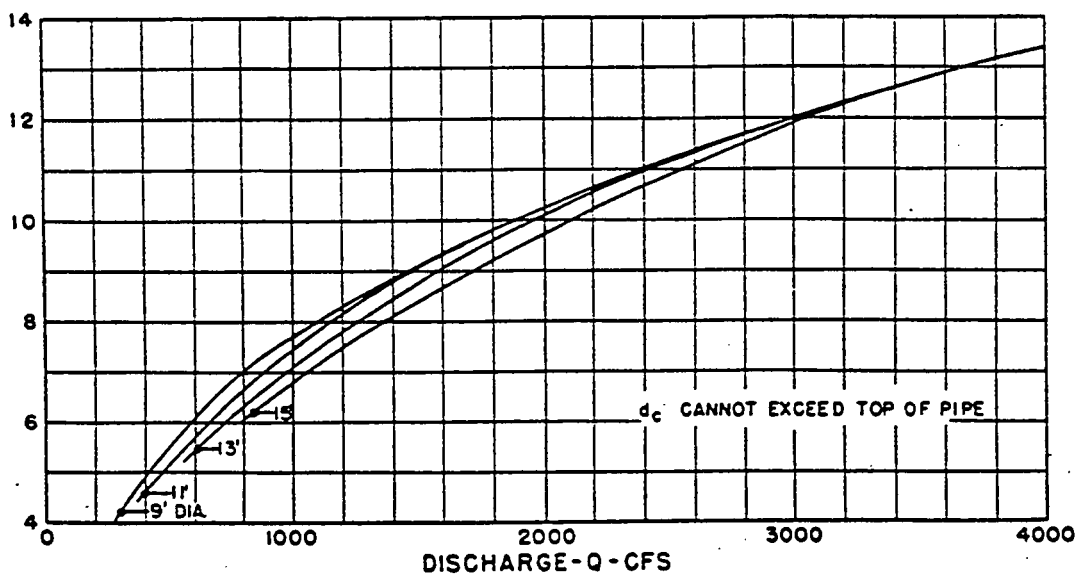
SHT C19

1062

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000461

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g}\right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000462

Quick TR-55 Ver.5.46 S/N:
Executed: 13:44:02 02-04-1997

SHT C21

1062

CULVERT 4

PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
WOODS	0.300	8.10						
VEG, FAIR	0.420	2.01						
GRAVEL RD	0.900	0.20						
BARE,(WDCHP)	0.700	0.50						
			39.00	0.352	0.352	2.750	10.81	10.46

SHT C22

Quick TR-55 Ver.5.46 S/N:
Executed: 13:42:27 02-04-1997 c:\po165d\C4.TCT

CULVERT 4

Tc COMPUTATIONS FOR: CULVERT 4

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		WOODS, LT	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0500	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.62	= 0.62

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	345.0	
Watercourse slope, s	ft/ft	0.0290	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.7476	
where: Unpaved Csf = 16.1345 Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.03	= 0.03

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.65

SHT C23

L-1062

Quick TR-55 Ver.5.46 S/N:
Executed: 13:42:27 02-04-1997 c:\po165d\C4.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

CULVERT 4

Subarea descr.	Tc or Tt	Time (hrs)
CULVERT 4	Tc	0.65

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 4

STATION: _____
SHEET ____ OF ____

CULVERT DESIGN FORM
DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

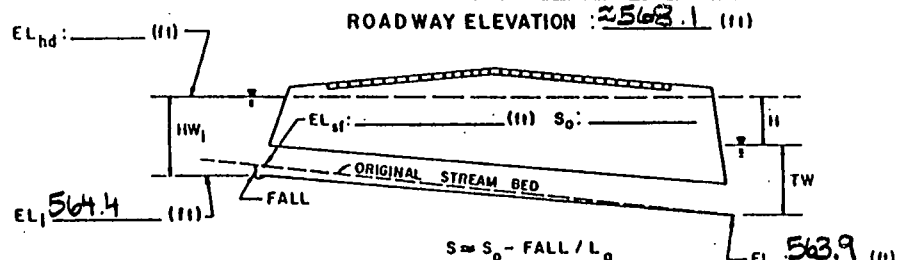
HYDROLOGICAL DATA

SEE ADD'L SHTS.
- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: — ☐ STREAM SLOPE: —
- ☐ CHANNEL SHAPE: —
- ☐ ROUTING: — ☐ OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	10.5	2'

ROADWAY ELEVATION: ≈568.1 (ft)



$S \approx S_o - FALL / L_o$
$S =$ ____
$L_o \approx 451'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 18" ϕ	10.5	10.5	1.8	2.7	—	567.1	2	1.3	1.4	2	0.9	2.4	568.3	568.3	—	
TRY 24" ϕ	10.5	10.5	0.95	1.9	—	566.3	2	1.2	1.6	2	0.9	0.7	566.6	566.6	—	
TRY 21" ϕ	10.5	10.5	1.2	2.1	—	566.5	2	1.25	1.5	2	0.9	1.2	567.1	567.1	—	

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:
- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:
SIZE: 21" ϕ
SHAPE: CIRCULAR
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

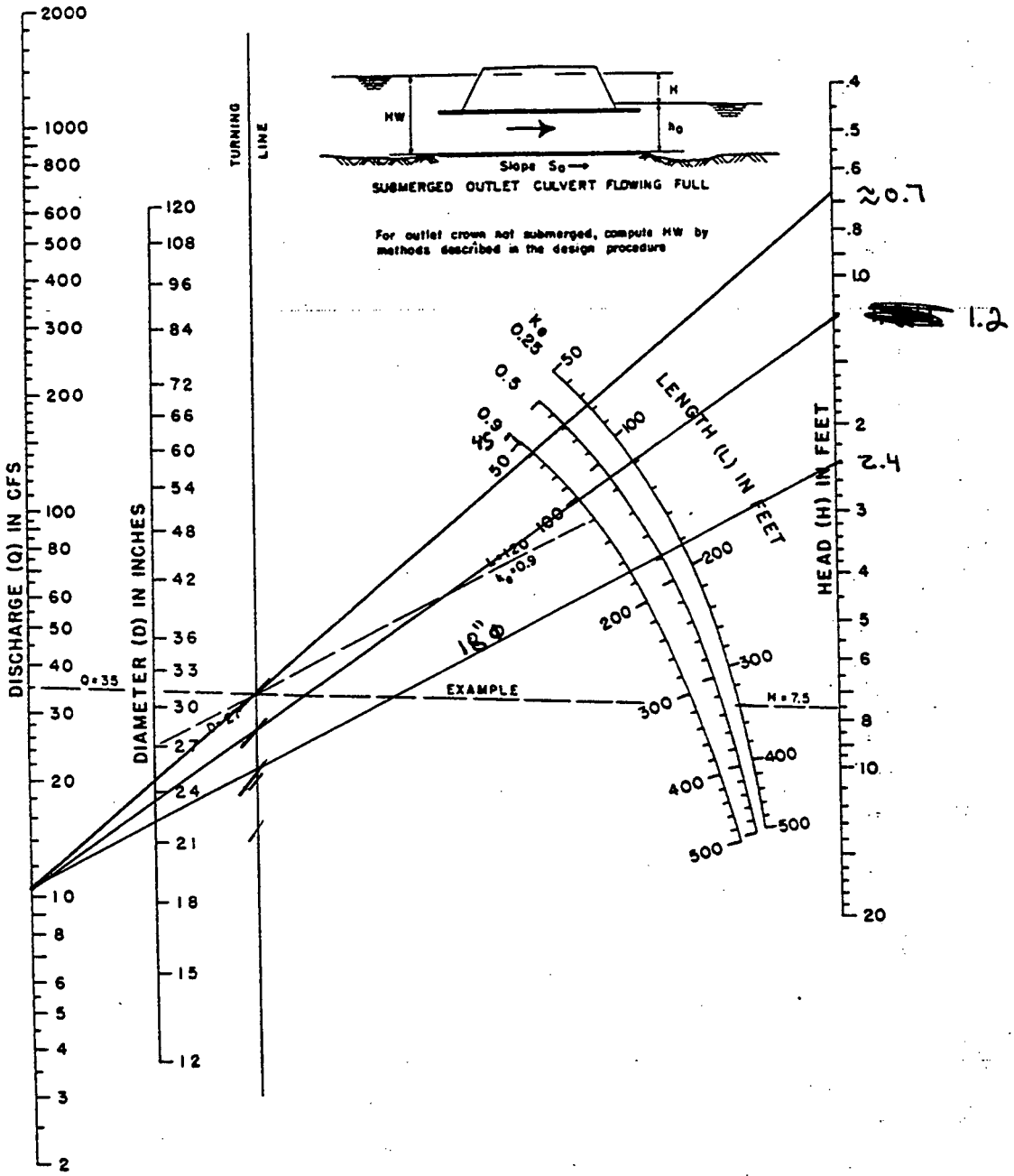
240

000466

SHT C24

SHT C25
1062

CHART 6



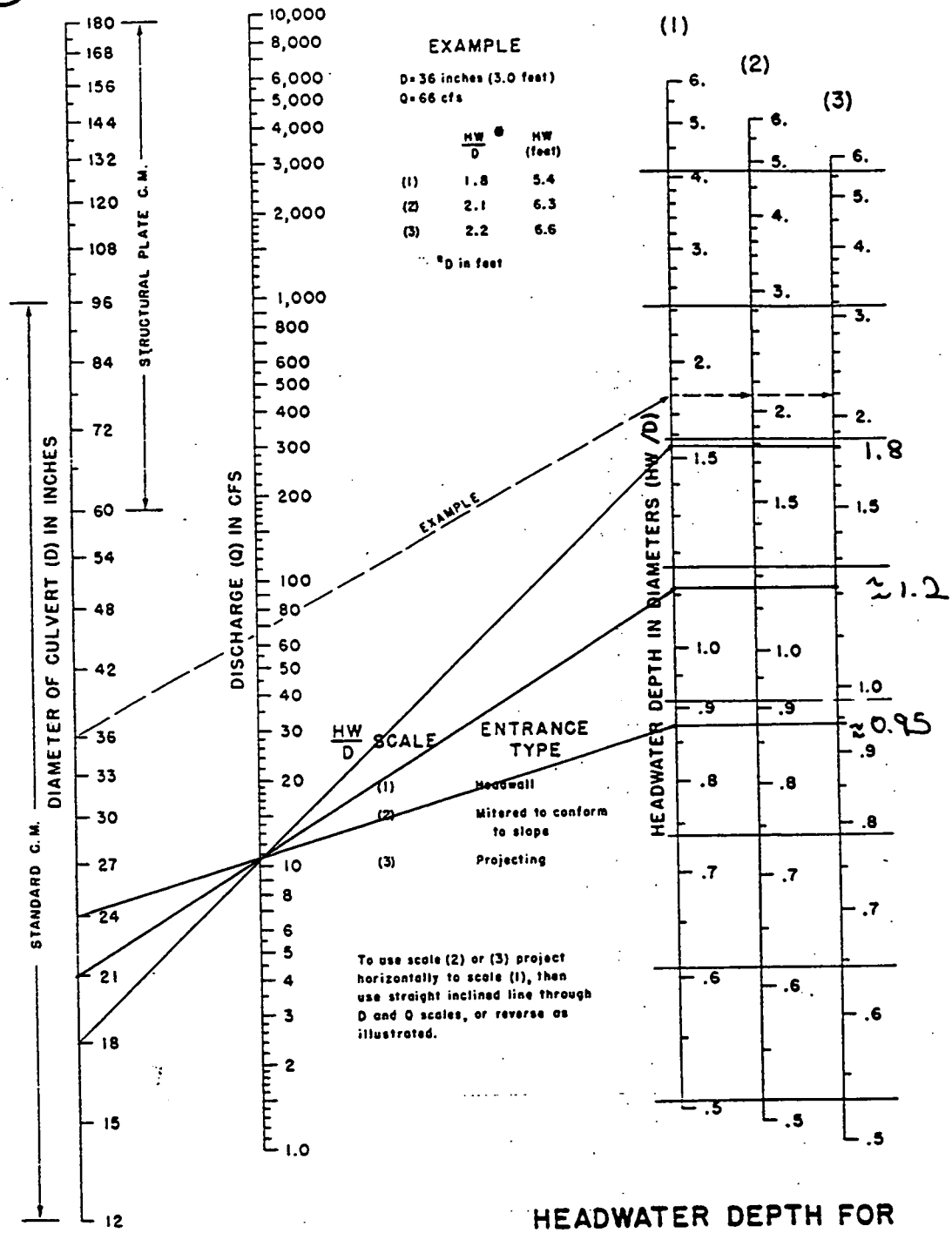
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

000467

SHT C26

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

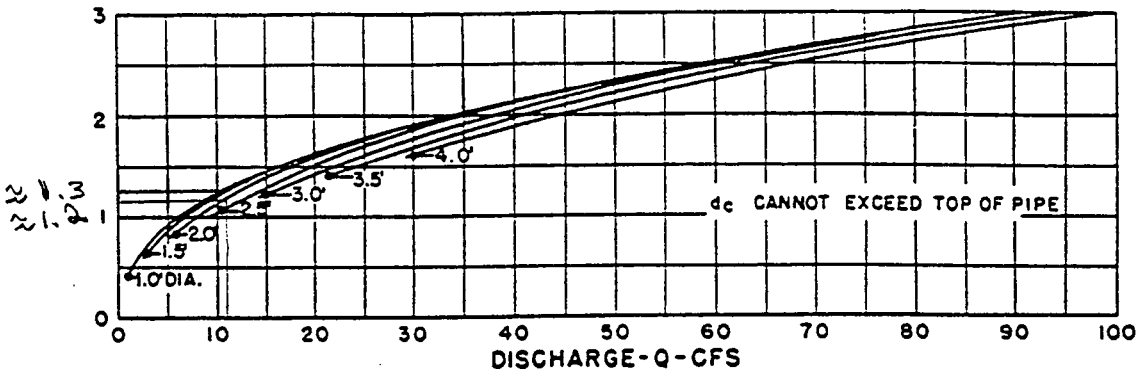
BUREAU OF PUBLIC ROADS JAN. 1963

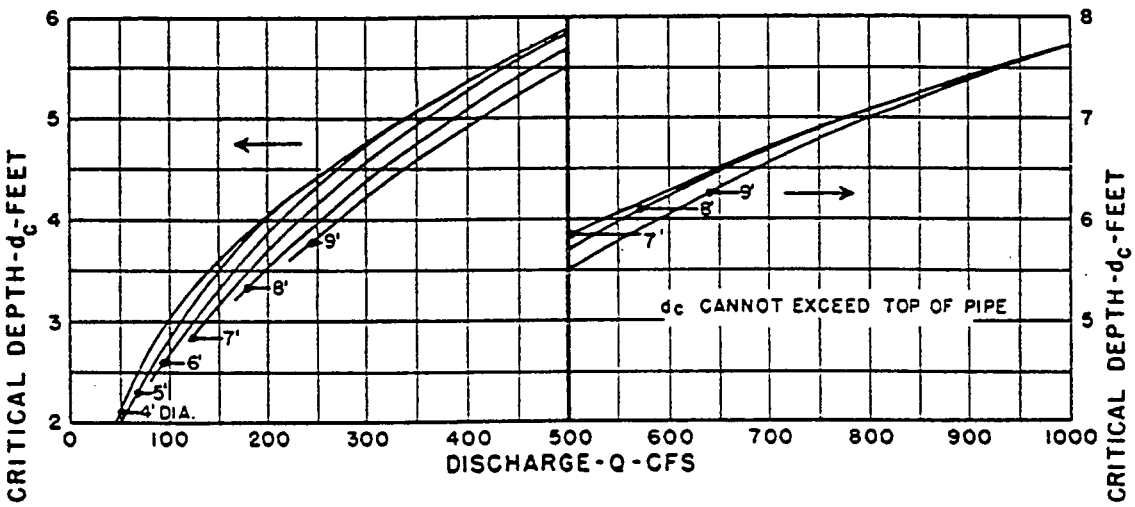
000468

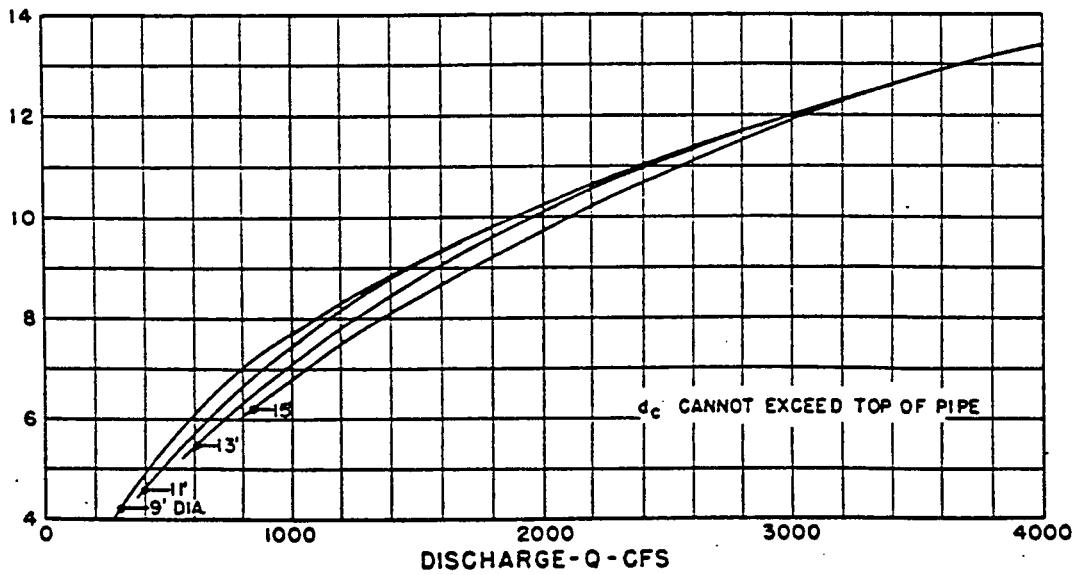
SHT C27

1062

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000469

SHT C28

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

SHT C29

L-1062

Quick TR-55 Ver.5.46 S/N:
Executed: 07:08:08 01-15-1997

CULVERT 5

PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
PAVEMENT	0.900	0.50						
			10.00	0.900	0.900	5.450	0.50	2.45

PROJECT: SOUTHERN WASTE UNIT
CULVERT-5

STATION: _____
SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

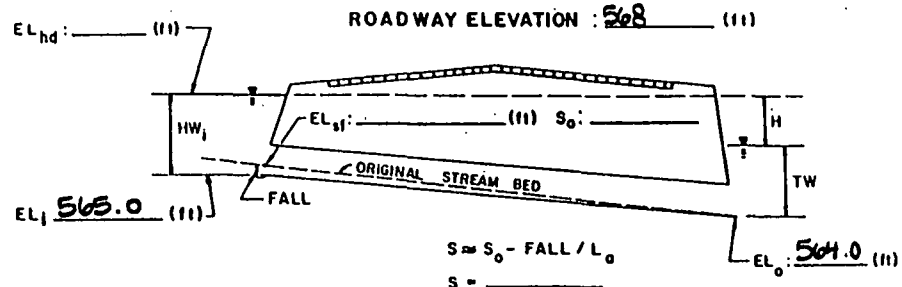
SEE ADD'L SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	2.5	2

ROADWAY ELEVATION: 568 (ft)



$S \approx S_o - FALL / L_o$
$S =$ _____
$L_o \approx 95'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW i/D (2)	HW i	FALL (3)	EL hi (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" ϕ	2.5	2.5	0.78	0.98	—	565.98	2	0.6	0.93	2	0.9	0.55	566.6	566.6	—	OUTLET CONTROL
TRY 18" ϕ	2.5	2.5	0.59	0.89	—	565.89	2	≈0.6	1.05	2	0.9	≈0	566.0	566.0	—	OUTLET CONTROL

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

PROJECTING ENDS

CULVERT BARREL SELECTED:

SIZE: 15" ϕ
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

240

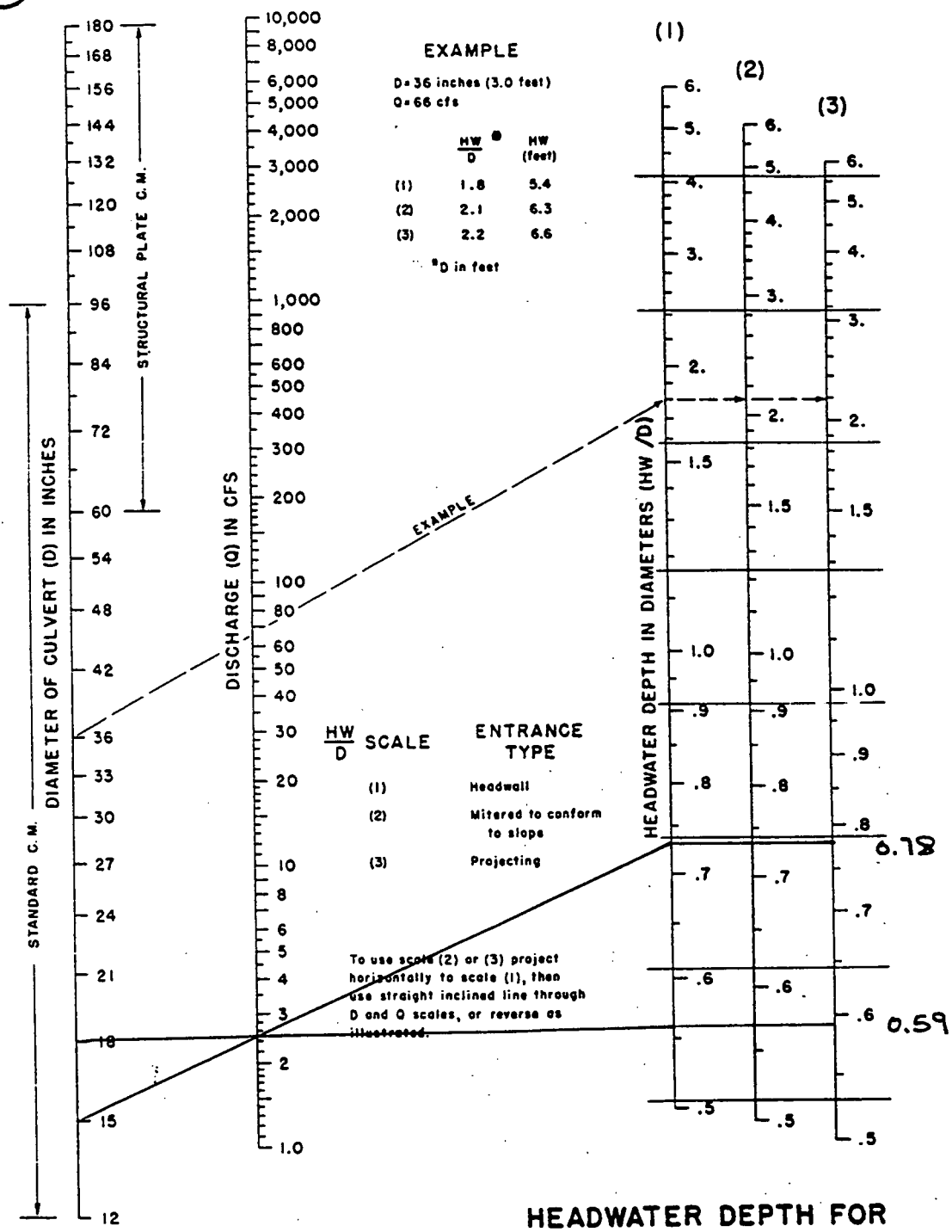
000472

SHT C30

SHT C31

1062

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

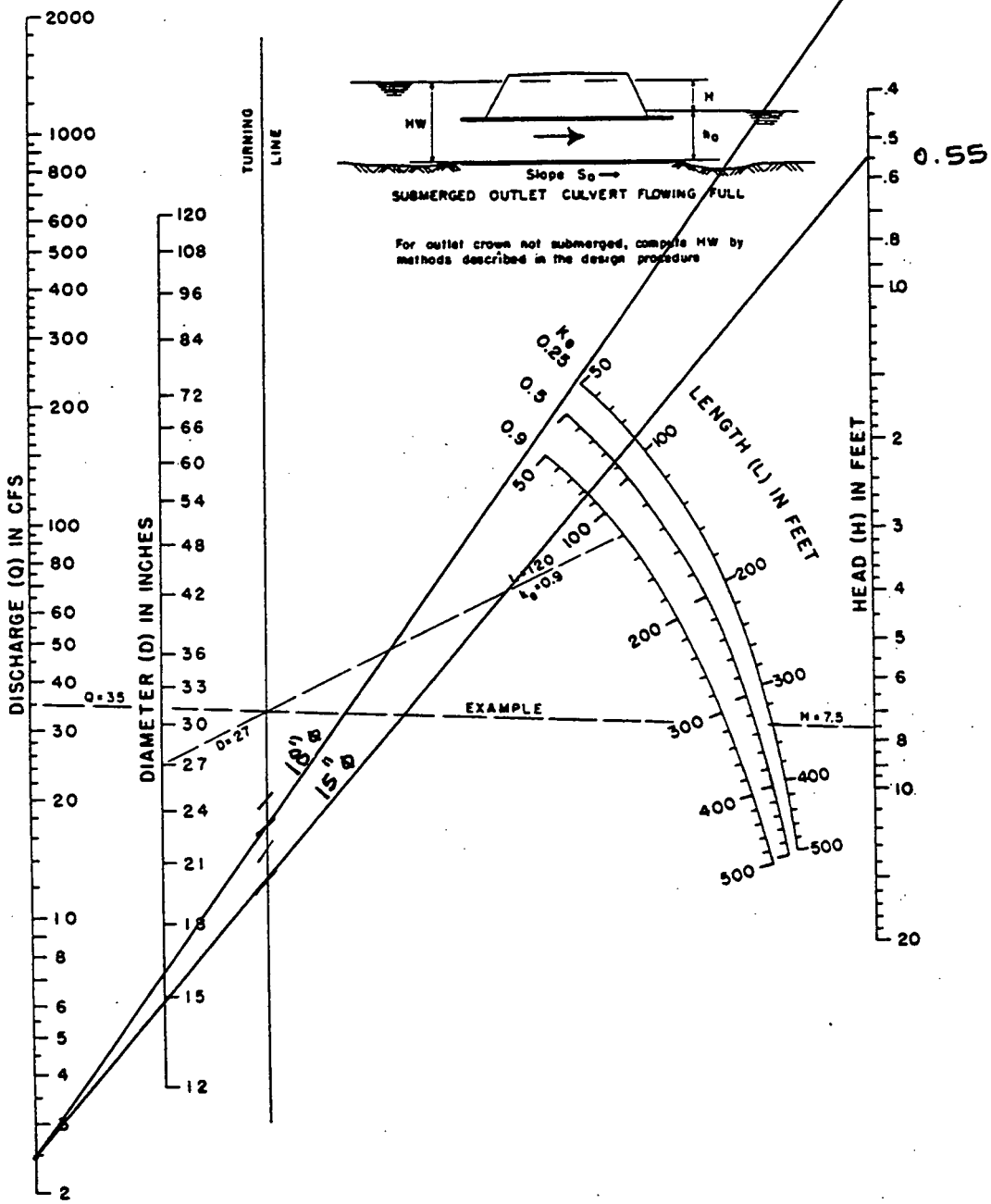
BUREAU OF PUBLIC ROADS JAN. 1963

000423

SHT C32

CHART 6

INSIGNIFICANT



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

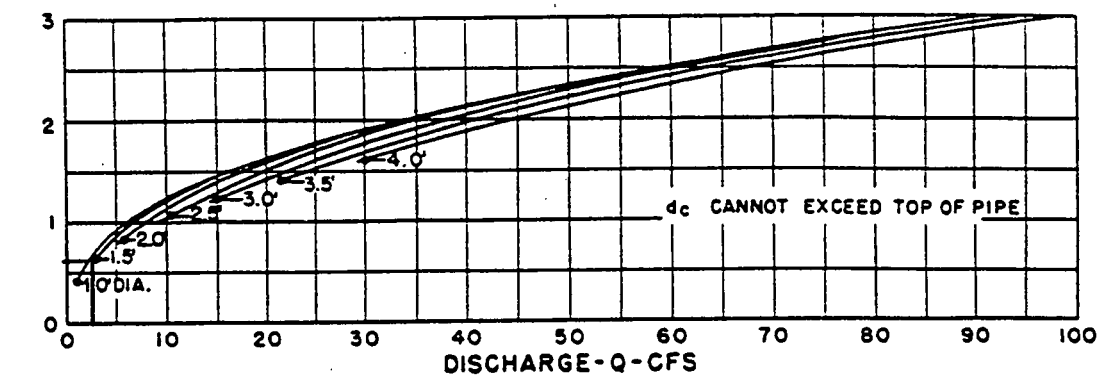
BUREAU OF PUBLIC ROADS JAN. 1963

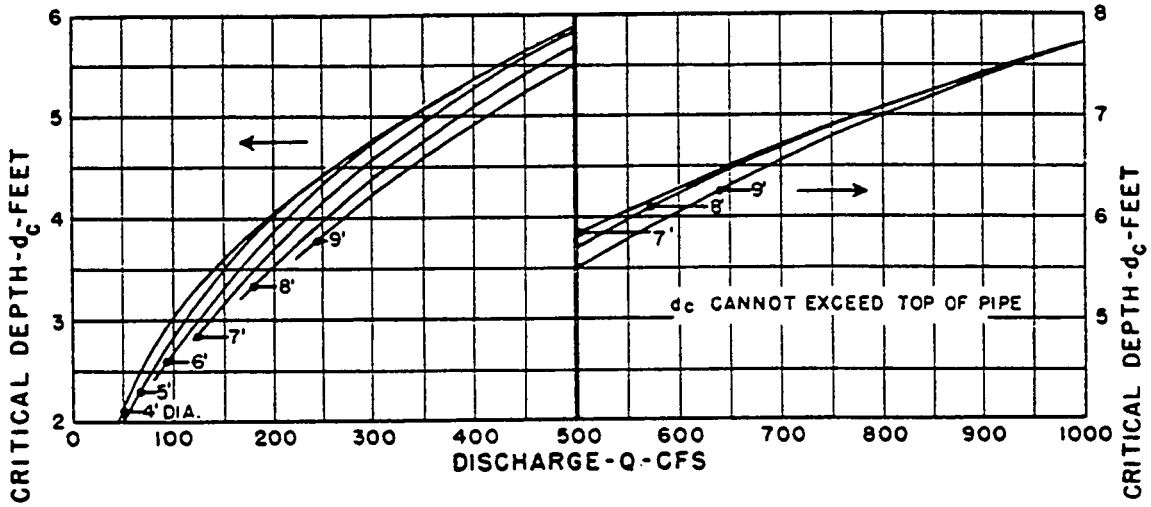
000474

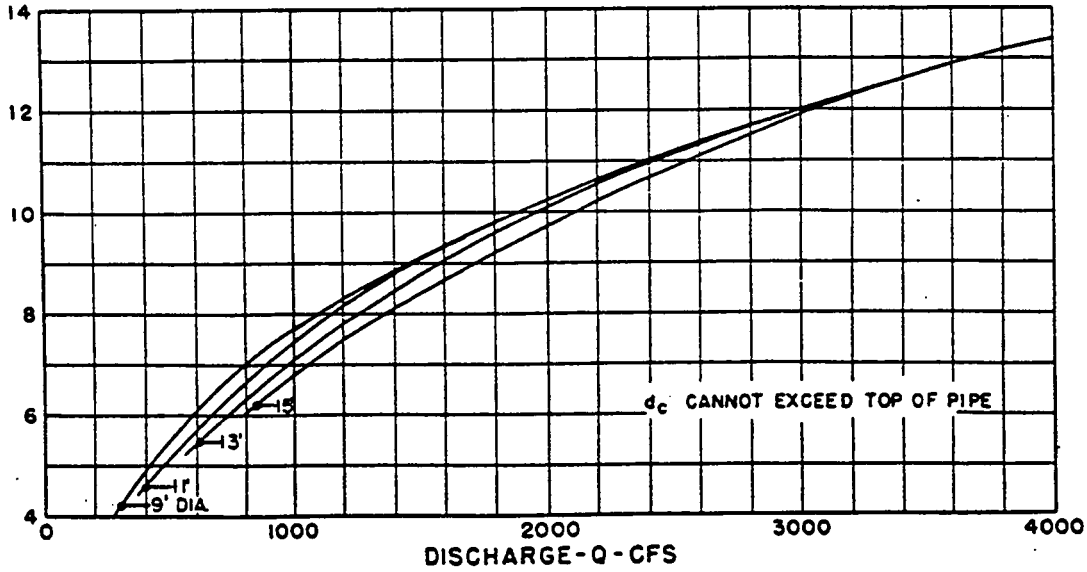
SHT C33

1062

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000475

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

SHT C35

Quick TR-55 Ver.5.46 S/N:
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1062

CULVERT-6
EXISTING AND PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	1.00						
			10.00	0.700	0.700	5.450	1.00	3.81

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 6 (CONTINGENCY CULVERT)

STATION: —

SHEET — OF —

CULVERT DESIGN FORM

DESIGNER / DATE: — / —

REVIEWER / DATE: — / —

HYDROLOGICAL DATA

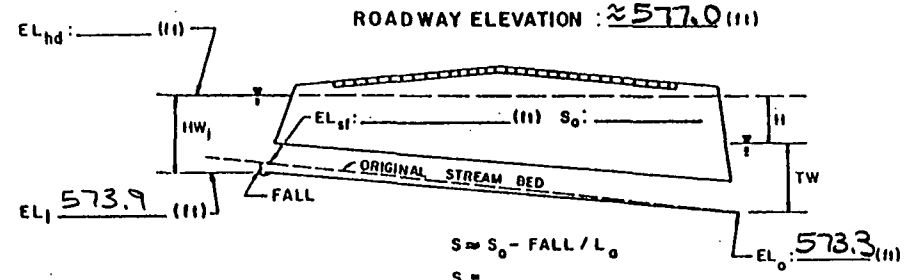
SEE ADD'L SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	3.81	*

ROADWAY ELEVATION: ≈577.0 (ft)



$S \approx S_o - FALL / L_o$

$S =$

$L_o = \approx 55'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" ϕ	3.8	3.8	1.0	1.25	—	575.2	1.2	0.7	1.0	1.2	0.9	0.9	576.4	576.4	—	OUTLET CONTROL OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION: * ASSUME TW AT FLOW DEPTH FOR DITCH 8A, FROM CALC FOR 8A, TW = 1.2 FT

CULVERT BARREL SELECTED:

SIZE: 15"

SHAPE: ROUND

MATERIAL: CMP n=0.024

ENTRANCE: PROJECTING

240

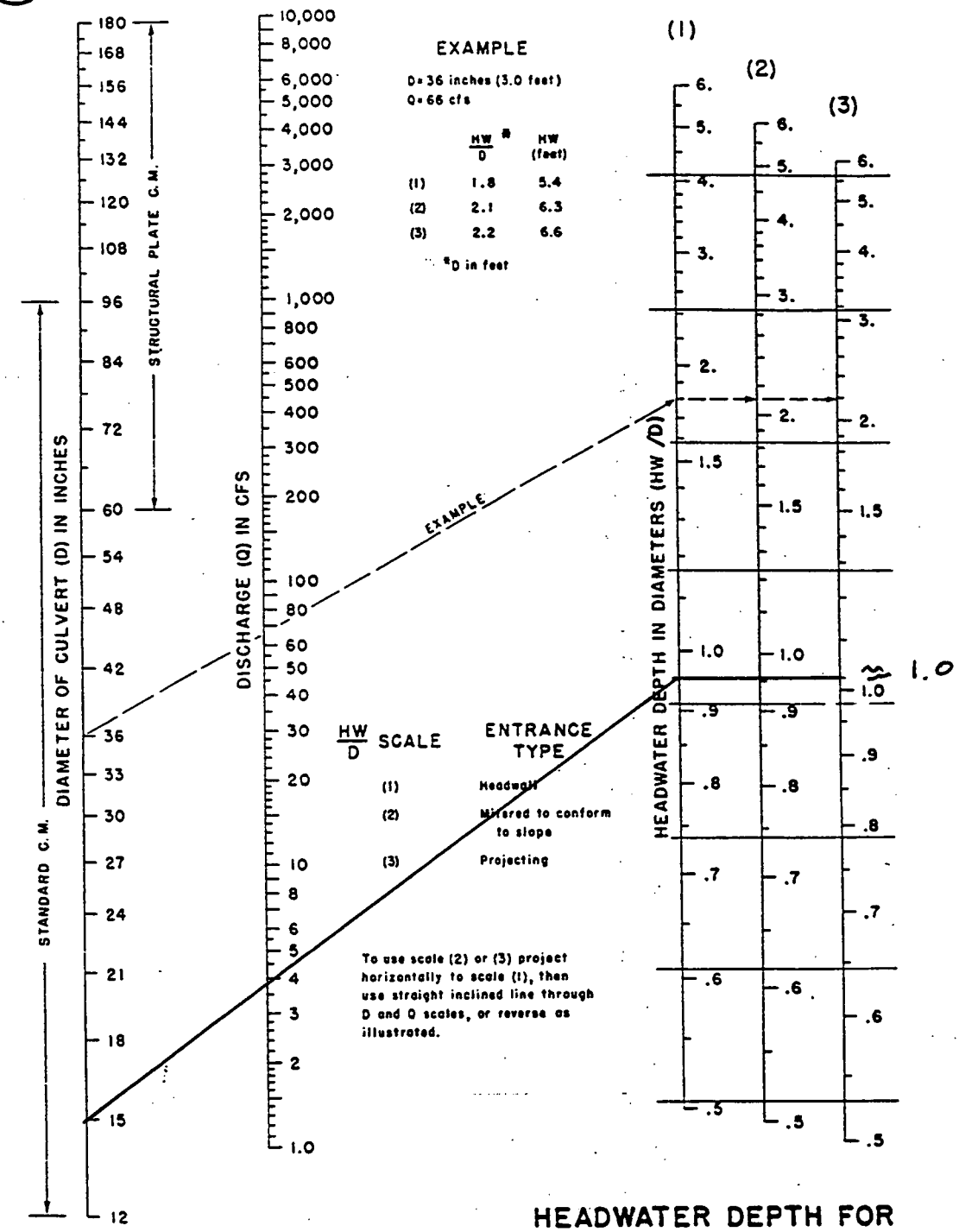
000478

SHT C36

SHT C37

1 v 02

CHART 2



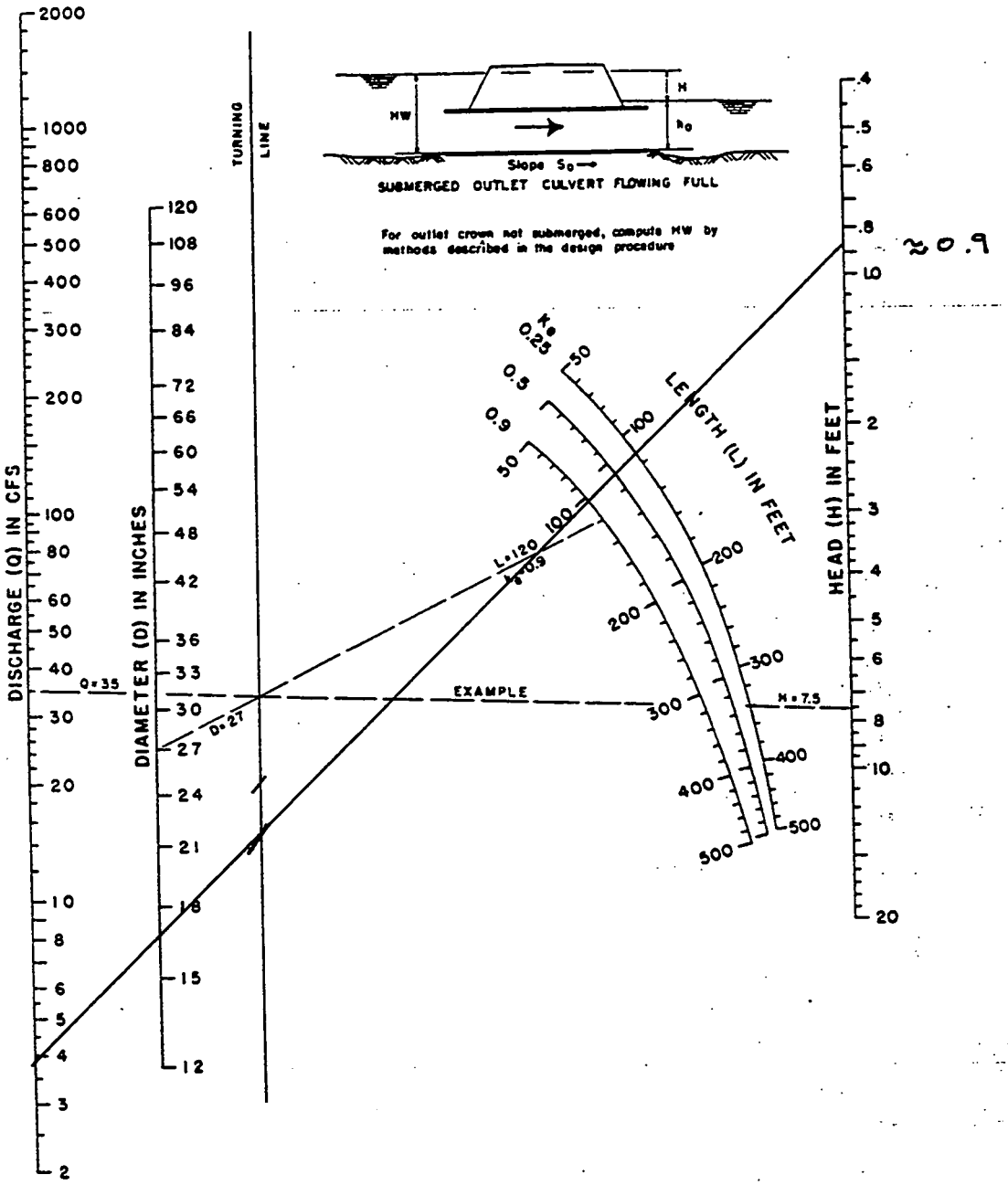
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000479

SHT C38

CHART 6



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

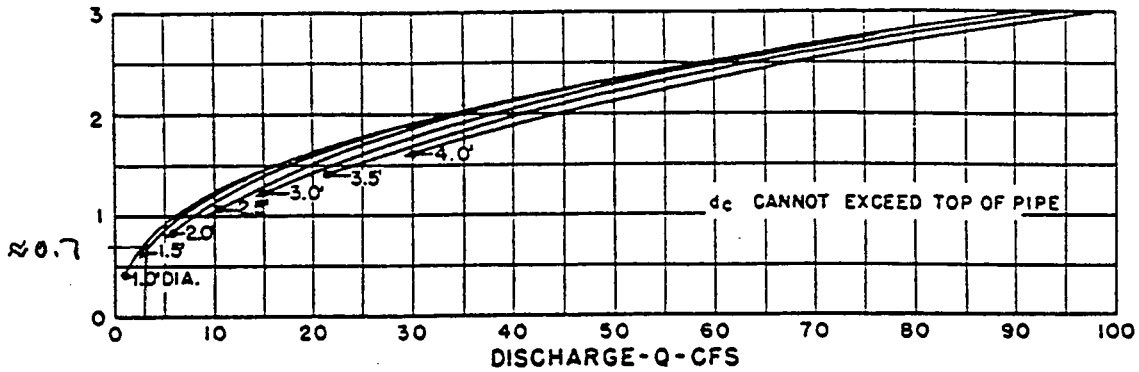
BUREAU OF PUBLIC ROADS JAN. 1963

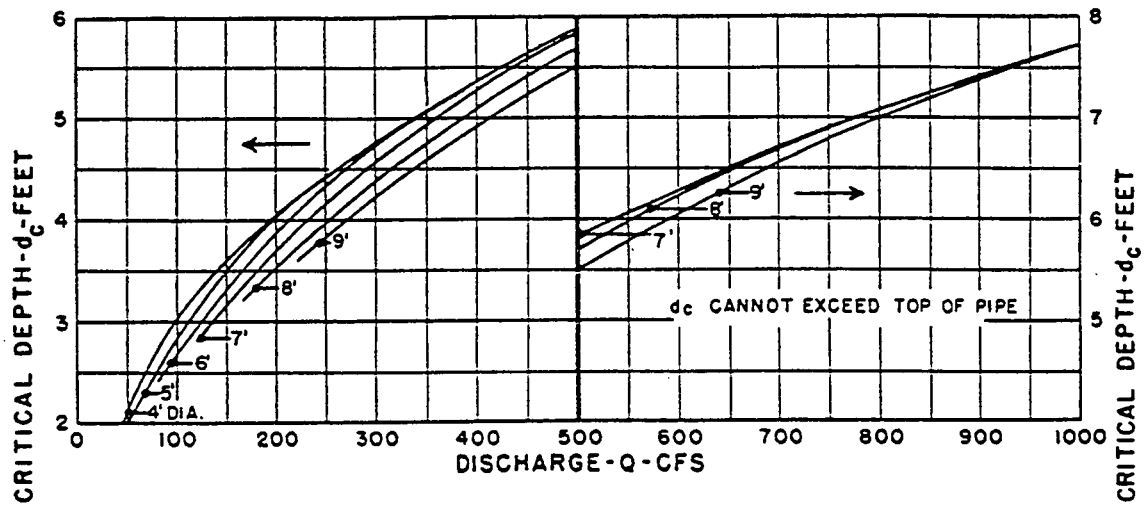
000480

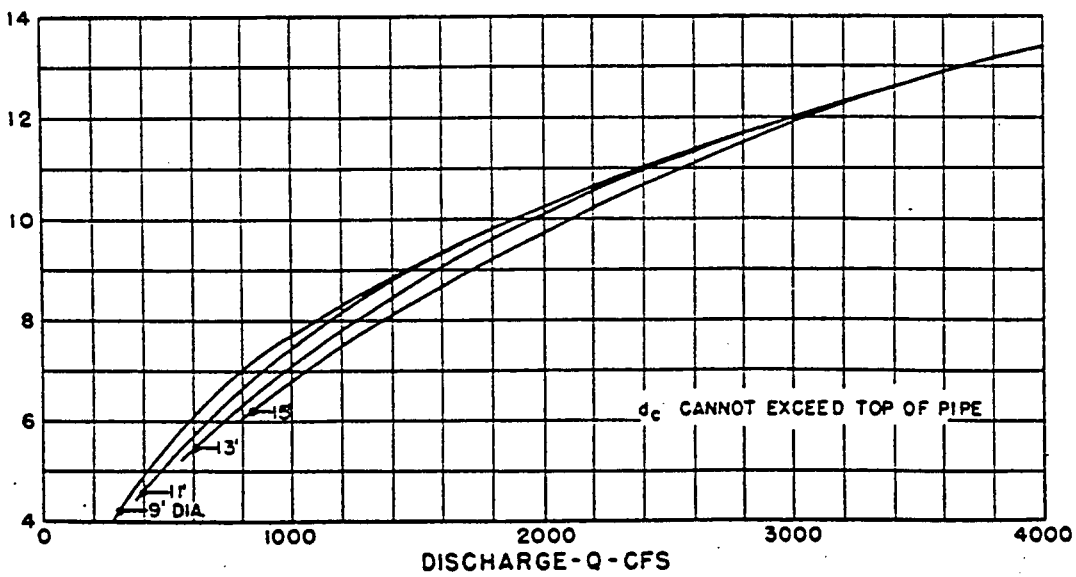
SHT C39

1062

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000481

SHTC40

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000482

SHT C41

Quick TR-55 Ver.5.46 S/N:
Executed: 16:53:28 06-07-1997

1062

CULVERT-7
EXISTING AND PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
GRAVEL	0.900	0.20						
			10.00	0.900	0.900	5.450	0.20	0.98

000483

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 7

STATION: _____
SHEET _____ OF _____

CULVERT DESIGN FORM
DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

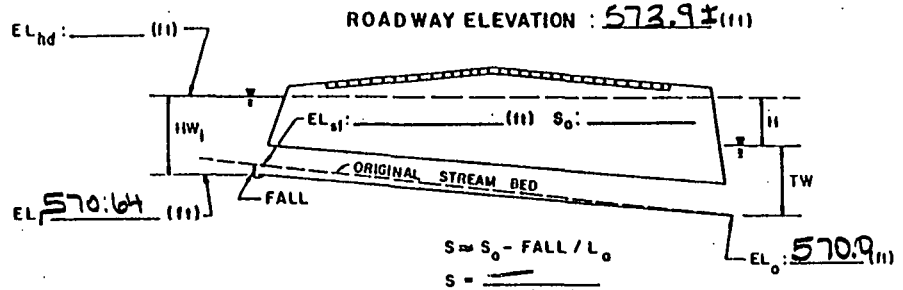
HYDROLOGICAL DATA

SEE ADD'L SHTS.
- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: — ☐ STREAM SLOPE: —
- ☐ CHANNEL SHAPE: —
- ☐ ROUTING: — ☐ OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	0.98	*

ROADWAY ELEVATION: 573.9± (ft)



$S \approx S_o - FALL / L_o$
$S =$ —
$L_o \approx 30'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 12" ϕ CMP	1.0	1.0	0.64	0.64	—	571.3	1	0.4	0.7	1	0.9	≈0	571.0	571.3	—	INLET CONTROL: OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:
- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:
* ASSUME TW = 1.0 ft

CULVERT BARREL SELECTED:
SIZE: 12"
SHAPE: ROUND
MATERIAL: CMP n=0.024
ENTRANCE: PROJECTING

240

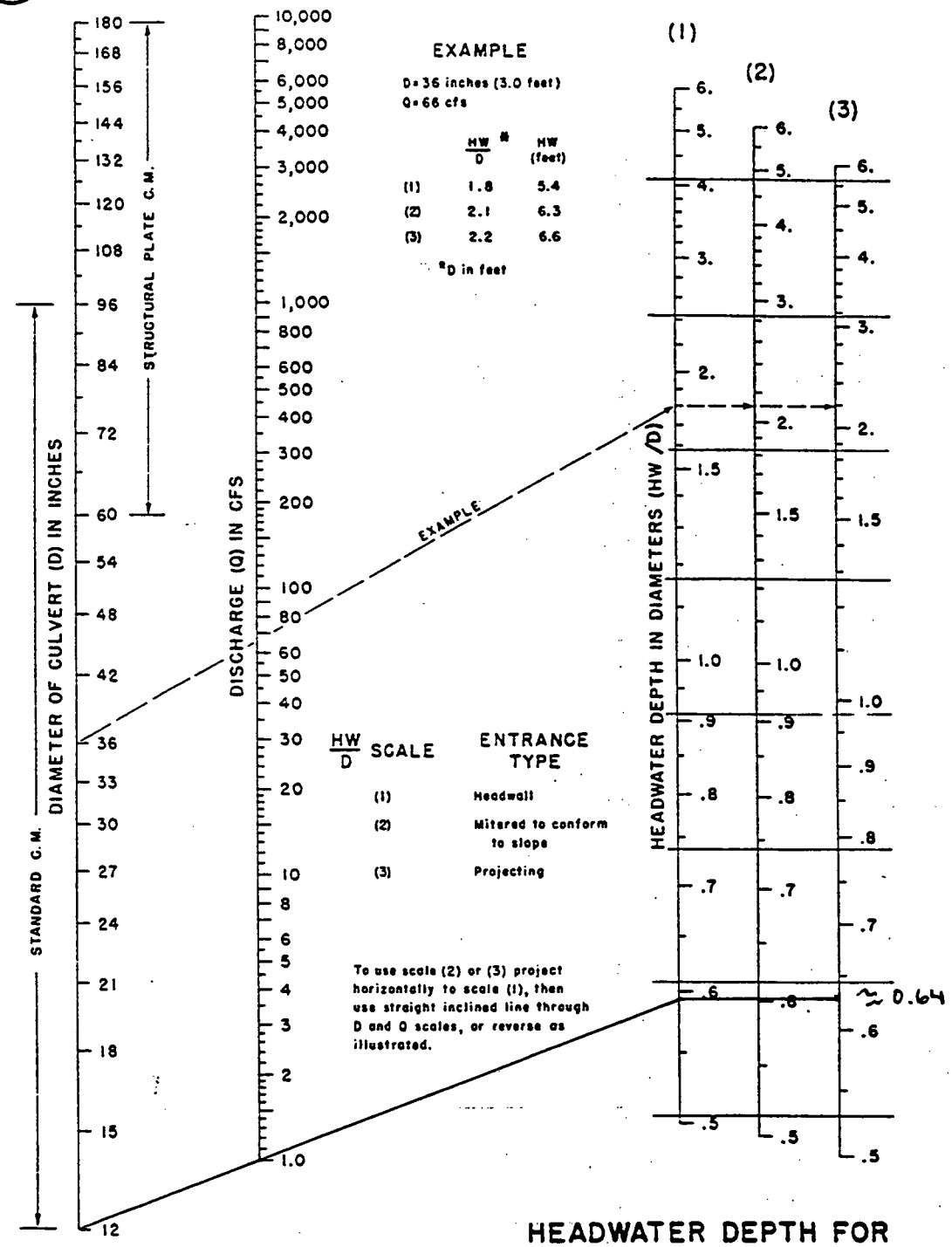
000184

54T C42

SHT C43

1062

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

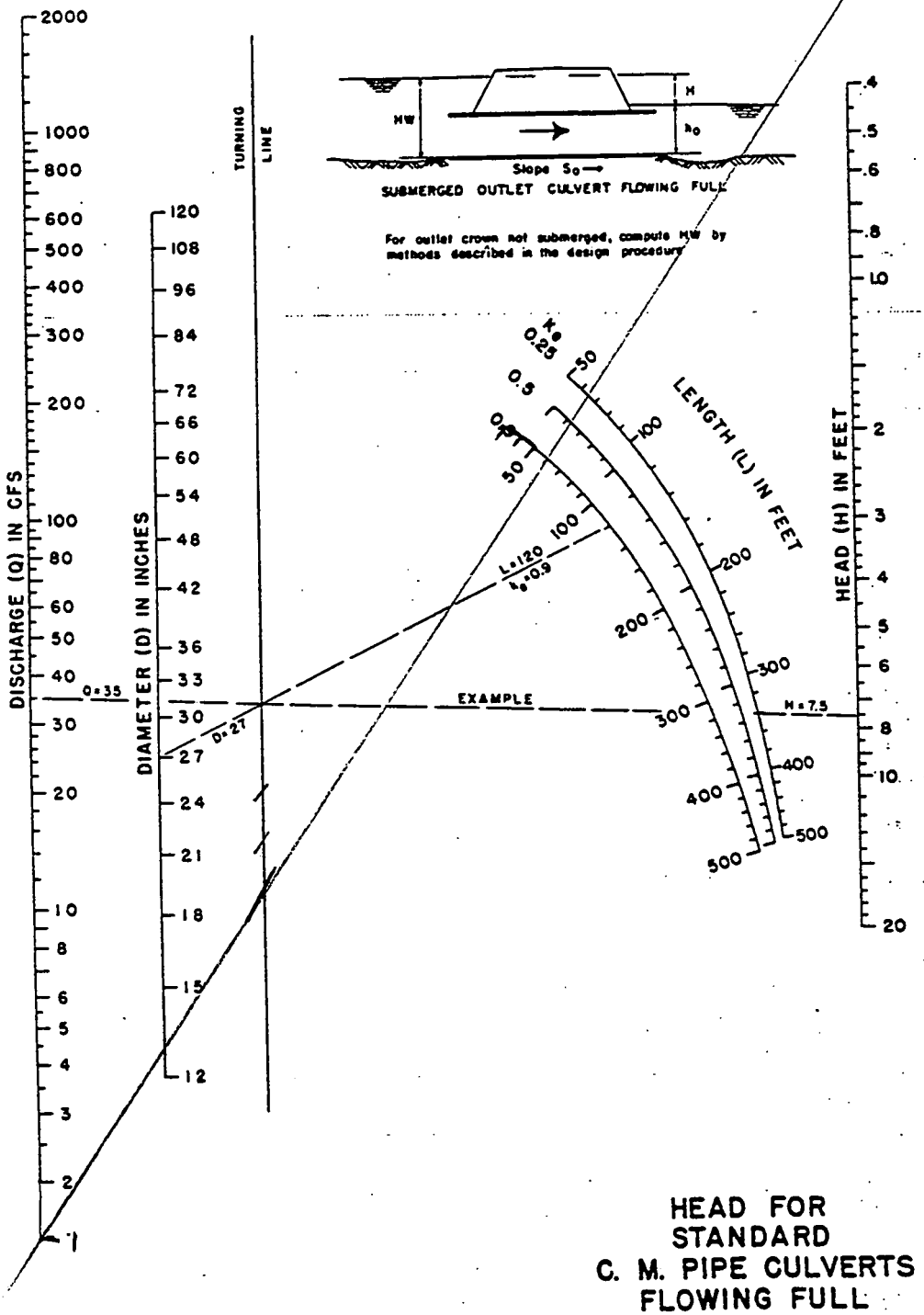
BUREAU OF PUBLIC ROADS JAN. 1963

000485

SHT C44

CHART 6

INSIGNIFICANT



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

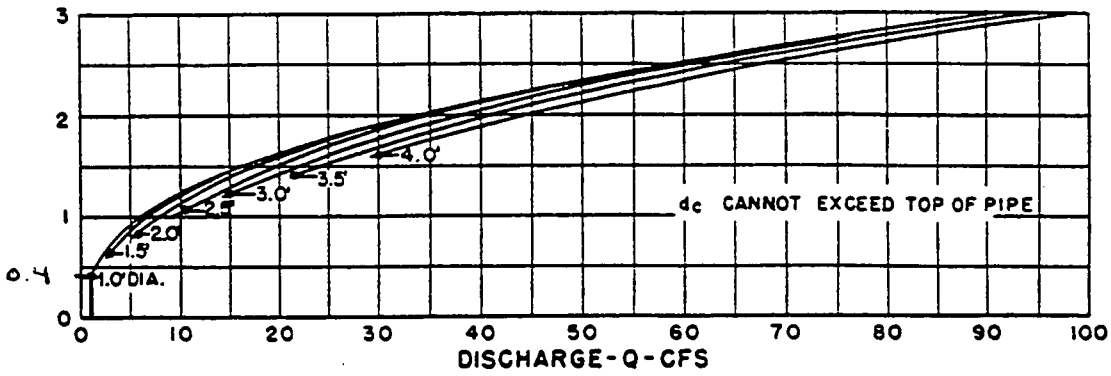
BUREAU OF PUBLIC ROADS JAN. 1963

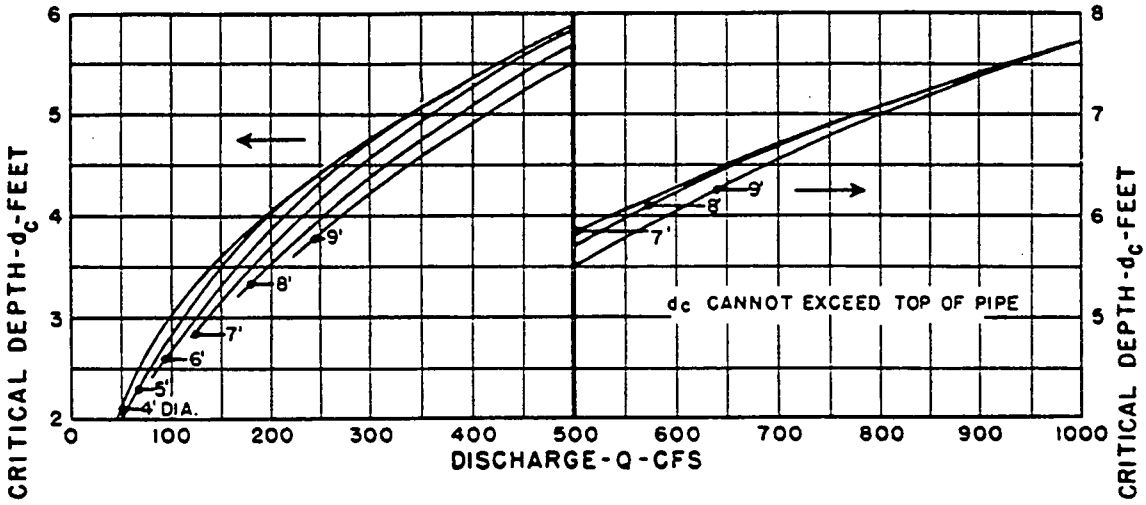
000486

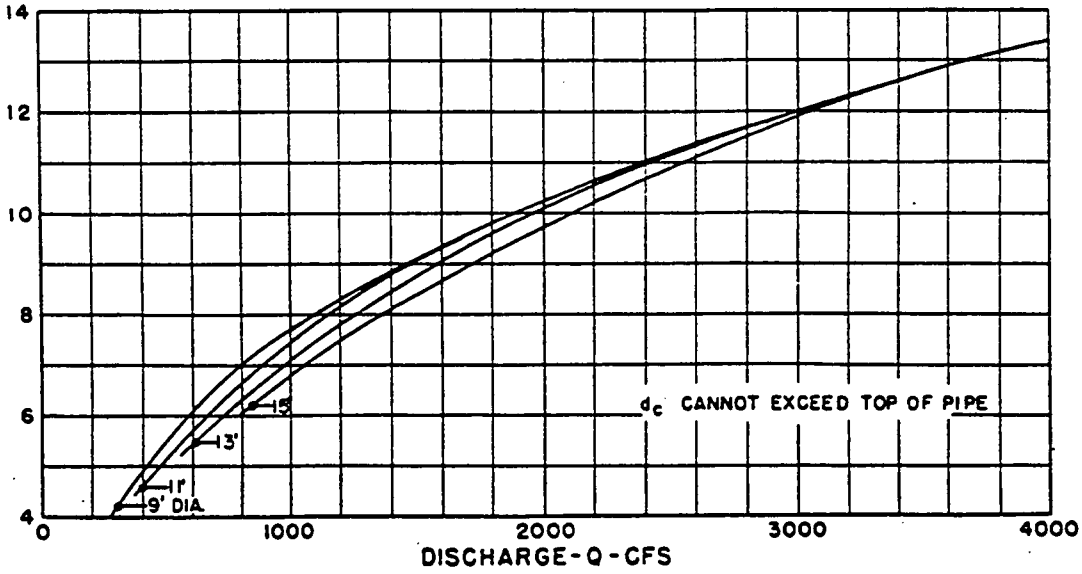
SHT C45

1062

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000487

SHT C46

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000488

Quick TR-55 Ver.5.46 S/N:
Executed: 07:29:49 10-08-1997

SHEET 1062

CULVERT 8
RESTORED CONDITIONS
(listed as culvert 1 on dwg 92X-5900-G-00333)

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	6.60						
GRAVEL RD	0.900	0.43						
VEG, POOR	0.600	0.25						
			10.00	0.708	0.708	5.450	7.28	28.11

TJB

FROM D7 PROPOSED CONDITIONS = 7.87 CFS
FROM D8 PROPOSED CONDITIONS = 7.02 CFS
14.89 CFS

PROJECT: SWU - EXCAVATION PKG
CULVERT 8 (CULVERT - 1 ON DWG 6003:23)

STATION: _____
SHEET _____ OF _____

CULVERT DESIGN FORM
DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

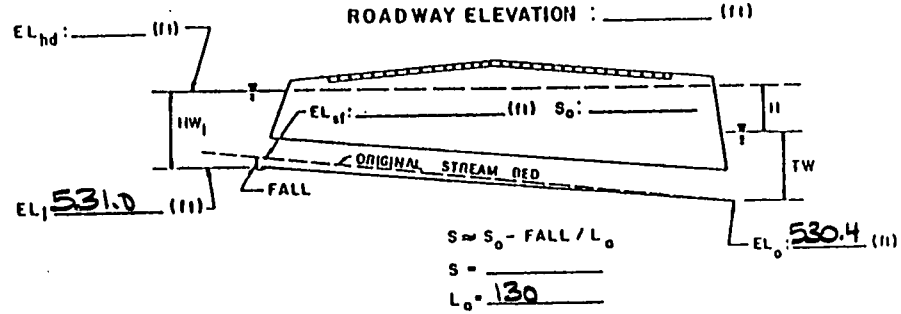
SEE ADD'L. SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	28.1	*

ROADWAY ELEVATION: _____ (ft)



$S \approx S_o - FALL / L_o$
$S =$ _____
$L_o =$ 130

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	h_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
Try 3-15" Ø	14.9	5.0	1.3	1.6	—	532.6	1.3	≈1.0	1.1	1.3	0.9	3.2	533.6	533.6	—	OK

TECHNICAL FOOTNOTES:

(1) USE Q/ND FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + h_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

* ASSUME TW EL AT TOP OF PIPE ≅ 531.7

CULVERT BARREL SELECTED:

SIZE: _____
SHAPE: _____
MATERIAL: _____ (1) _____
ENTRANCE: _____

240

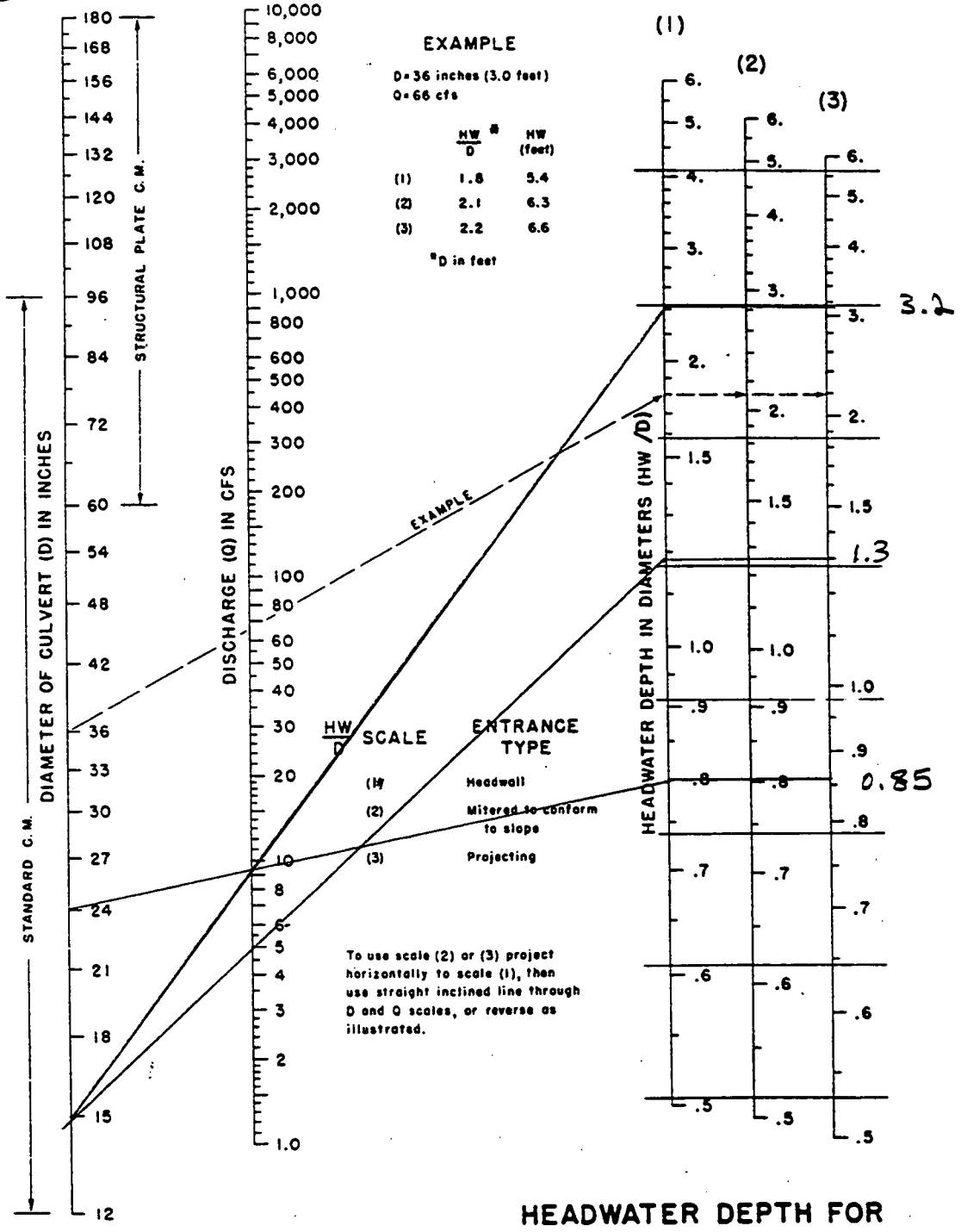
SHT C48

0004390

SHT C49

1062

CHART 2



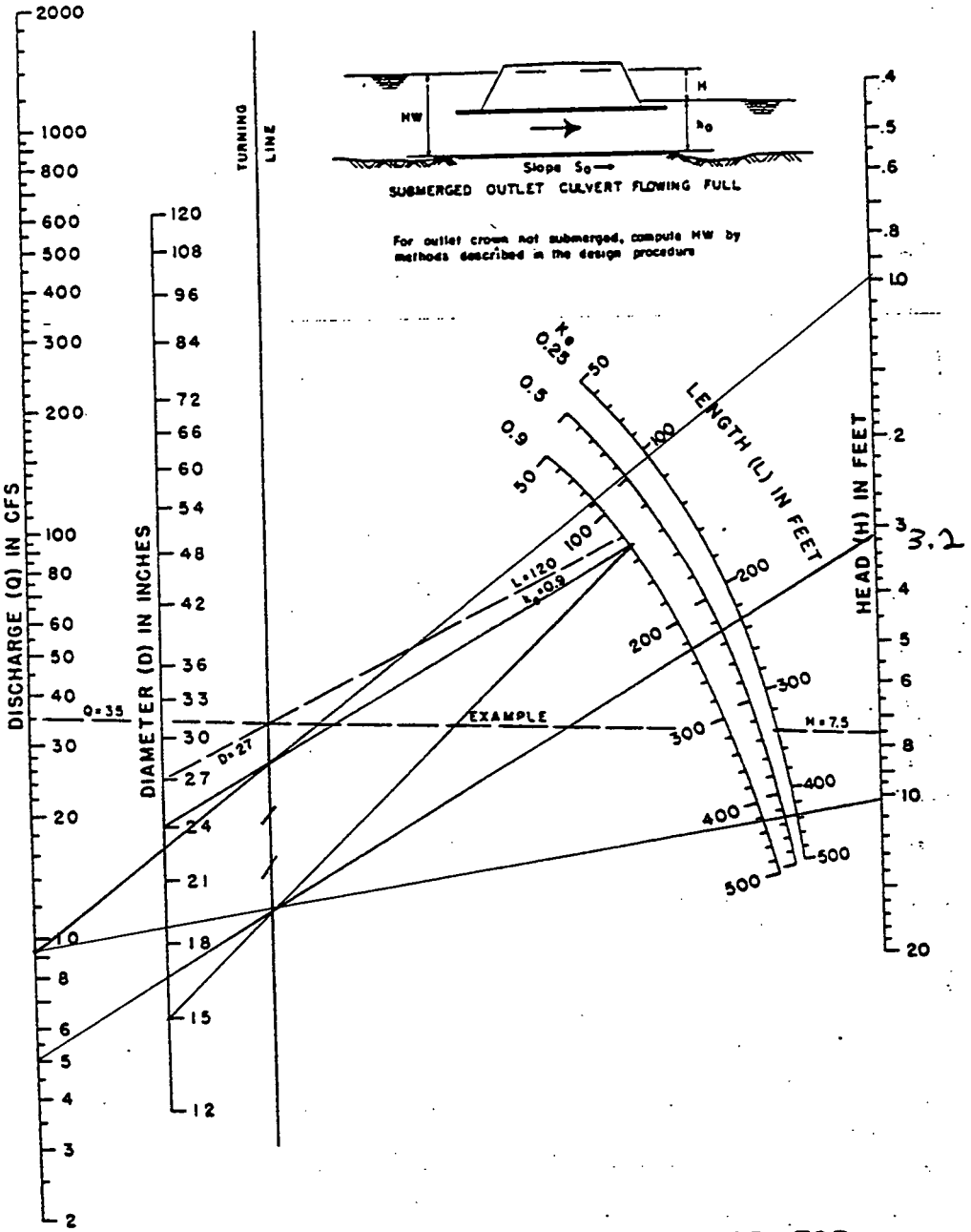
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000491

