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**OAK RIDGE
Y-12
PLANT**

MARTIN MARIETTA

Industrial Waste Landfill IV Upgrade Package

Prepared by
Martin Marietta Energy Systems, Inc.
Engineering Division

March 29, 1994

CAPE-3078
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Prepared Under
Contract No. DE-AC05-84R-21400

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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Y/TS-399/R1

DESIGN AND OPERATING PROCEDURE FOR THE Y-12 INDUSTRIAL LANDFILL IV

Date of Issue: March, 1994

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831-8169
managed by
Martin Marietta Energy Systems, Inc.
for the
U. S. DFPARTMENT OF ENERGY
under c tract DE-AC05-840R21400

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ACRONYMS

CFR	Code of Federal Regulations
CQC	Construction Quality Control
EP-TOX/TCLP	Extraction Procedure Toxicity Testing/Toxicity Characteristic Leaching Procedure
FML	Flexible Membrane Liner
GW	Groundwater
IWLF-IV	Industrial Waste Landfill IV
OC	Operating Contractor
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
RCRA	Resource Conservation Recovery Act
SLF-II	Sanitary Landfill II
TDEC/DSWM	Tennessee Department of Environmental and Conservation/Division of Solid Waste Management

Y-12 INDUSTRIAL WASTE LANDFILL IV

I. BACKGROUND

General

The United States Department of Energy (DOE) has three major operational facilities on the DOE Oak Ridge Reservation (ORR) at Oak Ridge, Tennessee: The Y-12 Plant (Y-12), the K-25 Site, and the Oak Ridge National Laboratory (ORNL). Along with these three major operating facilities, DOE has their own local administration building referred to as the DOE Federal Building. The Y-12 Plant, K-25 Site, and ORNL are managed by DOE's Operating Contractor (OC), Martin Marietta Energy Systems, Inc. (Energy Systems) for DOE. Operation associated with the facilities by the Operating Contractor and subcontractors, DOE contractors and the DOE Federal Building result in the generation of industrial solid wastes as well as construction/demolition wastes.

Due to the waste streams mentioned, the Y-12 Industrial Waste Landfill IV (IWLF-IV) was developed for the disposal of solid industrial waste in accordance to Rule 1200-1-7, Regulations Governing Solid Waste Processing and Disposal in Tennessee. This revised operating document is a part of a request for modification to the existing Y-12 IWLF-IV to comply with revised regulation (Rule Chapters 1200-1-7-.01 through 1200-1-7-.08) in order to provide future disposal space for the ORR, Subcontractors, and the DOE Federal Building. This revised operating manual also reflects approved modifications that have been made over the years since the original landfill permit approval. The drawings referred to in this manual are included in Drawings section of the package. IWLF-IV is a Tennessee Department of Environmental and Conservation/Division of Solid Waste Management (TDEC/DSWM) Class II disposal unit.

Landfill History

The initial operating permit (number IDL 47-103-0075) for IWLF-IV was issued on January 4, 1989 exclusively for the disposal of non-hazardous, non-radioactive solid waste generated from the Y-12 Plant operation or by DOE contractors working at the Y-12 Plant. (Since that time, a modified permit has been issued by TDEC which changed the permit number to IDL 01-103-0075.) The waste was to consist primarily of wood board, foam rubber, cardboard, metal strips, and magnetic tape. Along with the permit authorization, the Registration Conditions Part I contained 13 General Terms, and Part II contained 5 Conditions of Registration. The landfill has been operated as a Class II disposal facility and accepts non-radioactive, non-hazardous, solid waste as detailed in the initial permit and document entitled "Design and Operating Procedures for the Y-12 IWLF-IV", Y/TS-399, dated April 1988.

In late 1991, it became apparent that Sanitary Landfill II (SLF-II) may become full before the replacement landfill could be completed. Due to the lack of landfill space it was requested that construction/demolition waste be approved for disposal in IWLF-IV from the ORR facilities and DOE contractors on the ORR. Approval was granted by TDEC in February of 1992. For similar reasons, in January of 1993, a special waste request for disposal of fly ash from the Y-12 Steam Plant was sought. This request was approved in April of 1993. Both of these TDEC approvals contained approval conditions. Also in October of 1993 a request was submitted to dispose of Y-12 Steam Plant Wastewater Treatment Sludge and Oak Ridge National Laboratory Coal Yard Runoff Basin Sludge. This request is still pending.

In September of 1992 a request was submitted to expand the waste generator in the original permit from Y-12 Plant only to include Oak Ridge National Laboratory, the K-25 Site, and DOE contractors working at these sites. This request was resubmitted in September of 1993 with additional information on the waste streams the generators would be sending for disposal. The request also included the DOE Federal Building as a potential waste generator. This permit modification was granted in December of 1993.

It was apparent in 1992 that the landfill would not be fully utilized by March 1994. This date was significant because the current regulations required landfills that did not have leachate and gas management systems to be closed at that time. In September of 1992, a request was submitted to waive leachate and gas management systems due to the inert waste streams and the large existing geological buffer. The waiver request was modified in June of 1993 to limit the waiver to a small eastern portion of the landfill rather than the entire landfill.

During this time, efforts were initiated to convert the remaining landfill area in to a lined facility in compliance with the July 10, 1993 amendments to the regulations. The new amendments changed the liner requirements from a single clay liner to a single composite liner using clay and a geomembrane, and extended the closure date to October 1996 for non complying landfill areas that were foot printed with waste by October 9, 1993.

The waiver was granted for approximately 20 percent of the landfill, and a permit modification was issued on January 13, 1994. The permit modification changed Part I's title to "Terms And Conditions" and was revised/expanded to 21 items. Part II's title was changed to "Facility-Specific Permit Conditions". In between the sections, a new section was added and called "Variances And Waivers". This modification will allow the eastern 20 percent of the landfill area that does not have leachate and gas management systems to be fully utilized, even if filling that area goes beyond the October 1996 time frame. This area is designated as Area 1 on Figure 1 and Drawing C2E900000A034.

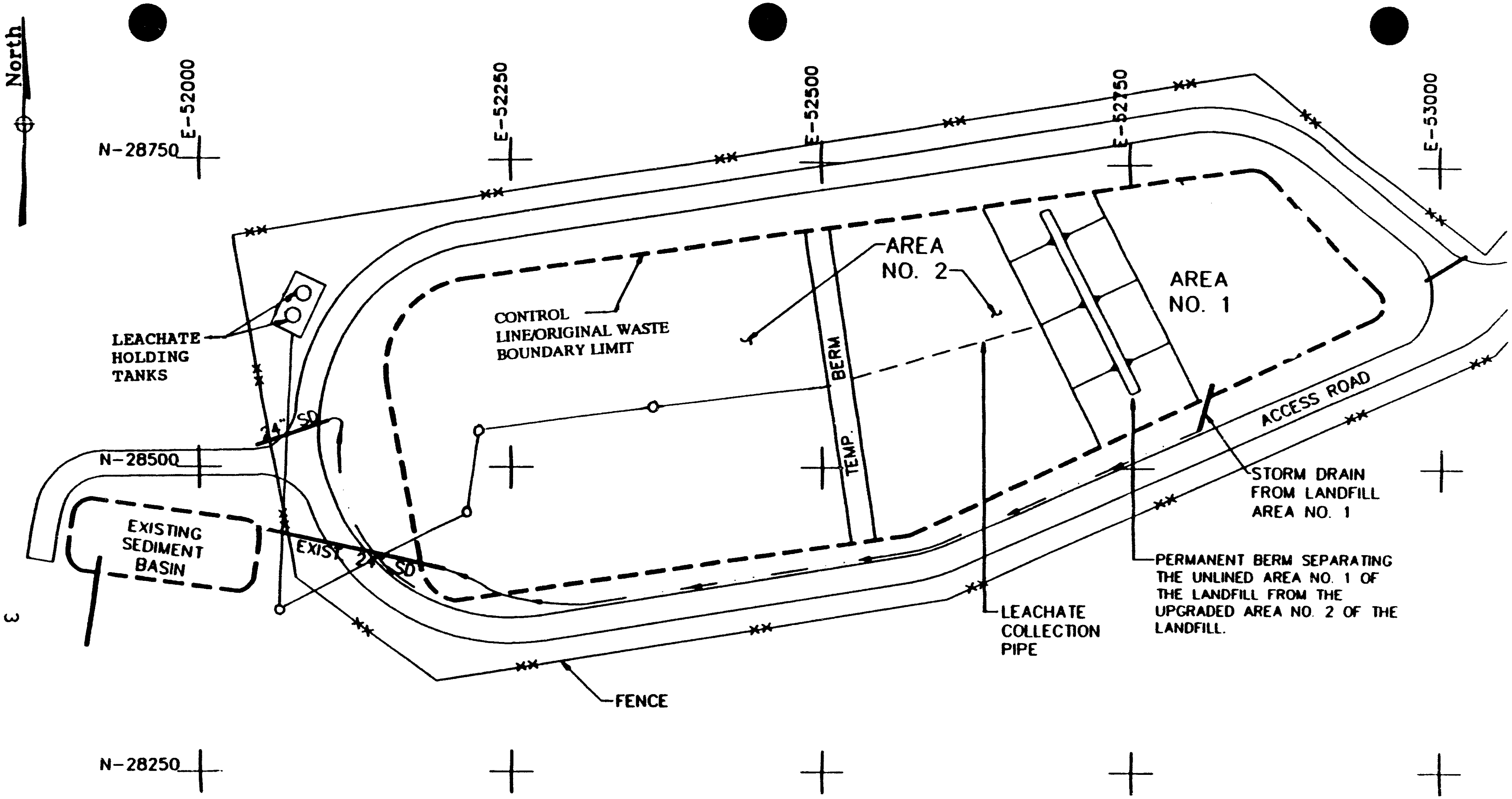
In this document, details are presented on the separation of Area 1 and Area 2, the remaining portion of the landfill which is being brought in to compliance with all requirements of the July 10, 1993 amendments.

Permit

IWLF-IV is planned to continue operation therefore, modifications are required to remain in compliance with revised Regulations Governing Solid Waste Processing and Disposal Facilities in Tennessee for a Class II Landfill. This Design and Operating Procedure is part of a modification request resulting from changes in the regulations from which the original IWLF-IV permit was issued. The remainder of this document will address the necessary modifications, describe site conditions, design, physical operation, administrative operation, closure plans, volume and life, and operating cost for the IWLF-IV.

Modifications

Modifications are being proposed to IWLF-IV in order to bring the west section of the landfill into compliance with the revised regulations. IWLF-IV, as it currently exists, is not lined with a flexible membrane liner (FML) or a recompacted clay liner, but the area has a geological buffer with a hydraulic conductivity ranging from 6.05E-8 to 7.91E-7 cm/sec. Modifications being proposed to IWLF-IV would include dividing the landfill into two areas without increasing the previously permitted waste boundaries. The two areas will be separated by an earthen berm. The division of the landfill is shown in Figure 1. The east end of the landfill, the area currently being used for waste disposal, will be referenced as Area 1,



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Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

PROJECT NAME:

DESCRIPTIVE SKETCH OF PLANNED MODIFICATIONS FOR IWLF – IV

DATE: JUNE 1, 1993	NOT TO SCALE

the east end, or the unlined portion; the remaining area will be referred to as Area 2, the west end, or the lined portion.

Current plans for IWLF-IV are to leave Area 1 of the landfill open for disposal of inert waste with no changes. The east end portion, approximately 1 acre, will be operated until all available disposal capacity is exhausted. Once Area 1 becomes full or in the event that closure of Area 1 is required, all necessary activities, as discussed in Section VI, will be implemented to ensure that complete closure of the facility is achieved.

The entire west end of the landfill is approximately 3.2 acres. This section, Area 2, of the IWLF-IV will be designed and constructed to meet regulatory conditions specified in Rule 1200-1-7-.04 for Class II landfills. Area 2 will be constructed in segments. The first segment will consist of approximately 100 feet by 220 feet section and will include a composite liner, leachate collection system and gas migration controls. The revision of IWLF-IV is developed on elevations used in the original design to maintain approximately the same capacity. Current plans are to use existing roads, the West Patrol Road and Old Mt. Vernon Road, as access for both Area 1 and Area 2. Both areas will continue to use the existing sedimentation basin and drainage ditches with some modifications to improve runoff. The addition of a composite liner system, gas migration controls and a leachate collection system will only apply to Area 2.

<u>Facilities Served</u>

The facilities to be served by the Y-12 IWLF-IV include the Y-12 Plant, the K-25 Site, ORNL, the DOE Federal Building and other prime contractors for DOE in Oak Ridge will also be served.

The Y-12 Plant, which is located adjacent to the city of Oak Ridge, has a mission to serve as a key manufacturing technology center for the development and demonstration of unique materials, components, and services of importance to the Department Of Energy (DOE) and the nation.

This is accomplished through the reclamation and storage of nuclear materials, manufacture of nuclear materials, manufacture of components for the nation's defense capabilities, support to national security programs, and services provided to other customers as approved by DOE.

The K-25 Site is a complex of production, research, development, and support facilities located west of the city of Oak Ridge. Although the primary function of the K-25 Site was the enrichment of uranium hexafluoride in the uranium-235 isotope, production at the plant has been discontinued, and the K-25 Site is in a shut down mode.

The ORNL is a large, multi-purpose research laboratory, whose basic mission is the discovery of new knowledge, both basic and applied, in all areas related to energy. To accomplish this mission, the laboratory conducts research in all fields of modern science and technology. The laboratory's facilities consist of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities.

Some work at the DOE ORR is accomplished by contractors other than the operating contractor. These contractors perform work at various locations on the ORR under the cognizance of Energy Systems, DOE, and/or MK-Ferguson, the DOE prime construction manager contractor.

II. GENERAL GEOLOGY

A discussion of the geology of IWLF-IV was submitted in the original permit application, and since that time no changes have occurred. The Y-12 Plant site is located in the Valley and Ridge Physiographic Province which is characterized by parallel ridges of sandstone, shale, and cherty dolomite, separated by valleys of less resistant limestone and shale. The ridges are oriented southwest - northeast. Topography of the area is the result of differential erosion of severely folded and faulted rocks ranging in age from early Cambrian to Early Mississippian. Major units present on the reservation include Cambrian Age Rome Formation and Conasauga Group, the Cambro-Ordovician Age Knox Group, and the Ordovician Age Chickamauga Limestone, Elevations range from 746 to 1,370 feet above mean sea level with a maximum relief of 624 feet.

The IWLF-IV site is located on the northwestern crest of Chestnut Ridge. The site is moderately sloping and is underlain by the lowest member of the Knox Dolomite Group, the Copper Ridge Dolomite. The Copper Ridge Dolomite typically consists of gray, fine to medium-grained, medium to thickly bedded siliceous dolomite. Silica occurs mainly as chert; either as nodules or in irregular or discontinuous layers and lenses. Chert fragments and blocks are evident in the soils, particularly on the surfaces of slopes where accumulation is enhanced as the finer soil materials are winnowed out by runoff flow. No outcrops were observed on this site. The soils on the site are Fullerton cherty silt loams. These soils are of residual origin, having been derived from weathering of the parent carbonate rocks which contain varying amounts of relatively insoluble materials (e.g. silica, clays, iron oxides, etc.). The soils associated with Copper Ridge dolomite are characteristically thick, in many places up to eighty feet or more.

Structurally the site is located in the overthrust plate of the Whiteoak Mountain fault, a homoclinal setting with the strata dipping 35 to 45 degrees to the southeast. No structural features are observed at the surface on this site. Groundwater flow beneath this site may be both northwestward and southeastward with the ridge cresting acting as a divide to a fractured karst bedrock media. Groundwater recharge appears to be chiefly by general permeation through the soil mantle. No sinks, depressions, bedrock outcroppings, or other features which would enhance infiltration were observed at the site.

III. DESIGN

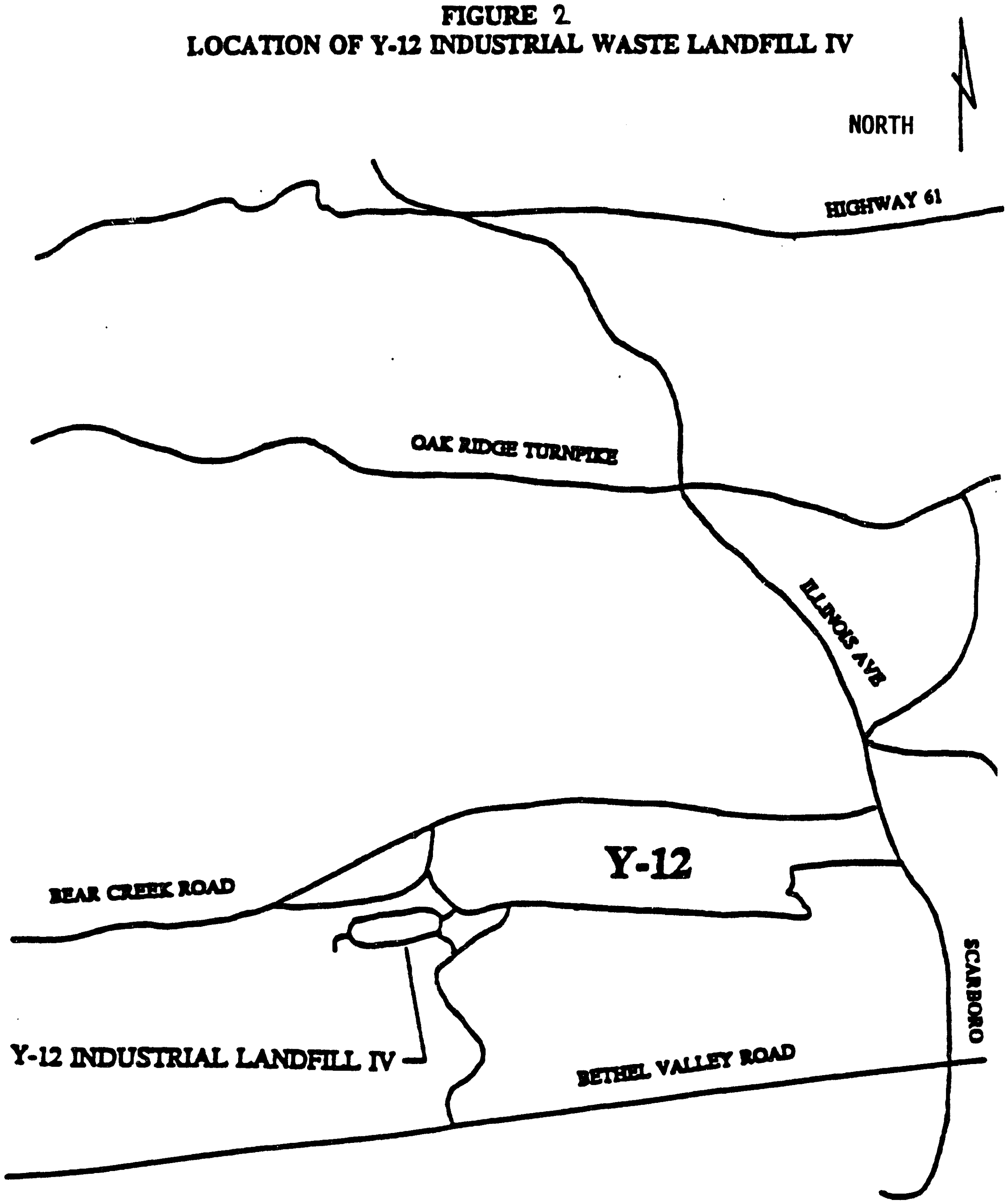
Site Selection - General Location

IWLF-IV is located near the west end of the Y-12 Plant site as shown in Figure 2. The site has gentle to moderate slopes, and is relatively clear. These features aid in the ease of development to the west portion of the site. The landfill is surrounded by a 8-foot-high chain link fence topped with three strands of barbed wire. Two locked entrance gates are located at the east end of the site. All access will be controlled. Flooding is not a concern since the site is located on a ridgetop well above the 100 year and 500 year flood elevation.

Soil Borings

Soil borings were performed and analyzed for the initial construction of the landfill under the existing permit. Since the soil media and hydrogeology has not changed since that time no additional data will be submitted. During the period of February 24 to March 9, 1987, six exploratory borings were drilled at designated locations (note: Boring No. 2B was drilled after Boring No. 2A encountered refusal at a relatively shallow depth) in order to determine

FIGURE 2
LOCATION OF Y-12 INDUSTRIAL WASTE LANDFILL IV



and establish the site soil characteristics, and to ascertain if groundwater is reached within the limits of the drill penetrations. The location of the borings are shown on Drawing C2E900000A033. Descriptive logs of the borings are included in the Subsurface Investigation. Drilling was reviewed as required by personnel of the TDEC/DSWM. One boring, No. 1, refused at 46 feet on rock and four other holes were drilled to a depth of 50 feet each with no refusal. Boring No. 2A initially refused at 25 feet, apparently on a chert boulder, and was relocated a short distance to the southeast and drilled to 50 feet without refusal. The relocated boring has been designated No. 2B.

The soils at this site are silty clays and clays with varying concentrations of chert fragments and occasional silt and sand seams. The moisture content of the soils ranges from 18% to 35%, the liquid limit ranges from 37 to 67, the dry unit density ranges from 95 to 105 pounds per cubic foot. The results of the borings indicated that the thick mantle of silty, clayey residual soil, the general absence of a shallow bedrock surface, the absence of shallow groundwater the site, and the low to moderate slopes over the site provided a suitable location for development of an industrial landfill.

Hydrogeology

No springs or seeps were identified within the site. All of the test holes were dry upon completion of the boring. However, hole No. 3 had water at 43 feet after standing open for three days. The other four holes remained dry. The water in hole No. 3 is assumed to have originated from a perched source of little areal extent very near to the location of the test hole. Groundwater in the bedrock aquifer beneath the site is indicated to be quite deep. Records from an observation well on the site indicates a groundwater depth of approximately 160 feet.

For purposes of field permeability testing, hole No. 1 was converted to a temporary well after drilling was completed. The monitor well installation data of the boring is included in the Subsurface Investigation. Subsequent field permeability testing was performed using clean water injection under constant head pressure as described U.S. Earth Manual (E-19) procedures. The resulting measured hydraulic conductivity under uniform flow conditions was 2.1 x 10E-3 centimeters per second (cm/sec). This is due in part to a two foot interval of very sandy soil at the 42 to 44 foot depth in the well. However, this zone will be isolated by its depth and an intervening thick buffer of much less permeable clay soils.

Laboratory hydraulic conductivity testing was performed utilizing Corps of Engineers Engineering Manual procedures (EM-1110-2-1906). The undisturbed soil samples were secured by 3 in. thin-wall Shelby tube samplers (ASTM Specification D1587). All soil samples were inundated to at least 98% saturation before subjection to flow at 10 to 20 pounds per square inch constant head differential. The remolded samples were tested at 95% of the Standard Proctor maximum dry density (ASTM D698). The hydraulic conductivity found from the lab testing ranges from 2.2 x 10E-8 to 7.4 x 10E-7 cm/sec. All test results are provided in the Subsurface Investigation.

Solid Waste Composition

Approximately 75 to 150 cubic yards of nonhazardous, nonradioactive industrial waste are received each month by the landfill. Currently, waste allowed in the landfill is non-putrescible. Appendix A identifies waste composition allowed for disposal in the landfill under the existing permit. Dependent on TDEC's approval of the waiver request dated September 21, 1992, Area 1 will continue to receive waste defined by Appendix A. Appendix B shows the Extraction Procedure Toxicity Testing/Toxicity Characteristic Leaching

Procedure (EP-TOX/TCLP) results on metal, magnetic tape, wood, and foam rubber/cardboard waste, currently permitted for disposal in IWFL-IV, does not exceed the E.P. Toxicity or TCLP Limit as shown in the Codes of Federal Regulations (CFR) nor does the waste exhibit characteristics of reactive or corrosive agents as defined under subtitle C of Resource Conservation Recovery Act (RCRA). The modified portion of the landfill, Area 2, designed to meet revised regulation for a class II facility will accept waste defined by Appendix C. Any waste stream identified, other than those listed in Appendix C, will be treated as different wastes and permitted by the TDEC before disposal in landfill IV. Administrative and other established in-plant controls are used to prevent the disposal of non-permitted materials at the IWLF-IV.

Design Loading

Based on existing practices and work loads, the compacted, in-place industrial waste loading (including daily and intermediate cover) at the landfill is estimated to be approximately 75 - 150 cubic yards per month. This waste stream will fluctuate with work loads, weather, and project schedules.

Site Capacity

The east end portion (Area 1) of IWLF-IV has an estimated airspace volume of 15,843 cubic yards. The airspace volume includes 7780 cubic yards of waste; 3,890 cubic yards of daily and intermediate soil cover; but excludes 4,482 cubic yards of final cover. The airspace volume remaining as shown between the excavation contours shown on the excavation plan (Drawing C2E900000A034) and the proposed final contours shown on the final closure plan (Drawing C2E900000A035) is 11,670 cubic yards.

The west end portion (Area 2) of IWLF-IV has an estimated airspace volume of 73,640 cubic yards. The airspace volume is the volume between the excavation contours shown on the excavation plan (Drawing C2E900000A034) and the proposed final contours shown on the final closure plan (Drawing C2E900000A035). The airspace volume includes 49,093 cubic yards of waste; 24,547 cubic yards of daily and intermediate soil cover; but excludes 18,284 cubic yards of final cover. The bottom liner encompass 4,314 cubic yards of recompacted clay layer with an estimated 12% shrinkage factor. The estimated life of the IWLF-IV is approximately 40 -80 years, based on the design loading of 75 - 150 cubic yards per month.

Initial Site Preparation

The following activities will take place prior to placing waste in the modified portion or Area 2 of the landfill:

- Construct an earthen berm to separate the disposal areas.
- Construct maintenance road and stormwater control channels into initial construction area.
- Excavate to elevations shown on Drawing C2E900000A034 (Phase I Grading Plan); Use soil from the initial excavation to construct the berm.
- Construct the landfill liner system (2 feet of recompacted clay and flexible membrane liner) in landfill Area 2 as shown on Drawing C2E900000A034.
- Construct leachate collection pipe, lift station, and holding tank for a 100 feet by a

220 feet segment as shown on Drawing C2E900000A034.

Proposed Landfill Development

Further development of the IWLF-IV disposal areas will be sequenced as shown on Drawing C2E900000A034, and according to the sections and details shown on Drawing C2E900000A036. The development of each disposal area will occur so as to promote drainage of runoff away from the working face. Temporary roads will be built as each area is developed. They will be located such that at least one road is available for traffic into a working face that can be accessed during all weather.

The excavations will not exceed 35 feet for that part of the site above the elevation of 1180 feet and will not extend below the elevation of 1160 feet. Excavations will not exceed 25 feet for that part of the landfill between 1140 and 1180 feet and there will be no excavations for landfilling below the elevation of 1140 feet.

The proposed final contours, shown on Drawing C2E900000A035, create a small, relatively flat top area with a five percent slope and a maximum elevation of approximately 1200.5 feet. The closed landfill will slope downward from this flat top with a minimum of four percent and a maximum of 3:1 side slopes.

Seismic Analysis

The consideration for seismic design is reflected in a memorandum to file included in Appendix D.

Soil Balance and Cover Material

All soil cover material to be used for the IWLF-IV, for both Area 1 and Area 2, is available on-site (i.e. East Borrow Area, West Borrow Area, Industrial Landfill V, Construction/Demolition Landfill VI, and Construction/Demolition Landfill VII). The total soil requirement for the entire IWLF-IV cover is estimated to be 52,203 cubic yards (includes daily, intermediate, and final soil cover). The landfill will be an area fill operation. Detailed plans of the landfill construction are provided in the drawings.

In order to develop Area 2, excavation will begin on the toe of the permanent berm and progress westward. The site will be excavated in stages to minimize land disturbance, control erosion and minimize leachate bed infiltration from stormwater flow. There will be an access/drainage way which will extend to the west end of the site from the working face.

Both areas of the landfill will operate concurrently and solid waste disposed of in the IWLF-IV will be covered at the end of each day with a minimum of 6" of soil. If deliveries become infrequent and cause covered surfaces to be exposed for more than 30 days, an intermediate cover of 12 inches will be used in lieu of daily cover of 6 inches.

Upon fill of the entire landfill grade, final cover will be placed. Final cover will be applied to minimize infiltration of precipitation into the waste, to provide a pleasing appearance, and to provide a growing surface for vegetation. Final cover on the side slopes and landfill top will consist of 42 inches of soil that includes a 24-inch compacted, low permeability layer, (1 x 10^{-7} centimeters per second or less) placed over the waste and overlain by a 30 or more mil FML, followed by a geonet, then a geotextile fabric and an 18 inch protective layer of soil that will support vegetative growth. Placement of the final cover will be according to procedures outlined in the construction quality assurance/quality control (CQC) plan.

Filter fabric fences, rip-rap, and other erosion controls will be used as necessary to minimize sediment runoff. Vegetation will be maintained as much as possible to enhance evapotranspiration and reduce erosion, thus playing an important part in surface water control. The final cover will be prepared for seeding. Fertilizer and lime will be applied based on guidelines established in agricultural publications (e.g., University of Tennessee Agricultural Extension Service publications). Mulch will be applied after seeding. Areas will be reseeded as necessary to establish and maintain vegetative cover at all times. Hydro-seeding and hydro-mulching together may be used to obtain the above.

Site Drainage and Sediment Control

Grading and drainage for Area 1 and Area 2 has been designed to minimize erosion according to state regulations for Area 1 and Area 2. Existing natural drainage is maintained where possible to avoid disturbing areas with vegetation. Drainage from trench excavations is channeled to an existing sediment basin on the southwest end of the site. The basin will have a sediment storage capacity of 1560 cubic yards. Design of the basin and its principal spillway is based on a 25-year frequency, 24-hour duration storm. Sediment will be removed from the basin when accumulation approaches 60 percent of the design capacity.

The bottom of the excavated area will be sloped to drain runoff from Area 1 in the rip rap ditch along the roadway while, Area 2 will be sloped to drain runoff along the drainage ditch inside the landfill. Both areas will drain surface water to the existing sediment basin as shown on Drawing C2E900000A034. Access roads to the disposal area will be provided and the site will be graded to drain water away from the excavated area. Typical details and cross-sections of the excavation, and method of fill are shown on Drawings C2E900000A036, and C2E900000A037.

Area 2 will not be excavated all at once, but will be excavated in phases to maintain a minimum of disturbed area. Any sand or chert layers uncovered in the excavated base of the landfill will be removed and replaced with high quality, recompacted clay soil. Every effort will be made to keep disturbed areas to a minimum. The working area of the landfill is brought to finished contour as soon as possible by using stairstep construction. All areas disturbed during site preparation are seeded or rip-rapped to control erosion. Other areas having some vegetation are overseeded.

Drainage Considerations

The site is graded and constructed to divert run-on from the active landfill area. Run-off will be removed from the landfill via a perimeter ditch inside the access road which drains off-site or to the sediment pond. This ditch is designed to carry a peak flow during a 100-year storm. The culverts crossing under the access road to West Patrol Road and down the northwest slope are sized to carry a peak flow during a 100-year storm. For design purposes, a 24 hour rainfall of 4.6, 5.5 and 6.5 inches respectively was used for the 10 year, 25 year and 100 year return frequency storms.

Erosion Control Considerations

To control erosion on the site, rip-rip, straw bales, silt fences, or other erosion control measures will be utilized at the pipe inlets and outlets as needed. Ditches with 3% grades or steeper will be lined with rip-rap. Silt fences will be used surrounding the site as necessary. Appropriate vegetative ground cover will be used to minimize erosion depending on the time of year, and for ease in maintenance.

Groundwater Protection and Monitoring

The previously established groundwater monitoring system, as required by the TDEC/DSWM, consists of five groundwater monitoring wells, one up-gradient (GW-521) and four down-gradient (GW-141; GW-217; GW-305; GW-522). These wells have been installed at the site as shown on Drawing C2E900000A033. The wells have a 4-inch diameter stainless steel casing extended a minimum of ten feet into the water table and screened at the bottom (see Subsurface Investigation/Monitoring Well Construction Data, Appendix A). Well monitoring responsibilities are described in a later section of this report. The groundwater sampling parameters have been established by the TDEC, DSWM and are given in the Sampling and Analysis Plan.

Liner Design and Leachate Collection

The composite liner system in Area 2 will consist of 2 feet of recompacted clay and a 45 mil flexible membrane liner (FML). Construction of the soil liner will begin on the bottom of the landfill as the area is opened and progresses up the side slopes. The clay will be placed in uniform, loose lifts not exceeding nine inches in uncompacted thickness. These lifts will be compacted to a maximum thickness of six inches using a footed roller that has a minimum of six-inch long feet and a minimum static weight of 30,000 pounds. A minimum of six passes of the equipment is required for each lift. Lifts will be placed to achieve a total compacted depth of two feet. The particular compaction procedure to achieve the required soil liner permeability are presented in detail in the specifications and the CQC plan. A smooth, well suited surface is required for the liner. Immediately above the composite liner is the leachate collection and removal system. The leachate removal system will be designed for the removal of the leachate and for the prevention of the buildup of any significant hydraulic head at the site (see engineering calculations document attached to the permit application). A geonet will be placed on the geotextile liner with the geotextile fabric inbetween, providing additional protection to the liner. The drainage net will be followed by a 6-inch, perforated PVC leachate collection line. The pipe will be embedded in the gravel drainage layer. The drainage layer will be covered with a geotextile fabric and finally one foot of compacted soil used as a protective cover.

The leachate generated by the landfill will be removed by the drainage layer and the leachate collection lines. The leachate collection line for Area 2 will discharge to a lift station located on the west end of the landfill. The leachate will then be pumped into one of two 10,000-gallon above ground, leachate holding tanks. The leachate will be pumped into a tanker truck and discharged to either sanitary sewer and treated by the City of Oak Ridge sewage treatment plant, or the West End Treatment Facility or ORNL Sewage Treatment Plant or the K-25 Sewage Treatment Plant or a National Pollutant Discharge Elimination System permitted waste water treatment plant. Leachate monitoring will be performed as required in order to comply with requirements or waste acceptance criteria of the treatment facility receiving the leachate.

In addition, leachate movement will be minimized by a geologic buffer, and in-situ soil layer extending from the top of the seasonal high water table to below the bottom of the liner. This in-situ soil layer is required by TDEC/DSWM regulation to be a minimum of 10 feet thick, with a maximum saturated hydraulic conductivity of 1×10^{-5} centimeters per second, or to be a minimum of 5 feet thick, with a maximum saturated hydraulic conductivity of 1×10^{-6} centimeters per second. Under all of the IWLF-IV, the soil samples analyzed within the 10 foot geologic buffer had a saturated hydraulic conductivity ranging from 2.2×10^{-8} to 7.4×10^{-7} centimeters per second.

The on-site soils, discussed in detail in the hydrogeologic report, are silty clays and clays with varying concentration of chert fragments and should be well-suited for use as liner material. It is anticipated that residual clay material removed from the landfill excavation along with other on-site clay will be used for construction of the landfill liner. A previous study, entitled "Permeability of Compacted Soils for the East and West Borrow Areas, Y-12 Plant" was prepared by David E. Daniel, has confirmed that material from the Chestnut Ridge areas at the Y-12 site can be recompacted to achieve the required permeability of 1×10^{-7} centimeters per second or less.

Leachate Holding Tank Area

Leachate from the landfill will gravity drain to a lift station. Pumps will transfer the leachate to one of two 10,000 gallon storage tanks. Leachate will be pumped from the holding tank to a tanker truck. This operation will be performed by trained OC personnel.

The tanks and transfer pumps (shown in Figure 3) will be located in a concrete diked area, as defined by MMES procedures, to prevent an uncontrolled release. Redundant pumps and transfer pumps will be provided. Level switches will automatically control the lift station pumps. The pumps will alternate to equalize pump use. By appropriate setting of the leachate line valves, the transfer pumps can also be used to transfer leachate from one tank to the other. The operation of the leachate holding tank area will be semi-automatic and will not require full-time personnel presence.

A sump will be provided in the diked area to collect rainwater or spills. After being sampled, a portable or fixed sump pump will be used to transfer the water to the ground, leachate tanks or disposal containers depending on sampling characteristics. Piping from the lift station to the holding tanks will be run underground. At the dike area, the pipe will be run aboveground, insulated, and heat traced. A flashing light will be positioned at the site to alert personnel of a tank high liquid level. An overflow line between the tanks will also be provided as a backup.

The TDEC/DSWM regulations require that the leachate holding tanks must have the capacity to store the volume of leachate expected to be generated in 30 days. The maximum monthly leachate generation was calculated to be 12,000 gallons using the Hydrological Evaluation Landfill Performance (HELP) model version 2. During operation, data will be collected to verify the size of the leachate storage system for long term operation of the facility.

Cap Design

The final cover or cap on the landfill top will consist of an 18 inch vegetative soil layer followed by a geotextile fabric, a geonet for drainage, a 30 mil. polyvinyl FML, and 24 inches of compacted - low-permeability clay (1×10^{-7} cm/sec or less) to place over waste and daily/intermediate cover material. An endloader will be used to spread and compact the cover material.

Gas Migration Control System

A gas migration control system will be installed in the final cover of IWLF-IV. Based upon information available and anticipated waste composition to be placed at the site, calculations can not be generated as to amounts of gas that will be produced since the organic component of wastes will be very small.

A gas migration control system will be installed that will allow gases within the compacted

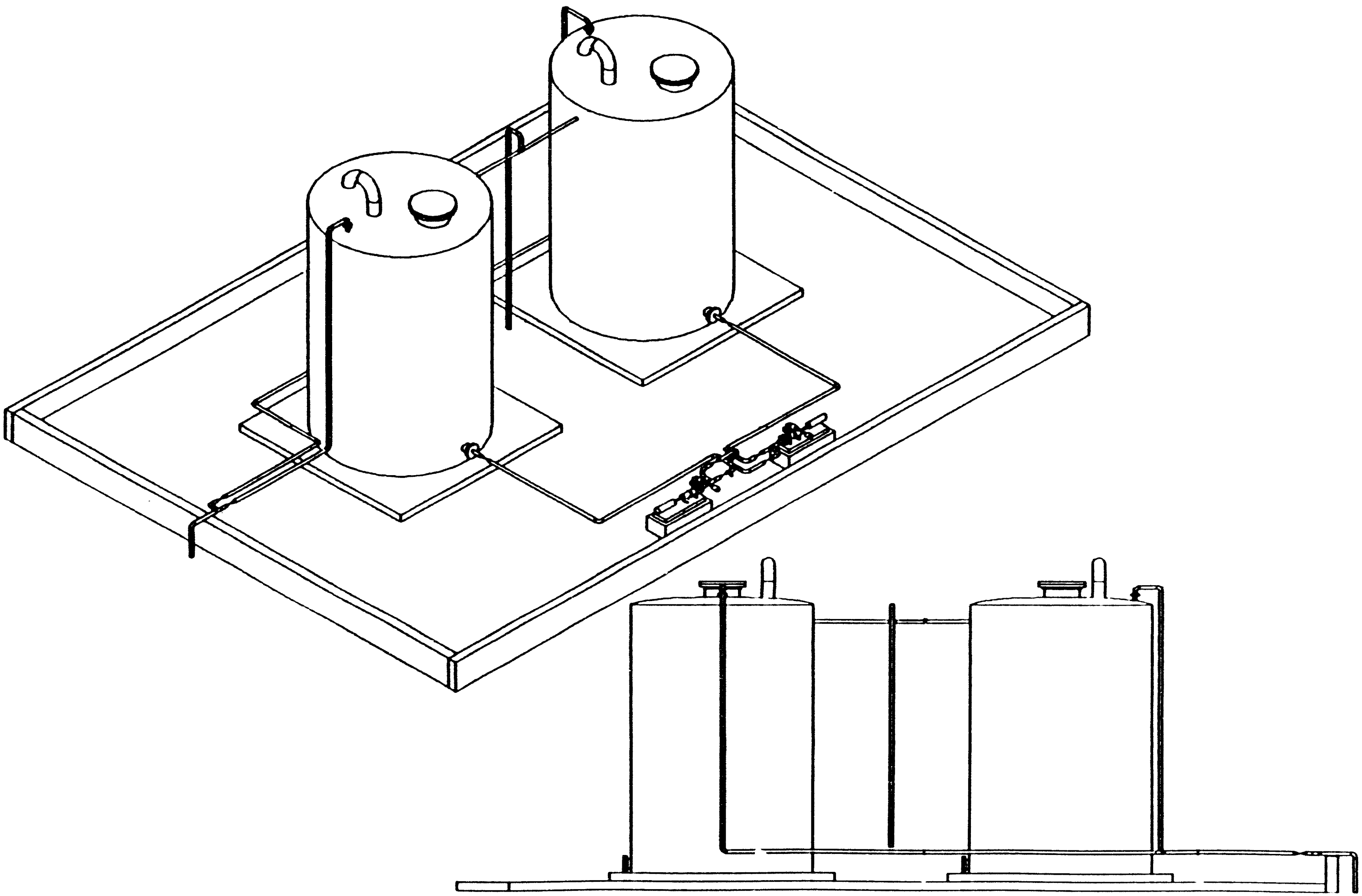


Figure 3. Leachate Holding Tank Area

waste to be collected and vented to the atmosphere. Gas vents (Drawing C2E900000A035) will be placed every 150 feet along the crest of the landfill. The vents will be placed over a continuous 18 inch wide sand filled trench excavated in the daily or intermediate waste cover traversing the crest of the final cover.