SHT C50

CHART 6



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

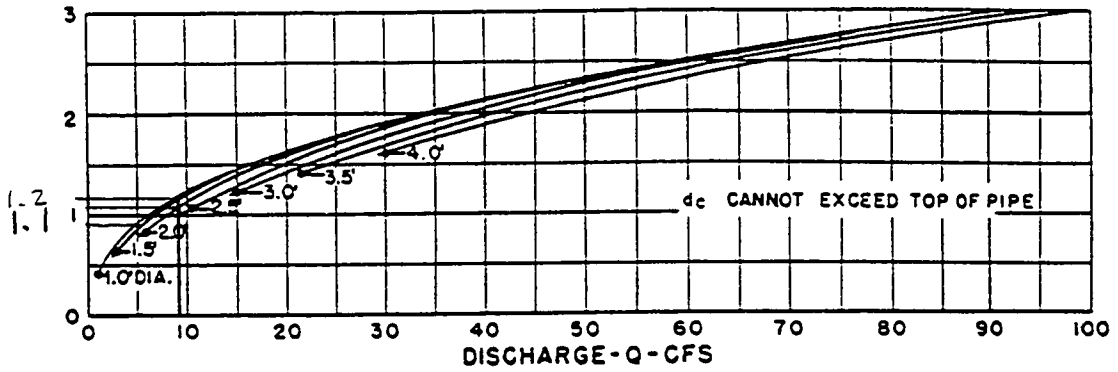
BUREAU OF PUBLIC ROADS JAN. 1963

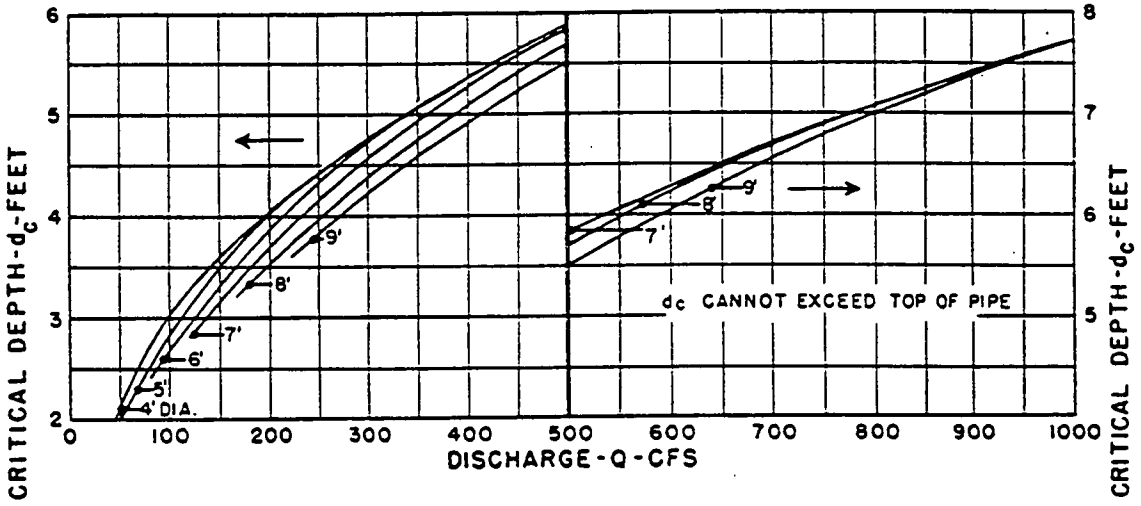
000492

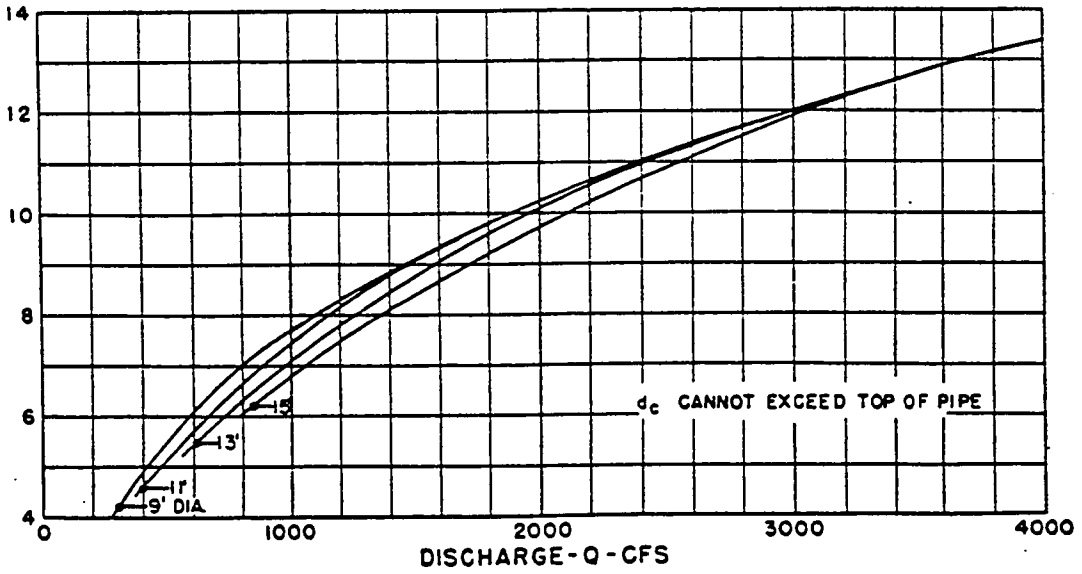
SHT C51

1062

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000493

SHT C52

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

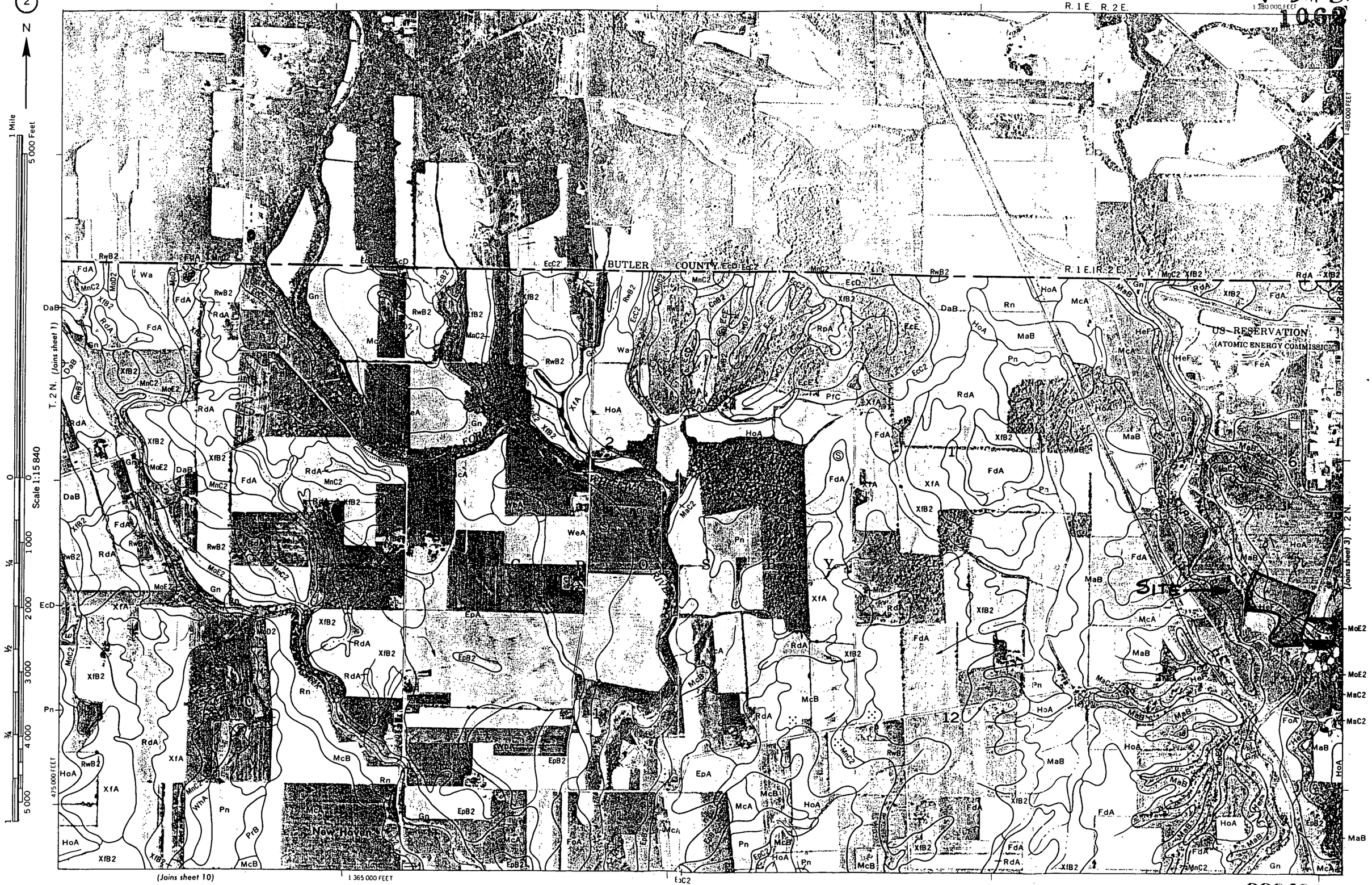
ATTACHMENT D

1062

1) Soils Map (Reference 6)
2) Rainfall Intensity-Duration-Frequency Curve (Reference 7)

SHT D1

1062



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SHT D2

1062

RAINFALL INTENSITY ZONE MAP

1101-3

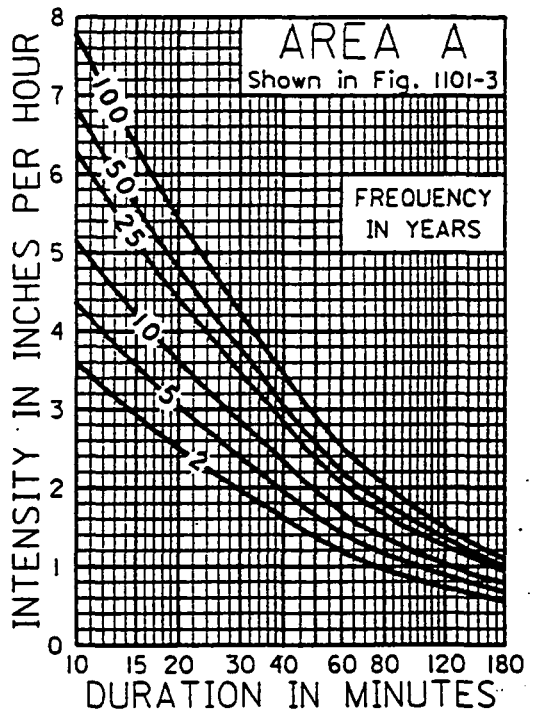
REFERENCE SECTION
1101.24

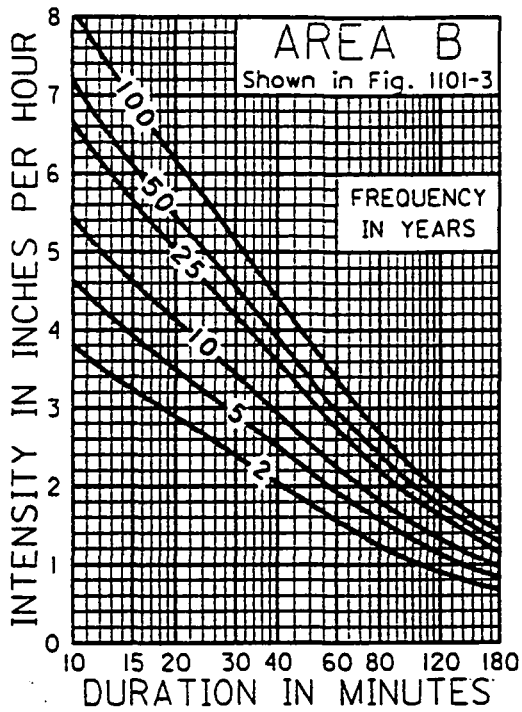
000497

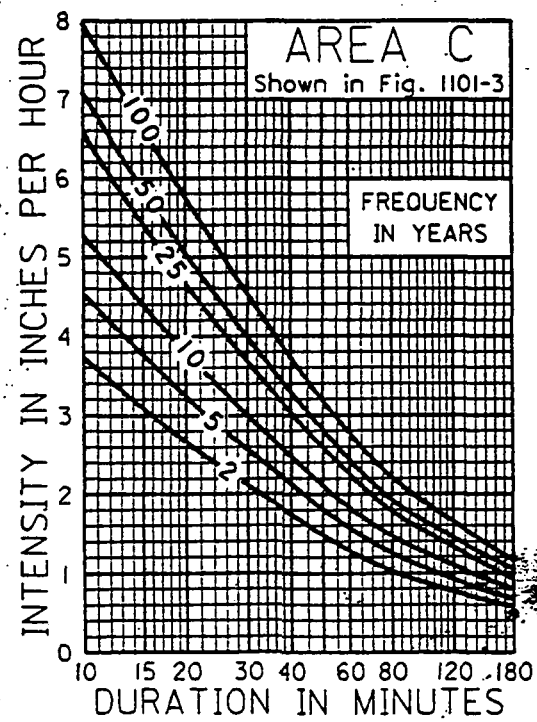
SHT D3

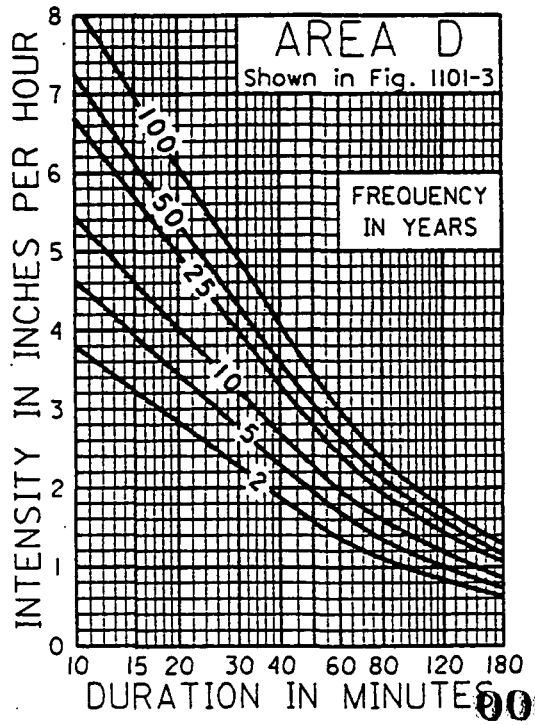
RAINFALL INTENSITY-FREQUENCY-DURATION CURVES	1101-2
	REFERENCE SECTION 1101.24

RAINFALL INTENSITY-FREQUENCY-DURATION CURVES









USE D CURVE

000498

ATTACHMENT E

L-1062

Calculation 15-02

PO158

Haulroad Drainage

1062

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 7/23/96
Sheet 1 of 2

Proj. Order No. 158 Calculation No. 15-02

Project Title HAUL ROAD CONSTRUCTION

Calculation Subject DRAINAGE Date Verified/Checked 5/21/96

STATUS: PRELIMINARY ____ FINAL X SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

DITCH & CULVERT DESIGN CALCULATIONS FOR THE HAUL ROAD.
HAUL ROAD MAXIMUM DITCH VELOCITY IS 2 FT/SEC.

SUMMARY OF CONCLUSIONS	Originator's Signature and Date
DITCHES ARE DESIGNED AND PLOTTED IN THE PROFILE AND CROSS SECTIONS	AJ Shanxton 5/21/96 REV 7/8/96
CHECKING METHOD	**Checker's Signature and Date**
1. Review X 2. Alternate Calculation ____	AM Christo 5/21/96 REV 7/8/96
	Lead Discipline Engineer's Signature and Date
	John Hasling 7/23/96

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date

05/93

ENG080

000500

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. 0
Sheet 2 of 2

Proj. Order No. 158 Calculation No. 15-02

Project Title HAUL ROAD CONSTRUCTION

Calculation Subject DRAINAGE Date Verified/Checked 5/21/96

Prepared By: [illegible] Checked/Verified By: [illegible]

Date 5/21/96 REV 7/8/96

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

- ASSUMPTIONS - STATED IN CALCULATIONS
- CODES - ODOT LOCATION & DESIGN MANUAL
- SOURCES - PLAN DRAWINGS

De Leuw, Cather
Engineers and Planners

Subject: Haul Road
Job No. 660620
Sheet No. 1 of 3
Made by: AJS Date: 7/3/96
Checked by: Amc Date: 7/8/96

Revised Conduit Design

Assumptions/Criteria

- Use Inlet Control: Allowable HW = D ($\frac{HW}{D} = 1$)
  Use ODOT L&D Manual, Fig 1100-245 (Attachment B)
- Use Corrugated Metal Pipe
- Design based on 25-year peak discharge, Rational Method
- 2 fps maximum ditch velocity ahead of Sta 121+00
- 3 fps maximum ditch velocity below Sta 121+00

Sta 101+20

A = 12.39 Acres

Overland flow width ≈ 800 ft

Ground slope = 0.01 = 1.0%

T_o = 33 min (Attachment D)

$$T_D = \frac{(106+50 - 101+20)}{3 \text{ fps}} = 176.67 \text{ sec} = 2.9 \text{ say } 3 \text{ min}$$

T_c = 36 min

i_{25} = 3.6 in/hr

$Q_{25} = 0.3(3.6)(12.39)$

$= 13.4$ cfs

Required Pipe Size is 24" (Attachment B)

Sta 109+30

A = 10.44 Acres

Overland flow width ≈ 800 ft

Ground slope = 1.0%

T_o = 33 min

$$T_D = \frac{109+30 - 106+50}{3 \text{ fps}} = 93.3 \text{ sec} = 1.56 \text{ say } 2 \text{ min}$$

$T_c = T_o + T_D$ = 35 min

i_{25} = 3.65 in/hr

$Q_{25} = 0.3(3.65)(10.44)$

= 11.4 cfs

Req'd Pipe Size is 24" (Attachment B)

Sta 119+12

A = 9.15 Acres (East Side from Sta 116+50 to the K-65 Trench @ 126+50)

Overland flow width = 350 ft, Ground slope ≈ 0.8%

T_o = 26 min

$$T_D = \frac{(126+50 - 119+12)}{3 \text{ fps}} \times \frac{1}{60} = 4.1 \text{ min}$$

T_c = 30 min

i_{25} = 4 inches/hr

De Leuw, Cather
Engineers and Planners

Subject: Haul Road
Job No. 660620
Sheet No. 3 of 3
Made by: AJS Date: 7/3/96
Checked by: [illegible] Date: 7/8/96

Sta 119+12 (cont)

$Q_{25} = 0.3(4.0)(9.15)$

$= 10.98$ cfs say 11 cfs

Required pipe size is 24" (Attachment B)

Pipe Slopes

Assumptions / Restrictions

- Maximum velocity of 3 fps for stations below 121+00
- Velocity based on full flow using Mannings Equation

$$S_{MAX.\ ALLOWABLE} = \left[\frac{V\,n}{1.49(A/P)^{2/3}}\right]^2 \quad \text{where}$$

$V = 3$ fps

$A = \pi r^2 = 3.141$ ft^2

$P = 2\pi r = 6.283$ ft

} All Pipes are 24" dia.

$n = 0.024$ (Attachment C)

$$S_{MAX.\ ALLOWABLE} = \left[\frac{(3\text{ fps})(0.024)}{1.49\,(0.500)^{2/3}}\right]^2$$

$S_{MAX.} = 0.0059$

De Leuw, Cather
Engineers and Planners

Subject: Haul Road

Job No. 660620
Sheet No. 1 of 5

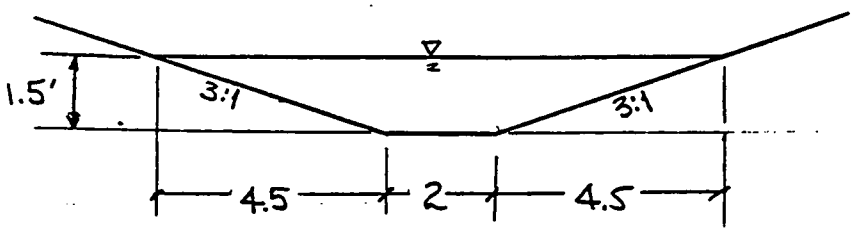
Made by: AJS Date: 5/17/96
Checked by: AMC Date: 5/22/96

Reiteration of Previous Calcs by DCB

Ditch Design

Assumptions/Restrictions

- Max velocity of 2 fps for Stations greater than 121+00
- Max velocity of 3 fps for Stations less than 121+00
- Trapezoidal Ditch Section; 2 foot bottom, 3:1 slopes
- Design Flow depth 1.5 ft. maximum



$A = 9.75\ ft^2$

$P = 11.49\ ft$

$R = A/P = 0.849\ ft$

Since capacity is not an issue on the Haul Rd due to small discharges, the main objective will be to control the velocity by means of restricting the allowable ditch slope.

De Leuw, Cather
Engineers and Planners

Subject: Haul Road
Job No. 660620
Sheet No. 2 of 5
Made by: AJS Date: 5/17/96
Checked by: Amc Date: 5/22/96

Reiteration of Previous Calc's by DCB

V = 3 fps (Sta 121+00 forward) n = 0.04 for sod lining
(ODOT L&D Manual, Table 1102-2 Attachment F)

$$S = \left[\frac{Vn}{1.49 R^{2/3}}\right]^2$$

$$= \left[\frac{(3\text{fps})(0.04)}{(1.49)(0.849)^{2/3}}\right]^2$$

$$= 0.008$$

$$= 0.80\% \text{ maximum}$$

V = 2 fps (Sta 121+00 back)

$$S = \left[\frac{(2\text{fps})(0.04)}{(1.49)(0.849)^{2/3}}\right]^2$$

$$= 0.0036$$

$$= 0.36\% \text{ maximum}$$

$$S = \left[\frac{(2\text{fps})(0.06)}{(1.49)(0.849)^{2/3}}\right]$$

$$= 0.008$$

$$= 0.80\% \text{ max}$$

Sta 121+00 to Sta 128+35

ΔElev = 573.05 − 569.10 = 3.95 ft

S = 3.95 ft / 735 ft = 0.0054

$$n = \frac{1.49}{V} R^{2/3} S^{1/2} = \frac{1.49}{2}(0.849)^{2/3}(0.0054)^{1/2} = 0.049$$

Use RCP, n = 0.06

AJS 5/14/96
Sheet 3 of 5
ck'd 5/22/96

Haul Road Ditch Checks (Steps)

- Restrict velocity to 2 fps maximum
- Minimize Use of Rock Channel Protection
  (try to limit to 'step' area)

Sta 130+07 to Sta 141+00
Ditch Length = 1093 ft
Drainage Area = 2.03 acres (from previous calcs)

From plans, the overland flow width to the high end of the ditch is 50 feet (±), and the ground slope is approximately 2% (0.02)

T_o = 10 min (L&D Manual, Figure 1101-1, Attachment D)

Based on a ditch velocity of 2 fps

T_D = 1093 ft / 2 ft/sec = 546.5 sec = 9 min

$T_c = T_o + T_D$ = 19 min

From Fig 1101-2, i_{25} = 5 inches/hr (Attachment E)

$Q_{25} = 0.3(5)(2.03) = 3.04$ cfs

Assume a flow depth of 1.5 feet, trapezoidal cross section with a bottom width of 2 feet and 3:1 side slopes, and sod lining ($n = 0.04$).

Then the flow area is

$$A = \tfrac{1}{2}\left[2 + 2 + 2(3)(1.5)\right](1.5) = 9.75\ ft^2$$

The wetted perimeter is

$$P = 2 + 2\left[(1.5)^2 + (4.5)^2\right]^{1/2} = 11.49\ ft$$

And the hydraulic radius is

$$R = A/P = 9.75/11.49 = 0.849\ ft$$

The ditch flow capacity is

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

For $S = 0.008$, $Q = 29.12$ cfs $\gg$ Max. discharge $= 3$ cfs

For $S = 0.006$, $Q = 25.22$ cfs $\gg 3$ cfs

Let $S = 0.006$ and find normal depth for $Q = 3$ cfs (peak flow in the ditch 'step' area).

Let $d = 0.5$ ft

$A = \frac{1}{2}[2 + (2 + 2(3)(0.5))](0.5) = 1.75 \text{ ft}^2$

$P = 2 + 2[(0.5)^2 + (1.5)^2]^{1/2} = 5.16$ ft

$R = A/P = 0.339$ ft

$Q = \frac{1.49}{0.04}(1.75)(0.339)^{2/3}(0.006)^{1/2} = 2.45$ cfs

Let $d = 0.6$ ft

$A = \frac{1}{2}[2 + (2 + 2(3)(0.6))](0.6) = 2.28 \text{ ft}^2$

$P = 2 + 2[(0.6)^2 + (1.8)^2]^{1/2} = 5.79$ ft

$R = A/P = 0.393$ ft

$Q = \frac{1.49}{0.04}(2.28)(0.393)^{2/3}(0.006)^{1/2} = 3.53$ cfs OKAY

$V = Q/A = 3.53/2.28 = 1.55$ f.p.s. OKAY

∴ In step area, use 0.60% ditch grade and 2-foot drops lined with Rock Channel Protection locally. Remainder of ditch to be lined with sod. Step interval is 200 ft.

1101 Estimating Design Discharge

1101.1 General

In order to properly design highway drainage facilities, it is essential that a reasonable estimate be made of the design and check discharges. Some of the more important factors affecting runoff are duration, intensity and frequency of rainfall, and the size, imperviousness, slope and shape of the drainage area. Also a proper evaluation should be made of probable changes in land use throughout the drainage area.

1101.2 Procedures

1101.21 Statistical Methods

The statistical methods developed by the U.S. Geological Survey and published in USGS Water Resources Investigations Reports 89-4126 and 86-4197 are recommended for estimating runoff from larger drainage areas. A description and limitations of these methods are described in Section 1003.

1101.22 Rational Method

The Rational method is considered to be more reliable for estimating runoff from small drainage areas, usually less than 6 acres; and for areas that contribute sheet flow only to the roadway ditch or pavement. The design discharge "Q" is obtained from the equation $Q = CiA$ where:

C = Coefficient of runoff

i = Average rainfall intensity, in inches per hour, for a given storm frequency and for a duration equal to the time of concentration

A = Drainage area, in acres

The time of concentration is the time required for runoff to flow from the most remote point of the drainage area to the point of concentration. The point of concentration could be a culvert inlet or the checkpoint in a roadway ditch used to determine the need for protection. Time of concentration is ordinarily designated by T and is the summation of the time of overland flow "t_o" and the time of ditch flow "t_d".

Overland flow is that flow not carried in a discernible channel, and the time of such flow may be obtained from Figure 1101-1 or a similar overland flow chart.

1101.23 Coefficient Of Runoff

The recommended value for the coefficient of runoff for various contributing surfaces are shown in Table 1101-1. Where two values are shown, the higher value ordinarily applies to the steeper slopes.

Table 1101-1

Types of Surface	Coefficient of Runoff "C"
Pavement & Paved Shoulders	0.9
Berms and slopes 4:1 or flatter	0.5
Berms and slopes steeper than 4:1	0.7
Contributing Areas:	
Residential (single family)	0.4-0.6
Residential (multi-unit)	0.5-0.7
Woods	0.3
Cultivated	0.3-0.6

The total width contributing flow to a given point usually consists of surfaces having a variable land cover and thereby require a weighted coefficient of runoff "C". The weighted coefficient is obtained by averaging the coefficients for the different types of contributing surfaces, as noted in the following example:

Contributing Width "W"	Land Use	"C"	"CW"
20 Ft.	Paved Area	0.9	18
40 Ft.	Earth Berms & Slopes	0.7	28
140 Ft.	Residential Area	0.6	84
200 Ft.			130

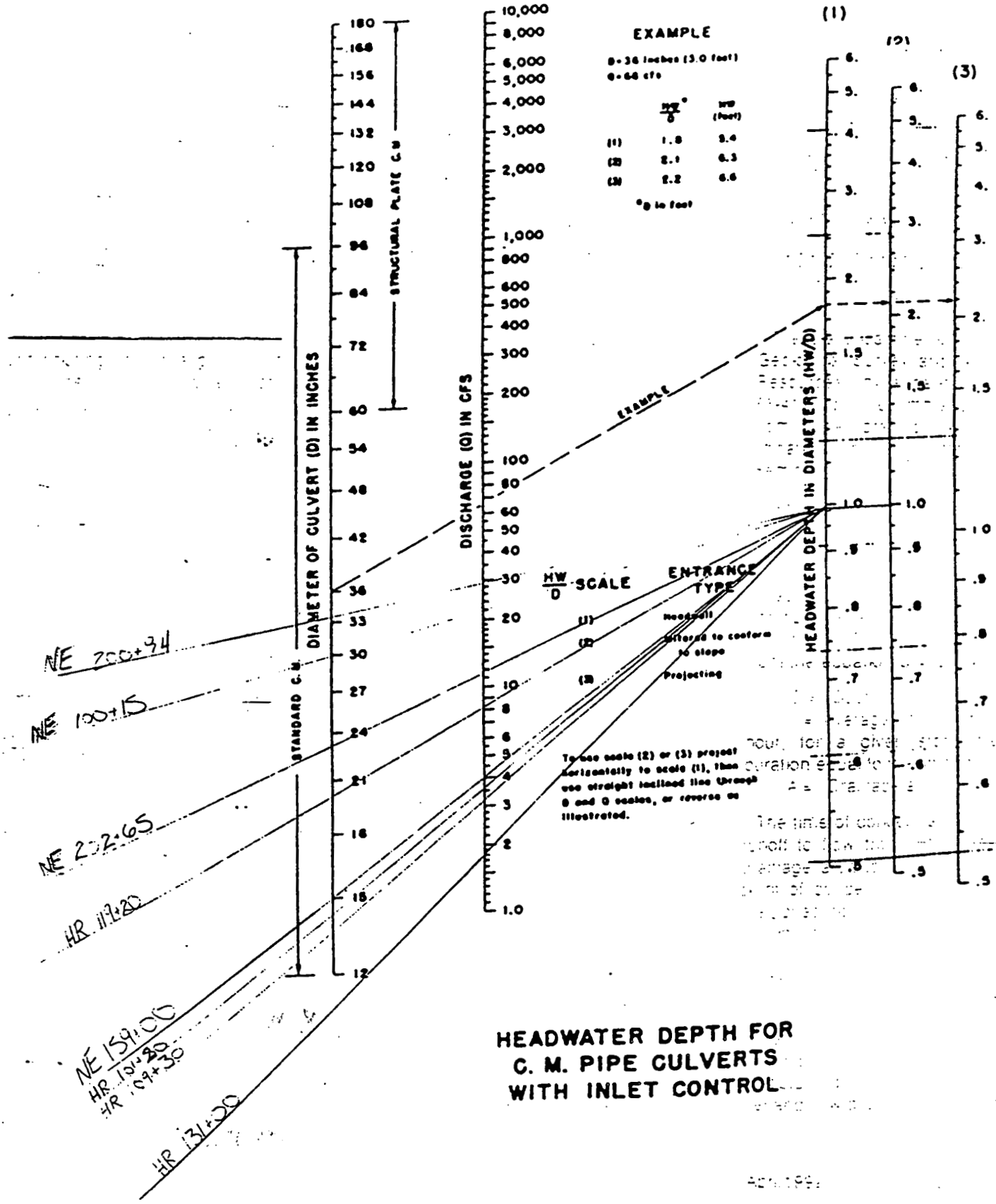
$$\text{Weighted "C"} = \frac{130}{200} = 0.65$$

1101.24 Rainfall Intensity

The average rainfall intensity "i" in inches per hour may be obtained from the Intensity-Frequency-Duration curves shown on Figure 1101-2. Each set of curves applies to a specific geographic area, A, B, C or D as shown on the Rainfall Intensity Zone Map, Figure 1101-3. The geographic areas were established from an analysis of rainfall records obtained from Weather Bureau stations in Ohio. Some political subdivisions may have developed curves for their specific area similar to Figure 1101-2. Such curves may be based on a much longer period of record,

Attachment B

Fig. 1100-245



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

91

TABLE 10.6 TYPICAL VALUES OF THE ROUGHNESS COEFFICIENT n

Lined Canals	n
Cement plaster	0.011
Untreated gunite	0.016
Wood, planed	0.012
Wood, unplaned	0.013
Concrete, troweled	0.012
Concrete, wood forms, unfinished	0.015
Rubble in cement	0.020
Asphalt, smooth	0.013
Asphalt, rough	0.016
Corrugated metal	0.024
Unlined Canals	
Earth, straight and uniform	0.023
Earth, winding and weedy banks	0.035
Cut in rock, straight and uniform	0.030
Cut in rock, jagged and irregular	0.045
Natural Channels	
Gravel beds, straight	0.025
Gravel beds plus large boulders	0.040
Earth, straight, with some grass	0.026
Earth, winding, no vegetation	0.030
Earth, winding, weedy banks	0.050
Earth, very weedy and overgrown	0.080

Manning Equation—Traditional System of Units

It can be shown that, in converting from SI to the traditional system one must apply a factor equal to 1.49 if the same value of n is used in systems. Thus in the traditional system the discharge equation using n is given as

$$Q = \frac{1.49}{n} A R_h^{2/3} S_0^{1/2}$$

EXAMPLE 10.16 If the channel of Example 10.15 has a slope what is the discharge in the channel and what is the numerical valu ning's n for this channel?

Solution From Example 10.15, we have an f value of 0.130, and th mate value of R_h is 4.3 ft. In Example 10.14 it was shown that

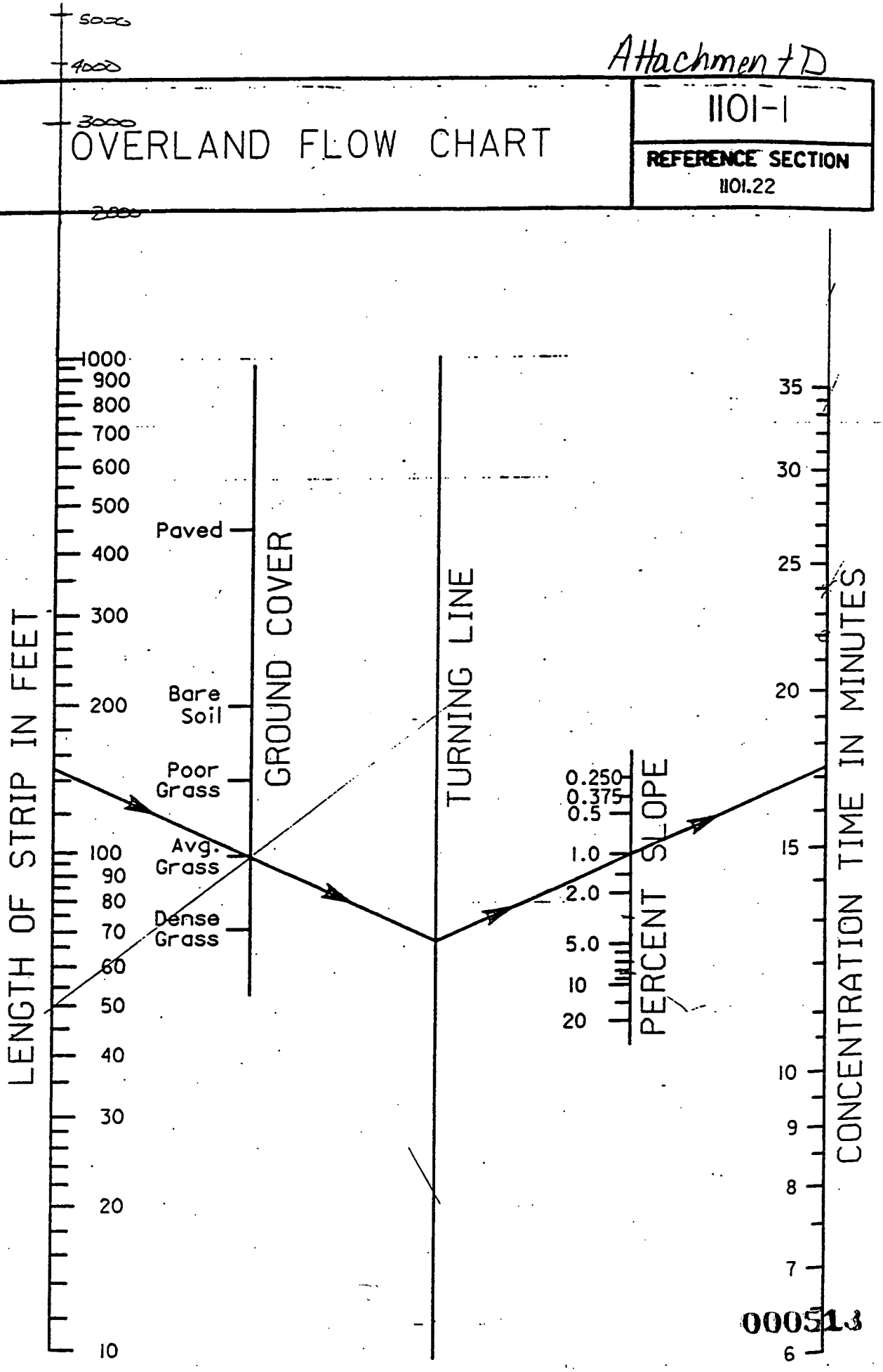
$$V = \sqrt{\frac{8g}{f}}\sqrt{R_h S_0}$$

Attachment D

OVERLAND FLOW CHART

1101-1

REFERENCE SECTION 1101.22

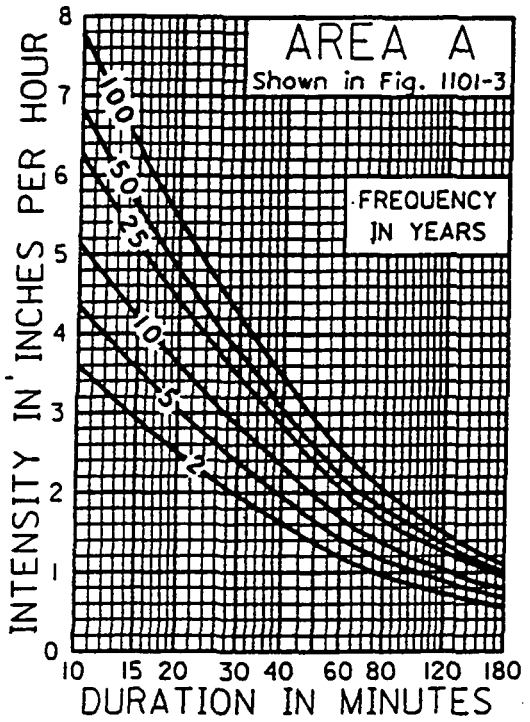


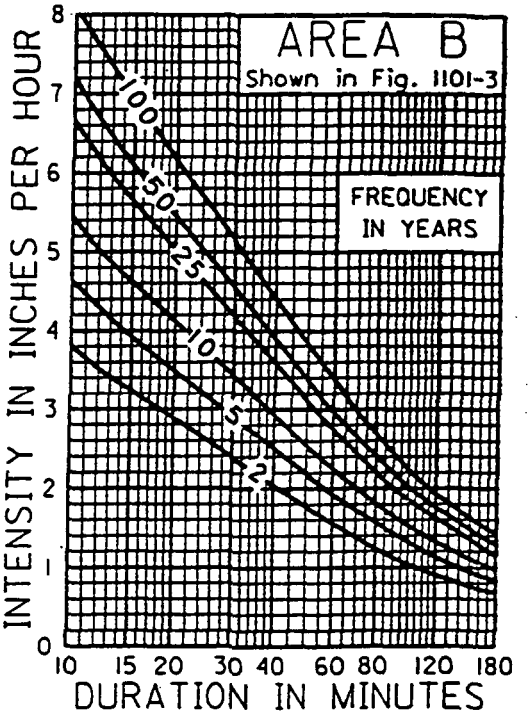
000513

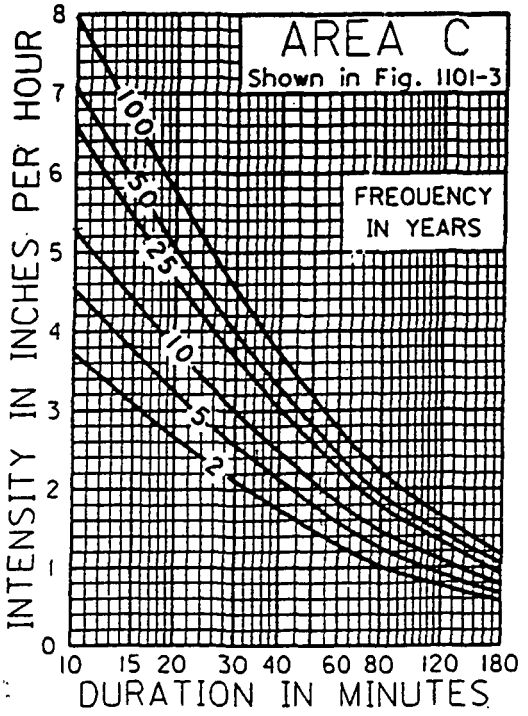
Attachment E

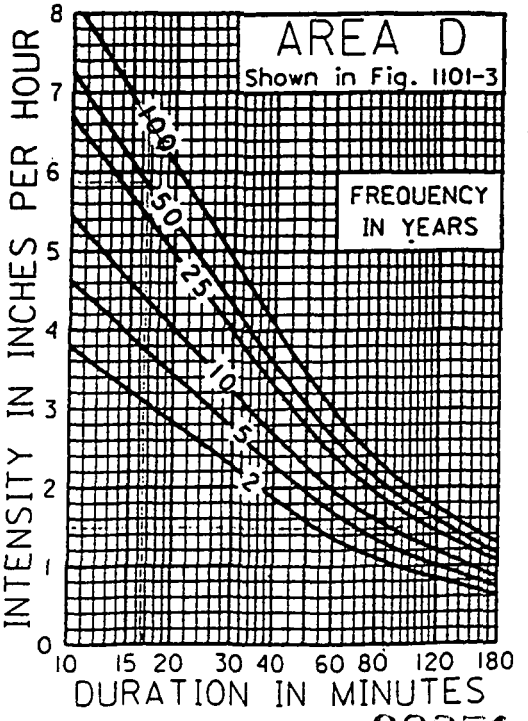
RAINFALL INTENSITY-FREQUENCY-DURATION CURVES	1101-2
	REFERENCE SECTION 1101.24

RAINFALL INTENSITY-FREQUENCY-DURATION CURVES









Attachment F

1102.3 Ditch Design Criteria - Design Traffic Exceeding 2000 ADT

1102.31 Design Frequency

It is recommended that a 10-year frequency storm be used to determine the depth of flow, and a 5-year frequency be used to determine the velocity of flow and the depth of ditch lining where needed. Where a flexible ditch lining is required for calculated velocities exceeding the allowable for seed, the minimum width of the lining shall be 7-1/2 feet. The depth of flow shall be limited to an elevation 12 inches below the edge of pavement for the design discharge. Other ditches, including toe of slope, should not be overtopped by the design discharge.

1102.32 Velocity

The velocity for the five-year frequency storm should not exceed the values shown in Table 1102-1 for the various soil types and flexible linings.

Table 1102-1

ALLOWABLE DITCH VELOCITIES
(Ft. Per. Sec.)

Soil Type	Seed Lining (659)	Sod Lining (660)	Jute or Excelsior Matting (667) or (668)
Sand	1.5	3.5	3.0
Firm Loam	2.0	4.0	4.0
Clay	2.5	5.0	4.0
Gravel	3.5	6.0	5.0
Weathering Shale	4.5	6.0	5.0

If the calculated velocity exceeds that shown in the table, a concrete lining should be considered only as a last resort. Also Type B, C or D Rock Channel Protection may be used to line the ditch if the nearest point of the lining is outside the design clear zone or located behind guardrail. Item 838 Seeding and Erosion Control with Matting may be used in lieu of rock, where average flow velocity is less than 10 feet per second and the ditch slope is less than 10%. Type B or C rock should be considered for lining ditches on steep grades that carry flow from the end of a cut section down to the valley floor.

1102.33 Roughness

Suggested values for Manning's Roughness Coefficient "n" for the various types of open water carriers covered in Section 1102.2 are listed in Table1102-2.

Table 1102-2

Type of Lining	Roughness Coefficient
Bare Earth	.02
Seeded	.03
Sod	.04
Jute Mat.	.04
Excelsior Mat.	.04
Item 838 Matting	.04
Concrete	.015
Bituminous	.018
Grouted Riprap	.02
Rock Channel Protection	.06 for ditches .04 for large channels

1102.34 Catch Basin Types

The Standard CB-4, 5 and 8 Catch Basins are suitable for the standard roadside designs covered in the Roadway Design Manual. The tilt built into the basin top provides a self-cleaning feature when the basins are used on continuous grades and the wide bar spacing minimizes clogging possibilities, thereby resulting in an efficient design. The bases of the 4, 5 and 8 Catch Basins can be expanded to accommodate larger diameter conduits by specifying 4A, 5A or 8A Basins, detailed on Standard Drawing CB-458A. The bar spacing can be decreased, when desirable for safety reasons, by specifying Grate E for the CB-4 and Grate B for CB-5. The following catch basin types are generally recommended based on the size and shape of the ditch.

A. Standard CB-4 for depressed medians wider than 40 feet.

B. Standard CB-5 for 40 foot radius roadside or median ditches (Use grate B where pedestrian traffic may be expected).

C. Standard CB-8 for 20 foot radius roadside or depressed medians 40 feet or less in width.

D. Standard CB-2-2-A catch basins may be used in trapezoidal toe ditches where the basin is located outside the design clear zone or behind guardrail and the protruding feature of the basin is

ATTACHMENT F

Calculation 15-01

PO139

Design of Seepage Collection & Removal of Sediment

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 20 Feb 95

Sheet 1 of 6

Proj. Order No. 139 Calculation No. 15-01

Project Title Seepage Design and Sediment Removal

Calculation Subject Storm Drainage Date Verified/Checked

STATUS: PRELIMINARY ____ FINAL X SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

Determine the peak runoff for the 25-year, 24-hour storm event for the proposed diversion pipe and size the pipe using corrugated HDPE. (Per FERMCO CRU-2 direction)

SUMMARY OF CONCLUSIONS	Originator's Signature and Date
The peak discharge is 9 cfs and the pipe is 18 inch diameter.	Kenneth F. Gerard 2/28/95
CHECKING METHOD	**Checker's Signature and Date**
1. Review X	CR TOMONGIN 3/17/95
2. Alternate Calculation ____	
	Lead Discipline Engineer's Signature and Date
	Ed Kuk 3/17/95

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. 0
Sheet 2 of 6

Proj. Order No. 139 Calculation No. 15-01

Project Title Seepage Design and Sediment Removal

Calculation Subject Storm Drainage Date Verified/Checked 3/17/95

Prepared By: K. Gerard Checked/Verified By: CR TOMONGIN

Date 2/20/95

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

Data Sources

1. PARSONS DWG. (used as DA Map)
2. Haestad Methods, 1989. *Quick TR-55™ Urban Hydrology for Small Watersheds*
3. SCS Ohio 24-Hour Rainfall (inches)
4. SCS, August 1982. *Soil Survey of Hamilton County, Ohio*
5. Advanced Drainage Systems, Inc. (ADS), 1988. N-12 Pipe product literature
6. ODOT, *Location and Design Manual, Volume Two, Drainage Design*
7. Brater, Ernest F. & Horace Williams King, 1976. *Handbook of Hydraulics*, Sixth Ed. New York: McGraw-Hill Book Company
8. Heald, C.C., Ed., 1992. *Cameron Hydraulic Data Book*, 17 ed. Woodcliff Lake, N.J.: Ingersoll-Rand

Codes

1. DOE Order 6430.1A / RM-FMPC-0001

Assumptions

1. Use SCS TR-55 to determine peak discharge. (Haestad Methods Quick TR-55).
2. Use SCS storm events for Hamilton County, Ohio. (Ref 3)
3. Pipe will be used for a short term, low-traffic area. Per FERMCO CRU-2 directive to use HDPE pipe material, use corrugated polyethylene pipe using ADS N-12 pipe data. Mannings n for ADS N-12 is o.010 - 0.012. Use 0.011 to account for the bends.

ENGINEERING CALCULATIONS
BASIS SHEET
SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS (continued)

4. Land use is mixed. Use weighted Runoff Curve Number. See D.A. Map (in the back of the calculations) and calculations for land use, acreage, and coverage conditions used. All ground coverage conditions were assumed to be in good condition.

5. From Reference 4, the soils in the vicinity of the site and their HSG are as follows:

Gn	Genesee Loam, HSG B (This is most likely in the Paddy's Run Flood Plain and not in the DA)
HeF	Hennepin Silt Loam, 35 to 60 % slopes, HSG B (This is most likely in the steep slope areas adjacent to Paddy's Run and not in the DA)
HoA	Henshaw Silt Loam, 0 to 2 % slopes, HSG C
MaB	Markland Silty Clay Loam, 2 to 6 % slopes, HSG C
MaC2	Markland Silty Clay Loam, 6 to 12 % slopes, HSG C

A copy of the soil survey map is in the back of the calculations. Given the information from the soil survey map, HSG C is used for all land uses for the peak discharge calculations.

6. For computing Tc segment DE, the same open channel assumed to exist between the proposed pipe and the gravel road was assumed to exist where the runoff goes under the gravel road (existing culvert is assumed to exist and is operational).

7. For computing Tc segment DE, the proposed open channel between the proposed pipe and the gravel road is assumed to be a 2 ft. flat bottom trapezoidal ditch with 4:1 side slopes, rip rap lined.

8. Other assumptions are as specified in the calculations.

PARSONS ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

CRU: 2 PO: 139 Job Number: 7663-0139-11112-120

Computer Code: OTR-55 Version: 5.46

Code Verification Status: REV 0, Nov 1992

Description of Program: Computes peak discharge per SCS TR-55 Method

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To determine peak discharge to size proposed storm drain

Run Performed By: K. Gerard

Date/Time of Run: 2/20/95

Computer Time of Run: n/a

Input Filename: WESTPIPE.***, *** = RCN, TCT, GPD

Output Filename: same as input

Files Saved to Diskname: a:\po139\SD Disk Location: with calc set w/ backup with discipline files

Results: Peak discharge for 25-year, 24-hour storm is 9 cfs.

Performed By: K. Gerard Date: 2/28/95

Checked By: CR TOMONGIN Date: 3/17/95

Approved By: E. J. Kuhn Date: 3/17/95

PARSONS
ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

CRU: 2 PO: 139 Job Number: 7663-0139-11112-120

Computer Code: FlowMaster Version: 3.41

Code Verification Status: REV 0, Dec 1992

Description of Program: Computes solutions to open channel hydraulics problems

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To determine Tc values and to size proposed storm drain

Run Performed By: K. Gerard

Date/Time of Run: 2/20/95 - 2/28/95

Computer Time of Run: n/a

Input Filename: WESTPIPE.H&H & PRODITCH.H&H

Output Filename: same as input

Files Saved to Diskname: a:\po139\SD Disk Location: with calc set w/ backup with discipline files

Results: Refer to the calculations.

Performed By: K. Gerard Date: 2/28/95

Checked By: CR TOMONGIN Date: 3/17/95

Approved By: E. Kahn Date: 3/17/95

RESULTS

The results of the peak discharge calculations are as follows:

2-yr	3 cfs
10-yr	7 cfs
25-yr	9 cfs

The table below summarizes the results of the pipe design calculations for a pipe slope at 0.6%:

	Dia.	$V_{2\text{-}Yr}$ fps	$V_{25\text{-}Yr}$ fps	Q_{FULL} cfs	Q_{MAX} cfs
ADS	15"	4.84	--	5.91	•
ADS	18"	4.81	6.18	9.62	10.34
ADS	24"	4.69	6.36	20.71	22.28

• not calculated

CONCLUSIONS AND RECOMMENDATIONS

The velocity is sufficient at the 2-year storm to provide self cleaning of sediment. An 18" HDPE (ADS N-12) pipe is large enough for the 25-year storm and is recommended.

ODOT Table 1107-1 indicates that 6.5 l.f. of 6" stone, Type C is required. This is based on a V = 6.2 fps for the $Q_{25\text{-}Yr}$ condition.

An ODOT No. 2-2-A catch basin was evaluated and found acceptable when modified for an East Jordan Iron Works, (EJIW), 6610 grate.

000522

ATTACHMENT A

SUPPORTING CALCULATIONS

Quick TR-55 Ver.5.46 S/N:
Executed: 09:17:20 02-20-1995

PO-139 RA #31
Design of Seepage Collection
and
Sediment Removal

RUNOFF CURVE NUMBER DATA

Composite Area: West Pipe

SURFACE DESCRIPTION	AREA (acres)	CN
Open Space/good/HSG C	3.13	74
Woods/good/HSG C	8.48	70
Gravel/HSG C	0.29	89
COMPOSITE AREA --->	11.90	71.5

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SEE D.A. MAP

A-1

Triangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: Tc Calc

Comment: Tc Segment B-C

Solve For Discharge

Given Input Data:

Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.040
Channel Slope....	0.0250 ft/ft
Depth.....	0.50 ft

Computed Results:

Discharge.....	1.08 cfs
Velocity.....	2.16 fps
Flow Area.....	0.50 sf
Flow Top Width...	2.00 ft
Wetted Perimeter.	2.24 ft
Critical Depth...	0.45 ft
Critical Slope...	0.0446 ft/ft
Froude Number....	0.76 (flow is Subcritical)

ASSUME Tc SEGMENT HAS THE INPUT DATA GIVEN

Open Channel Flow Module, Version 3.41 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: Tc Calc

Comment: Tc Segment D-E

Solve For Discharge

Given Input Data:

Bottom Width.....	2.00 ft
Left Side Slope..	4.00:1 (H:V)
Right Side Slope.	4.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0250 ft/ft
Depth.....	0.60 ft

Computed Results:

Discharge.....	9.30 cfs ≈ PEAK DISCHARGE, OK
Velocity.....	3.52 fps
Flow Area.....	2.64 sf
Flow Top Width...	6.80 ft
Wetted Perimeter.	6.95 ft
Critical Depth...	0.60 ft
Critical Slope...	0.0252 ft/ft
Froude Number....	1.00 (flow is Critical)

ASSUME Tc SEGMENT HAS THE INPUT DATA GIVEN,

Open Channel Flow Module, Version 3.41 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Quick TR-55 Ver.5.46 S/N:
Executed: 09:07:52 02-20-1995 a:\po139\sd\WESTPIPE.TCT

PO-139 RA #31
Design of Seepage Collection and Sediment Removal

Tc COMPUTATIONS FOR: West Pipe

SHEET FLOW (Applicable to Tc only)

Segment ID		AB	
Surface description		woods	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	210.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0025	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	1.54	= 1.54

SHALLOW CONCENTRATED FLOW

Segment ID		CD	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	270.0	
Watercourse slope, s	ft/ft	0.0075	
$Avg.V = Csf * (s)^{0.5}$	ft/s	1.3973	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.05	= 0.05

CHANNEL FLOW

Segment ID		BC	DE	
Cross Sectional Flow Area, a	sq.ft	0.50	2.64	
Wetted perimeter, Pw	ft	2.24	6.95	
Hydraulic radius, r = a/Pw	ft	0.223	0.380	
Channel slope, s	ft/ft	0.0250	0.0250	
Manning's roughness coeff., n		0.0400	0.0350	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.1673	3.5305	
Flow length, L	ft	260	125	
T = L / (3600*V)	hrs	0.03 +	0.01	= 0.04

::

TOTAL TIME (hrs) 1.63

A-4

000527

Quick TR-55 Version: 5.46 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

PO-139 RA #31
Design of Seepage Collection and Sediment Removal

CALCULATED
DISK FILE: a:\po139\sd\WESTPIPE.GPD

Drainage Area	(acres)	11.9	--->	0.0186 sq.mi.
Runoff Curve Number	(CN)	72		
Time of Concentration,Tc	(hrs)	1.63		
Rainfall Distribution	(Type)	II		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	2	10	25
Rainfall, P, 24-hr (in)	3.0	4.1	4.8
Initial Abstraction, Ia (in)	0.778	0.778	0.778
Ia/p Ratio	0.259	0.190	0.162
Unit Discharge, * qu (csm/in)	222	239	246
Runoff, Q (in)	0.81	1.53	2.05
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	3	7	9

Summary of Computations for qu

Ia/p	#1	0.100	0.100	0.100
C0	#1	2.553	2.553	2.553
C1	#1	-0.615	-0.615	-0.615
C2	#1	-0.164	-0.164	-0.164
qu (csm)	#1	260.210	260.210	260.210
Ia/p	#2	0.300	0.300	0.300
C0	#2	2.465	2.465	2.465
C1	#2	-0.623	-0.623	-0.623
C2	#2	-0.117	-0.117	-0.117
qu (csm)	#2	212.799	212.799	212.799
* qu (csm)		222	239	246

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$
$$qp\ (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond\ \&\ Swamp\ Adj.)$$

A-5

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Description: Proposed Pipe at West Pump Station

Solve For Actual Depth

Given Constant Data;

Slope.....	0.0060	
Mannings n.....	0.011	ADS N-12 *
Q_2=Discharge.....	3.00	

Variable Input Data	Minimum	Maximum	Increment By
Diameter	1.25 15"	2.00 24"	0.25

* ADS Recommends a "n" value of 0.010 — 0.012.

VARIABLE				COMPUTED	COMPUTED	COMPUTED
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs Q2-YR	Depth ft	Velocity fps	Capacity Full cfs
1.25	0.0060	0.011	3.00	0.63	4.84	5.91
1.50	0.0060	0.011	3.00	0.58	4.81	9.62
~~1.75~~	~~0.0060~~	~~0.011~~	~~3.00~~	~~0.54~~	~~4.75~~	~~14.51~~ N/A
2.00	0.0060	0.011	3.00	0.51	4.69	20.71

Open Channel Flow Module, Version 3.41 (c)
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Description: Proposed Pipe at West Pump Station

Solve For Actual Depth

Given Constant Data;

Slope..... 0.0060
Mannings n..... 0.011 * ADS N-12
Q_{25}=Discharge..... 9.00 cfs

Variable Input Data	Minimum	Maximum	Increment By
Diameter	1.25	2.00	0.25
	15"	24"	

VARIABLE				COMPUTED	COMPUTED	COMPUTED	
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs	Depth ft	Velocity fps	Capacity Full cfs	
Unable to compute this instance. (1.25' Ø Too small)							
1.50	0.0060	0.011	9.00	1.15	6.18	9.62	
~~1.75~~	~~0.0060~~	~~0.011~~	~~9.00~~	~~1.00~~	~~6.35~~	~~14.51~~	N/A
2.00	0.0060	0.011	9.00	0.92	6.36	20.71	

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Description: Proposed Pipe at West Pump Station

Solve For Full Flow Capacity

Given Constant Data;

Slope..... 0.0060
Mannings n..... 0.011 ADS N-12
Discharge..... 5.91

Variable Input Data	Minimum	Maximum	Increment By
Diameter	1.25	2.00	0.25
	15"	24"	

A-10

VARIABLE			COMPUTED	COMPUTED	COMPUTED	COMPUTED	
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs	Depth ft	Velocity fps	Capacity Full cfs	
1.25	0.0060	0.011	5.91	1.25	4.82	5.91	
1.50	0.0060	0.011	9.62	1.50	5.44	9.62	
~~1.75~~	~~0.0060~~	~~0.011~~	~~14.51~~	~~1.75~~	~~6.03~~	~~14.51~~	N/A
2.00	0.0060	0.011	20.71	2.00	6.59	20.71	

Open Channel Flow Module, Version 3.41 (c)
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

A-1

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Comment: Proposed Pipe at West Pump Station

Solve For Actual Discharge @ 0.94D

Given Input Data:

	Diameter.....	1.50 ft	18"
	Slope.....	0.0060 ft/ft	
	Manning's n.....	0.011	ADS N-12
0.94D =	Depth.....	1.41 ft	

Computed Results:

QMAX =	Discharge.....	10.34 cfs
V@QMAX =	Velocity.....	6.00 fps
	Flow Area.....	1.72 sf
	Critical Depth....	1.24 ft
	Critical Slope....	0.0069 ft/ft
	Percent Full.....	94.00 %
	Full Capacity.....	9.62 cfs
	QMAX @.94D.....	10.34 cfs
	Froude Number.....	0.68 (flow is Subcritical)

Open Channel Flow Module, Version 3.41 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Comment: Proposed Pipe at West Pump Station

Solve For Actual Discharge @ 0.94 D

Given Input Data:

D =	Diameter.....	2.00 ft	24"
	Slope.....	0.0060 ft/ft	
	Manning's n.....	0.011	ADS-N-12
0.94D =	Depth.....	1.88 ft	

Computed Results:

QMAX =	Discharge.....	22.28 cfs
VMAX =	Velocity.....	7.27 fps
	Flow Area.....	3.06 sf
	Critical Depth....	1.68 ft
	Critical Slope....	0.0066 ft/ft
	Percent Full.....	94.00 %
	Full Capacity.....	20.71 cfs
	QMAX @.94D.....	22.28 cfs
	Froude Number.....	0.71 (flow is Subcritical)

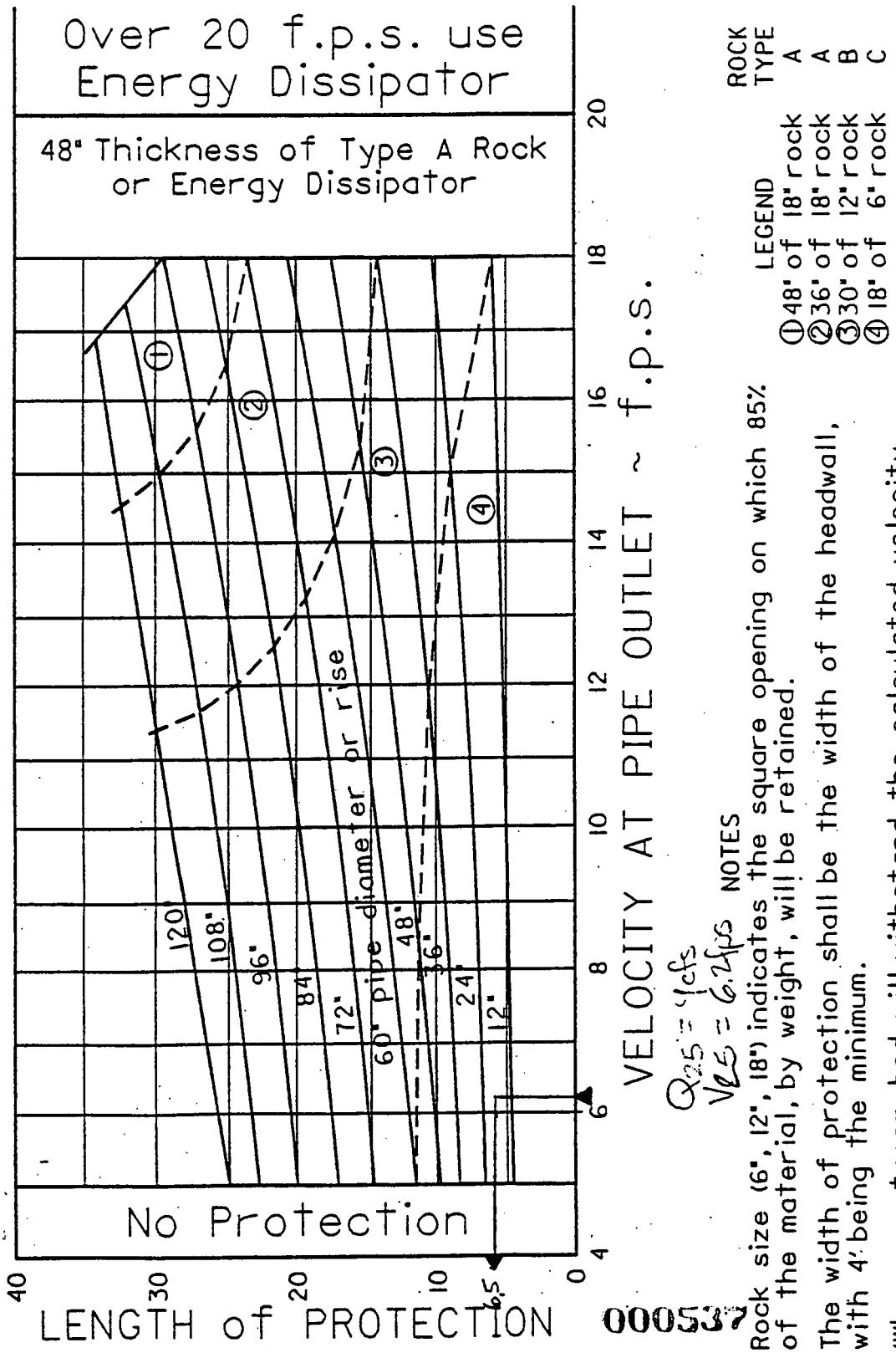
Open Channel Flow Module, Version 3.41 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

A-13

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1107-1

REFERENCE SECTION 1107.2



$Q_{25} = 4 cfs$
$V_{25} = 6.2 fps$

NOTES

Rock size (6", 12", 18") indicates the square opening on which 85% of the material, by weight, will be retained.

The width of protection shall be the width of the headwall, with 4' being the minimum.

(Where a stream bed will withstand the calculated velocity without erosion, no rock channel protection will be required.)

A-4

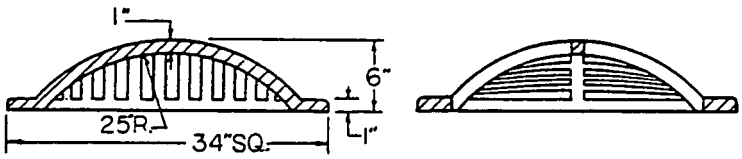
PARSONS
ERA PROJECT

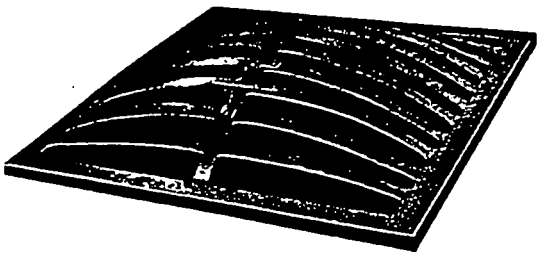
CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE
	KG	2/24/95	CRT	3/17/95	SEEPAGE CONTROL & SEDIMENT REMOVAL STORM DRAIN
					CRU 2
					AUTHOR K. Gerard SHEET OF PO 139

Heavy Duty
6610

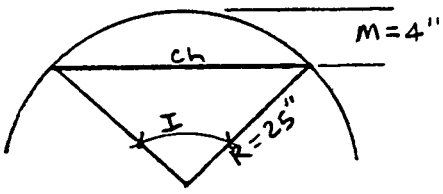
190 pounds total weight
Approximately 600 square inches of opening





104 *Always Specify EJIW Number*

***East Jordan Iron Works**, East Jordan, Michigan USA, 1-800-874-4100*



$M = R(1 - \cos I/2)$

$4" = 25"(1 - \cos I/2)$

$\cos I/2 = 1 - 0.16$

$I/2 = 32.8598°$

$Ch = 2R \sin I/2$

$= 2(25)(\sin 32.8598)$

$Ch = 27.13"$

ASSUME Ch IS THE PERIMETER DIMENSION / SIDE

ON LONG SLOT SIDES, MINUS 1" FOR STEEL, $2(26.13) = 52.26"$

ON SHORT OPENING SIDE, 10 - 1" BARS OR 17.13"/SIDE $2(17.13) = 34.26$

OPENING LENGTH @ PERIMETER = 86.52"

OR 7.2'

USE 7.2' FOR WEIR LENGTH, Lg, FOR WEIR CALCULATIONS.

$Q_w = 3.087 L H^{3/2}$ REF 7., pg 5-24

FOR ORIFICE FLOW CONDITIONS

$Q_o = C a (2gh)^{1/2}$ REF 7, pg 4-3

$C = 0.66$ (ASSUMED. SEE TABLE 4-5, REF 7 FOR 10:1 RECTANGLE @ h = 1FT.)

000538

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/23/95
CRU-2 KG

FIND: Head, H, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume weir flow conditions using EJIW 6610 grate

Given:

Q25 =	9	cfs	Q = 3.087*L*H ^ (3/2)
Lw =	4	lf	Q = Qw + Qg
h =	0.42	ft	Qw = weir flow
Lg =	7.2	lf	Qg = grate flow

H, ft	Q, cfs	Qw	Hg, ft	Qg
0.42	3.36	3.36	0.00	0.00
0.50	3.36	3.36	0.00	0.00
0.58	3.74	3.36	0.08	0.38
0.67	4.53	3.36	0.17	1.17
0.75	5.44	3.36	0.25	2.08
0.83	6.52	3.36	0.33	3.16
0.92	7.90	3.36	0.42	4.54
1.00	9.25	3.36	0.50	5.89
1.16	12.30	3.36	0.66	8.94
1.25	14.19	3.36	0.75	10.83
1.33	15.97	3.36	0.83	12.61

Note:

1. There are 2-2' wide openings which are the Lw for "weir flow" condition. Weir height = h.
2. Maximum "Weir flow" is assumed when H = h. When H > 0.50', then its "grate flow" which is also calculated by weir flow equation. Hgrate = H-0.50'. The grate is 1" thick and its top elev. is 6" above the weir elev.
3. Lg is the inside perimeter of the inlet.
4. An efficiency factor of 0.75 is used for the grate condition to compensate for grating and trash accumilation.
5. Lg based on East Jordon Iron Works, (EJIW), 6610 grate.
6. Hg is measured from the base of grate.

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/23/95
CRU-2 KC

FIND: Head, H, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume weir flow conditions using EJIW 6610 grate

Given:

7	Q25 =	9	cfs	Q = 3.087*L*H^(3/2)
	Lw =	3.33	lf	Q = Qw + Qg
9	h =	0.42	ft	Qw = weir flow
	Lg =	7.2	lf	Qg = grate flow

	A H, ft	B Q, cfs	C Qw	D Hg, ft	E Qg
13	0.42	+C13+E13	3.087*$A:$B$8*($A:$B$9^1.5)	+A13-$A:$B$9	0.75*3.087*$A:$B$10*(D13)^1.5
	0.50	+C14+E14	3.087*$A:$B$8*($A:$B$9^1.5)	+A14-$A:$B$9	0.75*3.087*$A:$B$10*(D14)^1.5
15	0.58	+C15+E15	3.087*$A:$B$8*($A:$B$9^1.5)	+A15-$A:$B$9	0.75*3.087*$A:$B$10*(D15)^1.5
	0.67	+C16+E16	3.087*$A:$B$8*($A:$B$9^1.5)	+A16-$A:$B$9	0.75*3.087*$A:$B$10*(D16)^1.5
17	0.75	+C17+E17	3.087*$A:$B$8*($A:$B$9^1.5)	+A17-$A:$B$9	0.75*3.087*$A:$B$10*(D17)^1.5
	0.83	+C18+E18	3.087*$A:$B$8*($A:$B$9^1.5)	+A18-$A:$B$9	0.75*3.087*$A:$B$10*(D18)^1.5
19	0.92	+C19+E19	3.087*$A:$B$8*($A:$B$9^1.5)	+A19-$A:$B$9	0.75*3.087*$A:$B$10*(D19)^1.5
	1.00	+C20+E20	3.087*$A:$B$8*($A:$B$9^1.5)	+A20-$A:$B$9	0.75*3.087*$A:$B$10*(D20)^1.5
21	1.16	+C21+E21	3.087*$A:$B$8*($A:$B$9^1.5)	+A21-$A:$B$9	0.75*3.087*$A:$B$10*(D21)^1.5
	1.25	+C22+E22	3.087*$A:$B$8*($A:$B$9^1.5)	+A22-$A:$B$9	0.75*3.087*$A:$B$10*(D22)^1.5
23	1.33	+C23+E23	3.087*$A:$B$8*($A:$B$9^1.5)	+A23-$A:$B$9	0.75*3.087*$A:$B$10*(D23)^1.5

Note:

1. There are 2-2' wide openings which are the Lw for "weir flow" condition. Weir height = h.
2. Maximum "Weir flow" is assumed when H = h. When H > 0.50', then its "grate flow" which is also calculated by weir flow equation. Hgrate = H-0.50'. The grate is 1" thick and its top elev. is 6" above the weir elev.
3. Lg is the inside perimeter of the inlet.
4. An efficiency factor of 0.75 is used for the grate condition to compensate for grating and trash accumilation.
5. Lg based on East Jordon Iron Works, (EJIW), 6610 grate.
6. Hg is measured from the base of grate.

\PO139\SS\139SD.WK3 A:

(This sheet is B in the LOTUS 1-2-3 file. Used to display formulas from A:)

A-17

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/24/95
CRU-2 KG

FIND: Head, h, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume orifice flow conditions using EJIW 6610 grate

Given:

area, a =	600	sq in	Qo =	C*a*(2*g*h) ^ (1/2)
	4.17	sq ft	H =	Head – from bottom of weir
C =	0.66		hg =	Head – above base of grate
g =	32.2	ft/s ^ 2	Q =	Q – Total Flow
Qw =	3.36	cfs (from side weirs. See weir calc)		

H, ft	Q, cfs	Qw, cfs	hg ft	a, sq ft	Qo cfs
0.42	3.36	3.36	0	0.00	0.00
0.50	3.36	3.36	0.00	0.00	0.00
0.58	4.11	3.36	0.08	0.67	0.75
0.67	5.68	3.36	0.17	1.42	2.32
0.75	7.50	3.36	0.25	2.08	4.14
0.83	9.64	3.36	0.33	2.75	6.28
0.92	12.37	3.36	0.42	3.50	9.01
1	15.06	3.36	0.50	4.17	11.70

Note:

1. Assumes that there is no increase in weir flow under orifice flow conditions.
2. Assume an efficiency factor of 0.75 used for the grate condition to compensate for trash accumulation.
3. Assumes that the full 600 sq ft opening value is available when the water surface elevation is equal to the top elevation of the grate. The area, a, is proportional to the hg; a = (hg/0.5')*4.17 sq ft up to O.5'. Initially, there will be weir flow which will transition to orifice. The "worst case" would be when hg is measured from the top of the grate and not the base.
4. EJIW – East Jordon Iron Works
5. The grate is 1" thick and its top elev. is 6" above the weir elev.

\PO139\SS\139SD.WK3 C:

A-18

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/24/95
CRU-2 K

FIND: Head, h, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume orifice flow conditions using EJIW 6610 grate

Given:

47	area, a =	600	sq in	Qo = C*a*(2*g*h) ^ (1/2)
		4.17	sq ft	H = Head – from bottom of weir
49	C =	0.66		hg = Head – above base of grate
	g =	32.2	ft/s ^ 2	Q = Q – Total Flow
51	Qw =	3.36	cfs (from side weirs. See weir calc)	

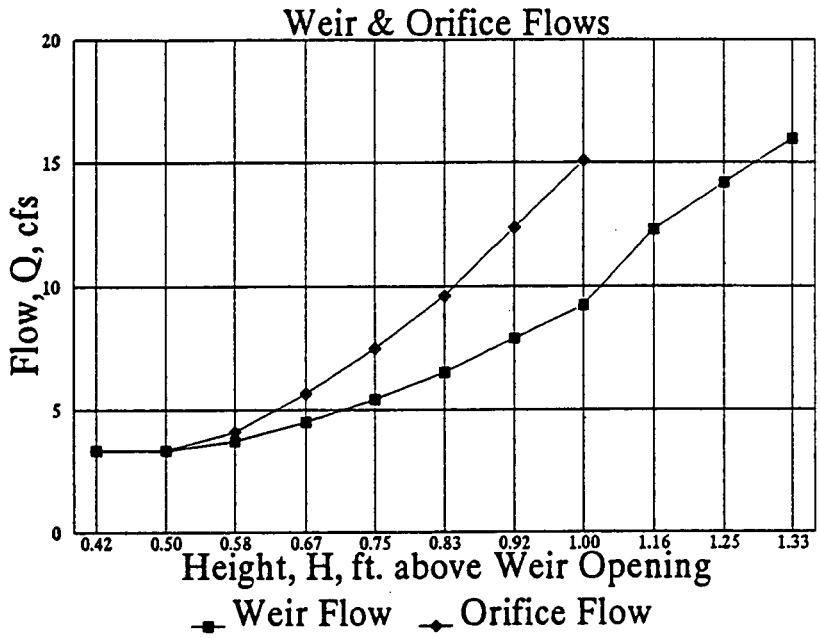
	A H, ft	B Q, cfs	C Qw, cfs	D hg ft	E a, sq ft	F Qo cfs
56	0.42	+C56+F56	+$C:$B$51	0	(D56/0.5)*$C:$B$48	0.75*$C:$B$49*E56*(2*$C:$B$10*D56) ^ 0.5
	0.50	+C57+F57	+$C:$B$51	+A57-0.5	(D57/0.5)*$C:$B$48	0.75*$C:$B$49*E57*(2*$C:$B$10*D57) ^ 0.5
58	0.58	+C58+F58	+$C:$B$51	+A58-0.42	(D58/0.5)*$C:$B$48	0.75*$C:$B$49*E58*(2*$C:$B$10*D58) ^ 0.5
	0.67	+C59+F59	+$C:$B$51	+A59-0.42	(D59/0.5)*$C:$B$48	0.75*$C:$B$49*E59*(2*$C:$B$10*D59) ^ 0.5
60	0.75	+C60+F60	+$C:$B$51	+A60-0.42	(D60/0.5)*$C:$B$48	0.75*$C:$B$49*E60*(2*$C:$B$10*D60) ^ 0.5
	0.83	+C61+F61	+$C:$B$51	+A61-0.42	(D61/0.5)*$C:$B$48	0.75*$C:$B$49*E61*(2*$C:$B$10*D61) ^ 0.5
62	0.92	+C62+F62	+$C:$B$51	+A62-0.42	(D62/0.5)*$C:$B$48	0.75*$C:$B$49*E62*(2*$C:$B$10*D62) ^ 0.5
	1	+C63+F63	+$C:$B$51	+A63-0.42	+$C:$B$48	0.75*$C:$B$49*E63*(2*$C:$B$10*D63) ^ 0.5

Note:
1. Assumes that there is no increase in weir flow under orifice flow conditions.
2. Assume an efficiency factor of 0.75 used for the grate condition to compensate for trash accumulation.
3. Assumes that the full 600 sq ft opening value is available when the water surface elevation is equal to the top elevation of the grate. The area, a, is proportional to the hg; a = (hg/0.5')*4.17 sq ft up to O.5'. Initially, there will be weir flow which will transition to orifice. The "worst case" would be when hg is measured from the top of the grate and not the base.
4. EJIW – East Jordon Iron Works
5. The grate is 1" thick and its top elev. is 6" above the weir elev.