<u>Structures</u>

No structures are expected to be located on this site.

<u>Fire Protection</u>

Open burning of refuse will not be permitted at the facility. Good compaction of the waste material and the application of cover material at the end of each day will reduce the potential for accidental fire occurrence and minimize the spread of any fires. In the event a fire occurs the Y-12 Fire Department will be notified. Depending upon the size and nature of the fire, on-site personnel may attempt to control or extinguish the fire by covering the area with soil or by using portable fire extinguisher located at the site or on the equipment. In the event the fire cannot be controlled by on-site personnel, the Y-12 Fire Department will assist in extinguishing the flames.

<u>Final Use of Landfill</u>

After final cover has been applied, grass will be planted on the remaining unvegetated area to control erosion and create a grassed area. There are no plans for future development of the closed site.

IV. OPERATION

<u>General</u>

Operations and Maintenance of the landfill is primarily controlled by this document, and the landfill development is controlled by the drawings and specifications.

<u>Access and Operating Hours</u>

The landfill site is located in Anderson County on Chestnut Ridge at the west end of the Y-12 Plant site. The site is located on property owned by the DOE.

The landfill will be available for operations on regularly scheduled workdays. Waste can be received during scheduled work hours. Time will be allowed for applying cover material at the end of each workday. All disposal at this site will be controlled and there will not be any delivery of waste to the site other than during a scheduled hours by WTSD.

Access to the site will be provided by the West Patrol Road which is located on the Y-12 Plant site and by Old Mt. Vernon Road (see Drawing C2E900000A032). A gravel roadway exists around the landfill site for access to the area in use. A plan view for the roadways is shown on Drawing C2E900000A034. Access to the site will be controlled by an eight foot steel mesh fence topped by three strands of barbed wire. This site will be considered a part of the Y-12 Plant site and will be regularly patrolled by Y-12 Security Personnel. All access to the site will be controlled.

Sign

A sign is located at the facility which can be viewed at both entrances and will provide the following information:

1. Facility Name
2. Emergency Phone Numbers
3. Restricted Users
4. Permitted Users
5. Standard Operating Hours

Equipment

The Principal pieces of equipment used at the landfill will include:

1. Landfill compactor.
2. Endloader for compaction and cover.
3. Scraper for providing cover materials.
4. Second endloader as backup to the endloader for compaction and cover.
5. Water trailer for dust control.

Other support equipment available for use at the site includes graders, dump trucks and bulldozers. Replacements for equipment are scheduled and procured with capital funds as approved by the DOE.

Placement of Waste Material

All waste material is subject to analysis under the Radioactive and Hazardous Constituents Screening Plan for Industrial Waste Landfill IV (Y/IA-215/Rev. 1). If the waste is acceptable for disposal at IWLF IV the collection vehicles will enter the site from the West Patrol Road or Old Mt. Vernon Road and unload the waste on the working face of the landfill as directed by the landfill operator. The waste is unloaded and placed on the working face in a confined area. The volume of in-place compacted waste and soil cover as constructed for each disposal shall constitute a cell. The top surface of the cell will be approximately square to facilitate compaction and to minimize the cover material required at the end of the day. The actual dimensions of a cell depends upon the waste received on any given day. Access roads from the perimeter road to the working face shall be moved or modified as required for proper operations. Personnel will immediately pick-up any liter scattered during disposal.

Cover Materials

Soil obtained during trench excavation, along with soil from the East Borrow Area, West Borrow Area, Industrial Landfill V, Construction/Demolition Landfill VI, and Construction/Demolition Landfill VII will be used as daily, and final cover for the compacted solid waste. Any soil stockpiled at the landfill will be contoured and seeded to minimize erosion. A minimum of six inches of compacted clay soil, will be distributed on the exposed edges of the solid waste at the end of each operating day. A landfill compactor or endloader will be used to spread and compact the cover material. Intermediate cover will be applied as the final lifts are completed. The top of the final cover will consist of a 18 inch vegetative cover to prevent erosion and surface deterioration. Sandwiched between the vegetative and the covered waste from the top down is a geotextile fabric, a geonet for drainage, a 30 mil or greater polyvinyl FML, and 24 inches of compacted clay. Side slopes will be maintained as shown on Drawing C2E900000A036 to ensure structural stability.

Leachate Holding Tank Area

The leachate holding tanks will consist of two 10,000 gallon containers. The operation of the leachate holding tank area will be semi-automatic and will not require full-time personnel presence. An overflow alarm (flashing light) will be positioned out side the gate to alarm personnel of high tank level. A concrete dike will be constructed around the tanks to prevent an uncontrolled release. Initial start-up of the leachate holding tank area includes the following two steps:

1) Select one holding tank to receive leachate by setting the leachate lift station pump discharge valving so that leachate will flow to the desired tank.

2) Energize lift station pumps 1 and 2.

The lift station control system then will automatically turn the pumps on and off by level controls. The system will also alternate lead and lag pumps to equalize pump use.

Leachate will be removed from the holding tank to a tank truck by setting the tank removal selector switch to the appropriate tank and energizing the transfer pump. This operation will be performed by trained personnel. By appropriate setting of the leachate line valves, the loading and transfer pump can also be used to transfer leachate from one tank to the other with an additional hose.

Maintenance

The Y-12 Plant employs and provides training for mechanics and equipment service personnel for maintaining the vehicles and equipment used in the plant. Programmed maintenance and minor repairs of equipment are performed in the field. For major repair work, the equipment will be transported to the Y-12 Garage or to a commercial repair facility.

Maintenance will be performed on leachate pumps, motors, valves, etc. Any critical spare parts necessary to maintain operation will be acquired. If necessary, the entire component will be replaced. The leachate collection lines will be inspected and will be cleaned as necessary.

Grounds maintenance, including seeding, mowing, road grading, and trash pickup, will be performed. Drainage channels will be maintained to minimize run-on onto the landfill area, to prevent erosion of earthen cover, and to drain surface runoff from the landfill. The sediment in the siltation pond will be removed as required. Excavated sediment will be dewatered and placed in IWLF-IV.

Grass cover will be established on completed and unused earthen surfaces around the open landfill area(s) to minimize erosion and the generation of dust. Gravel roads will be graded periodically and/or sprayed with water as necessary to control dust.

V. ADMINISTRATIVE OPERATIONS

Organization

The IWLF-IV is owned by the DOE and will be operated by the DOE'S Operating

Contractor (OC). Waste from the private sector of Oak Ridge and surrounding areas will not be accepted at the landfill.

As owners of the facility, the DOE interfaces with the regulating agency TDEC, DSWM, and the OC. The DOE is responsible for obtaining construction and operating permits for the facility, submission of reports to the regulating agency, and initiating any corrective actions required by the regulating agency.

The OC allocates equipment and manpower needed for operation, including trench excavation and the maintenance of areas adjacent to the site, oversees the landfill operation to include site maintenance, daily operations, excavation, and necessary actions to correct problems detected by monitoring activities. They are also responsible for maintaining engineering drawings and grade information, directing work activities on site, and overseeing monitoring activities at the site. The monitoring activities are designed to meet the requirements established by the DSWM. Y-12 Plant personnel collect the ground water samples and perform the laboratory analyses. A copy of the analyses is forwarded to the DOE for transmittal to DSWM.

The OC's employees participate in regularly scheduled and planned safety meetings designed to encourage safe working habits. Specific operating procedures for site operations and equipment are reviewed with the employees. In addition, site personnel are requested to report needed equipment repairs, unusual incidents, and site entry by unauthorized personnel.

The Plant Emergency Response personnel will respond to calls for incidents involving personnel injury, fire, and requests for assistance from the Guard Department.

<u>Inspection and Evaluation</u>

Inspections and evaluations of landfill operations will be performed periodically by personnel from the TDEC. Results of such evaluation will be appropriately distributed by TDEC.

<u>Records and Reports</u>

Records will be maintained on the source, weight, and volume of refuse received at the landfill. Additional records are kept on the operating costs, including labor, materials, and equipment maintenance. This information is maintained for future planning, and reports. A report will be filed annually with the DSWM to provide an estimate of the remaining useful life at the landfill site.

<u>Future Planning</u>

As the facility nears completion as determined by the evaluation of available records and estimated remaining life, planning for a new facility will be initiated. If necessary a feasibility study for a new site, facility, or system will be submitted to the DSWM.

VI. CLOSURE OF LANDFILL

A full closure/post closure care plan for this facility is required by the TDEC for approval prior to the closure of this facility. In general, the landfill will be closed in a manner that will minimize the need for further maintenance and will control, minimize, or eliminate post-closure escape of solid waste, leachate, or waste decomposition products to the ground or surface-waters or to the atmosphere. The TDEC/DSWM will be notified in writing of the intent to close the landfill at least 60 days prior to the date final closure is expected to begin. Upon achieving an elevation 42 inches below the final contours of the landfill top, final cover material will be placed over the completed landfill. This will be accomplished in the shortest time practicable, not to exceed 180 days after the landfill has achieved an elevation 42 inches below final contours of the side slopes and landfill top. Closure will be in accordance with the Closure Plan as approved by the TDEC/DSWM and as shown on Drawing C2E900000A035. The closure design implement measures to minimize erosion; the design does not adversely affect drainage of adjacent lands.

If at any point in time during the life of the landfill, it is necessary to partially close the landfill before maximum utilization of the fill area is achieved, an engineering assessment of the current state of the IWLF-IV with respect to the TDEC/DSWM-approved plan will be performed. Required changes to the closure/post-closure plan will be accomplished and submitted to the TDEC/DSWM for approval. Partial closure then will proceed in accordance with the approved, revised closure/post-closure plan.

Upon completion of closure activities for the IWLF-IV, the TDEC/DSWM will be notified in writing of the completion of closure, The notification will include certification as required by the TDEC/DSWM that the closure has been accomplished in accordance with the approved closure plan. An inspection of the closure will be made by the TDEC/DSWM to verify that the closure has been performed in accordance with the approved plan. Closure will not be considered final and complete until approved in writing by the TDEC/DSWM.

Within 90 days of completion of final closure, a notation will be recorded on the deed to the property or some other instrument which is normally examined during a title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

Due to the potential variability in the waste disposal rates, the anticipated life of IWLF-IV is 40-80 years. Therefore, it is estimated the landfill would close between 2033-2073. The complete Closure Plan is attached to the permit modification package however, the Closure Plan is subject to revision prior to actual implementation.

VII. POST-CLOSURE CARE OF LANDFILL

The closed landfill will be provided post-closure care for a period of thirty years after the date of the final completion of closure of the landfill. DOE and/or the OC will be responsible for all post-closure care activities which will include groundwater monitoring. A program of quarterly inspections will be conducted to check for settlement, cracks, erosion, insufficient vegetative cover, and other defects.

Post-closure care will include, as a minimum, the following activities:

1) Maintain the final contours to assure the proper functioning of the drainage system of the site.

2) Ensure that a healthy vegetative cover is established and maintained including mowing as required.

3) Maintain drainage facilities, siltation ponds, and erosion control measures until vegetative cover is established sufficiently to render such maintenance unnecessary.

4) Repair any cracked, eroded, and uneven areas that occur in the final cover.

5) Maintain groundwater monitoring in accordance with the approved plan.

6) Maintain leachate collection, disposal, and monitoring in accordance with the approved plan.

7) Maintain gas venting system.

The completed site will be owned and maintained by the DOE for an indefinite period. There is no future use of the area other than being a grassed area.

The TDEC/DSWM rules have a provision for landfill operator to provide financial assurance for closure and post-closure care of landfills. However, this requirement is not applicable for facilities operated by the Federal Government.

APPENDIX A

TYPICAL COMPOSITION OF WASTE ALLOWED UNDER EXISTING PERMIT

The disposal of the following materials is permissible at the landfill:

Cardboard
Plastics
Rubber
Metals (Standard Industrial)
Wood
Paper*
Special Wastes

(Categories of special wastes will be subject to approval by TDHE, DSWM prior to acceptance at the site)

The following materials are not allowed in the landfill:

Putrescible Garbage
Free Liquids
Radioactive Contaminated Materials
Hazardous Waste

(As defined in the Rules Governing Hazardous Waste Management in Tennessee)

*Incidental amounts such as placards and labels, etc., associated with containers in this waste stream. All other paper and all putrescible garbage is disposed of in the Y-12 Centralized Sanitary Landfill II or Industrial Landfill V.

Additional Waste Acceptance Since April 1992

TYPICAL COMPOSITION OF CONSTRUCTION/DEMOLITION WASTES[1,2,3] TO BE DELIVERED TO THE UNLINED OR LINED PORTION OF THE Y-12 INDUSTRIAL WASTE LANDFILL IV

Brick
Concrete
Masonry materials
Lumber
Paving materials
Sheetrock/gypsum
Roofing materials
Polyethylene sheeting
Rebar (embedded in concrete)
Vitrified clay materials (tile, pipe, block. etc.)
Insulation materials (fiberglass, rockwool, styrofoam)
Building siding materials
Miscellaneous metals associated with building demolition
Window and door glass associated with building demolition
Miscellaneous building demolition materials
Soil
Rock
Gravel
Road spoil
PVC pipe
Paneling
Flooring
Wood pallets

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[1]The manager of the Waste Transportation, Storage, and Disposal (WTSD) Department may limit the quantity of debris accepted from any source delivered to IWLF IV. Also, the manager of WTSD may impose conditions on acceptance as required to meet Plant Safety requirements.

[2]Exclusion of waste categories from this list does not preclude acceptance in the IWLF IV. Acceptance is based on requirements of TDEC/Division of Solid Waste Management rules.

[3]The following wastes will not be acceptable for disposal: Resource Conservation and Recovery Act (RCRA) wastes, polychlorinated biphenyl (PCB) wastes, radioactive wastes, wastes containing free liquids and lead acid batteries.

APPENDIX B

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - MAGNETIC TAPE

SAMPLE AS RECEIVED

Uranium - 235	14.6	%
Uranium, Total	0.091	ppm

E. P. TOXICITY/TCLP-PP

Mercury	<0.02	mg/l
Selenium	<0.1	mg/l
Alpha Activity	14	pCi/g
Beta Activity	18	pCi/g
Uranium-235 percent	<2.00	%
Uranium, Total	<0.001	mg/l
Endrin	<0.002	mg/l
Gamma-BHC (lindane)	<0.04	mg/l
Methoxychlor	<1.0	mg/l
Toxaphene	<0.05	mg/l
2,4,5-TP (Silvex)	<1.0	mg/l
2,4-D	<10	mg/l

Ignitability Test - Canceled
Reactivity Test - Non Reactive
Corrosivity - Non Corrosive Agent

ICP SWEEP

Aluminum	0.22	mg/l
Arsenic	<0.5	mg/l
Barium	<10	mg/l
Beryllium	<0.0005	mg/l
Boron	<0.04	mg/l
Cadmium	<0.1	mg/l
Calcium	2.1	mg/l
Cerium	<0.08	mg/l
Chromium	<0.5	mg/l
Cobalt	<0.01	mg/l
Copper	0.03	mg/l
Gallium	<0.05	mg/l
Iron	0.3	mg/l
Lanthanum	<0.01	mg/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - MAGNETIC TAPE
(continued)

Lead	<0.5	mg/l
Lithium	0.005	mg/l
Magnesium	0.2	mg/l
Manganese	0.119	mg/l
Molybdenum	<0.03	mg/l
Nickel	<0.04	mg/l
Niobium	<0.05	mg/l
Phosphorus	<0.2	mg/l
Potassium	<2.5	mg/l
Scandium	<0.002	mg/l
Silver	<0.5	mg/l
Sodium	2.3	mg/l
Strontium	0.002	mg/l
Thallium	<0.5	mg/l
Thorium	<0.05	mg/l
Titanium	<0.01	mg/l
Vanadium	<0.02	mg/l
Zinc	0.105	mg/l
Zirconium	<0.01	mg/l

PCB, Total	<0.0005	mg/l

PRIORITY POLLUTANTS - VOLATILE ORGANICS

1,1,2-Trichloro-1,2,2-trifluo	U[1]	ug/l
Methylene chloride	U	ug/l
Tetrachloroethene	U	ug/l
Trichloroethene	U	ug/l
Vinyl chloride	U	ug/l

PRIORITY POLLUTANTS - BASE NEUTRALS

Acenaphthene	U	ug/l
Acenaphthylene	U	ug/l
Anthracene	U	ug/l
Benzidine	U	ug/l
Benzo(a)anthracene	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - MAGNETIC TAPE
(continued)

Benzo(a)pyrene	U	ug/l
Benzo(ghi)perylene	U	ug/l
Benzo(k)flouranthene	U	ug/l
Bis(2-Chloroethoxy)methane	U	ug/l
Bis(2-chloroethyl)ether	U	ug/l
Bis(2-chloroisophropyl)ether	U	ug/l
Bis(2-ethylhexyl)phthalate	<10 B[2]	ug/l
Benzyl butyl phthalate	U	ug/l
Chrysene	U	ug/l
Di-n-butyl phthalate	U	ug/l
Di-n-octyl phthalate	U	ug/l
Dibenzo(a,h)anthracene	U	ug/l
Diethyl phthalate	U	ug/l
Dimethyl phthalate	U	ug/l
Fluoranthene	U	ug/l
Fluorene	U	ug/l
4-Bromophenylphenyl ether	U	ug/l
4-Chlorophenylphenyl ether	U	ug/l
Hexachlorobenzene	U	ug/l
Hexachlorobutadiene	U	ug/l
Hexachlorocyclopentadiene	U	ug/l
Hexachloroethane	U	ug/l
Indeno(1,2,3-cd)pyrene	U	ug/l
Isophorone	U	ug/l
N-Nitrosodi-n-propylamine	U	ug/l
N-Nitrosodimethylamine	U	ug/l
N-Nitrosodiphenylamine	<10	ug/l
Napthalene	U	ug/l
Nitrobenzene	U	ug/l
1,2-Dichlorobenzene	U	ug/l
1,2,4-Trichlorobenzene	U	ug/l
1,3-Dichlorobenzene	U	ug/l
1,4-Dichlorobenzene	U	ug/l
Phenanthrene	U	ug/l
Pyrene	U	ug/l
3,3'-Dichlorobenzidine	U	ug/l
Benzo(b)fluoranthene	U	ug/l
2-Chloronaphthalene	U	ug/l
2,4-Dinitrotoluene	U	ug/l
2,6-Dinitrotoluene	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - MAGNETIC TAPE
(continued)

PRIORITY POLLUTANTS - ACID EXTRACT

Phenol	U	ug/l
4-Nitrophenol	U	ug/l
2-Methyl-4,6-dinitrophenol	U	ug/l
4-Chloro-3-methylphenol	U	ug/l
Pentachlorophenol	U	ug/l
2-Chlorophenol	U	ug/l
2-Nitrophenol	U	ug/l
2,4-Oichlorophenol	U	ug/l
2,4-Dimethylphenol	U	ug/l
2,4-Dinitrophenol	U	ug/l
2,4,6-Trichlorophenol	U	ug/l