\PO139SS\139SD.WK3 C:
(This sheet is D in the LOTUS 1-2-3 file. Used to display formulas from C:)

A-9

Grate Flow Conditions



PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE DESIGN OF SEEPAGE COLLECTION AND SEDIMENT REMOVAL STORM DRAIN	CRU 2
0	KG	2/28/95	CRT	2/28/95		
					AUTHOR K. Gerard SHEET OF	PO 139

CALCULATE THE EQUIVALENT LENGTH OF PIPE FOR 22½° BENDS

$L = KD/f$ (pg 3-120)

D = ID, ft
K = Resistance Coefficient, use 0.10. (pg 3-113) (30°)
f = Friction Factor

FIND: f

ASSUME N-12 HDPE HAS SIMILAR FRICTION PROPERTIES AS COPPER, BRASS, LEAD, TIN OR GLASS PIPE

HAZEN-WILLIAMS - C = 130 (pg 3-8)
ABSOLUTE ROUGHNESS ε = 0.000005' (pg 3-5)

$\varepsilon/D = 0.000005'/1.5' = 0.0000033$

$R = \frac{VD}{\nu}$ (pg 3-6)

V = velocity, fps
D = ID, ft
ν = Kinematic viscosity, ft²/sec.

Assume ν of fluid is similar to fresh water at 60°F, or 1.13 centistokes. (pg 4-45) (pg 4-27)

(1.13 centistokes)(0.0000107639) = 0.0000121 ft²/sec

For full flow conditions. (Q_F = 9.62 cfs) V = 5.44 fps

$R = (5.44\text{ fps})(1.5\text{ ft})/0.0000121\text{ ft}^2/\text{s}$

R = 674,882
6.75×10^5

Using Moody diagram, f = 0.0125

L = (0.10)(1.5')/(0.0125) = 12' each bend or 36' for 3 bends.

L_{TOTAL} = 212' + 36' = 248' USE 250' FOR CALCULATIONS.

NOTE: ALL PAGE No. REFERENCES TAKEN FROM CAMERON HYDRAULIC DATA

PARSONS
ERA PROJECT

CALCULATION SHEET

1062

REV	BY	DATE	CK	DATE
0	KG	2/28/95	CRT	2/17/95

TITLE DESIGN OF SEEPAGE COLLECTION AND SEDIMENT REMOVAL
STORM DRAIN

CRU 2

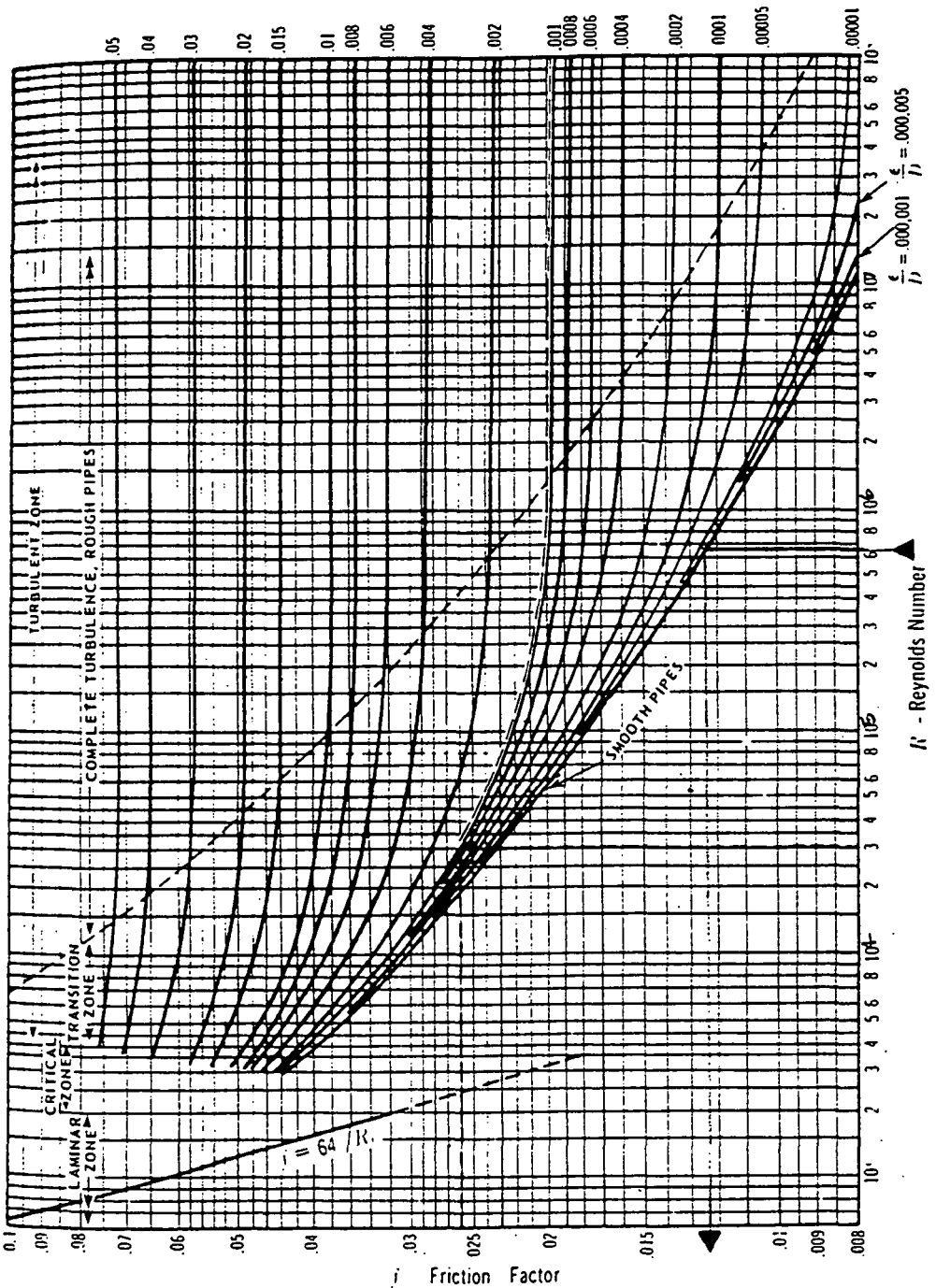
AUTHOR K. Gerard SHEET OF

PO 1391

Friction Factors for Commercial Pipe

(for Darcy-Weisbach formula, page 3-3)

Relative Roughness $= \frac{\epsilon}{D}$



Moody diagram. (V. L. Streeter, "Fluid Mechanics," 5th ed. Copyright 1971 by McGraw-Hill Book Company, New York)

Note: Chart shows relation of relative roughnesss—ϵ/D where ϵ is absolute roughness in feet and D is diameter in feet.

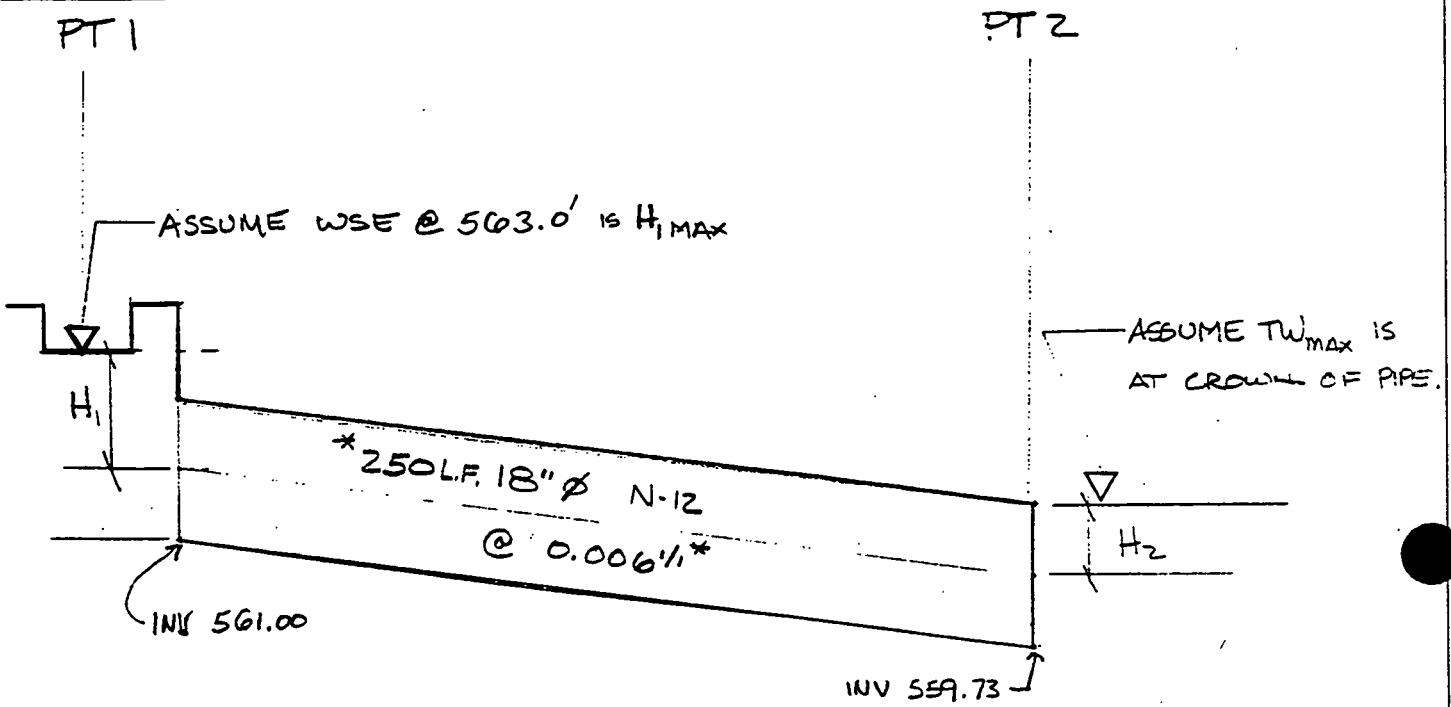
(REF. No. 8)
pg 3-11

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE DESIGN OF SEEPAGE COLLECTION AND SEDIMENT REMOVAL STORM DRAIN	CRU 2
0	KG	2/28/95	CRT	3/17/95		
					AUTHOR K. Gerard SHEET OF	PO 139

CHECK PIPE UNDER PRESSURE FLOW CONDITIONS



* 212' actual + 36' for bends, Invert elevations and S shown based on actual.

$$H_{1_{max}} = 1.25' \times 62.4\ lbs/CF \times 1SF/144\ in^2 = 0.54\ psi$$

$$Q_F = 9.62\ cfs \times 7.48\ gal/cf \times 60\ s/min = 4317\ gpm \quad \text{use } 4320\ gpm$$

$$H_2 = 0.75' \times 62.4\ lb/CF \times 1SF/144\ in^2 = 0.27\ psi$$

SEE FLOWMASTER CALCULATIONS FOR HAZEN-WILLIAMS EQUATION.

000546

Pressure Pipe Analysis & Design
Circular Pipe

Worksheet Name: West Diversion Pipe

Comment: Using 1/16 Bends

Solve For Pressure @ 1

Given Input Data:

Elevation @ 1.....	561.75	ft
Elevation @ 2.....	560.48	ft
Pressure @ 2.....	0.27	psi
Q_{FULL} = Discharge.....	4320.00	gpm (9.62 cfs)
Diameter.....	18.00	in
Length.....	250.00	ft
Hazen-Williams C..	130.00	

Computed Results:

Pressure @ 1.....	0.29	psi < 0.54 psi ∴ OK
Velocity.....	5.45	fps
Headloss.....	1.32	ft
Energy Grade @ 1..	562.89	ft
Energy Grade @ 2..	561.56	ft
Friction Slope....	5.289	ft/1000 ft

SEE SKETCH / CALC

Open Channel Flow Module, Version 3.41 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

A-24

ATTACHMENT B

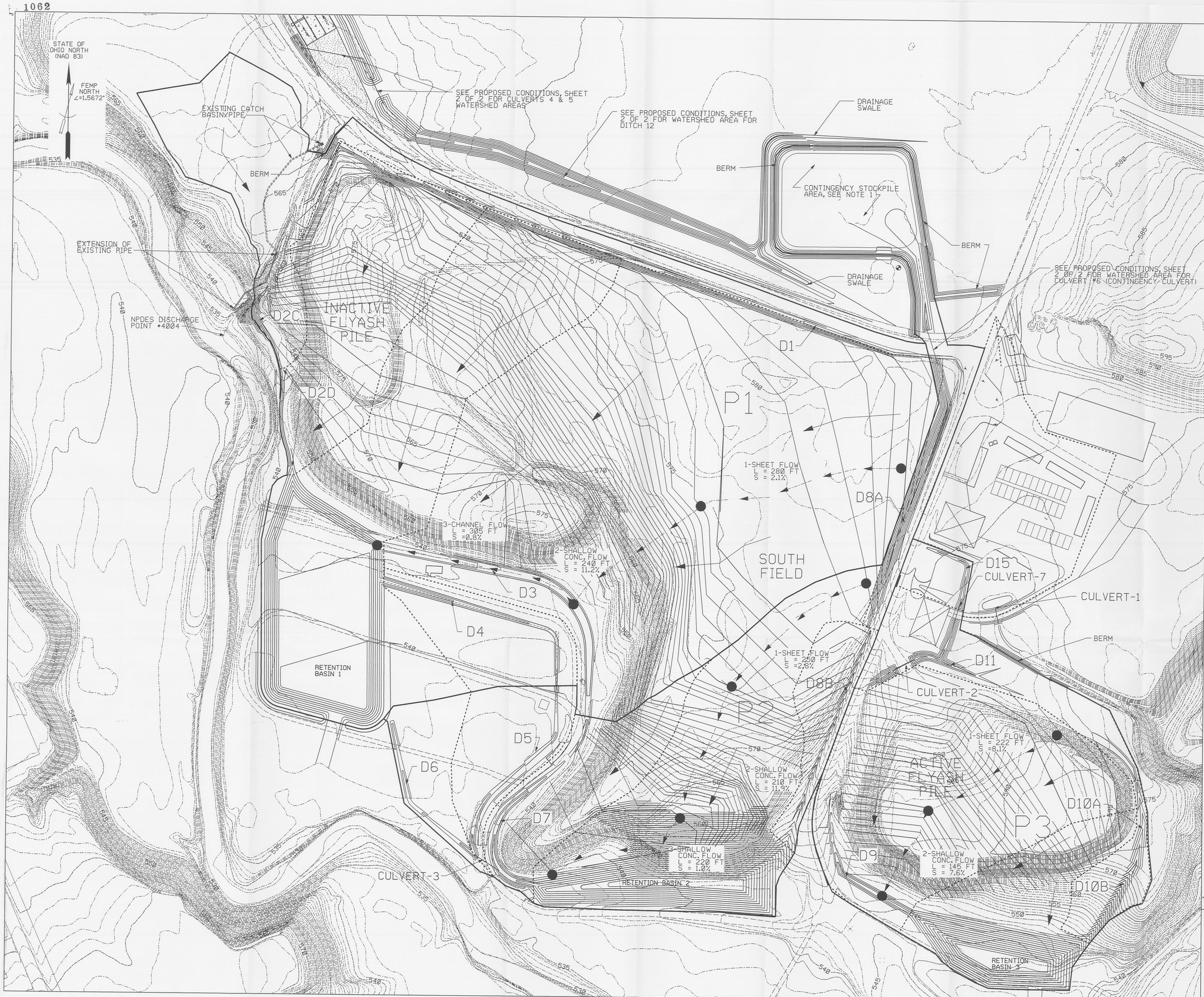
SUPPORTING FIGURES

R. 1 E. R. 2 E.
1 380 000 FEET
1 485 000 FEET
R. 1 E. R. 2 E.
US RESERVATION
(ATOMIC ENERGY COMMISSION)
DRAINAGE AREA
Paddy Run
(Joins sheet 3) T. 2 N.
1 Mile
5 000 Feet

APPENDIX B

DRAINAGE AREA MAPS

STATE OF OHIO NORTH (NAD 83)
FEMP NORTH ∠=1.5672°
EXISTING CATCH BASIN/PIPE
BERM
EXTENSION OF EXISTING PIPE
NPDES DISCHARGE POINT #4004
SEE PROPOSED CONDITIONS, SHEET 2 OF 2 FOR CULVERTS 4 & 5, AND DRAINAGE AROUND WHEEL WASH AREA
SEE PROPOSED CONDITIONS, SHEET 2 OF 2 FOR WATERSHED AREA FOR DITCH 12
M-2
D1
D2A
D2B
INACTIVE FLYASH PILE
D3
D4
D5
D6
D7
D8A
D8B
D9
D10A
D10B
D11
D15
CULVERT-1
CULVERT-2
CULVERT-3
CULVERT-7
RETENTION BASIN 1
RETENTION BASIN 2
RETENTION BASIN 3
SOUTH FIELD
ACTIVE FLYASH PILE
1-SHEET FLOW L = 150 FT S =1.0%
2-SHALLOW CONC. FLOW L = 60 FT S = 20.0%
3-CHANNEL FLOW L = 280 FT S = 10.0%
LEGEND
RETENTION BASIN DRAINAGE AREA
DITCH/CULVERT DRAINAGE AREA
DIRECTION OF FLOW
EXISTING CONDITIONS
SCALE: 1" = 50'
1062
000551



1. CONTINGENCY STOCKPILE AREA (STOCK PILE #2) IS PROVIDED FOR ADDITIONAL SOIL STORAGE SHOULD PRIMARY STOCKPILE AREA BECOME TOO SMALL. DITCHES 8A, 8B, AND BASIN 2 ARE DESIGNED TO ACCOMMODATE THE CONTINGENCY STOCKPILE AREA IF USED.

LEGEND

RETENTION BASIN DRAINAGE AREA — P1

DITCH/CULVERT DRAINAGE AREA

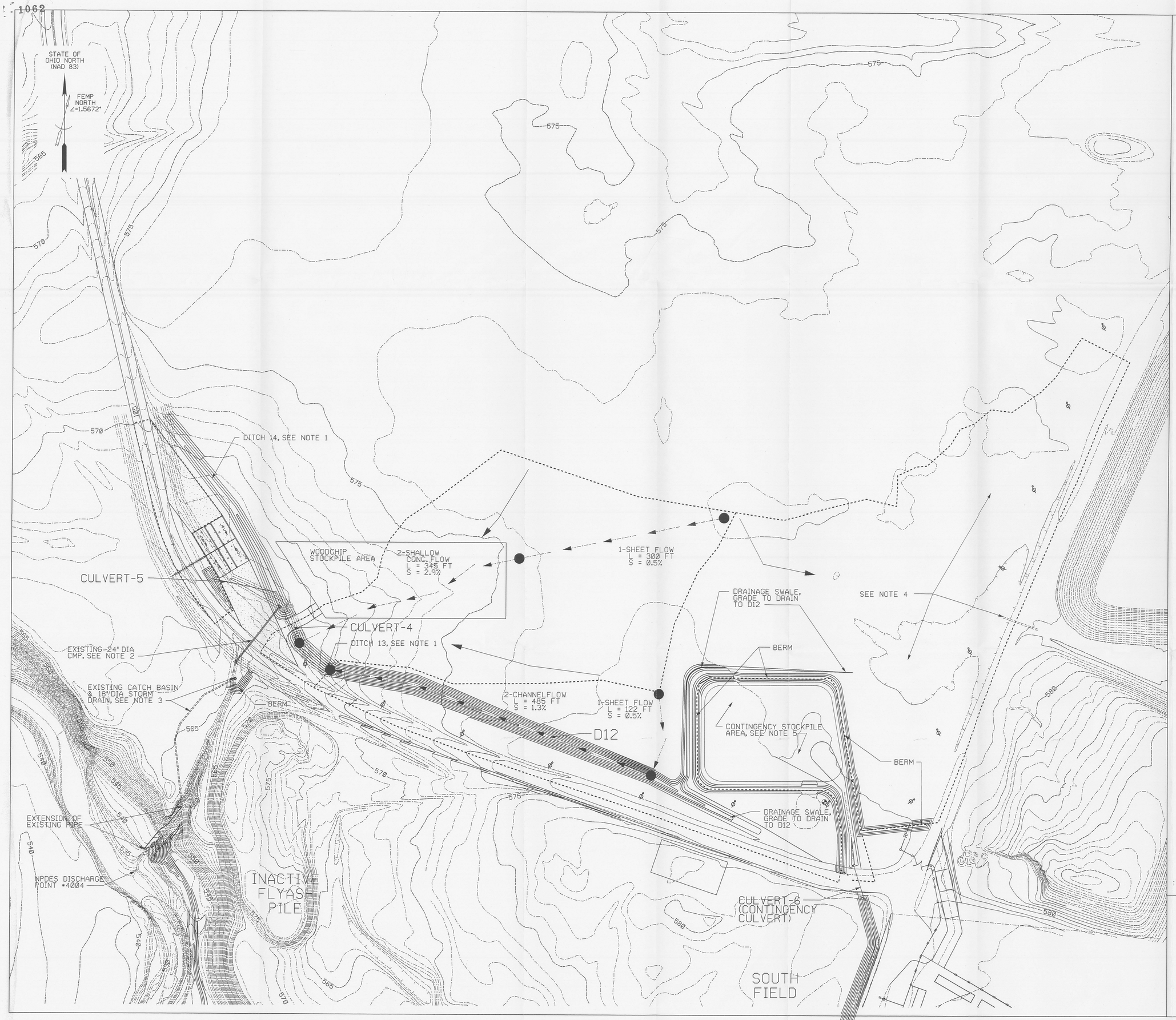
DIRECTION OF FLOW

1062

PROPOSED CONDITIONS
SHEET 1 OF 2

50 0 50 100
SCALE: 1" = 50'

000552



NOTES:

1. EXISTING DITCHES IN THIS AREA WERE ORIGINALLY DESIGNED UNDER THE HAULROAD UPGRADE PROJECT, (P0158), CALCULATION NO. 15-02. DITCHES 13 & 14 WILL BE THE SAME SIZE AS THE EXISTING DITCHES AND WILL BE USED TO ROUTE RUNOFF AROUND NEW WORK.
2. EXISTING 24" DIA CMP WAS DESIGNED UNDER THE HAULROAD UPGRADE PROJECT (P0158), CALCULATION NO. 15-02.
3. EXISTING 18" DIA STORM DRAIN AND CATCH BASIN WERE DESIGNED UNDER THE SEEPAGE COLLECTION AND SEDIMENT REMOVAL PROJECT, (P0139), CALCULATION NO. 15-01.
4. DITCH-12 AND CULVERT-4 WERE DESIGNED ASSUMING THAT THE EXISTING CULVERT SHOWN WAS PLUGGED. IT WAS FURTHER ASSUMED THAT THE RUNOFF FROM THE ADDITIONAL DRAINAGE AREA SHOWN WOULD FLOW SOUTH TO DITCH-12 AND CULVERT-4.
5. CONTINGENCY STOCKPILE AREA (STOCKPILE #2) IS PROVIDED FOR ADDITIONAL SOIL STORAGE SHOULD PRIMARY STOCKPILE AREA BECOME TOO SMALL. DITCHES 8A, 8B, AND BASIN 2 ARE DESIGNED TO ACCOMMODATE THE CONTINGENCY STOCKPILE AREA IF USED.

LEGEND

DITCH/CULVERT DRAINAGE AREA

DIRECTION OF FLOW

EXISTING POWER POLE

1062

PROPOSED CONDITIONS
SHEET 2 OF 2

50 0 50 100
SCALE: 1" = 50'

LEGEND

DITCH/CULVERT
DRAINAGE AREA

1062

BASE BID EXCAVATION
CONDITIONS

50 0 50 100
SCALE: 1" = 50'

000551

LEGEND

DITCH/CULVERT
DRAINAGE AREA

1062

SOUTH FIELD & APF EXCAVATION
GRADING CONDITIONS

50 0 50 100
SCALE: 1" = 50'

000555

LEGEND

DITCH/CULVERT DRAINAGE AREA

1062

RESTORED CONDITIONS

50 0 50 100

SCALE: 1" = 50'

APPENDIX C

Evaluation of the Potential Peak Stages in Paddys Run During Storm Events at Cross Sections Close to the Proposed Retention Basin No. 1

EVALUATION OF THE POTENTIAL PEAK STAGES IN PADDYS RUN DURING STORM EVENTS AT CROSS SECTIONS CLOSE TO THE PROPOSED RETENTION BASIN NO. 1

Fernald Environmental Management Project
Fernald, Ohio

Prepared By

BROWN & ROOT ENVIRONMENTAL
661 Andersen Drive
Pittsburgh, PA 15220

July, 1997

EVALUATION OF THE POTENTIAL PEAK STAGES IN PADDYS RUN DURING STORM EVENTS AT CROSS SECTIONS CLOSE TO THE PROPOSED RETENTION BASIN NO. 1

July, 1997

Objective

As proposed in the Area 2 Phase I Site Preparation Plan, a Surface Water Management Plan was prepared to address management of surface water at the Southern Waste Units (SWUs) during site preparation and excavation activities at the FEMP. According to this plan, the Retention Basin No. 1 will be constructed south of the Inactive Flyash Pile to control and collect potentially impacted storm water runoff from the Area 2, Phase I Remediation Area. The top bank elevations of the Retention Basin No.1 is proposed to be 540 feet. The objective of this task is to perform a hydraulic analysis to calculate the water surface elevations at the cross-sections A'-A', B'-B' and C'-C' along Paddys Run near the Retention Basin No.1, and to determine whether the water from Paddys Run will overflow into the proposed basin bank under 24-hour duration storms with the return periods of 1-year, 5-year, 10-year and 25-year, respectively. Locations of cross sections A'-A', B'-B' and C'-C' are shown in Figure 1.

Conceptual Model

The Paddys Run is an intermittent stream which drains a mid-size catchment (approximately 15 square miles) which includes most of the Fernald Environmental Management Project (FEMP) site. The Paddys Run drainage basin consists of land surface drained by streams and channels discharging to Paddys Run. The basin can be divided into subbasins so that the runoff from any particular area can be analyzed separately. The runoff from each of the subbasin can then be added together to yield the total hydrograph for the basin. The basin and subbasin boundaries were derived using topographic maps created by the U.S. Geological Survey (USGS) and supplemented with site topographic maps. Figure 2 shows all the subbasins in the simulation. The details of the boundaries of the basin and subbasins are presented in the Surface Water Flow and Infiltration Model (SWF&IM) Report (DOE 1993) developed for the FEMP and Operable Unit 5 RI/FS. The SWF&IM is a combination of the FEMP site-specific hydrological input parameters and several hydraulic and transport models used to simulate the various physical and chemical processes involved in the transport of contaminants from surface soil into surface water and subsequently into groundwater. The hydrologic/ hydraulic portion of the SWF&IM incorporated the U.S. Army

Corps of Engineers HEC-1 model to calculate runoff hydrographs and Manning's equation to calculate the Stage in Paddys Run. The methods are described in further detail in the following paragraphs.

Technical Approach

HEC-1 model was used to simulate surface runoff into Paddys Run. The HEC-1 model was developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. The HEC-1 generates runoff hydrographs from many different subbasins and then combines and routes the hydrographs through the watershed. The entire Paddys Run drainage basin was modeled by linking the various subbasins together within the HEC-1 model. In the HEC-1 model, a runoff hydrograph is calculated for each subbasin. The hydrographs are then added together at locations called stations in the HEC-1 model. The combined runoff hydrographs can then be routed through a channel reaches, and combined with hydrographs from other subbasins.

The HEC-1 model provides hydrographs in terms of discharge rate versus time at each cross-section location. The rating curve (discharge versus depth relationship) is developed at each cross section based on the Mannings equation (Henderson, 1966). Mannings equation assumes that the channel flow is steady and uniform. The rating curve for each cross section is then used to obtain the peak river stage based on the cross-section-specific peak discharge in the hydrographs from HEC-1 model. It should be noted that this modeling approach was developed for the SWF&IM model whose primary purposed was contaminant fate and transport. The river stage is a relatively insensitive parameter in the contaminant model. The method used to develop the rating curve is relatively simplistic and reasonable conservative. If more accuracy is required more detailed analysis could be performed.

In the SWF&IM, cross sections D-D and E-E were called stations. Hydrographs at these two stations are computed based on hydrographs generated from upstream subbasins and then combined and routed to these stations. Cross section D-D is located at upstream of cross section C'-C' and cross section E-E is located at downstream of cross section A'-A' (see Figure 1). (Note: Cross sections in the SWF&IM were named A-A through K-K, three new sections A'-A', B'-B' and C'-C' are intermediate sections between the original D-D and E-E sections used to study this particular area of interest) The peak river stages at cross sections D-D and E-E are calculated by using the rating curve presented in the SWF&IM and the peak discharge output from the HEC-1 model. As mentioned earlier, the rating curves were developed using the Mannings equation, cross section of Paddys run and Manning roughness coefficients based on field reconnaissance. The peak river stages at cross sections A'-A', B'-B' and C'-C' are then linearly interpolated from the peak stages at cross sections D-D and E-E based on the distance between these cross sections.

The procedures used to obtain the peak stages in Paddys Run at cross sections A'-A', B'-B' and C'-C' are summarized as follows:

(1) Obtaining the peak discharges at cross sections D-D and E-E from the output of HEC-1 runs,

(2) Calculating the peak stages at cross sections D-D and E-E by using the rating curves, and

(3) Interpolating the peak stages at cross sections A'-A', B'-B' and C'-C' from the peak stages at cross sections D-D and E-E.

Input Data

The HEC-1 model requires input to represent the rainfall event and to describe the surface hydrological properties of the drainage area. Four 24-hour storm events with return periods of 1-year, 5-year, 10-year and 25-year, respectively, were chosen to evaluate the peak discharge and stage at the cross sections near the Retention Basin No. 1. The volume of precipitation contained in a storm event is often reported in depth. The storms have total precipitation depths of 2.5 inches, 3.6 inches, 4.1 inches and 4.8 inches for the 1-year, 5-year, 10-year and 25-year return periods, respectively. The method used to produce the storm hyetograph (the variation of rainfall intensity with time) used in the HEC-1 requires the rainfall amounts (depth) for storm of various durations up to the entire length of the storm being modeled. The depth-duration data required by the HEC-1 model is listed in Table 1. The rainfall depth listed in Table 1 were obtained from the rainfall frequency atlas of the United States (Hershfield 1961).

Most of the parameters used to describe the drainage basin were taken from topographic maps of the Paddys Run watershed. Some information, such as Paddys Run cross section data, used for channel routing, were obtained from topographic maps developed from field surveys. Parameters such as channel roughness, slope, catchment lengths and areas, and stream channel dimensions are required to define the water movement over the basin surface. The detailed description of the input data can be found in SWF&IM. Appendix A and Appendix B list all data used to characterize overland flow and channel flow elements, respectively. The Soil Conservation Service (SCS) curve number method was utilized to calculate precipitation losses. The curve number associated with each of the different soil types, land uses, and vegetation are then weighted and averaged to represent each subbasin for input into the HEC-1 model. Appendix C provides the weighting procedure used to determine the SCS curve number for the subbasins. The final curve number(s) used for each subbasin is also presented in this Appendix.

The area upstream of Section D-D is covered by eleven subbasins in this simulation. Storm water from the former production area of the FEMP and the waste pit area is assumed to be collected in the Storm Water Retention Basin

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and pumped to the Great Miami River, therefore, the discharge from former production area and waste pit area does not affect the peak discharge at section A'-A', B'-B' and C'-C'.

The rating curve (depth-discharge relationship) was developed for the cross sections D-D and E-E. The Mannings roughness coefficient and slope for each cross section used in a rating curve calculation are listed in Appendix B. Figures 3 and 4 show the geometry of cross sections D-D and E-E, respectively. The resulting rating curves for cross sections D-D and E-E are presented in Figures 5 and 6, respectively.

The HEC-1 model input files for 1-year, 5-year, 10-year, and 25-year return period storms are presented in Appendix E

Calibration

A comparison between the model simulated and field measured river stages was performed in response to the EPA comments on SWF&IM in 1994. Appendix D includes the detailed description of the performance of this calibration. As described in Appendix D, the curve number used for the HEC-1 model of the representative storm event are based on an Antecedent Moisture Condition-II (AMC-II) which represents an average moisture content in the surface soils prior to the storm rainfall event. AMC-I represents a dryer than average moisture content in the surface soil and AMC-III represents a wetter than average soil condition. The AMC-II curve number are primarily used for design purposes (SCS, Technical Release 55, June 1986).

In order to better evaluate the performance of the runoff model, actual rainfall data from FEMP from two storm event (the April 28-29 1989 event and another one on April 3-4 1989) and SCS curve number that represent actual soil conditions during an abnormally wet season were input into the HEC-1 model. The rainfall in the spring of 1989 was above average (DOE 1993, Groundwater Modeling Report Summary of Model Development) indicating that the ground surface could have been saturated prior to the storm event which would cause a larger amount of runoff. The SCS National Engineering Handbook, Section 4, Hydrology (NEH-4 [SCS 1985]) recommends that if more than 1.1 inches of precipitation falls during the five days before the storm event being modeled that a AMC-III should be used. Approximately 1.3 inches of rain fell in the five days prior to the storm event on April 28-29, 1989. Since this was in the range of AMC-III recommended in NEH-4, an AMC-III was used to simulate this storm. An AMC-III was also used for the simulation of the April 3-4 storm since this storm occurred four days after a storm event on March 31, 1989 which caused the Storm Water Retention Basin to overflow. The site precipitation data was not readily available for the March 31 storm, but it is valid to assume that such a event would create AMC-III soil conditions for the April 3-4 event. The area weighted SCS curve number is 64 for AMC-II condition and 81 for AMC-III condition used in HEC-1 model.

Table 2 presents the comparison of the modeled and measured rise in the flow depth of Paddys Run. The measured rise in water surface elevation was measured at two locations along Paddys Run in April 1989: Stilling Well 9 (near cross section location C-C) and Stilling Well 14 (near cross section location E-E). The location of cross section C-C is indicated in Figure 2. As stated in Appendix D, the conclusion of the comparison for the response to comments in1994 was that the surface water model can predict the water surface elevation with acceptable accuracy.

Simulation Results

The output from the HEC-1 model includes runoff hydrographs, peak discharge, and the total volume of runoff from each subbasin and cross section location in the model. The peak discharges at cross sections D-D and E-E under different storm events from the HEC-1 model were used to calculate the peak river stages based on the rating curves at these cross sections. The peak discharges and river stages at cross sections D-D and E-E are shown in Figures 5 and 6. The peak river stages at cross sections D-D and E-E were then used to interpolate the peak river stages at cross sections A'-A', B'-B' and C'-C'. Figure 7 shows the interpolated peak river stages at cross sections A'-A', B'-B' and C'-C'. Also, the peak river stages at these cross sections are tabulated in Table 3. The top elevation of the proposed bank for Retention Basin No. 1 at cross sections A'-A', B'-B' and C'-C' is about 540 feet. The river stages in Table 3 indicates that the Paddys Run does not overflow the proposed basin bank at these cross sections even under the 25-year return period, 24-hour storm event.

References

Henderson, F.M., 1966," Open Channel Flow," McMillian Publishing Co., Inc., New York pp. 96

Hershfield, D.M., 1961, " Rainfall Frequency Atlas of the United States," Technical Paper No. 40, Department of Commerce, Washington, DC.

U.S. Army Corps of Engineers, 1990, " HEC-1 Flood Hydrograph Package User's Manual," CPD-1A, Version 4.0.

U.S. Department of Energy, Fernald Office, 1993, "Surface Water Flow and Infiltration Model Summary Report."

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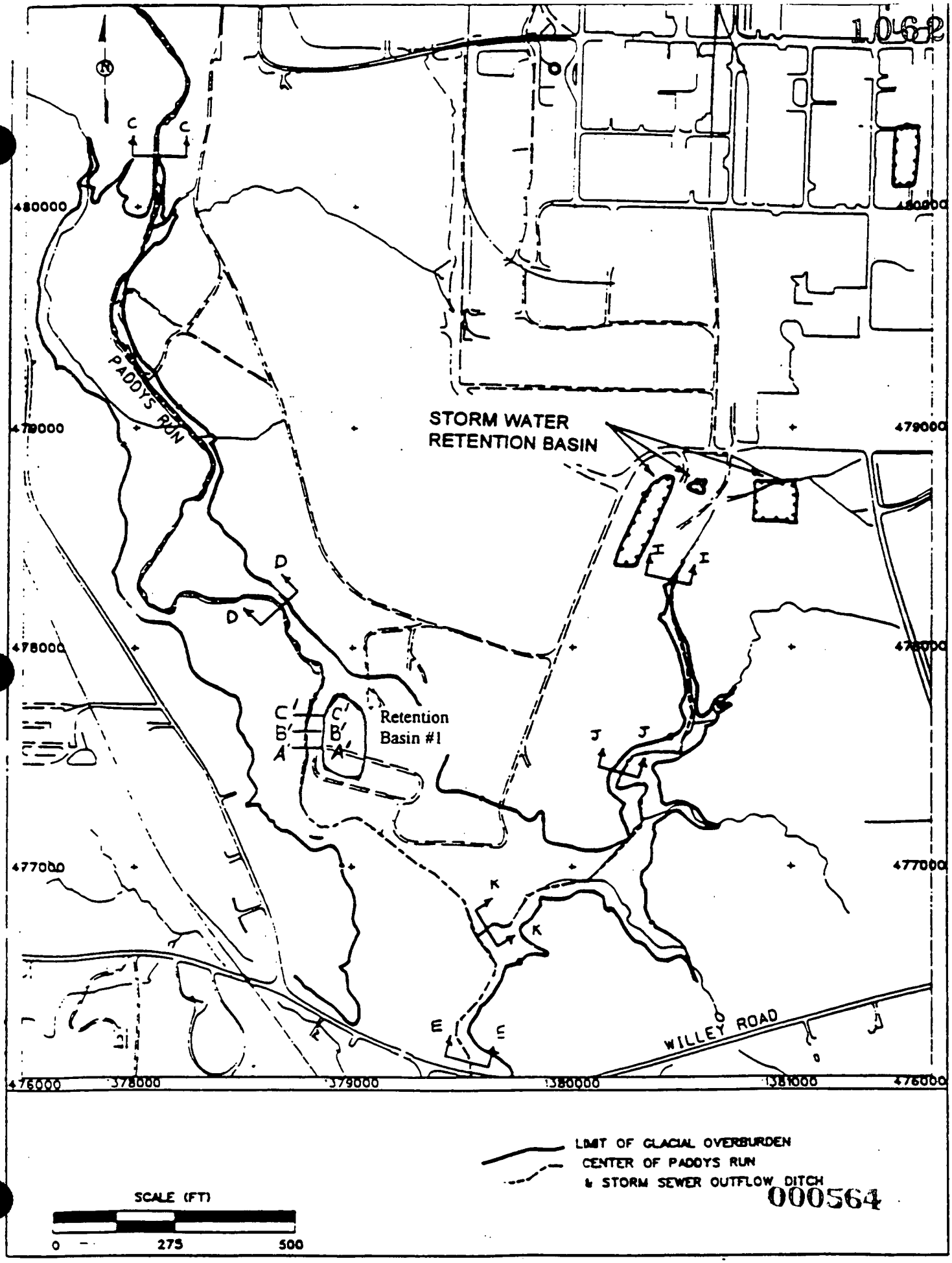

Figure 1 Location of Cross Sections

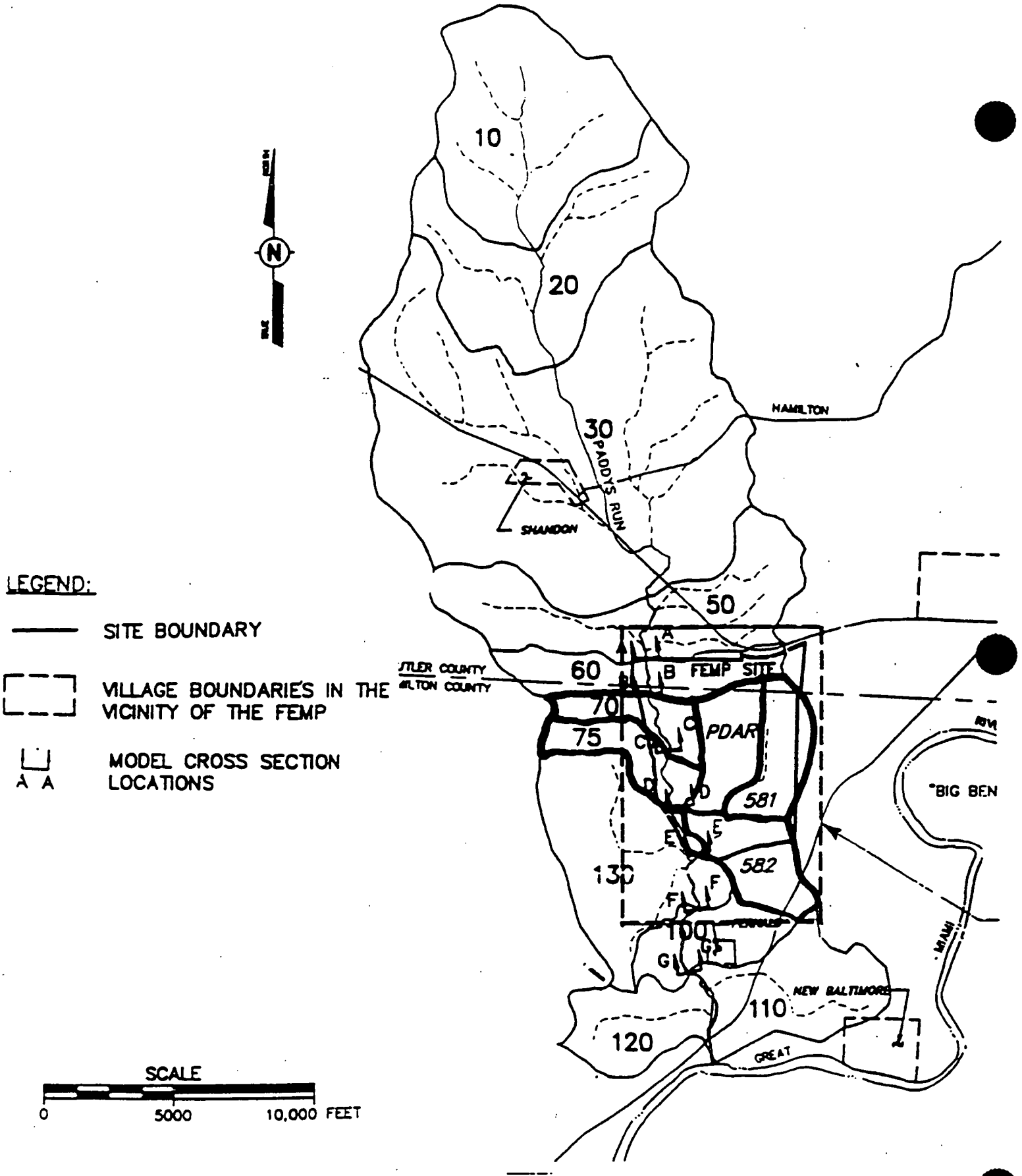

Figure 2 Paddys Run Subbasins

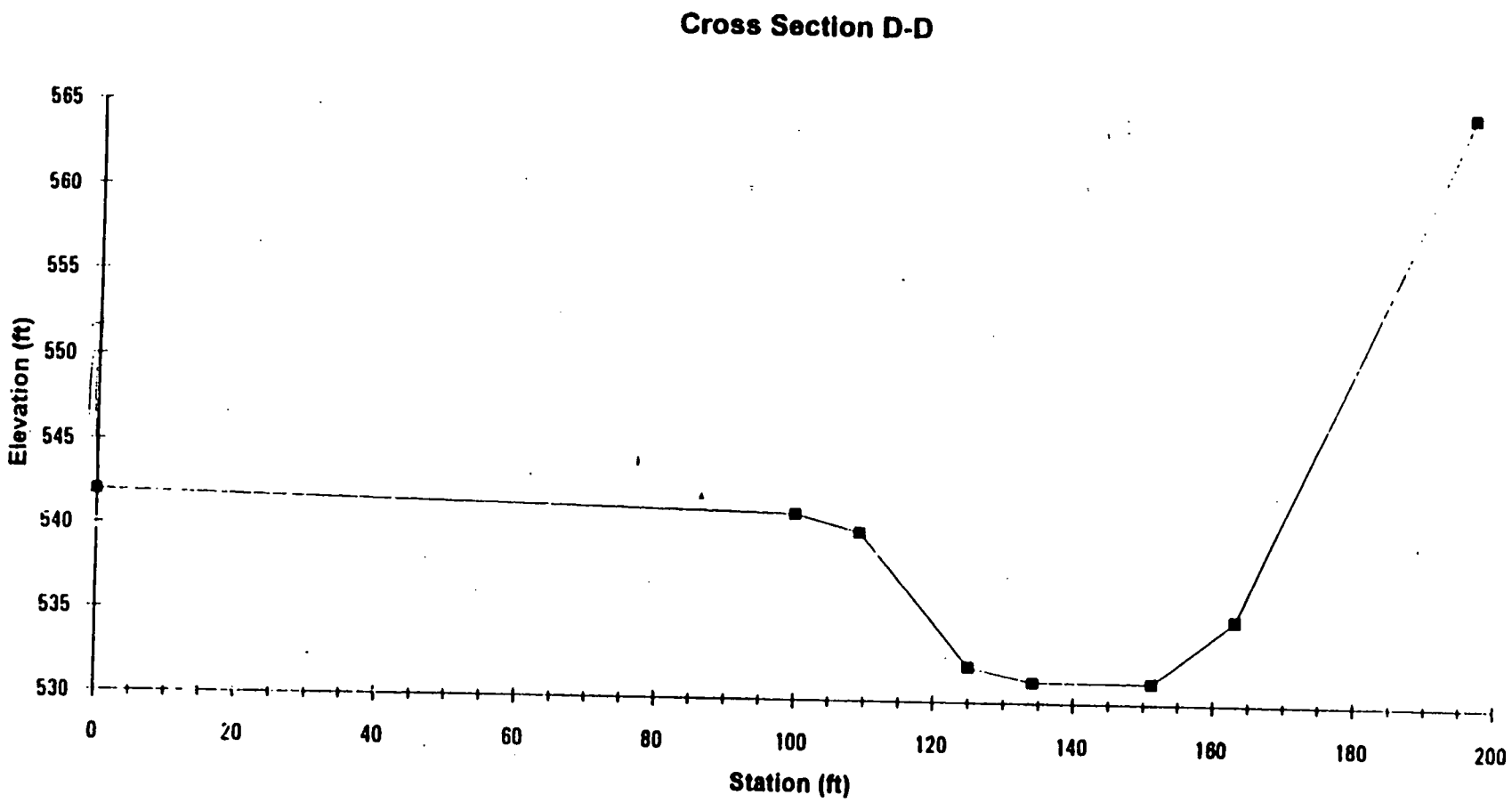

Figure 3 Cross Section D-D

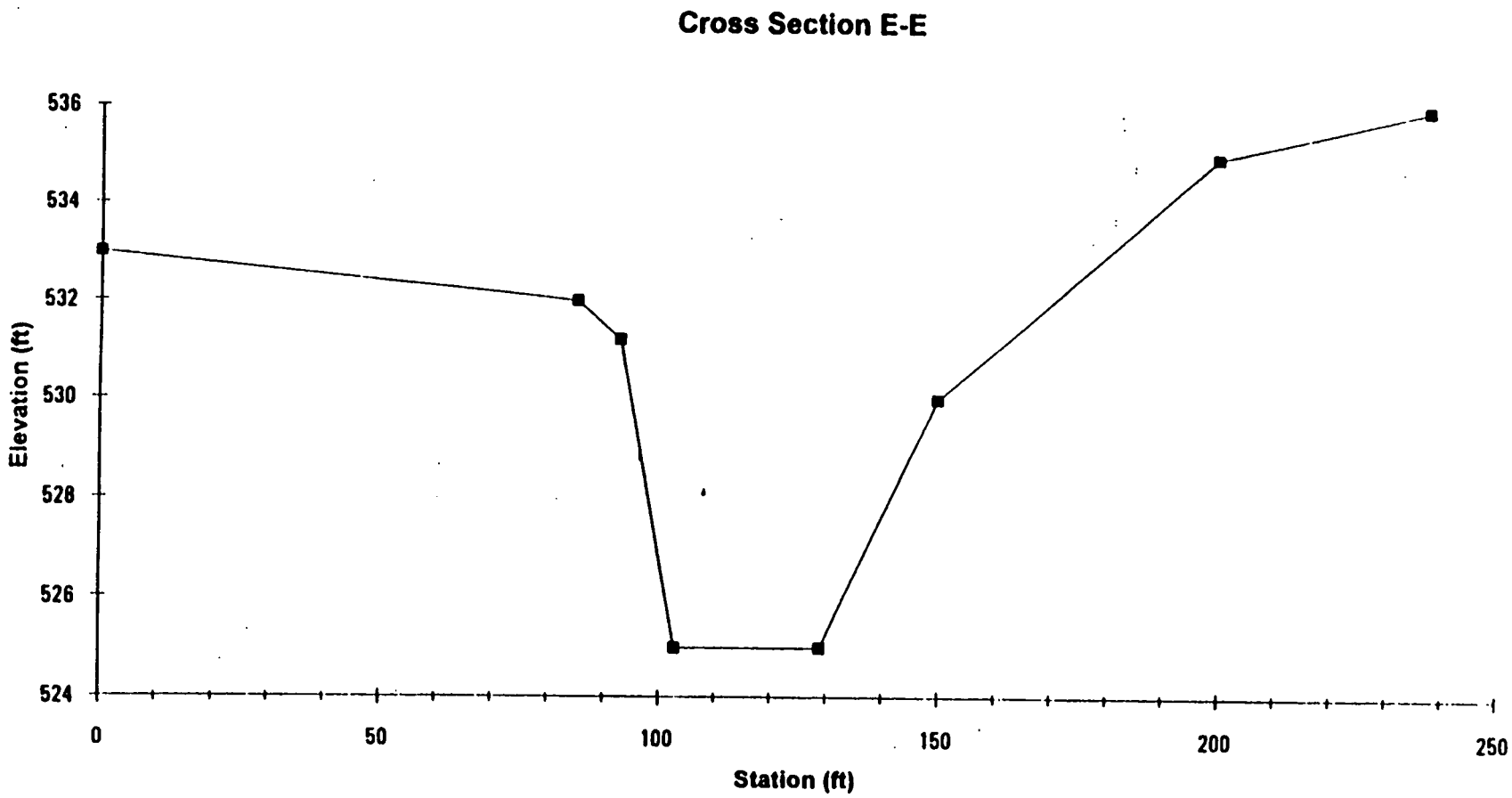

Figure 4 Cross Section E-E

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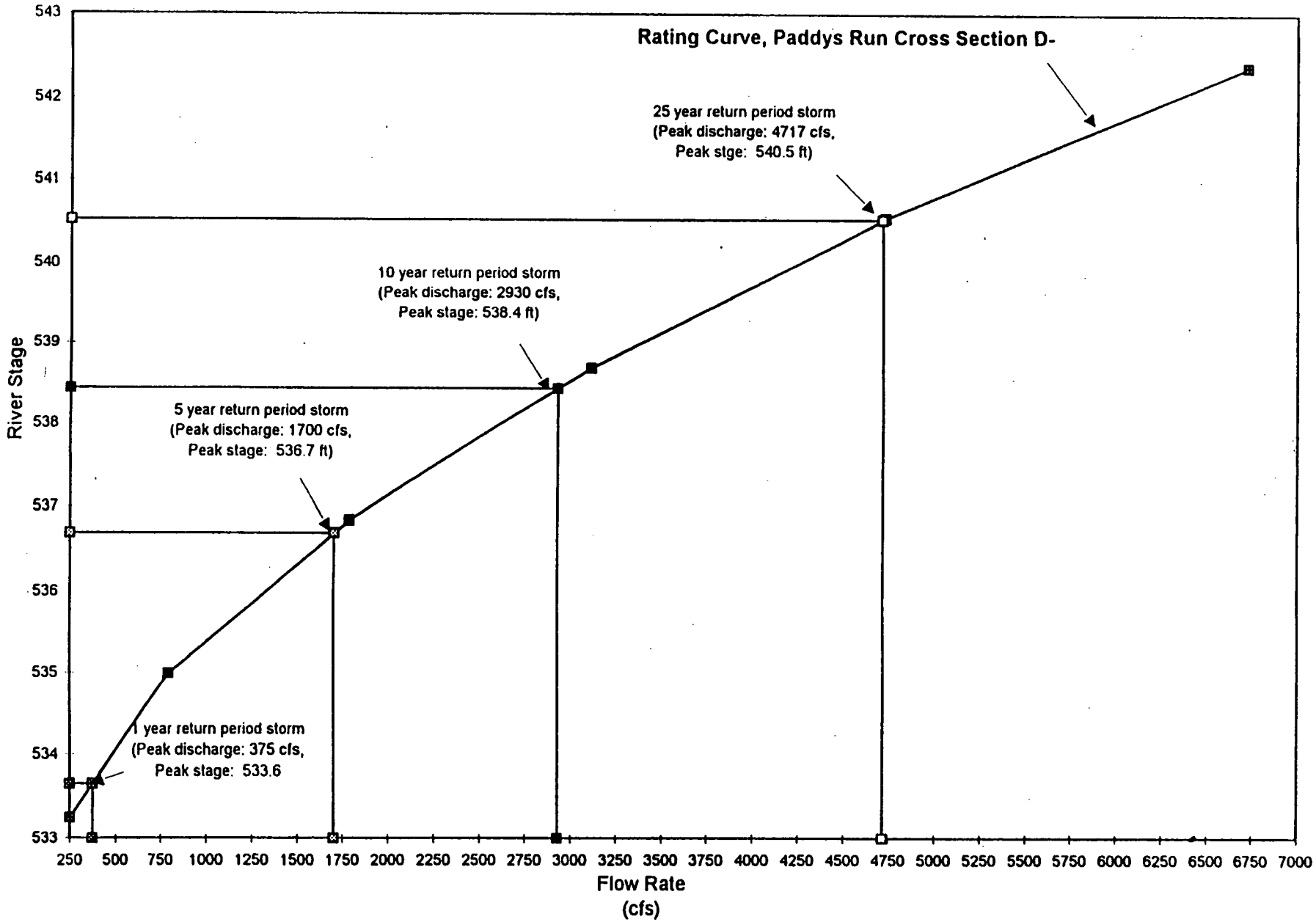

Figure 5 Rating Curve, Peak Discharge and Stage at Cross Section D-D

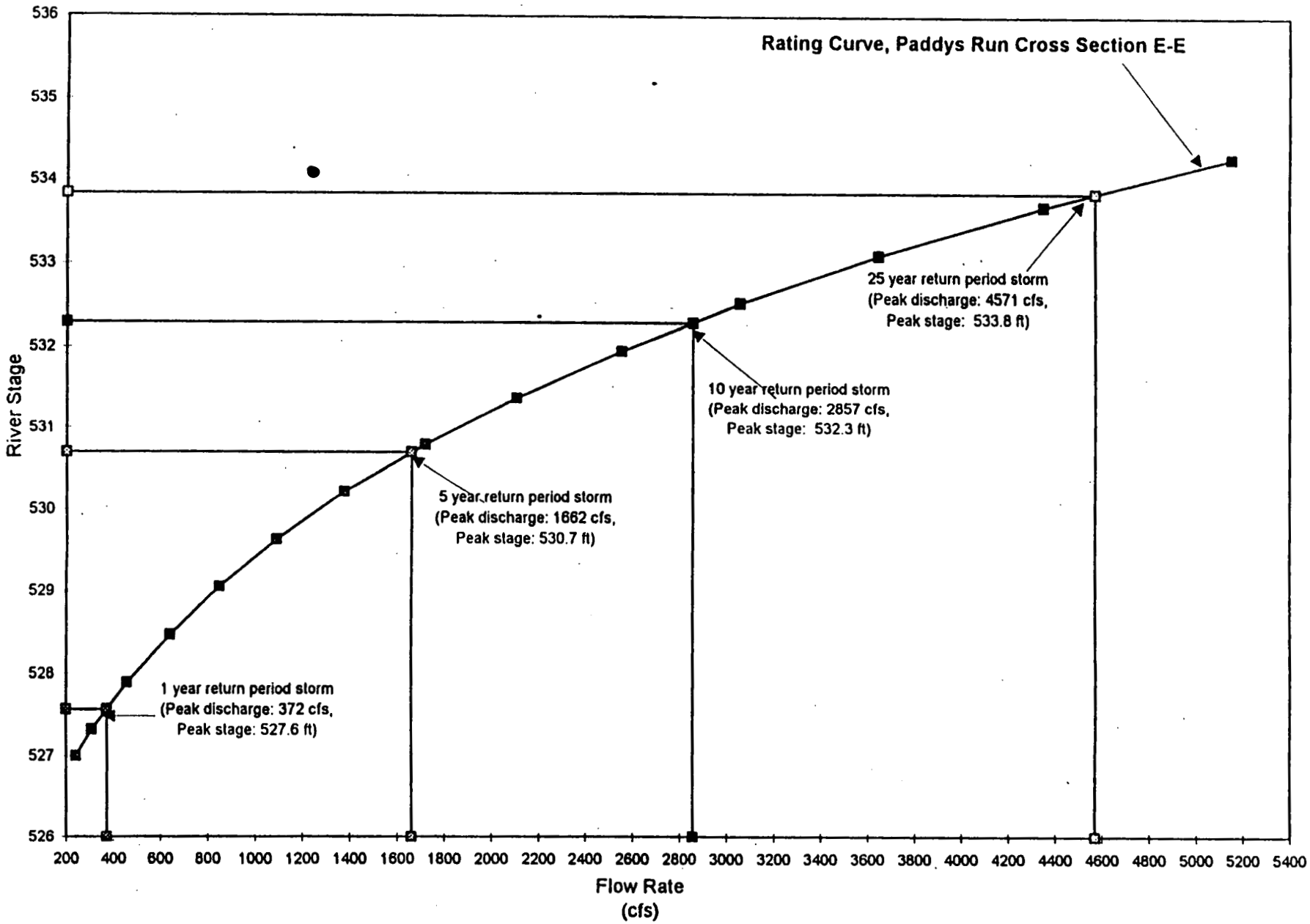

Figure 6 Rating Curve, Peak Discharge and Stage at Cross Section E-E

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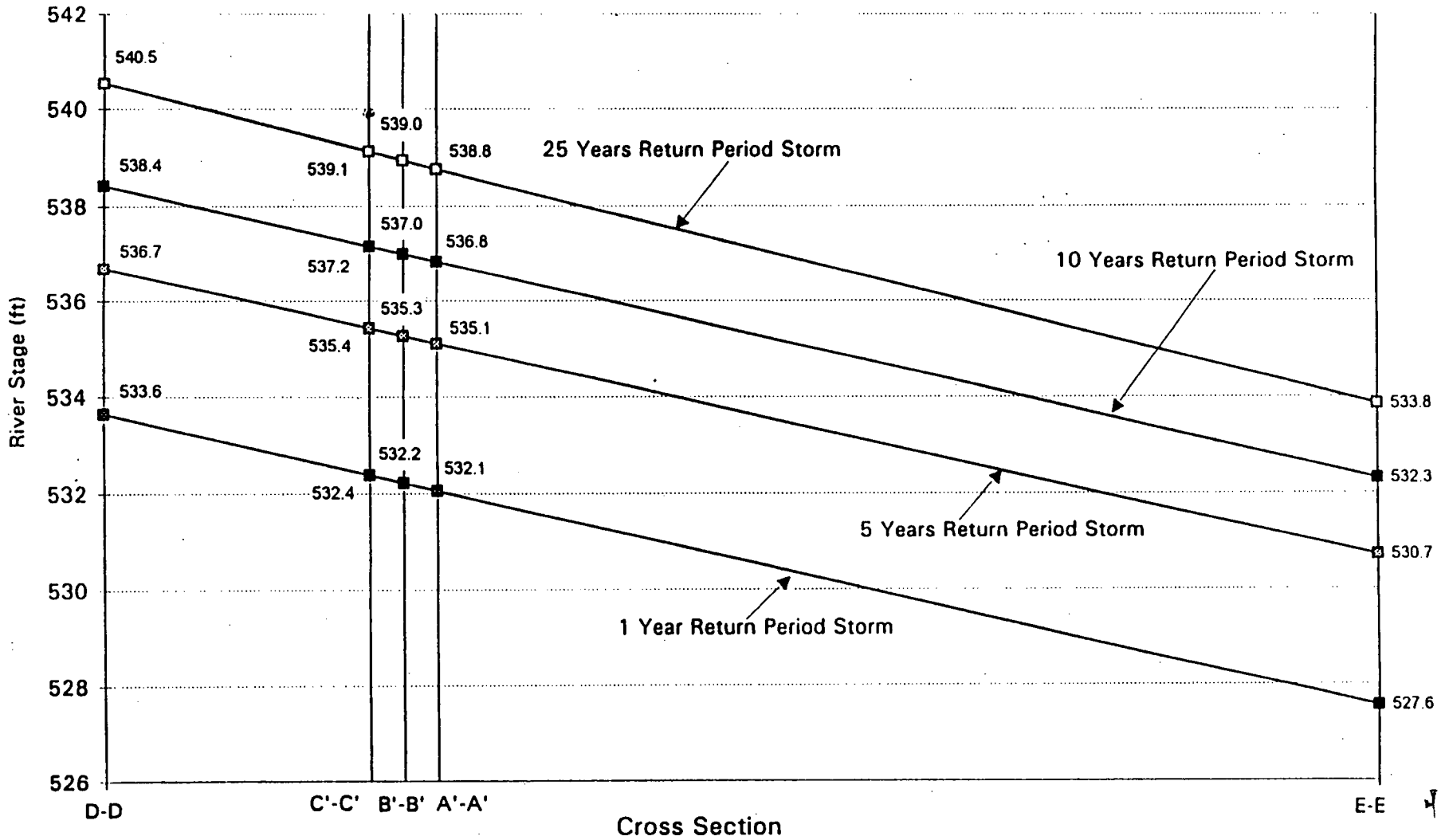

Figure 7 Interpolated Peak Stages at Cross Section A'-A', B'-B' and C'-C'

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Fig. 2

Table 1 Depth-Duration Data for 24-Hour Storm*

Duration	Depth (in)			
	1-Year Return Period Storm	5-Years Return Period Storm	10-Years Return Period Storm	25-Years Return Period Storm
5 minutes	0.330	0.500	0.540	0.625
15 minutes	0.625	1.000	1.125	1.250
60 minutes	1.100	1.500	1.900	2.220
2 hours	1.400	1.900	2.200	2.700
3 hours	1.480	2.100	2.400	3.000
6 hours	1.800	2.400	2.900	3.500
12 hours	2.100	3.000	3.360	4.100
24 hours	2.500	3.600	4.100	4.800

* Hershfield, D.M., 1961, Rainfall Frequency Atlas of the United States. Technical Paper No.40. Department of Commerce, Washington, D.C.

Table 2

COMPARISON OF MODELED AND MEASURED INCREASE OF PADDYS RUN FLOW DEPTHS

Date of Storm Event	Precipitation Amount IN.[a]	Cross Section C-C		Cross Section E-E	
		Measured Rise in Stream Depth (Stilling Well 9)[b] FT.	Modeled Rise in Stream Depth (STA70)[c] FT.	Measured Rise in Stream Depth (Stilling Well 14)[b] FT.	Modeled Rise in Stream Depth (STAEE)[c] FT.
April 3-4, 1989	1.92	4.06	3.99	5.51	5.35
April 28-29,1989	1.96	2.39	3.13	4.98	4.17

(a) Precipitation amounts from raingauge at the FEMP, except portion of April 28-29 storm which is supplemented with data from the Greater Cincinnati Airport due to missing data from the FEMP raingauge.

(b) Stream depth rise taken from data presented in Groundwater Report, Feed Materials Production Center, U.S. DOE December, 1990.

(c) Stream depth calculated from Paddys Run flow rate predicted with HEC-1 and Mannings equation.

Table 3 Peak River Stages at Cross Section A'-A', B'-B' and C'-C'

24-Hour Storm	River Stage (ft) at Cross Sections		
	A'-A'	B'-B'	C'-C'
1 Year Return Period	532.1	532.2	532.4
5 Years Return Period	535.1	535.3	535.4
10 Years Return Period	536.8	537.0	537.2
25 Years Return Period	538.8	539.0	539.1

Appendix A

HEC-1 INPUT DATA

SUBBASIN CHARACTERISTICS (OVERLAND FLOW PLANE DATA)

Subbasin	Overland Flow Length[a] (FT)	Overland Flow Slope[a] (ft/ft)	Resistance Factor[b] N	% Subbasin Area[a]	Drain Area[a] (Sq. mile)	SCS Curve Number[c]
10	150	0.07	0.4	100	1.869	65.4
20	200	0.075	0.4	100	1.589	63.7
30	200	0.08	0.4	100	5.188	63
50	200	0.04	0.4	100	1.288	66
60	200	0.08	0.4	100	0.599	59.8
70	150	0.013	0.4	75	0.313	61
	200	0.013	0.15	25		88.8
75	150	0.013	0.4	75	0.408	61
	200	0.013	0.15	25		88
PDAR	150	0.01	0.15	100	0.294	86.2
580	100	0.01	0.25	100	0.036	71.9
581	200	0.025	0.25	100	0.456	69.4
582	200	0.025	0.30	100	0.487	66.5
100	180	0.1	0.4	30	0.51	62.1
110	200	0.2	0.4	50	0.832	61.9
120	150	0.03	0.3	50		69
	100	0.28	0.4	100	0.561	69.4
130	200	0.033	0.4	100	1.385	68.2

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HEC-1 INPUT DATA

SUBBASIN CHARACTERISTICS (OVERLAND FLOW PLANE DATA)

SUBBASINS DIVIDED FOR CONTAMINATED CALCULATIONS

Subbasin	Overland Flow Length[d] (FT)	Overland Flow Slope[e] (ft/ft)	Resistance Factor[e] N	% Subbasin Area[a]	Drain Area[a] (Sq. mile)	SCS Curve Number[f]
60	200	0.08	0.4	100	0.282	59.9
560	200	0.10	0.4	100	0.317 0.599	62.9
70	200	0.01	0.4	100	0.121	62.4
570	200	0.017	0.25	100	0.120	76.7
WPA	200	0.024	0.15	100	0.072 0.313	76.8
75	150	0.15	0.40	100	0.288	67.6
575	200	0.013	0.15	25	0.120 0.408	69.8

[a]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437.5/7.5, 1981, DMA 4062 ISW-Series V852.

[b]Table 3.5, HEC-1 User's Manual.

[c]See Table 3-4 for SCS curve number calculation procedure.

[d]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437.5/7.5, 1981, DMA 4062 ISW-Series V852.

[e]Table 3.5, HEC-1 User's Manual.

[f]See Table 3-4 for SCS curve number calculation procedure.

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Appendix B

HEC-INPUT DATA

CHANNEL CHARACTERISTICS

Element	Length[a] (ft)	Slope[a]	Manning[b] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
Sub 10								
Subcollector Channel	500	0.07	0.045	0.08	TRAP	0	1	
Collector channel	3200	0.05	0.045	0.47	TRAP	0	1	
Main channel	5200	0.015	0.045		TRAP	0	1	No
Sub 20								
Collector channel	4500	0.065	0.045	0.132	TRAP		1	
Main channel	4800	0.015	0.045		TRAP	0	1	Yes
Sub 30								
Subcollector channel	3600	0.05	0.045	0.18	TRAP	0	1	
Collector channel	6000	0.007	0.045	1.297	TRAP	0	1	
Main channel	10800	0.003	0.045		TRAP	20	1	Yes
Sub 50								
Collector channel	5000	0.02	0.045	0.322	TRAP	0	1	
Main channel	2800	0.002	0.035		Irregular	–	1	Yes
Rout 60								
Main channel	1600	0.004	0.035		Irregular		1	Yes
Sub 60								
Collector channel	4500	0.04	0.02	0.15	TRAP	5	1	
Main channel	1600	0.004	0.035		Irregular		1	No
Rout 0								
Main channel	2986	0.004	0.025		Irregular			Yes
Sub 70								
Main channel	4000	0.013	0.045		TRAP	5	1	No

000578

HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Element	Length[a] (ft)	Slope[a]	Manning[b] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
Rout 1								
Main channel	3093	0.003	0.025		Irregular			Yes
Sub 75								
Main channel	4000	0.013	0.045		TRAP	5	1	No
Rout 2								
Main channel	2773	0.002	0.025		Irregular			Yes
PDAR								
Main channel	2600	0.005	0.015	–	CIRC	2	–	No
580								
Collector channel	500	0.100	0.04	0.020	TRAP	0	1	No
Main channel	600	0.010	0.035	–	TRAP	5	1	No
581								
Collector channel	1000	0.020	0.04	0.080	TRAP	0	1	No
Main channel	3300	0.012	0.030	–	TRAP	5	1	No
Rout 80								
Main channel	1300	0.009	0.035	–	Irregular	–	–	Yes

000579

HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Element	Length[a] (ft)	Slope[a]	Manning[b] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
582								
Colector channel	3600	0.022	0.045	0.033	TRAP	5	1	No
Main channel	3600	0.015	0.025	–	TRAP	26	2.27	No
Rout 25								
Main channel	2613	0.002	0.025		TRAP	52.8	4.55	Yes
Sub 100								
Collector channel	4000	0.01	0.045	0.412	TRAP	5	1	
Main channel	2773	0.0003	0.025		TRAP	27.2	26.32	Yes
Rout 3								
Main channel	3626	0.0025	0.025		TRAP	63.6	7.3	Yes
Sub 110								
Collector channel	500	0.04	0.045	0.21	TRAP	0	1	
Main channel	10,000	0.009	0.025		TRAP	20	3.33	No
Sub 120								
Collector channel	500	0.2	0.045	0.15	TRAP	0	1	
Main channel	8000	0.021	0.045		TRAP	20	3.33	No
Sub 130								
Collector channel	5000	0.016	0.045	0.588	TRAP	5	1	
Main channel	1800	0.02	0.025		TRAP	52.8	4.55	No

HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Element	Length[c] (ft)	Slope[b]	Manning[d] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
Sub 60								
Main Channel	4500	0.04	0.03	–	TRAP	0	1	No
Sub 560								
Main channel	4600	0.01	0.04	–	TRAP	0	1	No
Sub 70								
Main channel	4600	0.013	0.045	–	TRAP	0	1	No
Sub 570								
Main channel	1800	0.017	0.030	–	TRAP	0	1	No
WPA								
Main channel	1800	0.024	0.030	–	TRAP	0	1	No
Sub 75								
Main channel	4000	0.013	0.045	–	TRAP	5	1	No
Sub 575								
Main channel	650	0.067	0.045	–	TRAP	5	1	No

000181

[a]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437 5/7 5, 1981, DMA 4082 ISW-Series V852.

[b]Table 4.2, Henderson F.M., 1966, Open Channel Flow, MacMillan Publishing Co., Inc.

[c]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437 5/7.5, 1981, DMA 4082 ISW-Series V852.

[d]Table 4.2, Henderson F.M., 1966, Open Channel Flow, MacMillan Publishing Co., Inc.

000582

Appendix C

SCS CURVE NUMBER WEIGHTING

Subbasin	Land Cover[a]	Hydraulic Condition	Hydrologic Soil Group[b]	Weighted SCS Number[c]	Average SCS Number
10	Woods 30%	Good	0.5C + 0.5B	0.5 x 71 + 0.5 x 55	
	Meadow 60%	Good	0.4C + 0.6B	0.4 x 71 + 0.6 x 58	65.4
	Hard surface 10%	–	0.5 C + 0.5B	0.5 x 84 + 0.5 x 90	
20	Woods 15%	Good	0.7C + 0.3B	0.7 x 70 + 0.3 x 55	
	Meadow 80%	Good	0.3C + 0.7B	0.3 x 71 + 0.7 x 58	63.7
	Hard surface 5%	–	0.5C + 0.5B	0.5 x 84 + 0.5 x 90	
30	Woods 10%	Fair	0.4C + 0.6B	0.4 x 73 + 0.6 x 60	
	Meadow 85%	Good	0.25C + 0.75B	0.25 x 71 + 0.75 x 58	63
	Hard surface 5%	–	0.5C + 0.5B	0.5 x 84 + 0.5 x 90	
50	Woods 20%	Fair	0.4C + 0.6B	0.4 x 73 + 0.6 x 60	
	Meadow 70%	Good	0.4C + 0.6B	0.4 x 71 + 0.6 x 58	66
	Hard Surface 10%	–	0.4C + 0.6B	0.4 x 84 + 0.6 x 90	
60	Woods 35%	Good	0.1C + 0.9B	0.1 x 70 + 0.9 x 55	
	Meadow 60%	Good	0.1C + 0.9B	0.1 x 71 + 0.9 x 58	59.8
	Hard surface 5%	–	0.1C + 0.9B	0.1 x 84 + 0.9 x 90	
70	Woods 10%	Fair	0.2C + 0.8B	0.2 x 73 + 0.8 x 60	61
	Meadow 65%	Good	0.2C + 0.8B	0.2 x 71 + 0.8 x 58	
	Hard surface 25%	–	0.2C + 0.8B	0.2 x 84 + 0.8 x 90	88.8
75	Woods 10%	Fair	0.2C + 0.8B	0.2 x 73 + 0.8 x 60	61
	Meadow 65%	Good	0.2C + 0.8B	0.2 x 71 + 0.8 x 58	
	Hard surface 25%	–	0.2C + 0.8B	0.2 x 84 + 0.8 x 90	88.8
80	Woods 10%	Fair	0.5C + 0.5B	0.5 x 73 + 0.5 x 60	65
	Meadow 65%	Good	0.5C + 0.5B	0.5 x 71 + 0.5 x 58	
	Hard surface 25%	–	0.5C + 0.5B	0.5 x 84 + 0.5 x 90	87

SCS CURVE NUMBER WEIGHTING

Subbasin	Land Cover[a]	Hydraulic Condition	Hydrologic Soil Group[b]	Weighted SCS Number[c]	Average SCS Number
580	Woods 45%	Good	0.0B + 1.0C	0.0 x 55 + 1.0 x 71	
	Meadow 50%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	71.95
	Hard Surface 5%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
PDAR	Woods 0%	Good	0.0B + 1.0C	0.0 x 55 + 1.0 x 71	
	Meadow 20%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	86.20
	Hard Surface 80%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
581	Woods 0%	Good	0.5B + 0.5C	0.5 x 55 + 0.5 x 71	
	Meadow 85%	Good	0.4B + 0.6C	0.4 x 58 + 0.6 x 71	69.43
	Hard Surface 15%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
582	Woods 15%	Good	0.5B + 0.5C	0.5 x 55 + 0.5 x 71	
	Meadow 75%	Good	0.5B + 0.5C	0.5 x 58 + 0.5 x 71	66.53
	Hard Surface 10%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
100	Woods 5%	Fair	0.2C + 0.8B	0.2 x 73 + 0.8 x 60	
	Meadow 90%	Good	0.2C + 0.8B	0.2 x 71 + 0.8 x 58	62.1
	Hard surface 5%	--	0.2C + 0.8B	0.2 x 84 + 0.8 x 90	
110	Woods 15%	Fair	0.1C + 0.9B	0.1 x 73 + 0.9 x 60	
	Meadow 75%	Good	0.1C + 0.9B	0.1 x 71 + 0.9 x 58	61.9
	Hard surface 10%	--	0.1C + 0.9B	0.1 x 84 + 0.9 x 90	
120	Woods 85%	Good	0.9C + 0.1B	0.9 x 70 + 0.1 x 55	
	Meadow 10%	Good	0.9C + 0.1B	0.9 x 71 + 0.1 x 58	69.4
	Hard surface 5%	--	0.9C + 0.1B	0.9 x 84 + 0.1 x 90	
130	Woods 10%	Fair	0.7C + 0.3B	0.7 x 73 + 0.3 x 60	
	Meadow 85%	Good	0.7C + 0.3B	0.7 x 71 + 0.3 x 58	68.2
	Hard surface 5%	--	0.7C + 0.3B	0.7 x 84 + 0.3 x 90	

000585

SCS CURVE NUMBER WEIGHTING

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Subbasin	Land Cover[a]	Hydraulic Condition	Hydrologic Soil Group[b]	Weighted SCS Number[c]	Average SCS Number
60	Woods 30%	Good	0.9B + 0.1C	0.9 x 55 + 0.1 x 71	
	Meadow 65%	Good	0.9B + 0.1C	0.9 x 58 + 0.1 x 71	59.88
	Hard surface 5%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
560	Woods 25%	Good	0.7B + 0.3C	0.7 x 55 + 0.3 x 71	
	Meadow 70%	Good	0.7B + 0.3C	0.3 x 58 + 0.3 x 71	62.63
	Hard surface 5%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
70	Woods 20%	Good	0.2B + 0.8C	0.2 x 55 + 0.8 x 71	
	Meadow 75%	Good	0.9B + 0.1C	0.9 x 58 + 0.1 x 71	62.39
	Hard surface 5%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
WPA	Woods 5%	Good	1.0B + 0.0C	1.0 x 55 + 0.0 x 71	
	Meadow 60%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	76.85
	Hard Surface 35%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
570	Woods 5%	Good	0.0B + 1.0C	0.0 x 55 + 1.0 x 71	
	Meadow 65%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	76.70
	Hard surface 30%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
75	Woods 25%	Good	0.4B + 0.6C	0.4 x 55 + 0.6 x 71	
	Meadow 65%	Good	0.4B + 0.6C	0.4 x 58 + 0.6 x 71	
	Hard surface 10%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	67.62
575	Woods 50%	Good	0.3B + 0.7C	0.3 x 55 + 0.7 x 71	
	Meadow 35%	Good	0.3B + 0.7C	0.3 x 58 + 0.7 x 71	
	Hard surface 15%	--	0.3B + 0.7C	0.3 x 84 + 0.7 x 90	69.82

[a]Estimated from USGS Topographic Map, Shandon, Ohio, N3915-W8437. 5/7.5, 1981, DMA 4062 I SW-Series V852.

[b]0.4C and 0.6B means 40% is hydrologic soil group C and 60% is hydrologic soil group B. Percentages of each group were determined from soil survey maps: Soil Survey of Butler Co., Ohio, USDA 1980; Soil Survey of Hamilton Co., Ohio, USDA, 1982.

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SCS CURVE NUMBER WEIGHTING

[c]SCS curve number obtained from G. O. Schwab, R. K. Frevert, T. W. Edminster, and K. K. Barnes, 1981, ***Soil and Water Conservation Engineering***, John Wiley and Sons, Inc., pp. 74.

[d]Estimated from USGS Topographic Map, Shandon, Ohio, N3915-W8437. 5/7.5, 1981, DMA 4062 I SW-Series V852.

[e]0.4C and 0.6B means 40% is hydrologic soil group C and 60% is hydrologic soil group B. Percentages of each group were determined from soil survey maps: Soil Survey of Butler Co., Ohio, USDA 1980; Soil Survey of Hamilton Co., Ohio, USDA, 1982.

[f]SCS curve number obtained from G. O. Schwab, R. K. Frevert, T. W. Edminster, and K. K. Barnes, 1981, ***Soil and Water Conservation Engineering***, John Wiley and Sons, Inc., pp. 74.

Appendix D

sufficiently homogenous to only require one SCS curve number per subbasin.

For every subbasin, the last column in Table 3-2 labeled "Average SCS Number" represents a weighted average of the SCS curve numbers for each land use type. That is, a weighted curve number was calculated for each land use type (woods, meadow, or hard surface) based on the hydrologic soil group. This calculation is presented in the next to last column (labeled " Weighted SCS Number") of Table 3-2. The overall curve number for the subbasin was then calculated by averaging the curve numbers for each land use type weighted by the percent of the subbasin covered by each land use as indicated in the second column (labeled "Land Cover"). The results of this second weighted average (the overall curve numbers input into the HEC-1 model) are then presented in the last column of Table 3-2.

Action: The revised Surface Water Flow and Infiltration Model Summary Report submitted will contain additional text to clarify the contents of Table 3-2.

2. <u>Section 3.4.5. Page 3-39, Paragraph 4</u>

Comment: The report concludes that the model compares favorably to measured increases in the river stage of Paddys Run and the elevation of the groundwater in response to an observed precipitation event. The report also presents a reasonable explanation for the error associated with the increase in the groundwater levels. While these statements are qualitatively correct, the quantitative comparison indicated a potential for significant error. For example, the modeled river stage of Paddys Run rose only one-half the height of what was observed. Assuming that U.S. DOE's explanation of why the modeled groundwater elevation rose only 1.65 feet is correct, the modeled rise in the river stage of Paddys Run should have been much greater than what was reported. U.S. DOE should explain why the river stage did not increase as much as it should have. In addition, U.S. DOE should collect more field data to further verify the model.

Response: This comment raises two issues with the performance of the surface water model. The first is concerned with the predicted amount of infiltration and the response of the groundwater table to the representative storm event. The second is the comparison of the predicted rise in water surface elevation and the measured rise in water surface elevation in Paddys Run. As was discussed in the response to the first general comment, the infiltration model is very conservative in its estimation of

the annual percent of contaminated runoff which infiltrates into the GMA, so that the distribution of the infiltration determined from the representative storm event is more important than the actual volume of infiltration from that storm event. The infiltration distribution is then applied to the annual infiltration and in turn the contaminant loading. In addition, the differences in the initial conditions of the modeled event and the measured event make a true quantitative comparison difficult although qualitatively the general aquifer response was similar.

It is difficult to quantitatively compare the output from the model for the representative storm to actual field data because of the differences in the initial conditions of the ground surface and the streambeds, the duration of the storm event and the variation of intensity of the rainfall with time (hyetograph), and differences in the shape of the stream cross sections where the stage measurements and calculations were made. The Surface Water Flow and Infiltration Model Summary Report qualitatively compares the results from the model of the representative storm event to a rainfall event occurring in April of 1989 (note the report incorrectly indicates that the date of the rainfall event; it should have been reported as April 28-29). The curve numbers used for the HEC-1 model of the representative storm event are based on an Antecedent Moisture Condition-II (AMC-II) which represents an average moisture content in the surface soils prior to the storm rainfall event. AMC-I condition represents a dryer than average initial soil condition and AMC-III represents a wetter than average soil condition. The AMC-II curve numbers are primarily used for design (SCS, Technical Release 55, June 1986). The SCS curve numbers presented for use in the Superfund Exposure Assessment Manual (EPA, 1988) do not specifically indicate what AMC they are for, but they do match the curve numbers given for the same land use and soil type for AMC-II conditions in the SCS's Technical Release 55 (SCS 1986). Since AMC-II is most commonly used in design and because of the curve number presented in the Superfund Exposure Assessment Manual, AMC-II Curve numbers were also used in the HEC-1 model of the representative storm event. In order to better evaluate the performance of the runoff model, actual rainfall data from the FEMP from two storm events (the April 28-29 event and another one on April 3-4 1989) and SCS curve numbers that represent actual soil conditions during an abnormally wet season were input into the HEC-1 model. The input and results for these modeled conditions are discussed below.

The rainfall in the spring of 1989 was above average (DOE, 1993 Groundwater Modeling Report Summary of Model Development) indicating that the ground surface could have been saturated prior

to the storm event which would cause a larger amount of runoff (and deeper depth in Paddys Run) than if the ground surface is unsaturated. If the ground surface is saturated prior to the storm event, a greater percentage of the rainfall will become runoff (than if the ground is unsaturated) since the ground surface does not have unsaturated pore spaces available to capture the rainfall. Storm water runoff is the only major source of flow in Paddys Run since flow from groundwater would only represent a small portion of the total flow during a fairly large storm event. The total amount of precipitation as measured at the Greater Cincinnati Airport by the National Weather Service (NWS) was 5.19 inches during April 1989. The average monthly rainfall of April for the years 1958 through 1992 also at the Greater Cincinnati Airport is 3.53 inches. The rain gauge information at the FEMP reported 6.09 inches of rainfall in the month of April 1989 before it stopped recording during the rainfall event on April 28. If the site rainfall data is supplemented with rainfall data from the Greater Cincinnati Airport to replace the missing data, a total of 7.48 inches of rain would have fallen on the FEMP in April 1989.

Storm events occurring on April 3-4 and 28-29, 1989 were simulated with the surface water model. Hourly precipitation data from the FEMP supplemented with data from the Greater Cincinnati Airport was input into the HEC-1 model with the curve number modified to represent an AMC-III initial moisture condition. The FEMP precipitation data was supplemented with data from the Greater Cincinnati Airport to replace several missing data points from the FEMP rain gauge. This data was used because it was the best information available for the missing data points in question. The SCS National Engineering Handbook, Section 4, Hydrology (NEH-4 [SCS 1985]) recommends that if more than 1.1 inches of precipitation falls during the five days before the storm event being modeled that a AMC-III should be used. Approximately, 1.3 inches of rain fell in the five days prior to the storm event on April 28-29, 1989. Since this was in the range for AMC-III recommended in NEH-4 an AMC-III was used to simulate this storm. An AMC-III was also used for the simulation of the April 3-4 storm since this storm occurred four days after a storm event on March 31, 1989 which caused the Storm Water Retention Basin to overflow. The site precipitation data was not readily available for the March 31 storm, but it is valid to assume that such a event would create AMC-III soil conditions for the April 3-4 event.

A comparison of the modeled and measured rise in flow depth of Paddys run is presented in the attached Table 1. The measured rise in water surface elevation was measured at two location along

Paddys Run in April of 1989; stilling well 9 (near cross section location C-C) and stilling well 14 (near cross section location E-E). The measured and modeled rises in stream elevation for the April 3-4 storm were within three percent of each other at both measuring locations on Paddys Run. The modeled rise in stream depth for the April 28-29 storm did not match as well although the differences between the modeled and the measured elevation rises are less than 10 inches. The second storm event may not match as well because the site rainfall data for this event had to be supplemented with rainfall data from the Greater Cincinnati Airport approximately 17 miles to the south. Based on the simulated actual storm events, it is determined that the surface water model is predicting the water surface elevations with acceptable accuracy so that additional field data is not required to verify the model.

Changing parameters in the HEC-1 model of the representative storm event to match the changes in the simulation of actual storm events discussed above (curve numbers based on AMC-III) is not necessary for the following reasons. An average Antecedent Moisture Condition (AMC-II) is usually used for designs and match values given in U.S. EPA documents. As was discussed in the response to the general comment, the representative storm event runoff is used to estimate the annual runoff. Using an AMC-II (average moisture condition) for the representative storm event would provide more realistic results to base the annual calculations on. An AMC-III initial moisture content will tend to increase the overall discharge from the basin, however, the amount of contaminant released in the dissolved phase is directly proportional to the amount of runoff from a subbasin so that the concentration should not change. The predicted mass of contaminant loaded to the GMA could increase for the simulated representative storm event. The single representative storm event will not have a significant effect on the annual loading to the GMA since the representative storm event only accounts for 6% of the annual runoff. The annual runoff is based on average moisture conditions since it is used to represent all of the different storms that occur during the year. In addition, the surface water model already is conservatively overestimating the annual loadings to the GMA. Modeled simulations performed for the Draft Remedial Investigation Report for Operable Unit 5 submitted for internal review at the U.S. Department of Energy (U.S. DOE) illustrated the conservativeness of the predicted loadings to the GMA. The surface water model was set up to predict the total amount of uranium-238 released to the GMA through the streambeds of Paddys Run and the SSOD. The predicted amount ranged from 6200 kg to 12300 kg. Out of the total estimated mass of 4800 kg of uranium within the plume of significant concentration in the GMA, 1860 kgs are

000792

located along the SSOD and Paddys Run south of the SSOD in the GMA. The 1860 kg of uranium is believed to originate primarily from the surface water loading.

Action: Actual storm rainfall was put into the HEC-1 model to compare the modeled rise in stream depth to the measured rise in stream depth. As was discussed in the Response to this comment, the model compared well with the measured data so that the collection of additional field data is not necessary. The comparison between the model output and measured data will be included in the revised Surface Water Flow and Infiltration Model Summary Report.

3. <u>Section 3.4.5, Page 3-41, Paragraph 1.</u>

Comment: U.S. DOE attempted to validate the model by conducting two types of volume calculations. The results of the two methods differed significantly but U.S. DOE stated that because the results of the two methods are within one order of magnitude, the results are therefore reasonable. An order of magnitude estimation of surface water infiltration does not appear to be accurate. Because the amount of water infiltrating into the GMA will affect the mass of contaminants entering the GMA and ultimately the concentration of contaminants in the GMA, U.S. DOE should provide additional documentation on the accuracy of its infiltration estimate.

Response: The response to the general comment discusses the relative importance of the predicted infiltration volume resulting from the representative storm event. Because of the conservative assumptions used in the method of predicting the contaminant loading (96 percent of the annual dissolved contaminant released is predicted to reach the GMA) the distribution of the infiltration amount along Paddys Run and the SSOD is more important than the actual infiltration volume.

The Surface Water Flow and Infiltration Model (SWF&IM) Summary Report in actuality only attempted to estimate the volume of infiltration with the VS2DT model. The other method discussed in the report (described as the verification infiltration volume calculation in the SWF&IM report) which simply involved the calculation of the unsaturated pore space beneath the streambed was only intended to be used as a general reference to check the range of the infiltration volume predicted with VS2DT. It was understood that the calculation of the unsaturated pore space beneath the streambed would yield results that are lower than actual infiltration volumes because it did not account for lateral movement of water in the unsaturated zone away from the streambed and it did not account for

TABLE 1

COMPARISON OF MODELED AND MEASURED
INCREASE OF PADDYS RUN
FLOW DEPTHS

Date of Storm Event	Precipitation Amount IN.[a]	Cross Section C-C		Cross Section E-E	
		Measured Rise in Stream Depth (Stilling Well 9)[b] FT.	Modeled Rise in Stream Depth (STA70)[c] FT.	Measured Rise in Stream Depth (Stilling Well 14)[b] FT.	Modeled Rise in Stream Depth (STAEE)[c] FT.
April 3-4, 1989	1.92	4.06	3.99	5.51	5.35
April 28-29,1989	1.96	2.39	3.13	4.98	4.17

(a) Precipitation amounts from raingauge at the FEMP, except portion of April 28-29 storm which is supplemented with data from the Greater Cincinnati Airport due to missing data from the FEMP raingauge.

(b) Stream depth rise taken from data presented in Groundwater Report, Feed Materials Production Center, U.S. DOE December, 1990.

(c) Stream depth calculated from Paddys Run flow rate predicted with HEC-1 and Mannings equation.

Appendix E

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ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          1-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.333   0.625   1.100   1.400   1.480   1.800     2.1     2.5
LS           65.4
UK  150.     0.07     0.4     100
RK   500     0.07   0.045    0.06    TRAP       0       1
RK  3200     0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.    0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS           63.7
UK   200    0.075     0.4     100
RK  4500    0.065   0.045   0.132    TRAP       0       1
RK 4800.    0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS             63
UK   200     0.08     0.4     100
RK  3600     0.05   0.045    0.18    TRAP       0       1
RK  6000    0.007   0.045   1.297    TRAP       0       1
RK 10800    0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO             0                1      21
KF   YES(f12.4)
BA 1.288
LS             66
UK   200     0.04     0.4     100
RD  5000     0.02   0.045   0.322    TRAP       0       1
RD                                                           YES
RC 0.045    0.035   0.045    2800   0.002
RX   129      140   141.1   144.1   168.1     190   194.1   196.2
RY566.08   563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO             0                1      21
RD                                                           YES
RC 0.045    0.035   0.045  1599.8   0.004
RX    77       83      86    86.5   120.1     123     126   130.1
RY562.16   559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO             0                1      21
BA 0.282
LS           59.9
UK   200     0.08     0.4     100
RD  4500     0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS           62.6
UK   200     0.10     0.4     100
```

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RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT0
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0               1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0               1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 70CT,SUB70 AND UPSTREAM FLOW
KO     1       0               1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0               1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0               1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
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RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                 1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035            TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                 1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030            TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                 1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                 1      21
RD                                                            YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                 1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025            TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                 1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                 1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                 1      21
RD   2613   0.002   0.025            TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                 1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025            TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                 1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS           62.1                    62.11
UK   180      0.1      0.4      30
UK   250    0.018      0.3      70
RD  4000     0.01    0.045    0.412    TRAP       5       1
RD  2773   0.0003    0.025             TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD  3626   0.0025    0.025             TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS           61.9                      69
UK   200      0.2      0.4      50
UK   150     0.03      0.3      50
RD   500     0.04    0.045    0.21    TRAP       0       1
RD 10000    0.009    0.025             TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS           69.4
UK   100     0.28      0.4     100
RD   500      0.2    0.045    0.15    TRAP       0       1
RD  8000    0.021    0.045             TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
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ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          5-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.500   1.000   1.500   1.900   2.100   2.400     3.0     3.6
LS          65.4
UK  150.    0.07     0.4     100
RK   500    0.07   0.045    0.06    TRAP       0       1
RK  3200    0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.   0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS          63.7
UK   200   0.075     0.4     100
RK  4500   0.065   0.045   0.132    TRAP       0       1
RK 4800.   0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS            63
UK   200    0.08     0.4     100
RK  3600    0.05   0.045    0.18    TRAP       0       1
RK  6000   0.007   0.045   1.297    TRAP       0       1
RK 10800   0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO             0                1      21
KF   YES(f12.4)
BA 1.288
LS            66
UK   200    0.04     0.4     100
RD  5000    0.02   0.045   0.322    TRAP       0       1
RD                                                          YES
RC 0.045   0.035   0.045    2800   0.002
RX   129     140   141.1   144.1   168.1     190   194.1   196.2
RY566.08  563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO             0                1      21
RD                                                          YES
RC 0.045   0.035   0.045  1599.8   0.004
RX    77      83      86    86.5   120.1     123     126   130.1
RY562.16  559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO             0                1      21
BA 0.282
LS          59.9
UK   200    0.08     0.4     100
RD  4500    0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS          62.6
UK   200    0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUTO
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0               1      21
RD                                                             YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0               1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0               1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 70CT,SUB70 AND UPSTREAM FLOW
KO     1       0               1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0               1      21
RD                                                             YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0               1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0               1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0               1      21
RD                                                             YES
RC 0.045   0.025   0.045    2773   0.002
```

```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                 1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035            TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                 1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030            TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                 1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                 1      21
RD                                                          YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                 1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025            TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                 1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                 1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                 1      21
RD   2613   0.002   0.025            TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                 1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025            TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                 1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS          62.1                    62.11
UK   180     0.1     0.4      30
UK   250   0.018     0.3      70
RD  4000    0.01   0.045   0.412    TRAP       5       1
RD  2773  0.0003   0.025            TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD  3626  0.0025   0.025            TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS          61.9                      69
UK   200     0.2     0.4      50
UK   150    0.03     0.3      50
RD   500    0.04   0.045    0.21    TRAP       0       1
RD 10000   0.009   0.025            TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS          69.4
UK   100    0.28     0.4     100
RD   500     0.2   0.045    0.15    TRAP       0       1
RD  8000   0.021   0.045            TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
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ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          10-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.540   1.125   1.900   2.200   2.400   2.900    3.36     4.1
LS          65.4
UK  150.    0.07     0.4     100
RK   500    0.07   0.045    0.06    TRAP       0       1
RK  3200    0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.   0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS          63.7
UK   200   0.075     0.4     100
RK  4500   0.065   0.045   0.132    TRAP       0       1
RK 4800.   0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS            63
UK   200    0.08     0.4     100
RK  3600    0.05   0.045    0.18    TRAP       0       1
RK  6000   0.007   0.045   1.297    TRAP       0       1
RK 10800   0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO            0               1      21
KF   YES(f12.4)
BA 1.288
LS            66
UK   200    0.04     0.4     100
RD  5000    0.02   0.045   0.322    TRAP       0       1
RD                                                          YES
RC 0.045   0.035   0.045    2800   0.002
RX   129     140   141.1   144.1   168.1     190   194.1   196.2
RY566.08  563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO            0               1      21
RD                                                          YES
RC 0.045   0.035   0.045  1599.8   0.004
RX    77      83      86    86.5   120.1     123     126   130.1
RY562.16  559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO            0               1      21
BA 0.282
LS          59.9
UK   200    0.08     0.4     100
RD  4500    0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0               1      21
BA 0.317
LS          62.6
UK   200    0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0                1      21
HC     3.
*
KK ROUT0
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0                1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0                1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0                1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 7OCT,SUB70 AND UPSTREAM FLOW
KO     1       0                1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0                1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0                1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0                1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0                1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0                1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
```

```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035            TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030            TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                1      21
RD                                                              YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025            TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                1      21
RD   2613   0.002   0.025            TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025            TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS           62.1                    62.11
UK   180      0.1      0.4      30
UK   250    0.018      0.3      70
RD  4000     0.01    0.045    0.412    TRAP       5       1
RD  2773   0.0003    0.025             TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD  3626   0.0025    0.025             TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS           61.9                      69
UK   200      0.2      0.4      50
UK   150     0.03      0.3      50
RD   500     0.04    0.045    0.21    TRAP       0       1
RD 10000    0.009    0.025             TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS           69.4
UK   100     0.28      0.4     100
RD   500      0.2    0.045    0.15    TRAP       0       1
RD  8000    0.021    0.045             TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
```

```
ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          25-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.625   1.250   2.220   2.700   3.000   3.500    4.10     4.8
LS          65.4
UK  150.    0.07     0.4     100
RK   500    0.07   0.045    0.06    TRAP       0       1
RK  3200    0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.   0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS          63.7
UK   200   0.075     0.4     100
RK  4500   0.065   0.045   0.132    TRAP       0       1
RK 4800.   0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS            63
UK   200    0.08     0.4     100
RK  3600    0.05   0.045    0.18    TRAP       0       1
RK  6000   0.007   0.045   1.297    TRAP       0       1
RK 10800   0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO            0                1      21
KF   YES(f12.4)
BA 1.288
LS            66
UK   200    0.04     0.4     100
RD  5000    0.02   0.045   0.322    TRAP       0       1
RD                                                          YES
RC 0.045   0.035   0.045    2800   0.002
RX   129     140   141.1   144.1   168.1     190   194.1   196.2
RY566.08  563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO            0                1      21
RD                                                          YES
RC 0.045   0.035   0.045  1599.8   0.004
RX    77      83      86    86.5   120.1     123     126   130.1
RY562.16  559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO            0                1      21
BA 0.282
LS          59.9
UK   200    0.08     0.4     100
RD  4500    0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS          62.6
UK   200    0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUTO
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0               1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0               1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 70CT,SUB70 AND UPSTREAM FLOW
KO     1       0               1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0               1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0               1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
```

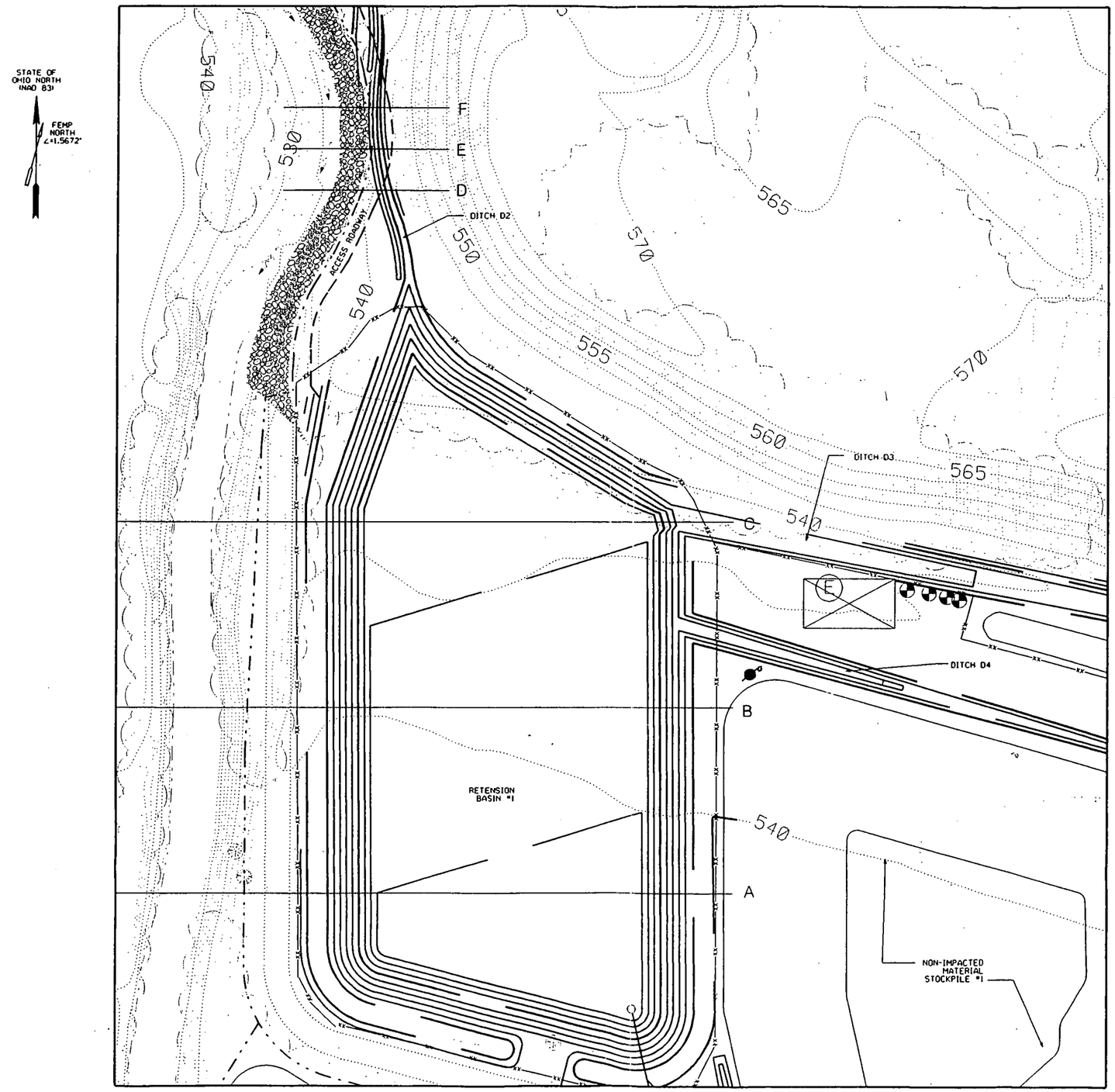
```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0               1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035           TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0               1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030           TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0               1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0               1      21
RD                                                            YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0               1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025           TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0               1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0               1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0               1      21
RD   2613   0.002   0.025           TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0               1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025           TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0               1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS           62.1                    62.11
UK    180     0.1     0.4      30
UK    250   0.018     0.3      70
RD   4000    0.01   0.045   0.412    TRAP       5       1
RD   2773  0.0003   0.025            TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD   3626  0.0025   0.025            TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS           61.9                      69
UK    200     0.2     0.4      50
UK    150    0.03     0.3      50
RD    500    0.04   0.045    0.21    TRAP       0       1
RD  10000   0.009   0.025            TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS           69.4
UK    100    0.28     0.4     100
RD    500     0.2   0.045    0.15    TRAP       0       1
RD   8000   0.021   0.045            TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
```

APPENDIX D

Additional Sketches of Paddys Run

skg04548.m po165@ws316. Wed Aug 27 12:30:52 CDT 1997



NOTES

1062

FOR INFORMATION ONLY

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERNCO	DATE
		INITIALS AND DATE		

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
WASTE UNITS REMEDIATION
SOUTHERN WASTE UNITS

DRAWING TITLE
SKETCH #1

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
PLANT/BLDG NO.		FLOOR		SCALE 1"=20'	CLASS
SUBMITTED FOR APPROVAL		FERNCO CRU APPROVAL			

A-E PROJECT NO.	FEMP PROJECT NO.	DRAWING INDEX CODE NO.	SHEET NO.	REV. NO.
PREPARED UNDER PARSONS PROJECT ORDER NUMBER	00-90701	SK-G-04548		A

000613

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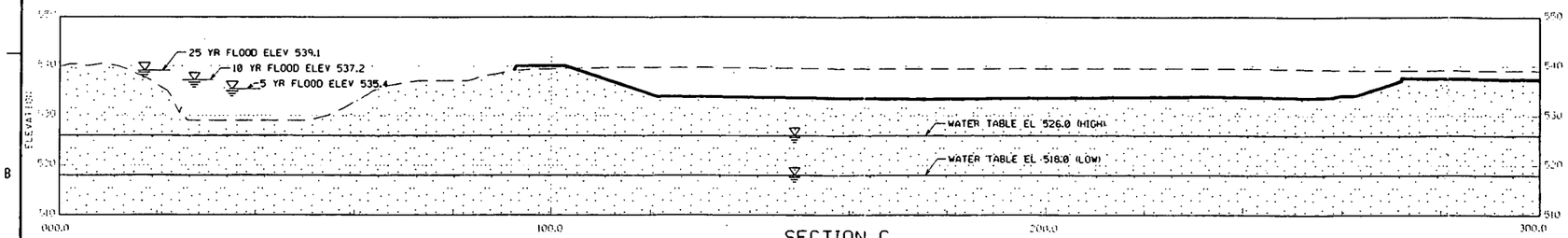
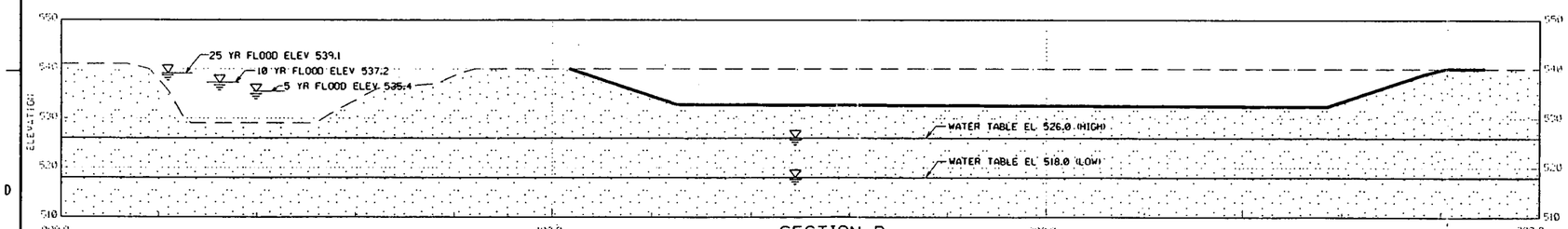


SECTION C
SCALE: HOR 1"=10'
VER 1"=10'



SECTION B
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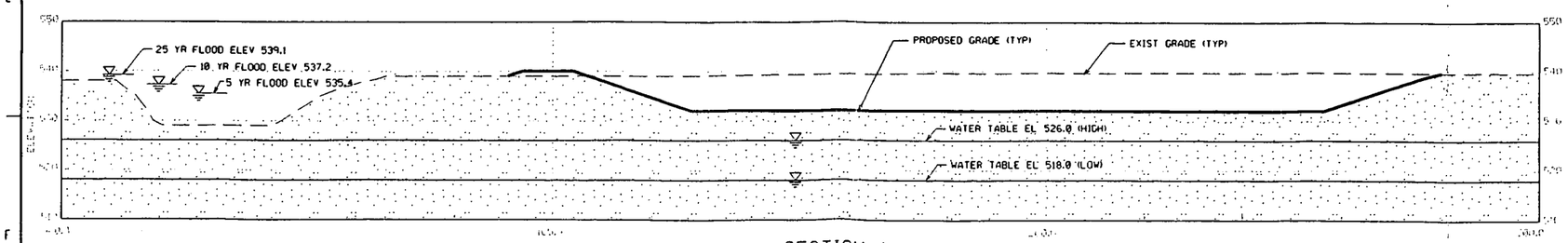
VER 1"=10'



SECTION A
SCALE: HOR 1"=10'
VER 1"=10'

GRAPHIC SCALE: 1"=10' VERTICAL

GRAPHIC SCALE: 1"=10' HORIZONTIAL

NOTES

1. THE 5 YEAR, 10 YEAR, AND 25 YEAR FLOOD ELEVATIONS ARE FROM FDF HYDROLOGICAL MODEL CROSS - SECTION C'-C'.

1062

LEGEND:

- EXISTING GROUND
- EXCAVATION GRADE LINE
- WATER TABLE (AVERAGE)
- GREAT MIAMI AQUIFER

THE 5 YEAR, 10 YEAR, AND 25 YEAR FLOOD ELEVATIONS WERE PROVIDED BY FDF.

FOR INFORMATION ONLY

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERNCO	DATE
		INITIALS AND DATE		

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
WASTE UNITS REMEDIATION
SOUTHERN WASTE UNITS

DRAWING TITLE
SKETCH #2

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
PLANT/BLDG NO.		FLOOR		SCALE 1"=10'	CLASS
SUBMITTED FOR APPROVAL		FERNCO CPU APPROVAL			
A-E	DATE				

000614

A-E PROJECT NO.	DATE	TEMP PROJECT NO.	DATE	GRAPHIC SHEET CODE NO.	SHEET NO.	REV. NO.
		00-90701		SK-G-04548		A

PREPARED UNDER PARSONS PROJECT GREEP NUMBER

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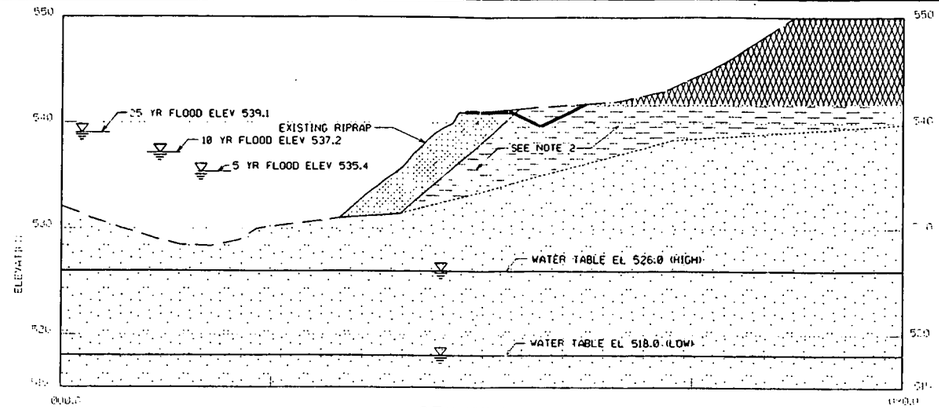
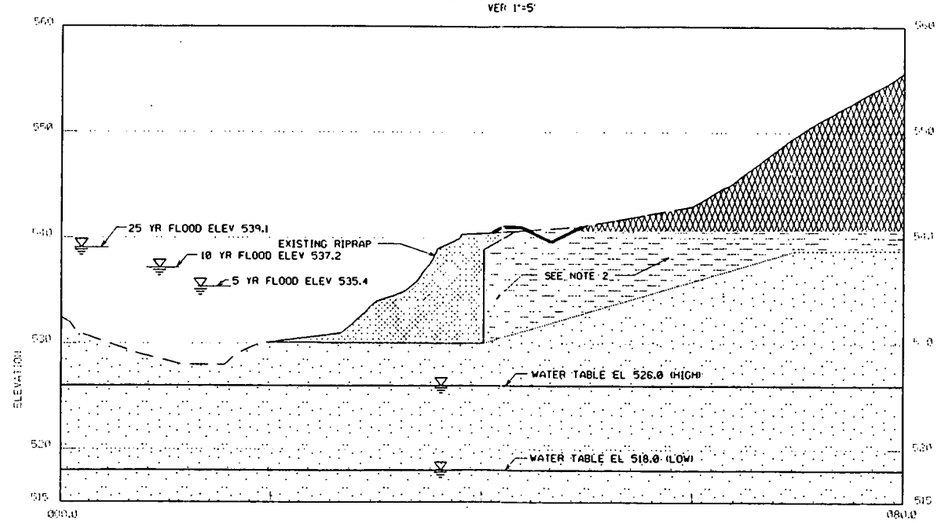
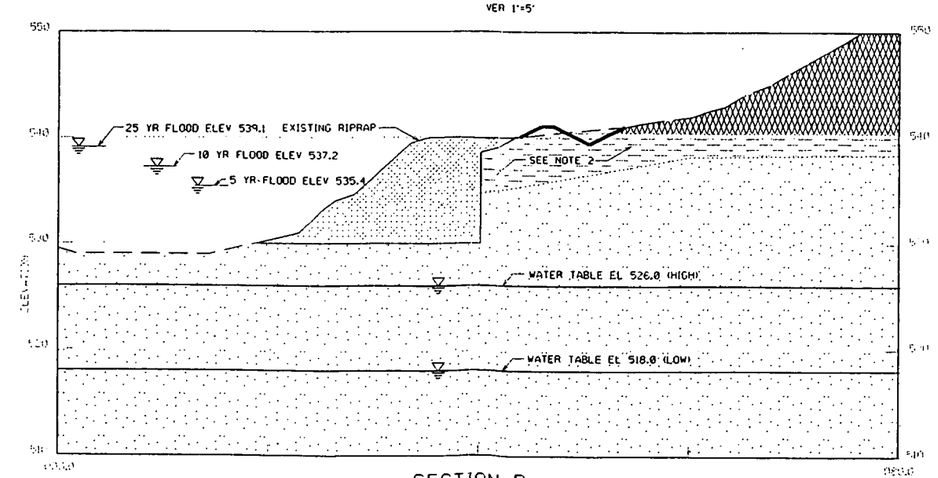


SECTION F
SCALE: HOR 1"=5'
VER 1"=5'



SECTION E
SCALE: HOR 1"=5'
VER 1"=5'



SECTION D
SCALE: HOR 1"=5'
VER 1"=5'

5' 0' 5' 10'
GRAPHIC SCALE: 1"=5'
VERTICAL

5' 0' 5' 10'
GRAPHIC SCALE: 1"=5'
HORIZONTIAL

NOTES

1. THE 5 YEAR, 10 YEAR, AND 25 YEAR FLOOD ELEVATIONS ARE FROM FDF HYDROLOGICAL MODEL CROSS - SECTION C'-C'.
2. GEOLOGY ADJACENT TO RIPRAP BASED ON FIELD OBSERVATIONS AND INTERPOLATION FROM SUBSURFACE INVESTIGATIONS.

1062

LEGEND:

- EXISTING GROUND
- EXCAVATION GRADE LINE
- WATER TABLE
- SAND/GRAVEL
- GLACIAL OVERBURDEN/TILL
- GREAT MIAMI AQUIFER
- RIPRAP
- ASH

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REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERNCO	DATE
		INITIALS AND DATE		

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
WASTE UNITS REMEDIATION
SOUTHERN WASTE UNITS

DRAWING TITLE
SKETCH #3

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
PLANT/BLDG NO.		FLOOR		SCALE 1"=5'	CLASS
SUBMITTED FOR APPROVAL		FERNCO ORU APPROVAL 000615			

PREPARED UNDER PARSONS PROJECT WORK NUMBER	A-E JOB PROJECT NO.	TEMP PROJECT NO.	DRAWING SHEET CODE NO.	SHEET NO.	REV. NO.
		00-90701	SK-G-04548		A

C

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 3/22/97
Sheet 1 of 48

Proj. Order No. 165 Calculation No. 15-03

Project Title WASTE UNIT REMEDIATION

Calculation Subject EARTHWORK Date Verified/Checked 5/5/97

STATUS: PRELIMINARY ✓ FINAL ____ SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

ESTIMATE EXCAVATION VOLUMES OF VARIOUS DITCHS, RETENTION BASINS, ETC.

SUMMARY OF CONCLUSIONS

SEE SUMMARY OF VOLUMES

Originator's Signature and Date

John J Fern 5/5/97

CHECKING METHOD

1. Review ✓
2. Alternate Calculation ____

Checker's Signature and Date

[illegible] 5/5/97

Technical Lead's Signature and Date

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date
1	2-10, 17-20	OVERALL QUANTITIES UPDATE	JACK FERN (CS) 10/3/97	FRANK PARTON (CS) 10/14/97	C. Schroeder 10/15/97

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. A
Sheet 2 of 48

Proj. Order No. 165 Calculation No. 15-03

Project Title WASTE UNIT REMEDIATION

Calculation Subject EARTHWORK Date Verified/Checked 5/5/97

Prepared By: J. FERN Checked/Verified By: J. Parton

Date 4/22/97

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

1. DATA SOURCES:
   a. PARSONS 1997 SITE PREPARATION PACKAGE

2. CODES:
   a. N/A

3. ASSUMPTIONS:
   a. VOLUME QUANTITIES WILL BE IN SITU, NO SHRINK/SWELL FACTORS APPLIED.
   b. LARGER VOLUMES ARE CALCULATED BY PLANIMETERING CROSS SECTIONS AND USING END AREA CALCULATIONS
   c. SMALLER VOLUMES ARE CALCULATED BY PREPARING SELECTED SECTIONS AND CALCULATING THEIR AREAS, VOLUMES ARE CALCULATED USING AREAS AND LENGTHS

SITE PREPARATION

QUANTITIES IN CU YDS	IMPACTED MATERIAL EXCAVATION	NON IMPACTED MATERIAL EXCAVATION	FILL	INFILTRATION BARRIER PLACED	DUMPED ROCK FILL PLACED	GRAVEL PLACED
EQUIPMENT WASH AREA (INCLUDING BERM SOUTH OF ROAD)		489*	289*			
SUPPORT AREA		100*	100*			790
RETENTION BASIN 1	3268	9276		1507		
RETENTION BASIN 2	11906	4844		1146		
RETENTION BASIN 3	894	5188		944		
DITCH 1	142					
DITCH 2	40		200***		28	
DITCH 3	348					
DITCH 4	145					
DITCH 5	67					
DITCH 6	80					
DITCH 7	222					
DITCH 8	306				356	
DITCH 9	497				302	
DITCH 10	288				108	
DITCH 11	296					
DITCH 12	2489					
DITCH 13	202					
DITCH 14	540					
SWALES @ NON IMPACTED MATERIAL STOCKPILE #2	100					
BERMS @ NON IMPACTED MATERIAL STOCKPILE #2			1830**			
BERM NORTH OF AFP			10**			
ROAD REGRADING (AT RETENTION BASIN 2)			111**			89
Swale Repair @ AFP		40*	40*		35	
TOTALS	21830	19308	2580	3597	829	879
* Material to used as fill within the area	**Use excavated material from Non-Impacted Material Stockpile					
*** Material to be borrowed from Equipment Wash Area						

000618

IFP

QUANTITIES IN CU YDS	IMPACTED MATERIAL EXCAVATION	NON IMPACTED MATERIAL EXCAVATION	INFILTRATION BARRIER PLACED	DUMPED ROCK FILL PLACED	GRAVEL PLACED	ABOVE WAC MATERIAL
IFP(incl temp. ditch)	110445		0	156		1690
INTERCEPTOR DITCH 1	3583					
TOTALS	114028	0	0	156	0	1690

SOUTH FIELD

QUANTITIES IN CU YDS	IMPACTED MATERIAL EXCAVATION	NON IMPACTED MATERIAL EXCAVATION	INTERCEPTOR DITCH (3)	DUMPED ROCK FILL REMOVAL	IMPACTED MATERIAL STOCKPILE REMOVAL	LEAD CONTAMINATED SOIL
SOUTH FIELD	137347		0	0	21830	93
INTERCEPTOR DITCH 3	796					
TOTALS	138143	0	0	0	21830	93

000620

1062

AFP

QUANTITIES IN CU YDS	IMPACTED MATERIAL EXCAVATION	NON IMPACTED MATERIAL EXCAVATION	FILL	INFILTRATION BARRIER PLACED	DUMPED ROCK FILL PLACED	
ACTIVE FLYASH PILE	61237					
TOTALS	61237	0	0	0	0	

000321

INTERIM RESTORATION

QUANTITIES IN CU YDS	NON IMPACTED MATERIAL EXCAVATION	FILL	INFILTRATION BARRIER REMOVAL	DUMPED ROCK FILL REMOVAL
EQUIPMENT WASH AREA BERM SOUTH OF ROAD	10			
SUPPORT AREA				
RETENTION BASIN 1	347			
RETENTION BASIN 2				
RETENTION BASIN 3				
RUNNING TRACK				
SOUTH FIELD				
DITCH 1(SITE PREP)				
DITCH 2(SITE PREP)				
DITCH 3(SITE PREP)				
DITCH 4(SITE PREP)				
DITCH 5(SITE PREP)				
DITCH 6(SITE PREP)				
DITCH 7(SITE PREP)				
DITCH 8(SITE PREP)				
DITCH 9(SITE PREP)				
DITCH 10(SITE PREP)		694*		198
DITCH 11(SITE PREP)				
DITCH 12(SITE PREP)				
DITCH 13(SITE PREP)				
DITCH 14(SITE PREP)				
DAYLIGHT DITCH @ PADDY'S RUN	57			
NON IMPACTED MATERIAL STOCKPILE				
DITCH 1(EXCAVATION)				
TOTALS	414			198
*Use excavated material from Non-Impacted Material Stockpile				

000622

1062

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97
1	JJF	10/3/97	[illegible]	10/6/97

TITLE EXCAVATION QUANTITIES

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Project

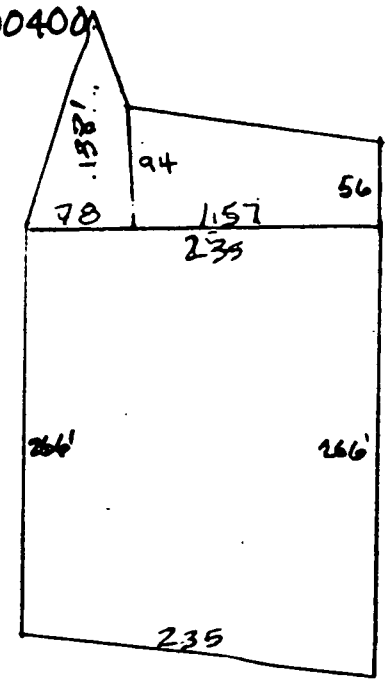
PO No. 165

SITE PREPARATION

SOF 1 RB-1

REF: G00400

STRIP TOP ONE FOOT (SOUTH AREA) AND TOP 1.5 FEET (NORTH AREA) (IMPACTED MAT'L)



NORTH AREA

$\frac{78 \times 138}{2} = 5382$

$\frac{94+56}{2} \times 157 = 11775$

17157 SF × 1.5 = 25735.5 CF

SOUTH AREA

235 × 266 = 62510 × 1 = 62510 CF

88246 CF

$V = \frac{88246 \text{ CF}}{27 \frac{\text{CF}}{\text{CY}}} = 3268 \text{ CY}$

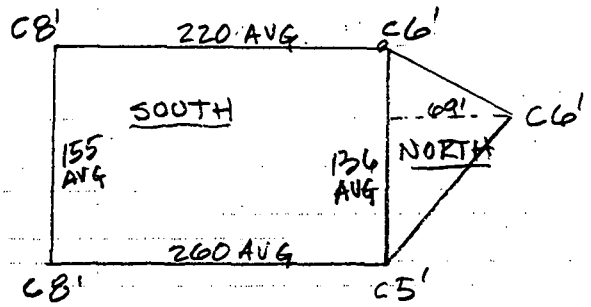
PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	GMP	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	GMP	5/30/97		PO No.
1	JJF	10/3/97	GMP	10/6/97	AUTHOR J. FERN 3/28/97 SHEET 9 OF 48	165

SITE PREPARATION

RB-1 RETENTION BASIN #1



VOL. OF BASIN ABOVE GEOMEMBRANE

$A = \frac{220+260}{2} \times \frac{155+136}{2} + \frac{136 \times 69}{2}$

$= 34920 + 469 = 35390$ SF

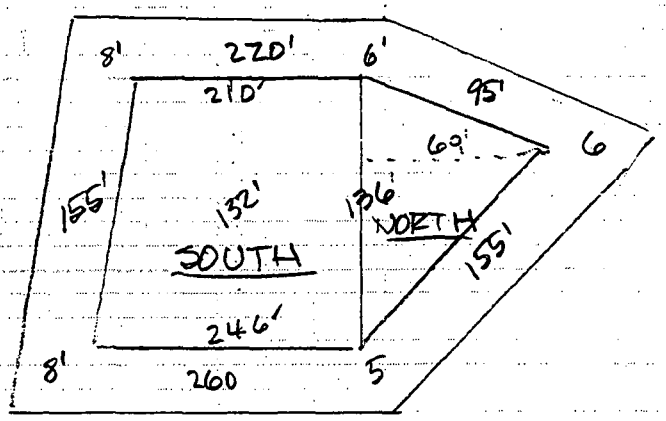
$D = \frac{6+6+5 \times 8+8}{5} = 6.6'$

$V = \frac{35390 \times 6.6}{27} = 8650$

MINUS STRIPPING $= -2438$

6212 CY.

VOLUME OF 1' THICK INFL. BARRIER



$A_{BOTT} = 132 \times \frac{210+246}{2} = 30096$

$136 \times \frac{69}{2} = 4692$

34788 SF BOTT

$A_{SIDES} = 220 \times \frac{8+6}{2} = 1540$

$95 \times 6 = 570$

$155 \times \frac{6+5}{2} = 853$

$260 \times \frac{8+5}{2} = 1690$

$155 \times 8 = 1240$

5893 SF SIDES

$V = \frac{(34788 + 5893) \times 1}{27} = 1507$ CY. ✓

000624

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97
1	JJF	10/3/97	[illegible]	[illegible]

TITLE: EXCAVATION QUANTITIES

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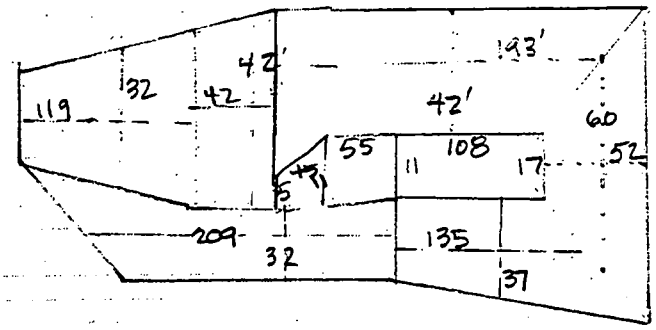
Project

PO No. 165

SITE PREPARATION

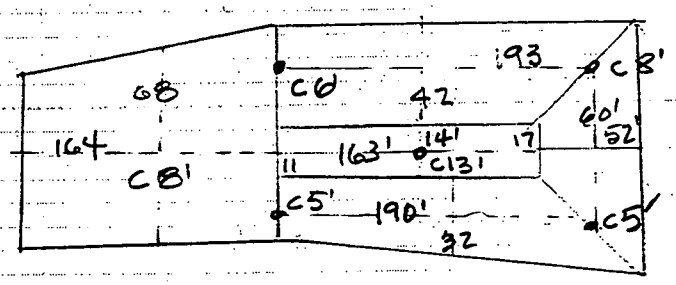
RB-2 RETENTION BASIN #2



VOLUME OF 1' INFILTRATION BARR.

A = 32 × 119 = 3808
42 × 42 = 1764
42 × 193 = 8106
$\frac{5+11}{2}$ × 45 = 360
53 × 11 = 583
108 × $\frac{11+17}{2}$ = 1512
32 × 209 = 6688
37 × 135 = 4995
60 × 52 = 3120
30936

$V = \frac{30936 \times 1}{27} = 1146$ CY

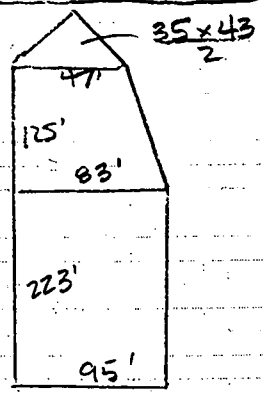


VOLUME OF BASIN ABOVE GEOMEMBRANE
REF. G00371

V = 164 × 68 × 8 = 89216
193 × 42 × $\frac{6+18}{2}$ = 97272
52 × 60 × $\frac{18+5}{2}$ = 35880
190 × 37 × $\frac{5+5}{2}$ = 35150
163 × 14 × 13 = 29666
287184 CF

$\frac{287184}{27} = 10636$ CY

STRIP TOP 42" (3.5')



$A = \left(\frac{95+83}{2} \times 223\right) + \left(\frac{83+47}{2} \times 125\right) + \left(\frac{35 \times 43}{2}\right) = 28725$ SF

$V = \frac{28725 \times 3.5}{27} = 3724$ CY

SUMMARY
− 3724 CY
+ 7318
+ 3594 CY

REF. G00400

000625

04/96

NA/ENG025

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
0	JJF	5/30/97	JMP	5/30/97	EXCAVATION QUANTITIES	
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RETENTION BASIN #2 CUT NORTH OF RB #2

AREA (1) AVG CUT

$\frac{0+7.0+7.0+0+0}{5} = 2.8'$

AREA $\frac{55+83}{2} \times 20 = 1380$ SF

(1) $V = \frac{2.8 \times 1380}{27} = 143$ CY

AREA (2) AVG CUT

$\frac{0+7.0+3.0+1.5+0}{5} = 2.3'$

AREA

$\frac{130 \times 20}{2} = 1300$ SF

(2) $V = \frac{2.3 \times 1300}{27} = 111$ CY

AREA (3) AVG. CUT

$\frac{0+0+6+5+1.5}{5} = 2.5'$

AREA

$\frac{60+25}{2} \times 15 = 638$ SF

(3) $V = \frac{2.5 \times 638}{27} = 59$ CY

AREA (4) AVG. CUT

$\frac{0+7.0+8.0+0}{4} = 3.75'$

AREA

$\frac{40+33}{2} \times 17.5 = 639$ SF

(4) $V = \frac{3.75 \times 639}{27} = 89$ CY

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
0	JJF	5/30/97	[illegible]	5/30/97

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RETENTION BASIN #2 — CUT NORTH OF RB#2

AREA (5)

AVG. CUT

$$\frac{8+7+7+8+6}{5} = 7.2'$$

AREA.

$$\frac{50+67}{2} \times 17.5 = 1024 \text{ SF}$$

(5)

$$V = \frac{7.2 \times 1024}{27} = \underline{273 \text{ CY}}$$

AREA (6)

AVG. CUT

$$\frac{7+3+2+8}{4} = 5'$$

AREA

$$\frac{63+63}{2} \times 17.5 = 1103 \text{ SF}$$

(6)

$$V = \frac{5 \times 1103}{27} = \underline{204 \text{ CY}}$$

AREA (7)

AVG. CUT

$$\frac{3+1.5+1.5+2}{4} = 2'$$

AREA

$$\frac{65+73}{2} \times 17.5 = 1208 \text{ SF}$$

(7)

$$V = \frac{2 \times 1208}{27} = \underline{90 \text{ CY}}$$

AREA (8)

AVG. CUT

$$\frac{1.5+5.0+4.5+1.5}{4} = 3.125'$$

AREA.

$$60 \times 17.5 = 1050 \text{ SF}$$

(8)

$$V = \frac{3.125 \times 1050}{27} = \underline{122 \text{ CY}}$$

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PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
0	VJF	5/30/97	SMP	5/30/97	EXCAVATION QUANTITIES	
						PO No. 165
					AUTHOR J. FERN 5/21/97 SHEET 13 OF 48	

RETENTION BASIN #2 — CUT NORTH OF RB#2

(9) AVG CUT

$$\frac{0+0+0+0+7+8+12.5+8.0}{8} = 4.48'$$

AREA

$145 \times 19 = 2755$ SF

$$V = \frac{4.48 \times 2755}{27} = \underline{457 \text{ CY}}$$ (9)

(10) AVG CUT

$$\frac{8+12.5+8+0+8+9}{6} = 7.58'$$

AREA.

$$\frac{96 \times 57}{2} = 2736 \text{ SF}$$

$$V = \frac{7.58 \times 2736}{27} = \underline{768 \text{ CY}}$$ (10)

(11) AVG. CUT

$$\frac{0+9.0+8.0+0+0+0}{6} = 2.83'$$

AREA

$$\frac{120+24}{2} \times 17.5 = 1260 \text{ SF}$$

$$V = \frac{2.83 \times 1260}{27} = \underline{132 \text{ CY}}$$ (11)

(12) AVG. CUT

$$\frac{0+8+6+0}{4} = 3.5'$$

AREA.

$$\frac{57+40}{2} \times 30 = 1455 \text{ SF}$$

$$V = \frac{3.5 \times 1455}{27} = \underline{189 \text{ CY}}$$ (12)

PARSONS ERA PROJECT

CALCULATION SHEET

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0	JJF	5/30/97	[illegible]	5/30/97

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Project

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RETENTION BASIN #2

CUT NORTH OF RB #2

(13) AVG. CUT

$\frac{6+8+13+0+0}{5} = 5.4'$

AREA

$44 \times 57 = 2508$ SF

$V = \frac{5.4 \times 2508}{27} =$ (13) 502 CY

(14) AVG. CUT

$\frac{8+2+1.5+15.5+13}{5} = 8'$

AREA.

$\frac{135+89}{2} \times 57 = 6384$ SF

$V = \frac{8 \times 6384}{27} =$ (14) 1892 CY

(15) AVG. CUT.

$\frac{1.5+4.5+13+15.5}{4} = 8.63$

AREA.

$\frac{60+67}{2} \times 57 = 3620$ SF

$V = \frac{8.63 \times 3620}{27} =$ (15) 1157 CY.

(16) AVG. CUT

$\frac{0+0+7+13+4.5+5.0+0}{7} = 4.2'$

AREA

$38 \times 109 = 4142$ SF

$V = \frac{4.2 \times 4142}{27} =$ (16) 644 CY

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NA/ENG025

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE EXCAVATION QUANTITIES	Project
0	JJF	5/30/97	[illegible]	5/30/97		
						PO No. 165
					AUTHOR J. FERN 5/21/97 SHEET 15 OF 48	

RETENTION BASIN #2 — CUT NORTH OF R.B. #2

(17) AVG. CUT

$$\frac{0+13+15.5+13+7+6+10+14.5+14+0}{10} = 9.3'$$

AREA

17.5 x 224 = 3920 SF

$$V = \frac{9.3 \times 3920}{27} = 1350 \text{ CY}$$ (17)

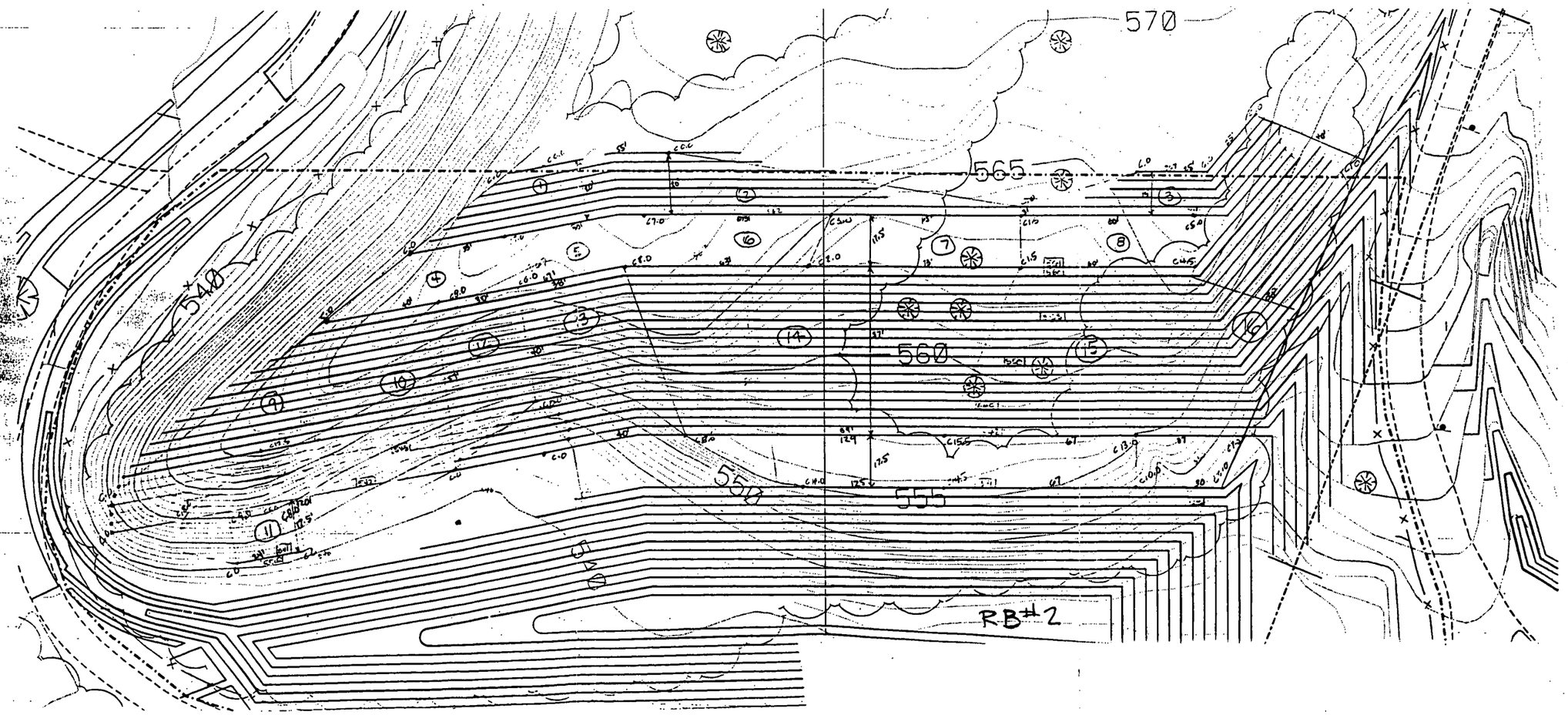
SUMMARY

AREA	VOL.
1	143
2	111
3	59
4	89
5	273
6	204
7	90
8	122
9	457
10	768
11	132
12	189
13	502
14	1892
15	1157
16	644
17	1350
TOTAL	8182 CY

TOTAL IMPACTED SOIL EXCAVATION

8182
588 — TOP 1' OVER BASIN AREA.
8770 CY

000630



SCALE 1" = 40'

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
4	JNF	5/5/97	[illegible]	5/5/97
0	JNF	5/30/97	[illegible]	5/30/97
1	JNF	10/3/97	[illegible]	10/3/97

TITLE: EXCAVATION QUANTITIES

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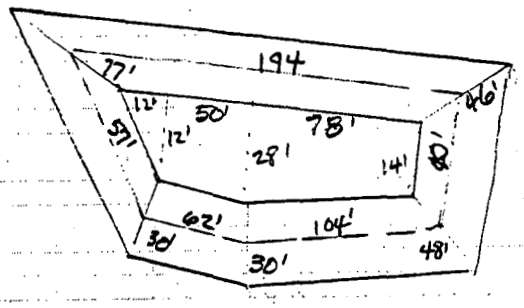
SITE PREPARATION

RB-3 RETENTION BASIN 3

VOLUME OF 1' INFILTRATION BARRIER

$A_{BASE} = \frac{12 \times 12}{2} + \left[\frac{12+28}{2} \times 50\right] + \left[\frac{28+14}{2} \times 78\right] = 2710$ SF



A_{SIDES}

$194 \times \frac{46+77}{2} = 11931$

$48 \times \frac{46+48}{2} = 1880$

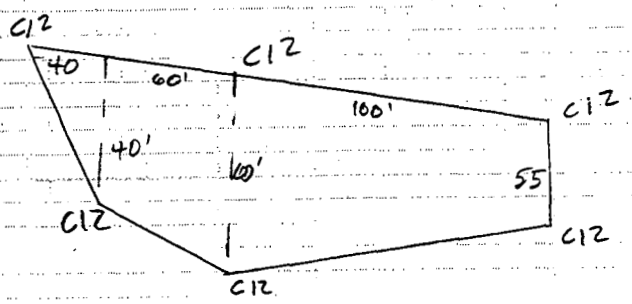
$104 \times \frac{48+30}{2} = 4056$

$62 \times 30 = 1860$

$57 \times \frac{30+77}{2} = 3050$

22777 SF

$V = \frac{(2710 + 22777) \times 1}{27} = 944$ CY



VOLUME OF BASIN ABOVE GEOMEMBRANE

$A = 1/2 \times 40 \times 40 = 800$

$\frac{40+60}{2} \times 60 = 3000$

$\frac{60+55}{2} \times 100 = 5750$

9550 SF

$V = \frac{9550 \times 12}{27} = 4244$ CY

MINUS 1' IMPACTED MATERIAL 844 CY

3400 CY

D = 12' AVG.

000632

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JNF	5/5/97	[illegible]	5/5/97
0	JNF	5/30/97	[illegible]	5/30/97
1	JNF	10/3/97	[illegible]	10/6/97

TITLE EXCAVATION QUANTITIES

AUTHOR J. FERN 5/5/97 SHEET 18 OF 48

Project

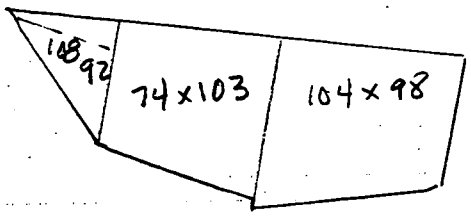
PO No. 165

SITE PREPARATION

STRIP TOP 1 FT.

(3)

SOF 3 EE-3



$A = \frac{108 \times 92}{2} = 4968$

$103 \times 74 = 7622$

$104 \times 98 = 10192$

22782 SF

$V = \frac{22782 \times 1}{27} = 844$ CY.

000633

NA/ENG025

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PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JNF	5/5/97	[illegible]	5/5/97
0	JNF	5/30/97	[illegible]	5/30/97
1	JNF	10/3/97	[illegible]	10/6/97

TITLE: EXCAVATION QUANTITIES

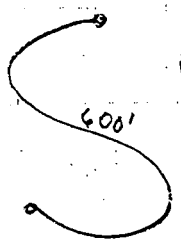
AUTHOR: J. FERN [illegible] SHEET 19 OF 48

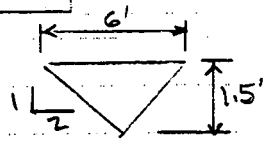
Project:

PO No.: [illegible]

SITE PREPARATION REF. G 00286 INACTIVE FLYASH PILE

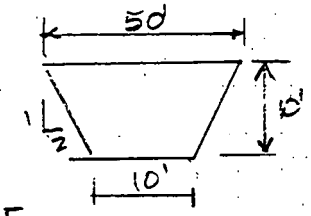
DITCH D1





START

$A = \frac{6 \times 1.5}{2} = 4.5\ SF$



END

$A = \frac{50+10}{2} \times 10 = 300\ SF$

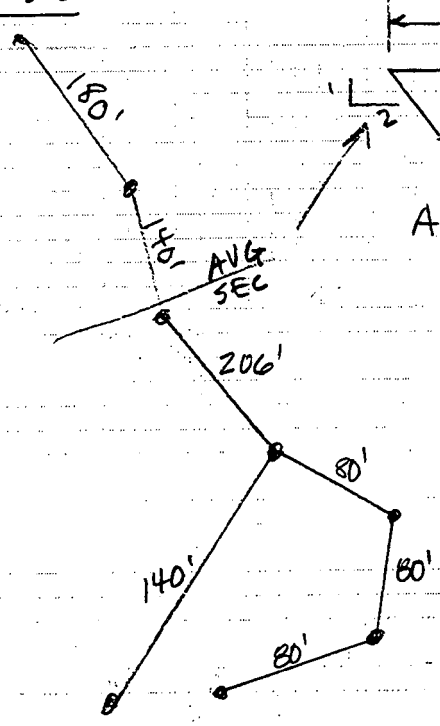
$V = \frac{\frac{4.5+300}{2} \times 600}{27} = 3383\ CY.$

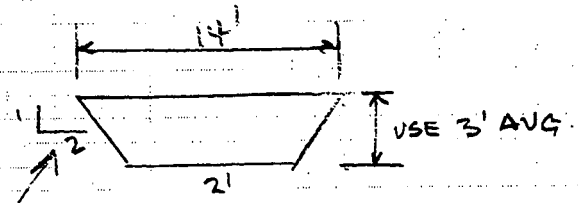
EXCAV. ONLY.

RIPRAP EXCAV.

$\frac{12 \times 300 \times 1.5}{27} = 200\ CY.$

DITCH D2





$L_1 = 180 + 140 + 206 + 140 = 666'$

$L_2 = 80 + 80 + 80 = 240'$

$A = \frac{14+2}{2} \times 3 = 24\ SF$

$V_1 = \frac{24 \times 666}{27} = 592\ CY.$

$V_2 = \frac{24 \times 240}{27} = 213\ CY.$

$805\ CY$

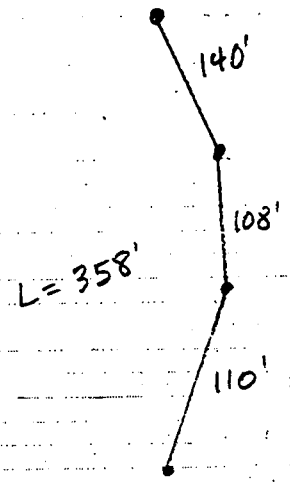
PARSONS ERA PROJECT

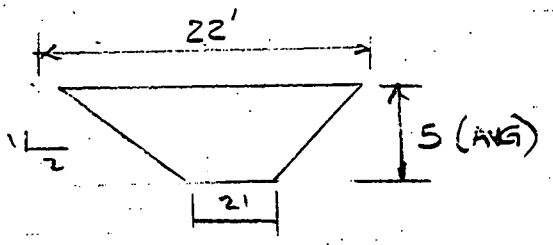
CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	[illegible]	5/30/97		PO No. 165
1	JJF	10/3/97	[illegible]	10/6/97	AUTHOR FERN 3/26/97 SHEET 20 OF 48	

SITE PREPARATION

AIM 6 DITCH D-3 INTERCEPTOR DITCH

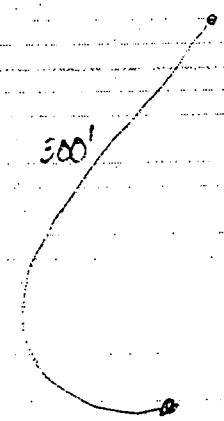




$$A = \frac{22+2}{2} \times 5 = 60 \text{ SF}$$

$$V = \frac{60 \times 358}{27} = 796 \text{ CY}$$

AIM 7 DITCH D-7



$$V = \frac{20 \times 300}{27} = 222 \text{ CY}$$

AREA SAME AS D-3 ABOVE.
(20SF)

000635

04/96

NA/ENG025

PARSONS ERA PROJECT

CALCULATION SHEET

1062

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97

TITLE EXCAVATION QUANTITIES

AUTHOR J. FERN 3/25/97 SHEET 21 OF 48

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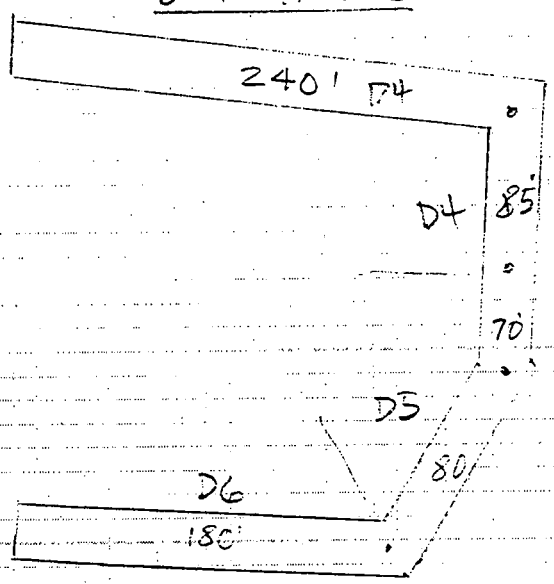
SITE PREPARATION

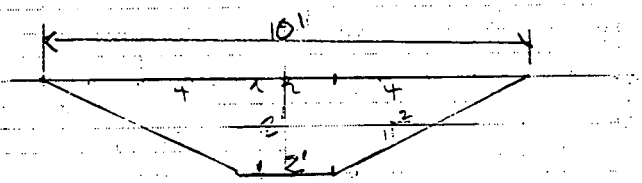
SOE 4 DITCH D-4
DITCH D-5
DITCH D-6



DITCH D-4
L = 240+85 = 325'
V = 145 CY

DITCH D-5
L = 70+80 = 150
V = 67 CY

DITCH D-6
L = 180'
V = 80 CY



$A = \frac{2+10}{2} \times 2 = 12\ SF$

D4 $\frac{12 \times 325}{27} = 145\ CY$

D5 $\frac{12 \times 150}{27} = 67\ CY$

D6 $\frac{12 \times 180}{2} = 80\ CY$

000636

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97

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Project

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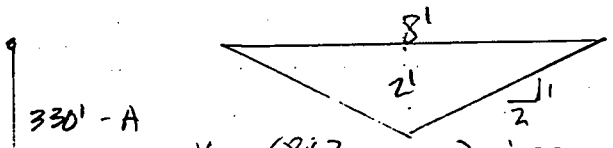
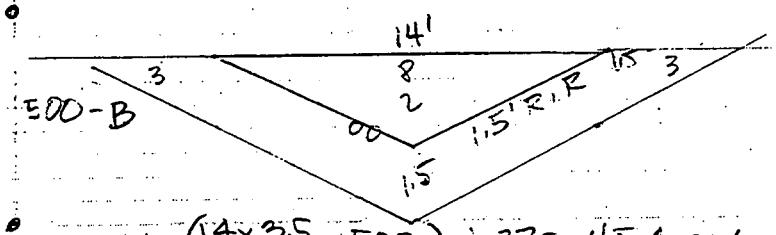
SITE PREPARATION

AIM 8 & 9 DITCH D-8



$V_{A\ EXCAV} = \left(\frac{8 \times 2}{2} \times 330\right) \div 27 = \underline{98\ CY}$



$V_{TOTAL} = \left(\frac{14 \times 3.5}{2} \times 500\right) \div 27 = \underline{454\ CY}$

$\left(\frac{8 \times 2}{2} \times 500\right) \div 27 = \underline{148}$

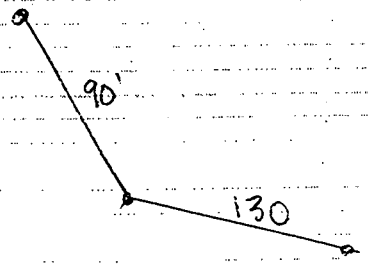
$\underline{306\ CY}$

D8A		D8B	
TOTAL EXCAV CY.		TOTAL EXCAV CY	RR EXCAV CY
98		454	306

REMOVE RIP RAP

$V = \left(\frac{14 \times 3.5}{2} \times 75\right) \div 27 = \underline{68\ CY}$

AIM 10 DITCH D-9

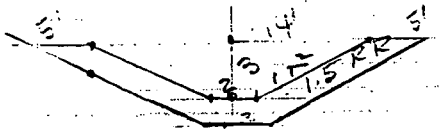


TOTAL EXCAV.