1 Undetected in sample

2 Also detected in blank

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - METAL STRIP

SAMPLE AS RECEIYED

Uranium - 235 percent	1.16	%
Uranium, Total	2.15	ppm

E. P. TOXICITY/TCLP-PP

Mercury	<0.02	mg/l
Selenium	<0.1	mg/l
Alpha Activity	130	pCi/g
Beta Activity	34	pCi/g
Uranium - 235	<2.00	%
Uranium, Total	<0.001	mg/l
Endrin	<0.002	mg/l
Gamma-BHC (lindane)	<0.04	mg/l
Methhoxychlor	<1.0	mg/l
Toxaphene	<0.05	mg/l
2, 4, 5-TP (Silvex)	<1.0	mg/l
2, 4-D	<10	mg/l

Ignitability Test - Cancelled
Reactivity Test - Non Reactive
Corrosivity Test - Non Corrosive Agent

ICP SWEEP

Aluminum	0.14	mg/l
Arsenic	<0.5	mg/l
Barium	<10	mg/l
Beryllium	<0.0005	mg/l
Boron	0.04	mg/l
Cadmium	<0.1	ma/l
Calcium	0.4	mg/l
Cerium	<0.08	mg/l
Chromium	<0.5	mg/l
Cobalt	<0.01	mg/l
Copper	<0.01	mg/l
Gallium	<0.05	mg/l
Iron	36.9	mg/l
Lanthanum	<0.01	mg/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - METAL STRIP
(continued)

Lead	0.5	mg/l
Lithium	<0.005	mg/l
Magnesium	<0.1	mg/l
Manganese	0.376	mg/l
Molybdenum	<0.03	mg/l
Nickel	<0.04	mg/l
Niobium	<0.05	mg/l
Phosphorus	<0.2	mg/l
Potassium	<2.5	mg/l
Scandium	<0.002	mg/l
Silver	<0.5	mg/l
Sodium	0.2	mg/l
Strontium	0.001	mg/l
Thallium	<0.5	mg/l
Thorium	<0.05	mg/l
Titanium	<0.01	mg/l
Vanadium	<0.02	mg/l
Zinc	<0.005	mg/l
Zirconium	<0.01	mg/l
PCB, Total	<0.0005	mg/l

PRIORITY POLLUTANTS - VOLATILE ORGANICS

1,1,2-Trichloro-1,2,2-trifluo	U[1]	ug/l
Methyl isobutyl ketone	23	ug/l
Methylene chloride	<10	ug/l
Tetrachloroethene	U	ug/l
Trichloroethene	<10	ug/l
Vinyl chloride	U	ug/l

PRIORITY POLLUTANT - BASE NEUTRALS

Acenaphthene	U	ug/l
Acenaphthylene	U	ug/l
Anthracene	U	ug/l
Benzidine	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - METAL STRIP
(continued)

Benzo(a)anthracene	U	ug/l
Benzo(a)pyrene	U	ug/l
Benzo(ghi)perylene	U	ug/l
Benzo(k)flouranthene	U	ug/l
Bis(w-Chloroethoxy)methane	U	ug/l
Bis(2-chloroethyl)ether	U	ug/l
Bis(2-chloroisophropyl)ether	U	ug/l
Bis(2-ethylhexyl)phthalate	<10 B[2]	ug/l
Benzyl butyl phthalate	U	ug/l
Chrysene	U	ug/l
Di-n-butyl phthalate	U	ug/l
Di-n-octyl phthalate	U	ug/l
Dibenzo(a,h)anthracene	U	ug/l
Diethyl phthalate	U	ug/l
Dimethyl phthalate	U	ug/l
Fluoranthene	U	ug/l
Fluorene	U	ug/l
4-Bromophenylphenyl ether	U	ug/l
4-Chlorophenylphenyl ether	U	ug/l
Hexachlorobenzend	U	ug/l
Hexachlorobutadiene	U	ug/l
Hexachlorocyclopentadiene	U	ug/l
Hexachloroethane	U	ug/l
Indeno(1,2,3-cd)pyrene	U	ug/l
N-Nitrosodi-n-propylamine	U	ug/l
N-Nitrosodimethylamine	U	ug/l
N-Nitrosodiphenylamine	<10 B	ug/l
Napthalene	U	ug/l
Nitrobenzene	U	ug/l
1,2-Dichlorobenzene	U	ug/l
1,2,4-Trichlorobenzene	U	ug/l
1,3-Dichlorobenzene	U	ug/l
1,4-Dichlorobenzene	U	ug/l
Phenanthrene	U	ug/l
Pyrene	U	ug/l
3,3'-Dichlorobenzidine	U	ug/l
Benzo(b)fluoranthene	U	ug/l
2-Chloronaphthalene	U	ug/l
2,4-Dinitrotoluene	U	ug/l
2,6-Dinitrotoluene	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - METAL STRIP
(continued)

PRIORITY POLLUTANTS - ACID EXTRACT

Phenol	U	ug/l
4-Nitrophenol	U	ug/l
2-Methyl-4,6-dinitrophenol	U	ug/l
4-Chloro-3-methylphenol	U	ug/l
Pentachlorophenol	U	ug/l
2-Chlorophenol	U	ug/l
2-Nitrophenol	U	ug/l
2,4-Dichlorophenol	U	ug/l
2,4-Dimethylphenol	U	ug/l
2,4-Dinitrophenol	U	ug/l
2,4,6-Trichlorophenol	U	ug/l

1 Undetected in sample

2 Also detected in blank

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - WOOD BOARD

SAMPLE AS RECEIYED

Uranium - 235 percent	5.21	%
Uranium, Total	0.170	ppm

E. P. TOXICITY/TCLP-PP

Mercury	<0.02	mg/l
Selenium	<0.1	mg/l
Alpha Activity	83	pCi/g
Beta Activity	84	pCi/g
Uranium - 235	0.76	%
Uranium, Total	0.024	mg/l
Gamma-BHC (lindane)	<0.04	mg/l
Methhoxychlor	<1.0	mg/l
Toxaphene	0.05	mg/l
2, 4, 5-TP (Silvex)	<0.1	mg/l
2, 4-D	<1.0	mg/l

Ignitability Test - Cancelled
Reactivity Test - Non Reactive
Corrosivity Test - Non Corrosive Agent

ICP SWEEP

Aluminum	0.40	mg/l
Arsenic	<0.5	mg/l
Barium	<10	mg/l
Beryllium	<0.0005	mg/l
Boron	0.08	mg/l
Cadmium	<0.1	mg/l
Calcium	11.8	mg/l
Cerium	<0.08	mg/l
Chromium	<0.5	mg/l
Cobalt	<0.01	mg/l
Copper	0.02	mg/l
Gallium	<0.05	mg/l
Iron	0.1	mg/l
Lanthanum	<0.01	mg/l
Lead	<0.5	mg/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - WOOD BOARD
(continued)

Lithium	<0.005	mg/l
Magnesium	0.4	mg/l
Manganese	0.157	mg/l
Molybdenum	<0.03	mg/l
Nickel	<0.04	mg/l
Niobium	<0.05	mg/l
Phosphorus	0.4	mg/l
Potassium	6	mg/l
Scandium	<0.002	mg/l
Silver	<0.5	mg/l
Sodium	81.4	mg/l
Strontium	0.017	mg/l
Thallium	<0.5	mg/l
Thorium	<0.05	mg/l
Titanium	<0.01	mg/l
Vanadium	<0.02	mg/l
Zinc	0.043	mg/l
Zirconium	<0.01	mg/l
PCB, Total	<0.0005	mg/l
Endrin	<0.002	mg/l

PRIORITY POLLUTANTS - VOLATILE ORGANICS

1,1,2-Trichloro-1,2,2-trifluo	U[1]	ug/l
Methylene chloride	U	ug/l
Tetrachloroethene	U	ug/l
Trichloroethene	U	ug/l
Vinyl chloride	U	ug/l

PRIORITY POLLUTANTS - BASE NEUTRALS

Acenaphthene	U	ug/l
Acenaphthylene	U	ug/l
Anthracene	U	ug/l
Benzidine	U	ug/l
Benzo(a)anthracene	U	ug/l
Benzo(a)pyrene	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - WOOD BOARD
(continued)

Benzo(ghi)perylene	U	ug/l
Benzo(k)flouranthene	U	ug/l
Bis(2-Chloroethoxy)methane	U	ug/l
Bis(2-chloroethyl)ether	U	ug/l
Bis(2-chloroisophropyl)ether	U	ug/l
Bis(2-ethylhexyl)phthalate	<10 B[2]	ug/l
Benzyl butyl phthalate	U	ug/l
Chrysene		
Di-n-butly phthalate		
Di-n-octyl phthalate		
Dibenzo(a,h)anthracene		
Diethyl phthalate		
Dimethly phthalate		
Fluoranthene	U	ug/l
Fluorene	U	ug/l
4-Bromophenylhpenly ether	U	ug/l
4-Chlorophenylphenyl	U	ug/l
Hexachlorobenzene	U	ug/l
Hexachlorobutadiene	U	ug/l
Hexachlorocyclopentadiene	U	ug/l
Hexachloroethane	U	ug/l
Indeno(1,2,3-cd)pyrene	U	ug/l
Isophorone	U	ug/l
N-Nitrosodi-n-propylamine	U	ug/l
N-Nitrosodimethylamine	U	ug/l
N-Nitrosodiphenlyamine	<10 B	ug/l
Napthalene	U	ug/l
Nitrobenzene	U	ug/l
1,2-Dichlorobenzene	U	ug/l
1,2,4-Trichlorobenzene	U	ug/l
1,3-Dichlorobenzene	U	ug/l
1,4-Dichlorobenzene	U	ug/l
Phenanthrene	U	ug/l
Pyrene	U	ug/l
3,3'-Dichlorobenzidine	U	ug/l
Benzo(b)fluoranthene	U	ug/l
2-Chloronaphthalene	U	ug/l
2,4-Dinitrotoluene	U	ug/l
2,6-Dinitrotoluene	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSES REPORT

MATERIAL DESCRIPTION - WOOD BOARD
(continued)

PRIORITY POLLUTANTS - ACID EXTRACT

Phenol	190	ug/l
4-Nitrophenol	U	ug/l
2-Methyl-4,6-dinitrophenol	U	ug/l
4-Chloro-3-methylphenol	19	ug/l
Pentachlorophenol	U	ug/l
2-Chlorophenol	U	ug/l
2-Nitrophenol	U	ug/l
2,4-Dichlorophenol	U	ug/l
2,4-Dimethylphenol	28 J[3]	ug/l
2,4-Dinitrophenol	U	ug/l
2,4,6-Trichlorophenol	U	ug/l

[1] Undetected in sample

[2] Also detected in blank

[3] Estimated value

Y-12 PLANT LAB ENVIRONMENTAL ANALYSIS REPORT

MATERIAL DESCRIPTION - FOAM RUBBER/CARDBOARD

SAMPLE AS RECEIVED

Uranium-235 percent	0.97	%
Uranium, Total	3.52	ppm

E. P. TOXICITY/TCLP-PP

Mercury	<0.02	mg/l
Selenium	<0.1	mg/l
Alpha Activity	41	pCi/g
Beta Activity	<4.0	pCi/g
Uranium-235 percent	0.24	%
Uranium, Total	0.234	mg/l
Endrin	<0.002	mg/l
Gamma-BHC (lindane)	<0.04	mg/l
Methoxychlor	<1.0	mg/l
Toxaphene	<0.05	mg/l
2,4,5-TP (Silvex)	<0.1	mg/l
2,4-D	<1.0	mg/l

Ignitability Test - Not Ignitable
Reactivity Test - Non Reactive
Corrosivity Test - Non Corrosive Agent

ICP SWEEP

Aluminum	1.55	mg/l
Arsenic	<0.5	mg/l
Barium	<10	mg/l
Beryllium	<0.0005	mg/l
Boron	<0.04	mg/l
Cadmium	<0.1	mg/l
Calcium	0.3	mg/l
Cerium	<0.08	mg/l
Chromium	<0.5	mg/l
Cobalt	<0.01	mg/l
Copper	0.03	mg/l
Gallium	0.05	mg/l
Iron	0.1	mg/l
Lanthanum	<0.01	mg/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSIS REPORT

MATERIAL DESCRIPTION - FOAM RUBBER/CARDBOARD
(continued)

Lead	<0.5	mg/l
Lithium	<0.005	mg/l
Magnesium	<0.1	mg/l
Manganese	0.010	mg/l
Molybdenum	<0.03	mg/l
Nickel	<0.04	mg/l
Niobium	<0.05	mg/l
Phosphorus	0.4	mg/l
Potassium	<2.5	mg/l
Scandium	<0.002	mg/l
Silver	<0.5	mg/l
Sodium	77.7	mg/l
Strontium	0.002	mg/l
Thallium	<0.5	mg/l
Thorium	<0.05	mg/l
Titanium	<0.01	mg/l
Vanadium	<0.02	mg/l
Zinc	0.036	mg/l
Zirconium	<0.01	mg/l

PCB, Total	<0.0005	mg/l

PRIORITY POLLUTANTS - VOLATILE ORGANICS

1,1,2-Trichloro-1,2,2-trifluo	U[1]	ug/l
Methyl isobutyl ketone	12	ug/l
Methylene chloride	<10	ug/l
Tetrachloroethene	U	ug/l
Trichloroethene	<10	ug/l
Vinyl chloride	U	ug/l

PRIORITY POLLUTANTS - BASE NEUTRALS

Acenaphthene	U	ug/l
Acenaphthylene	U	ug/l
Anthracene	U	ug/l
Benzidine	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSIS REPORT

MATERIAL DESCRIPTION - FOAM RUBBER/CARDBOARD
(continued)

Benzo(a)anthracene	U	ug/l
Benzo(a)pyrene	U	ug/l
Benzo(ghi)perylene	U	ug/l
Benzo(k)flouranthene	U	ug/l
Bis(2-Chloroethoxy)methane	U	ug/l
Bis(2-chloroethyl)ether	U	ug/l
Bis(2-chloroisophropyl)ether	U	ug/l
Bis(2-ethylhexyl)phthalate	U	ug/l
Benzyl butyl phthalate	U	ug/l
Chrysene	U	ug/l
Di-n-butyl phthalate	U	ug/l
Di-n-octyl phthalate	U	ug/l
Dibenzo(a,h)anthracene	U	ug/l
Diethyl phthalate	U	ug/l
Dimethyl phthalate	U	ug/l
Fluoranthene	U	ug/l
Fluorene	U	ug/l
4-Bromophenylphenyl ether	U	ug/l
4-Chlorophenylphenyl ether	U	ug/l
Hexachlorobenzene	U	ug/l
Hexachlorobutadiene	U	ug/l
Hexachlorocyclopentadiene	U	ug/l
Hexachloroethane	U	ug/l
Indeno(1,2,3-cd)pyrene	U	ug/l
Isophorone	U	ug/l
N-Nitrosodi-n-propylamine	U	ug/l
N-Nitrosodimethylamine	U	ug/l
N-Nitrosodiphenylamine	11 B[2]	ug/l
Napthalene	U	ug/l
Nitrobenzene	U	ug/l
1,2-Dichlorobenzene	U	ug/l
1,2,4-Trichlorobenzene	U	ug/l
1,3-Dichlorobenzene	U	ug/l
1,4-Dichlorobenzene	U	ug/l
Phenanthrene	U	ug/l
Pyrene	U	ug/l
3,3-Dichlorobenzidine	U	ug/l
enzo (b) fl uoranthene	U	ug/l
2-Chloronaphthalene	U	ug/l
2.4-Dinitrotoluene	U	ug/l
2,6-Dinitrotoluene	U	ug/l

Y-12 PLANT LAB ENVIRONMENTAL ANALYSIS REPORT

MATERIAL DESCRIPTION - FOAM RUBBER/CARDBOARD
(continued)

PRIORITY POLLUTANTS - ACID EXTRACT

Phenol	U	ug/l
4-Nitrophenol	U	ug/l
2-Methyl-4,6-dinitrophenol	U	ug/l
4-Chloro-3-methylphenol	U	ug/l
Pentachlorophenol	U	ug/l
2-Chlorophenol	U	ug/l
2-Nitrophenol	U	ug/l
2,4-Dichlorophenol	U	ug/l
2,4-Dimethylphenol	U	ug/l
2,4-Dinitrophenol	U	ug/l
2,4,6-Trichlorophenol	U	ug/l

1 Undetected in sample

2 Also detected in blank

APPENDIX C

COMPOSITION OF WASTE TYPICALLY ALLOWED TO BE DISPOSED OF AT AREA 2 OF THE Y-12 INDUSTRIAL WASTE LANDFILL IV

The disposal of the following at the landfill is permissible[1,2,3,4]:

Primary Waste Stream

Paper and cardboard	Packaging Materials
Plastic and rubber	Machinery Equipment
Styrofoam	Miscellaneous metals (Non-hazardous Specialty Metals)
Gloves	Common Industrial metals
Textile products	Polyethylene
Empty containers	(not otherwise listed as special wastes)
Glass	Polyurethane

Secondary Waste Stream

Brick	Soil
Concrete	Rock
Masonry materials	Gravel
Lumber	Road spoil
Paving materials	PVC pipe
Sheetrock/Gypsum	Paneling
Roofing materials	Flooring

Polyethylene sheeting
Rebar (embedded in concrete)
Vitrified clay materials (tile, pipe, block, etc...)
Insulation materials (fiberglass, rockwool, styrofoam)
Building Siding materials
Miscellaneous metals associated with building demolition
Window and door glass associated with building demolition
Miscellaneous building demolition materials

Special Waste

Fly Ash

1 The WTSD Department manager may limit the quantity of debris accepted from any source delivered to the IWLF-IV. Also, the WTSD Department manager may impose conditions on acceptance as required to meet Plant Safety Department Requirements.

2 Exclusion of waste categories form this list does not preclude acceptance at the IWLF-IV. Acceptance is based on requirements of the TDEC/DSWM rules.

3 The following wastes will not be acceptable for disposal: Resource Conservation and Recovery ACT (RCRA) wastes, polychlorinated biphenyl (PCB) wastes, radioactive wastes, wastes containing free liquids, and lead acid batteries.

4 Typically, construction/demolition waste will be placed in Area 1.

APPENDIX D

MEMORANDUM

Date: August 18, 1993

To: File

From: A.A. Berkes A.A. Berkes

Re. Landfill IV Chapter 1200-1-7

During a telephone conversation on 9/17/93 with Mr Rick Brown of the Tennessee Department of Environment and Conservation, Division of Solid Waste Management, the need for seismic design of landfill containment structures was discussed. Mr Brown said that state geologists were not concerned with seismic activity in the East Tennessee area. It will therefore not be necessary to address seismic design for the landfill components in the permit documents for Landfill IV located on the Department of Energy reservation at the Y-12 Plant.

Y-12 INDUSTRIAL LANDFILL IV

GROUNDWATER SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN (S AND A)

1.0 GROUND-WATER LEVELS

The ground-water level in each well shall be determined prior to each sampling for calculation of the appropriate purge volumes. In addition, water levels are collected annually from selected wells independently of sampling events to preclude the possibility of purging activities influencing water level measurements used for construction of water-table elevation maps. The following procedure shall be used to determine ground-water levels (any variations on this procedure will be reported to the Division of Solid Waste Management in detail):

Scope/Applications

This procedure outlines the use of a conducting probe to obtain water level measurements in completed wells.

Summary of Method

The electronic water level indicator is an instrument with conducting probes. The probe is lowered by means of an electrical cord from the top of the well casing to the water level. When the probe intersects the water a circuit is completed, activating the meter. The depth to water level is determined by reading the measured and marked increments on the cord.

Procedures

Starting with the background well:

A. Unlock and open well; note condition of well and don clean gloves.

B. Record sampling station number, date, time, weather conditions, and any other well-specific pertinent information in field log.

C. Locate reference mark at top of well casing and record.

   1. If reference mark is not present, alert management.

Collect water level measurements with electronic water level indicator.

D. Check battery on cleaned electronic water level indicator.

E. Lower electronic water level indicator probe into well making sure the cord on the probe does not scrape the sides of the well casing.

F. When the meter needle moves or alarm sounds, stop lowering the probe.

G. Pull up on the probe until the meter needle no longer registers or alarm is no longer audible.

H. Lower probe again slowly. Stop at the instant the needle moves forward or alarm sounds and remains activated.

I. Hold cord to side of casing where reference mark is attached.

J. Mark cord with thumb where it touches reference mark.

K. For water level indicators with the cord marked in increments of 0.01 ft, read the measurement directly from the cord. Otherwise, use a measuring device to determine distance from last marked increment to marked point on cord. The total depth is the distance from top of casing to the water level.