$V = \frac{61 \times (90+130)}{27} = \underline{497\ CY}$

RIP RAP

$V = \frac{37 \times (90+130)}{27} = \underline{302\ CY}$



TOTAL EXCAV. $A = \frac{24+3}{2} \times 4.5 = 61\ SF$

MINUS OPENING $A = \frac{14+2}{2} \times 3 = 24\ SF$

RIPRAP A = 61 - 24 = 37 SF

000637

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97

TITLE EXCAVATION QUANTITIES

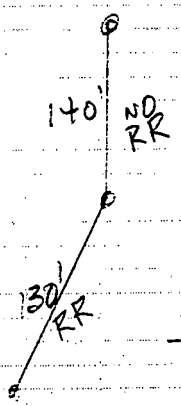
AUTHOR J. FERN 3/25/97 SHEET 23 OF 48

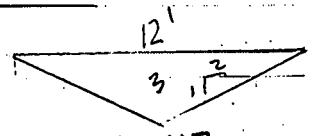
Project

PO No. 165

SITE PREPARATION

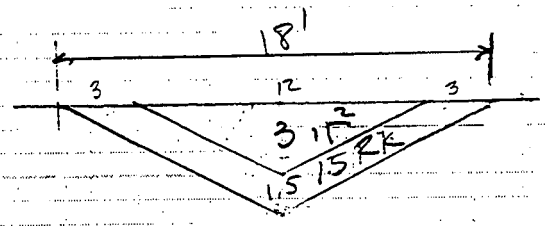
SOF-5 DITCH D10





$A = \frac{3 \times 12}{2} = 18\,SF$

$V_{EXCAV\ NO\ RR} = \frac{18 \times 140}{27} = 93\ CY.$



$V_{EXCAV\ TOTAL} = \frac{40.5 \times 130}{27} = 195\ CY.$

$V_{RIPRAP} = \frac{22.5 \times 130}{27} = 108\ CY$

$A_{TOTAL} = \frac{18 \times 4.5}{2} = 40.5\,SF$

MINUS $\frac{3 \times 12}{2} = 18\,SF$

RIP RAP $40.5 - 18 = 22.5\,SF$

TOTALS 93
195
V = 288 CY.

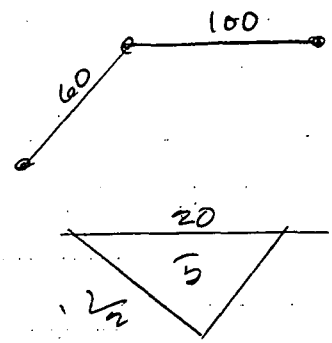
PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	[illegible]	5/30/97		PO No. 165
					AUTHOR J. FERN 3/26/97 SHEET 24 OF 48	

SITE PREPARATION

AIM 11 DITCH D-11



$$V = \frac{\frac{20 \times 5}{2} \times 100}{27} = 296 \text{ CY}$$

000639

PARSONS ERA PROJECT

CALCULATION SHEET

1062

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	JJP	5/5/97
0	JJF	5/30/97	JJP	5/30/97

TITLE EXCAVATION QUANTITIES

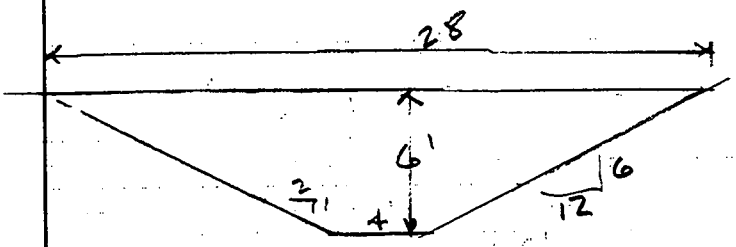
AUTHOR J. FERN 5/2/97 SHEET 25 OF 48

Project

PO No. 165

SITE PREPARATION

SOF 6 DITCH D12



$$V = \frac{700 \times 96}{27} = \underline{2489\ CY}$$

$$A = \frac{4+28}{2} \times 6 = 96\ SF$$

000640

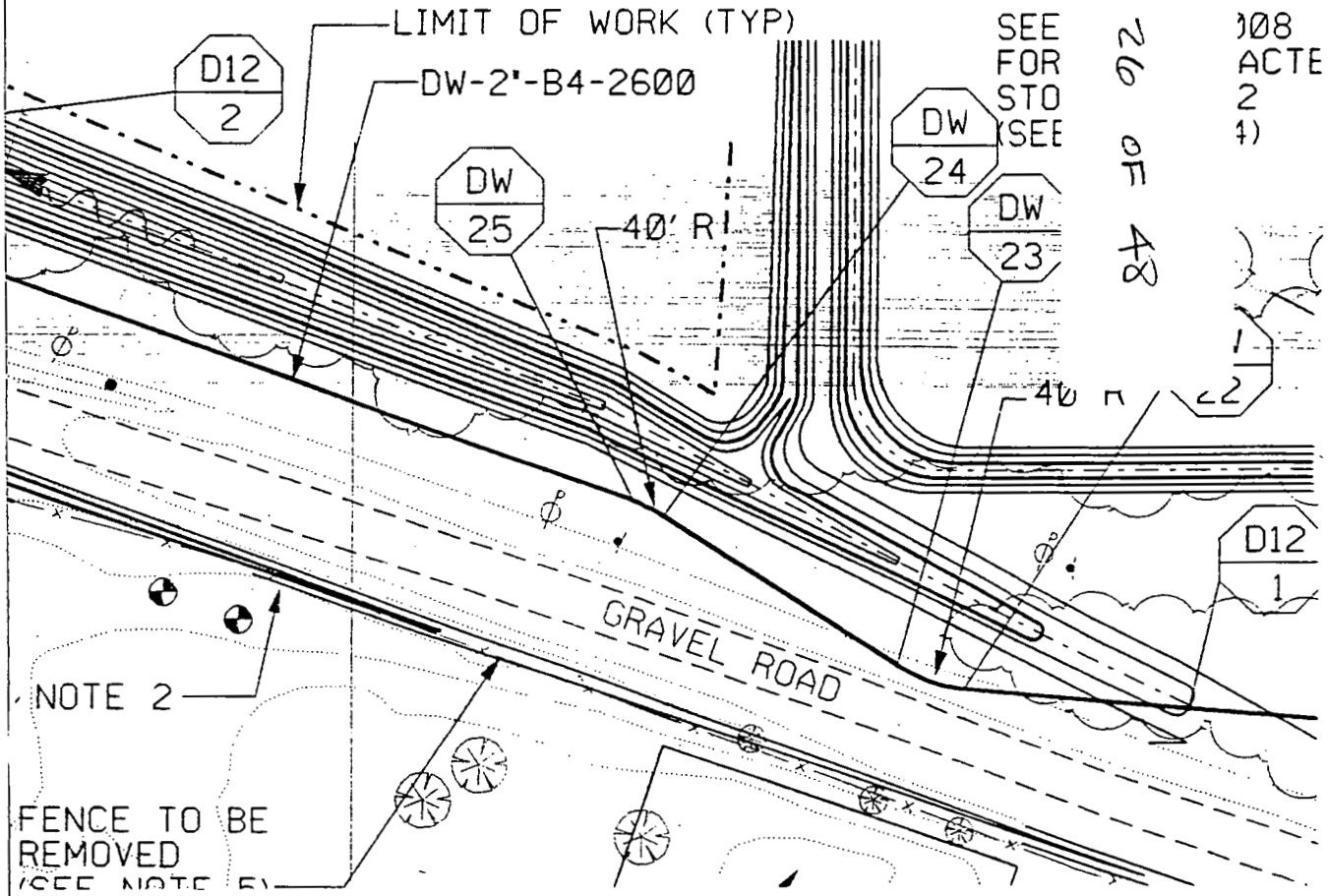
04/96

NA/ENG025

CULVERT NO.	POINT	NORTHING	EASTING	INVERT ELEV	DIA	PIPE MATE
1	58	477601.2	1348467.8	571.0	18"	CMP
	59	477573.6	1348473.8	570.7		
2	60	477521.2	1348349.2	567.5	15"	CMP
	61	477503.7	1348316.2	567.1		
3	62	477225.5	1347703.0	534.6	15"	CMP
	63	477202.5	1347739.3	534.3		

GRAVEL ROAD (RD) CENTERLINE

POINT	NORTHING	EASTING	ELEV	DESC
17	477397.8	1347838.0	BEGIN	ROAD, SEE
18	477367.8	1347814.1	540.0	PT
19	477313.9	1347747.9	539.2	PC, R=90
20	477187.3	1347734.7	536.9	PT



SEE 008
FOR ACTE
STO 2
(SEE 4)

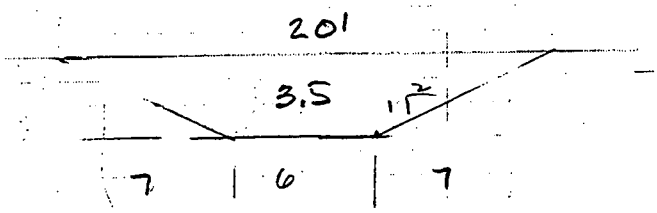
PARSONS ERA PROJECT

CALCULATION SHEET

V	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	[illegible]	5/30/97		PO No. 165
					AUTHOR J. FERN 5/2/97 SHEET 27 OF 48	

SITE PREPARATION

SOF 6 DITCH D13



$V = \frac{45.5 \times 120}{27} = 202$ CY

$A = \frac{6+20}{2} \times 3.5 = 45.5$ SF

DITCH D14

AREAS SAME AS D13 ABOVE.

A = 45.5 SF

$V = \frac{45.5 \times 320}{27} = 540$ SY.

B1&EPS

PARSONS ERA PROJECT

CALCULATION SHEET

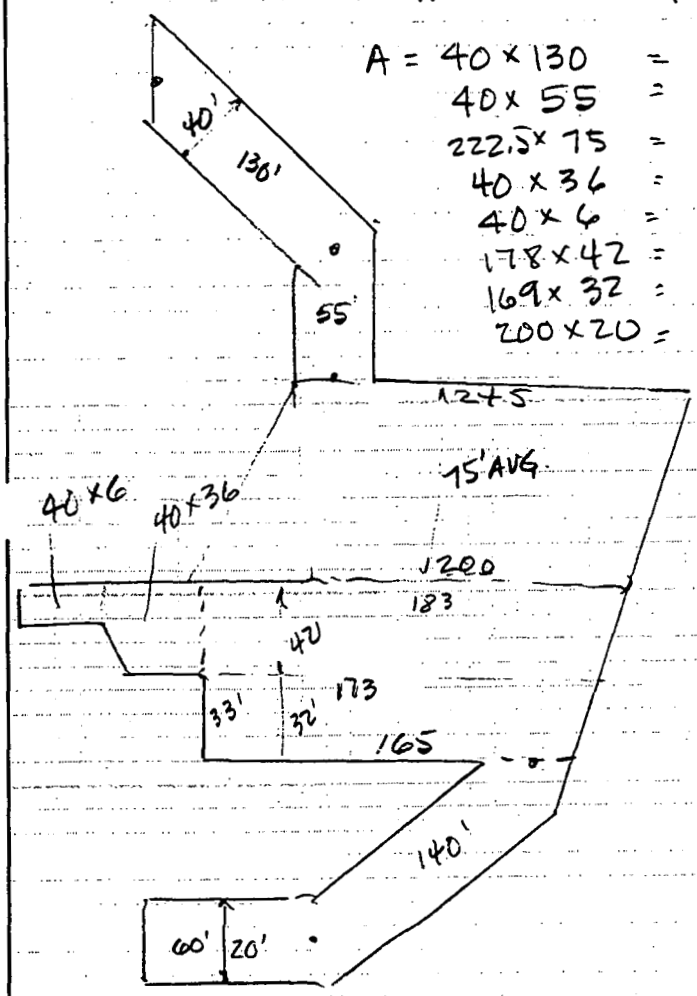
REV	BY	DATE	CK	DATE	TITLE	Project
4	JNF	5/5/97	JMP	5/5/97	EXCAVATION QUANTITIES	
0	JNF	5/30/97	JMP	5/30/97		PO No. 165
					AUTHOR J. FERN 3/27/97 SHEET 28 OF 48	

SITE PREPARATION

GAS

SUPPORT AREA

ASSUME 1' GRADING (STRIPPING)



A = 40 × 130 = 5200
40 × 55 = 2200
222.5 × 75 = 16687.5
40 × 36 = 1440
40 × 6 = 240
178 × 42 = 7476
169 × 32 = 5408
200 × 20 = 4000
42652 SF

$V = \frac{42652 \times 1}{27} = 1580$ CY

C = 100 CY
F = 50 CY

000643

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97

TITLE: EXCAVATION QUANTITIES

AUTHOR: J. FERN

SHEET 29 OF 48

Project

PO No. 165

OPTION 1 BULK EXCAVATION

STA.	CUT	
10+30	0	
		176855
11+0	5053	
		675800
12+0	8463	
		956350
13+0	10664	
		706800
14+0	3472	
		286350
15+0	3255	
		358050
16+0	3906	
		364250
17+0	3379	
		226300
18+0	1147	
		16058
18+28	0	
		3,766,813 CF
		139,512 CY

TOTAL BULK EXCAVATION OPTION 1

EXCAV.	139,512 CY
IMP. MATL STOCKPILE	
RIP RAP (FROM BASE)	

000644

04/96

NA/ENG025

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	JJP	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	JJP	5/30/97		PO No.
					AUTHOR J FERN SHEET 30 OF 48	165

OPTION 1 ~ LEAD.

STA	CUT	
0+15	0	
		186.0
0+20	24.4	
		595.2
0+28	74.4	
		1007.5
0+41	80.6	
		502.2
0+47	86.8	
		217.0
0+52	0	
		2507.9 CF
		93 CY.

000645

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	WF	5/5/97	JKP	5/5/97	EXCAVATION QUANTITIES	
0	WF	5/30/97	JKP	5/30/97		PO No. 165
					AUTHOR J FERN SHEET 31 OF 48	

OPTION 1 - BASE BID

STA.	CUT	
13+45	0	
		20460
14+0	744	
		217000
15+0	3596	
		404550
16+0	4495	
		499100
17+0	5487	
		623100
18+0	6975	
		422375
18+50	9920	
		481275
19+0	9331	
		623100
20+0	3131	
		39138
20+25	0	
		3,330,098 CF
		123,337 CY.

BASE BID BULK EXCAVATION

EXCAV 123,337

ABOVE WAC − 1250

110,836 CY

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JVF	5/5/97	SJP	5/5/97	EXCAVATION QUANTITIES	
0	JVF	5/30/97	SJP	5/30/97		PO No. 165
					AUTHOR J FERN' SHEET 32 OF 48	

ABOVE WAC

STA.	CUT	
0+23	0	
		58924.8
0+47	4910.4	
		122380
0+72	4880.0	
		120520
0+97	4761.6	
		35712
1+12	0	
		337 537 CF
		12501 CY

000647

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	[illegible]	5/30/97	AUTHOR J. FERN 3/31/97 SHEET 33 OF 48	PO No. 165

OPTION 2 EXCAVATION

ACTIVE FLY ASH PILE - AFP

STA.	CUT	FILL
30+54	0	0
31+0	4913	"
32+0	6467	"
33+0	4704	"
34+0	2457	"
34+46	0	"

AVG CUT	AVG FILL	DIST L	L/27	CUT	FILL
2457	0	46	1.70	4177	0
5690	"	100	3.70	21053	"
5586	"	100	3.70	20668	"
3581	"	100	3.70	13250	"
1229	"	46	1.70	2089	"
		TOTAL		61237 CY.	0

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	[illegible]	5/5/97
0	JJF	5/30/97	[illegible]	5/30/97

TITLE: EXCAVATION QUANTITIES

AUTHOR J. FERN 3/28/97 SHEET 34 OF 48

Project

PO No. 165

OPTION 3 RESTORATION

SEE ATTACHED X SECTIONS. SOUTH FIELD

STA	CUT	FILL	AVG CUT	AVG FILL	DIST L	L/27	CUT	FILL
10+40	0	0						
			299	76	60	2.22	664	753
11+0	597	151						
			413	390	100	3.70	1528	1443
12+0	229	628						
			115	959	100	3.70	426	3548
13+0	0	1290						
			–	727	100	3.70	–	2690
14+0	0	163						
			–	82	100	3.70	–	303
15+0	0	0						
							2618 CY	8737 CY

000649

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
C	JNF	5/5/97	SAP	5/5/97
D	JNF	5/30/97	SAP	5/30/97

TITLE EXCAVATION QUANTITIES

AUTHOR J. FERN 3/28/97 SHEET 35 OF 48

Project

PO No. 165

OPTION 3 | RESTORATION

RETENTION BASIN 1

SEE ATTACHED X SECTIONS.

STA	CUT	FILL	AVG. CUT	AVG. FILL	DIST L	L/27	CUT	FILL
16+60	0	0						
			–	546	40	1.48	–	808
17+0	–	1092						
			–	1437	100	3.70	–	5317
18+0	–	1782						
			–	1401	50	1.85	–	2592
18+50	–	1019						
			–	568	50	1.85	–	1051
19+0	–	116						
			–	58	100	3.70	–	215
20+0	–	0						
							–	9983 CY.

RESTORATION VOLUME OF PIT ONLY 9983

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	JMP	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	JMP	5/30/97	AUTHOR J. FERN 4/2/97 SHEET 36 OF 48	PO No. 165

OPTION 3 RESTORATION

RETENTION BASIN 2

SEE ATTACHED X SECTIONS

STA	CUT	FILL
10+40	0	0
11+0	178	391
12+0	170	620
13+0	109	279
14+0	213	0
15+0	0	0

AVG CUT	AVG FILL	DIST L	L/27	CUT	FILL
89	196	60	2.22	198	435
174	506	100	3.70	644	1872
140	450	"	3.70	157	478
161	140	"	3.70	151	295
107	0	"	3.70	34	70
				1284 CY	3150 CY

RESTORATION VOLUME OF PIT ONLY = 3150 CY

000651

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JJF	5/5/97	SAP	5/5/97
0	JJF	5/30/97	SAP	5/30/97

TITLE: EXCAVATION QUANTITIES

AUTHOR J. FERN 4/2/97 SHEET 37 OF 48

Project

PO No.

OPTION 3 RESTORATION

RETENTION BASIN 3

STA	CUT	FILL
30+0	0	0
31+0	16	46
32+0	35	73
33+0	151	740
34+0	155	736
35+0	0	0

AVG CUT	AVG FILL	DIST L	L/27	CUT	FILL
8	23	100	3.70	30	85
26	60	"	"	96	222
93	407	"	"	344	1506
153	738	"	"	566	2731
78	368	"	"	289	1362
				1325 CY	5905 CY.

RESTORATION VOLUME OF PIT ONLY = 5905 CY.

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	WF	5/5/97	SAP	5/5/97
D	WF	5/30/97	SAP	5/30/97

TITLE EXCAVATION QUANTITIES

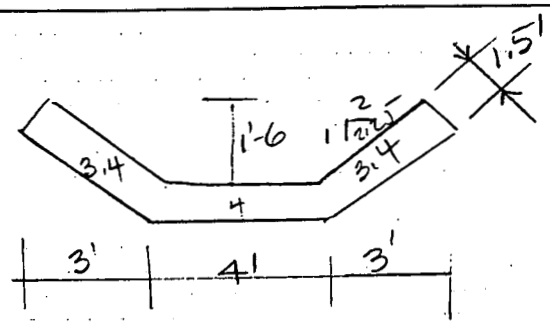
AUTHOR J. FERN 4/2/97 SHEET 38 OF 48

Project

PO No. 165

TEMPORARY DITCH

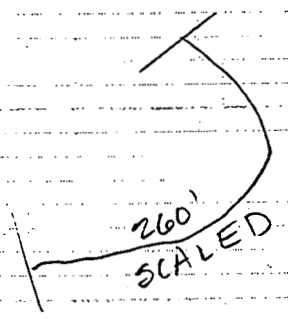
RIP RAP



$A = (3.4 + 4 + 3.4) \times 1.5 = 16.2$ SF

$\frac{2}{3} = \frac{2.25}{3.38}$

$V = \frac{16.2 \times 260}{27} = 156$ CY.



PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JWF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	JWF	5/30/97	[illegible]	5/30/97	AUTHOR J. FERN 3/27/96 SHEET 39 OF 48	PO No. 165

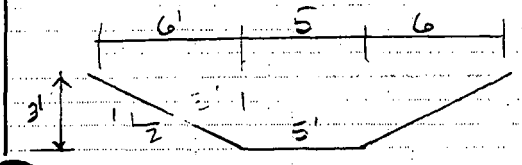
SITE PREPARATION

GWWF WHEEL WASH FACILITY

STRIP 1'

SAY $\frac{50 \times 30 \times 1}{27} = 56\,CY$ (NOT USED)

FILL HAUL ROAD DITCH - L = 460'



$$V_{FILL} = \frac{\left[\left(\frac{3\times 6}{2}\right)2 + (3\times 5)\right] \times 460}{27} = 562\,CY.$$

(18, 15)

FILL

L = 400'

CUT NEW DITCH

A = SAME AS ABOVE

$$V = \frac{\left[\left(\frac{3\times 6}{2}\right)2 + (3\times 5)\right] \times 400}{27} = 489\,CY.$$

CUT.

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
4	JJF	5/5/97	JMP	5/5/97	EXCAVATION QUANTITIES	
0	JJF	5/30/97	JMP	5/30/97		PO No. 165
					AUTHOR J. FERN 4/2/97 SHEET 40 OF 48	

ROAD REGRADING
WEST OF RETENTION BASIN #2

GRAVEL PAVING SAY 300' LONG

$$V = \frac{300 \times 1.6 \times 0.5}{27} = 89 \text{ CY GRAVEL}$$

CUT SAY $\frac{2' \times \frac{150}{2} \times 20}{27} = 111$ CY

FILL SAY $\frac{2' \times \frac{150}{2} \times 20}{27} = 111$ CY.

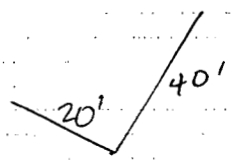
000655

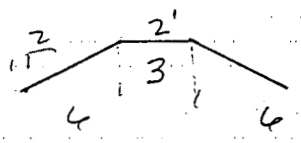
PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
9	VJF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	VJF	4/30/97	[illegible]	5/30/97	AUTHOR V. FERN 4/2/97 SHEET 41 OF 48	PO No. 165

AMOUNT OF CUT IN NORTHERN (WHEEL WASH) BERM TO MEET DAYLIGHT

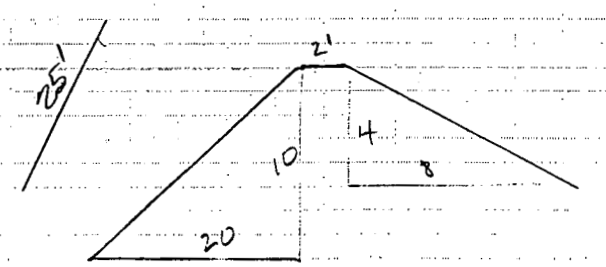




$$A = 2\left(\frac{6\times3}{2}\right) + (2\times3) = 24\,SF$$

$$V = \frac{24 \times \frac{20+40}{2}}{27} = 27\ CY.$$

AMOUNT OF CUT IN SOUTHERN (HEAD OF DITCH D-2) BERM TO MEET DAYLIGHT



$$A = \overset{100}{\frac{20\times10}{2}} + \overset{8}{2\times4} + \overset{16}{\frac{4\times8}{2}} = 124\,SF$$

$$V = \frac{\frac{25\times124}{2}}{27} = 57\ CY.$$

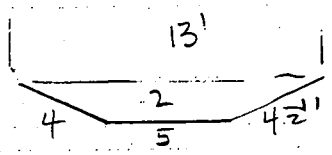
PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	VJF	5/5/97	[illegible]	5/5/97	EXCAVATION QUANTITIES	
0	VJF	5/30/97	[illegible]	5/30/97		PO No. 165
					AUTHOR V. FERN 4/2/97 SHEET 42 OF 48	

AMOUNT OF CUT AT DITCH D-1

TOTAL DITCH LENGTH = 460'



$$\underline{CUT} = \frac{\frac{5+13}{2} \times 2 \times \frac{460}{2}}{27} = \underline{153\,CY}$$

$$\underline{FILL} = \frac{\frac{5+13}{2} \times 2 \times \frac{460}{3}}{27} = \underline{102\,CY}$$

AMOUNT OF FILL AT RUNNING TRACK TO MEET RESTORATION GRADING

$A = 240 \times 250 = 60000\,SF$

$$\underline{V} = \frac{60000 \times 0.5\,AVG}{27} = \underline{1111\,CY}$$

000657

04/96

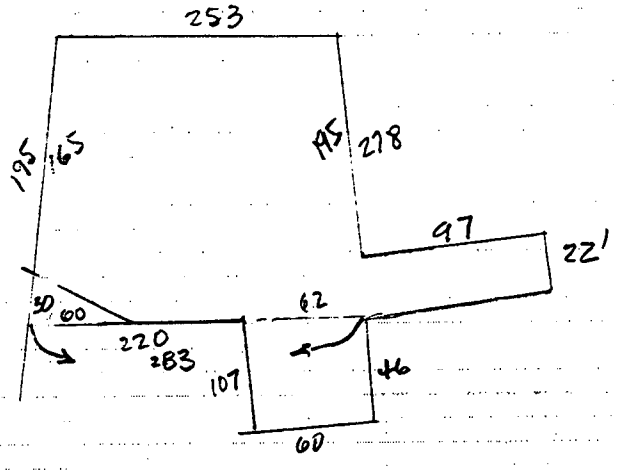
NA/ENG025

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	WF	5/5/97	[illegible]	5/5/97		
0	WF	5/30/97	[illegible]	5/30/97		PO No. 165
					AUTHOR J. FERN 5/1/97 SHEET 43 OF 48	

NON-IMPACTED MATERIAL STOCKPILE #2
(REMOVE TOP FOOT)



$A = \frac{253+283}{2} \times 195 = 52260$

$97 \times 22 = 2134$

$\frac{107+46}{2} \times 60 = 4590$

$- \frac{30 \times 60}{2} = - 900$

58084 SF

$V = \frac{58084 \times 1}{27} = \underline{2151 \text{ CY}}$

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE
A	JF	5/5/97	[illegible]	5/5/97
D	JJF	5/30/97	[illegible]	5/30/97

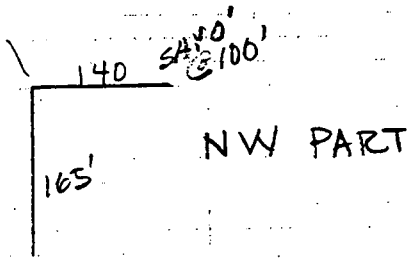
TITLE EXCAVATION QUANTITIES

AUTHOR J. FERN 5/1/97 SHEET 44 OF 48

Project

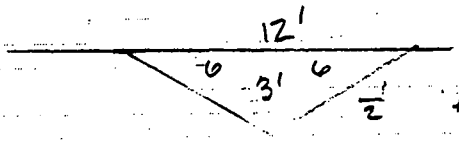
PO No. 165

SWALES AT NON-IMPACTED MATERIAL STOCKPILE #2



NW PART

$V = \frac{0+8}{2} \times 140 = 560$ CF

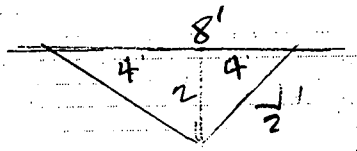


$A = \frac{12 \times 3}{2} = 18$ SF

$\frac{8+18}{2} \times 165 = 2145$

2705 CF

100 CY



$A = \frac{8 \times 2}{2} = 8$ SF

000659

04/96

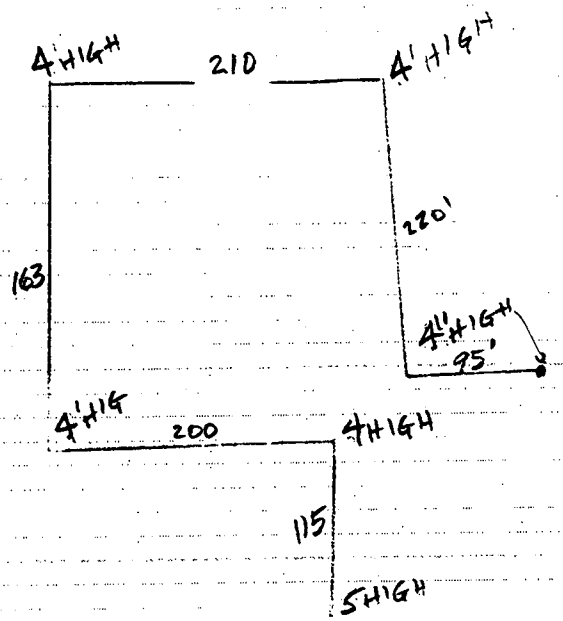
NA/ENG025

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	JMP	5/5/97		
0	JJF	5/30/97	JMP	5/30/97	AUTHOR J. FERN 5/1/97 SHEET 45 OF 48	PO No. 165

BERMS AT NON-IMPACTED MATERIAL STOCKPILE #2



$V = \frac{70+48}{2} \times 115 =$ 6785 CF

48 x 200 = 9600

48 x 163 = 7824

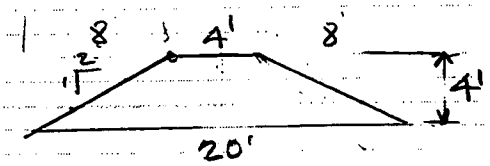
48 x 210 = 10080

48 x 220 = 10560

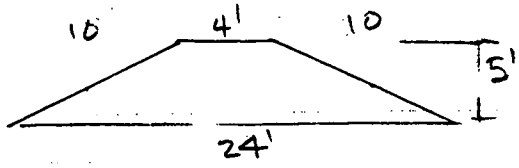
48 x 95 = 4560

49409 CF

1830 CY



$A = \frac{20+4}{2} \times 4 = 48$ SF



$A = \frac{24+4}{2} \times 5 = 70$ SF

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
A	JJF	5/5/97	[illegible]	5/5/97		
D	JJF	5/30/97	[illegible]	5/30/97		PO No.
					AUTHOR J. FERN 5/5/97 SHEET 46 OF 48	165

STOCKPILE VOL NEEDED = 22031 (BANK - SITE PREP SUMMARY TABLE)

22031 + 10% (SWELL) = ASSUME 10% SWELL

22031 + 2203 = 24234 ASSUME 15% CONTIG.

24234 + 15% (CONTIG) =

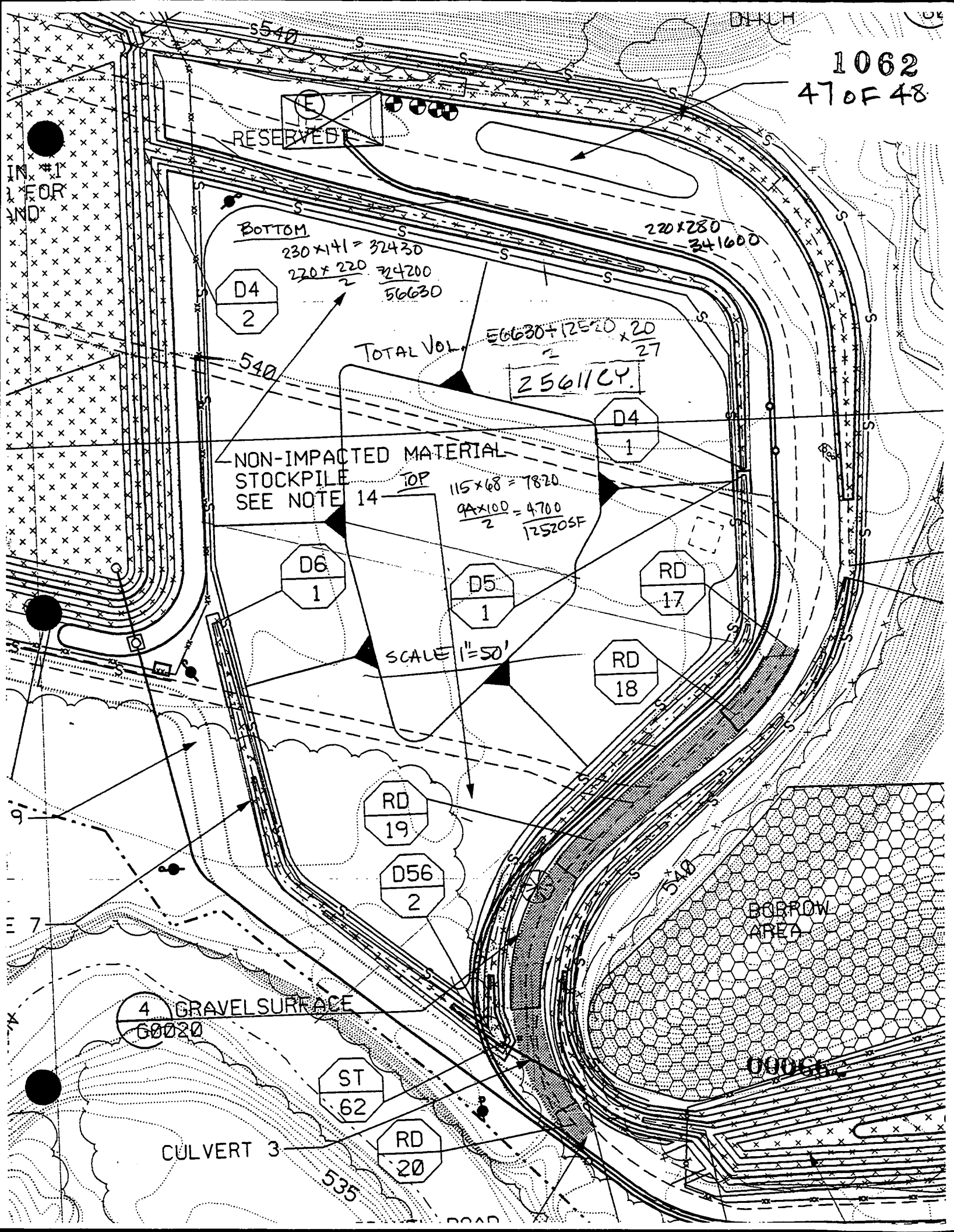
24234 + 3635 = 27869 CY

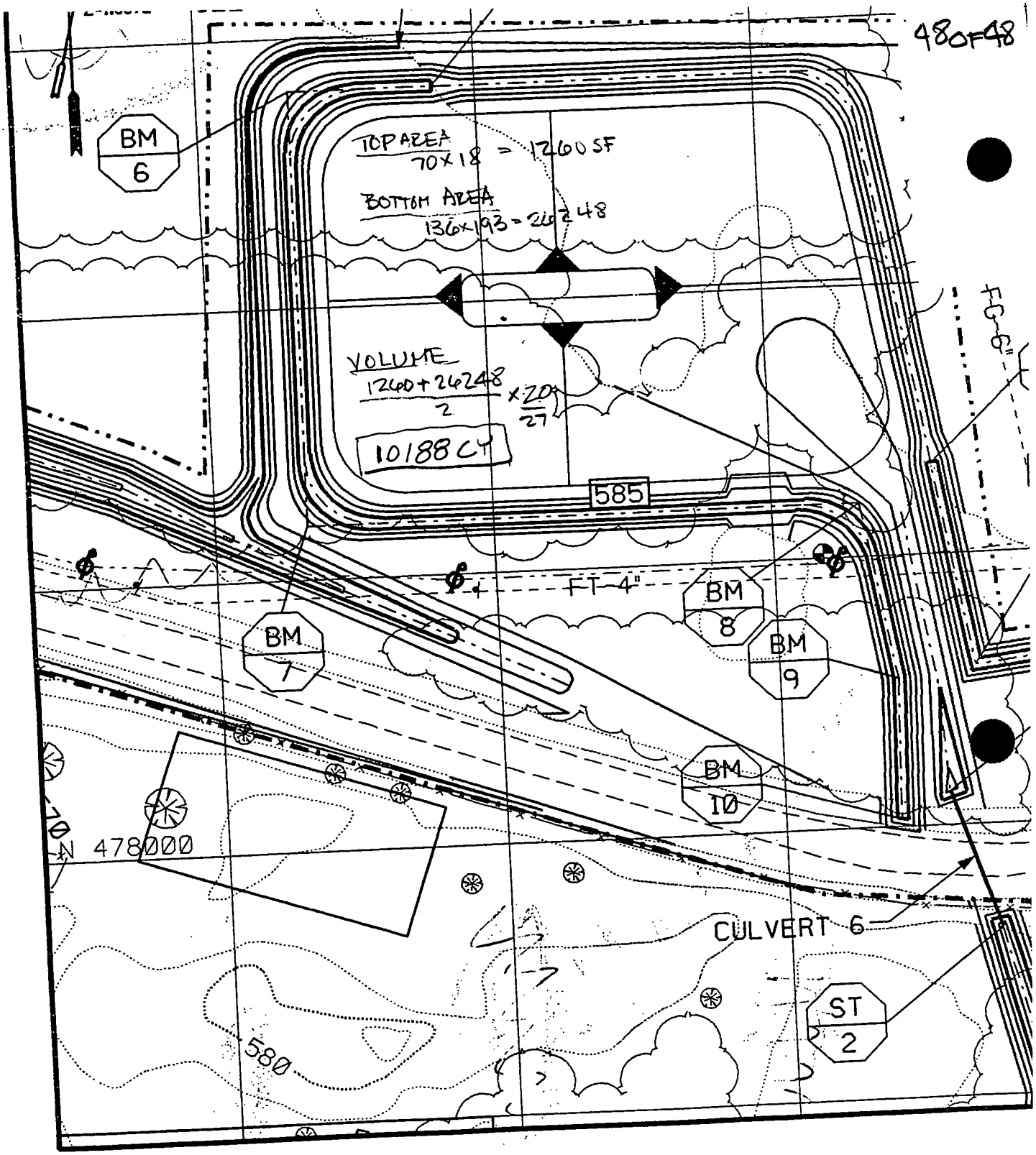
STOCKPILE VOL AVAILABLE: NON IMPACTED MATERIAL STOCKPILE # 1 25611

NON IMPACTED MATERIAL STOCKPILE # 2 = 10188 C

35799 CY

000661


DITCH
540
RESERVED
BOTTOM
230 x 141 = 32430
220 x 220 / 2 = 24200
56630
220 x 280
34 1600
D4
2
TOTAL VOL.
56630 + 12520 / 2 x 20 / 27
25611 CY.
540
D4
1
NON-IMPACTED MATERIAL
STOCKPILE
SEE NOTE 14
TOP
115 x 68 = 7820
94 x 100 / 2 = 4700
12520 SF
D6
1
D5
1
RD
17
SCALE 1" = 50'
RD
18
RD
19
D56
2
540
BORROW
AREA
4
GRAVEL SURFACE
60020
ST
62
RD
20
CULVERT 3
535
00066



NON IMPACTED MATERIAL ST

D

APPENDIX D

AREA 2, PHASE I PREDESIGN DATA SUMMARY

APPENDIX D
AREA 2, PHASE I PREDESIGN DATA SUMMARY

This appendix summarizes the data generated to date from the Area 2, Phase I (A2PI) predesign investigations. The A2PI area is shown in Figure D-1. It should be noted that the data contained in this appendix is not complete; incomplete data sets will be discussed in the applicable text section. Final data will be provided as it becomes available and will be incorporated in the next version of the IRDP.

Three predesign investigations were identified for the A2PI area:

- Site preparation areas
- Delineation of areas exceeding waste acceptance criteria (WAC)
- Lead delineation in the A2PI former firing range.

These investigations are discussed below.

D.1 SITE PREPARATION AREAS

Prior to excavation of the three retention basins in A2PI (site preparation activities), a sampling effort was undertaken to define the extent of impacted material and WAC attainment in the basin areas. The investigation consisted of RTRAK measurements, HPGe measurements, and collection of soil samples. The Site Preparation areas are shown in Figure D-2; the fill and nonfill areas are shown in Figure D-3.

RTRAK

Measurements were collected with the RTRAK where accessible. Initial efforts to use the RTRAK were less than satisfactory due to data drift and an abundance of overhead foliage that prevented the collection of accurate data. In areas inaccessible to the RTRAK, HPGe measurements were conducted to provide 100 percent radiological field survey coverage. Since the collected HPGe measurements provided approximately 100 percent coverage of the accessible area, the RTRAK data was not used as a basis for WAC attainment or characterization for reuse decisions.

HPGe

As stated above, HPGe measurements were collected in approximately 100 percent of all accessible Site Preparation areas. The measurements were taken for a period of 15 minutes at a detector height of 1 meter. The HPGe measurement locations are shown in Figure D-4.

A total of 81 HPGe measurements were collected from known fill areas within the site preparation area. The maximum total uranium HPGe reading was 43.2 ppm (FA-W-74-G); the minimum total uranium reading was 4.6 ppm (FA-W-34-G). The HPGe results for total uranium in the fill areas are listed in Table D-1.

A total of 64 HPGe measurements (16 from each of the four retention basin areas) were collected from the characterization for reuse areas within the retention basin footprints. The maximum total uranium HPGe reading for IFP-B1 was 21.3 ppm (IFP-B1-14-G); the minimum reading was 3.1 ppm (IFP-B1-2-G). The maximum total uranium reading for IFP-B2 was 37.0 ppm (IFP-B2-1-G); the minimum reading was 4.2 ppm (IFP-B2-15-G). The maximum total uranium reading for SF-B was 46.3 ppm (SF-B-14-G); the minimum reading was 12.5 ppm (SF-B-13-G). The maximum total uranium reading for AFP-B was 25.1 ppm (AFP-B-7-G); the minimum reading was 10.2 ppm (AFP-B-10-G). Table D-2 lists the HPGe results for these areas.

Soil Sample Collection

Soil samples were collected from fill areas and the footprint of each of the three planned retention basins (see Figures D-5 through D-10) for three purposes: certification readiness (preliminary), WAC attainment, and characterization for reuse. Certification readiness sampling (also known as preliminary sampling) data was used to determine which depth interval of soil within each retention basin was likely to pass characterization analysis. The WAC attainment sampling was conducted to ensure that no above-WAC material was present in the retention basins area and to prevent the improper disposition of excavated material. Characterization for reuse sampling was conducted to determine the boundary between material exceeding the FRL concentrations (impacted) and the material below the FRL concentrations (nonimpacted); this information will be used during basin excavation to segregate the two types of materials.

A total of 69 soil samples were collected for the certification readiness (preliminary) sampling effort and analyzed for uranium-238. The maximum concentration was 5.7 pCi/g (SF-B-P5-4-R, 2 to 2.5 ft); the minimum concentration was 0.3 pCi/g [AFP-B-P3-3-R (1 to 1.5 ft), IFP-B2-P4-2-R (1.5 to 2 ft), IFP-B2-P4-3-R (1.5 to 2 ft), IFP-B2-P5-3-R (2 to 2.5 ft)]. Table D-3 lists the uranium 238 results for certification readiness (preliminary sampling).

The total uranium WAC attainment sampling (see Figure D-5) was conducted in the fill area along the perimeters of the Inactive Flyash Pile (IFP) and the South Field (SF) and in nonfill areas adjacent to the IFP, SF, and Active Flyash Pile (AFP). One sample was collected for every 3,500 square foot area expected to be excavated; in narrow areas, one sample was collected every 100 feet along the center line. The boring depths varied in accordance with the depth of the fill to be excavated during Site Preparation activities. A total of 117 soil samples were collected from 54 locations. The maximum total uranium concentration was 79.0 ppm (FA-W1-31-R, 0 to 2 ft); the minimum concentration was 1.0 ppm [FA-W3-51-R (4 to 6 ft), FA-W3-52-R (4 to 6 ft), and FA-W2-54-R (2 to 4 ft)]. Table D-4 summarizes the total uranium data in the fill areas. Table D-5 compares HPGe and soil sampling results for the fill areas (FA-W-21, FA-W-25, and FA-W-27 HPGe measurements were not collected due to unsafe conditions in rough terrain).

The characterization for reuse sampling (see Figure D-11) was conducted in the footprint of the three A2PI proposed retention basins. A total of 89 samples were collected (including quality control samples) from four areas (IFP-B1, IFP-B2, AFP-B, and SF-B). Each area was gridded into 16 subsections and one soil sample was collected from each of the 16 subsections. A summarization of the characterization for reuse data for radiological constituents is listed in Table D-6; a summary of chemical constituent data is contained in Table D-7.

D.2 AREAS EXCEEDING WASTE ACCEPTANCE CRITERIA

Five areas in A2PI were identified during the Operable Unit 2 RI/FS as containing material that exceeded the OSDF total uranium WAC, one of which also exceeded the technetium-99 (Tc-99) WAC. Additional sampling was completed in these areas to determine the accuracy of these constituent concentrations and also to better estimate the volume of above-WAC material to be excavated, shipped, and disposed at an off-site permitted commercial disposal facility. The investigation consisted of HPGe

measurements and collection of soil samples in five areas: SWU-1 (total uranium), SWU-2 (total uranium), SWU-3 (total uranium), SWU-4 (total uranium and Tc-99), and SWU-5 (total uranium).

HPGe

No RTRAK measurements were taken in the above-WAC areas; HPGe measurements were collected to provide 100 percent radiological field survey coverage. The measurements were taken for a period of 15 minutes at a detector height of 1 meter. The HPGe measurement locations are shown in Figure D-4.

A total of 31 HPGe measurements were collected (see Figure D-4) from the suspected above-WAC areas within A2PI (based on process knowledge and previous sampling events). The maximum total uranium HPGe reading was 85.5 ppm (SWUCA-5-4-G); the minimum total uranium reading was 14.3 ppm (SWUCA-6-3-G). The HPGe results for total uranium in the above-WAC areas are listed in Table D-8.

Soil Sample Collection

Five potentially above-WAC areas in A2PI were sampled: SWU-1, SWU-2, SWU-3, SWU-4, and SWU-5 (see Figures D-11 through D-14). Shallow soil borings (0 to 3.5 ft) were completed in SWU-1, SWU-2, SWU-3, and SWU-4; soil samples were collected and analyzed for total uranium (SWU-1, SWU-2, SWU-3, and SWU-4) and Tc-99 (SWU-4 only). Borings in SWU-5 were completed to a depth of 27 feet; soil intervals were scanned with a Geiger-Mueller frisker to determine relative radiological activity. The soil interval exhibiting the highest reading was submitted for total uranium analysis; any interval exceeding 100 corrected counts per minute (ccpm) was archived for potential future analysis. If the initial soil interval submitted for analysis exceeded the total uranium WAC (1,030 ppm), the archived soil intervals above and below the above-WAC interval were submitted for analysis to determine the vertical extent of contamination.

A total of 234 soil samples were collected in the above-WAC areas (including quality control samples). Total uranium analysis was performed at the on-site lab by inductively coupled plasma/mass spectroscopy (ICP/MS), BromoPADAP, and alpha spec; total uranium analysis was performed at off-site labs by alpha spec. Technetium-99 analysis was conducted at both on-site and off-site labs by gas proportional counting.

Soil samples collected from SWU-1, SWU-2, SWU-3, and SWU-4 and analyzed for total uranium did not exhibit the elevated concentrations formerly reported for these areas. The total uranium concentrations ranged from 4 ppm to 104 ppm in SWU-1, from 2.37 ppm to 65 ppm in SWU-2, from 2.01 ppm to 418 ppm in SWU-3, and from 11.8 ppm to 123 ppm in SWU-4 [(results of split samples with Ohio Environmental Protection Agency (OEPA) pending].

Previous data indicated the presence of Tc-99 in excess of WAC in SWU-4. Samples were collected in approximately the same location as the previous data and the immediate adjacent area (see Figure D-14). Technetium-99 results for SWU-4 did not exhibit the elevated concentrations formerly reported for this area; data results ranged from <-0.58 pCi/g to <0.72 pCi/g (results of split samples with OEPA pending). The 'less than' sign indicates all results were below the method detection concentration (MDC); the MDC will be established (not expected to exceed 3 pCi/g) and substituted for these 'less than' values. Therefore, Tc-99 is no longer considered an area-specific constituent of concern for the A2PI area. A summarization of the data for the suspected above-WAC areas is contained in Table D-9.

Twenty-three borings were completed in SWU-5 (see Figure D-14) to a total depth of 27 feet. As mentioned earlier, soil intervals submitted for analysis exhibited the highest relative radiological reading for the entire core length. Gross construction debris (nails, clear and brown glass, shop rags, coal, fibers) was removed from the sample intervals prior to submission for analysis. Total uranium concentrations exceeding WAC ranged in depth from 15 feet [4,980 ppm (SWU-5-10)] to 26.5 feet [1,810 ppm (SWU-22B)]. Table D-9 summarizes the total uranium data results.

For purposes of soil excavation volume estimation, it is assumed the vertical extent of the above-WAC total uranium area is continuous from a depth of 15 feet below present grade to a depth of 26.5 feet below present grade. The assumption is based on the analytical data presented in Table D-9 (SWU-5-10-31, 4980 ppm at 15-15.5 ft and SWU-5-22B-53, 1810 ppm at 26 to 26.5 ft).

To date, a total of 169 SWU-5 soil samples have been submitted for analysis; 29 samples exhibited total uranium concentrations above the total uranium WAC of 1030 ppm. Additionally, one sample exhibited a total concentration of 1020 ppm. The maximum total uranium concentration in SWU-5 was

9090 ppm (SWU-5-15, 18.5 to 19 ft); the minimum total uranium concentration was 1.18 ppm (SWU-5-11, 17.5 to 18 ft).

The known extent of above-WAC material in the SWU-5 area is shown in Drawing G0006. Additional borings will be conducted in the SWU-5 area, approximately 10 to 12 feet south and southwest of borings SWU-5-22 and SWU-5-23 (see Figure D-14) to further delineate the extent of the total uranium above-WAC area.

Additionally, HPGe measurements and soil samples will be collected along a corridor between the IFP and the SF to ensure no material above the total uranium WAC is present. This corridor (approximately 40 ft x 300 ft) is designated for construction of an interceptor ditch (shown as Ditch #2 on Drawing G0005) to prevent runon from the SF entering the IFP area.

D.3 LEAD DELINEATION IN THE FORMER FIRING RANGE

The A2PI former firing range has been identified as an area that exceeds the lead final remediation level (FRL) and may possess the toxicity characteristic for lead. The PSP for this sampling effort is currently under development.

The sampling strategy contained in the PSP was based upon soil collection and real-time studies [x-ray fluorescence (XRF)] from previous investigations (see Figure D-15). Tables D-10, D-11, and D-12 summarize the existing firing range data. Additional sampling conducted in 1992 is summarized in the Operable Unit 2 ROD.

The current proposed sampling strategy for the former firing range is twofold: sample and analyze for total lead analysis to bound the area above the lead FRL of 400 ppm; sample and analyze for TCLP lead from three areas of bullet density (high, moderate, and low) to determine if sieving of the material to remove the bullets would render the material noncharacteristic for toxicity. This sampling event is expected to be initiated in November, 1997. Data from this sampling effort will be provided as it becomes available.

HPGE RESULTS FOR TOTAL URANIUM - FILL AREAS

Table D-1

TION NUMBER	NORTHING /	EASTING	PARAMETER	HPGE SAMPLE AND RESULT		
FA-W-1	478054.01	1347376.34	Uranium, Total	FA-W-1-G	7.5	PPM
FA-W-2	477964.03	1347399.23	Uranium, Total	FA-W-2-G	14.5	PPM
FA-W-3	477866.78	1347413.96	Uranium, Total	FA-W-3-G	11.8	PPM
FA-W-4	477807.64	1347416.89	Uranium, Total	FA-W-4-G	13.4	PPM
FA-W-5	477778.91	1347398.47	Uranium, Total	FA-W-5-G	11.0	PPM
FA-W-6	477759.75	1347434.57	Uranium, Total	FA-W-6-G	14.0	PPM
FA-W-7	477739.29	1347413.85	Uranium, Total	FA-W-7-G	12.2	PPM
FA-W-8	477732.49	1347478.76	Uranium, Total	FA-W-8-G	17.4	PPM
FA-W-9	477714.81	1347461.08	Uranium, Total	FA-W-9-G	15.6	PPM
FA-W-10	477711.12	1347508.23	Uranium, Total	FA-W-10-G	17.6	PPM
FA-W-11	477686.81	1347543.59	Uranium, Total	FA-W-11-G	20.0	PPM
FA-W-12	477666.18	1347609.88	Uranium, Total	FA-W-12-G	27.3	PPM
FA-W-13	477651.45	1347691.65	Uranium, Total	FA-W-13-G	18.3	PPM
FA-W-14	477631.57	1347781.04	Uranium, Total	FA-W-14-G	25.1	PPM
W-15	477586.63	1347846.6	Uranium, Total	FA-W-15-G	22.5	PPM
A-W-16	477484	1347870.84	Uranium, Total	FA-W-16-G	11.6	PPM
FA-W-17	477408.89	1347862.74	Uranium, Total	FA-W-17-G	9.8	PPM
FA-W-18	477366.16	1347841.38	Uranium, Total	FA-W-18-G	11.2	PPM
FA-W-19	477326.37	1347784.66	Uranium, Total	FA-W-19-G	10.6	PPM
FA-W-20	477290.27	1347747.82	Uranium, Total	FA-W-20-G	18.0	PPM
FA-W-22	477232.8	1347729.41	Uranium, Total	FA-W-22-G	10.1	PPM
FA-W-23	477256.41	1347797.24	Uranium, Total	FA-W-23-G	10.7	PPM
FA-W-24	477184.91	1347753.72	Uranium, Total	FA-W-24-G	14.3	PPM
FA-W-26	477306.15	1347893.62	Uranium, Total	FA-W-26-G	11.0	PPM
FA-W-28	477321.69	1347958.13	Uranium, Total	FA-W-28-G	14.6	PPM
FA-W-29	477248.99	1347999.59	Uranium, Total	FA-W-29-G	26.8	PPM
FA-W-30	477258.43	1348051.79	Uranium, Total	FA-W-30-G	29.6	PPM
FA-W-31	477227.85	1348055	Uranium, Total	FA-W-31-G	18.7	PPM
FA-W-32	477270.22	1348093.78	Uranium, Total	FA-W-32-G	17.7	PPM
FA-W-33	477318.58	1348091.04	Uranium, Total	FA-W-33-G	35.9	PPM

Table D-1

STATION NUMBER	NORTHING /	EASTING	PARAMETER	HPGE SAMPLE AND RESULT		
FA-W-34	477245.35	1348176.44	Uranium, Total	FA-W-34-G	4.6	PPM
FA-W-35	477245.17	1348176.28	Uranium, Total	FA-W-35-G	13.8	PPM
FA-W-36	477286.42	1348153.45	Uranium, Total	FA-W-36-G	21.6	PPM
FA-W-37	477319.75	1348177.02	Uranium, Total	FA-W-37-G	19.5	PPM
FA-W-38	477467.07	1348242.94	Uranium, Total	FA-W-38-G	15.5	PPM
FA-W-39	477556.6	1348242.94	Uranium, Total	FA-W-39-G	11.1	PPM
FA-W-40	477644.45	1348271.78	Uranium, Total	FA-W-40-G	11.4	PPM
FA-W-41	477751.85	1348304.81	Uranium, Total	FA-W-41-G	11.7	PPM
FA-W-42	477832.3	1348337.43	Uranium, Total	FA-W-42-G	17.7	PPM
FA-W-43	477893.21	1348367.77	Uranium, Total	FA-W-43-G	14.8	PPM
FA-W-44	477940.77	1348385.54	Uranium, Total	FA-W-44-G	19.4	PPM
FA-W-45	477939.93	1348400.21	Uranium, Total	FA-W-45-G	18.3	PPM
FA-W-46	477968.67	1348350.14	Uranium, Total	FA-W-46-G	10.6	PPM
FA-W-47	477991.51	1348268.37	Uranium, Total	FA-W-47-G	19.2	PPM
FA-W-48	478026.14	1348165.98	Uranium, Total	FA-W-48-G	26.0	PPM
FA-W-49	478065.18	1348057.7	Uranium, Total	FA-W-49-G	19.4	PPM
FA-W-50	478096.13	1347963.42	Uranium, Total	FA-W-50-G	17.1	PPM
FA-W-51	478122.65	1347884.6	Uranium, Total	FA-W-51-G	14.9	PPM
FA-W-52	478155.07	1347798.41	Uranium, Total	FA-W-52-G	11.2	PPM
FA-W-53	478191.17	1347701.91	Uranium, Total	FA-W-53-G	14.1	PPM
FA-W-54	478226.53	1347612.04	Uranium, Total	FA-W-54-G	15.7	PPM
FA-W-55	478209.5	1347662	Uranium, Total	FA-W-55-G	12.3	PPM
FA-W-56	478173.3	1347751	Uranium, Total	FA-W-56-G	16.3	PPM
FA-W-56	478173.3	1347751	Uranium, Total	FA-W-56-G	16.3	PPM
FA-W-57	478129.6	1347853	Uranium, Total	FA-W-57-G	14.5	PPM
FA-W-58	478108.2	1347933	Uranium, Total	FA-W-58-G	16.8	PPM
FA-W-59	478081.6	1348016	Uranium, Total	FA-W-59-G	17.2	PPM
FA-W-60	478049	1348114	Uranium, Total	FA-W-60-G	31.4	PPM
FA-W-61	478009.8	1348221	Uranium, Total	FA-W-61-G	22.5	PPM
FA-W-62	477979.6	1348318	Uranium, Total	FA-W-62-G	18.8	PPM
FA-W-63	477968.7	1348385	Uranium, Total	FA-W-63-G	13.7	PPM
FA-W-64	477920.3	1348406	Uranium, Total	FA-W-64-G	16.7	PPM

Table D-1

STATION NUMBER	NORTHING /	EASTING	PARAMETER	HPGE SAMPLE AND RESULT		
W-64	477920.3	1348406	Uranium, Total	FA-W-64-G	16.8	PPM
FA-W-65	477865.7	1348382	Uranium, Total	FA-W-65-G	17.0	PPM
FA-W-66	477801.9	1348362	Uranium, Total	FA-W-66-G	14.8	PPM
FA-W-67	477708.2	1348331	Uranium, Total	FA-W-67-G	18.2	PPM
FA-W-68	477603	1348297	Uranium, Total	FA-W-68-G	12.7	PPM
FA-W-69	477505.5	1348262	Uranium, Total	FA-W-69-G	7.5	PPM
FA-W-70	477422.9	1348232	Uranium, Total	FA-W-70-G	12.5	PPM
FA-W-71	477320.5	1348116	Uranium, Total	FA-W-71-G	17.9	PPM
FA-W-72	477262.8	1348161	Uranium, Total	FA-W-72-G	22.9	PPM
FA-W-73	477220.3	1348155	Uranium, Total	FA-W-73-G	20.0	PPM
FA-W-74	477328.2	1348061	Uranium, Total	FA-W-74-G	43.2	PPM
FA-W-75	477285.5	1348029	Uranium, Total	FA-W-75-G	27.8	PPM
FA-W-76	477536.3	1347877	Uranium, Total	FA-W-76-G	14.4	PPM
FA-W-78	477631.3	1347722	Uranium, Total	FA-W-78-G	18.5	PPM
FA-W-79	477669.1	1347589	Uranium, Total	FA-W-79-G	21.2	PPM
-W-79	477669.1	1347589	Uranium, Total	FA-W-79-G	21.4	PPM
W-80	477911	1347410	Uranium, Total	FA-W-80-G	12.1	PPM
FA-W-81	478006	1347379	Uranium, Total	FA-W-81-G	15.3	PPM
FA-W-82	477286	1347851	Uranium, Total	FA-W-82-G	10.9	PPM

AVERAGE OF ALL RESULTS **16.9 PPM**

MAXIMUM OF ALL RESULTS **43.2 PPM**

HPGE RESULTS FOR TOTAL URANIUM - CHARACTERIZATION FOR REUSE AREAS

Table D-2

STATION NUMBER	NORTHING /	EASTING	PARAMETER	HPGE SAMPLE AND RESULT		
AFP-B-1	477090.99	1348394	Uranium, Total	AFP-B-1-G	11.4	PPM
AFP-B-2	477051.76	1348425.25	Uranium, Total	AFP-B-2-G	21.8	PPM
AFP-B-3	477085.99	1348436	Uranium, Total	AFP-B-3-G	10.7	PPM
AFP-B-4	477044.99	1348490	Uranium, Total	AFP-B-4-G	19.0	PPM
AFP-B-5	477021.52	1348521.61	Uranium, Total	AFP-B-5-G	20.7	PPM
AFP-B-6	477067.99	1348537	Uranium, Total	AFP-B-6-G	16.8	PPM
AFP-B-7	477039.99	1348574	Uranium, Total	AFP-B-7-G	25.2	PPM
AFP-B-8	477130.99	1348344	Uranium, Total	AFP-B-8-G	10.2	PPM
AFP-B-9	477136.99	1348393	Uranium, Total	AFP-B-9-G	10.5	PPM
AFP-B-10	477141.99	1348424	Uranium, Total	AFP-B-10-G	12.5	PPM
AFP-B-11	477106.99	1348444	Uranium, Total	AFP-B-11-G	11.7	PPM
AFP-B-12	477102.99	1348488	Uranium, Total	AFP-B-12-G	11.5	PPM
AFP-B-13	477107.99	1348511	Uranium, Total	AFP-B-13-G	11.6	PPM
AFP-B-14	477120.99	1348529	Uranium, Total	AFP-B-14-G	13.6	PPM
AFP-B-15	477111.99	1348569	Uranium, Total	AFP-B-15-G	14.8	PPM
AFP-B-16	477086.99	1348590	Uranium, Total	AFP-B-16-G	15.0	PPM
IFP-B1-1	477706	1347393	Uranium, Total	IFP-B1-1-G	5.6	PPM
IFP-B1-2	477676	1347449	Uranium, Total	IFP-B1-2-G	3.1	PPM
IFP-B1-3	477679	1347471	Uranium, Total	IFP-B1-3-G	6.4	PPM
IFP-B1-4	477663	1347520	Uranium, Total	IFP-B1-4-G	5.7	PPM
IFP-B1-5	477663	1347546	Uranium, Total	IFP-B1-5-G	13.2	PPM
IFP-B1-6	477734	1347422	Uranium, Total	IFP-B1-6-G	11.6	PPM
IFP-B1-7	477705	1347441	Uranium, Total	IFP-B1-7-G	12.2	PPM
IFP-B1-8	477711	1347476	Uranium, Total	IFP-B1-8-G	12.9	PPM
IFP-B1-9	477694	1347515	Uranium, Total	IFP-B1-9-G	17.1	PPM
IFP-B1-10	477688	1347546	Uranium, Total	IFP-B1-10-G	19.0	PPM
IFP-B1-11	477746	1347423	Uranium, Total	IFP-B1-11-G	13.4	PPM
IFP-B1-12	477755	1347443	Uranium, Total	IFP-B1-12-G	15.0	PPM
IFP-B1-13	477751	1347463	Uranium, Total	IFP-B1-13-G	13.5	PPM
IFP-B1-14	477722	1347504	Uranium, Total	IFP-B1-14-G	21.3	PPM
IFP-B1-15	477706	1347524	Uranium, Total	IFP-B1-15-G	20.5	PPM
IFP-B1-16	477769	1347448	Uranium, Total	IFP-B1-16-G	13.1	PPM
IFP-B2-1	477446	1347423	Uranium, Total	IFP-B2-1-G	37.0	PPM

Table D-2

STATION NUMBER	NORTHING /	EASTING	PARAMETER	HPGE SAMPLE AND RESULT		
[illegible]B2-2	477450	1347454	Uranium, Total	IFP-B2-2-G	16.1	PPM
IFP-B2-3	477436	1347511	Uranium, Total	IFP-B2-3-G	17.6	PPM
IFP-B2-4	477433	1347537	Uranium, Total	IFP-B2-4-G	13.4	PPM
IFP-B2-5	477535	1347396	Uranium, Total	IFP-B2-5-G	14.1	PPM
IFP-B2-6	477568	1347503	Uranium, Total	IFP-B2-6-G	11.9	PPM
IFP-B2-7	477532	1347512	Uranium, Total	IFP-B2-7-G	12.9	PPM
IFP-B2-8	477512	1347554	Uranium, Total	IFP-B2-8-G	13.1	PPM
IFP-B2-9	477577	1347412	Uranium, Total	IFP-B2-9-G	10.5	PPM
IFP-B2-10	477552	1347468	Uranium, Total	IFP-B2-10-G	13.3	PPM
IFP-B2-11	477597	1347481	Uranium, Total	IFP-B2-11-G	13.0	PPM
IFP-B2-12	477565	1347532	Uranium, Total	IFP-B2-12-G	15.7	PPM
IFP-B2-13	477673.5	1347424	Uranium, Total	IFP-B2-13-G	5.2	PPM
IFP-B2-14	477644	1347469	Uranium, Total	IFP-B2-14-G	6.7	PPM
IFP-B2-15	477658	1347484	Uranium, Total	IFP-B2-15-G	4.2	PPM
IFP-B2-16	477610	1347521	Uranium, Total	IFP-B2-16-G	12.9	PPM
SF-B-1	477170.99	1347792	Uranium, Total	SF-B-1-G	15.5	PPM
SF-B-2	477159.99	1347842	Uranium, Total	SF-B-2-G	17.4	PPM
[illegible]B-3	477171.99	1347884	Uranium, Total	SF-B-3-G	16.7	PPM
SF-B-4	477166.99	1347932	Uranium, Total	SF-B-4-G	15.2	PPM
SF-B-5	477151.99	1347983	Uranium, Total	SF-B-5-G	17.1	PPM
SF-B-6	477181.78	1348047.34	Uranium, Total	SF-B-6-G	22.0	PPM
SF-B-7	477161.91	1348074.57	Uranium, Total	SF-B-7-G	18.9	PPM
SF-B-8	477144.99	1348126	Uranium, Total	SF-B-8-G	18.3	PPM
SF-B-9	477196.93	1348127.75	Uranium, Total	SF-B-9-G	14.3	PPM
SF-B-10	477231.81	1348065.17	Uranium, Total	SF-B-10-G	19.3	PPM
SF-B-11	477231.93	1348017.95	Uranium, Total	SF-B-11-G	14.7	PPM
SF-B-12	477193.21	1347981.06	Uranium, Total	SF-B-12-G	23.6	PPM
SF-B-13	477195.99	1347958	Uranium, Total	SF-B-13-G	12.5	PPM
SF-B-14	477218.99	1347908	Uranium, Total	SF-B-14-G	46.3	PPM
SF-B-15	477193.99	1347843	Uranium, Total	SF-B-15-G	14.9	PPM
SF-B-16	477181.99	1347794	Uranium, Total	SF-B-16-G	17.1	PPM

AVERAGE OF ALL RESULTS **15.0 PPM**

MAXIMUM OF ALL RESULTS **46.3 PPM**

RESULTS FOR URANIUM 238 - CERTIFICATION READINESS (PRELIMINARY) SAMPLES

Table D-3

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
AFP-B-P-1	AFP-B-P2-1-R	0.5 - 1	Uranium-238	NV	0.6 pCi/g dry
	AFP-B-P3-1-R	1 - 1.5		NV	0.5 pCi/g dry
	AFP-B-P4-1-R	1.5 - 2		NV	0.4 pCi/g dry
	AFP-B-P5-1-R	2 - 2.5		NV	0.4 pCi/g dry
AFP-B-P-2	AFP-B-P2-2-R	0.5 - 1	Uranium-238	NV	0.4 pCi/g dry
	AFP-B-P3-2-R	1 - 1.5		NV	0.4 pCi/g dry
	AFP-B-P4-2-R	1.5 - 2		NV	0.4 pCi/g dry
	AFP-B-P5-2-R	2 - 2.5		NV	0.5 pCi/g dry
AFP-B-P-3	AFP-B-P2-3-R	0.5 - 1	Uranium-238	NV	0.6 pCi/g dry
	AFP-B-P3-3-R	1 - 1.5		NV	0.3 pCi/g dry
	AFP-B-P4-3-R	1.5 - 2		NV	0.4 pCi/g dry
	AFP-B-P5-3-R	2 - 2.5		NV	0.4 pCi/g dry
AFP-B-P-4	AFP-B-P2-4-R	0.5 - 1	Uranium-238	NV	0.8 pCi/g dry
	AFP-B-P3-4-R	1 - 1.5		NV	0.4 pCi/g dry
	AFP-B-P4-4-R	1.5 - 2		NV	0.4 pCi/g dry
	AFP-B-P5-4-R	2 - 2.5		NV	0.4 pCi/g dry
IFP-B1-P-1	IFP-B1-P2-1-R	0.5 - 1	Uranium-238	NV	2.6 pCi/g dry
	IFP-B1-P3-1-R	1 - 1.5		NV	0.9 pCi/g dry
	IFP-B1-P4-1-R	1.5 - 2		NV	0.7 pCi/g dry
	IFP-B1-P5-1-R	2 - 2.5		NV	0.6 pCi/g dry
IFP-B1-P-2	IFP-B1-P2-2-R	0.5 - 1	Uranium-238	NV	2.2 pCi/g dry
	IFP-B1-P3-2-R	1 - 1.5		NV	0.9 pCi/g dry
	IFP-B1-P4-2-R	1.5 - 2		NV	0.7 pCi/g dry
	IFP-B1-P5-2-R	2 - 2.5		NV	0.5 pCi/g dry
IFP-B1-P-3	IFP-B1-P2-3-R	0.5 - 1	Uranium-238	NV	1.7 pCi/g dry
	IFP-B1-P3-3-R	1 - 1.5		NV	2.1 pCi/g dry
	IFP-B1-P4-3-R	1.5 - 2		NV	0.9 pCi/g dry
	IFP-B1-P5-3-R	2 - 2.5		NV	0.5 pCi/g dry
IFP-B1-P-4	IFP-B1-P2-4-R	0.5 - 1	Uranium-238	NV	4.7 pCi/g dry
	IFP-B1-P3-4-R	1 - 1.5		NV	3.1 pCi/g dry
	IFP-B1-P4-4-R	1.5 - 2		NV	3.0 pCi/g dry
	IFP-B1-P5-4-R	2 - 2.5		NV	2.4 pCi/g dry

Table D-3

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
-B2-P-1	IFP-B2-P2-1-R	0.5 - 1	Uranium-238	NV	1.0 pCi/g dry
	IFP-B2-P3-1-R	1 - 1.5		NV	0.4 pCi/g dry
	IFP-B2-P4-1-R	1.5 - 2		NV	0.5 pCi/g dry
	IFP-B2-P5-1-R	2 - 2.5		NV	0.5 pCi/g dry
IFP-B2-P-2	IFP-B2-P2-2-R	0.5 - 1	Uranium-238	NV	0.9 pCi/g dry
	IFP-B2-P3-2-R	1 - 1.5		NV	0.4 pCi/g dry
	IFP-B2-P4-2-R	1.5 - 2		NV	0.3 pCi/g dry
	IFP-B2-P5-2-R	2 - 2.5		NV	0.4 pCi/g dry
IFP-B2-P-3	IFP-B2-P2-3-R	0.5 - 1	Uranium-238	NV	2.5 pCi/g dry
	IFP-B2-P3-3-R	1 - 1.5		NV	0.7 pCi/g dry
	IFP-B2-P4-3-R	1.5 - 2		NV	0.3 pCi/g dry
	IFP-B2-P5-3-R	2 - 2.5		NV	0.3 pCi/g dry
IFP-B2-P-4	IFP-B2-P2-4-R	0.5 - 1	Uranium-238	NV	1.0 pCi/g dry
	IFP-B2-P3-4-R	1 - 1.5		NV	0.4 pCi/g dry
	IFP-B2-P4-4-R	1.5 - 2		NV	0.4 pCi/g dry
	IFP-B2-P5-4-R	2 - 2.5		NV	0.4 pCi/g dry
SF-B-P-1	SF-B-P2-1-R	0.5 - 1	Uranium-238	NV	1.7 pCi/g dry
	SF-B-P3-1-R	1 - 1.5		NV	1.8 pCi/g dry
	SF-B-P4-1-R	1.5 - 2		NV	1.3 pCi/g dry
	SF-B-P5-1-R	2 - 2.5		NV	0.9 pCi/g dry
SF-B-P-2	SF-B-P2-2-R	0.5 - 1	Uranium-238	NV	2.4 pCi/g dry
	SF-B-P3-2-R	1 - 1.5		NV	2.1 pCi/g dry
	SF-B-P4-2-R	1.5 - 2		NV	1.6 pCi/g dry
	SF-B-P5-2-R	2 - 2.5		NV	1.3 pCi/g dry
SF-B-P-3	SF-B-P2-3-R	0.5 - 1	Uranium-238	NV	3.1 pCi/g dry
	SF-B-P3-3-R	1 - 1.5		NV	1.5 pCi/g dry
	SF-B-P4-3-R	1.5 - 2		NV	1.2 pCi/g dry
	SF-B-P5-3-R	2 - 2.5		NV	0.9 pCi/g dry
SF-B-P-4	SF-B-P10-4-R	4.5 - 5	Uranium-238	NV	0.5 pCi/g dry
	SF-B-P2-4-R	0.5 - 1		NV	3.7 pCi/g dry
	SF-B-P3-4-R	1 - 1.5		NV	4.8 pCi/g dry
	SF-B-P4-4-R	1.5 - 2		NV	5.3 pCi/g dry
	SF-B-P5-4-R	2 - 2.5		NV	5.7 pCi/g dry
	SF-B-P6-4-R	2.5 - 3		NV	1.9 pCi/g dry
	SF-B-P7-4-R	3 - 3.5		NV	2.3 pCi/g dry
	SF-B-P8-4-R	3.5 - 4		NV	1.0 pCi/g dry
	SF-B-P9-4-R	4 - 4.5		NV	0.7 pCi/g dry

Table D-3

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
AVERAGE OF ALL RESULTS:	1.3 pCi/g				
MAXIMUM OF ALL RESULTS:	5.7 pCi/g				

BrPADAP RESULTS FOR TOTAL URANIUM - FILL AREA SAMPLES

Table D-4

ION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
FA-W-1	FA-W1-1-R	0 - 2	Uranium, Total		2.0 ppm dry
FA-W-2	FA-W1-2-R	0 - 2	Uranium, Total		12.0 ppm dry
FA-W-3	FA-W1-3-R	0 - 2	Uranium, Total		12.0 ppm dry
FA-W-4	FA-W1-4-R	0 - 2	Uranium, Total		11.6 ppm dry
FA-W-5	FA-W1-5-R	0 - 2	Uranium, Total		8.6 ppm dry
FA-W-6	FA-W1-6-R	0 - 2	Uranium, Total		10.8 ppm dry
FA-W-7	FA-W1-7-R	0 - 2	Uranium, Total		10.2 ppm dry
	FA-W2-7-R	2 - 4			5.2 ppm dry
	FA-W3-7-R	4 - 6			3.0 ppm dry
FA-W-8	FA-W1-8-R	0 - 2	Uranium, Total		18.0 ppm dry
	FA-W2-8-R	2 - 4			8.0 ppm dry
FA-W-9	FA-W1-9-R	0 - 2	Uranium, Total		9.0 ppm dry
	FA-W2-9-R	2 - 4			2.0 ppm dry
W-10	FA-W1-10-R	0 - 2	Uranium, Total		18.0 ppm dry
FA-W-11	FA-W1-11-R	0 - 2	Uranium, Total		10.0 ppm dry
	FA-W2-11-R	2 - 4			3.0 ppm dry
FA-W-12	FA-W1-12-R	0 - 2	Uranium, Total		19.0 ppm dry
FA-W-13	FA-W1-13-R	0 - 2	Uranium, Total		16.0 ppm dry
FA-W-14	FA-W1-14-R	0 - 2	Uranium, Total		16.0 ppm dry
FA-W-15	FA-W1-15-R	0 - 2	Uranium, Total		12.0 ppm dry
FA-W-16	FA-W1-16-R	0 - 2	Uranium, Total		14.0 ppm dry
FA-W-17	FA-W1-17-R	0 - 2	Uranium, Total		5.0 ppm dry
	FA-W2-17-R	2 - 4			2.0 ppm dry
FA-W-18	FA-W1-18-R	0 - 2	Uranium, Total		8.0 ppm dry
FA-W-19	FA-W1-19-R	0 - 2	Uranium, Total		6.0 ppm dry
FA-W-20	FA-W1-20-R	0 - 2	Uranium, Total		17.0 ppm dry

Table D-4

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
FA-W-21	FA-W1-21-R	0 - 2	Uranium, Total		9.0 ppm dry
	FA-W2-21-R	2 - 4			3.0 ppm dry
	FA-W3-21-R	4 - 6			2.0 ppm dry
FA-W-22	FA-W1-22-R	0 - 2	Uranium, Total		15.0 ppm dry
FA-W-23	FA-W1-23-R	0 - 2	Uranium, Total		8.0 ppm dry
	FA-W2-23-R	2 - 4			3.0 ppm dry
	FA-W3-23-R	4 - 6			11.0 ppm dry
	FA-W4-23-R	6 - 8			10.0 ppm dry
FA-W-24	FA-W1-24-R	0 - 2	Uranium, Total		7.0 ppm dry
FA-W-25	FA-W1-25-R	0 - 2	Uranium, Total		6.0 ppm dry
	FA-W2-25-R	2 - 4			4.0 ppm dry
FA-W-26	FA-W1-26-R	0 - 2	Uranium, Total		4.0 ppm dry
	FA-W2-26-R	2 - 4			4.0 ppm dry
	FA-W3-26-R	4 - 6			4.0 ppm dry
FA-W-27	FA-W1-27-R	0 - 2	Uranium, Total		11.0 ppm dry
	FA-W2-27-R	2 - 4			7.0 ppm dry
	FA-W3-27-R	4 - 6			6.0 ppm dry
FA-W-28	FA-W1-28-R	0 - 2	Uranium, Total		5.0 ppm dry
	FA-W2-28-R	2 - 4			18.0 ppm dry
	FA-W3-28-R	4 - 6			7.0 ppm dry
FA-W-29	FA-W1-29-R	0 - 2	Uranium, Total		15.0 ppm dry
	FA-W2-29-R	2 - 4			13.0 ppm dry
	FA-W3-29-R	4 - 6			11.0 ppm dry
	FA-W4-29-R	6 - 8			12.0 ppm dry
	FA-W5-29-R	8 - 10			9.0 ppm dry
	FA-W6-29-R	10 - 12			12.0 ppm dry
	FA-W7-29-R	12 - 14			3.0 ppm dry
FA-W-30	FA-W1-30-R	0 - 2	Uranium, Total		5.0 ppm dry
	FA-W2-30-R	2 - 4			13.0 ppm dry
	FA-W3-30-R	4 - 6			7.0 ppm dry
	FA-W4-30-R	6 - 8			9.0 ppm dry
	FA-W5-30-R	8 - 10			3.0 ppm dry
	FA-W6-30-R	10 - 12			4.0 ppm dry
	FA-W7-30-R	12 - 14			2.0 ppm dry

Table D-4

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
W-31	FA-W1-31-R	0 - 2	Uranium, Total		79.0 ppm dry
	FA-W2-31-R	2 - 4			34.0 ppm dry
	FA-W3-31-R	4 - 6			24.0 ppm dry
	FA-W4-31-R	6 - 8			41.0 ppm dry
	FA-W5-31-R	8 - 10			28.0 ppm dry
	FA-W6-31-R	10 - 12			11.0 ppm dry
	FA-W7-31-R	12 - 14			4.0 ppm dry
FA-W-32	FA-W1-32-R	0 - 2	Uranium, Total		11.1 ppm dry
	FA-W2-32-R	2 - 4			11.0 ppm dry
	FA-W3-32-R	4 - 6			15.0 ppm dry
	FA-W4-32-R	6 - 8			13.0 ppm dry
	FA-W5-32-R	8 - 10			9.0 ppm dry
FA-W-33	FA-W1-33-R	0 - 2	Uranium, Total		26.0 ppm dry
FA-W-34	FA-W1-34-R	0 - 2	Uranium, Total		8.0 ppm dry
	FA-W2-34-R	2 - 4			3.0 ppm dry
	FA-W3-34-R	4 - 6			4.0 ppm dry
	FA-W4-34-R	6 - 8			3.0 ppm dry
	FA-W5-34-R	8 - 10			3.0 ppm dry
W-35	FA-W1-35-R	0 - 2	Uranium, Total		16.0 ppm dry
FA-W-36	FA-W1-36-R	0 - 2	Uranium, Total		17.0 ppm dry
FA-W-37	FA-W1-37-R	0 - 2	Uranium, Total		10.0 ppm dry
FA-W-38	FA-W1-38-R	0 - 2	Uranium, Total		9.0 ppm dry
FA-W-39	FA-W1-39-R	0 - 2	Uranium, Total		10.0 ppm dry
FA-W-40	FA-W1-40-R	0 - 2	Uranium, Total		8.0 ppm dry
FA-W-41	FA-W1-41-R	0 - 2	Uranium, Total		12.0 ppm dry
	FA-W2-41-R	2 - 4			6.0 ppm dry
FA-W-42	FA-W1-42-R	0 - 2	Uranium, Total		11.0 ppm dry
	FA-W2-42-R	2 - 4			5.0 ppm dry
FA-W-43	FA-W1-43-R	0 - 2	Uranium, Total		11.0 ppm dry
	FA-W2-43-R	2 - 4			6.0 ppm dry
FA-W-44	FA-W1-44-R	0 - 2	Uranium, Total		17.0 ppm dry
	FA-W2-44-R	2 - 4			21.0 ppm dry
	FA-W3-44-R	4 - 6			32.0 ppm dry

Table D-4

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
FA-W-45	FA-W1-45-R	0 - 2	Uranium, Total		13.0 ppm dry
	FA-W2-45-R	2 - 4			23.0 ppm dry
FA-W-46	FA-W1-46-R	0 - 2	Uranium, Total		7.0 ppm dry
FA-W-47	FA-W1-47-R	0 - 2	Uranium, Total		22.0 ppm dry
	FA-W2-47-R	2 - 4			7.0 ppm dry
FA-W-48	FA-W1-48-R	0 - 2	Uranium, Total		36.2 ppm dry
	FA-W2-48-R	2 - 4			12.8 ppm dry
	FA-W3-48-R	4 - 6			21.6 ppm dry
FA-W-49	FA-W1-49-R	0 - 2	Uranium, Total		13.0 ppm dry
	FA-W2-49-R	2 - 4			4.0 ppm dry
	FA-W3-49-R	4 - 6			3.0 ppm dry
FA-W-50	FA-W1-50-R	0 - 2	Uranium, Total		18.0 ppm dry
	FA-W2-50-R	2 - 4			2.0 ppm dry
	FA-W3-50-R	4 - 6			2.0 ppm dry
FA-W-51	FA-W1-51-R	0 - 2	Uranium, Total		51.0 ppm dry
	FA-W2-51-R	2 - 4			15.6 ppm dry
	FA-W3-51-R	4 - 6		U	1.0 ppm dry
FA-W-52	FA-W1-52-R	0 - 2	Uranium, Total		20.6 ppm dry
	FA-W2-52-R	2 - 4			6.0 ppm dry
	FA-W3-52-R	4 - 6		U	1.0 ppm dry
FA-W-53	FA-W1-53-R	0 - 2	Uranium, Total		14.2 ppm dry
	FA-W2-53-R	2 - 4			6.0 ppm dry
FA-W-54	FA-W1-54-R	0 - 2	Uranium, Total		16.5 ppm dry
	FA-W2-54-R	2 - 4		U	1.0 ppm dry

AVERAGE OF ALL RESULTS: 11.6 PPM

MAXIMUM OF ALL RESULTS: 79.0 PPM

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HPGE VS BRPADAP RESULTS FOR TOTAL URANIUM - FILL AREA SAMPLES

Table D-5

STATION NUMBER	NORTHING	EASTING	PARAMETER	HPGE SAMPLE AND RESULT (ppm)		BRPADAP SAMPLE AND RESULT (ppm)	
FA-W-1	478054.01	1347376.34	Uranium, Total	FA-W-1-G	7.5	FA-W1-1-R	2
FA-W-2	477964.03	1347399.23	Uranium, Total	FA-W-2-G	14.5	FA-W1-2-R	12
FA-W-3	477866.78	1347413.96	Uranium, Total	FA-W-3-G	11.8	FA-W1-3-R	12
FA-W-4	477807.64	1347416.89	Uranium, Total	FA-W-4-G	13.4	FA-W1-4-R	11.6
FA-W-5	477778.91	1347398.47	Uranium, Total	FA-W-5-G	11.0	FA-W1-5-R	8.6
FA-W-6	477759.75	1347434.57	Uranium, Total	FA-W-6-G	14.0	FA-W1-6-R	10.8
FA-W-7	477739.29	1347413.85	Uranium, Total	FA-W-7-G	12.2	FA-W1-7-R	10.2
FA-W-7			Uranium, Total			FA-W2-7-R	5.2
FA-W-7			Uranium, Total			FA-W3-7-R	3
FA-W-8	477732.49	1347478.76	Uranium, Total	FA-W-8-G	17.4	FA-W1-8-R	18
FA-W-8			Uranium, Total			FA-W2-8-R	8
FA-W-9	477714.81	1347461.08	Uranium, Total	FA-W-9-G	15.6	FA-W1-9-R	9
FA-W-9			Uranium, Total			FA-W2-9-R	2
FA-W-10	477711.12	1347508.23	Uranium, Total	FA-W-10-G	17.6	FA-W1-10-R	18
FA-W-11	477686.81	1347543.59	Uranium, Total	FA-W-11-G	20.0	FA-W1-11-R	10
FA-W-11			Uranium, Total			FA-W2-11-R	3
FA-W-12	477666.18	1347609.88	Uranium, Total	FA-W-12-G	27.3	FA-W1-12-R	19
FA-W-13	477651.45	1347691.65	Uranium, Total	FA-W-13-G	18.3	FA-W1-13-R	16
FA-W-14	477631.57	1347781.04	Uranium, Total	FA-W-14-G	25.1	FA-W1-14-R	16
FA-W-15	477586.63	1347846.6	Uranium, Total	FA-W-15-G	22.5	FA-W1-15-R	12
FA-W-16	477484	1347870.84	Uranium, Total	FA-W-16-G	11.6	FA-W1-16-R	14
FA-W-17	477408.89	1347862.74	Uranium, Total	FA-W-17-G	9.8	FA-W1-17-R	5
FA-W-17			Uranium, Total			FA-W2-17-R	2

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Table D-5

STATION NUMBER	NORTHING	EASTING	PARAMETER	HPGE SAMPLE AND RESULT (ppm)		BRPADAP SAMPLE AND RESULT (ppm)	
FA-W-18	477366.16	1347841.38	Uranium, Total	FA-W-18-G	11.2	FA-W1-18-R	8
FA-W-19	477326.37	1347784.66	Uranium, Total	FA-W-19-G	10.6	FA-W1-19-R	6
FA-W-20	477290.27	1347747.82	Uranium, Total	FA-W-20-G	18.0	FA-W1-20-R	17
FA-W-22	477232.8	1347729.41	Uranium, Total	FA-W-22-G	10.1	FA-W1-22-R	15
FA-W-23	477256.41	1347797.24	Uranium, Total	FA-W-23-G	10.7	FA-W1-23-R	8
FA-W-23			Uranium, Total			FA-W2-23-R	3
FA-W-23			Uranium, Total			FA-W3-23-R	11
FA-W-23			Uranium, Total			FA-W4-23-R	10
FA-W-24	477184.91	1347753.72	Uranium, Total	FA-W-24-G	14.3	FA-W1-24-R	7
FA-W-26	477306.15	1347893.62	Uranium, Total	FA-W-26-G	11.0	FA-W1-26-R	4
FA-W-26			Uranium, Total			FA-W2-26-R	4
FA-W-26			Uranium, Total			FA-W3-26-R	4
FA-W-28	477321.69	1347958.13	Uranium, Total	FA-W-28-G	14.6	FA-W1-28-R	5
FA-W-28			Uranium, Total			FA-W2-28-R	18
FA-W-28			Uranium, Total			FA-W3-28-R	7
FA-W-29	477248.99	1347999.59	Uranium, Total	FA-W-29-G	26.8	FA-W1-29-R	15
FA-W-29			Uranium, Total			FA-W2-29-R	13
FA-W-29			Uranium, Total			FA-W3-29-R	11
FA-W-29			Uranium, Total			FA-W4-29-R	12
FA-W-29			Uranium, Total			FA-W5-29-R	9
FA-W-29			Uranium, Total			FA-W6-29-R	12
FA-W-29			Uranium, Total			FA-W7-29-R	3
FA-W-30	477258.43	1348051.79	Uranium, Total	FA-W-30-G	29.6	FA-W1-30-R	5
FA-W-30			Uranium, Total			FA-W2-30-R	13
FA-W-30			Uranium, Total			FA-W3-30-R	7

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Table D-5

STATION NUMBER	NORTHING	EASTING	PARAMETER	HPGE SAMPLE AND RESULT (ppm)		BRPADAP SAMPLE AND RESULT (ppm)	
FA-W-30	477258.43	1348051.79	Uranium, Total	FA-W-30-G	29.6	FA-W4-30-R	9
FA-W-30			Uranium, Total			FA-W5-30-R	3
FA-W-30			Uranium, Total			FA-W6-30-R	4
FA-W-30			Uranium, Total			FA-W7-30-R	2
FA-W-31	477227.85	1348055	Uranium, Total	FA-W-31-G	18.7	FA-W1-31-R	79
FA-W-31			Uranium, Total			FA-W2-31-R	34
FA-W-31			Uranium, Total			FA-W3-31-R	24
FA-W-31			Uranium, Total			FA-W4-31-R	41
FA-W-31			Uranium, Total			FA-W5-31-R	28
FA-W-31			Uranium, Total			FA-W6-31-R	11
FA-W-31			Uranium, Total			FA-W7-31-R	4
FA-W-32	477270.22	1348093.78	Uranium, Total	FA-W-32-G	17.7	FA-W1-32-R	11.1
FA-W-32			Uranium, Total			FA-W2-32-R	11
FA-W-32			Uranium, Total			FA-W3-32-R	15
FA-W-32			Uranium, Total			FA-W4-32-R	13
FA-W-32			Uranium, Total			FA-W5-32-R	9
FA-W-33	477318.58	1348091.04	Uranium, Total	FA-W-33-G	35.9	FA-W1-33-R	26
FA-W-34	477245.35	1348176.44	Uranium, Total	FA-W-34-G	4.6	FA-W1-34-R	8
FA-W-34			Uranium, Total			FA-W2-34-R	3
FA-W-34			Uranium, Total			FA-W3-34-R	4
FA-W-34			Uranium, Total			FA-W4-34-R	3
FA-W-34			Uranium, Total			FA-W5-34-R	3
FA-W-35	477245.17	1348176.28	Uranium, Total	FA-W-35-G	13.8	FA-W1-35-R	16
FA-W-36	477286.42	1348153.45	Uranium, Total	FA-W-36-G	21.6	FA-W1-36-R	17
FA-W-37	477319.75	1348177.02	Uranium, Total	FA-W-37-G	19.5	FA-W1-37-R	10

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Table D-5

STATION NUMBER	NORTHING	EASTING	PARAMETER	HPGE SAMPLE AND RESULT (ppm)		BRPADAP SAMPLE AND RESULT (ppm)	
FA-W-38	477467.07	1348242.94	Uranium, Total	FA-W-38-G	15.5	FA-W1-38-R	9
FA-W-39	477556.6		Uranium, Total	FA-W-39-G	11.1	FA-W1-39-R	10
FA-W-40	477644.45	1348271.78	Uranium, Total	FA-W-40-G	11.4	FA-W1-40-R	8
FA-W-41	477751.85	1348304.81	Uranium, Total	FA-W-41-G	11.7	FA-W1-41-R	12
FA-W-41			Uranium, Total			FA-W2-41-R	6
FA-W-42	477832.3	1348337.43	Uranium, Total	FA-W-42-G	17.7	FA-W1-42-R	11
FA-W-42			Uranium, Total			FA-W2-42-R	5
FA-W-43	477893.21	1348367.77	Uranium, Total	FA-W-43-G	14.8	FA-W1-43-R	11
FA-W-43			Uranium, Total			FA-W2-43-R	6
FA-W-44	477940.77	1348385.54	Uranium, Total	FA-W-44-G	19.4	FA-W1-44-R	17
FA-W-44			Uranium, Total			FA-W2-44-R	21
FA-W-44			Uranium, Total			FA-W3-44-R	32
FA-W-45	477939.93	1348400.21	Uranium, Total	FA-W-45-G	18.3	FA-W1-45-R	13
FA-W-45			Uranium, Total			FA-W2-45-R	23
FA-W-46	477968.67	1348350.14	Uranium, Total	FA-W-46-G	10.6	FA-W1-46-R	7
FA-W-47	477991.51	1348268.37	Uranium, Total	FA-W-47-G	19.2	FA-W1-47-R	22
FA-W-47			Uranium, Total			FA-W2-47-R	7
FA-W-48	478026.14	1348165.98	Uranium, Total	FA-W-48-G	26.0	FA-W1-48-R	36.2
FA-W-48			Uranium, Total			FA-W2-48-R	12.8
FA-W-48			Uranium, Total			FA-W3-48-R	21.6
FA-W-49	478065.18	1348057.7	Uranium, Total	FA-W-49-G	19.4	FA-W1-49-R	13
FA-W-49			Uranium, Total			FA-W2-49-R	4
FA-W-49			Uranium, Total			FA-W3-49-R	3
FA-W-50	478096.13	1347963.42	Uranium, Total	FA-W-50-G	17.1	FA-W1-50-R	18
FA-W-50			Uranium, Total			FA-W2-50-R	2

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Table D-5

STATION NUMBER	NORTHING	EASTING	PARAMETER	HPGE SAMPLE AND RESULT (ppm)		BRPADAP SAMPLE AND RESULT (ppm)	
FA-W-50	478096.13	1347963.42	Uranium, Total	FA-W-50-G	17.1	FA-W3-50-R	2
FA-W-51	478122.65	1347884.6	Uranium, Total	FA-W-51-G	14.9	FA-W1-51-R	51
FA-W-51			Uranium, Total			FA-W2-51-R	15.6
FA-W-51			Uranium, Total			FA-W3-51-R	1
FA-W-52	478155.07	1347798.41	Uranium, Total	FA-W-52-G	11.2	FA-W1-52-R	20.6
FA-W-52			Uranium, Total			FA-W2-52-R	6
FA-W-52			Uranium, Total			FA-W3-52-R	1
FA-W-53	478191.17	1347701.91	Uranium, Total	FA-W-53-G	14.1	FA-W1-53-R	14.2
FA-W-53			Uranium, Total			FA-W2-53-R	6
FA-W-54	478226.53	1347612.04	Uranium, Total	FA-W-54-G	15.7	FA-W1-54-R	16.5
FA-W-54			Uranium, Total			FA-W2-54-R	1

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RESULTS FOR RADIOLOGICAL SUITE - CHARACTERIZATION FOR REUSE SAMPLES

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
AFP-B-1	AFP-B-C-1-R	1 - 1.5	Uranium-238	NV	1.7	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.62	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.87	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.47	pCi/g dry
		1 - 1.5	Radium-226	NV	0.84	pCi/g dry
		1 - 1.5	Potassium-40	NV	11	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-2	AFP-B-C-2-R	1 - 1.5	Uranium-238	NV	3.6	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.72	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.75	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.44	pCi/g dry
		1 - 1.5	Radium-226	NV	0.99	pCi/g dry
		1 - 1.5	Potassium-40	NV	14	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-3	AFP-B-C-3-R	1 - 1.5	Uranium-238	NV	0.69	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.64	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.73	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.6	pCi/g dry
		1 - 1.5	Radium-226	NV	0.83	pCi/g dry
		1 - 1.5	Potassium-40	NV	14	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-4	AFP-B-C-4-R	1 - 1.5	Uranium-238	NV	1.4	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.86	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.81	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.54	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Potassium-40	NV	15	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-5	AFP-B-C-5-R	1 - 1.5	Uranium-238	NV	1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.34	pCi/g dry
		1 - 1.5	Thorium-230	NV	1.1	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.53	pCi/g dry
		1 - 1.5	Radium-226	NV	0.69	pCi/g dry
		1 - 1.5	Potassium-40	NV	6	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-6	AFP-B-C-6-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.92	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.97	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.55	pCi/g dry
		1 - 1.5	Radium-226	NV	1.1	pCi/g dry
		1 - 1.5	Potassium-40	NV	15	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
AFP-B-7	AFP-B-C-7-R	1 - 1.5	Uranium-238	NV	2.9	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.6	pCi/g dry
		1 - 1.5	Thorium-230	NV	1.4	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.71	pCi/g dry
		1 - 1.5	Radium-226	NV	1.1	pCi/g dry
		1 - 1.5	Potassium-40	NV	8	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-8	AFP-B-C-8-R	1 - 1.5	Uranium-238	NV	4.2	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.8	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.97	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.66	pCi/g dry
		1 - 1.5	Radium-226	NV	2.4	pCi/g dry
		1 - 1.5	Potassium-40	NV	11	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.003	pCi/g dry
AFP-B-9	AFP-B-C-9-R	1 - 1.5	Uranium-238	NV	0.83	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.84	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.69	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.66	pCi/g dry
		1 - 1.5	Radium-226	NV	0.97	pCi/g dry
		1 - 1.5	Potassium-40	NV	15	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-10	AFP-B-C-10-R	1 - 1.5	Uranium-238	NV	1.5	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.79	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.65	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.67	pCi/g dry
		1 - 1.5	Radium-226	NV	0.91	pCi/g dry
		1 - 1.5	Potassium-40	NV	14	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-11	AFP-B-C-11-R	1 - 1.5	Uranium-238	NV	0.51	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.47	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.66	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.6	pCi/g dry
		1 - 1.5	Radium-226	NV	0.68	pCi/g dry
		1 - 1.5	Potassium-40	NV	8.9	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-11	AFP-B-C-11-R-D	1 - 1.5	Uranium-238	NV	0.69	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.48	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.54	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.62	pCi/g dry
		1 - 1.5	Radium-226	NV	0.75	pCi/g dry
		1 - 1.5	Potassium-40	NV	9	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
AFP-B-12	AFP-B-C-12-R	1 - 1.5	Uranium-238	NV	1.2	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.7	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.65	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Potassium-40	NV	19	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.003	pCi/g dry
AFP-B-13	AFP-B-C-13-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.99	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.72	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.75	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Potassium-40	NV	18	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-14	AFP-B-C-14-R	1 - 1.5	Uranium-238	NV	1.3	pCi/g dry
		1 - 1.5	Thorium-232	NV	1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.69	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.66	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Potassium-40	NV	18	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.004	pCi/g dry
AFP-B-15	AFP-B-C-15-R	1 - 1.5	Uranium-238	NV	1.5	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.69	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.62	pCi/g dry
		1 - 1.5	Radium-226	NV	1.1	pCi/g dry
		1 - 1.5	Potassium-40	NV	17	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
AFP-B-16	AFP-B-C-16-R	1 - 1.5	Uranium-238	NV	1.4	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.94	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.72	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.68	pCi/g dry
		1 - 1.5	Radium-226	NV	1.1	pCi/g dry
		1 - 1.5	Potassium-40	NV	17	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.002	pCi/g dry
IFP-B1-1	IFP-B1-C-1-R	1.5 - 2	Uranium-238	NV	1.5	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.88	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.68	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.62	pCi/g dry
		1.5 - 2	Radium-226	NV	1.1	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
B1-2	IFP-B1-C-2-R	1.5 - 2	Uranium-238	NV	1.5	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.94	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.66	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.56	pCi/g dry
		1.5 - 2	Radium-226	NV	1.2	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-3	IFP-B1-C-3-R	1.5 - 2	Uranium-238	NV	1.4	pCi/g dry
		1.5 - 2	Thorium-232	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.73	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.61	pCi/g dry
		1.5 - 2	Radium-226	NV	1.5	pCi/g dry
		1.5 - 2	Neptunium-237	NV	0.036	pCi/g dry
IFP-B1-4	IFP-B1-C-4-R	1.5 - 2	Uranium-238	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.84	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.75	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.62	pCi/g dry
		1.5 - 2	Radium-226	NV	1.2	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-4	IFP-B1-C-4-R-D	1.5 - 2	Uranium-238	NV	1	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.84	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.8	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.62	pCi/g dry
		1.5 - 2	Radium-226	NV	1.1	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-5	IFP-B1-C-5-R	1.5 - 2	Uranium-238	NV	1.2	pCi/g dry
		1.5 - 2	Thorium-232	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.94	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.6	pCi/g dry
		1.5 - 2	Radium-226	NV	1.3	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-6	IFP-B1-C-6-R	1.5 - 2	Uranium-238	NV	1.4	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.76	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.62	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.72	pCi/g dry
		1.5 - 2	Radium-226	NV	1	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-7	IFP-B1-C-7-R	1.5 - 2	Uranium-238	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-232	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.89	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.58	pCi/g dry
		1.5 - 2	Radium-226	NV	1.3	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.03	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B1-8	IFP-B1-C-8-R	1.5 - 2	Uranium-238	NV	1.2	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.42	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.64	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.76	pCi/g dry
		1.5 - 2	Radium-226	NV	0.87	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-9	IFP-B1-C-9-R	1.5 - 2	Uranium-238	NV	1	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.91	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.89	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.59	pCi/g dry
		1.5 - 2	Radium-226	NV	1.2	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-10	IFP-B1-C-10-R	1.5 - 2	Uranium-238	NV	0.92	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.87	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.79	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.52	pCi/g dry
		1.5 - 2	Radium-226	NV	1.3	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-11	IFP-B1-C-11-R	1.5 - 2	Uranium-238	NV	3.9	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.96	pCi/g dry
		1.5 - 2	Thorium-230	NV	1.1	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.52	pCi/g dry
		1.5 - 2	Radium-226	NV	1.5	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.03	pCi/g dry
IFP-B1-12	IFP-B1-C-12-R	1.5 - 2	Uranium-238	NV	1.2	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.73	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.7	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.65	pCi/g dry
		1.5 - 2	Radium-226	NV	1	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-13	IFP-B1-C-13-R	1.5 - 2	Uranium-238	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.88	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.74	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.84	pCi/g dry
		1.5 - 2	Radium-226	NV	1.2	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry
IFP-B1-14	IFP-B1-C-14-R	1.5 - 2	Uranium-238	NV	1.9	pCi/g dry
		1.5 - 2	Thorium-232	NV	1.1	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.76	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.51	pCi/g dry
		1.5 - 2	Radium-226	NV	1.5	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.02	pCi/g dry

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Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
-B1-15	IFP-B1-C-15-R	1.5 - 2	Uranium-238	NV	6.1	pCi/g dry
		1.5 - 2	Thorium-232	NV	1.3	pCi/g dry
		1.5 - 2	Thorium-230	NV	3.5	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.51	pCi/g dry
		1.5 - 2	Radium-226	NV	2.4	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.03	pCi/g dry
IFP-B1-16	IFP-B1-C-16-R	1.5 - 2	Uranium-238	NV	2.5	pCi/g dry
		1.5 - 2	Thorium-232	NV	0.75	pCi/g dry
		1.5 - 2	Thorium-230	NV	0.62	pCi/g dry
		1.5 - 2	Technetium-99	UNV	0.56	pCi/g dry
		1.5 - 2	Radium-226	NV	1	pCi/g dry
		1.5 - 2	Neptunium-237	UNV	0.01	pCi/g dry
IFP-B2-1	IFP-B2-C-1-R	1 - 1.5	Uranium-238	NV	1.6	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.95	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.61	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.54	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.023	pCi/g dry
IFP-B2-2	IFP-B2-C-2-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.71	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.53	pCi/g dry
		1 - 1.5	Radium-226	NV	1.4	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.023	pCi/g dry
IFP-B2-3	IFP-B2-C-3-R	1 - 1.5	Uranium-238	NV	1.4	pCi/g dry
		1 - 1.5	Thorium-232	NV	1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.66	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.51	pCi/g dry
		1 - 1.5	Radium-226	NV	1.3	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.026	pCi/g dry
IFP-B2-4	IFP-B2-C-4-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.95	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.68	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.5	pCi/g dry
		1 - 1.5	Radium-226	NV	1.3	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.024	pCi/g dry
IFP-B2-5	IFP-B2-C-5-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.94	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.69	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.62	pCi/g dry
		1 - 1.5	Radium-226	NV	1.4	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.024	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B2-6	IFP-B2-C-6-R	1 - 1.5	Uranium-238	NV	1.3	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.97	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.74	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.6	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.021	pCi/g dry
IFP-B2-7	IFP-B2-C-7-R	1 - 1.5	Uranium-238	NV	0.81	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.97	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.96	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.59	pCi/g dry
		1 - 1.5	Radium-226	NV	1.5	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.025	pCi/g dry
IFP-B2-8	IFP-B2-C-8-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.8	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.51	pCi/g dry
		1 - 1.5	Radium-226	NV	1.5	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.024	pCi/g dry
IFP-B2-9	IFP-B2-C-9-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.73	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.59	pCi/g dry
		1 - 1.5	Radium-226	NV	1.4	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.025	pCi/g dry
IFP-B2-10	IFP-B2-C-10-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.78	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.53	pCi/g dry
		1 - 1.5	Radium-226	NV	1.3	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.022	pCi/g dry
IFP-B2-11	IFP-B2-C-11-R	1 - 1.5	Uranium-238	NV	1.4	pCi/g dry
		1 - 1.5	Thorium-232	NV	1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.65	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.54	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.025	pCi/g dry
IFP-B2-12	IFP-B2-C-12-R	1 - 1.5	Uranium-238	NV	1.4	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.96	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.68	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.6	pCi/g dry
		1 - 1.5	Radium-226	NV	1.3	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.023	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
-B2-13	IFP-B2-C-13-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.92	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.76	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.61	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.025	pCi/g dry
IFP-B2-14	IFP-B2-C-14-R	1 - 1.5	Uranium-238	NV	1.3	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.92	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.58	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.52	pCi/g dry
		1 - 1.5	Radium-226	NV	1.1	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.021	pCi/g dry
IFP-B2-14	IFP-B2-C-14-R-D	1 - 1.5	Uranium-238	NV	1.2	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.95	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.66	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.67	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.028	pCi/g dry
IFP-B2-15	IFP-B2-C-15-R	1 - 1.5	Uranium-238	NV	1.5	pCi/g dry
		1 - 1.5	Thorium-232	NV	1	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.68	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.69	pCi/g dry
		1 - 1.5	Radium-226	NV	1.2	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.026	pCi/g dry
IFP-B2-16	IFP-B2-C-16-R	1 - 1.5	Uranium-238	NV	1.1	pCi/g dry
		1 - 1.5	Thorium-232	NV	0.96	pCi/g dry
		1 - 1.5	Thorium-230	NV	0.77	pCi/g dry
		1 - 1.5	Technetium-99	UNV	0.78	pCi/g dry
		1 - 1.5	Radium-226	NV	1.1	pCi/g dry
		1 - 1.5	Neptunium-237	UNV	0.025	pCi/g dry
SF-B-1	SF-B-C-1-R	3.5 - 4	Uranium-238	NV	0.63	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.75	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.58	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.714	pCi/g dry
		3.5 - 4	Radium-226	NV	1	pCi/g dry
		3.5 - 4	Potassium-40	NV	13	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SF-B-2	SF-B-C-2-R	3.5 - 4	Uranium-238	NV	1.2	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.97	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.68	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.75	pCi/g dry
		3.5 - 4	Radium-226	NV	1.2	pCi/g dry
		3.5 - 4	Potassium-40	NV	16	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-3	SF-B-C-3-R	3.5 - 4	Uranium-238	NV	0.91	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.52	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.47	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.87	pCi/g dry
		3.5 - 4	Radium-226	NV	0.79	pCi/g dry
		3.5 - 4	Potassium-40	NV	9.4	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-4	SF-B-C-4-R	3.5 - 4	Uranium-238	NV	1.3	pCi/g dry
		3.5 - 4	Thorium-232	NV	1	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.79	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.59	pCi/g dry
		3.5 - 4	Radium-226	NV	1.4	pCi/g dry
		3.5 - 4	Potassium-40	NV	18	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-5	SF-B-C-5-R	3.5 - 4	Uranium-238	NV	0.85	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.68	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.59	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.66	pCi/g dry
		3.5 - 4	Radium-226	NV	0.93	pCi/g dry
		3.5 - 4	Potassium-40	NV	12	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-6	SF-B-C-6-R	3.5 - 4	Uranium-238	NV	1.2	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.32	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.45	pCi/g dry
		3.5 - 4	Technetium-99	UNV	1.1	pCi/g dry
		3.5 - 4	Radium-226	NV	0.65	pCi/g dry
		3.5 - 4	Potassium-40	NV	6.9	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-7	SF-B-C-7-R	3.5 - 4	Uranium-238	NV	0.93	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.31	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.4	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.74	pCi/g dry
		3.5 - 4	Radium-226	NV	0.59	pCi/g dry
		3.5 - 4	Potassium-40	NV	7.9	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.001	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
B-8	SF-B-C-8-R	3.5 - 4	Uranium-238	NV	0.98	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.27	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.37	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.57	pCi/g dry
		3.5 - 4	Radium-226	NV	0.6	pCi/g dry
		3.5 - 4	Potassium-40	NV	6.2	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-8	SF-B-C-8-R-D	3.5 - 4	Uranium-238	NV	0.69	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.23	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.4	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.99	pCi/g dry
		3.5 - 4	Radium-226	NV	0.6	pCi/g dry
		3.5 - 4	Potassium-40	NV	5.6	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.001	pCi/g dry
SF-B-9	SF-B-C-9-R	3.5 - 4	Uranium-238	NV	0.69	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.25	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.38	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.57	pCi/g dry
		3.5 - 4	Radium-226	NV	0.54	pCi/g dry
		3.5 - 4	Potassium-40	NV	6.9	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
B-10	SF-B-C-10-R	3.5 - 4	Uranium-238	NV	2.7	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.86	pCi/g dry
		3.5 - 4	Thorium-230	NV	1.3	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.58	pCi/g dry
		3.5 - 4	Radium-226	NV	1.9	pCi/g dry
		3.5 - 4	Potassium-40	NV	10	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-11	SF-B-C-11-R	3.5 - 4	Uranium-238	NV	4.8	pCi/g dry
		3.5 - 4	Thorium-232	NV	1.8	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.98	pCi/g dry
		3.5 - 4	Technetium-99	UNV	1.4	pCi/g dry
		3.5 - 4	Radium-226	NV	1.4	pCi/g dry
		3.5 - 4	Potassium-40	NV	13	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-12	SF-B-C-12-R	3.5 - 4	Uranium-238	NV	2.7	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.66	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.54	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.8	pCi/g dry
		3.5 - 4	Radium-226	NV	0.99	pCi/g dry
		3.5 - 4	Potassium-40	NV	12	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry

Table D-6

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SF-B-13	SF-B-C-13-R	3.5 - 4	Uranium-238	NV	0.73	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.59	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.56	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.65	pCi/g dry
		3.5 - 4	Radium-226	NV	0.91	pCi/g dry
		3.5 - 4	Potassium-40	NV	12	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-14	SF-B-C-14-R	3.5 - 4	Uranium-238	NV	1.1	pCi/g dry
		3.5 - 4	Thorium-232	NV	1.1	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.77	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.57	pCi/g dry
		3.5 - 4	Radium-226	NV	1.4	pCi/g dry
		3.5 - 4	Potassium-40	NV	17	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-15	SF-B-C-15-R	3.5 - 4	Uranium-238	NV	1.1	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.87	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.69	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.61	pCi/g dry
		3.5 - 4	Radium-226	NV	1.1	pCi/g dry
		3.5 - 4	Potassium-40	NV	14	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry
SF-B-16	SF-B-C-16-R	3.5 - 4	Uranium-238	NV	1.2	pCi/g dry
		3.5 - 4	Thorium-232	NV	0.99	pCi/g dry
		3.5 - 4	Thorium-230	NV	0.73	pCi/g dry
		3.5 - 4	Technetium-99	UNV	0.6	pCi/g dry
		3.5 - 4	Radium-226	NV	1.3	pCi/g dry
		3.5 - 4	Potassium-40	NV	16	pCi/g dry
		3.5 - 4	Neptunium-237	UNV	0.002	pCi/g dry

RESULTS FOR CHEMICAL SUITE - CHARACTERIZATION FOR REUSE SAMPLES

Table D-7

TION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
AFP-B-1	AFP-B-C-1-M	1 - 1.5	Arsenic	-	4.5	mg/kg
		1 - 1.5	Lead	-	12.5	mg/kg
AFP-B-1	AFP-B-C-1-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	320	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	85	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	91	ug/kg
AFP-B-2	AFP-B-C-2-M	1 - 1.5	Arsenic	-	4.1	mg/kg
		1 - 1.5	Lead	J	11.9	mg/kg
AFP-B-2	AFP-B-C-2-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	J	67	ug/kg
		1 - 1.5	Benzo(a)pyrene	J	57	ug/kg
		1 - 1.5	Benzo(b)fluorant	J	62	ug/kg
		1 - 1.5	Benzo(k)fluorant	J	57	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	J	37	ug/kg
		1 - 1.5	Phenanthrene	-	100	ug/kg
AFP-B-3	AFP-B-C-3-M	1 - 1.5	Arsenic	-	3.2	mg/kg
		1 - 1.5	Lead	-	11.5	mg/kg
AFP-B-3	AFP-B-C-3-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	J	29	ug/kg
		1 - 1.5	Benzo(a)pyrene	J	26	ug/kg
		1 - 1.5	Benzo(b)fluorant	J	34	ug/kg
		1 - 1.5	Benzo(k)fluorant	J	31	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	86	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	J	40	ug/kg
AFP-B-4	AFP-B-C-4-M	1 - 1.5	Arsenic	-	6	mg/kg
		1 - 1.5	Lead	J	20.4	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
AFP-B-4	AFP-B-C-4-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	92	ug/kg
AFP-B-5	AFP-B-C-5-M	1 - 1.5	Arsenic	-	4	mg/kg
		1 - 1.5	Lead	J	14.6	mg/kg
AFP-B-5	AFP-B-C-5-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	320	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	86	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	91	ug/kg
AFP-B-6	AFP-B-C-6-M	1 - 1.5	Arsenic	-	4.2	mg/kg
		1 - 1.5	Lead	J	12.7	mg/kg
AFP-B-6	AFP-B-C-6-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	88	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	94	ug/kg
AFP-B-7	AFP-B-C-7-M	1 - 1.5	Arsenic	-	3.2	mg/kg
		1 - 1.5	Lead	-	11.3	mg/kg
AFP-B-7	AFP-B-C-7-SP	1 - 1.5	Aroclor-1260	U	35	ug/kg
		1 - 1.5	Benzo(a)anthrac	J	20	ug/kg
		1 - 1.5	Benzo(a)pyrene	J	18	ug/kg
		1 - 1.5	Benzo(b)fluorant	J	26	ug/kg
		1 - 1.5	Benzo(k)fluorant	J	26	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	84	ug/kg
		1 - 1.5	Dieldrin	U	3.5	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	260	ug/kg
		1 - 1.5	Phenanthrene	U	89	ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
-B-8	AFP-B-C-8-M	1 - 1.5	Arsenic	-	16.9	mg/kg
		1 - 1.5	Lead	J	20.8	mg/kg
AFP-B-8	AFP-B-C-8-SP	1 - 1.5	Aroclor-1260	-	64	ug/kg
		1 - 1.5	Benzo(a)anthrac	J	110	ug/kg
		1 - 1.5	Benzo(a)pyrene	J	110	ug/kg
		1 - 1.5	Benzo(b)fluorant	J	110	ug/kg
		1 - 1.5	Benzo(k)fluorant	J	110	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	J	26	ug/kg
		1 - 1.5	Dieldrin	U	4.8	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	J	87	ug/kg
		1 - 1.5	Phenanthrene	-	130	ug/kg
AFP-B-9	AFP-B-C-9-M	1 - 1.5	Arsenic	-	3.5	mg/kg
		1 - 1.5	Lead	-	12.8	mg/kg
AFP-B-9	AFP-B-C-9-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	94	ug/kg
AFP-B-10	AFP-B-C-10-M	1 - 1.5	Arsenic	-	4.2	mg/kg
		1 - 1.5	Lead	J	11.2	mg/kg
AFP-B-10	AFP-B-C-10-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5		Z	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	88	ug/kg
		1 - 1.5	Dieldrin	Z	3.7	ug/kg
		1 - 1.5		UJ	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	94	ug/kg
AFP-B-11	AFP-B-C-11-M	1 - 1.5	Arsenic	-	3.5	mg/kg
		1 - 1.5	Lead	-	9.8	mg/kg
AFP-B-11	AFP-B-C-11-M-D	1 - 1.5	Arsenic	-	3.5	mg/kg
		1 - 1.5	Lead	-	9	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
AFP-B-11	AFP-B-C-11-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	350	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	320	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	85	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	90	ug/kg
AFP-B-11	AFP-B-C-11-SP-D	1 - 1.5	Aroclor-1260	U	35	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	350	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	260	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	320	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	84	ug/kg
		1 - 1.5	Dieldrin	U	3.5	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	260	ug/kg
		1 - 1.5	Phenanthrene	U	90	ug/kg
AFP-B-12	AFP-B-C-12-M	1 - 1.5	Arsenic	-	3.4	mg/kg
		1 - 1.5	Lead	J	11.8	mg/kg
AFP-B-12	AFP-B-C-12-SP	1 - 1.5	Aroclor-1260	U	38	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	380	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	340	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	90	ug/kg
		1 - 1.5	Dieldrin	U	3.8	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	96	ug/kg
AFP-B-13	AFP-B-C-13-M	1 - 1.5	Arsenic	-	3.7	mg/kg
		1 - 1.5	Lead	-	13.8	mg/kg
AFP-B-13	AFP-B-C-13-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	37	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	88	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	UJ	94	ug/kg
AFP-B-14	AFP-B-C-14-M	1 - 1.5	Arsenic	-	2.7	mg/kg
		1 - 1.5	Lead	J	11.5	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
-B-14	AFP-B-C-14-SP	1 - 1.5	Aroclor-1260	Z	37	ug/kg
		1 - 1.5		UJ	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89	ug/kg
		1 - 1.5	Dieldrin	UJ	3.7	ug/kg
		1 - 1.5		Z	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	95	ug/kg
AFP-B-15	AFP-B-C-15-M	1 - 1.5	Arsenic	-	2.8	mg/kg
		1 - 1.5	Lead	-	13.5	mg/kg
AFP-B-15	AFP-B-C-15-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	95	ug/kg
-B-16	AFP-B-C-16-M	1 - 1.5	Arsenic	-	3.7	mg/kg
		1 - 1.5	Lead	J	11.6	mg/kg
AFP-B-16	AFP-B-C-16-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	340	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	90	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	95	ug/kg
IFP-B1-1	IFP-B1-C-1-M	1.5 - 2	Arsenic	-	4.1	mg/kg
		1.5 - 2	Lead	J	13.1	mg/kg
IFP-B1-1	IFP-B1-C-1-SP	1.5 - 2	Aroclor-1260	U	37	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	370	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	280	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	89	ug/kg
		1.5 - 2	Dieldrin	U	3.7	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	95	ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B1-2	IFP-B1-C-2-M	1.5 - 2	Arsenic	-	4.6	mg/kg
		1.5 - 2	Lead	-	14.9	mg/kg
IFP-B1-2	IFP-B1-C-2-SP	1.5 - 2	Aroclor-1260	U	38	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	380	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	280	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	340	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	90	ug/kg
		1.5 - 2	Dieldrin	U	3.8	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	96	ug/kg
IFP-B1-3	IFP-B1-C-3-M	1.5 - 2	Arsenic	-	4.6	mg/kg
		1.5 - 2	Lead	J	13.8	mg/kg
IFP-B1-3	IFP-B1-C-3-SP	1.5 - 2	Aroclor-1260	U	38	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	380	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	280	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	340	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	90	ug/kg
		1.5 - 2	Dieldrin	U	3.8	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	96	ug/kg
IFP-B1-4	IFP-B1-C-4-M	1.5 - 2	Arsenic	-	5.3	mg/kg
		1.5 - 2	Lead	J	11	mg/kg
IFP-B1-4	IFP-B1-C-4-M-D	1.5 - 2	Arsenic	-	6.3	mg/kg
		1.5 - 2	Lead	-	12.6	mg/kg
IFP-B1-4	IFP-B1-C-4-SP	1.5 - 2	Aroclor-1260	U	36	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	240	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	360	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	87	ug/kg
		1.5 - 2	Dieldrin	U	3.6	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	92	ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
B1-4	IFP-B1-C-4-SP-D	1.5 - 2	Aroclor-1260	U	36	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	240	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	360	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	87	ug/kg
		1.5 - 2	Dieldrin	U	3.6	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	92	ug/kg
IFP-B1-5	IFP-B1-C-5-M	1.5 - 2	Arsenic	-	4.9	mg/kg
		1.5 - 2	Lead	-	15.4	mg/kg
IFP-B1-5	IFP-B1-C-5-SP	1.5 - 2	Aroclor-1260	U	38	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	380	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	280	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	340	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	90	ug/kg
		1.5 - 2	Dieldrin	U	3.8	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	96	ug/kg
IFP-B1-6	IFP-B1-C-6-M	1.5 - 2	Arsenic	-	4.2	mg/kg
		1.5 - 2	Lead	J	10.5	mg/kg
IFP-B1-6	IFP-B1-C-6-SP	1.5 - 2	Aroclor-1260	U	36	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	240	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	360	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	320	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	86	ug/kg
		1.5 - 2	Dieldrin	U	3.6	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	92	ug/kg
IFP-B1-7	IFP-B1-C-7-M	1.5 - 2	Arsenic	-	4.3	mg/kg
		1.5 - 2	Lead	-	15.6	mg/kg
IFP-B1-7	IFP-B1-C-7-SP	1.5 - 2	Aroclor-1260	U	38	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	260	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	380	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	290	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	350	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	92	ug/kg
		1.5 - 2	Dieldrin	U	3.8	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	290	ug/kg
		1.5 - 2	Phenanthrene	U	98	ug/kg

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STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B1-8	IFP-B1-C-8-M	1.5 - 2	Arsenic	-	5	mg/kg
		1.5 - 2	Lead	J	8.5	mg/kg
IFP-B1-8	IFP-B1-C-8-SP	1.5 - 2	Aroclor-1260	U	36	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	240	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	360	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	320	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	85	ug/kg
		1.5 - 2	Dieldrin	U	3.6	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	91	ug/kg
IFP-B1-9	IFP-B1-C-9-M	1.5 - 2	Arsenic	-	4.8	mg/kg
		1.5 - 2	Lead	-	15.1	mg/kg
IFP-B1-9	IFP-B1-C-9-SP	1.5 - 2	Aroclor-1260	U	37	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	370	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	88	ug/kg
		1.5 - 2	Dieldrin	U	3.7	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	93	ug/kg
IFP-B1-10	IFP-B1-C-10-M	1.5 - 2	Arsenic	-	4.7	mg/kg
		1.5 - 2	Lead	J	13.1	mg/kg
IFP-B1-10	IFP-B1-C-10-SP	1.5 - 2	Aroclor-1260	U	37	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	370	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	88	ug/kg
		1.5 - 2	Dieldrin	U	3.7	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	93	ug/kg
IFP-B1-11	IFP-B1-C-11-M	1.5 - 2	Arsenic	-	5.5	mg/kg
		1.5 - 2	Lead	-	15.4	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
-B1-11	IFP-B1-C-11-SP	1.5 - 2	Aroclor-1260	U	37	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	370	ug/kg
		1.5 - 2	Benzo(b)fluorant	J	19	ug/kg
		1.5 - 2	Benzo(k)fluorant	J	21	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	89	ug/kg
		1.5 - 2	Dieldrin	U	3.7	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	95	ug/kg
IFP-B1-12	IFP-B1-C-12-M	1.5 - 2	Arsenic	-	3.9	mg/kg
		1.5 - 2	Lead	-	10.8	mg/kg
IFP-B1-12	IFP-B1-C-12-SP	1.5 - 2	Aroclor-1260	U	36	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	240	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	360	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	87	ug/kg
		1.5 - 2	Dieldrin	U	3.6	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	92	ug/kg
-B1-13	IFP-B1-C-13-M	1.5 - 2	Arsenic	-	4.6	mg/kg
		1.5 - 2	Lead	J	12.6	mg/kg
-B1-13	IFP-B1-C-13-SP	1.5 - 2	Aroclor-1260	U	37	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	370	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	280	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	89	ug/kg
		1.5 - 2	Dieldrin	U	3.7	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	95	ug/kg
-B1-14	IFP-B1-C-14-M	1.5 - 2	Arsenic	-	4.3	mg/kg
		1.5 - 2	Lead	J	13.2	mg/kg
-B1-14	IFP-B1-C-14-SP	1.5 - 2	Aroclor-1260	U	37	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	370	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	280	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	89	ug/kg
		1.5 - 2	Dieldrin	U	3.7	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	280	ug/kg
		1.5 - 2	Phenanthrene	U	95	ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B1-15	IFP-B1-C-15-M	1.5 - 2	Arsenic	-	15.7	mg/kg
		1.5 - 2	Lead	J	21.8	mg/kg
IFP-B1-15	IFP-B1-C-15-SP	1.5 - 2	Aroclor-1260	U	40	ug/kg
		1.5 - 2	Benzo(a)anthrac	J	29	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	400	ug/kg
		1.5 - 2	Benzo(b)fluorant	J	36	ug/kg
		1.5 - 2	Benzo(k)fluorant	J	46	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	96	ug/kg
		1.5 - 2	Dieldrin	U	4	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	300	ug/kg
		1.5 - 2	Phenanthrene	J	40	ug/kg
IFP-B1-16	IFP-B1-C-16-M	1.5 - 2	Arsenic	-	4.5	mg/kg
		1.5 - 2	Lead	-	10.9	mg/kg
IFP-B1-16	IFP-B1-C-16-SP	1.5 - 2	Aroclor-1260	U	36	ug/kg
		1.5 - 2	Benzo(a)anthrac	U	250	ug/kg
		1.5 - 2	Benzo(a)pyrene	U	360	ug/kg
		1.5 - 2	Benzo(b)fluorant	U	270	ug/kg
		1.5 - 2	Benzo(k)fluorant	U	330	ug/kg
		1.5 - 2	Dibenzo(a,h)anth	U	87	ug/kg
		1.5 - 2	Dieldrin	U	3.6	ug/kg
		1.5 - 2	Indeno(1,2,3-cd)	U	270	ug/kg
		1.5 - 2	Phenanthrene	U	93	ug/kg
IFP-B2-1	IFP-B2-C-1-M	1 - 1.5	Arsenic	NV	5.6	mg/kg
		1 - 1.5	Lead	NV	11.9	mg/kg
IFP-B2-1	IFP-B2-C-1-SP	1 - 1.5	Aroclor-1260	U	38	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	260	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	380	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	290	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	340	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	92	ug/kg
		1 - 1.5	Dieldrin	U	3.8	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	290	ug/kg
		1 - 1.5	Phenanthrene	U	97	ug/kg
IFP-B2-2	IFP-B2-C-2-M	1 - 1.5	Arsenic	NV	5.2	mg/kg
		1 - 1.5	Lead	NV	12.5	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
-B2-2	IFP-B2-C-2-SP	1 - 1.5	Aroclor-1260	U	37 ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250 ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89 ug/kg
		1 - 1.5	Dieldrin	U	3.7 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280 ug/kg
		1 - 1.5	Phenanthrene	U	95 ug/kg
IFP-B2-3	IFP-B2-C-3-M	1 - 1.5	Arsenic	NV	2.7 mg/kg
		1 - 1.5	Lead	NV	12.2 mg/kg
IFP-B2-3	IFP-B2-C-3-SP	1 - 1.5	Aroclor-1260	U	38 ug/kg
		1 - 1.5	Benzo(a)anthrac	U	260 ug/kg
		1 - 1.5	Benzo(a)pyrene	U	380 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	340 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	91 ug/kg
		1 - 1.5	Dieldrin	U	3.8 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280 ug/kg
		1 - 1.5	Phenanthrene	U	96 ug/kg
-P-B2-4	IFP-B2-C-4-M	1 - 1.5	Arsenic	NV	3.6 mg/kg
		1 - 1.5	Lead	NV	12.7 mg/kg
IFP-B2-4	IFP-B2-C-4-SP	1 - 1.5	Aroclor-1260	U	40 ug/kg
		1 - 1.5	Benzo(a)anthrac	U	270 ug/kg
		1 - 1.5	Benzo(a)pyrene	U	400 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	300 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	360 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	96 ug/kg
		1 - 1.5	Dieldrin	U	4 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	300 ug/kg
		1 - 1.5	Phenanthrene	U	100 ug/kg
IFP-B2-5	IFP-B2-C-5-M	1 - 1.5	Arsenic	NV	6.9 mg/kg
		1 - 1.5	Lead	NV	13.4 mg/kg
IFP-B2-5	IFP-B2-C-5-SP	1 - 1.5	Aroclor-1260	U	36 ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250 ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87 ug/kg
		1 - 1.5	Dieldrin	U	3.6 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270 ug/kg
		1 - 1.5	Phenanthrene	U	93 ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B2-6	IFP-B2-C-6-M	1 - 1.5	Arsenic	NV	3.1	mg/kg
		1 - 1.5	Lead	NV	12	mg/kg
IFP-B2-6	IFP-B2-C-6-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	93	ug/kg
IFP-B2-7	IFP-B2-C-7-M	1 - 1.5	Arsenic	NV	6.6	mg/kg
		1 - 1.5	Lead	NV	15.4	mg/kg
IFP-B2-7	IFP-B2-C-7-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	94	ug/kg
IFP-B2-8	IFP-B2-C-8-M	1 - 1.5	Arsenic	NV	3.3	mg/kg
		1 - 1.5	Lead	NV	13	mg/kg
IFP-B2-8	IFP-B2-C-8-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	93	ug/kg
IFP-B2-9	IFP-B2-C-9-M	1 - 1.5	Arsenic	NV	5.7	mg/kg
		1 - 1.5	Lead	NV	14.3	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
-B2-9	IFP-B2-C-9-SP	1 - 1.5	Aroclor-1260	U	38 ug/kg
		1 - 1.5	Benzo(a)anthrac	Z	260 ug/kg
		1 - 1.5		U	260 ug/kg
		1 - 1.5	Benzo(a)pyrene	Z	380 ug/kg
		1 - 1.5		U	380 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280 ug/kg
		1 - 1.5		Z	280 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	340 ug/kg
		1 - 1.5		Z	340 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	Z	91 ug/kg
		1 - 1.5		U	91 ug/kg
		1 - 1.5	Dieldrin	U	3.8 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	Z	280 ug/kg
		1 - 1.5		U	280 ug/kg
		1 - 1.5	Phenanthrene	Z	96 ug/kg
		1 - 1.5		U	96 ug/kg
IFP-B2-10	IFP-B2-C-10-M	1 - 1.5	Arsenic	NV	5.3 mg/kg
		1 - 1.5	Lead	NV	13.3 mg/kg
IFP-B2-10	IFP-B2-C-10-SP	1 - 1.5	Aroclor-1260	U	37 ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250 ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89 ug/kg
		1 - 1.5	Dieldrin	U	3.7 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280 ug/kg
		1 - 1.5	Phenanthrene	U	94 ug/kg
IFP-B2-11	IFP-B2-C-11-M	1 - 1.5	Arsenic	NV	2.8 mg/kg
		1 - 1.5	Lead	NV	11.8 mg/kg
IFP-B2-11	IFP-B2-C-11-SP	1 - 1.5	Aroclor-1260	U	36 ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250 ug/kg
		1 - 1.5		Z	250 ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360 ug/kg
		1 - 1.5		Z	360 ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270 ug/kg
		1 - 1.5		Z	270 ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330 ug/kg
		1 - 1.5		Z	330 ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87 ug/kg
		1 - 1.5		Z	87 ug/kg
		1 - 1.5	Dieldrin	U	3.6 ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	Z	270 ug/kg
		1 - 1.5		U	270 ug/kg
		1 - 1.5	Phenanthrene	Z	93 ug/kg
		1 - 1.5		U	93 ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
IFP-B2-12	IFP-B2-C-12-M	1 - 1.5	Arsenic	NV	2.8	mg/kg
		1 - 1.5	Lead	NV	12.8	mg/kg
IFP-B2-12	IFP-B2-C-12-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	92	ug/kg
IFP-B2-13	IFP-B2-C-13-M	1 - 1.5	Arsenic	NV	4.2	mg/kg
		1 - 1.5	Lead	NV	13.4	mg/kg
IFP-B2-13	IFP-B2-C-13-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	92	ug/kg
IFP-B2-14	IFP-B2-C-14-M	1 - 1.5	Arsenic	NV	3	mg/kg
		1 - 1.5	Lead	NV	12.2	mg/kg
IFP-B2-14	IFP-B2-C-14-M-D	1 - 1.5	Arsenic	NV	3.2	mg/kg
		1 - 1.5	Lead	NV	11.3	mg/kg
IFP-B2-14	IFP-B2-C-14-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	92	ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
-B2-14	IFP-B2-C-14-SP-D	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	87	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	92	ug/kg
IFP-B2-15	IFP-B2-C-15-M	1 - 1.5	Arsenic	NV	6.2	mg/kg
		1 - 1.5	Lead	NV	10.9	mg/kg
IFP-B2-15	IFP-B2-C-15-SP	1 - 1.5	Aroclor-1260	U	37	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	250	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	370	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	280	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	330	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	89	ug/kg
		1 - 1.5	Dieldrin	U	3.7	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	280	ug/kg
		1 - 1.5	Phenanthrene	U	94	ug/kg
IFP-B2-16	IFP-B2-C-16-M	1 - 1.5	Arsenic	NV	2.4	mg/kg
		1 - 1.5	Lead	NV	11.2	mg/kg
IFP-B2-16	IFP-B2-C-16-SP	1 - 1.5	Aroclor-1260	U	36	ug/kg
		1 - 1.5	Benzo(a)anthrac	U	240	ug/kg
		1 - 1.5	Benzo(a)pyrene	U	360	ug/kg
		1 - 1.5	Benzo(b)fluorant	U	270	ug/kg
		1 - 1.5	Benzo(k)fluorant	U	320	ug/kg
		1 - 1.5	Dibenzo(a,h)anth	U	85	ug/kg
		1 - 1.5	Dieldrin	U	3.6	ug/kg
		1 - 1.5	Indeno(1,2,3-cd)	U	270	ug/kg
		1 - 1.5	Phenanthrene	U	91	ug/kg
SF-B-1	SF-B-C-1-M	3.5 - 4	Arsenic	J	2.5	mg/kg
		3.5 - 4	Lead	-	10.6	mg/kg
SF-B-1	SF-B-C-1-SP	3.5 - 4	Aroclor-1260	U	38	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	250	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	370	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	280	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	340	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	90	ug/kg
		3.5 - 4	Dieldrin	U	3.8	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	280	ug/kg
		3.5 - 4	Phenanthrene	U	95	ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SF-B-2	SF-B-C-2-M	3.5 - 4	Arsenic	J	2.5	mg/kg
		3.5 - 4	Lead	-	11	mg/kg
SF-B-2	SF-B-C-2-SP	3.5 - 4	Aroclor-1260	U	38	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	260	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	380	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	280	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	340	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	91	ug/kg
		3.5 - 4	Dieldrin	U	3.8	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	280	ug/kg
		3.5 - 4	Phenanthrene	U	96	ug/kg
SF-B-3	SF-B-C-3-M	3.5 - 4	Arsenic	J	2.7	mg/kg
		3.5 - 4	Lead	-	7.5	mg/kg
SF-B-3	SF-B-C-3-SP	3.5 - 4	Aroclor-1260	U	36	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	240	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	360	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	270	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	320	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	86	ug/kg
		3.5 - 4	Dieldrin	U	3.6	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	270	ug/kg
		3.5 - 4	Phenanthrene	U	91	ug/kg
SF-B-4	SF-B-C-4-M	3.5 - 4	Arsenic	J	2.8	mg/kg
		3.5 - 4	Lead	-	13.8	mg/kg
SF-B-4	SF-B-C-4-SP	3.5 - 4	Aroclor-1260	U	38	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	250	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	380	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	280	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	340	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	90	ug/kg
		3.5 - 4	Dieldrin	U	3.8	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	280	ug/kg
		3.5 - 4	Phenanthrene	U	96	ug/kg
SF-B-5	SF-B-C-5-M	3.5 - 4	Arsenic	J	3.2	mg/kg
		3.5 - 4	Lead	-	14.1	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
B-5	SF-B-C-5-SP	3.5 - 4	Aroclor-1260	U	37 ug/kg
		3.5 - 4	Benzo(a)anthrac	J	40 ug/kg
		3.5 - 4	Benzo(a)pyrene	J	53 ug/kg
		3.5 - 4	Benzo(b)fluorant	J	56 ug/kg
		3.5 - 4	Benzo(k)fluorant	J	46 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	88 ug/kg
		3.5 - 4	Dieldrin	U	3.7 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	J	41 ug/kg
		3.5 - 4	Phenanthrene	J	25 ug/kg
SF-B-6	SF-B-C-6-M	3.5 - 4	Arsenic	J	3 mg/kg
		3.5 - 4	Lead	-	5.6 mg/kg
SF-B-6	SF-B-C-6-SP	3.5 - 4	Aroclor-1260	U	35 ug/kg
		3.5 - 4	Benzo(a)anthrac	U	230 ug/kg
		3.5 - 4	Benzo(a)pyrene	U	350 ug/kg
		3.5 - 4	Benzo(b)fluorant	U	260 ug/kg
		3.5 - 4	Benzo(k)fluorant	U	310 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	83 ug/kg
		3.5 - 4	Dieldrin	U	3.5 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	260 ug/kg
		3.5 - 4	Phenanthrene	U	88 ug/kg
SF-B-7	SF-B-C-7-M	3.5 - 4	Arsenic	J	2.2 mg/kg
		3.5 - 4	Lead	-	5.6 mg/kg
SF-B-7	SF-B-C-7-SP	3.5 - 4	Aroclor-1260	U	35 ug/kg
		3.5 - 4	Benzo(a)anthrac	U	240 ug/kg
		3.5 - 4	Benzo(a)pyrene	U	350 ug/kg
		3.5 - 4	Benzo(b)fluorant	U	260 ug/kg
		3.5 - 4	Benzo(k)fluorant	U	320 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	84 ug/kg
		3.5 - 4	Dieldrin	U	3.5 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	260 ug/kg
		3.5 - 4	Phenanthrene	U	89 ug/kg
SF-B-8	SF-B-C-8-M	3.5 - 4	Arsenic	J	7.6 mg/kg
		3.5 - 4	Lead	-	4.6 mg/kg
SF-B-8	SF-B-C-8-M-D	3.5 - 4	Arsenic	J	1.9 mg/kg
		3.5 - 4	Lead	-	4 mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SF-B-8	SF-B-C-8-SP	3.5 - 4	Aroclor-1260	U	35	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	230	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	350	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	260	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	310	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	84	ug/kg
		3.5 - 4	Dieldrin	U	3.5	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	260	ug/kg
		3.5 - 4	Phenanthrene	U	89	ug/kg
SF-B-8	SF-B-C-8-SP-D	3.5 - 4	Aroclor-1260	U	35	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	240	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	350	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	260	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	320	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	84	ug/kg
		3.5 - 4	Dieldrin	U	3.5	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	260	ug/kg
		3.5 - 4	Phenanthrene	U	90	ug/kg
SF-B-9	SF-B-C-9-M	3.5 - 4	Arsenic	J	2.5	mg/kg
		3.5 - 4	Lead	-	4.9	mg/kg
SF-B-9	SF-B-C-9-SP	3.5 - 4	Aroclor-1260	U	35	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	230	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	340	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	260	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	310	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	82	ug/kg
		3.5 - 4	Dieldrin	U	3.5	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	260	ug/kg
		3.5 - 4	Phenanthrene	U	87	ug/kg
SF-B-10	SF-B-C-10-M	3.5 - 4	Arsenic	J	3.3	mg/kg
		3.5 - 4	Lead	-	12.9	mg/kg
SF-B-10	SF-B-C-10-SP	3.5 - 4	Aroclor-1260	U	37	ug/kg
		3.5 - 4	Benzo(a)anthrac	J	75	ug/kg
		3.5 - 4	Benzo(a)pyrene	J	110	ug/kg
		3.5 - 4	Benzo(b)fluorant	J	77	ug/kg
		3.5 - 4	Benzo(k)fluorant	J	73	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	88	ug/kg
		3.5 - 4	Dieldrin	U	3.7	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	J	81	ug/kg
		3.5 - 4	Phenanthrene	U	94	ug/kg
SF-B-11	SF-B-C-11-M	3.5 - 4	Arsenic	J	3.8	mg/kg
		3.5 - 4	Lead	-	20.7	mg/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
B-11	SF-B-C-11-SP	3.5 - 4	Aroclor-1260	U	38 ug/kg
		3.5 - 4	Benzo(a)anthrac	J	84 ug/kg
		3.5 - 4	Benzo(a)pyrene	J	81 ug/kg
		3.5 - 4	Benzo(b)fluorant	J	80 ug/kg
		3.5 - 4	Benzo(k)fluorant	J	81 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	91 ug/kg
		3.5 - 4	Dieldrin	U	3.8 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	J	54 ug/kg
		3.5 - 4	Phenanthrene	J	78 ug/kg
SF-B-12	SF-B-C-12-M	3.5 - 4	Arsenic	J	3.2 mg/kg
		3.5 - 4	Lead	-	10.2 mg/kg
SF-B-12	SF-B-C-12-SP	3.5 - 4	Aroclor-1260	U	37 ug/kg
		3.5 - 4	Benzo(a)anthrac	U	240 ug/kg
		3.5 - 4	Benzo(a)pyrene	U	360 ug/kg
		3.5 - 4	Benzo(b)fluorant	U	270 ug/kg
		3.5 - 4	Benzo(k)fluorant	U	330 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	87 ug/kg
		3.5 - 4	Dieldrin	U	3.7 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	270 ug/kg
		3.5 - 4	Phenanthrene	U	92 ug/kg
SF-B-13	SF-B-C-13-M	3.5 - 4	Arsenic	J	2.5 mg/kg
		3.5 - 4	Lead	-	8 mg/kg
SF-B-13	SF-B-C-13-SP	3.5 - 4	Aroclor-1260	U	36 ug/kg
		3.5 - 4	Benzo(a)anthrac	U	240 ug/kg
		3.5 - 4	Benzo(a)pyrene	U	360 ug/kg
		3.5 - 4	Benzo(b)fluorant	U	270 ug/kg
		3.5 - 4	Benzo(k)fluorant	U	320 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	85 ug/kg
		3.5 - 4	Dieldrin	U	3.6 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	270 ug/kg
		3.5 - 4	Phenanthrene	U	91 ug/kg
SF-B-14	SF-B-C-14-M	3.5 - 4	Arsenic	J	2.3 mg/kg
		3.5 - 4	Lead	-	12 mg/kg
SF-B-14	SF-B-C-14-SP	3.5 - 4	Aroclor-1260	U	39 ug/kg
		3.5 - 4	Benzo(a)anthrac	U	260 ug/kg
		3.5 - 4	Benzo(a)pyrene	U	390 ug/kg
		3.5 - 4	Benzo(b)fluorant	U	290 ug/kg
		3.5 - 4	Benzo(k)fluorant	U	350 ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	93 ug/kg
		3.5 - 4	Dieldrin	U	3.9 ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	290 ug/kg
		3.5 - 4	Phenanthrene	U	99 ug/kg

Table D-7

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SF-B-15	SF-B-C-15-M	3.5 - 4	Arsenic	J	2.9	mg/kg
		3.5 - 4	Lead	-	10.6	mg/kg
SF-B-15	SF-B-C-15-SP	3.5 - 4	Aroclor-1260	U	37	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	250	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	370	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	270	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	330	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	88	ug/kg
		3.5 - 4	Dieldrin	U	3.7	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	270	ug/kg
		3.5 - 4	Phenanthrene	U	93	ug/kg
SF-B-16	SF-B-C-16-M	3.5 - 4	Arsenic	J	2.7	mg/kg
		3.5 - 4	Lead	-	12	mg/kg
SF-B-16	SF-B-C-16-SP	3.5 - 4	Aroclor-1260	U	39	ug/kg
		3.5 - 4	Benzo(a)anthrac	U	260	ug/kg
		3.5 - 4	Benzo(a)pyrene	U	390	ug/kg
		3.5 - 4	Benzo(b)fluorant	U	290	ug/kg
		3.5 - 4	Benzo(k)fluorant	U	350	ug/kg
		3.5 - 4	Dibenzo(a,h)anth	U	93	ug/kg
		3.5 - 4	Dieldrin	U	3.9	ug/kg
		3.5 - 4	Indeno(1,2,3-cd)	U	290	ug/kg
		3.5 - 4	Phenanthrene	U	98	ug/kg