L. Record measurement to 0.01 ft. as Depth to Water (DOW) in field log.

M. Repeat steps E-L, two to three times for consistency. Measurement should remain consistent.

N. Pull water level indicator from well.

O. Close and lock well cap.

P. After each measurement as a minimum rinse the probe with deionized water to avoid possible cross contamination.

2.0 WELL DEPTH MEASUREMENT PROCEDURES

The depth to the bottom of the well is measured during annual routine well inspections of monitoring wells. The following procedures shall be used to determine these measurements:

A. Lower a weighted measurement probe until refusal;

B. Measure and record the distance from the well bottom to the top of the well casing;

C. All measurements should be taken to 0.1 foot;

D. After each measurement rinse the measurement probe with deionized water to avoid possible cross contamination.

The rinse water from both measurement procedures shall be collected and properly disposed of within the wastewater treatment system at the facility.

3.0 WELL PURGING PROCEDURES

Scope and Application

The procedure covers the purging of water from a well prior to sampling so that the sample is representative of the formation groundwater. The device used (bailer or pump) depends upon aquifer properties, individual well construction and data quality objectives.

Summary of Method

Well construction information is gathered prior to beginning purging. Water level is measured to calculate the volume of water present in the well. Purging is completed using a calculated number of volumes and/or field measurements to determine the end point.

Comments

Rate of purging should be regulated to minimize agitation of the ground water. If using a bailer to purge the well, lower and raise it slowly so as not to agitate the water in the well. Water will be removed from top of water column.

Required Equipment and Apparatus

A. Bailer or pump as necessary

B. Water level measurement equipment

C. Measuring tape

D. pH/Conductivity/Temperature measuring device

Procedures

A. Obtain the following information about well to be sampled.

- Well location
- Diameter(s) of well
- Depth of well
- Screen interval or open interval

B. Determine method to be used to purge well (i.e., pump or bailer).

C. Calibrate instruments according to manufacture's instrument calibration and maintenance manual.

D. Locate well and record well number, site, date and well condition in log.

E. Unlock and open well after placing plastic sheeting on ground.

F. Collect water level measurements as described previously in Section 1.0.

G. Use known well depth information to determine the height of water column in well. Subtract distance to water level from depth of well to get the length of the water column. Record all information in field log.

(Depth of well) - (distance to water level) = (length of water column)

H. Measure initial pH/specific conductance/temperature to evaluate water quality.

I. Purge well of required volumes after calculating volume of water in well.

1. The formula for calculating the volume in gallons of water in the well casing or sections of telescoping well casing is as follows:

   (r^2h) 7.481 = gallons: where = 3.142
   r = radius of the well pipe in feet
   h = linear feet of water in well
   7.481 = gallons per cubic foot of water

2. Calculation of the volume of water in typical well casings may be done as follows:

   a. 2" dia. well:
      0.1632 gal/ft x (linear ft of water) = gal.

   b. 4" dia well:
      0.6528 gal/ft x (linear ft of water) = gal.

   c. 6" dia well:
      1.4688 gal/ft x (linear ft of water) = gal.

J. The well purging end point will be determined with the use of field measurement such as pH, specific conductance and/or temperature.

1. Purge one well volume, then begin measuring field parameters once during each well volume.

2. Purge a minimum of 3 well volumes.

3. Field parameters are considered stabilized when pH measurements agree within 0.5 units, temperature measurements agree within 1°C and specific conductance measurements are within 10 percent (i.e., 100 units for readings over 1000 umhos/cm).

4. If readings do not stabilize after three well volumes obtain additional guidance.

K. Purge the required well volumes or to dryness if insufficient water is present to yield the required purge volumes.

L. Record all purge times and rates of well evacuation in field log.

M. When all necessary procedures are complete lock well, clean area and dispose of refuse, in accordance with guidelines.

All purged water from downgradient wells will be collected for processing through the wastewater treatment system. After each well is sampled the bailer or pump will be cleaned in accordance with the procedures described in Section 7.0. Samples will be taken as soon as practical, i.e., sufficient recovery after purging.

4.0 SAMPLE COLLECTION PROCEDURES

All monitoring wells shall be sampled in accordance with the most recent approved version of Procedure No. 8102.R5, Field Sampling. Samples shall be collected by the facility.

Order of Collection

The following order will be observed for collection of analytical samples from each monitoring well. Collect samples that may be affected by the loss of volatile components first, i.e., volatile organic analysis (VOA). These samples will be collected with zero headspace. Collect the balance of the required samples for the particular site in the following order:

Anions
Metals, total and dissolved
Radiochemistry Parameters

Exceptions to this would include deep wells purged using a gas-driven piston pump. In these situations the piston pump can be used to sample all nonvolatile sample fractions listed above, after which the pump shall be removed to collect the volatile fractions with a bailer. Any exceptions to this order shall be noted on the field data sheet.

4.1 Sampling with a Bailer

Scope and Applications

This procedure describes the use of a bailer (hollow, cylindrical tube) for collecting groundwater samples. Groundwater samples may be used to obtain physical, chemical, or radiological data.

Summary of Method

A bailer is lowered by cord into the groundwater where it fills. The bailer is withdrawn, and its contents are drained into the appropriate containers.

Comments

A. Only bottom loading stainless steel or Teflon bailers will be used.

B. A separate bailer will be dedicated to each well to minimize cross contamination. Bailers will be removed from each well once sampling has been completed.

C. Only new, clean cord will be used.

D. A reel upon which the cord may be wound is helpful in lowering and raising the bailer. It also reduces chance of contamination.

E. Bailers constructed with adhesive joints will not be used.

F. Each days sampling event will begin with cleanest well.

Procedures

A. Record sampling station number, sample I.D.. date, time, weather conditions, and any other well specific, pertinent information (i.e-, water level, presence of product, etc. in field log).

B. Place plastic sheeting around well and work area as necessary.

C. Unlock and remove well cap.

D. Collect water level measurements as described in Section 1.0 and calculate required purge volume as described in Section 3.0.

E. After purging is complete and recovery is sufficient, remove clean bailer from protective covering; attach cord allowing enough length for bailer to reach bottom of well.

F. Lower bailer slowly to the interval from which the sample is to be collected.

G. Allow bailer to fill with a minimum of surface disturbance in order to prevent sample water aeration.

H. Raise bailer to surface, feeding cord into a container or reel. Do not allow bailer cord to contact ground.

I. Remove the cap from the sample bottle, and tilt the bottle slightly.

J. Pour the sample slowly down the inside of the sample bottle. Avoid splashing of the\sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle. Properly dispose of all excess water collected in bailer in wastewater treatment system.

K. Leave adequate air space in the bottle to allow for expansion, except for VOA vials which must be filled to overflowing.

L. Label the bottle carefully, and clearly. Enter all information accurately, and check to be sure it is legible.

M. Samples will be placed in containers defined according to the needs, and then, when appropriate, packed in a cooled ice chest as soon as practical. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in Sections 8.0 and 10.0.

N. Complete field log and chain-of-custody forms in accordance with Section 10.0.

O. Replace well cap and lock.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

4.2 Sampling with a Gas Driven Piston Pump

Scope and Applications

This procedure discusses collection of groundwater samples using a single stage, positive displacement, double action, gas driven, reciprocating piston type pump (such as the Bennett pump). The water samples may be used to obtain physical, chemical, or radiological data.

Summary of Method

A piston pump can be either dedicated to a well or cleaned/decontaminated before use. The pump is placed in the well prior to sample collection. A compressed air source drives a piston which is connected to another piston that forces water into the discharge line of the pump.

Comments

The piston pump will not be used to collect sample for volatile organic analysis. If outgasing is of concern, this method may not be appropriate.

Procedures

A. Locate well and record well number, site, date, and well condition in field log.

B. Use plastic sheeting as necessary to prevent equipment from coming in contact with potentially contaminated surfaces.

C. Unlock and open well.

D. Collect water level measurements as described in Section 1.0 and calculate purge volume as described in Section 3.0.

E. Lower pump in well to desired level, if pump is not dedicated.

F. Connect air lines from regulated compressed air source to pump.

G. Start air flow.

H. Adjust flow rate with throttle knob found on pump regulator.

I. When a piston pump is used for purging, measure the amount of water discharged with a container of known volume, if capacity of pumped well is unknown, and calculate purge time for the required purge volume.

J. Obtain and record required measurements of the well water, (i.e., pH, specific conductance, and temperature).

K. Remove the cap from the sample bottle, and tilt the bottle slightly.

L. Pour the sample slowly down the inside of the sample bottle. Avoid splashing of the sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle.

M. Leave adequate air space in the bottle to allow for expansion. The exception to this statement are VOA vials, which must be filled to overflowing and capped.

N. Label the bottle carefully, and clearly. Enter all information accurately, and check to be sure it is legible.

O. Samples will be placed in containers defined according to the needs, and then, when appropriate, packed in cooled ice chest coolers as soon as practical. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in Section 8.0 and 10.0.

P. Complete field log and chain-of-custody forms in accordance with Section 10.0.

Q. If not dedicated, remove pump, close well cap and lock.

R. Decontaminate pump as described in Section 7.0.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

4.3 Sampling with a Bladder Pump

Scope and Applications

This procedure discusses collection of groundwater samples using the bladder pump. The water samples may be used to obtain physical, chemical, or radiological data.

Summary of Method

A bladder pump is either dedicated to a well or cleaned before each use. The pump is placed in the well prior to sample collection. A compressed air source forces air through a control box which regulates timed intervals of air discharges into, and air escapes from, the bladder pump, along with air intake pressure. The bladder expands and contracts with air intake and escape, and thereby forces water to the head of the well where it is collected.

Comments

Because there is little aeration or agitation of the water, the bladder pump can be used to collect samples for volatile organic analysis.

Procedures

A. Locate well and record well number, site, date, and well condition in log.

B. Use plastic sheeting as necessary to prevent equipment from coming in contact with potentially contaminated surfaces.

C. Unlock and open well.

D. Collect water level measurements as described in Section 1.0 and calculate purge volume as described in Section 3.0.

E. Attach air lines, sample lines and lifting lines to pump. Lifting lines should bear the weight of the pump with air and sample lines attached to lifting lines approximately every 10 feet with appropriate inert devices.

F. Lower pump in well to desired level, if pump is not dedicated.

G. Connect air lines from regulated compressed gas source to control box.

H. Connect battery, if required.

I. Start air flow.

J. Adjust flow rate with throttle knob found on control box.

K. To control discharge and refill cycle rate of the bladder, use the discharge and refill control knobs located on control box.

L. Equal length discharge and refill cycles are generally desirable, but individual well conditions may dictate otherwise.

M. When a bladder pump is used for purging, measure the amount of water discharged with a container of known volume, and calculate purge time for the required purge volume.

N. Obtain and record required measurements of the well water, (i.e., specific conductance, temperature, and pH).

O. Remove the cap from the sample bottle, and tilt the bottle slightly.

P. Pour the sample slowly down the inside of the sample bottle. Avoid splashing the sample. Assure that any suspended matter in the sample is transferred quantitatively to the sample bottle.

Q. Leave adequate air space in the bottle to allow for expansion, except for VOA vials which are filled to overflowing and capped

R. Label the bottle carefully, and clearly. Enter all information accurately, and check to be sure it is legible.

S. Samples will be placed in containers defined according to the needs, and then, when appropriate, packed in a cooled ice chest as soon as practical. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in Section 8.0 and 10.0.

T. Complete field log and chain-of-custody forms in accordance with Section 10.0.

U. If pump not dedicated, remove from well and decontaminate as described in Section 7.0.

V. Replace well cap and lock.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

5.0 FIELD MEASUREMENT PROCEDURES

5.1 Temperature

Scope and Application

This procedure is applicable to ground water from monitoring wells.

Summary of Method

Temperature measurements may be made with any calibrated high quality mercury-filled thermometer or thermistor with analog or digital read-out device.

Comments

For field operations using a glass thermometer, the thermometer will be transported in a protective case to prevent breakage. Thermometers or thermistors used with this procedure require calibration with a certified NBS thermometer.

Procedure

A. Use only mercury-filled thermometer or thermistor that is in calibration.

B. Inspect thermometer before each field trip to ensure that there are neither cracks in the glass, nor air spaces or bubbles in the mercury.

C. Allow thermometer or thermistor enough time to equilibrate to outside temperature when removed from a field vehicle.

D. Insert thermometer or thermistor in-situ when possible, or in a grab sample. Swirl the thermometer or thermistor in the sample, and take the temperature reading when the mercury column or digital readout stabilized; record temperature in field log to the nearest 0.5° C or 1.0° C, depending on need. Collect all contaminated water in a container for later disposal in the wastewater treatment system.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

Calibration

Each temperature measurement device will be initially calibrated at three temperatures covering the range of the device against a National Bureau of Standards (NBS) certified thermometer, and then cross-checked against a calibrated NBS certified thermometer at least semiannually.

5.2 pH (Hydrogen Ion Concentration)

Scope and Application

This procedure is applicable to ground water from monitoring wells.

Summary of Method

The pH of a sample is determined electrometrically using a combination electrode and a pH meter.

Comments

Coatings of oily material or particulate matter can impair electrode response. Remove these coatings by gentle wiping with a clean tissue followed by a distilled water rinse. Temperature effects on the electrometric measurement of pH are controlled by using instruments having temperature compensation or by calibrating the electrode meter system at the temperature of the sample.

Poorly buffered solutions with low specific conductance values (less than 200 umhos) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in sample before taking pH measurements.

Procedure

A. Prior to field activity check meter for mechanical and electrical failures, weak batteries, and cracked or fouled electrodes. Check pH recorders for recording and time scale accuracy.

B. Following instructions provided with each type of meter, test the meter against standard buffer solutions before using. Thereafter, the meter can be checked periodically against two buffers that bracket the expected value of the sample. Use a fresh aliquot of buffer solution for each measurement. Multi-range pH paper may be used to determine expected value.

C. For pH meter without automatic temperature compensation, bring the sample and buffer to same temperature, if possible. If the sample temperature differs more than 2°C from the buffer solutions, adjust for temperature difference.

D. Thoroughly rinse the electrode with distilled water and remove excess water between immersion in each buffer solution and sample.

E. Immerse the electrode in-situ when possible. If it is necessary to measure pH on a portion of the sample swirl the electrode at a constant rate until the meter reading reaches equilibrium. The rate of stirring used should minimize the air transfer rate at the air-water interface of the sample.

F. Note and record sample pH to the nearest 0.1 pH unit; repeat measurement on successive volumes of sample or in-situ until values differ by no less than 0.1 pH unit. Two or three volumes are usually sufficient.

G. For samples of high ionic strength, condition electrodes after cleaning by dipping them into sample for one minute, immerse in fresh portion of the same sample, and read pH.

H. For dilute, poorly buffered solutions, equilibrate electrodes immersing in three or four successive portions of sample. Take a fresh sample to measure pH.

I. Turn off meter at last reading.

J. Rinse electrodes thoroughly with distilled water and store in appropriate storage solution as described in operating instructions for the specific meter or electrode.

K. Record data in field log and complete Chain-of-Custody forms.

L. Collect all contaminated water in container for later disposal in the wastewater treatment system.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

5.3 Conductivity

Scope and Application

This procedure is applicable to groundwater from monitoring wells.

Summary of Method

The conductivity of the sample is determined by measuring the conductance of the sample using a digital or analog conductivity meter.

Comments

Temperature effects on the measurement of conductivity are controlled by using an instrument having temperature compensation or by calibrating the electrode meter system at the temperature of the sample.

Procedure

A. Prior to field activity check meter for mechanical and electrical failures, weak batteries, and cracked or fouled electrode(s).

B. Following instructions provided with the meter, test the meter for accuracy.

C. Thoroughly rinse the electrode with distilled water and remove excess water between each sample.

D. Immerse the probe into the sample and move around in sample several times before taking the reading. Record values to nearest 1.0 unit.

E. Turn off meter at last reading.

F. Rinse electrode thoroughly with distilled water and store according to operating instructions.

G. Record data in field log and complete Chain-of-Custody form.

H. Collect all contaminated water in a container for later disposal in the wastewater treatment system.

Control of Deviations

When feasible, any departure from specified requirements will be justified and authorized prior to deviating from the requirements. Deviations shall be sufficiently documented to allow repetition of the activity as actually performed.

6.0 SAMPLING OA/OC PROGRAM

A. Trip Blank - Fill two VOA vials with Type II reagent trade water, transport to the site, handle like a sample, and return to the laboratory for analysis. One trip blank per cooler is recommended.

B. Field Duplicate - One per well grouping of 20 wells or less. For more than 20 wells per group there shall be one per 20 wells or fraction thereof.

C. Rinsate Blank - One per well grouping.

D. Field Blank - One field blank per 10 well groupings.

7.0 CLEANING AND DECONTAMINATING SAMPLE CONTAINERS AND SAMPLING DEVICES

Scope and Application

This procedure establishes methodologies for cleaning and decontaminating sample containers and sampling devices.

Summary of Method

Sampling devices will be cleaned prior to being used in the field to prevent potential contamination of a sample. Sampling devices will be cleaned and decontaminated to prevent cross-contamination and will be decontaminated at the close of the sampling event prior to being taken off-site.

An acceptable alternative to cleaning and decontaminating sampling containers is the se of items cleaned or sterilized by the manufacturer that are discarded after use. Care must be exercised to ensure such previously cleaned or sterilized items do not retain residues of chemical or radioactive sterilizing agents that might interfere with analytical techniques.

Definitions

A. Sample containers include, but are not limited to, the following:

Jars
Vials
Jugs

B. The laboratory detergent must be a standard brand of phosphate-free laboratory detergent.

C. The nitric acid solution (10 percent) is made from reagent-grade nitric acid and deionized or organic-free water.

D. The standard cleaning solvent will be pesticide-grade isopropanol. The use of any solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified and approved by the responsible project personnel and will be documented in the log. The laboratory must be informed as well.

E. Tap water may be used from an approved municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute for tap water.

F. Deionized water is defined as tap water that has been treated by passing through a standard deionizing resin column. The deionized water should contain no heavy metals or other inorganic compounds (i.e.. at or above analytical detection limits) as defined by a standard Inductively coupled Argon Plasma Spectrophotometer (ICP) scan.

General

During cleaning operations, the substitution of a higher grade water (i.e., deionized) is permitted and need not be noted as a variation.

The brushes used to clean equipment as outlined in the various sections of this procedure must not be of the wire-wrapped type.

The solvents, nitric acid solution, laboratory detergent, and rinse waters used to clean equipment must not be reused, except as specifically permitted.

Procedure

A. Select appropriate cleaning procedure Section 7.1 or 7.2.

B. Segregation of Used Field Equipment

Field equipment or reusable sample containers needing cleaning must not be stored with clean equipment, or sample containers. Field equipment, reusable sample containers, and disposable sample containers that have not been used may not be replaced in storage without being recleaned if these materials have been transported to a facility or study site where contamination or suspected contamination is present.

C. Storage of Cleaned Field Equipment and Sample Containers

Previously cleaned sample containers and field equipment are stored in a contaminant-free environment. Sample containers and field equipment are stored separately from all other equipment and supplies and from each other.

D. Transporting Used Sample Containers Off-Site

Sampling containers that contain a sample, regardless of the assumed or known level of hazard associated with that sample, must have all exterior surfaces decontaminated. For sample containers used in areas other than a controlled access area, a wipedown with disposable rags or toweling, or rinse with deionized water followed by drying with disposable rags or toweling, will suffice. Any visible dirt, water droplets, stains, or other extraneous materials must be removed.

E. Sample Equipment Cleaning Procedures (From Testing Laboratory Sampling Container Decontamination Procedures)

Containers are purchased with regard to materials of construction, volume, and cleanliness. Depending upon the project, varying degrees of detail in these three areas are assessed. EPA's 40 CFR Part 136, Table II (Table 5.6.2), and SW-846's Table 11-1 (Table 5.6.1) are consulted for appropriate container type and preservation rules.

<u>Contamination Control</u>

The solvent used to implement the cleaning procedures outlined in this method will be collected and disposed of properly. Similarly, spent acids will be collected and-disposed of properly. These procedures apply whether cleaning procedures take place in the laboratory or in the field.

7.1. Cleaning Procedures for PVC, Teflon, or Glass Field Sampling Equipment Used for the Collection of Samples for Nonvolatile Compound Analyses

A. Wash Equipment thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film; pumps and tubing will be steam-cleaned prior to this wash.

B. Rinse equipment thoroughly with hot tap water.

C. Rinse equipment with a 10 percent nitric acid solution.

D. Rinse equipment thoroughly 2 times with ASTM Type II deionized, distilled water.

E. Wrap equipment with aluminum foil, if applicable, to prevent contamination during storage and/or transport to the field.

7.2 Cleaning Procedures for PVC, Teflon, or Glass Field Sampling Equipment Used for the Collection of Volatile Organic Compound Analyses, Including TOX and TOC

A. Wash equipment throughly with laboratory detergent and hot water using a brush to remove any particulates.

B. Rinse equipment thoroughly with hot tap water.

C. Rinse Equipment 2 times with ASTM Type II deionized distilled water.

D. Rinse equipment thoroughly with reagent grade isopropyl alcohol.

E. Allow equipment to air dry 2 hours.

F. Wrap equipment in aluminum foil.

7.3 Miscellaneous Equipment Cleaning Procedures

A. Well Sounders Used to Measure Groundwater Levels

1. Wash with laboratory detergent and tap water.

2. Rinse with tap water.

3. Rinse with deionized water, as appropriate.

4. Equipment will be wrapped to prevent contamination during storage or transit.

B. Submersible Pumps and Hoses Used to Purge Wells

Proceed as outlined in Section 7.2.A.

C. Ice Chests and Shipping Containers

All ice chests and reusable containers will be washed with laboratory detergent (interior and exterior and rinsed with tap water and air dried before storage. In the event that an ice chest becomes severely contaminated, in the opinion of the field investigator, with concentrated waste or other toxic material, it shall be cleaned as thoroughly as possible, rendered unusable, and disposed of properly.

8.0 PACKAGING ENVIRONMENTAL SAMPLES FOR TRANSPORTATION

Scope of Application

This method describes the minimum procedures required to properly package containers of environmental samples for transport to analysis at testing laboratory. It outlines the general requirements to be followed for laboratory samples collected in the course of field investigations and monitoring activities.

Summary of Method

Individual sample containers will be checked against accompanying chain-of-custody form(s) prior to signing the receipt for the sample collection. Site samples will be placed in strong exterior shipping packages and surrounded with compatible cushioning absorbent material if necessary.

The chain-of-custody must accompany the package. The package will be closed and sealed as appropriate.

Procedures for Sample Container Packaging

1. The sample container will be determined based on the analytical requirements as defined in the individual sampling and analysis plan.

2. The sample container will be cleaned in the field to remove sampled material from Its exterior prior to packing for shipment.

3. Samples will be packed to insure physical integrity during the normal rigors of transportation. These requirements will include, but not be limited to:

    a) Strong, light outer containers as appropriate for sample;

    b) the outer container will provide secondary containment for the sample provided the primary container is breached;

    c) Absorbent material will be used, as required, to contain liquid samples and will be compatible with the sample;

    d) Cushioning materials may be appropriable to reduce shock to samples and breakage of sample containers.

4. The outer container will be closed and secured as appropriate to maintain chain-of-custody.

5. Prepare chain-of-custody as described in Section 10.0.

9.0 CHEMICAL ANALYSIS PROCEDURES

For most of the analytical parameters to be measured, there is usually more than one analytical method that may be applied. Selecting the appropriate method involvesassessing the characteristics of each sample, the intended use of the data obtained from the analysis, and the limitations imposed by the analytical facility.

To select the most appropriate method for the analysis, the following factors should be considered:

a) Physical state of sample
b) Anticipated concentration of analytes
c) Required detection limit
d) Data quality objectives D(O)
e) Regulatory requirements
f) Set up and equipment available at the analytical facility
g) Cost of analysis

After all of the above has been taken into consideration, the analytical method used can be found in Table 1.

10.0 ChAIN-OF-CUSTODY CONTROL

Procedure

A. Samples Under Custody

Chain-of-custody requirements are necessary whenever a sample leaves the sampling team's custody. A sample is considered to be under a persons custody if any of the following conditions are met:

1. The sample is in the persons physical possession;

2. The sample is in line of sight of the person after he/she has taken possession;

3. The sample is secured by that person so any tampering can be detected

4. The sample is secured by the person in possession, in an area which only authorized personnel can enter.

B. Sample Labels or Tags

Sample labels (Figure D-1) will be fixed to all sample containers prior to or at the time of sampling. Sample labels will be waterproof paper or plastic with gummed backs or waterproof tags, as appropriate. Labels will be completed with black indelible ink and will include the following information:

1. Unique field study or sampling activity name and/or number,

2. Unique sample number.

3. Sample location or appropriate identification as identified in the sampling program;

4. Sampling date:

5. Sample preservation used:

6. Media sample or sample type;

7. Analyses required;

8. Comments and special precautions as needed.

Included is an example copy of sample labels (Figure D-1).

C. Sample Seals

Sample seals (Figure D-1) are used to detect tampering of samples, following sample collection prior to the time of analysis. The seal will be attached in such a way that it is necessary to break the seal in order to open the sample container. Here, "sample containers" may refer to either individual sample containers or a shipping container such as an ice chest. Seals will be affixed to the containers before they leave the custody of the sampling personnel.

Sample seals will be waterproof paper or plastic. All samples designated for shipment which leaves the sampler's custody will have a sample seal affixed which includes the following information:

1. Name(s) of collectors) or initials;

2. Date of sampling.

Included is an example of a Sample Seal (Figure D-l).

D. Field log Field Data Sheet)

A field log entry (Figure D-2) will be completed at the time the sample is taken. The field log entry will include, but not be limited to, the following information:

1. Unique field study or sampling activity name and number and sample number.

2. Volume of sample taken;

3. Name(s) of collector(s);

4. Date and time of sample collection;

5. Analytical parameter(s) to be measured;

6. Preservative;

7. Location of sampling point (i.e. well number);

8. Designation of QC samples (e.g., blank, splits, or duplicates);

9. Sampling methodology;

10. Observations during sampling (e.g., odors and colors);

11. Field observations and measurements.

E. Chain-of-Custody Records

The chain-of-custody record (Figure D-2) will be completed by the sampling personnel at the time of the sampling event. The record(s) will be signed as relinquished or received each time the sample changes possession, from collection to final deposition. The chain-of-custody record will include the following information. This information may be integrated into the field log sheet.

1. Unique sample number(s);

2. Unique field study of sampling activity name and/or number,

3. Date and time of sample collection:

4. Place and address of collection;

5. Name(s) of sample team member(s);

6. Signature(s) of the collector(s) or field sample custodian;

7. Laboratory destination, if known;

8. Container type;

9. Condition of sample on receipt;

10. Chain-of-custody control number (Does not apply to on-site analyses);

11. Signature ad date blocks for personnel relinquishing or receiving sample custody.

Included is an example copy of the chain-of-custody form/field sheet (Figure D-2).

F. Sample Request for Analysis

Sample request for analysis will be pre-arranged with the laboratory.

G. Laboratory Chain-of-Custody Sheet

The laboratory chain-of-custody sheet will be completed by the laboratory personnel receiving custody of the field samples.

The laboratory personnel will verify the information on the appropriate form is complete and accurate. He/she will verify that the sample received is with all pertinent information and that the integrity of the sample(s) has been maintained.

TAB' 1
RECOMMENDED SAMPLE CONTAINERS, SAMPLE PRESERVATION, SAMPLE HOLDING TIMES, AND ANALYTICAL METHODS

Parameter	Container	Preservative	Holding Time	Analytical Method[1]	Reference
Metals	1-liter polyethylene with polyethylene lined closure	Nitric Acid,3 pH<2	6 months		
Barium				6010(3010)[2]	1
Cadmium				7131(3020)	1
Chromium				7191(3020)	1
Lead				7421(3020)	1
Mercury				7470	1
Nickel				6010(3010)	1
Uranium (Fluorometric)				*	
Organic Compounds -					
Purgeable (VOA)	Two 40-ml vials with Teflon lined septum caps	Cool, 4°C	7 days	8420	1
Nitrate - (N)	250-ml polyethylene	Cool, 4°C	48 hours	300.0	2
Radionuclides	1-liter polyethylene	Nitric Acid to pH<2[3]	4 months	*	
Iodine-129	1-liter polyethylene	Cool, 4°C	NA	*	
Tritium	250-ml glass	Cool, 4°C	NA	*	

Footnotes:

1. Or equivalent analytical method.
2. Metal Digestion Method indicated in parentheses.
3. Must be preserved in the field at time of collection.

* Analyzed using Technical Procedures issued by Analytical Chemistry Department

References:

1. Test Methods for Evaluating Solid Waste, Third Edition, USEPA, SW-846, November 1986
2. Methods for Chemical Analysis of Water and Wastes, USEPA EPA 600/4-79-200, March 1979, as amended by EPA 500/4-82-005, December 1982.

Abbreviations: N/A = Not Applicable

GROUNDWATER BACKGROUND CHARACTERIZATION AND MONITORING PARAMETERS AND FREQUENCIES

I. Groundwater Background Characterization

Since background monitoring was performed in the late 1980's for this currently permitted landfill and operational monitoring is currently being performed, additional background monitoring will not be performed.

II. Groundwater Monitoring

1. Sample collection and analyses will be accomplished in accordance with the document, "Y-12 Industrial Landfill IV Groundwater Sampling and Analysis Plan," attached to the modification package.

2. Groundwater monitoring will continue uninterrupted under the approved modified permit and during modification to the landfill permit changes to monitoring will be used on TDEC Approval.

3. The elevation of the groundwater surface will be determined and recorded at each monitoring well each time a sample is obtained, but prior to any pumping or bailing of the well.

4. Samples will be analyzed for the parameters identified in Sections III, IV, V of this Appendix. Because wells at this facility are part of a comprehensive monitoring program, certain constituents other than those required by 1200-1-7-.04 Appendix I, are included as part of additional data gathering purposes and maybe modified without TDEC approval.

5. Groundwater sample analysis results and associated recordings of groundwater surface elevations will be submitted to the TDEC/DSWM within 15 days after completing the analysis.

6. Monitoring samples will be taken semiannually.

7. Monitoring will be continued through the post-closure care period for the landfill.

III. Radionuclides

Gross alpha activity	Gross beta activity
Total uranium	

IV. Groundwater Chemistry

Calcium*
Chloride*

Fluoride
Iron*
Magnesium*
Manganese*
Nitrate (as N)*
Potassium*
Sodium*
Sulfate*
Total Dissolved Solids (TDS)*
pH*

V. Groundwater Quality

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Copper
Cyanide
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc

VI. Groundwater Volatile Organic Constituents (VOCs)

Acetone
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
2-Butanone (Methyl ethyl ketone)
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
1,2-Dibromo-3-Chloropropane
Chloroethane
Chloroform
Chloromethane
Dibromomethane
1,2-Dichlorobenzene
1,4-Dichloro-2-butene
1,1-Dichloroethane
1,2-Dichloroethane
trans-1,2-Dichloroethene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone
Iodomethane
Methylene chloride
4-Methyl-2-pentanone
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Trichloroethane
Trichlorofluoromethane
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylene

*Parameter not required under 1200-1-7-.04, Appendix I.

The TDEC/DSWM requirements for groundwater monitoring at Class II disposal facilities do not require VOC monitoring. Rule 1200-1-7-.04(7)(b)1 states:

> Class II disposal facilities are not required to perform the analysis for the volatile organic compounds in Appendix I unless specifically required by the Commissioner;

and Rule 1200-1-7-.04(7)(b)2 states:

> Class II disposal facilities are not required to perform the analysis for the Appendix II parameters unless specifically required by the Commissioner.

The Y-12 Plant Comprehensive Groundwater Monitoring Plan (Y-SUB/90-00206C/5, September 1990) provides an overall monitoring strategy necessary to collect the variety of data needed to address the multiple, and often overlapping, regulatory requirements for groundwater monitoring at the Y-12 Plant. Currently, the Y-12 standard program for VOC monitoring is an abbreviated list of constituents defined by the EPA as target compounds for monitoring at National Priority List (NPL) sites (the ORR has been placed on the NPL). However, the annual monitoring and reporting of the listed VOCs will be undertaken to maintain a general consistency with the comprehensive monitoring program at the Y-12 Plant and to fulfill the TDEC Commissioner's requirements.

The proposed list of VOCs, as outlined in this section, differs from the TDEC/DSWM Appendix I list as follows:

1. Bromochloromethane is an internal and/or surrogate standard used by laboratories, per EPA procedures, to quantitate VOCs on the EPA target compound list. A review of the analytical methodology failed to identify approved methods for these constituents in groundwater. Therefore, these compounds are not suitable parameters for analysis and are not included in the groundwater monitoring program.

United States Department of Energy
Oak Ridge Field Office

**Y-12 INDUSTRIAL WASTE
LANDFILL IV
CLOSURE/POST-CLOSURE
PLAN**

Date: January 1994

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831-8169
managed by
Martin Marietta Energy Systems, Inc.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-840R21400

TABLE OF CONTENTS

1.0 INTRODUCTION

The following text details closure and post-closure activities to be conducted at the Y-12 Industrial Waste Landfill IV. The landfill is owned by the U.S. Department of Energy (DOE) and co-operated by DOE's Operating Contractor (OC), under Tennessee Permit Number: IDL 01-103-0075. This plan has been prepared in accordance with Rule 1200-1-7, Solid Waste Processing and Disposal, promulgated under the authority of the Tennessee Department of Environment and Conservation (TDEC).

The original permit issued for IWLF IV by TDEC had a registration number of IDL 47-103-0075. In December 1993 TDEC issued a modified permit for the facility with a registration number of IDL 01-103-0075.

1.1 Facility Description

The Y-12 Plant is located in Anderson County, Tennessee, adjacent to and south of the city of Oak Ridge. Industrial Waste Landfill IV is located in a secured area on Chestnut Ridge, in the southwest quadrant of the Y-12 Plant. The IWLF-IV site is bounded on the east by West Patrol Road and on the south by a TVA 1.61 kV power line. A sediment basin is located at the southwest end of the landfill. There are no structures on the site. The landfill is surrounded by a 8-foot-high chain link fence topped with three strands of barbed wire. Two locked entrance gates are located at the east end of the site and provides access from West Patrol Road and old Mt. Vernon Road. A site location is provided (Drawing C2E900000A031). The operating plans for the landfill indicate that approximately 4.1 acres of land are available for waste disposal. The method of operation at the landfill is area excavation and fill.

The landfill is divided into Area 1 and Area 2. Area 1 is approximately one acre foot printed with waste prior to October 9, 1993 and has a large geological buffer, but does not contain a flexible membrane liner. Area 2 is roughly 3.2 acres and is designed to meet revised Regulations Governing Solid Waste Processing and Disposal Facilities in Tennessee (Rule Chapters 1200-1-7-.01 through 1200-1-7-.08). Area 2 contains a composite liner, leachate collection system, and gas migration controls. The closure plan is prepared as a guideline for Area 1 and Area 2.

This manual describes the closure and post-closure plans for the industrial solid waste disposal unit referred to as the Y-12 Industrial Waste Landfill IV (IWLF-IV). This is a Tennessee Department of Environment and Conservation/Division of Solid Waste Management (TDEC/DSWM) Class II disposal unit.

1.2 Expected Year of Closure

According to existing practices and work loads, the IWLF-IV has a compacted waste loading of approximately 75-88 cubic yards per month (including cover material) however, future waste loading is estimated to range from 75 to 150 cubic yards per month. The available airspace is the volume between the excavation contours shown on the excavation plan (Drawing C2E900000A034) and the proposed final contours (Drawing C2E900000A034). Based on the waste loading and on the estimated airspace volume, the anticipated life of the IWLF-IV is approximately 40 to 80 years. Therefore, it is estimated that the landfill would close between the year 2033-2073.

1.3 Facility Contact

The operating contractor (OC) will operate the landfill. The facility contact during closure activities and the subsequent post-closure period will be the following:

Department Head
Waste, Transportation, Storage, and Disposal Department
Y-12 Plant
P. O. Box 2009
Oak Ridge, TN 37831-8060; Telephone: 615/576-4965

2.0 FACILITY CLOSURE

The facility closure will consist of placement of the final cover material, the establishment of vegetation on the cover, and modification of the drainage systems as necessary to control run-on, runoff, and sedimentation in off-site water courses. These activities will be implemented to achieve the following closure performance standards as specified in Tennessee Rule 1200-1-7-.04(8):

1. Minimize the need for further maintenance.

2. Protect public health and the environment by controlling, minimizing, or eliminating the post-closure escape of solid waste or solid waste constituents, including leachate, contaminated runoff, or waste decomposition products, to surface waters, groundwater, or the atmosphere.

3. Provide for the post-closure care of the facility as necessary to ensure the above performance standards are attained.

Specific closure procedures pertaining to partial and complete facility closure are provided in Sections 2.1 and 2.2.

2.1 Partial Closure

It is not intended to close the Y-12 Industrial Waste Landfill IV prior to exhausting all permitted disposal capacity. If at any point in time during the life of the landfill, it is necessary to close the landfill before maximum utilization of the fill area is achieved, an engineering assessment of the current state of the IWLF-IV with respect to the TDEC/DSWM - approved plan will be performed. In the event that closure of the existing fill area is required prior to reaching permitted capacity, the following activities will be implemented to ensure that a complete closure of the facility is achieved:

1. TDEC will be notified at least 60 days before the date of facility closure.

2. The approved closure plan will be revised to address any final grading, drainage, or other modifications necessary to ensure complete closure in accordance with existing regulations.

3. Final cover will be placed in accordance with Section 2.2.1 and the revised grading plan.

4. Drainage facilities will be inspected at the time of closure and stabilized, if necessary,

in accordance with Section 2.2.2.

5. A groundwater monitoring system is in place and operational. Proper groundwater monitoring will be continued.

6. Certification that all closure activities have been completed in accordance with the approved plans, will be provided to TDEC.

2.2 Complete Closure

The TDEC/DSWM will be notified in writing of the intent to close the landfill at least 60 days prior to the date final closure is expected to begin. Upon achieving a compacted waste elevation 3'- 6" below the final contours of the side slopes and the landfill top, compacted final cover material will be placed over the completed landfill. This work will be accomplished in the shortest time practicable, not to exceed 180 days after the completion of waste filling operations, and will include grading, surface drainage, and establishing vegetative cover. Closure will be in accordance with this closure plan as approved by the TDEC/DSWM, and as shown on Drawing C2E900000A035. This design will minimize run-on, optimize drainage, prevent pooling, and minimize erosion. The design will not adversely affect drainage of adjacent lands.

The landfill was in operation prior to March 18, 1990, at which time the new liner and final cover standards became effective. The March 18, 1990 standards required unlined landfills to be closed in March 19994. In September of 1992 a request was submitted to waive leachate and gas management system due to the inert waste streams and the large geological buffer. The waiver request was modified in June of 1993 to limit the waiver to a small eastern portion of the landfill rather than the entire landfill. The remainder of the landfill (Area 2) will be upgraded as a lined landfill to be in compliance with the July 10, 1993 amendments. Also in September of 1992 a request was made to expand the generator from the original permit of Y-12 Plant and on site contractors, exclusively, to the three major operating facilities on the ORR. This request was resubmitted in July of 1993 with additional information on the waste streams the generators would be sending for disposal and added the DOE Federal Building as a potential generator. In August of 1993 a request was submitted to TDEC for approval to dispose of bottom ash from the Y-12 Steam Plant. Once the entire landfill has been utilized, final cover will be placed on Areas 1 and 2 in accordance with Section 2.2.1.

2.2.1 Final Cover

The final cover will be installed over a minimum 6 inches of daily or 12 inches of intermediate cover. The final cover is composed of a 24-inch compacted low-permeability soil layer covered by a flexible membrane liner, drainage layer and a 18 inches of vegetative soil cover. The geonet will assist in drainage and in promoting vegetative growth in the protective soil layer on the mildly sloped landfill top to minimize erosion. The 24 inches of compacted soil will not exceed 6-inches per compacted lift. These lifts will be compacted using a footed roller that has feet a minimum of six inches long and a minimum static weight of 30,000 pounds. A minimum of six passes of the equipment is required over each lift. Lifts will be placed to achieve a total compacted depth of 24 inches. The compaction procedures to achieve the required soil cap permeability are presented in the construction quality assurance (CQC) plan attached to the permit application. It is desirable not to compact the top one and one-half foot of soil with wheel-type equipment, because it makes the establishment of vegetation difficult.