RESULTS FOR TOTAL URANIUM - ABOVE WAC DELINEATION SAMPLES

Table D-8

TION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
SWU-1-1	SWU-1-1-1-R	0 - 0.5	Uranium, Total	NV	16 ppm dry
	SWU-1-1-2-R	0.5 - 1		NV	16 ppm dry
	SWU-1-1-3-R	1 - 1.5		NV	36 ppm dry
	SWU-1-1-4-R	1.5 - 2		NV	44 ppm dry
	SWU-1-1-5-R	2 - 2.5		NV	23 ppm dry
	SWU-1-1-6-R	2.5 - 3		NV	14 ppm dry
	SWU-1-1-7-R	3 - 3.5		NV	7 ppm dry
SWU-1-2	SWU-1-2-1-R	0 - 0.5	Uranium, Total	NV	29 ppm dry
	SWU-1-2-2-R	0.5 - 1		NV	71 ppm dry
	SWU-1-2-3-R-D	1 - 1.5		NV	69 ug/g dry
	SWU-1-2-4-R	1.5 - 2		NV	62 ppm dry
	SWU-1-2-5-R	2 - 2.5		NV	42 ppm dry
	SWU-1-2-6-R	2.5 - 3		NV	14 ppm dry
	SWU-1-2-7-R	3 - 3.5		NV	4 ppm dry
SWU-1-3	SWU-1-3-1-R	0 - 0.5	Uranium, Total	NV	29 ppm dry
	SWU-1-3-2-R	0.5 - 1		NV	25 ppm dry
	SWU-1-3-3-R	1 - 1.5		NV	25 ppm dry
	SWU-1-3-4-R	1.5 - 2		NV	10 ppm dry
	SWU-1-3-5-R	2 - 2.5		NV	10 ppm dry
	SWU-1-3-6-R-D	2.5 - 3		NV	9.2 ug/g dry
	SWU-1-3-7-R	3 - 3.5		NV	8.95 ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SWU-1-4	SWU-1-4-1-R	0 - 0.5	Uranium, Total	NV	50.5	ppm dry
	SWU-1-4-3-R	1 - 1.5		NV	82.6	ppm dry
	SWU-1-4-4-R	1.5 - 2		NV	104	ppm dry
	SWU-1-4-5-R	2 - 2.5		NV	95.4	ppm dry
	SWU-1-4-6-R	2.5 - 3		NV	45.5	ppm dry
	SWU-1-4-7-R	3 - 3.5		NV	30.9	ppm dry
SWU-1-5	SWU-1-5-1-R	0 - 0.5	Uranium, Total	NV	71.4	ppm dry
	SWU-1-5-2-R-D	0.5 - 1		NV	39	ug/g dry
	SWU-1-5-3-R	1 - 1.5		NV	46.3	ppm dry
	SWU-1-5-4-R	1.5 - 2		NV	35	ppm dry
	SWU-1-5-5-R	2 - 2.5		NV	28.2	ppm dry
	SWU-1-5-6-R	2.5 - 3		NV	13.7	ppm dry
	SWU-1-5-7-R-D	3 - 3.5		NV	9.9	ug/g dry
SWU-2-1	SWU-2-1-1-R	0 - 0.5	Uranium, Total	NV	36.2	ppm dry
	SWU-2-1-2-R	0.5 - 1		NV	16.2	ppm dry
	SWU-2-1-3-R	1 - 1.5		NV	12.9	ppm dry
	SWU-2-1-4-R	1.5 - 2		NV	6.48	ppm dry
	SWU-2-1-5-R	2 - 2.5		NV	5.54	ppm dry
	SWU-2-1-6-R	2.5 - 3		NV	3.26	ppm dry
	SWU-2-1-7-R	3 - 3.5		NV	2.37	ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
U-2-2	SWU-2-2-1-R	0 - 0.5	Uranium, Total	NV	24 ppm dry
	SWU-2-2-2-R	0.5 - 1		NV	64 ppm dry
	SWU-2-2-3-R-D	1 - 1.5		NV	18 ug/g dry
	SWU-2-2-4-R	1.5 - 2		NV	11 ppm dry
	SWU-2-2-5-R	2 - 2.5		NV	8 ppm dry
	SWU-2-2-6-R	2.5 - 3		NV	6 ppm dry
	SWU-2-2-7-R	3 - 3.5		NV	5 ppm dry
SWU-2-3	SWU-2-3-1-R	0 - 0.5	Uranium, Total	NV	18 ppm dry
	SWU-2-3-2-R	0.5 - 1		NV	19 ppm dry
	SWU-2-3-3-R	1 - 1.5		NV	17 ppm dry
	SWU-2-3-4-R	1.5 - 2		NV	13 ppm dry
	SWU-2-3-5-R	2 - 2.5		NV	9 ppm dry
	SWU-2-3-6-R-D	2.5 - 3		NV	8.2 ug/g dry
	SWU-2-3-7-R	3 - 3.5		NV	65 ppm dry
SWU-2-4	SWU-2-4-1-R	0 - 0.5	Uranium, Total	NV	36 ppm dry
	SWU-2-4-2-R	0.5 - 1		NV	16 ppm dry
	SWU-2-4-3-R	1 - 1.5		NV	8 ppm dry
	SWU-2-4-4-R	1.5 - 2		NV	7 ppm dry
	SWU-2-4-5-R	2 - 2.5		NV	7 ppm dry
	SWU-2-4-6-R	2.5 - 3		NV	8 ppm dry
	SWU-2-4-7-R	3 - 3.5		NV	4 ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SWU-2-5	SWU-2-5-1-R	0 - 0.5	Uranium, Total	NV	30	ppm dry
	SWU-2-5-2-R-D	0.5 - 1		NV	20	ug/g dry
	SWU-2-5-3-R	1 - 1.5		NV	11.5	ppm dry
	SWU-2-5-4-R	1.5 - 2		NV	7.73	ppm dry
	SWU-2-5-5-R	2 - 2.5		NV	7.45	ppm dry
	SWU-2-5-6-R	2.5 - 3		NV	5.53	ppm dry
	SWU-2-5-7-R-D	3 - 3.5		NV	4.1	ug/g dry
SWU-3-1	SWU-3-1-1-R	0 - 0.5	Uranium, Total	NV	11	ppm dry
	SWU-3-1-2-R	0.5 - 1		NV	8.41	ppm dry
	SWU-3-1-3-R	1 - 1.5		NV	10.6	ppm dry
	SWU-3-1-4-R	1.5 - 2		NV	66.5	ppm dry
	SWU-3-1-5-R	2 - 2.5		NV	40.7	ppm dry
	SWU-3-1-6-R	2.5 - 3		NV	8.97	ppm dry
	SWU-3-1-7-R	3 - 3.5		NV	3.06	ppm dry
SWU-3-2	SWU-3-2-1-R	0 - 0.5	Uranium, Total	NV	6.68	ppm dry
	SWU-3-2-2-R	0.5 - 1		NV	6.93	ppm dry
	SWU-3-2-3-R-D	1 - 1.5		NV	5.7	ug/g dry
	SWU-3-2-4-R	1.5 - 2		NV	11.8	ppm dry
	SWU-3-2-5-R	2 - 2.5		NV	20.8	ppm dry
	SWU-3-2-6-R	2.5 - 3		NV	40.6	ppm dry
	SWU-3-2-7-R	3 - 3.5		NV	39.5	ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
U-3-3	SWU-3-3-1-R	0 - 0.5	Uranium, Total	NV	9	ppm dry
	SWU-3-3-2-R	0.5 - 1		NV	3.21	ppm dry
	SWU-3-3-3-R	1 - 1.5		NV	5.54	ppm dry
	SWU-3-3-4-R	1.5 - 2		NV	5.42	ppm dry
	SWU-3-3-5-R	2 - 2.5		NV	17.6	ppm dry
	SWU-3-3-6-R-D	2.5 - 3		NV	53	ug/g dry
	SWU-3-3-7-R	3 - 3.5		NV	2.01	ppm dry
SWU-3-4	SWU-3-4-1-R	0 - 0.5	Uranium, Total	NV	17.6	ppm dry
	SWU-3-4-2-R	0.5 - 1		NV	28.9	ppm dry
	SWU-3-4-3-R	1 - 1.5		NV	34	ppm dry
	SWU-3-4-4-R	1.5 - 2		NV	54.1	ppm dry
	SWU-3-4-5-R	2 - 2.5		NV	221	ppm dry
	SWU-3-4-6-R	2.5 - 3		NV	418	ppm dry
	SWU-3-4-7-R	3 - 3.5		NV	298	ppm dry
SWU-3-5	SWU-3-5-1-R	0 - 0.5	Uranium, Total	NV	12.2	ppm dry
	SWU-3-5-2-R-D	0.5 - 1		NV	8.9	ug/g dry
	SWU-3-5-3-R	1 - 1.5		NV	12.9	ppm dry
	SWU-3-5-4-R	1.5 - 2		NV	25.9	ppm dry
	SWU-3-5-5-R	2 - 2.5		NV	50.7	ppm dry
	SWU-3-5-6-R	2.5 - 3		NV	40.4	ppm dry
	SWU-3-5-7-R-D	3 - 3.5		NV	29	ug/g dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SWU-4-1	SWU-4-1-1-R	0 - 0.5	Uranium, Total	NV	12.8	ppm dry
	SWU-4-1-2-R	0.5 - 1		NV	13.3	ppm dry
	SWU-4-1-3-R	1 - 1.5		NV	17	ppm dry
	SWU-4-1-4-R	1.5 - 2		NV	17.6	ppm dry
	SWU-4-1-5-R	2 - 2.5		NV	31.9	ppm dry
	SWU-4-1-6-R	2.5 - 3		NV	56.3	ppm dry
	SWU-4-1-7-R	3 - 3.5		NV	66.3	ppm dry
SWU-4-2	SWU-4-2-1-R	0 - 0.5	Uranium, Total	NV	20.9	ppm dry
	SWU-4-2-2-R	0.5 - 1		NV	14.7	ppm dry
	SWU-4-2-3-R-D	1 - 1.5		NV	19	ug/g dry
	SWU-4-2-4-R	1.5 - 2		NV	84.5	ppm dry
	SWU-4-2-5-R	2 - 2.5		NV	69.6	ppm dry
	SWU-4-2-6-R	2.5 - 3		NV	72.7	ppm dry
	SWU-4-2-7-R	3 - 3.5		NV	65.2	ppm dry
SWU-4-3	SWU-4-3-1-R	0 - 0.5	Uranium, Total	NV	26.4	ppm dry
	SWU-4-3-2-R	0.5 - 1		NV	23.8	ppm dry
	SWU-4-3-3-R	1 - 1.5		NV	50.5	ppm dry
	SWU-4-3-4-R	1.5 - 2		NV	81	ppm dry
	SWU-4-3-5-R	2 - 2.5		NV	99	ppm dry
	SWU-4-3-6-R-D	2.5 - 3		NV	92	ug/g dry
	SWU-4-3-7-R	3 - 3.5		NV	123	ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
U-4-4	SWU-4-4-1-R	0 - 0.5	Uranium, Total	NV	36.7	ppm dry
	SWU-4-4-2-R	0.5 - 1		NV	20.4	ppm dry
	SWU-4-4-3-R	1 - 1.5		NV	13.2	ppm dry
	SWU-4-4-4-R	1.5 - 2		NV	12.2	ppm dry
	SWU-4-4-5-R	2 - 2.5		NV	23.9	ppm dry
	SWU-4-4-6-R	2.5 - 3		NV	55.8	ppm dry
	SWU-4-4-7-R	3 - 3.5		NV	30.6	ppm dry
SWU-4-5	SWU-4-5-1-R	0 - 0.5	Uranium, Total	NV	25.4	ppm dry
	SWU-4-5-2-R-D	0.5 - 1		NV	13	ug/g dry
	SWU-4-5-3-R	1 - 1.5		NV	11.8	ppm dry
	SWU-4-5-4-R	1.5 - 2		NV	13.6	ppm dry
	SWU-4-5-5-R	2 - 2.5		NV	34.5	ppm dry
	SWU-4-5-6-R	2.5 - 3		NV	46.2	ppm dry
	SWU-4-5-7-R-D	3 - 3.5		NV	49	ug/g dry
SWU-5-1	SWU-5-1-48-R	23.5 - 24	Uranium, Total	NV	10	ppm dry
SWU-5-10	SWU-5-10-21-R	10 - 10.5	Uranium, Total	NV	292	ppm dry
	SWU-5-10-24-R	11.5 - 12		NV	520	ppm dry
	SWU-5-10-29-R	14 - 14.5		NV	186	ppm dry
	SWU-5-10-31-R	15 - 15.5		NV	4980	ppm dry
	SWU-5-10-32-R	15.5 - 16		NV	1290	ppm dry
SWU-5-11	SWU-5-11-36-R	17.5 - 18	Uranium, Total	NV	1.18	ppm dry
SWU-5-12	SWU-5-12-32-R	15.5 - 16	Uranium, Total	NV	1.72	ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS	
SWU-5-13	SWU-5-13-32-R-D	15.5 - 16	Uranium, Total	NV	2.8	ug/g dry
	SWU-5-13-32-R-D	15.5 - 16		NV	5.26	ppm dry
SWU-5-14	SWU-5-14-15-R	7 - 7.5	Uranium, Total	NV	632	ppm dry
SWU-5-15	SWU-5-15-37-R	18 - 18.5	Uranium, Total	NV	2180	ppm dry
	SWU-5-15-38-R	18.5 - 19		NV	9090	ppm dry
	SWU-5-15-39-R	19 - 19.5		NV	3690	ppm dry
	SWU-5-15-46-R	22.5 - 23		NV	3980	ppm dry
	SWU-5-15-49-R	24 - 24.5		NV	1110	ppm dry
	SWU-5-15-51-R	25 - 25.5		NV	3660	ppm dry
	SWU-5-15-52-R	25.5 - 26		NV	168	ppm dry
SWU-5-16	SWU-5-16-39-R	19 - 19.5	Uranium, Total	NV	3220	ppm dry
SWU-5-17	SWU-5-17-32-R	15.5 - 16	Uranium, Total	NV	469	ppm dry
SWU-5-18	SWU-5-18-37-R	18 - 18.5	Uranium, Total	NV	1390	ppm dry
	SWU-5-18-38-R	18.5 - 19		NV	1930	ppm dry
	SWU-5-18-41-R	20 - 20.5		NV	8890	ppm dry
SWU-5-19	SWU-5-19-44-R	21.5 - 22	Uranium, Total	NV	242	ppm dry
	SWU-5-19-48-R	23.5 - 24		NV	1480	ppm dry
	SWU-5-19-49-R-D	24 - 24.5		NV	2000	ug/g dry
	SWU-5-19-49-R-D	24 - 24.5		NV	1770	ppm dry
	SWU-5-19-50-R	24.5 - 25		NV	1870	ppm dry
SWU-5-2	SWU-5-2-34-R	16.5 - 17	Uranium, Total	NV	612	ppm dry
SWU-5-21	SWU-5-21-47-R	23 - 23.5	Uranium, Total	NV	2640	ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
U-5-23	SWU-5-23-49-R	24 - 24.5	Uranium, Total	NV	683 ppm dry
SWU-5-3	SWU-5-3-2-R	0.5 - 1	Uranium, Total	NV	14 ppm dry
	SWU-5-3-36-R	17.5 - 18		NV	1.24 ppm dry
SWU-5-4	SWU-5-4-29-R	14 - 14.5	Uranium, Total	NV	2 ppm dry
SWU-5-5	SWU-5-5-13-R	6 - 6.5	Uranium, Total	NV	424 ppm dry
SWU-5-6	SWU-5-6-41-R	20 - 20.5	Uranium, Total	NV	1.39 ppm dry
SWU-5-7	SWU-5-7-46-R	22.5 - 23	Uranium, Total	NV	626 ppm dry
SWU-5-8	SWU-5-8-44-R	21.5 - 22	Uranium, Total	NV	138 ppm dry
	SWU-5-8-45-R	22 - 22.5		NV	1130 ppm dry
	SWU-5-8-46-R	22.5 - 23		NV	1140 ppm dry
	SWU-5-8-47-R	23 - 23.5		NV	1070 ppm dry
	SWU-5-8-54-R	26.5 - 27		NV	195 ppm dry
SWU-5-9	SWU-5-9-39-R	19 - 19.5	Uranium, Total	NV	2080 ppm dry
	SWU-5-9-40-R	19.5 - 20		NV	1220 ppm dry
	SWU-5-9-42-R	20.5 - 21		NV	144 ppm dry

AVERAGE OF ALL RESULTS: 391.4 ppm dry

MAXIMUM OF ALL RESULTS: 9090.0 ppm dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
SWU-4-1	SWU-4-1-1-R	0 - 0.5	Technetium-99	UNV	1 pCi/g dry
	SWU-4-1-2-R	0.5 - 1		UNV	1.3 pCi/g dry
	SWU-4-1-3-R	1 - 1.5		UNV	1.2 pCi/g dry
	SWU-4-1-4-R	1.5 - 2		UNV	1.2 pCi/g dry
	SWU-4-1-5-R	2 - 2.5		UNV	1.5 pCi/g dry
	SWU-4-1-6-R	2.5 - 3		UNV	1.4 pCi/g dry
	SWU-4-1-7-R	3 - 3.5		UNV	1.4 pCi/g dry
SWU-4-2	SWU-4-2-1-R	0 - 0.5	Technetium-99	UNV	1.3 pCi/g dry
	SWU-4-2-2-R	0.5 - 1		UNV	1.1 pCi/g dry
	SWU-4-2-3-R-D	1 - 1.5		UNV	0.647 pCi/g dry
	SWU-4-2-4-R	1.5 - 2		UNV	1.3 pCi/g dry
	SWU-4-2-5-R	2 - 2.5		UNV	1.3 pCi/g dry
	SWU-4-2-6-R	2.5 - 3		UNV	1.2 pCi/g dry
	SWU-4-2-7-R	3 - 3.5		UNV	1.2 pCi/g dry
SWU-4-3	SWU-4-3-1-R	0 - 0.5	Technetium-99	UNV	1.3 pCi/g dry
	SWU-4-3-2-R	0.5 - 1		UNV	1.5 pCi/g dry
	SWU-4-3-3-R	1 - 1.5		UNV	1.6 pCi/g dry
	SWU-4-3-4-R	1.5 - 2		UNV	1.3 pCi/g dry
	SWU-4-3-5-R	2 - 2.5		UNV	1.9 pCi/g dry
	SWU-4-3-6-R-D	2.5 - 3		UNV	0.622 pCi/g dry
	SWU-4-3-7-R	3 - 3.5		UNV	1.6 pCi/g dry

Table D-8

STATION NUMBER	SAMPLE NUMBER	DEPTH (in ft.)	PARAMETER	QUAL.	RESULT AND UNITS
U-4-4	SWU-4-4-1-R	0 - 0.5	Technetium-99	UNV	1.4 pCi/g dry
	SWU-4-4-2-R	0.5 - 1		UNV	1.4 pCi/g dry
	SWU-4-4-3-R	1 - 1.5		UNV	1.3 pCi/g dry
	SWU-4-4-4-R	1.5 - 2		UNV	1.4 pCi/g dry
	SWU-4-4-5-R	2 - 2.5		UNV	1.3 pCi/g dry
	SWU-4-4-6-R	2.5 - 3		UNV	1.4 pCi/g dry
	SWU-4-4-7-R	3 - 3.5		UNV	1.5 pCi/g dry
SWU-4-5	SWU-4-5-1-R	0 - 0.5	Technetium-99	UNV	1.4 pCi/g dry
	SWU-4-5-2-R-D	0.5 - 1		UNV	0.571 pCi/g dry
	SWU-4-5-3-R	1 - 1.5		UNV	1.2 pCi/g dry
	SWU-4-5-4-R	1.5 - 2		UNV	1.1 pCi/g dry
	SWU-4-5-5-R	2 - 2.5		UNV	1.3 pCi/g dry
	SWU-4-5-6-R	2.5 - 3		UNV	1.3 pCi/g dry
	SWU-4-5-7-R-D	3 - 3.5		UNV	0.528 pCi/g dry

AVERAGE OF ALL RESULTS: 1.3 pCi/g dry

MAXIMUM OF ALL RESULTS: 1.9 pCi/g dry

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU 1-1-1	0-0.5	8/22/97	16	NA	0
SWU 1-1-2	0.5-1	8/22/97	16	NA	0
SWU 1-1-3	1-1.5	8/22/97	44	NA	0
SWU 1-1-4	1.5-2	8/22/97	23	NA	0
SWU-1-1-5	2-2.5	8/22/97	14	NA	0
SWU-1-1-6	2.5-3	8/22/97	7	NA	0
SWU-1-1-7	3-3.5	8/22/97	7	NA	0
SWU-1-2-1	0-0.5	8/22/97	29	NA	50
SWU-1-2-2	0.5-1	8/22/97	12.7	NA	50
SWU-1-2-3	1-1.5	8/22/97	56.9	NA	50
SWU-1-2-3-D	1-1.5	8/22/97	69	NA	50
SWU-1-2-4	1.5-2	8/22/97	62	NA	50
SWU-1-2-5	2-2.5	8/22/97	8.3	NA	50
SWU-1-2-6	2.5-3	8/22/97	14	NA	50
SWU-1-2-7	3-3.5	8/22/97	4	NA	50
SWU-1-3-1	0-0.5	8/22/97	29	NA	50
SWU-1-3-2	0.5-1	8/22/97	25	NA	50
SWU-1-3-3	1-1.5	8/22/97	25	NA	50
SWU-1-3-4	1.5-2	8/22/97	10	NA	50
SWU-1-3-5	2-2.5	8/22/97	10	NA	50
SWU-1-3-6	2.5-3	8/22/97	11.2	NA	50
SWU-1-3-6-D	2.5-3	8/22/97	9.2	NA	50
SWU-1-3-7	3-3.5	8/22/97	16	NA	50
SWU-1-4-1	0-0.5	8/22/97	50.5	NA	50
SWU-1-4-2	0.5-1	8/22/97	44.2	NA	50
SWU-1-4-3	1-1.5	8/22/97	82.6	NA	50

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-1-4-4	1.5-2	8/22/97	104	NA	50
SWU-1-4-5	2-2.5	8/22/97	95.4	NA	50
SWU-1-4-6	2.5-3	8/22/97	45.5	NA	50
SWU-1-4-7	3-3.5	8/22/97	30.9	NA	50
SWU-1-5-1	0-0.5	8/22/97	71.4	NA	0
SWU-1-5-2	0.5-1	8/22/97	33.8	NA	0
SWU-1-5-2-D	0.5-1	8/22/97	39	NA	0
SWU-1-5-3	1-1.5	8/22/97	46.3	NA	0
SWU-1-5-4	1.5-2	8/22/97	35	NA	0
SWU-1-5-5	2-2.5	8/22/97	28.2	NA	0
SWU-1-5-6	2.5-3	8/22/97	13.7	NA	0
SWU-1-5-7	3-3.5	8/22/97	18.9	NA	0
SWU-1-5-7-D	3-3.5	8/22/97	9.9	NA	0
SWU-2-1-1	0-0.5	8/22/97	36.2	NA	0
SWU-2-1-2	0.5-1	8/22/97	16.2	NA	0
SWU-2-1-3	1-1.5	8/22/97	12.9	NA	0
SWU-2-1-4	1.5-2	8/22/97	6.48	NA	0
SWU-2-1-5	2-2.5	8/22/97	5.54	NA	0
SWU-2-1-6	2.5-3	8/22/97	3.26	NA	0
SWU-2-1-7	3-3.5	8/22/97	2.37	NA	0
SWU-2-2-1	0-0.5	8/24/97	24	NA	0
SWU-2-2-2	0.5-1	8/24/97	64	NA	0
SWU-2-2-3	1-1.5	8/24/97	20.6	NA	0
SWU-2-2-3-D	1-1.5	8/24/97	18	NA	0
SWU-2-2-4	1.5-2	8/24/97	11	NA	0
SWU-2-2-5	2-2.5	8/24/97	8	NA	0

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-2-2-6	2.5-3	8/24/97	6	NA	0
SWU-2-2-7	3-3.5	8/24/97	5	NA	0
SWU-2-3-1	0-0.5	8/22/97	18	NA	0
SWU-2-3-2	0.5-1	8/22/97	19	NA	0
SWU-2-3-3	1-1.5	8/22/97	17	NA	0
SWU-2-3-4	1.5-2	8/22/97	13	NA	0
SWU-2-3-5	2-2.5	8/22/97	9	NA	0
SWU-2-3-6	2.5-3	8/22/97	8.73	NA	0
SWU-2-3-6-D	2.5-3	8/22/97	8.2	NA	0
SWU-2-3-7	3-3.5	8/22/97	65	NA	0
SWU-2-4-1	0-0.5	8/22/97	36	NA	0
SWU-2-4-2	0.5-1	8/22/97	16	NA	0
SWU-2-4-3	1-1.5	8/22/97	8	NA	0
SWU-2-4-4	1.5-2	8/22/97	7	NA	0
SWU-2-4-5	2-2.5	8/22/97	7	NA	0
SWU-2-4-6	2.5-3	8/22/97	8	NA	0
SWU-2-4-7	3-3.5	8/22/97	4	NA	0
SWU-2-5-1	0-0.5	8/22/97	30	NA	0
SWU-2-5-2	0.5-1	8/22/97	19.3	NA	0
SWU-2-5-2-D	0.5-1	8/22/97	20	NA	0
SWU-2-5-3	1-1.5	8/22/97	11.5	NA	0
SWU-2-5-4	1.5-2	8/22/97	7	NA	0
SWU-2-5-5	2-2.5	8/22/97	7.45	NA	0
SWU-2-5-6	2.5-3	8/22/97	5.53	NA	0
SWU-2-5-7	3-3.5	8/22/97	3.11	NA	0
SWU-2-5-7-D	3-3.5	8/22/97	4.1	NA	0

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-3-1-1	0-0.5	8/24/97	11	NA	0
SWU-3-1-2	0.5-1	8/24/97	8.41	NA	0
SWU-3-1-3	1-1.5	8/24/97	10.6	NA	0
SWU-3-1-4	1.5-2	8/24/97	66.5	NA	0
SWU-3-1-5	2-2.5	8/24/97	40.7	NA	0
SWU-3-1-6	2.5-3	8/24/97	8.97	NA	0
SWU-3-1-7	3-3.5	8/24/97	3.06	NA	0
SWU-3-2-1	0-0.5	8/24/97	6.68	NA	0
SWU-3-2-2	0.5-1	8/24/97	6.93	NA	0
SWU-3-2-3	1-1.5	8/24/97	9.37	NA	0
SWU-3-2-3-D	1-1.5	8/24/97	5.7	NA	0
SWU-3-2-4	1.5-2	8/24/97	11.8	NA	0
SWU-3-2-5	2-2.5	8/24/97	20.8	NA	0
SWU-3-2-6	2.5-3	8/24/97	40.6	NA	0
SWU-3-2-7	3-3.5	8/24/97	39.5	NA	0
SWU-3-3-1	0-0.5	8/24/97	9	NA	0
SWU-3-3-2	0.5-1	8/24/97	3.21	NA	0
SWU-3-3-3	1-1.5	8/24/97	5.54	NA	0
SWU-3-3-4	1.5-2	8/24/97	5.42	NA	0
SWU-3-3-5	2-2.5	8/24/97	17.6	NA	0
SWU-3-3-6	2.5-3	8/24/97	57.7	NA	0
SWU-3-3-6-D	2.5-3	8/24/97	53	NA	0
SWU-3-3-7	3-3.5	8/24/97	2.01	NA	0
SWU-3-4-1	0-0.5	8/24/97	17.6	NA	0
SWU-3-4-2	0.5-1	8/24/97	28.9	NA	0
SWU-3-4-3	1-1.5	8/24/97	34	NA	0

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-4-2-5	2-2.5	8/24/97	69.6	<-0.24	0
SWU-4-2-6	2.5-3	8/24/97	72.7	<-0.16	0
SWU-4-2-7	3-3.5	8/24/97	65.2	<0.24	0
SWU-4-3-1	0-0.5	8/24/97	26.4	<-0.16	0
SWU-4-3-2	0.5-1	8/24/97	23.8	<0.21	0
SWU-4-3-3	1-1.5	8/24/97	50.5	<-0.58	0
SWU-4-3-4	1.5-2	8/24/97	81	<-0.072	0
SWU-4-3-5	2-2.5	8/24/97	99	<-0.020	0
SWU-4-3-6	2.5-3	8/24/97	92	<-0.183	0
SWU-4-3-7	3-3.5	8/24/97	123	<-0.21	0
SWU-4-4-1	0-0.5	8/24/97	36.7	<0.72	0
SWU-4-4-2	0.5-1	8/24/97	20.4	<0.18	0
SWU-4-4-3	1-1.5	8/24/97	13.2	<-0.02	0
SWU-4-4-4	1.5-2	8/24/97	12.2	<0.032	0
SWU-4-4-5	2-2.5	8/24/97	23.9	<0.083	0
SWU-4-4-6	2.5-3	8/24/97	55.8	<-0.29	0
SWU-4-4-7	3-3.5	8/24/97	30.6	<0.42	0
SWU-4-5-1	0-0.5	8/24/97	25.4	<0.44	0
SWU-4-5-1-Y	0-0.5	8/25/97	RP	RP	
SWU-4-5-2	0.5-1	8/24/97	13	<-0.11	0
SWU-4-5-2-Y	0.5-1	8/25/97	RP	RP	
SWU-4-5-3	1-1.5	8/24/97	11.8	<-0.28	0
SWU-4-5-4	1.5-2	8/24/97	13.6	<0.20	0
SWU-4-5-5	2-2.5	8/24/97	34.5	<-0.46	0
SWU-4-5-6	2.5-3	8/24/97	46.2	<-0.19	0
SWU-4-5-7	3-3.5	8/24/97	49	<-0.114	0

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-3-4-4	1.5-2	8/24/97	54.1	NA	0
SWU-3-4-5	2-2.5	8/24/97	221	NA	0
SWU-3-4-6	2.5-3	8/24/97	418	NA	250
SWU-3-4-7	3-3.5	8/24/97	298	NA	150
SWU-3-5-1	0-0.5	8/24/97	12.2	NA	0
SWU-3-5-2	0.5-1	8/24/97	14.6	NA	0
SWU-3-5-2-D	0.5-1	8/24/97	8.9	NA	0
SWU-3-5-3	1-1.5	8/24/97	12.9	NA	0
SWU-3-5-4	1.5-2	8/24/97	25.9	NA	0
SWU-3-5-5	2-2.5	8/24/97	50.7	NA	0
SWU-3-5-6	2.5-3	8/24/97	40.4	NA	0
SWU-3-5-7	3-3.5	8/24/97	33.2	NA	0
SWU-3-5-7-D	3-3.5	8/24/97	29	NA	0
SWU-4-1-1	0-0.5	8/24/97	12.8	<-0.44	0
SWU-4-1-1-Y	0-0.5	8/25/97	RP	RP	
SWU-4-1-2	0.5-1	8/24/97	13.3	<-0.54	0
SWU-4-1-2-Y	0.5-1	8/25/97	RP	RP	
SWU-4-1-3	1-1.5	8/24/97	17	<-0.38	0
SWU-4-1-4	1.5-2	8/24/97	17.6	<-0.067	0
SWU-4-1-5	2-2.5	8/24/97	31.9	<-0.46	0
SWU-4-1-6	2.5-3	8/24/97	56.3	<0.10	0
SWU-4-1-7	3-3.5	8/24/97	66.3	<0.12	0
SWU-4-2-1	0-0.5	8/24/97	20.9	<-0.44	0
SWU-4-2-2	0.5-1	8/24/97	14.7	<-0.18	0
SWU-4-2-3	1-1.5	8/24/97	19	<-0.211	0
SWU-4-2-4	1.5-2	8/24/97	84.5	<-0.31	0

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-5-1-48	23.5-24	8/28/97	10	NA	0
SWU-5-2-34	16.5-17	8/25/97	612	NA	950
SWU-5-3-2	0.5-1	8/26/97	14	NA	0
SWU-5-3-36	17.5-18	8/27/97	1.24	NA	0
SWU-5-4-29	14-14.5	8/28/97	2	NA	0
SWU-5-5-13	6-6.5	9/2/97	424	NA	150
SWU-5-6-41	20-20.5	9/2/97	1.39	NA	0
SWU-5-7-46	22.5-23	8/29/97	626	NA	3950
SWU-5-8-44	21.5-22	8/29/97	138	NA	100
SWU-5-8-45	22-22.5	8/29/97	1130	NA	950
SWU-5-8-46	22.5-23	8/29/97	1140	NA	1950
SWU-5-8-47	23-23.5	8/29/97	1070	NA	750
SWU-5-8B-54	26.5-27	8/29/97	195	NA	400
SWU-5-9-39	19-19.5	9/9/97	2080	NA	550
SWU-5-9-40	19.5-20	9/9/97	1220	NA	600
SWU-5-9-42	20.5-21	9/9/97	144	NA	0
SWU-5-10-21	10-10.5	9/8/97	292	NA	150
SWU-5-10-24	11.5-12	9/8/97	520	NA	550
SWU-5-10-29	14-14.5	9/8/97	186	NA	350
SWU-5-10-31	15-15.5	9/8/97	4980	NA	1000
SWU-5-10-32	15.5-16	9/8/97	1290	NA	0
SWU-5-11-36	17.5-18	9/11/97	1.18	NA	0
SWU-5-12-32	15.5-16	9/5/97	1.72	NA	0
SWU-5-13-32	15.5-16	9/10/97	5.6	NA	0
SWU-5-13-32-D	15.5-16	9/10/97	2.8	NA	0
SWU-5-14-15	7-7.5	9/10/97	632	NA	750

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-5-15-37	18-18.5	9/5/97	2180	NA	1000
SWU-5-15-38	18.5-19	9/5/97	9090	NA	8000
SWU-5-15-39	19-19.5	9/5/97	3690	NA	1450
SWU-5-15-40	19.5-20	9/5/97	981	NA	1000
SWU-5-15-43	21-21.5	9/5/97	1810	NA	1000
SWU-5-15-45	22-22.5	9/5/97	646	NA	900
SWU-5-15-46	22.5-23	9/5/97	3980	NA	3000
SWU-5-15-47	23-23.5	9/5/97	2120	NA	1000
SWU-5-15-48	23.5-24	9/5/97	1970	NA	1000
SWU-5-15-49	24-24.5	9/5/97	1110	NA	1250
SWU-5-15-50	24.5-25	9/5/97	491	NA	250
SWU-5-15-51	25-25.5	9/5/97	3660	NA	1850
SWU-5-15-52	25.5-26	9/5/97	168	NA	150
SWU-5-16-39	19-19.5	9/10/97	22.6	NA	2000
SWU-5-17-32	15.5-16	9/4/97	469	NA	150
SWU-5-18-37	18-18.5	9/3/97	1390	NA	1000
SWU-5-18-38	18.5-19	9/3/97	1930	NA	1000
SWU-5-18-41	20-20.5	9/3/97	8890	NA	1500
SWU-5-19-44	21.5-22	9/9/97	242	NA	300
SWU-5-19-48	23.5-24	9/9/97	1480	NA	1000
SWU-5-19-49	24-24.5	9/9/97	1770	NA	1700
SWU-5-19-49-D	24-24.5	9/9/97	2000	NA	1700
SWU-5-19-50	24.5-25	9/9/97	1870	NA	850
SWU-5-20-50	24.5-25	9/17/97	287	NA	450
SWU-5-20A-45	22-22.5	9/18/97	881	NA	550
SWU-5-20A-49	23.5-24	9/18/97	2250	NA	1750

TABLE D-9
AREA 2, PHASE I ABOVE-WAC DELINEATION BETA-GAMMA SCAN AND SOIL SAMPLING RESULTS
(Continued)

Location	Depth (ft.)	Date Collected	Total Uranium (ppm)	Tc-99 (pCi/g)	Beta-Gamma Scan (ccpm)
SWU-5-20B-49	23.5-24	9/18/97	377	NA	300
SWU-5-20B-50	24.5-25	9/18/97	401	NA	350
SWU-5-21-45	22-22.5	9/18/97	277	NA	150
SWU-5-21-46	22.5-23	9/18/97	486	NA	200
SWU-5-21-47	23-23.5	9/18/97	2640	NA	1000
SWU-5-21-48	23.5-24	9/18/97	1820	NA	800
SWU-5-21-51	25-25.5	9/18/97	773	NA	400
SWU-5-21-52	25.5-26	9/18/97	1020	NA	500
SWU-5-21-53	26-26.5	9/18/97	569	NA	400
SWU-5-22-51	25-25.5	9/19/97	949	NA	1000
SWU-5-22B-52	25.5-26	9/19/97	1660	NA	1150
SWU-5-22B-53	26-26.5	9/19/97	1810	NA	1550
SWU-5-23-47	23-23.5	9/22/97	800	NA	450
SWU-5-23-48	23.5-24	9/22/97	804	NA	750
SWU-5-23-49	24-24.5	9/22/97	683	NA	1050
SWU-5-23B-50	24.5-25	9/22/97	302	NA	300
SWU-5-23B-51	25-25.5	9/22/97	106	NA	850
SWU-5-23B-52	25.5-26	9/22/97	1870	NA	1000

ppm = parts per million
ccpm = corrected counts per minute
NA = Not Analyzed
D = Duplicate
RP = Result pending
Y = Split sample

TABLE D-10
TOTAL LEAD CONCENTRATIONS, AREA 2, PHASE I FIRING RANGE, 0-1 FOOT DEPTH
OCTOBER 1996

Location	X-Ray Fluorescence (ppm)	Physical Soil Sample (ppm)[a]
PB-11-0-3	132	110/112
PB-12-0-3	65	NA
PB-13-0-3	51	NA
PB-14-0-3	1165	NA
PB-15-0-3	99	NA
PB-16	167	NA
PB-17B	440	NA
PB-18	1142	1431/1398
PB-19	866	NA
PB-20	211	NA
PB-21	104	NA
PB-21B	13 (0-6 inches) 388 (6-12 inches)	NA
PB-22	609	423/445
PB-23	494	NA
PB-24	481	NA
PB-25	1013	NA
PB-26	63[b]	NA
PB-27	49[b]	NA
PB-28	292	NA
PB-29	452	NA
PB-30	1573	NA
PB-31	75	NA
PB-32	107	NA
PB-33	96	NA
PB-34	583	NA
PB-35	55[b]	NA

TABLE D-10
TOTAL LEAD CONCENTRATIONS, AREA 2, PHASE I FIRING RANGE, 0-1 FOOT DEPTH
OCTOBER 1996
(Continued)

Location	X-Ray Fluorescence (ppm)	Physical Soil Sample (ppm)[a]
PB-36	42	49/57
PB-37	2906	NA
PB-38	101	NA
PB-39	76 (0-6 inches)	NA
PB-40	34[b] (0-6 inches) 11 (6-12 inches)	NA
PB-41	31 (0-6 inches)	NA
PB-42	92 (0-6 inches)	NA
PB-43	61[b] (0-6 inches) 10 (6-12 inches)	NA

[a] First value is analysis by inductively coupled argon plasma (ICP); second value is analysis by graphite furnace atomic absorption (GFAA).
[b] Average of two readings.
NA= not analyzed

TABLE D-11
TOTAL LEAD CONCENTRATIONS, AREA 2, PHASE I FIRING RANGE, 1-2 FOOT DEPTH
OCTOBER 1996

Location	X-Ray Fluorescence (ppm)	Physical Soil Sample (ppm)[a]
PB-11-0-3	19	NA
PB-12-0-3	3	NA
PB-13-0-3	35	NA
PB-14-0-3	367	NA
PB-15-0-3	9	NA
PB-16	75	NA
PB-17B	ND	NA
PB-18	254	NA
PB-19	1065	NA
PB-20	30	NA
PB-21	NA	NA
PB-21B	296 (12-18 inches) 33 (18-24 inches)	210/293 56/56
PB-22	41	32/37
PB-23	30[b]	NA
PB-24	29[b]	NA
PB-25	41[b]	NA
PB-26	23	NA
PB-27	24	NA
PB-28	2	NA
PB-29	138	NA
PB-30	166	NA
PB-31	10	NA
PB-32	NA	NA
PB-33	NA	NA
PB-34	495	412/402
PB-35	15	NA

TABLE D-11
TOTAL LEAD CONCENTRATIONS, AREA 2, PHASE I FIRING RANGE, 1-2 FOOT DEPTH
OCTOBER 1996
(Continued)

Location	X-Ray Fluorescence (ppm)	Physical Soil Sample (ppm)[a]
PB-36	NA	NA
PB-37	233	NA
PB-38	22[b]	NA
PB-39	NA	NA
PB-40	NA	NA
PB-41	NA	NA
PB-42	NA	NA
PB-43	NA	NA

[a] First value is analysis by inductively coupled argon plasma (ICP); second value is analysis by graphite furnace atomic absorption (GFAA).
[b] Average of two readings.
ND - not detected
NA - not analyzed

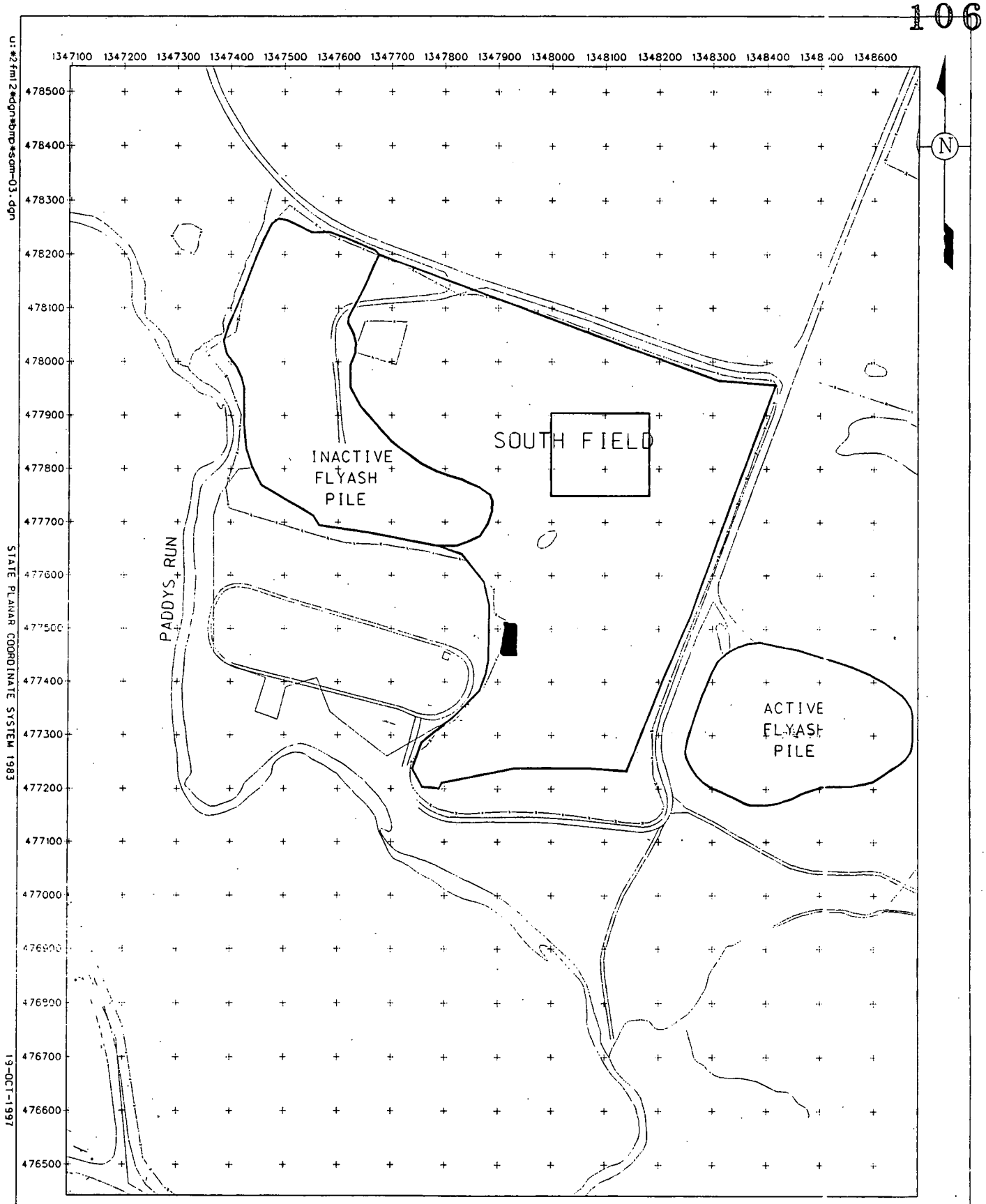
TABLE D-12
TOTAL LEAD CONCENTRATIONS, AREA 2, PHASE I FIRING RANGE, 2-3 FOOT DEPTH OCTOBER 1996

Location	X-Ray Fluorescence (ppm)	Physical Soil Sample (ppm)[a]
PB-11-0-3	10	NA
PB-12-0-3	32	NA
PB-13-0-3	19	NA
PB-14-0-3	14	NA
PB-15-0-3	14	NA
PB-16	17[b]	NA
PB-17B	ND	NA
PB-18	11	NA
PB-19	2	NA
PB-20	2	NA
PB-21	NA	NA
PB-21B	25 (24-30 inches) 42 (30-36 inches)	NA
PB-22	28[c]	NA
PB-23	27	NA
PB-24	17	NA
PB-25	31	NA
PB-26	ND	NA
PB-27	7	NA
PB-28	NA	NA
PB-29	NA	NA
PB-30	NA	NA
PB-31	NA	NA
PB-32	NA	NA
PB-33	NA	NA
PB-34	37	71/82
PB-35	NA	NA
PB-36	NA	NA

TABLE D-12
TOTAL LEAD CONCENTRATION, AREA 2, PHASE I FIRING RANGE, 2-3 FOOT DEPTH
OCTOBER 1996
(Continued)

Location	X-Ray Fluorescence (ppm)	Physical Soil Sample (ppm)[a]
PB-37	53	NA
PB-38	NA	NA
PB-39	NA	NA
PB-40	NA	NA
PB-41	NA	NA
PB-42	NA	NA
PB-43	NA	NA

[a] First value is analysis by inductively coupled argon plasma (ICP); second value is analysis by graphite furnace atomic absorption (GFAA).
[b] 2- to 5-foot interval composited.
[c] Average of two readings.
ND - not detected
NA - not analyzed



LEGEND:

LEAD CONTAMINATED SOIL SAMPLING AREA

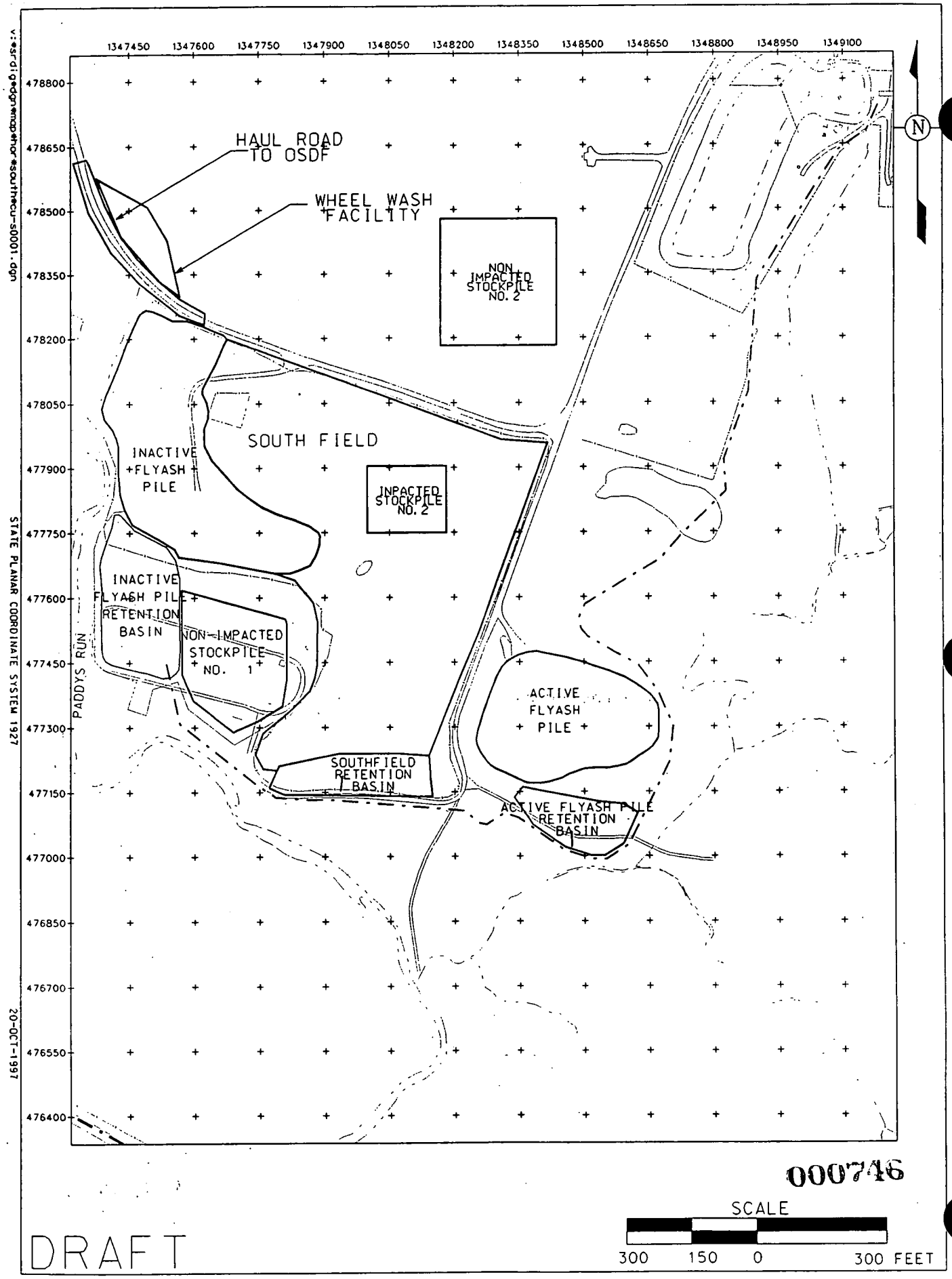
SCALE

250 175 0 250 FEET

DRAFT

000745

FIGURE D-1. SOUTHERN WASTE UNITS LOCATION MAP



000746

FIGURE D-2. AREA 2, PHASE I SITE PREPARATION AREAS

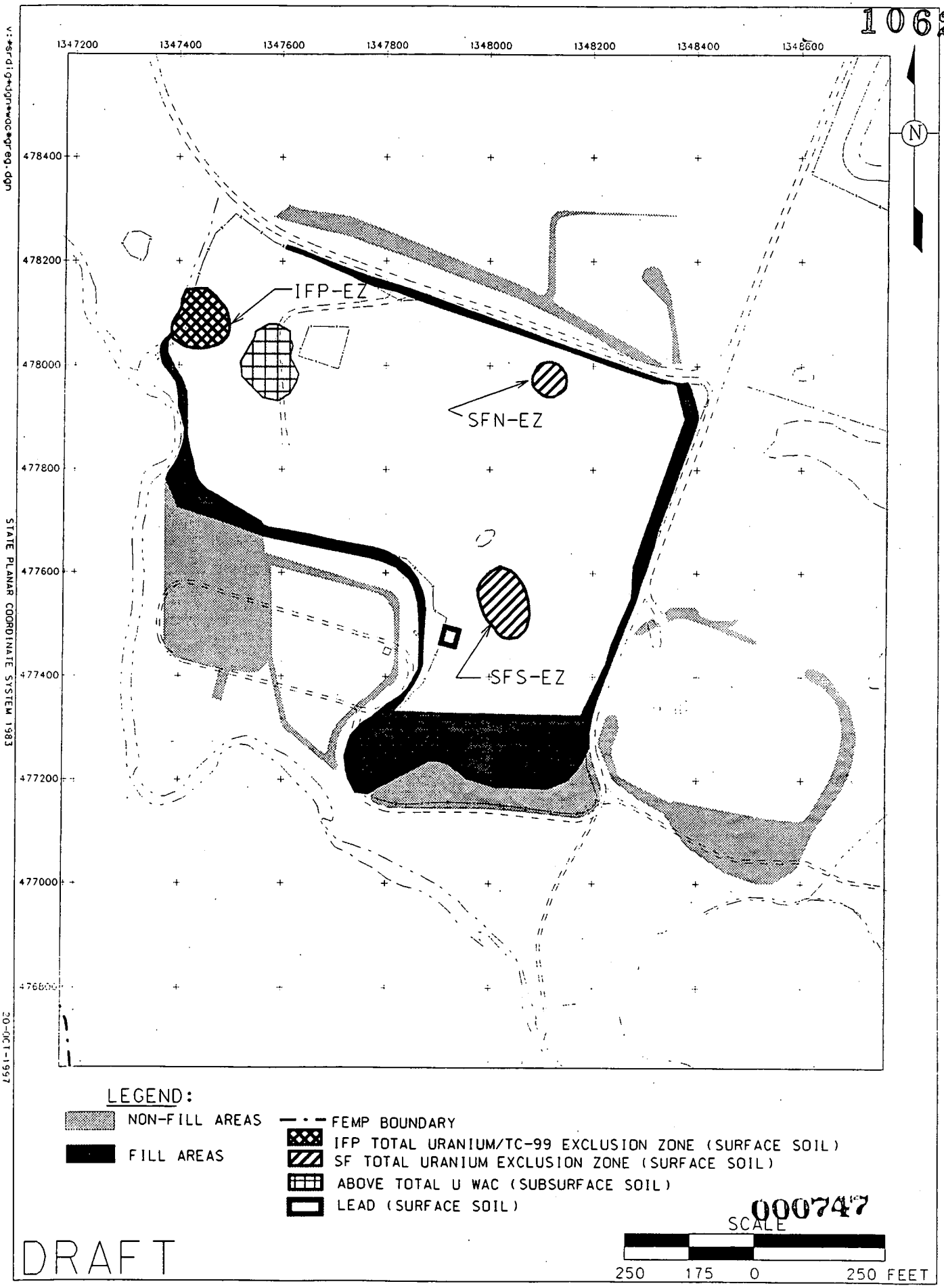
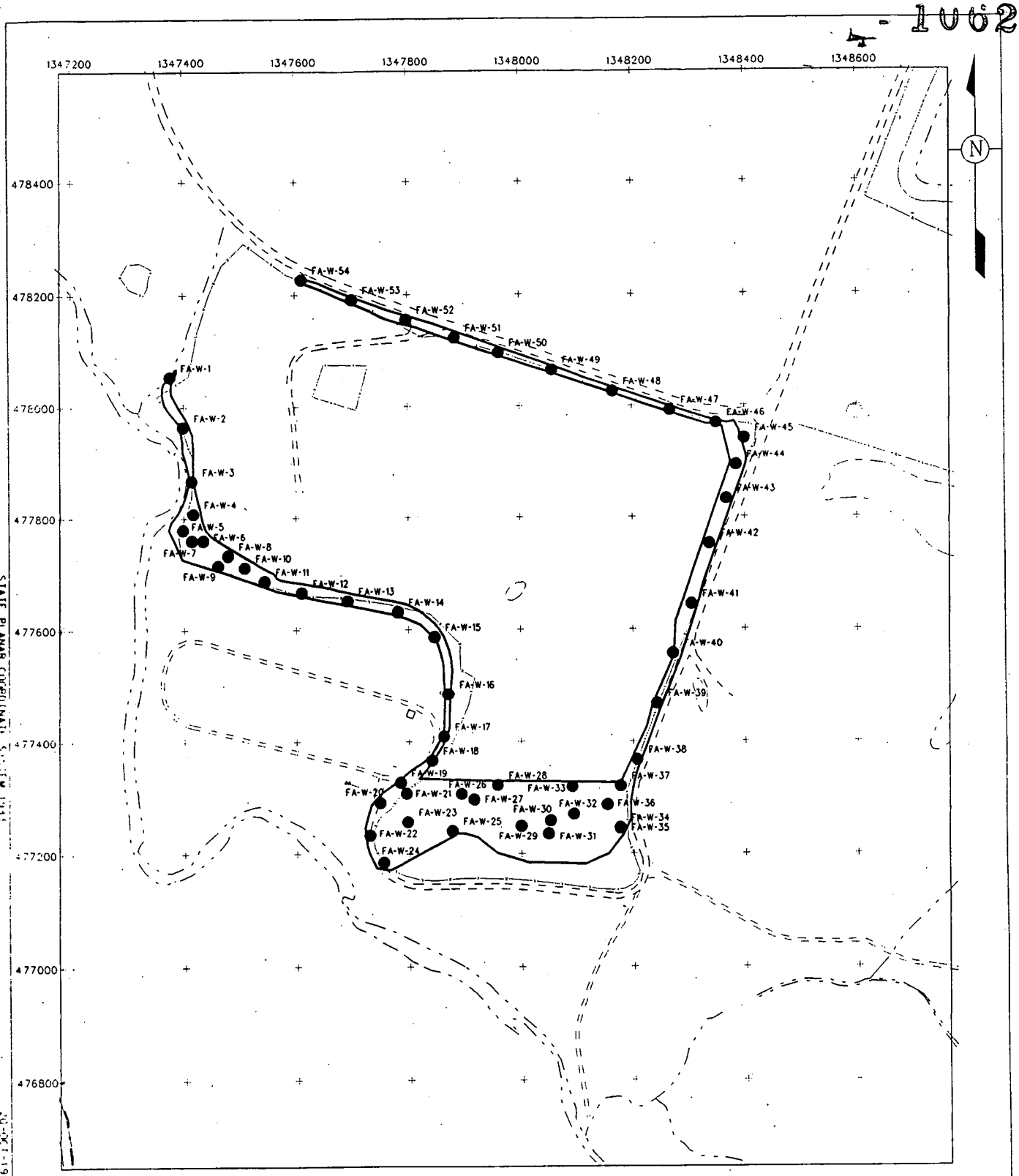


FIGURE D-3. A2P1 SITE PREPARATION WAC AREAS

FIGURE D-4. AREA 2, PHASE I HPGE MEASUREMENTS



LEGEND:

FILL AREA WAC BOUNDARY

SAMPLE LOCATION

000749

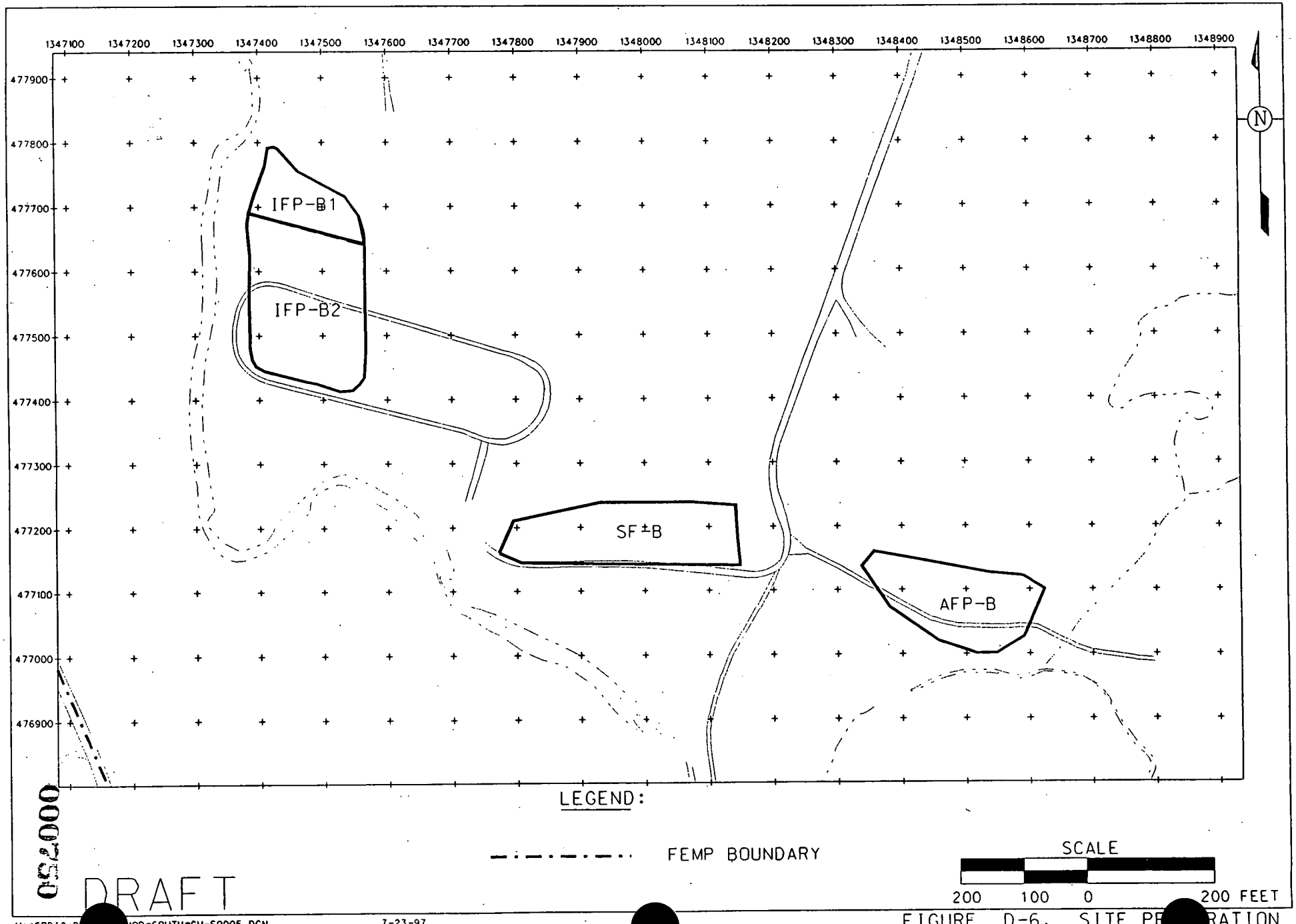
SCALE

250 175 0 250 FEET

DRAFT

FIGURE D-5. A2P1 SITE PREPARATION WAC SAMPLING LOCATIONS

v:\5cr05\dgn\bmp\cu-s0054.dgn
STATE PLANAR COORDINATE SYSTEM 1927
20-OCT-1997

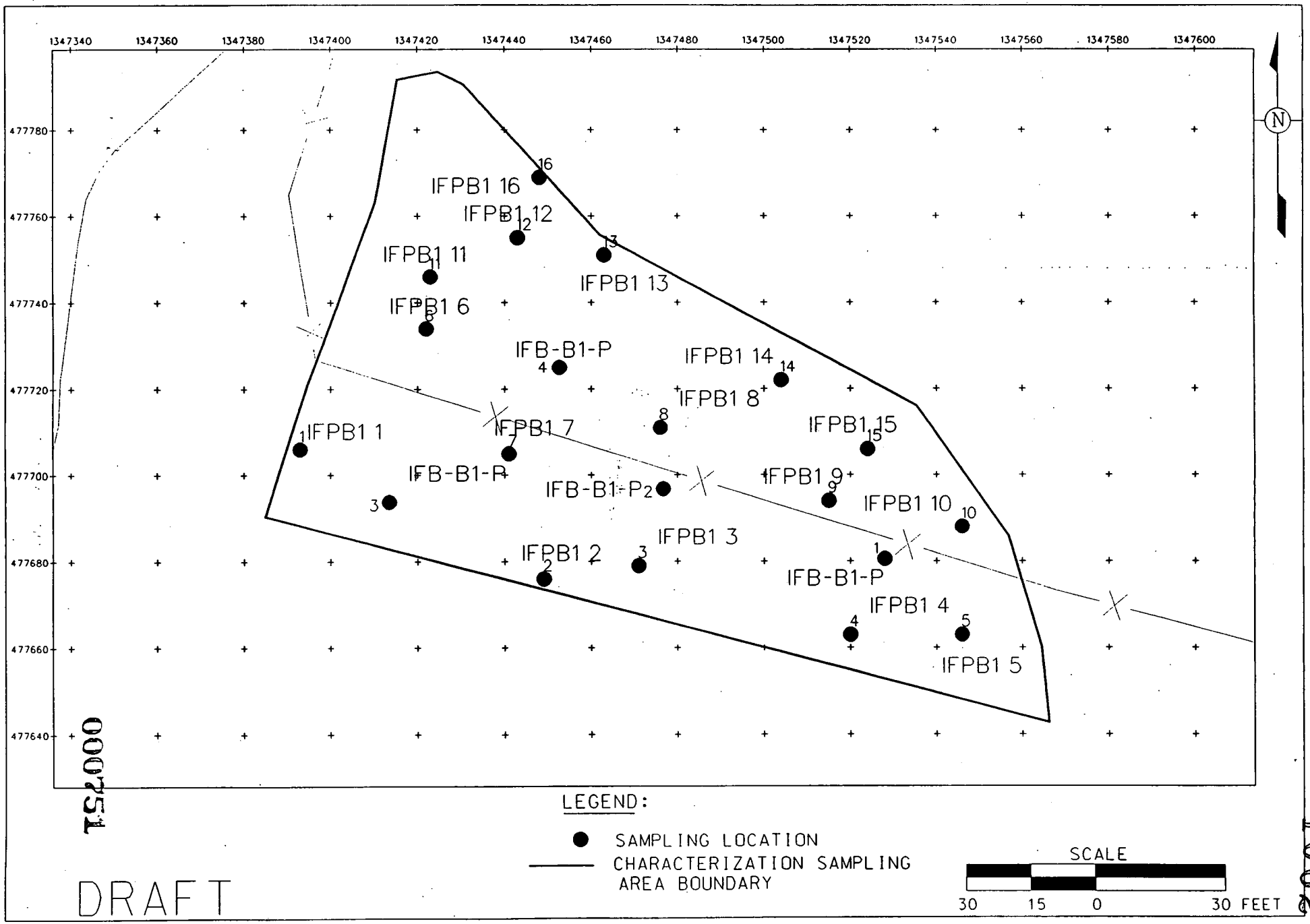


DRAFT

U:*SRDIG*D[redacted]HOR*SOUTH*CU-S0005.DGN
STATE PLAN[redacted]DINATE SYSTEM 1983

7-23-97

FIGURE D-6. SITE PR[redacted]RATION
CHARACTERIZATION FOR [redacted]SE AREAS



DRAFT

0007751

1062

v:\5cra5\dgn\bmp\cu-s0052.dgn
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE D-7. IFP-B1 SAMPLING LOCATIONS

20-OCT-1997

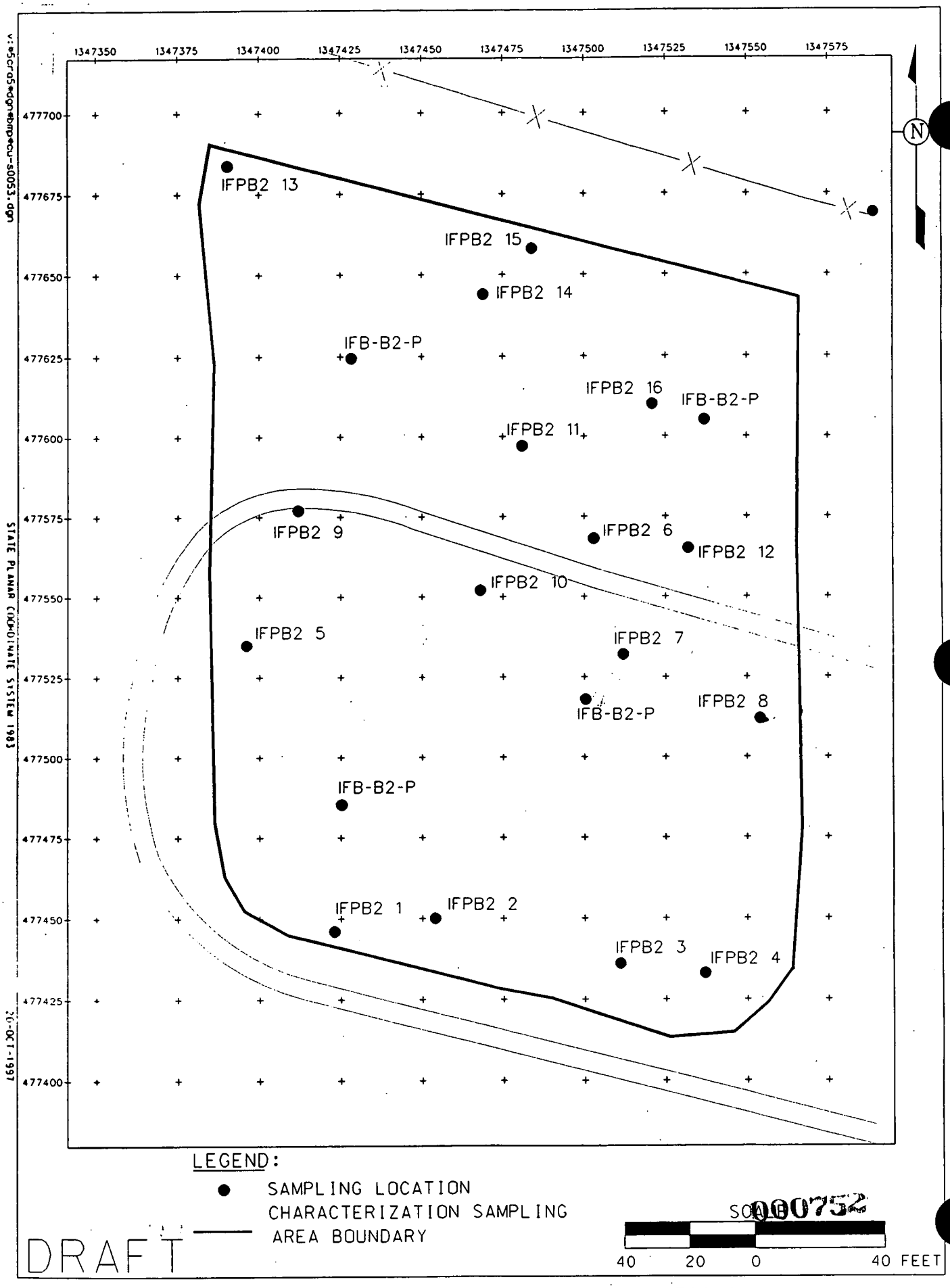
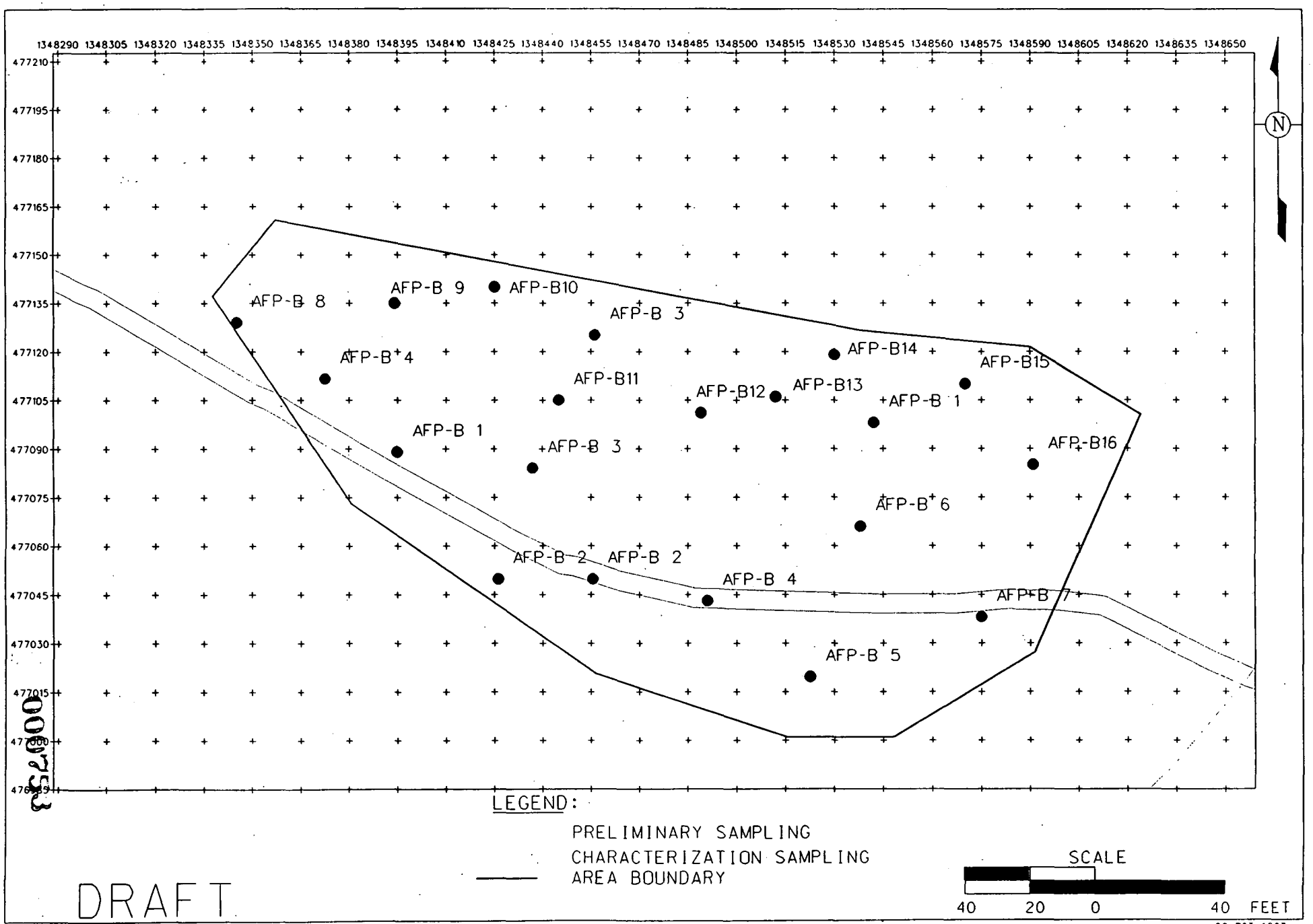


FIGURE D-8. IFP-B2 SAMPLING LOCATIONS

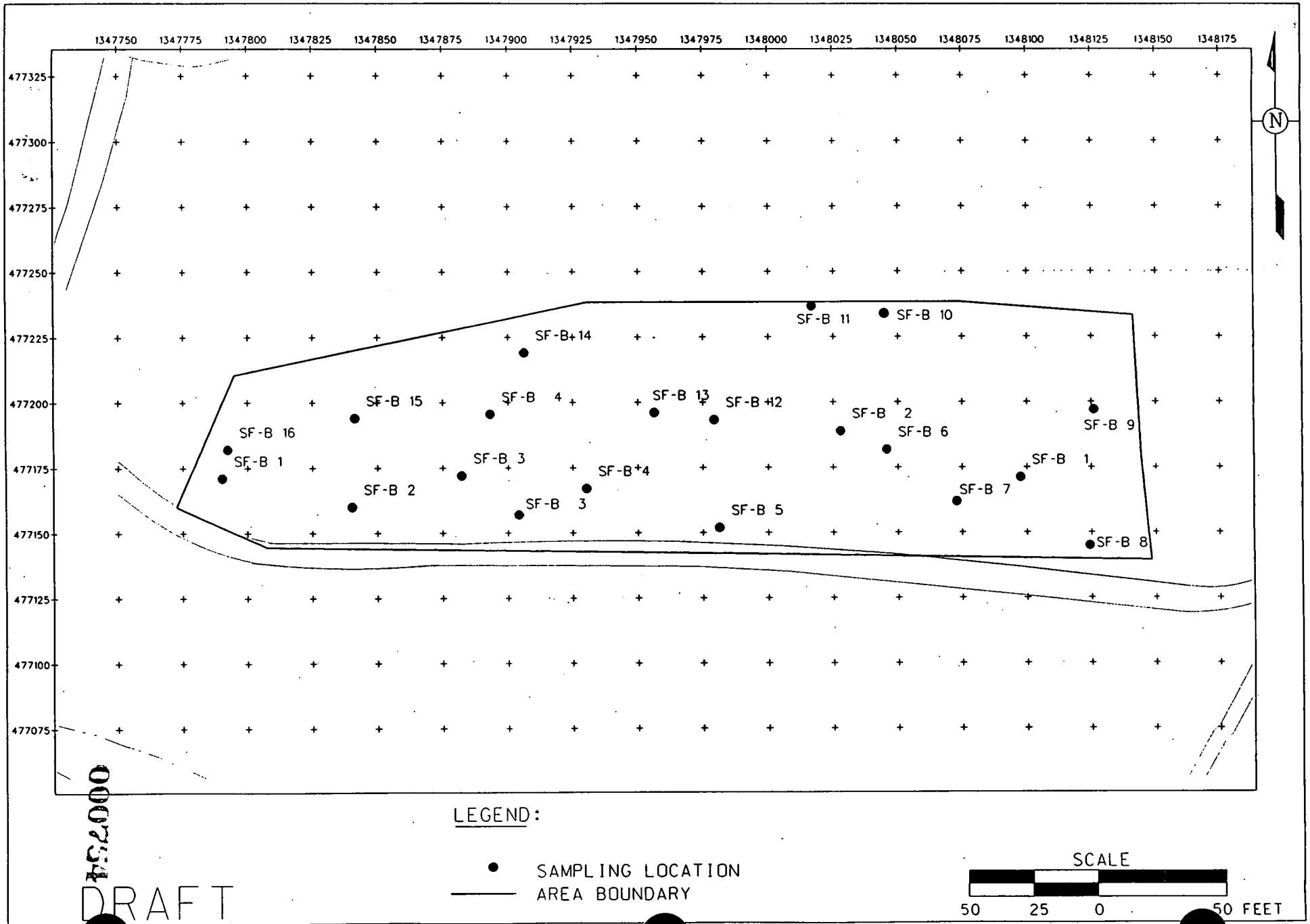


v:\srdig\dgn\map\hor\south\cu-s0051.dgn
STATE PLANAR COORDINATE SYSTEM 1983

20-OCT-1997

FIGURE D-9. AFP-B SAMPLING LOCATIONS

000253



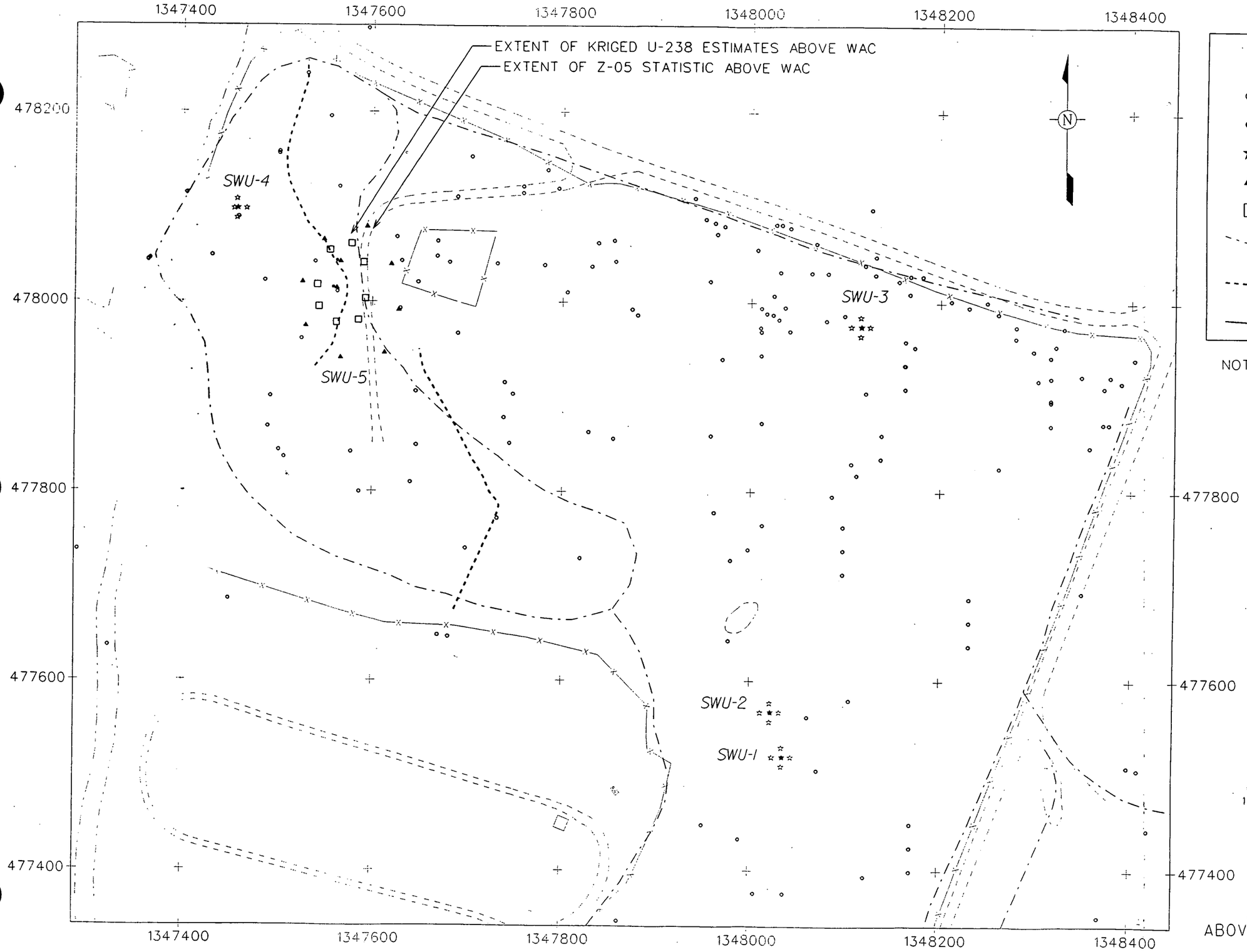
DRAFT

v:\srdig\dg[illegible]pr\south\cu-s0050.dgn
STATE PLANA[illegible]INATE SYSTEM 1983