The top and side slopes of the completed landfill will be fertilized, seeded, and mulched. Hydroseeding and hydro-mulching may be used. The side slopes will be roughened before seed is applied to facilitate vegetative growth.

Due to the nature of the operation and the types of waste disposed of in the landfill, no significant amounts of gas is expected to be generated. However, a minimum gas migration control system will be constructed as a part of the final cover as shown on drawing C2E900000A035.

2.2.1.1 Low-Permeability Soil Layer

A low-permeability layer of the closure cap consisting of compacted soil will be constructed over the waste fill. The procedures associated with this process include:

- Preparation of existing landfill surface.
- Excavation of borrow soils; moisture adjustment; mixing.
- Transport borrow soils to landfill site.
- Maximum thickness of a compacted layer can be no more than 6-inches.
- Final moisture adjustment; mixing; hydration.
- Compaction; smoothing of surface.
- Construction Quality Assurance/Quality Control (CQC) testing.
- Further compaction, if necessary.

2.2.1.1.1 Construction Quality Assurance

A program of quality control will be implemented throughout the closure construction process. Elements of the program include materials testing, field compaction studies, and inspection and testing during construction. The objective of this program is to ensure that the materials and methods used for construction of the final cover and associated systems are consistent with design specifications. The CQC Program will also ensure that the closure performance standards for final closure of the Y-12 Industrial Waste Landfill IV are attained.

A CQC Inspector will be engaged during construction of the low-permeability soil layer and composite geosynthetic liner. A Construction Quality Control Officer, registered engineer in the State of Tennessee, will monitor the construction inspection, testing, and provide final documentation that closure was performed according to project requirements.

2.2.1.1.2 Specifications and Sources of Material

Soils being used in construction of the low-permeability layer have been tested to confirm that a permeability less than or equal to 1×10^{-7} centimeters/second (cm/s) can be achieved. Various ORR borrow areas ("East", "West", Industrial Landfill V, Construction Demolition Landfill VI and VII) contain suitable soils for construction of the low-permeability layer for Y-12 Industrial Waste Landfill

IV. Extensive compaction and permeability testing of the soils from these areas indicate that they can be compacted to produce a permeability of less than or equal to 1x10-7 cm/s. The laboratory data from the tests have been used to define acceptable ranges for density and moisture content that will ensure the permeability criteria can be achieved.

Existing and future sources from developed and undeveloped borrow areas that have soil comparable to those listed as suitable may be used to provide finial cover material. All soils used in construction of the final cover will be evaluated by a rigorous testing program to establish a correlation between permeability and in-place moisture/density. This program shall be completed prior to placement to ensure that the cap can be constructed to satisfy the specified permeability.

2.2.1.1.3 Materials Testing

Soils will be tested periodically to ensure that the materials are consistent with the specified soils and that the in-place density and moisture content correlate to the specified permeability. In addition to testing, the soils will be inspected by an experienced soils technician during selection of the materials. A more detailed plan for all source area soils testing and inspection is included in a CQC Plan.

2.2.1.1.4 Field Testing

Field testing will be conducted during construction to ensure that the materials are placed in a manner that will achieve the desired permeability. The testing methodology will follow the recommendations of the report "Permeability of Compacted Soils from the East and West Borrow Areas" prepared by David E. Daniel, March 1989 (included in the CQC). This document defines acceptable ranges for water content and density needed to obtain permeabilities of less than or equal to $1x10^{-7}$ cm/s in both "East" and "West" borrow area soils. Measurements of moisture content and density will be collected from each of the compacted lifts in accordance with the procedures to be presented in the CQC Plan. These data will be compared to the moisture content/density/permeability relationships presented in the above referenced report, or similar data developed for other borrow soils. If the moisture content/density falls within the acceptable range, the tested section will be considered to have "passed." If it falls outside the acceptable range, corrective action will be taken and appropriate verification testing completed.

2.2.1.1.5 Inspection During Construction

The CQC Officer and CQC Inspector will be responsible for inspection activities during construction as outline in Section 3C of the Construction Quality Control Procedures of Soils.

2.2.1.2 Vegetative Layer

Eighteen inches of soil will be placed in the closure cap over the low-permeability layer to provide a protective cover/vegetative layer.

2.2.1.2.1 Source of Materials

Soil used for construction of the protective cover/vegetative layer will be obtained from available sources at the time of construction. This layer will support the growth of vegetation needed to minimize soil erosion. Potential source areas include excavations associated with planned facilities and designated borrow areas.

2.2.1.2.2 Seeding and Mulching

The protective soil cover will be seeded, mulched, and fertilized. Manual seeding and mulching or hydroseeding and/or hydromulching may be used. A sound vegetative cover will be established through grasses such as Kentucky 31 Fescue and Annual Ryegrass.

2.2.1.2.3 Fertilizing

The protective cover will be fertilized as necessary to promote establishment of the vegetative cover. The type and quantities of fertilizer to be used will depend on the requirements of the soil materials used for the protective cover.

2.2.2 Drainage System

The existing drainage facilities at the Y-12 Industrial Waste Landfill IV will be enhanced as needed to ensure compliance with the drainage system requirements identified in Tennessee Rule 1200-1-7-.04(8)(c)4. These requirements specify that the final surface of the disposal facility shall be graded and/or provided with drainage facilities in a manner that:

- Minimizes precipitation run-on from adjacent areas onto the disposal facility.
- Minimizes erosion of cover material.
- Optimizes drainage of precipitation falling on the disposal facility.
- Provides a surface drainage system which is consistent with the surrounding area and does not adversely affect proper drainage from the adjacent land.

Drawing No. C2E900000A035 shows the final configuration of drainage and erosion controls to be constructed during closure. These controls have been designed to address each of the requirements identified in the regulations.

Diversion of run-on from adjacent areas will be accomplished by maintenance of the existing perimeter ditch, which drains off site. Drainage of precipitation will be facilitated by grading the final cover to produce moderate slopes that do not to exceed 5:1.

Closure operations will begin at the east end of the landfill, and all on-site drainage will continue to be directed to the existing drainage ditches and sediment basin. The sediment basin will remain until vegetation is well established on the landfill cover. During closure operations, sedimentation will be controlled by the sediment basin and by the placement of erosion controls at the toe of the landfill as shown on Drawing No. C2E900000A035. The erosion controls will be removed only when vegetative growth is established across the entire facility.

2.2.3 Topographic Survey

A topographic survey to provide final elevations of the final cover will be completed at the termination of construction activities. The survey will support the development of a final contour map of the site at a scale of 1"=100' and a contour interval of 2 feet. This map will also show the as-built configuration of the drainage systems, roads, monitoring wells, and other constructed features.

2.2.4 Notification and Certification

In accordance with Tennessee Rule 1200-1-7-.04(8)(c)9, written notification will be provided to the TDEC upon completion of closure of the Y-12 Industrial Waste Landfill IV. This notification will include a certification that the disposal facility has been closed in accordance with the approved closure/post-closure plan. Within 21 days after the TDEC receives this notification, the TDEC is required to inspect the facility to verify that closure has been completed in accordance with the approved plan. If proper closure is verified, the TDEC will notify the DOE within 10 days that closure has been approved. This final notification will constitute final approval and acknowledgement by the state that closure of the Y-12 Industrial Waste Landfill IV has been completed.

2.2.5 Closure Schedule

The anticipated closure schedule for the Y-12 Industrial Waste Landfill IV is provided in Table 2. It is anticipated that the landfill will be closed within 180 days from start of closure, if unfavorable weather is not encountered that would impact construction activities.

TABLE 2

Y-12 Industrial Waste Landfill IV Closure Schedule

ACTIVITY	SCHEDULE
Notification of intent to close	-60
Begin construction	0
Construct low-permeability cap	90
Construct protective soil layer	120
Topographic survey and revegetate	170
Complete closure activities	180

3.0 POST-CLOSURE ACTIVITIES

The post-closure activities planned for the Y-12 Industrial Waste Landfill IV include post-closure maintenance and inspection, and recording of a notification on the property deed that the site has been used as a disposal facility. One additional survey of the landfill site will be conducted during the post-closure care period. This survey will be conducted 5 years after closure. If settlement is not significant, no additional surveys will be performed.

3.1 Abandonment of Sediment Basin

After vegetation is established on the landfill cover, the sediment basin will be abandoned. To abandon the basin, water in the basin will be pumped into the existing natural drainage. After the basin sediments have dried, fill material will be brought in, spread and compacted into the basin area and graded to match the grades as shown on Drawing No. C2E900000A035. Final cover will then be placed over the basin area and extended downslope to match the proposed closure grades as shown on Drawing No. C2E900000A035. The erosion control measures will be maintained until all slopes are vegetated.

3.2 Post-Closure Care

Subparagraph (d) of Tennessee Rule 1200-1-7-.04(8) states that post-closure care activities at disposal facilities such as the Y-12 Industrial Waste Landfill IV will be conducted for 30 years. The primary requirements for this post-closure care are to maintain the approved final contours (with prevention of ponding on the surface), drainage system, and healthy vegetative cover (once it is established). The objective of these requirements is to ensure the integrity of the final cover and thereby minimize the potential for future releases of waste or waste constituents from the facility. The closed site will be maintained as a grassed area. There are no plans for future development of the closed site.

3.2.1 Inspections

A program of quarterly inspections will be conducted to check for settlement, cracks, erosion, insufficient vegetative cover, and other defects. Any observed defects will be corrected. Normal maintenance activities, such as grass mowing and drainage ditch maintenance, will also be performed on as-needed basis. Post-closure care will be provided on an as-needed basis throughout the post-closure period to ensure the long-term integrity of the final cover.

3.2.2 Leachate

Leachate removal will continue throughout the post-closure period. As leachate quantities decrease after final closure, the frequency of leachate removal will be revised as necessary. Whenever personnel enter the site to remove leachate, an observation record will be completed and any deficiencies will be corrected. Leachate sampling and analyses as required by the accepting wastewater treatment plant pretreatment program will also be continued.

Maintenance, as needed, will be performed on leachate pumps, motors, valves, etc. Any parts necessary to maintain operation will be acquired and installed. The leachate collection lines will be inspected for blockage and will be cleaned as necessary.

3.2.3 Groundwater Monitoring Activities

The compliance monitoring boundary is normally coincident with the landfill property boundary. However, the nearest property boundary is approximately 1 mile from the facility. Therefore, the location of the existing monitoring wells or any approved replacement groundwater characterization wells installed prior to, or subsequent to, final closure will constitute the compliance monitoring boundary for the Y-12 Industrial Waste Landfill IV. This boundary is the vertical surface located at the hydraulic down gradient limit of the unit where the vertical surface extends to the uppermost aquifer.

Groundwater monitoring is currently conducted at one up gradient monitoring well (GW-521) and four down gradient monitoring wells (GW-141; GW-217; GW-305; GW-522). The wells are constructed of 4-inch diameter stainless steel well casing and screen. The locations of these wells are shown on the final closure drawing, Drawing No. C2E900000A033. These wells have been used to monitor the quality of background groundwater that has not yet been affected by leakage from the landfill as well as to determine the groundwater quality that passes the compliance boundary down landfill as well as to determine the groundwater quality that passes the compliance boundary down gradient.

As of the effective date of the new Tennessee solid waste disposal regulations, the Y-12 Industrial Waste Landfill IV has been subject to groundwater monitoring standards applicable to a Class II Disposal Facility (i.e., industrial waste landfill, as defined in the new regulations). Class II disposal facilities are required to conduct groundwater sampling and analysis in accordance with Rule 1200-1-7-.04(7)(a)4.(ii)(I) and 1200-1-7-04-(8)(e)6.

3.2.3.1 Sample Collection

The monitoring wells will be sampled in accordance with the guidelines set forth in the USEPA "RCRA Groundwater Monitoring Technical Enforcement Guidance Document."

Before purging or sampling at any well, the water level will be measured and recorded. The water level will be obtained using a level indicator. The well depth will be determined annually using a weighted measuring probe.

Prior to sampling, the wells will be purged of at least three well volumes, or to dryness if insufficient water is present to yield the required purge volumes. This will stimulate groundwater flow into the well and provide a representative groundwater sample.

Samples will be taken as soon as practical after purging. Samples will be collected with a stainless steel or Teflon bailer or by using a submersible sample pump. The sample bottles will be filled directly from the sample device. Groundwater pH and temperature will be determined in the field after the samples have been collected.

3.2.3.2 Sample Identification

Samples will be labeled in the field with the following information:

- Location
- Sample Number
- Date
- Time
- Intended Analysis
- Initials of Sampling Personnel

3.2.3.3 Sample Containers and Preservation

To ensure the quality of samples by preventing cross-contamination between wells, all sampling equipment will be decontaminated before reuse. The equipment will be washed thoroughly with laboratory grade detergent, rinsed with appropriate solvents and deionized water, and allowed to air dry.

All analytical procedures will be conducted according to the protocols described in Test Methods for Evaluation Solid Wastes (EPA/SW-846) or equivalent. Each well will be sampled in accordance with Rule 1200-1-7-.04(7)(b)9(b).

3.2.3.5 Chain of Custody

A chain-of-custody form will be used to track sample possession. The form will include sample type, sample number, intended analysis, sampling dates, times, and signatures of sampling and laboratory personnel.

3.2.3.6 Record Keeping and Reporting

a. The operator must keep records of all groundwater sampling activities conducted, the sample analysis results, and the associated groundwater surface elevations throughout the active life of the facility and throughout the post-closure care period as well. Such records must be kept at the facility or at some other location within Tennessee as specified in the permit.

b. All groundwater sample analysis results and associated recordings of groundwater surface elevations must be submitted to the Commissioner within 15- days after completing the analysis. To facilitate handling and evaluation of this data, the Commissioner may specify in the permit the manner and form in which the data must be reported.

3.3 Deed Notification

Within 60 days of completing final closure at the Y-12 Industrial Waste Landfill IV, the DOE will record a notation will be recorded on the deed to the property (or other instrument which is normally examined during a title search). This notation will in perpetuity notify any person conducting a title search that the area associated with the Y-12 Industrial Waste Landfill IV has been used as a disposal facility.

4.0 COST ESTIMATE AND FINANCIAL ASSURANCE

An itemized estimate of the cost of performing the closure and post-closure care activities for Y-12 Industrial Waste Landfill IV is included as Attachment A to this plan. This estimate details the costs associated with construction of the low-permeability layer, vegetative layer, and drainage system as well as the costs of the topographic survey and 30 years of post-closure care. Closure costs are escalated to the year 2073 using an annual inflation rate of 4 1/2 percent. Post closure costs are calculated for 30 years beyond the year of closure using an annual inflation rate of 4 1/2 percent.

The landfill is owned and operated by the DOE. Rule 1200-1-7.03(1)(6)3 states that the financial assurance requirements do not apply if the operator is an agency of the state of Tennessee or the federal government. The Y-12 Industrial Waste Landfill IV is exempt from the financial assurance requirements delineated in Rule 1200-1-7-.03.

ATTACHMENT A

WORK SHEET A:

CLOSURE ACTIVITIES

1. Establishing final cover:

A. Topsoil

1.	Quantity needed (yd^3)	9,757
2.	Excavation unit cost ($\$/yd^3$)	27.16
3.	Excavation cost (1. x 2.)	265,000
4.	Placement and spreading unit cost ($\$/yd^3$)	54.79
5.	Placement cost (1. x 6.)	534,586
6.	Delivery unit cost ($\$/yd^3$)	223.28
7.	Delivery cost (1. x 6.)	2,178,543
8.	Compaction unit cost ($\$/yd^3$)	76.42
9.	Compaction cost (1. x 8.)	745,630
TOTAL:	Top soil (3. + 5. + 7. + 9.)	3,723,759

B. Landfill cap

1. Random Fill Material

a.	Quantity needed (yd^3)	NA
b.	Excavation unit cost ($\$/yd^3$)	NA
c.	Excavation cost (a. x b.)	NA
d.	Placement and spreading unit cost ($\$/yd^3$)	NA
e.	Placement cost (a. x. d.)	NA
f.	Compaction unit cost ($\$/yd^3$)	NA
g.	Compaction cost (a. x f.)	NA
TOTAL:	On-site clay (c. + e. + g.)	NA

2. Off-site clay

a.	Quantity needed (yd^3)	13,000
b.	Purchase unit cost ($\$/yd^3$)	46.04
c.	Purchase cost (a. x b.)	598,494.00
d.	Delivery unit cost ($\$/yd^3$)	250.45
e.	Delivery cost (a. x d.)	3,255,850.00
f.	Placement and spreading unit cost ($\$/yd^3$)	54.79
g.	Placement cost ($\$/yd^3$)	712,270.00
h.	Compaction unit cost ($\$/yd^3$)	114.63
i.	Compaction cost (a. x h.)	1,490,190.00
TOTAL:	Off-site clay (c. + e. + g. + i.)	6,056,804.00

3. Quality control/testing of clay

a.	Number of sample to be tested	250.00
b.	Clay testing unit cost ($/sample)	2,205.22
c.	Testing cost (a. x b.)	551,305.00
TOTAL:	Clay testing (c.)	551,305.00

C.	Synthetic membrane		
	1.	Quantity needed (yd^2)	19,511
	2.	Purchase unit cost ($/$yd^2$)	161.37
	3.	Purchase cost (1. x 2.)	3,148,490
	4.	Installation unit cost ($/$yd^2$)	34.46
	5.	Installation cost (1. x 4.)	672,345
	TOTAL:	Synthetic membrane (3. x 5.)	3,820,839
D.	Geotextile filter fabric		
	1.	Quantity needed (yd^2)	19,511
	2.	Purchase unit cost ($/$yd^2$)	48.72
	3.	Purchase cost (1. x 2.)	950,570
	4.	Installation unit cost ($/$yd^2$)	9.84
	5.	Installation cost (1. x 4.)	191,988
	TOTAL:	Synthetic membrane (3.+5.)	1,142,564
E.	Geonet		
	1.	Quantity needed (yd^2)	19,511
	2.	Purchase unit cost ($/$yd^2$)	76.11
	3.	Purchase cost (1.x2.)	1,484,982
	4.	Installation cost ($/$yd^2$)	14.80
	5.	Installation cost (1.x4.)	288,763
	TOTAL:	Geonet (3+5)	1,773,745
	TOTAL for Establishing final cover:(A+B+C+D)		17,069,016

2. Establishing vegetation cover:

A.	Labor ($/acre)	16,452.60
B.	Seeding ($/acre)	39,962.89
C.	Fertilizing ($/acre)	46,626.37
D.	Mulching ($/acre)	15,990.84
E.	Number of acres	4.00
TOTAL for Establishing vegetation cover: E. x (A+ B+ C+ D)		476,131.00

3. Establishing or completing & system to minimize and control erosion/sedimentation:

A.	Sediment pond (abandon)		
	1.	Remove pond ($)	1,348,460.00
	TOTAL:		1,384,460.00
B.	Diversion ditch		
	1.	Construction ($)	NA
	2.	Materials ($)	NA
	TOTAL:	(1. + 2.)	NA
C.	Access road to monitoring station		
	1.	Quantity needed (yd^2)	NA
	2.	Unit cost ($)	NA

TOTAL: (1. + 2.)	NA

D.	Temporary structures (e.g., silt fence; swales)	
	1. Construction ($)	230,190.00
	2. Materials ($)	460,380.00
	TOTAL: (1. + 2.)	690,570.00

TOTAL for establishing or completing a system to minimize and control erosion and sedimentation: (A.+ B.+ C.+ D.) 2,075,030.00

4. Establishing or completing leachate collection removal, and treatment system:

A.	Installation	
	1. Number of feet	NA
	2. Unit cost ($/ft)	NA
	3. Storage tanks ($)	NA
	4. Pumps ($)	NA

TOTAL for Establishing or completing leachate system: NA

(1.+ 2.+ 3.+ 4.)