FIGURE D-10. S[illegible] SAMPLING LOCATIONS

20-OCT-1997

20-OCT-1997



LEGEND

- ○ PREVIOUS SAMPLING LOCATION, NO RESULTS ABOVE WAC
- ● PREVIOUS SAMPLING LOCATION, ONE OR MORE RESULTS ABOVE WAC
- ☆ PROPOSED SHALLOW SAMPLING LOCATION
- ▲ PROPOSED INITIAL DEEP SAMPLING LOCATION
- □ POTENTIAL DEEP SAMPLING LOCATION
- INACTIVE FLYASH PILE/ SOUTH FIELD BOUNDARY
- APPROXIMATE LOCATION OF DITCHES FROM 1950 AERIAL PHOTOGRAPH
- MODELED ABOVE WAC AREA

NOTE : WAC U-238 = 346 pCi/g
WAC U-TOTAL = 1030 PPM

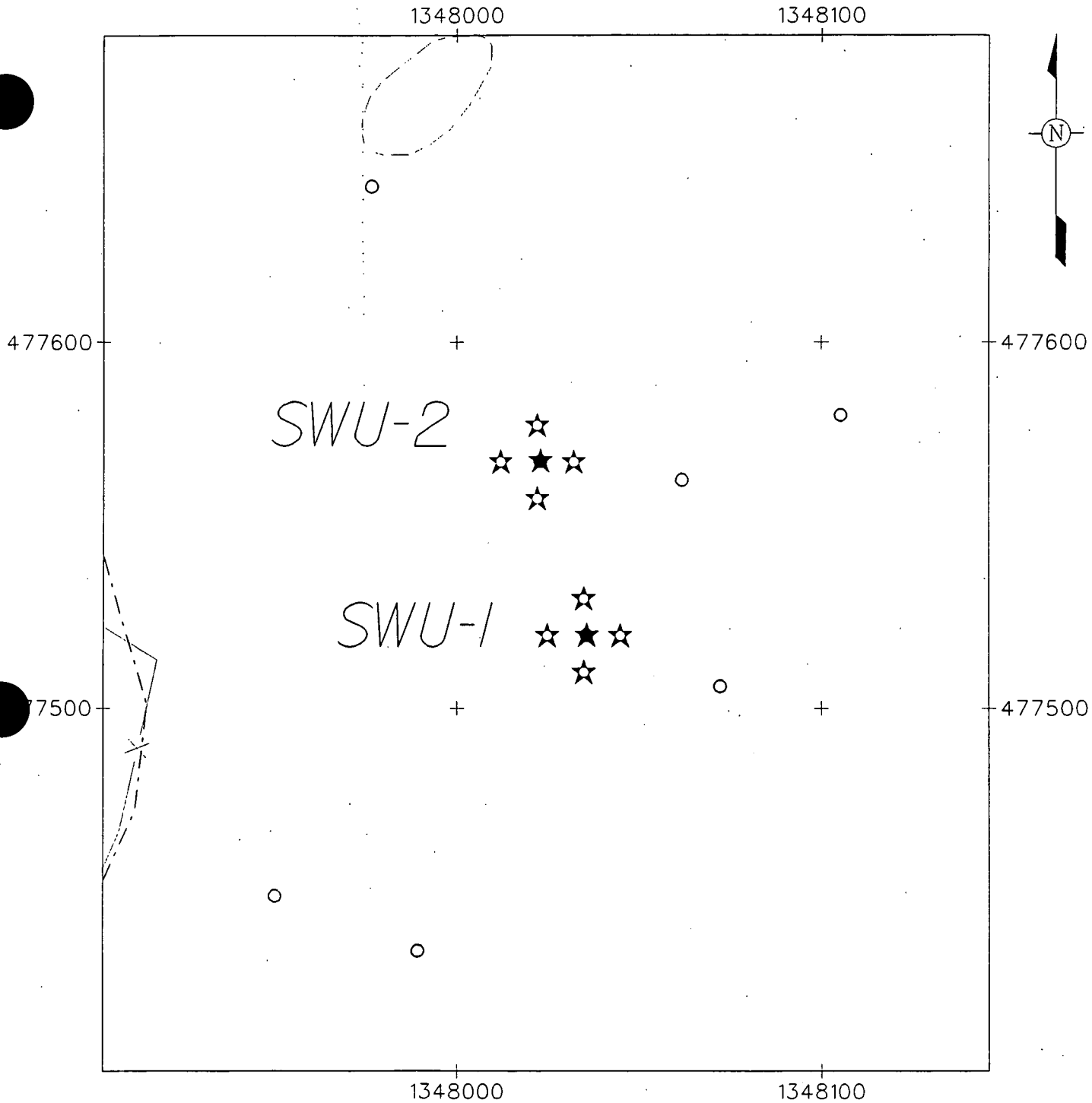
SCALE
100 50 0 100 FEET

2FM12/DGN/PMD/SAMPLES.DGN

000755

FIGURE D-II. SUSPECTED ABOVE - WAC SAMPLE LOCATIONS

20-OCT-1997



LEGEND

- ○ PREVIOUS SAMPLING LOCATION, NO RESULTS ABOVE WAC
- ● PREVIOUS SAMPLING LOCATION, ONE OR MORE RESULTS ABOVE WAC
- ☆ PROPOSED SHALLOW SAMPLING LOCATION

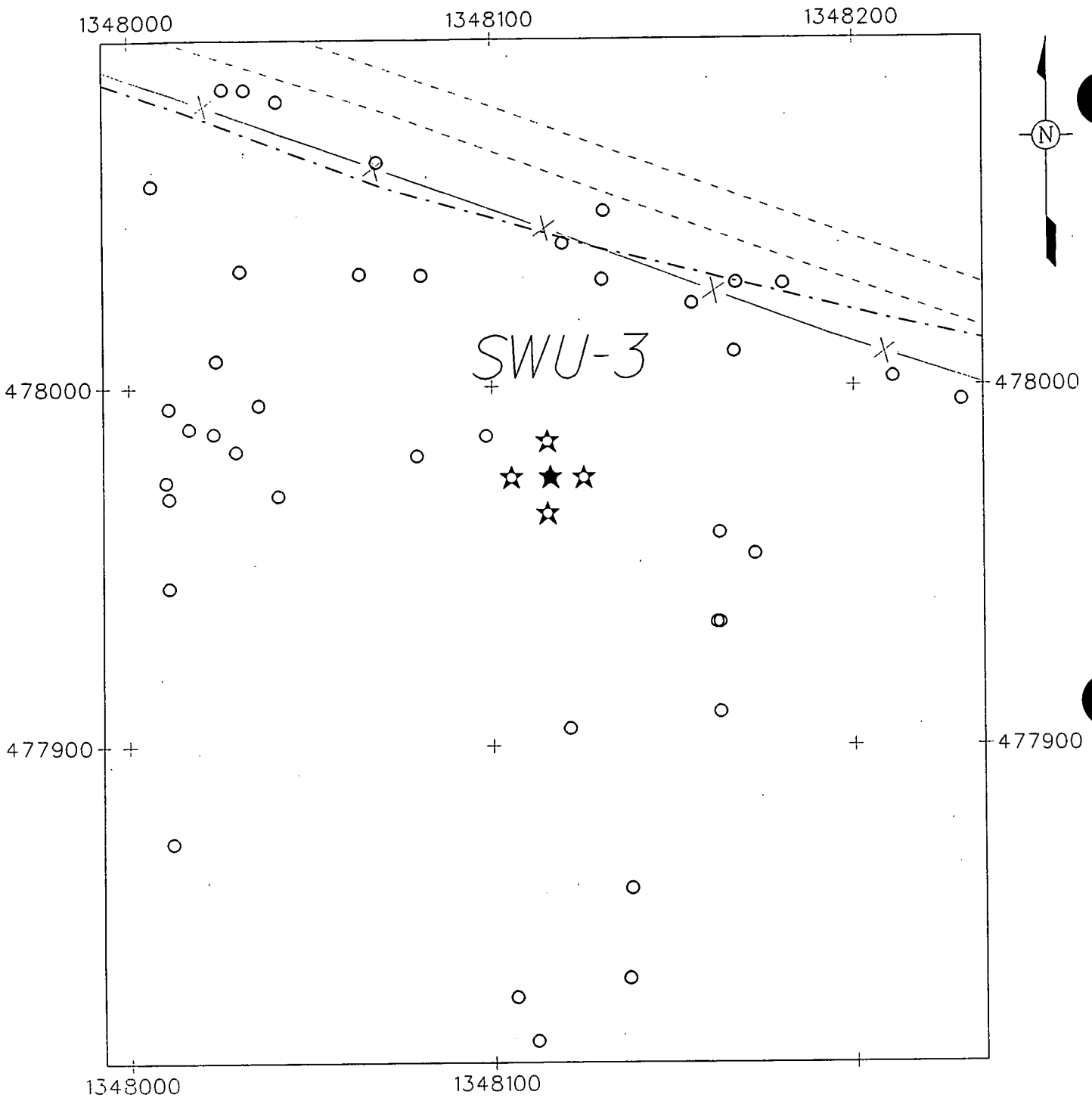
SCALE

20 0 40 FEET

2FM12/DGN/P SAMPLE3.DGN

FIGURE D-12. SUSPECTED ABOVE - WAC SAMPLING LOCATIONS, SWU-1 & SWU-2

20-OCT-1997



LEGEND

- ○ PREVIOUS SAMPLING LOCATION, NO RESULTS ABOVE WAC
- ● PREVIOUS SAMPLING LOCATION, ONE OR MORE RESULTS ABOVE WAC
- ☆ PROPOSED SHALLOW SAMPLING LOCATION

SCALE

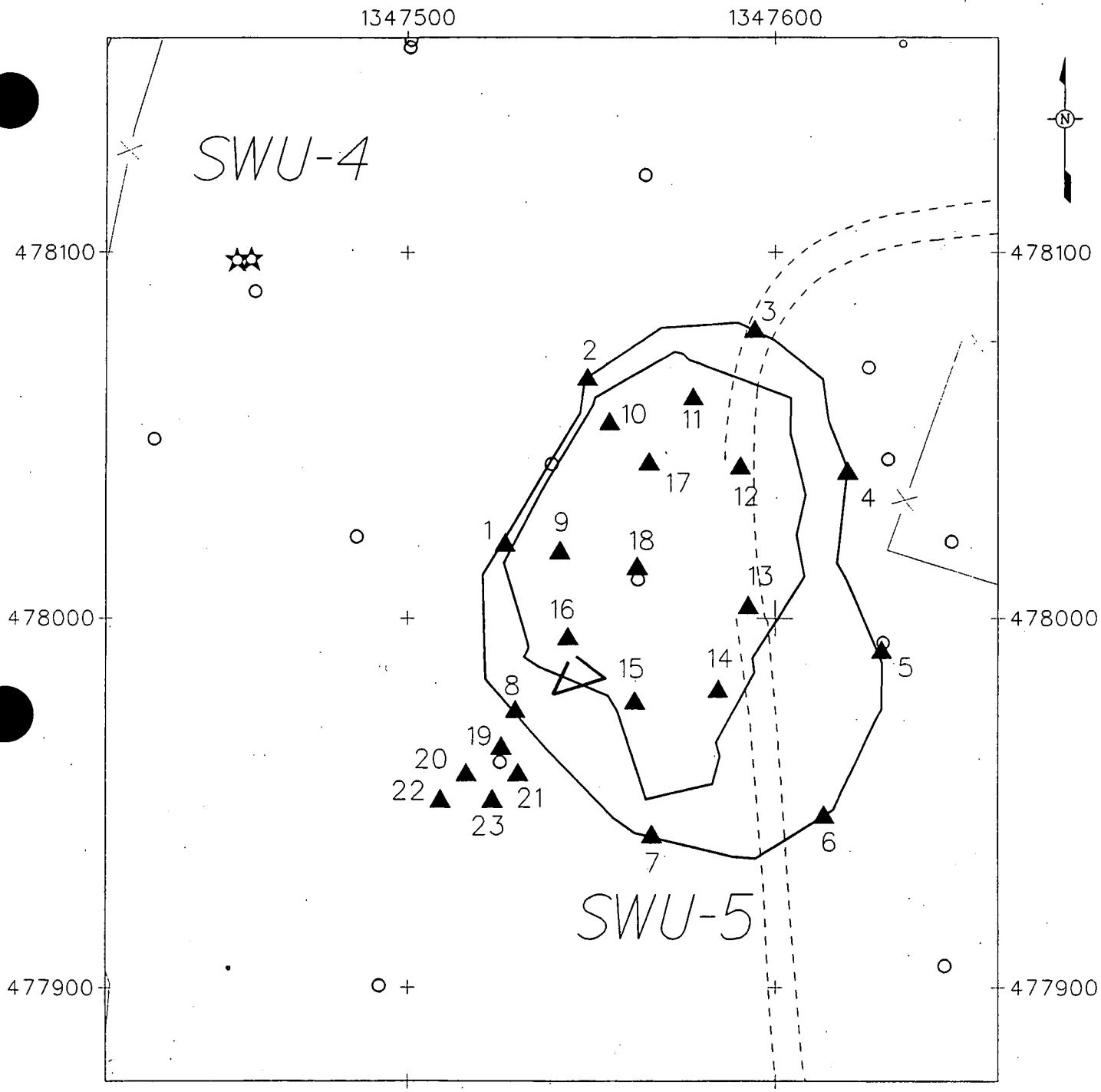
40 20 0 40 FEET

000757

FIGURE D-13. SUSPECTED ABOVE - WAC SAMPLING LOCATIONS, SWU-3

2FM12/DGN/BMP/SAMPLE2.DGN

20-OCT-1997



LEGEND

APPROX. LOCATION OF DITCHES FROM 1950 AERIAL PHOTOGRAPHS

SAMPLING LOCATION

SCALE

0 20 0 40 FEET

2FM12/DGN/B SAM-02.DGN

FIGURE D-14. SUSPECTED ABOVE - WAC SAMPLING LOCATIONS, SWU-4 AND SWU-5

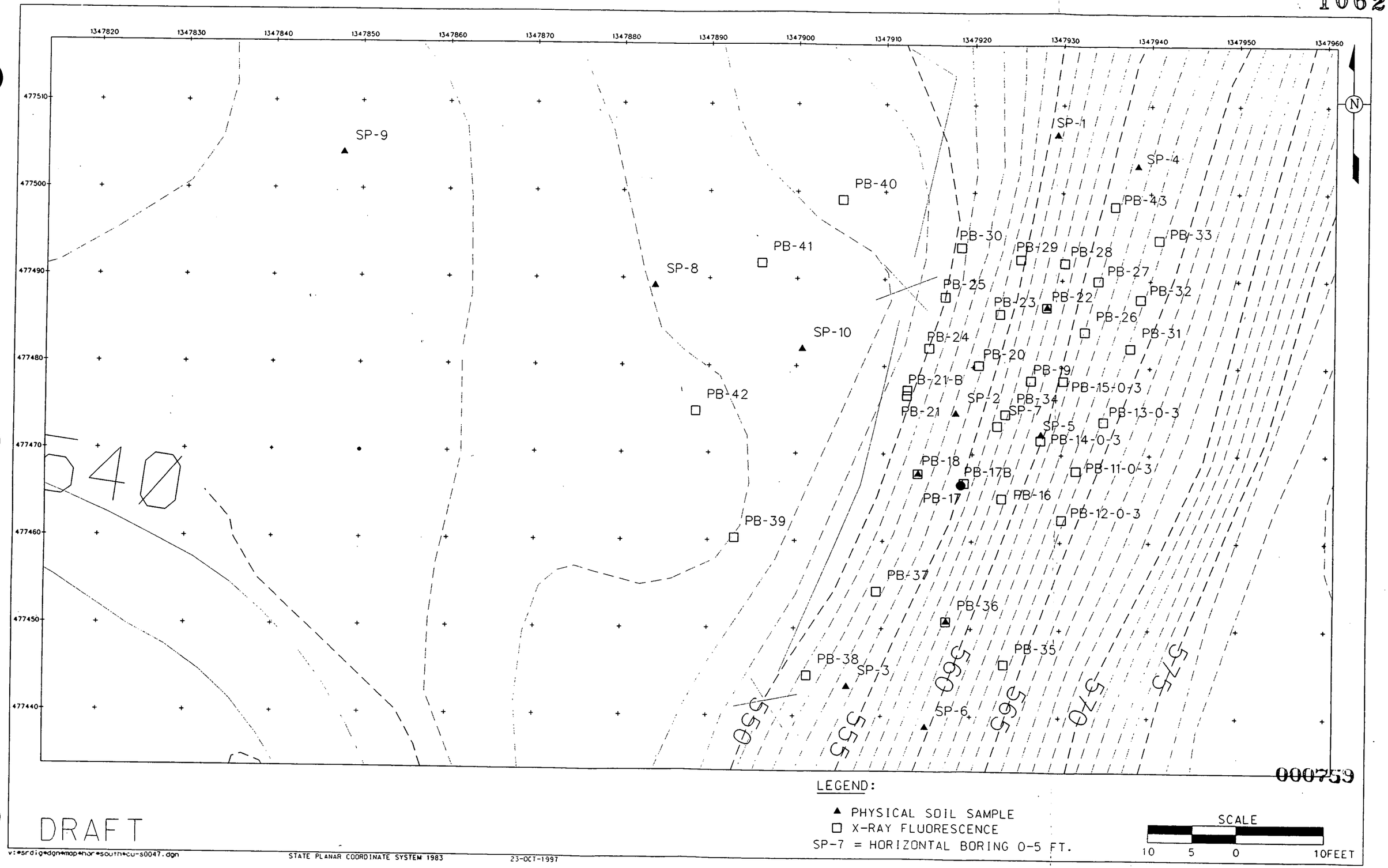


FIGURE D15. EXISTING SOIL AND X-RAY FLUORESCENCE DATA FOR A2P1 FORMER FIRING RANGE

APPENDIX E

INTEGRATED MEASUREMENT APPROACH FOR REMEDIATION OF AREA 2, PHASE I

APPENDIX E

INTEGRATED MEASUREMENT APPROACH FOR REMEDIATION OF AREA 2, PHASE I

E.1 INTRODUCTION

This appendix discusses the field and laboratory measurements that will be used by the Fernald Environmental Management Project (FEMP) to delineate soil excavation boundaries in Remediation Area 2 Phase I (A2PI), to demonstrate attainment of Final Remediation Levels (FRLs), and to satisfy Waste Acceptance Criteria (WAC) established for the On-Site Disposal Facility (OSDF). The integration of field and laboratory measurements provides the remediation process with real-time monitoring of gamma-emitting radionuclides and metals during construction activities, the ability to bias sample locations to ensure that above-WAC and hot-spot (i.e., a contaminant concentration equal to or greater than three times its FRL) areas can be delineated accurately for removal, and the opportunity to continue the demonstration of reliable certification measurements using in-situ gamma spectrometry. In particular, a significant improvement in the certification process can be realized by using in-situ gamma spectrometry because of its ability to provide accurate and representative concentrations of radionuclides.

E.1.1 Background

The FEMP is remediating site soil contaminated by radioactive and chemical constituents per the Operable Units 2 and 5 Records of Decision (DOE 1995a, 1996a) to fulfill obligations established in the Amended Consent Agreement (ACA) between DOE and EPA (EPA, 1991). This appendix addresses the integration of field and laboratory measurements for remediation activities carried out in A2PI (Figure 1-2). Additional details on A2PI associated regulatory drivers, the nature and extent of contamination, and remediation sequencing are provided in Sections 1.0 through 3.0 of this Implementation Plan.

The nature and extent of soil contamination at the FEMP site poses considerable demands on the coordination of characterization and excavation activities carried out during the remediation process. In many remediation areas, data generated from RI activities are not comprehensive for the purpose of preparing detailed engineering designs and excavation drawings, and additional radiological surveys and sampling programs must be implemented to collect the needed data. Real-time, field-deployable instruments have the capability to satisfy a major portion of these additional data needs, and their use

will be integrated with discrete sampling and subsequent laboratory analysis to maintain efficiency in the remediation process. Field-deployable instruments that have been demonstrated to provide data useful for making remediation decisions include:

- Sodium iodide (NaI) and high-purity germanium (HPGe) detectors for in-situ measurement of gamma-emitting radionuclides
- Geiger-Mueller counters for screening gross gamma/beta disintegrations
- Portable x-ray fluorescence (XRF) for metals (except mercury)
- Photo-ionization detectors (PID) for volatile and semi-volatile organic compounds.

The application of NaI and HPGe detectors to the in-situ measurement of gamma-emitting radionuclides has been described, for example, by Miller et. al. (1994), the International Commission on Radiation Units and Measurements (1994), and Fong and Alvarez (1997). Detailed assessments of the data quality produced by these field-deployable radiological instruments are provided in the U.S. DOE reports "Comparability of In-Situ Gamma Spectrometry and Laboratory Data" (DOE 1997k) and "RTRAK Applicability Study" (DOE 1997l). Three addenda to the above reports have expanded and improved the assessment of data quality and comparability of in-situ gamma spectrometry: "Comparability of Total Uranium Data as Measured by In-Situ Gamma Spectrometry and Four Laboratory Methods" (DOE 1997m), "RTRAK Applicability Measurements in Locations of Elevated Radionuclide Concentrations" (DOE 1997n), and "Comparability of In-Situ Gamma Spectrometry and Laboratory Measurements of Radium-226"(DOE 1997o).

Geiger-Mueller counters are used to screen subsurface soil cores and suspect materials encountered during excavation to locate elevated activity areas for sampling purposes. The use of PIDs is limited to field investigations and excavations dealing with removal of soil, tanks, pipes, drums, or other containers containing fuels and solvents. A portable XRF instrument was used for rapid assessment of lead concentrations in soil samples collected at the A2PI firing range. Operational details for the above instruments are described in FDF field procedures.

E.1.2 Purpose

The purpose of this appendix is two fold: 1) to describe how in-situ field measurements are integrated with the laboratory analytical program to delineate above-WAC, above-FRL, and potential RCRA

excavation boundaries, and to support precertification and certification activities; and 2) to provide area-specific (A2PI) comparability data that validates the use of in-situ gamma spectrometry and XRF in A2PI.

E.1.3 Remediation Process and Associated Data Needs

The remediation process carried out in A2PI will follow the general approach outlined in Sections 3.0 and 4.0 of the Sitewide Excavation Plan (SEP) (DOE 1997a) and Sections 2.0 and 3.0 of this Implementation Plan. Steps in the remediation of A2PI include:

- Predesign investigations to establish the extent of above-WAC material, the extent of soil with the potential to exhibit the toxicity characteristic
- Site-preparation activities to construct retention basins and ditches, to establish any needed stockpile and support areas, and to connect utilities
- Preparation of the remedial design (i.e., the IRDP)
- Soil excavation of above-WAC, of potential RCRA, and of other below-WAC impacted materials
- Precertification and certification activities
- Grading and restoration activities.

Data needs are primarily tied to establishing the horizontal and vertical excavation boundaries for above-WAC material (technetium-99 and/or total uranium), potential RCRA characteristic waste (lead), and above-FRL soil volumes; and to demonstrating that soil remaining after completion of the excavations can be certified as meeting the established FRLs. Additional data needs are centered on monitoring excavated surfaces to determine if all above-WAC material and/or potential RCRA characteristic waste have been removed, and to identify locations where uranium-238, thorium-232, and/or radium-226 levels exceed three times their FRL value (i.e., hot-spot identification). The need to identify soil containing total uranium above 50 milligrams per kilogram (mg/kg or ppm) (i.e., the ALARA goal) is not a data need for A2PI, because the uranium-238 FRL in A2PI has been set at 3.22 picocuries per gram (pCi/g), or approximately 10 ppm total uranium. Therefore, by meeting the uranium-238 FRL, ALARA considerations are also addressed.

Real-time, field-deployable instruments have been used in the predesign investigations and precertification activities to characterize soil for select constituents of concern (COCs). During soil excavation activities, field instruments will be used to monitor the excavated surfaces at intervals discussed in Section E.3. Radiological monitoring will also be conducted during excavation activities if special materials are encountered (Section 3.3.2.5).

E.1.4 Previous FEMP Studies on Environmental Measurement Approaches

Several FEMP soil studies have been completed where real-time field measurements have been collected and compared to laboratory analytical results to assess the viability of using field instruments to increase the efficiency of remediation activities. Miller et. al., (1994) used in-situ gamma spectrometry to measure uranium in FEMP soil and found good agreement between in-situ measurements and laboratory measurements for uranium-238. As part of a collaboration between Sandia National Laboratories and Fluor Daniel Fernald (FDF), HPGe and NaI gamma-ray detectors were used to determine the level of uranium contamination in FEMP soil. Rautman et al. (1994) issued a report on this joint study indicating additional site-specific testing was warranted to demonstrate the potential usefulness of the in-situ measurements in achieving quick quantitative assessments of gamma-emitting radionuclides. Further discussion on the application of HPGe and NaI detectors to characterization activities at the FEMP is provided below.

E.1.4.1 HPGe Gamma Spectrometry Comparability Study

Results from the initial studies described above warranted further evaluation of a field-deployable HPGe system at the FEMP site. In the summer of 1995, FDF personnel used a field-deployable HPGe instrument to collect gamma spectra and compared the results to laboratory measurements of total uranium, thorium-232, and radium-226. Total uranium data from the field and laboratory measurements correlated well, and thorium-232 and radium-226 results also indicated acceptable comparability between the methods.

The encouraging results from this preliminary field investigation lead DOE to proceed with a comprehensive in-situ gamma spectrometry comparability study at the FEMP site. Part A of the comprehensive study was conducted to determine if certification decisions at the Certification Unit (CU) level, based on HPGe measurements, were comparable to certification decisions based on laboratory analysis of discrete soil samples. In Part B of the study, HPGe measurements were

compared to laboratory alpha- and gamma-spectrometry measurements on discrete soil samples collected from 10 site locations, where total uranium concentrations varied from approximately 5 to 300 ppm. Two additional contaminated sites were evaluated after the initial report (DOE 1997k) was issued to increase the comparability range of total uranium to 1,100 ppm (i.e., a value close to the WAC limit for uranium) and to investigate the comparison of HPGe measurements to laboratory mass measurements by gamma spectrometry, BromoPADAP, and Inductively Coupled Plasma Mass Spectrometry methods. Results from this add-on work were issued in an addendum (DOE 1997m) to the initial report (DOE 1997k). Additional details on experimental design, instrument operating conditions (e.g., viewing window, acquisition time, and detector height), and data reduction are discussed in the report and its addendum. A second addendum report was issued (DOE 1997o) that extends the comparability of radium-226 to higher concentration levels and also presents an algorithm that allows HPGe radium-226 measurements to be connected to compensate for radium-222 excavation from soils.

Results presented in the initial reports and its addenda indicate that pass/fail decisions for CUs are similar regardless of whether the data are from HPGe or laboratory measurements. The initial report further demonstrated that total uranium, thorium-232, cesium-137, and potassium-40 measurements obtained by the HPGe instrument are comparable to laboratory analytical results. Accurate (i.e., similar to laboratory analysis) results for total uranium can be obtained with the HPGe instrument up to uranium WAC levels (1,030 ppm) and for thorium-232 up to levels approximately five times its FRL (5 times 1.5 pCi/g = 7.5 pCi/g). Using the correction algorithm discussed in an addendum report (DOE 1997o), acceptable comparability of radium-226 measurements can be obtained up to concentrations approximately 10 times the FRL (1.7 pCi/g x 10 = 17 pCi/g). The HPGe instrument provides excellent precision (i.e., well within the ± 20 percent guideline) on sequential measurements for total uranium, thorium-232, radium-226, cesium-137, and potassium-40, which is analogous to the way duplicate measurements are carried out in the laboratory. That is, laboratory duplicates are generally measured in the same batch, rather than on separate days.

As noted in the July 1997 HPGe Comparability Study, the MDCs for various radionuclides are low enough for HPGe to be used in A2PI for FRL certification attainment. By analogy with the statistical methodology used for certification testing, the MDC acceptance criteria for a given analyte will be that the 95 percent upper confidence limit of the MDC must be less than the FRLs of concern for ASL D

analysis. By analogy with radiochemistry performance specification in the SCQ, a less stringent acceptance criterion for ASL B will be that the 90 percent upper confidence limit of the MDC must be less than the FRL of concern. Table E-2 shows the 90 and 95 percent upper confidence limits in relation to the FRLs for A2PI. Given the data in this table, the HPGe technique should easily be capable of detecting each radionuclide when it is present at the FRL in A2PI.

E.1.4.2 RTRAK Applicability Study

The radiation tracking (RTRAK) system consists of a John Deere tractor with a mounted boom that holds one 4x4x16-inch NaI detector and associated electronics. A rapid assessment of surface gamma photon activity in open areas is obtained with this equipment, and 100 percent coverage of the area may be achieved. RTRAK may be operated at various speeds and gamma photon spectra may be collected using various acquisition times. The RTRAK Applicability Study (DOE 1997l) demonstrated that gamma spectra nominally collected every four seconds at a speed of one mile per hour are sufficient to achieve the requisite data quality. At this speed and data acquisition time, a field of view of approximately 90 ft^2 is attained. The data are tied to coordinates using global positioning system (GPS) software integrated with the data collection system. The collected gamma spectrum may be processed to generate gross gamma counts or radionuclide-specific activities for uranium-238, thorium-228, radium-226, cesium-137, and potassium-40. A more detailed description of this unit and its capabilities is provided in the report "RTRAK Applicability Study" (DOE 1997l) and its addendum (DOE 1997n).

Data from the RTRAK Applicability Study (1997l) and its addendum (DOE 1997n) may be used to generate trigger levels. The method of setting trigger levels is explained in the DOE 1997n report and will be amplified in a forthcoming memorandum as noted below. Basically, however, RTRAK's ability to meet trigger levels is based upon RTRAK precision at a given concentration. In general, to meet a trigger level of 70 percent of the FRL for uranium-238 (2.25 pCi/g), thorium-232 (1.05 pCi/g), and radium-226 (1.2 pCi/g), individual measurements obtained from a 4-second acquisition time must be aggregated. The number of individual measurements that must be aggregated to meet the acceptable precision at the indicated trigger levels are greater than 1,119, 2, and 5, respectively. (Trigger levels and aggregation of measurement were discussed in detail at the October 9, 1997, real-time work group technical meeting. Based upon decisions consensually agreed to at the meeting, a memorandum is in preparation detailing the 70 percent trigger levels.) The large number of samples needed for uranium-238 indicates that FRL screening for uranium-238 in A2PI is not practical using the RTRAK,

but that FRL screening for thorium-232 and radium-226 are practical. Additional information on preliminary trigger levels and the number of aggregate measurements needed to meet these preliminary levels for hot-spot and WAC values (uranium only) is summarized in Table E-1, as they apply to A2PI. A comprehensive discussion of suggested trigger levels for uranium-238, thorium-232, and radium-226 will be detailed in a forthcoming memorandum as noted above.

The accuracy of the RTRAK system was assessed by comparing measurements collected by the RTRAK with measurements obtained by the field-deployable HPGe instrument (DOE 1997l). RTRAK and HPGe Measurements taken in the same locations exhibit good agreement. This is the case for both static and dynamic RTRAK measurements. This comparison indicates the RTRAK system can be useful for discerning contamination patterns above FRLs for thorium-232 and radium-226, identifying hot spots for all three isotopes, and delineating above-WAC areas for total uranium (Table E-1). Therefore, screening remediation areas with the RTRAK allows the more accurate HPGe to be focused on the needed areas. Further discussion on the application of these techniques to the A2PI remediation is provided in Sections E.2 and E.3 of this appendix.

E.1.5 Strengths and Limitations of Measurement Approaches Used

The collection of both physical samples and field measurements constitutes a rational, efficient, and integrated approach to meeting remediation data needs. Limitations in the data provided by one approach are commonly compensated by data obtained from the other approach. Discussion in this section highlights the strengths and limitations of the proposed measurement approaches.

E.1.5.1 Collection of Physical Samples for Laboratory Analysis

Analytical laboratories can provide quantitative information on a large number of potential COCs (e.g., radionuclides, metals, organic compounds) using a very small volume of soil and industry-standard equipment and protocols. Although the nature and types of data obtained from laboratory analysis of discrete samples is diverse and quantitative, a considerable limitation is the inability of a discrete soil sample to adequately represent the heterogenous soil system without extremely intensive sampling. Therefore, many discrete soil samples must be collected, analyzed, and statistically evaluated to determine an average or mean concentration for COCs in the soil volume of interest. Moreover, discrete soil samples are likely to miss small hot spots or above-WAC areas. While the discrete soil-sampling approach is currently used for final certification and release of remediated areas,

it is neither cost effective nor time efficient when implemented at every step of the remediation process. For example, excavation proceeding in lifts requires a quick assessment of radionuclide activity on newly-cut surfaces to determine if OSDF WAC are met prior to excavating the next lift. In this case, collection of physical samples for laboratory analysis is not a practical approach due to the delay imposed upon the excavation activity while waiting for analytical results from the laboratory. Although laboratory results from predesign investigations will provide some surface and subsurface information on COC concentrations, it is not reasonable to assume that these data will provide a comprehensive picture of surface and subsurface conditions in heterogenous media. Therefore, the collection of data with field-deployable instruments is a vital component of the remediation program.

E.1.5.2 Collection of Data with Field-Deployable Instruments

Field-deployable systems that are providing useful data to the FEMP remediation program consist of analytical and survey instruments. Analytical instruments include the HPGe, RTRAK, and Radiation Scanning System (RSS) for assessment of gamma-emitting radionulides and a portable XRF unit to assess hazardous metal concentrations in soil. The RSS is a smaller version of the RTRAK that may be used in areas which cannot be accessed by the RTRAK (e.g., forested areas). Survey instruments include Geiger-Mueller counters to scan for gross gamma/beta activity and PID meters to monitor for hazardous organic vapors. A major use of field-deployable systems has been to assess gamma activity derived from uranium and its gamma emitting daughters in surface soil and subsurface cores, as uranium is the most widespread and abundant COC across the site.

The HPGe, RTRAK, and RSS systems are capable of obtaining semi-quantitative (ASL A) to highly quantitative (ASL B, D) data on distinct gamma-emitting radionuclides and/or gross gamma activity in surface soil. These instruments measure the average gamma photon flux from a given surface area, as determined by the height of the instrument above the surface. For the HPGe detector, the average gamma photon flux is measured quantitatively for uranium-235, uranium-238, thorium-232, and radium-226. The RTRAK and RSS systems use NaI detectors to either measure gross gamma activity and/or uranium-238, thorium-232, and radium-226.

A portable XRF instrument has been used to assess lead concentrations in lead-contaminated soil associated with the former firing range. This instrument can be used for in-situ analyses or ex-situ, with a discrete sample of soil. To provide a quantitative measurement of lead concentration. This is

useful to estimate the location of the boundary of characteristically hazardous concentrations of lead (i.e., leach less than 5 mg/L lead in the TCLP test), the lead FRL boundary (i.e., lead less than 400 mg/kg), and to bias the collection of samples for laboratory analysis. Because the measurement is based on a discrete small volume of soil, XRF has the same limitations discussed above for physical samples collected for laboratory analysis (i.e., it may not provide the needed data to make proper certification decisions in heterogeneous areas). Additionally, it is limited in its application by low precision as metal concentrations decrease. Therefore, its use is generally restricted to areas where the concentration of a metal COC is greater than 100 mg/kg.

E.1.5.2.1 Strengths and Limitations of HPGe Measurements

A major strength of the HPGe instrument lies in its ability to provide a rapid (900 second/15 minute) quantitative measurement of the activity of uranium-235, uranium-238, thorium-232, and radium-226 over a large surface area (up to 120m^2). Results from the report "Comparability of In-Situ Gamma Spectrometry and Laboratory Data" (DOE 1997k) and its addenda (DOE 1997m,o) indicate that the HPGe instrument is capable of producing good precision and accuracy (relative to laboratory measurements) for uranium-238 and thorium-232 at activities corresponding to their FRLs, while for radium-226 good precision is obtained, but only acceptable accuracy.

A second major strength of HPGe is that this measurement technique provides a better average over the survey unit for a given number of measurements than physical samples collected for laboratory analysis. This results from the fact that the HPGe is measuring tons of soil rather than potentially non-representative kilogram (or less) sized quantities. Considering the fact that a dose model is tied to the average concentration of a radionuclide over a specified area, obtaining that average in the most efficient and representative manner is advantageous for arriving at the correct decision rule.

A third major strength of HPGe that is particularly important for excavation operations is that a single measurement (without the necessity of aggregating measurements as must be done for RTRAK data) may satisfy three different data objectives. First, the measurement can indicate whether the area has potentially exceeded WAC concentrations. Second, the measurement can provide information on the existence of hot spots, and third, it can denote whether the FRL has been attained.

The limitations to HPGe are primarily three fold. First, it should not be used where the soils are muddy and standing water is present. Second, if used in the early morning, "bad radon" conditions may result in falsely elevated measured radium-226 concentrations. Third, if used in close proximity to steep side walls, trigger levels different from those in Table E-1 may need to be employed.

E.1.5.2.2 Strengths and Limitations of RTRAK Measurements

The RTRAK system provides a rapid assessment of potential hot-spot and above-WAC zones within remediation areas at 100 percent coverage, which cannot be achieved by physical sampling. This strength is a vital component of the remediation process, as it identifies contaminated soil that can easily be missed by the collection of discrete soil samples. Additionally, usable maps are readily provided on contamination patterns and anthropogenic surface features (e.g., roads).

The RTRAK Applicability Study (DOE 1997l) and its addendum (DOE 1997n) identify the primary limitations of the RTRAK system as:

- Large uncertainty and high minimum detection activities for individual measurements, especially uranium-238. This necessitates the aggregation of multiple measurements, particularly at low concentrations near FRLs
- In A2PI the low FRL of 3.22 pCi/g for Uranium-238 effectively precludes the use of RTRAK for FRL screening given its low degree of precision for individual measurements at such concentration levels and the very high number of data points that must be aggregated to achieve acceptable precision
- A potential for false high radium-226 measurements when "bad radon" conditions are present in the early morning
- Certain areas may prove not to be well-suited for RTRAK or RSS operations (e.g., rugged terrain). In such areas, HPGe will be used.

The first of these limitations can be resolved by aggregating measurements, albeit with a corresponding loss of spatial resolution in defining the radionuclide distribution. For a four-second acquisition time, the number of aggregated measurements necessary to achieve the trigger level criterion of 70 percent of the FRL is given in Table E-1. In soil locations where thorium-232 and/or radium-226 activities are high, or areas that are near storage facilities containing large quantities of radioactive materials (not a concern in A2PI), measurements indicating elevated uranium-238 activity may require verification with the HPGe instrument.

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E.2 PREDESIGN INVESTIGATIONS/EVALUATIONS RELATIVE TO DATA COMPARABILITY

Preliminary data from the predesign investigation activities (Appendix D) have been used to assess the necessity of establishing an area-specific correlation between in-situ gamma spectrometry and laboratory data. The HPGe Comparability Study (DOE 1997k,m) demonstrated that HPGe and laboratory data for total uranium are comparable and, when plotted against each other, fall along a perfect correlation line having a slope of 1.0. Data from the predesign investigations is used to see if the same relationship between HPGe and laboratory data holds for the South Field areas.

Two Project-Specific Plans (PSPs) incorporating in-situ gamma spectrometry measurements for total uranium have been implemented as part of the predesign investigation for A2PI. A third PSP incorporated XRF measurements for total lead. These results are briefly summarized below.

E.2.1 PSP for Site Preparation Activities

Characterization data were collected to support soil excavation activities associated with the construction of retention basins, ditches, and connection of utilities (DOE 1997g). The characterization data were obtained on surface-soil and subsurface soil-core samples to determine: 1) if COCs exceeded their respective OSDF WAC, 2) the excavation extent of below-WAC/above-FRL material, and 3) if the soil was suitable for reuse (i.e., below FRLs). HPGe measurements were used to quantify the distribution of total uranium in surface soil within the boundaries designated for construction of retention basins and ditches and to bias locations for the placement of borings to recover soil samples for total uranium analysis. Part of the data collected to address those items included fifty-two physical surface samples for total uranium analysis by BromoPADAP, and fifty-two HPGe measurements (1.0 meter detector height) where the HPGe detector was centered over the physical sample collection location. These data are presented in Table D-5 of Appendix D.

E.2.2 PSP to Delineate Material Containing COCs Above the OSDF WAC

Data collection during the implementation of this PSP (DOE 1997h) focused on five areas of known and suspected uranium contamination above the OSDF WAC, as indicated by the Operable Unit 2 RI (DOE 1995b) and the Characterization Investigation Study (CIS) (Weston 1987). Field measurements and sampling activities were carried out to delineate the extent of excavation required to remove uranium that exceeded OSDF WAC from known or suspected above-WAC areas. Soil samples collected during the RI and CIS indicated four surface areas and one subsurface area with the potential

to contain uranium at levels above the WAC. One HPGe measurement (1.0 meter detector height) and five samples were collected at each of the four surface areas with potential to exceed WAC concentrations for total uranium. These data are contained in Tables D-8 and D-9 of Appendix D.

E.2.3 HPGe Data Results

Data from the Fill Areas and potential WAC exceedance areas are summarized in Table E-3. The averages of the data from the 52 Fill Area HPGe and laboratory measurements are very close (15.5 ppm for HPGe vs. 14.5 ppm from BromoPADAP). The average data from the four WAC delineation areas are also quite close. In these four areas HPGe measurements were not co-located over sample collection points as they were for the Fill Areas, so the agreement between laboratory and HPGe data is especially noteworthy.

Figure E-1 shows an x,y scatter plot of 52 individual pairs of Fill Area HPGe and physical sample data points. Data for the WAC Delineation Areas is represented by averages in Table E-3 for each area (four total data points). A perfect correction line going through the origin with a slope of 1.0 is also shown in Figure E-1. Of the 56 data points shown in Figure E-1, only five fall significantly off the perfect correlation line. Two data points have laboratory values for total uranium significantly higher than HPGe measurements. Three data points have HPGe measurements significantly higher than laboratory data values. However, the vast majority of points demonstrate that HPGe and laboratory data are quite comparable. In no cases do the data points which fall well off the perfect correlation line indicate a potential WAC exceedance.

In conclusion, data from Fill Areas and WAC Delineation Areas conclusively demonstrate that formulation of an A2PI area-specific correlation between HPGe and laboratory data is not necessary. The correlations and degree of comparability guidelines set out in the July 1997 HPGe Comparability Study (DOE 1997k) are valid for A2PI.

E.2.4 PSP to Delineate Lead Contamination

Data were collected (DOE 1997i) to delineate the extent of lead contamination at the former firing range that exceeds the FRL (400 mg/kg) and make a preliminary determination of the RCRA status of this material. Results are based on XRF analysis of field samples, although laboratory results were obtained for some of the discrete samples. To obtain field analyses, a field screening technique

employing a field portable XRF was used. The spectrometer used was a Spectrace 9000 XRF, manufactured by Texas Nuclear Technologies. For a complete description of the calibration and QC specifications for this instrument, please refer to the Environmental Monitoring Project procedure EQT-09, Spectrace 9000 X-Ray Fluorescence Spectrometer - Calibration, Operation, and Maintenance. In addition to the routine instrument calibration and QC checks, an independent QC self-assessment was performed. This self assessment included the daily analysis of a certified soil standard purchased from Environmental Resource Associates, (5540 Marshall Street, Arvada, Colorado). The same spectral acquisition parameters were used for the standard analysis as was used for the field measurements (i.e., ^{109}Cd - 300 seconds, ^{55}Fe - 20 seconds, ^{241}Am - 20 seconds).

Laboratory analyses were performed using both inductively coupled argon plasma (ICP) and graphite furnace atomic adsorption (GFAA) methods. The XRF and laboratory data are presented in Tables D-10 through D-12 in Appendix D.

The data for both XRF and GFAA analyses are plotted on Figure E-2. The linear regression line and 95 percent confidence interval lines are also shown. The correlation coefficient (expressed as R^2) for the linear regression line is 0.96, which indicates a good correlation between the XRF and GFAA results (a correlation coefficient of 1.0 represents a perfect correlation). Based on these results, the FRL for lead (400 mg/kg - laboratory results) indicates an XRF measurement of 368 mg/kg using the lower confidence interval. An XRF measurement of 300 mg/kg will be conservatively used as the trigger for delineating above-FRL concentrations of lead (Table E-1). When TCLP results are available, a similar trigger for delineating characteristically hazardous concentrations of lead will be developed.

E.3 INTEGRATED APPROACH FOR ENVIRONMENTAL MEASUREMENTS IN A2PI

This section summarizes the proposed approach for integrating field measurements with laboratory data during above-WAC excavations, excavations of characteristically hazardous material, excavations of below-WAC material, precertification activities, and the certification process.

E.3.1 Above-WAC Excavation

Material containing uranium above the OSDF WAC has been delineated by the predesign investigation and consists of approximately 1,700 yd^3 of fill, soil, and debris located in the Inactive Flyash Pile.

Additional material with uranium above the OSDF WAC may be identified during the excavation of these heterogenous waste units. The reader should refer to Figures 3-6 and 3-7 in Section 3.0 of the Implementation Plan for illustrations of the discussion in Section E.3.1.2.

E.3.1.1 Data Quality and Needs

Data measurements for the removal of uranium exceeding OSDF WAC include scanning with the Geiger-Mueller counter to assess gross gamma activity of excavated special materials, use of the RTRAK and RSS systems to establish excavation boundaries at data quality level ASL A, and HPGe measurements and laboratory analysis of discrete samples at ASL-B to verify the above-WAC excavation boundary.

Actions required to collect the data needed for the above-WAC excavation of uranium contaminated material include:

- Delineation of horizontal and vertical extent of uranium concentration above the OSDF WAC (delineated on design drawings)
- Identification of additional material containing uranium above the OSDF WAC during excavation
- Assessment of the gross gamma activity associated with any encountered special materials.

E.3.1.2 Sequence of Activities and Measurement Approach

As discussed in Section 3.3.2.1, the delineated volume of above-WAC material is covered by material containing uranium that is below WAC. Therefore, the overburden material will be removed first, followed by excavation of the above-WAC material in lifts.

After removal of each lift of above-WAC material, the entire side of the cut face of the excavation will be scanned, to the extent possible, for total uranium activity with the RSS system and/or HPGe instrument to assess the lateral removal of all above-WAC material. If RSS is used, a four-second acquisition time at 1.0 mph will be used. If the gross counts and total uranium concentrations using the RSS system (Table E-1) indicate above-WAC material, additional material will be excavated, as required. Alternatively, HPGe measurements at a distance of one foot from the side of the cut face (or closer, depending upon the height) may be used to scan for the presence of above-WAC material

instead of the RSS system, or to determine if the the gross counts from the RSS system are a result of the presence of uranium. In any case, if measurements indicate the presence of above-WAC material, additional material will be excavated until all such above-WAC material is removed.

Upon reaching the design-based floor of the above-WAC excavation, the entire floor will be scanned, to the extent possible, for total uranium in excess of the WAC with the RSS or RTRAK system or HPGe equipment. One hundred percent coverage by RTRAK or RSS will consist of paths offset by approximately two meters with a four-second acquisition time at 1.0 mph. If the gross counts and total uranium concentration using the RSS or RTRAK system (Table E-1) indicate above-WAC material, additional material will be excavated, as required. If only gross counts using the RSS or RTRAK system indicate the potential presence of above-WAC material, HPGe measurements at a height of one foot may be used to determine if the gross counts are a result of the presence of uranium. Alternatively, complete coverage by HPGe may be performed at a 1.0 meter detector height. As needed in any case, total uranium activity that indicates above-WAC material will be excavated.

If special materials (Section 3.3.2.5) are identified by visual observation during excavation, excavation will be paused to assess the gross activity of the material with a Geiger-Mueller counter. If the gross activity of the material exceeds 90,000 dpm, the excavation will be stopped to upgrade personal protective gear and remove the radioactive material.

E.3.1.3 Quality Assurance and Quality Control

Quality assurance and control measures will be implemented during all phases of the construction activity and field measurements. Above-WAC boundaries will be clearly marked in the field with fencing or rope based on RI/FS predesign data. These boundaries will be moved based on field survey results as excavation proceeds. The contractor will be responsible for controlling field conditions such that field surveying does not interfere with the removal of delineated volumes.

Independent assessment will be conducted to verify compliance to excavation design, PSP/DQOs, above-WAC material tracking documentation, and IRDP requirements for above-WAC areas. The documentation demonstrating WAC attainment at the active working grade will be verified before above-WAC boundaries are removed. Final construction drawings will show the verified known WAC attainment boundary cut grades.

Data obtained in above-WAC excavation must be managed such that waste profiles can certify material shipment for off-site disposal.

E.3.2 RCRA Excavation

Material with the potential to exhibit the toxicity characteristic for lead (i.e., fails a TCLP test) has been delineated by analytical results from the predesign investigation and consists of approximately 100 yd^3 of lead-contaminated soil located in the former firing range. A summary of the use of the field-deployable XRF instrument and associated sampling activity to support the excavation of this material follows.

E.3.2.1 Data Quality and Needs

Data measurements for the removal of soil with lead contamination that exceeds the lead FRL include estimating the excavation boundary with insitu field XRF measurements at data quality level ASL A and conducting total lead tests at ASL B on discrete soil samples collected.

Actions required to collect data needed for the lead-contaminated soil excavation include:

- Delineation of the horizontal and vertical extent of lead-contaminated soil that passes the TCLP test but exceeds the lead FRL of 400 mg/kg.

E.3.2.2 Sequence of Activities and Measurement Approach

As discussed in Section 3.3.2.1, excavation will remove the soil with lead contamination that fails the TCLP test (i.e., leaches more than 5 mg/L in the TCLP test). As delineated by sampling and laboratory analysis, excavation of this material is not expected to exceed a depth of two feet. Excavation of charateristically hazardous concentrations of lead will followed by removal of soil with contamination that exceeds the FRLs, including the lead FRL of 400 mg/kg. Upon completion of this excavation, field XRF measurements will be taken to verify removal of above-lead-FRL material, based on a trigger level of 300 mg/kg. If necessary due to these measurements, additional material will be excavated. Confirmatory samples will then be taken for total lead analysis. The number of samples will depend on the final size of the area to be excavated. At a minimum, the sample density will be equal to that required in precertification.

E.3.2.3 Quality Assurance and Quality Control

Soils with characteristically hazardous concentrations of lead will be containerized in FDF approved containers. The subcontractor will supply the containers and FDF QA will verify container fabrication to DOT specifications. Other lead contaminated soil will be dispositioned to the OSDF.

All total lead laboratory samples for will be analyzed to ASL B validatable data packages, with 10 percent validation of those packages. The field data packages associated with validated chemical data will also be validated.

The excavation boundary for characteristically hazardous and above-FRL concentrations of lead will be identified on final construction drawings.

E.3.3 Below-WAC Excavation

Material containing COCs above established FRLs but below OSDF WAC have been delineated using existing RI data. A summary of the integrated measurement approach applied to the excavation of this material follows.

E.3.3.1 Data Quality and Needs

A high level of confidence must be placed in the data indicating below-WAC levels of total uranium prior to excavating material for the OSDF. Therefore, the data demonstrating that total uranium in the soil are below WAC values must be of quality of ASL B or higher. A minimum of 10 percent of the data will be validated.

Data measurements for the removal of COCs exceeding their FRLs include scanning with the Geiger-Mueller counter to assess gross gamma activity of encountered special materials, use of the RTRAK or RSS system to evaluate remnant hot-spot and/or above-WAC areas at data quality level ASL A, and confirmation that above-WAC material is present using HPGe at data quality level ASL B.

Actions required to collect data needed for the above-FRL excavation include:

- Delineation of the horizontal and vertical extent of soil containing uranium and other COCs that are above their FRLs on excavation design drawings

- Identification of additional above-WAC material during excavation
- Assessment of the gross gamma activity associated with any encountered special materials.

E.3.3.2 Sequence of Activities and Measurement Approach

As discussed in Section 3.3.2.3, soil and debris designated for excavation as below-WAC will be loaded and hauled to the OSDF for staging or disposal. If special materials (Section 3.3.2.5) are encountered during the excavation, excavation will be stopped to assess the gross activity of the material with a Geiger-Mueller counter, as noted in Section E.3.1.2. Special materials will be segregated and staged in the Special Materials Transfer Area.

The surface of each lift will be field surveyed for total uranium with the RSS, RTRAK, or HPGe systems to screen for the presence of above-WAC material. One hundred percent coverage by RSS or RTRAK systems will be accomplished by runs offset by 2.0 meters with a four-second acquisition time at 1.0 mph. If the gross counts and total uranium concentration using the RSS or RTRAK system (Table E-1) indicate above-WAC material, that material will be excavated, as required. If only gross counts using the RSS or RTRAK system indicate the potential presence of above-WAC material, HPGe measurements at a height of one foot may be used to determine if the gross counts are a result of the presence of uranium. Alternatively, complete coverage by HPGe may be performed at a 1.0 meter detector height. As needed in any case, total uranium activity that indicates above-WAC material will be excavated. Monitoring associated with the excavation of the newly identified above-WAC area will proceed as indicated in Section E.3.1.

The above sequence of activities will be repeated for consecutive lifts until the design-based floor of the above-FRL excavation is reached. Upon reaching the floor of the excavation, the floor will be precertified (Section E.3.4).

E.3.3.3 Quality Assurance and Quality Control

During excavation, QA will perform surveillances to verify compliance to A2PI related FEMP procedures, PSPs, A2PI PEP, A2PI IRDP, WAC Attainment Plan, OSDF Impacted Materials Placement Plan, SEP and the SCQ with respect to field sampling, field measurements, analytical analyses and related data management of soil data. Nonconformances will be submitted to the A2PI

Project Manager and the A2PI Construction Manager for nonconformance resolution and corrective action implementation.

Field surveys of above-WAC and below-WAC uranium during excavation will be done at ASL A. Predesign investigation determinations of final boundaries for WAC and FRL attainment will be at ASL B. Additionally, ASL B, C, or D data may be required to support waste disposition profiles and will be determined in PSPs. Identified hot-spots will be evaluated for total uranium, thorium-232, and radium-226 with the HPGe system.

E.3.4 Precertification

Upon completion of all excavation activities in A2PI, the precertification phase will be implemented to prepare the remediation area for certification. A summary of the use of field and laboratory measurements in the precertification process follows.

E.3.4.1 Data Quality and Needs

Data measurements for the precertification process include use of RTRAK/RSS (at ASL A) and HPGe (at ASL B) measurements to verify that the area has no hot spots remaining and that average uranium-238, thorium-232, and radium-226 activities are below their FRLs.

Actions required to meet the data needs for precertification activities include:

- Delineate area where further excavation is required due to the average activity of primary radionuclides exceeding established FRLs
- Delineate hot spot areas for excavation, if present
- Perform physical sampling activities for other COCs, as needed

E.3.4.2 Sequence of Activities and Measurement Approach

The activities associated with establishing a list of COCs and delineating CU boundaries during the precertification process are described in the SEP (Section 3.4). Activities in this precertification sequence that are relevant to the use of field and laboratory measurements include:

- A 100 percent coverage scan with RSS or RTRAK equipment, using previously described procedures, to evaluate the pattern of residual radiological activity (gross counts) and to identify potential radiological hot spots.

- Selective use of HPGe to evaluate potential hot spots identified by the RSS/RTRAK scan. The height will depend on the area and potential concentration indicated by the RSS/RTRAK scan.

- Additional RSS/RTRAK and HPGe measurements in locations where hot spot removal and/or further excavation takes place

- Physical sampling activities for nonradiological COCs, as needed.

The major benefit of using the RTRAK, RSS, or HPGe instrument in the precertification process is their ability to measure the average uranium-238 and thorium-232 activities over a large area to assess heterogeneous distribution patterns, which is not possible with a single physical sample collected in an equivalent area.

E.3.4.3 QA/QC

The results of precertification measurements will be documented in accordance with respective PSPs. The purpose of the scanning and sampling plan will be to assess the residual gamma activity of primary ASCOCs in the soil. The resulting patterns of radiological activity will be plotted. Once certification sample points are determined, additional assurance of FRL attainment will be provided by conducting HPGe measurements above designated certification sample locations.

The precertification data, documentation, and residual contamination plots will be verified by project personnel to project program requirements. The resulting reports will become part of the Certification Design Letter.

E.3.5 Certification

Upon completion of all precertification activities in A2PI, the certification phase will be implemented to prepare the CUs for release to the restoration process. A summary of the use of real-time measurements in the certification process follows.

E.3.5.1 Data Quality and Needs

Data measurements for the certification process include using HPGe measurements at ASL D to verify that the average uranium-238 and thorium-232 activities are below their FRL in each CU and that no hot spots remain, and laboratory analysis at ASL D for all CU-specific COCs to demonstrate compliance with established FRLs.

Actions required to meet the data needs for certification activities include:

- Collect physical samples and submit for laboratory analysis to demonstrate that all CU-specific COCs meet certification criteria for each individual CU. Certification criteria are discussed in Section 3.4 of the SEP
- Collect HPGe measurements to compare field data and decisions made with the data to primary radionuclide activities obtained from laboratory gamma-spectrometry analysis
- Collect and analyze additional samples and perform additional certification measurements with the HPGe if the CU fails certification.

E.3.5.2 Sequence of Activities and Measurement Approach

The sequence of activities carried out during the certification process are described in the SEP (Section 3.4). Activities within the certification sequence that are applicable to the use of field and laboratory measurements include use of the HPGe instrument to perform measurements in the CUs for primary radionuclide certification and the collection of physical samples for laboratory analysis of all CU-specific COCs. HPGe measurements will be compared to laboratory results to continue the assessment of using HPGe for final certification of uranium-238, thorium-232, and radium-226 (i.e., primary radiological COCs). As the body of laboratory and field data grows, it is probable that a sufficient level of confidence will be reached to allow primary radionuclides to be certified using the HPGe instrument. The number of HPGe measurements and physical samples will be determined as specified in the SEP. HPGe measurements will be co-located above the locations where physical samples are collected.

E.3.5.3 QA/QC

All data collected for certification will be in accordance to the SCQ at ASL D. All associated field QCs must be specified in PSP/DQOs. A minimum of 10 percent of the data packages will be validated, including the associated field data packages. Therefore, HPGe must have ASL D validation protocols

established before HPGe measurements can be used for certification.

Statistical treatment of CU data will be to SEP requirements in certifying average ASCOC FRL attainment. Data sets used in statistical calculations will be controlled in a manner that can be traced from the Certification Report back to the SED CU data set. Associated calculations and spreadsheets will be independently verified.

E.4 SUMMARY

E.4.1 Remediation Process and Data Needs

The remediation process carried out in A2PI will follow the general approach outlined in Section 3 of the SEP. Steps in the remediation of A2PI include:

- Predesign investigations to establish the extent of above-WAC material, lead-contaminated soil with the potential to exhibit the toxicity characteristic
- Site-preparation activities to create retention basins and ditches, to establish any needed staging areas, and to connect utilities
- Use of pre-design PSPs and information obtained during site preparation activities to prepare the IRDP
- Soil excavation of above-WAC, potential RCRA, and below-WAC volumes
- Precertification and certification activities
- Grading and restoration activities

Data needs are primarily tied to establishing the horizontal and vertical excavation boundaries for total uranium contamination that exceeds the OSDF WAC, potential RCRA characteristic waste (lead), and below-WAC soil volumes, and demonstrating that soil remaining after completion of the excavations can be certified as meeting the established FRLs. Technetium-99 has not been identified above its FRL/WAC level in the predesign investigation and will no longer be considered as a COC for A2PI. Additional data needs are centered on determining if all above-WAC material has been removed and identifying locations where uranium-238, thorium-232, and/or radium-226 levels exceed the hot-spot criterion. The need to identify soil containing uranium above 50 ppm (i.e., the ALARA goal) is not a data need for A2PI, because the uranium-238 FRL in this area has been set at 3.22 pCi/g (about 10 ppm total uranium).

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Real-time, field-deployable instruments will be used during the predesign, excavation, and precertification phases to characterize soil for select COCs. During site-preparation and soil-excavation activities, real-time field instruments will be used to monitor the surfaces of each lift and to assess the radionuclide activity of encountered special materials.

The remedial actions carried out at A2PI will be supported by a variety of data collection activities that involve the use of RTRAK, RSS, and HPGe instruments for the assessment of primary radionuclide activities, a Geiger-Mueller counter to screen gross-gamma activity of any encountered special materials, a portable XRF instrument to estimate select heavy metal concentrations. The primary benefits offered by the use of these instruments includes assessment of average uranium-238 and thorium-232 activity in heterogeneous media and the ability to direct excavation.

E.4.2 Integrated Measurement Approach

The integrated measurement approach proposed for A2PI can be generalized as follows:

- Use RTRAK/RSS or HPGe to determine the distribution of above-WAC uranium and above-FRL contamination pattern of total uranium and thorium-232 on the surface being monitored.
- Use a Geiger-Mueller counter to assess gross-gamma activity of any encountered special materials.
- In areas with the potential to contain material that exhibits the toxicity characteristic for lead, conduct field XRF measurements to estimate the RCRA excavation boundary.
- Collect confirmation samples for laboratory analysis at base of RCRA excavation.
- Use visual monitoring for special materials during excavation activities and assess special materials, if exhumed.
- Use HPGe, RSS, and RTRAK during precertification to identify and evaluate residual patterns of contamination for hot spot and FRL attainment.
- Collect HPGe measurements and physical samples for CU Certification to compare field data and decisions based upon those data to data and decisions obtained/made from laboratory analysis of physical samples.

TABLE E-1

SUMMARY OF TRIGGER LEVELS FOR SOME FIELD-DEPLOYABLE INSTRUMENTS

Instrument	Analyte	Remediation Driver	Trigger Level (TL)	Number of Measurements to Reach TL[a]
RTRAK or RSS System	Uranium-238	Above WAC	240 pCi/g	1 w/ 4s count
		Hot Spot	6.76 pCi/g	125 w/ 4s count
		Above FRL	2.25 pCi/g	1119 w/ 4s count
	Thorium-232	Hot Spot	3.15 pCi/g	1 w/ 4s count
		Above FRL	1.05 pCi/g	2 w/ 4s count
	Gamma-emitting radionuclides	Above WAC	17,000 gross counts per second [b]	1 w/ 4s count
XRF System	Lead	Above FRL	300 mg/kg	1 w/ 300s count

[a] Entry "1 w/ 4s count" read as 1 aggregated measurement with a four-second counting time for each measurement.

[b] See Figure E-3.

TABLE E-2

HPGe MINIMUM DETECTABLE CONCENTRATIONS COMPARED TO FRLs

Analyte	MDC	95% UCL	90% UCL	FRL
Total Uranium	5.8 ppm	6.2 ppm	6.1 ppm	10 ppm
Thorium-232	0.075 pCi/g	0.076 pCi/g	0.075 pCi/g	1.5 pCi/g
Radium-226	0.076 pCi/g	0.078 pCi/g	0.077 pCi/g	1.7 pCi/g

TABLE E-3

COMPARISON OF HPGe AND LABORATORY ANALYSIS TOTAL URANIUM RESULTS

Area	Total Uranium by HPGe* (ppm)	Total Uranium by Laboratory Analysis* (ppm)
Fill Area	15.5 ± 6.2	14.5 ± 12.2
WAC Delineation Area SWU-1	62.4 ±6.0	39.2 ± 21.8
WAC Delineation Area SWU-2	34.9 ± 12.0	28.8 ± 7.9
WAC Delineation Area SWU-3	17.6 ± 1.3	11.3 ± 4.1
WAC Delineation Area SWU-4	24.0 ± 3.0	24.4 ± 8.7

* Average ± one standard deviation

Figure E-1
HPGe vs Laboratory Total Uranium Data for South Field Area

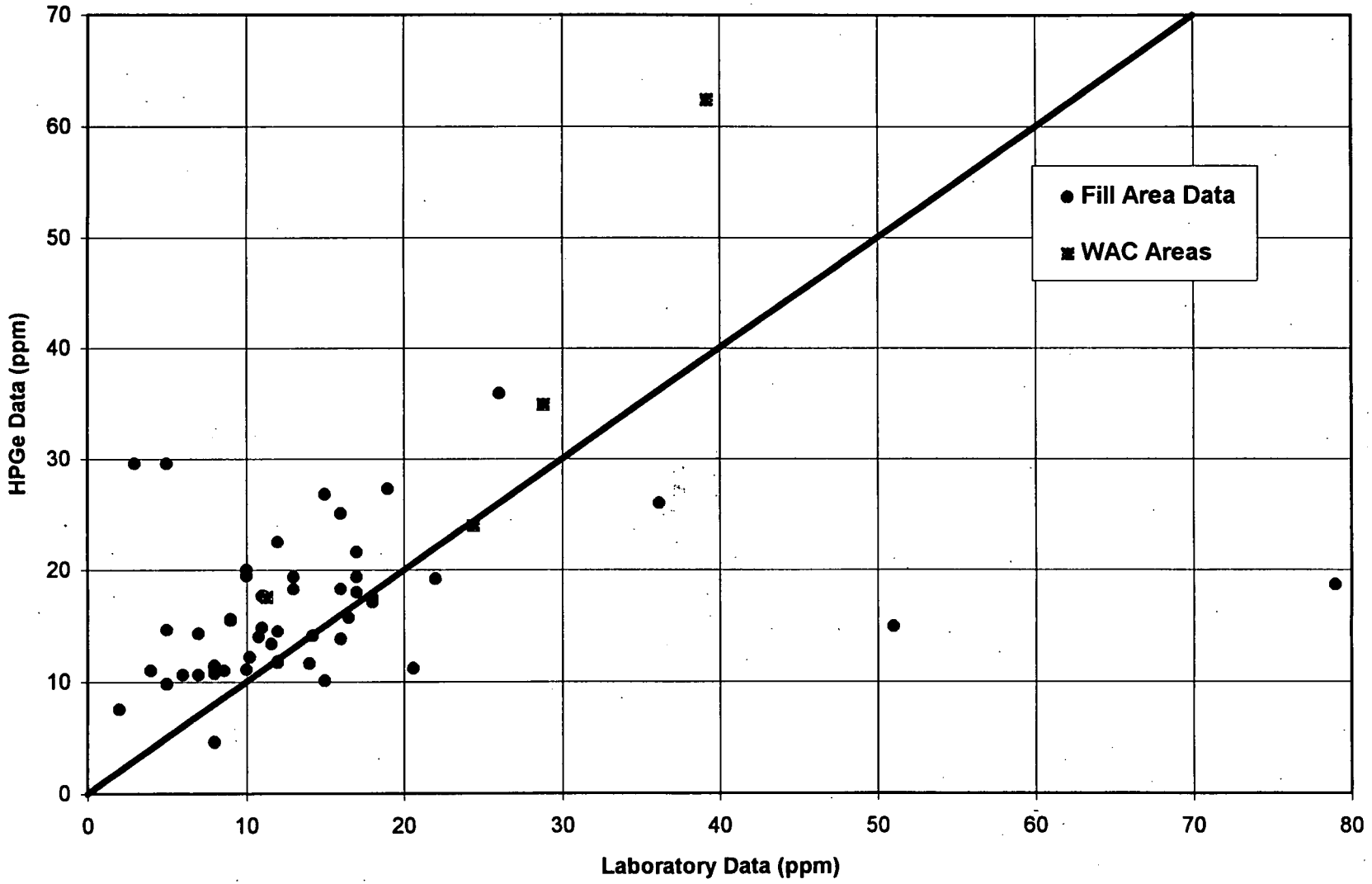

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Figure E-2
XRF vs Laboratory Total Lead for the Former FEMP Firing Range

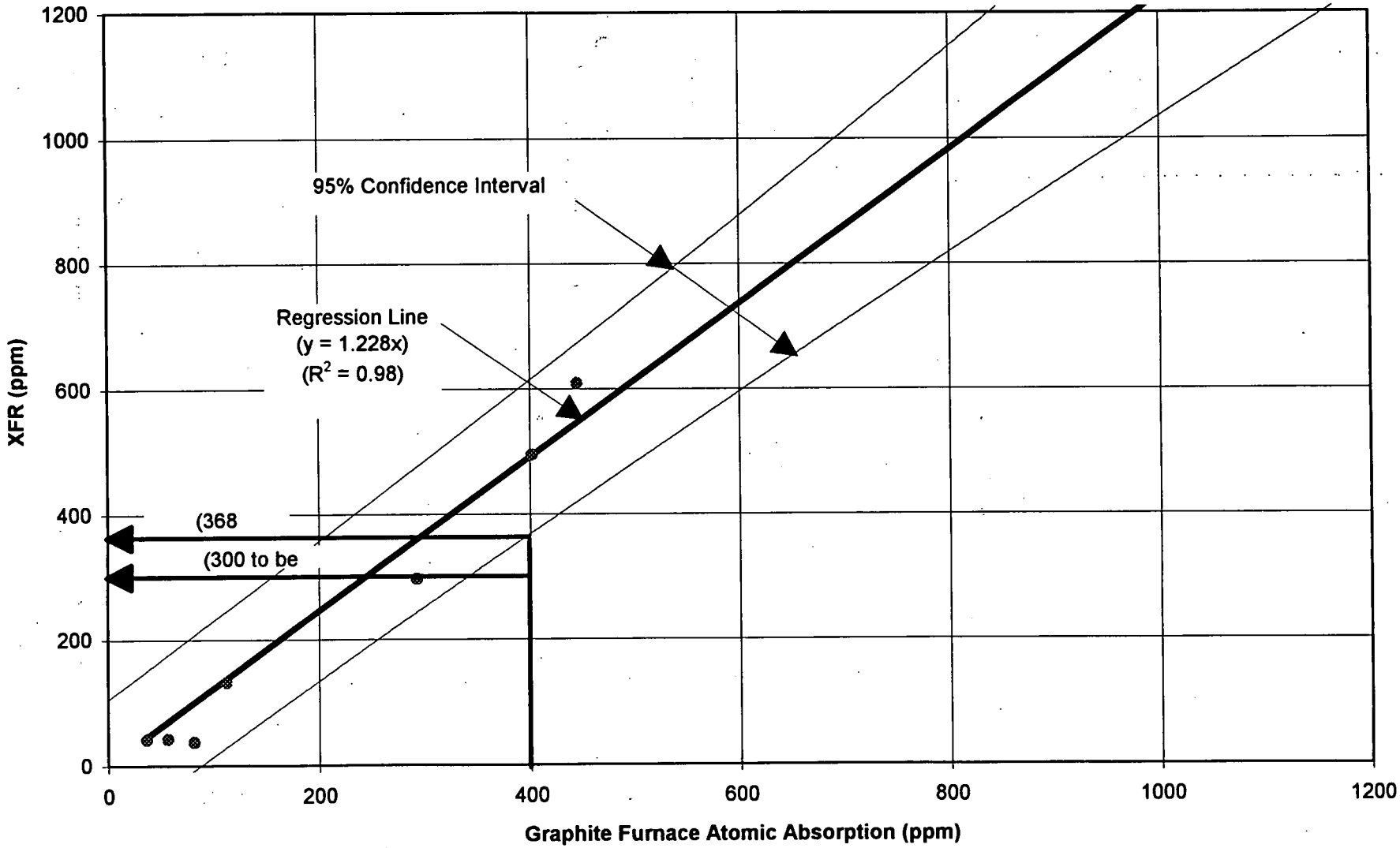
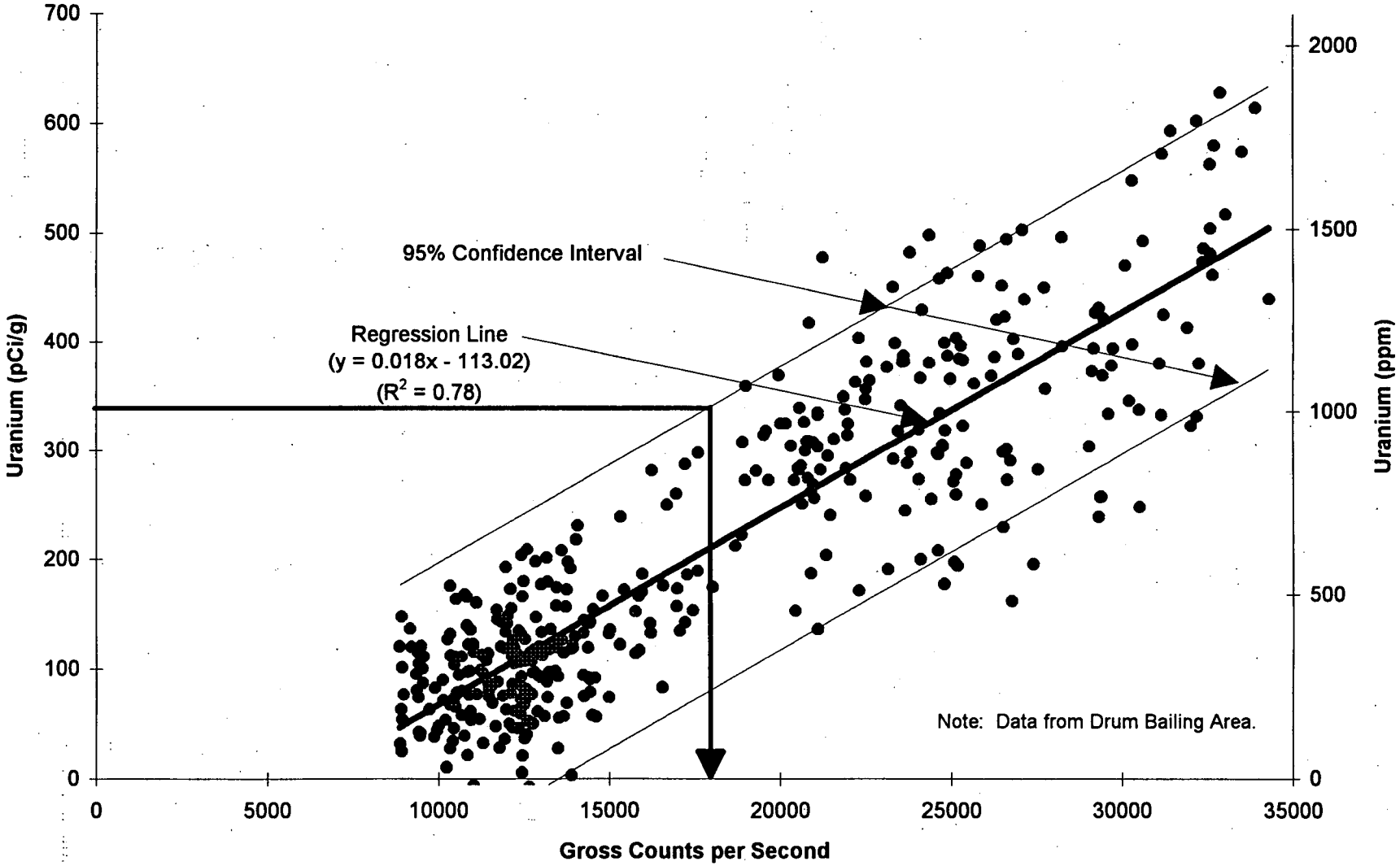
Figure E-3
Uranium Levels vs Gross Counts