5. Establishing or completing a system to collect or vent gases:

A.	Installation	
	1. Materials (e.g., piping)	270,640
	2. Equipment (e.g., pumps)	NA
	3. Labor (e.g., drilling)	NA
	4. Sand Trench	83,222

TOTAL for Establishing or completing a system to collection or vent gases: (1. + 2. + 3.) 353,862

6. Establishing or completing groundwater/surface water monitoring system:

A.	Installation	
	1. Number of well	NA
	2. Drilling cost (1. x 2.)	NA
	3. Materials (e.g., casing) (1. x 3.)	NA
	4. Equipment (e.g., pumps)	NA
	5. Labor	NA

TOTAL for Establishing or completing groundwater monitoring system: (1. + 2. + 3.) NA

TOTAL CLOSURE COSTS
(sum of TOTALS for Sections 1. thru 6.) 19,974,039.00 *

* Closure cost in the year 2073

WORK SHEET B:

POST CLOSURE ACTIVITIES

1. Surveying inspections to confirm final grade and drainage are maintained:

A.	Transportation	Included in 1.B
B.	Labor	1,724,000.00

TOTAL for Surveying inspection: (A. + B.) 1,724,000.00

2. Maintain healthy vegetation:

A.	Transportation	Included in 2.B
B.	Labor	1,206,800.00
C.	Seeding	Included in 2.B
D.	Fertilizing	Included in 2.B
E.	Mulching	Included in 2.B
F.	Rodent Control	Included in 2.B
G.	Mowing	862,000.00

TOTAL for Maintaining healthy vegetation:
(A. + B. + C. + D. + E. + F. + G.) 2,068,800.00

3. Maintain the drainage facilities, sediment ponds, and other erosion/sedimentation control measures:

A.	Transportation			Included in 3.B
B.	Labor			1,724,000.00
C.	Cleaning out of systems			862,000.00
D.	Repair of gullies or rills			
	1.	Soil acquisition		
		a.	Quantity needed (yd^3)	Included in 3.D.2
		b.	Purchase unit cost ($\$/yd^3$)	Included in 3.D.2
		c.	Purchase cost (a. x b.)	Included in 3.D.2
		d.	Delivery unit cost ($\$/yd^3$)	Included in 3.D.2
		e.	Delivery cost (a. x d.)	Included in 3.D.2
		TOTAL 1: (c. + e.)		Included in 3.D.2
	2.	Placement/spreading/compaction		862,000.00
	3.	Revegetation		Included in 3.D.2
	TOTAL D: (1. + 2. + 3.)			862,000.00

TOTAL for Maintaining Drainage:
(A. + B. + C. + D.) — 3,448,000

4. Maintain and monitor the leachate collection, removal and treatment system:

A. Treatment of leachate:

1. On site	
a. Quantity (yd^3)	NA
b. Treatment unit cost ($\$/yd^3$)	NA
c. Treatment costs (a. x. b.)	NA
d. Sewer discharge unit cost	NA
e. Discharge cost (a. x u.)	NA
TOTAL 1: (c. + e.)	NA
1. Off site	
a. Quantity (yd^3)	66,840 gal
b. Hauling unit cost ($\$/yd^3$)	NA
c. Hauling costs (a. x b.)	NA
d. Treatment unit cost ($\$/yd^3$)	534
e. Treatment costs (a. x d.)	35,692,560
TOTAL 2: (c. + e.)	35,692,560
TOTAL A: (1. or 2. Total)	35,692,560

B. Maintenance of leachates collection system:

1. Transportation	Included in 2
2. Labor	23,011,760
3. Repairs/Materials	
a. Pumps	201,188
b. Cleaning out system	1,102,800
c. Leak detection	NA
d. Other	NA
TOTAL 3: (a. + b. + c. + d.)	1,303,988
TOTAL B: (1. + 2. + 3.)	24,315,748

TOTAL for Maintaining and monitoring leachate systems:
(A. + B.) — 60,008,308

5. Maintenance and monitor the gas collection or venting system:

A. Transportation	Included in B
B. Labor	26,246,640
C. Repairs/Materials (e.g., below)	
1. Cleaning	Included in B

2. Caps	NA
3. Other	NA
TOTAL: (1. + 2. + 3.)	NA
TOTAL for Maintaining and monitoring gas control system: (A. + B. + C.)	26,246,640

6. Maintain and monitor the groundwater and/or surface water monitoring system:

A. Monitoring of groundwater systems:	
1. Number of wells/springs	5
2. Number of samples/wells	20
3. Unit cost of analysis	81,192
4. Cost of sampling + analysis (1. x 2. x 3.)	8,119,200
5. Labor cost per well	64,277
6. Labor cost (1. x 5.)	321,385
TOTAL A: (4. + 6.)	8,440,585
B. Inspection and maintenance of systems:	
1. Transportation	6,766
2. Labor	N/A
3. Repairs/Materials	N/A
a. Caps	N/A
b. Tubing	N/A
c. Pumps	N/A
d. Well replacement	N/A
e. Other	N/A
TOTAL 3: (a. + b. + c. + d. + e.)	N/A
TOTAL B: (1. + 2. + 3.)	6,766
TOTAL for Maintaining and monitoring groundwater systems:	8,447,351

TOTAL POST CLOSURE COSTS:

Annual Basis: (1st yr only) (Sum of Sections 1. thru 6.)	41,934,791
Inflation rate Utilized:	4.5%
30-Year Basis: (annual cost)(Inflation rate)(30 yrs.)	56,611,968

	Year 1	
1.	Surveying	$322,000
2.	Maintaining vegetation	$552,000
3.	Monitoring well sampling	$ 73,700
	Year 2	
1.	Maintain vegetation	$576,800
2.	Monitoring well sampling	$ 77,000
	Year 3	
1.	Maintain vegetation	$602,760
2.	Monitoring well sampling	$ 81,301
	Year 4	
1.	Maintain vegetation	$629,900
2.	Monitoring well sampling	$ 85,000
	Year 5	
1.	Maintain vegetation	$658,230
2.	Surveying	$384,000
3.	Monitoring well sampling	$ 92,800
	Year 6	
1.	Maintain vegetation	$687,850
2.	Monitoring well sampling	$ 92,800
	Year 7	
1.	Maintain vegetation	$718,800
2.	Monitoring well sampling	$ 96,980
	Year 8	
1.	Maintain vegetation	$751,100
2.	Monitoring well sampling	$101,350
	Year 9	
1.	Maintain vegetation	$784,900
2.	Monitoring well sampling	$105,900

	Year 10	
1.	Maintain vegetation	$ 820,200
2.	Monitoring well sampling	$ 110,700
	Year 11	
1.	Maintain vegetation	$ 857,100
2.	Monitoring well sampling	$ 115,680
	Year 12	
1.	Maintain vegetation	$ 895,670
2.	Monitoring well sampling	$ 120,890
	Year 13	
1.	Maintain vegetation	$ 936,000
2.	Monitoring well sampling	$ 126,330
	Year 14	
1.	Maintain vegetation	$ 978,120
2.	Monitoring well sampling	$ 132,000
	Year 15	
1.	Maintain vegetation	$1,022,140
2.	Monitoring well sampling	$ 137,900
	Year 16	
1.	Maintain vegetation	$1,116,200
2.	Monitoring well sampling	$ 144,100
	Year 17	
1.	Maintain vegetation	$1,116,200
2.	Monitoring well sampling	$ 150,600
	Year 18	
1.	Maintain vegetation	$1,166,430
2.	Monitoring well sampling	$ 157,380
	Year 19	
1.	Maintain vegetation	$1,219,900
2.	Monitoring well sampling	$ 164,460
	Year 20	
1.	Maintain vegetation	$1,273,750
2.	Monitoring well sampling	$ 171,860

	Year 21	
1.	Maintain vegetation	$1,331,070
2.	Monitoring well sampling	$ 179,600
	Year 22	
1.	Maintain vegetation	$1,391,000
2.	Monitoring well sampling	$ 187,680
	Year 23	
1.	Maintain vegetation	$1,453,560
2.	Monitoring well sampling	$ 196,120
	Year 24	
1.	Maintain vegetation	$1,519,000
2.	Monitoring well sampling	$ 204,950
	Year 25	
1.	Maintain vegetation	$1,587,320
2.	Monitoring well sampling	$ 214,170
	Year 26	
1.	Maintain vegetation	$1,658,750
2.	Monitoring well sampling	$ 223,800
	Year 27	
1.	Maintain vegetation	$1,733,400
2.	Monitoring well sampling	$ 244,400
	Year 28	
1.	Maintain vegetation	$1,811,400
2.	Monitoring well sampling	$ 244,400
	Year 29	
1.	Maintain vegetation	$1,892,900
2.	Monitoring well sampling	$ 255,400
	Year 30	
1.	Maintain vegetation	$1,978,100
2.	Monitoring well sampling	$ 266,900

Synopsis Of Rule 1200-1-7-.04(9)(a) and Hydrogeological Reports

There were two hydrogeologic reports done for IWLF IV, one being a preliminary and the other is a final report. Both of these reports were done prior to the latest rule, but meet the latest rule with the following exceptions:

(a)1. The report was done by Mr. Glenn N. Pruitt, Environmental Specialist/Geologist, Division of Solid Waste Management of TDHE. Mr. Pruitt was recently contacted to determine if he was a geologist registered in the state of Tennessee. He said at the time of the report such registration through the state of Tennessee did not exist. Since then geologist registration was established in the state of Tennessee and he had obtained that registration.

(a)3.(iii) is provided in permit drawings C2E139901.

(a)3.(vi) and (vii) can be demonstrated through Construction/Demolition Landfill VIs hydrological report. The two landfill centers differ by approximately 1300 feet. The hydrological report done by Glenn N. Pruitt does mention streams within 1500 feet. His report does not mention a designated [illegible]dius. There are no public water supply system intakes within a two mile radius.

(a)4. and 5. hydraulic conductivity was determined using Corps Of Engineers, Engineering Manual, Procedure EM 1110-2-1906.

Please note that several reports exist which are redundant in information. For example, the hydrogeological report for Construction/Demolition Landfill VI uses the IWLF IV groundwater monitoring wells showing yearly fluctuations. Another report would be the Daniel's Report.

STATE OF TENNESSEE
DEPARTMENT OF HEALTH AND ENVIRONMENT
1605 PROSSER ROAD
KNOXVILLE, TENNESSEE 37914-3434

October 22, 1987

REPORT OF GEOLOGIC INVESTIGATION

Subject: Anderson County, U.S. Department of Energy (DOE), Y-12 Plant-FINAL GEOLOGIC EVALUATION of a proposed landfill site for the disposal of "classified" waste (temporary ID, NRS 01-103-0124).

Dates: The field portion of this investigation was conducted over the period, February 23 to March 9, 1987. Geotek Engineering Company provided the drilling and testing services in behalf of the Y-12 plant. Various representatives of Martin Marietta Energy systems, the operator of Y-12, were present at different times during the investigation.

Location and Property Description: Quadrangle 130-NE, Bethel Valley. The site is located on Chestnut Ridge near the southwest end of the Y-12 plant area of the DOE Oak Ridge Reservation. The site, which is owned by DOE, consists of about 13 acres.

Previous Investigation: A preliminary geologic evaluation of this site was conducted on October 15, 1986, by the Division of Solid Waste Management (DSWM), the results of which are presented in the Report of Geologic Investigation, December 15, 1986, by G. N. Pruitt. This report concludes that the site "...appear(s) to have sufficient potential for landfill use...", and the factors supporting this conclusion are given as (1) deep soils, (2) moderate to low slopes, (3) the absence of streams and springs, and (4) the absence of sinks and depressions. The report also noted that "No particular adverse features were observed..."

The aforesaid report has described the topography, geology, hydrology, etc., of the site and only such descriptions as are necessary for clarity or further definition will be restated or expanded upon herein.

One deep groundwater observation well, GW-135, is located near the east end of the site.

Investigative Procedures and Results: This investigation has included both exploratory soil borings and more extensive visual inspections of the site. Auger holes were drilled at five (5) designated locations in order to determine the general soil conditions over the site and to ascertain if groundwater occurs within the limits of the drill penetrations. Drill hole logs are attached.

One hole, B-1, refused at 46 feet on rock and four other holes were drilled to a depth of 50 feet each with no refusal. Hole number B-2A initially refused at 25 feet, apparently on a chert boulder, and was relocated a short distance to the southeast and drilled to 50 feet without refusal. The relocated hole is designated B-2B.

All the holes appeared to be dry upon completion, however, hole B-3 had water at 43 feet after standing open for three days. The other holes remained dry. The water in B-3 is presumed to have originated from a perched source of little areal extent very near to the location of the hole. Groundwater in the bedrock aquifer beneath this site is indicated to be quite deep, about 160 feet in the aforesaid observation well, according to Y-12 monitoring records.

The soil borings were drilled with 6- inch hollow-stem augers, and continuous sampling was done with either split-spoon or Shelby tube samplers for every 2-foot interval in each hole. The Shelby tubes were used for taking "undisturbed" samples. The soil tests conducted (by Geotek) were for moisture content, liquid limit, plasticity index, and hydraulic conductivity. A table summarizing the test results is attached. Hydraulic conductivity of the soil here is indicated to be low, ranging from 3.04×10^{-8} to 7.42×10^{-7} centimeters per second for the undisturbed samples. However, hole B-1 encountered a 2-foot interval of very sandy material at 42 to 44 feet, and a field permeability test was performed over that interval utilizing a "well" installation designed for that purpose. The hydraulic conductivity reported for the 42 to 44 foot interval of B-1 is 2.1×10^{-3} cm/sec.; however, this zone will be isolated by its depth and an intervening thick buffer of much less permeable clay soils.

One very shallow depression of small areal extent was found near the west boundary of the site along the ridge crest. Relief in this depression appeared to be no more than about 3 feet. Hole B-4 was drilled nearby to a depth of 50 feet without refusal. This depression appears to be inactive and is of no significance regarding the proposed use of the site.

Groundwater flow direction beneath this site may be both northwestward and southeastward with the ridge acting as a divide. However, groundwater movement to the northwest will depend on the degree of hydraulic interconnection between the Copper Ridge dolomite and the underlying Maynardville limestone. Also, there may be groundwater flow parallel to regional strike (northeast - southwest) in this area, the flow direction being controlled by both stratigraphic and structural features with lesser influence from topographic factors.

Conclusions and Recommendations: This site is geologically suitable for landfill use according to the following factors:

1. The thick mantle of silty, clayey residual soil which covers the site.

2. The general absence of a shallow bedrock surface as indicated by the drilling.

3. The absence of shallow groundwater beneath the site.

4. The low to moderate slopes over the site.

The use of this site for landfill disposal is subject to the following restrictions and conditions:

1. Only non-putrescible, non-radioactive solid waste may be disposed of here. No hazardous waste, as defined by the Regulations Governing Hazardous Waste Disposal in Tennessee, may be disposed of at this site.

2. The areas approved for landfilling are indicated on an attached map according to depth of excavation and elevation restrictions as follows:

   A. On that part of the site above the elevation of 1180 feet (MSL datum), excavations shall not exceed thirty-five (35) feet in depth below the existing natural land surface, and these excavations may not extend below the elevation of 1160 feet.

   B. On that part of the site between elevations 1180 and 1140 feet, excavations shall not exceed twenty-five (25) feet in depth below the existing natural land surface, and these excavations may not extend below the elevation of 1140 feet.

   C. No excavations for landfilling will be allowed below the elevation of 1140 feet.

3. The landfill must be designed and operated so as to preclude abnormal run-off and erosional problems. Sediment ponds and diversion structures or other suitable means must be utilized as necessary to prevent the siltation of area streams.

4. If bedrock is exposed in landfill excavations, it must be re-covered with at least four (4) feet of compacted clay soil. Any such exposures, as well as any other unusual rock or soil conditions, water seeps, etc., must be immediately reported to this office.

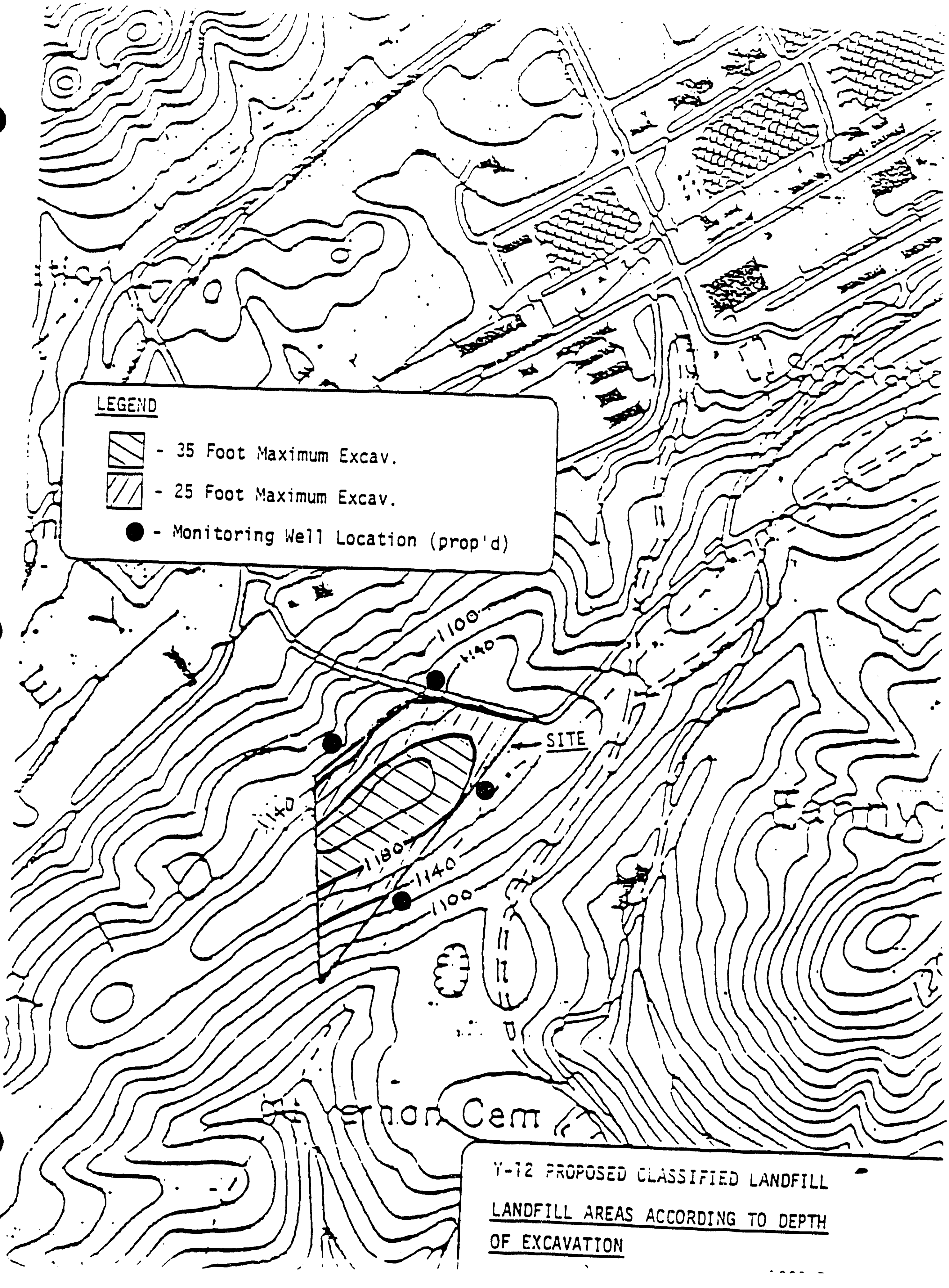
5. Groundwater monitoring is required if this site is to be utilized for landfilling. The tentative locations for four (4) monitoring wells are indicated on an attached map. A list of monitoring parameters and a sampling schedule are also attached.

The aforesaid restrictions and the monitoring program are subject to change as required by the Division of Solid Waste Management. Future site conditions, operating problems, or changes in waste characterisitics may also mandate restriction or monitoring changes.

Glenn N. Pruitt
Environmental Specialist/Geologist
Division of Solid Waste Management

GNP:pjl DSW3


BETHEL VALLEY QUADRANGLE
TENNESSEE
7.5 MINUTE SERIES (TOPOGRAPHIC) 130-NE
1100
1100
1100
SITE
Depression
1200
1000
1000
1000
1000
• - Auger Holes
Anderson County - Y-12 PLANT (DOE)
PROPOSED LANDFILL SITE FOR CLASSIFIED WASTE
0 500 1000 2000 3000 Feet
SCALE



Y-12 PROPOSED CLASSIFIED LANDFILL

LANDFILL AREAS ACCORDING TO DEPTH OF EXCAVATION

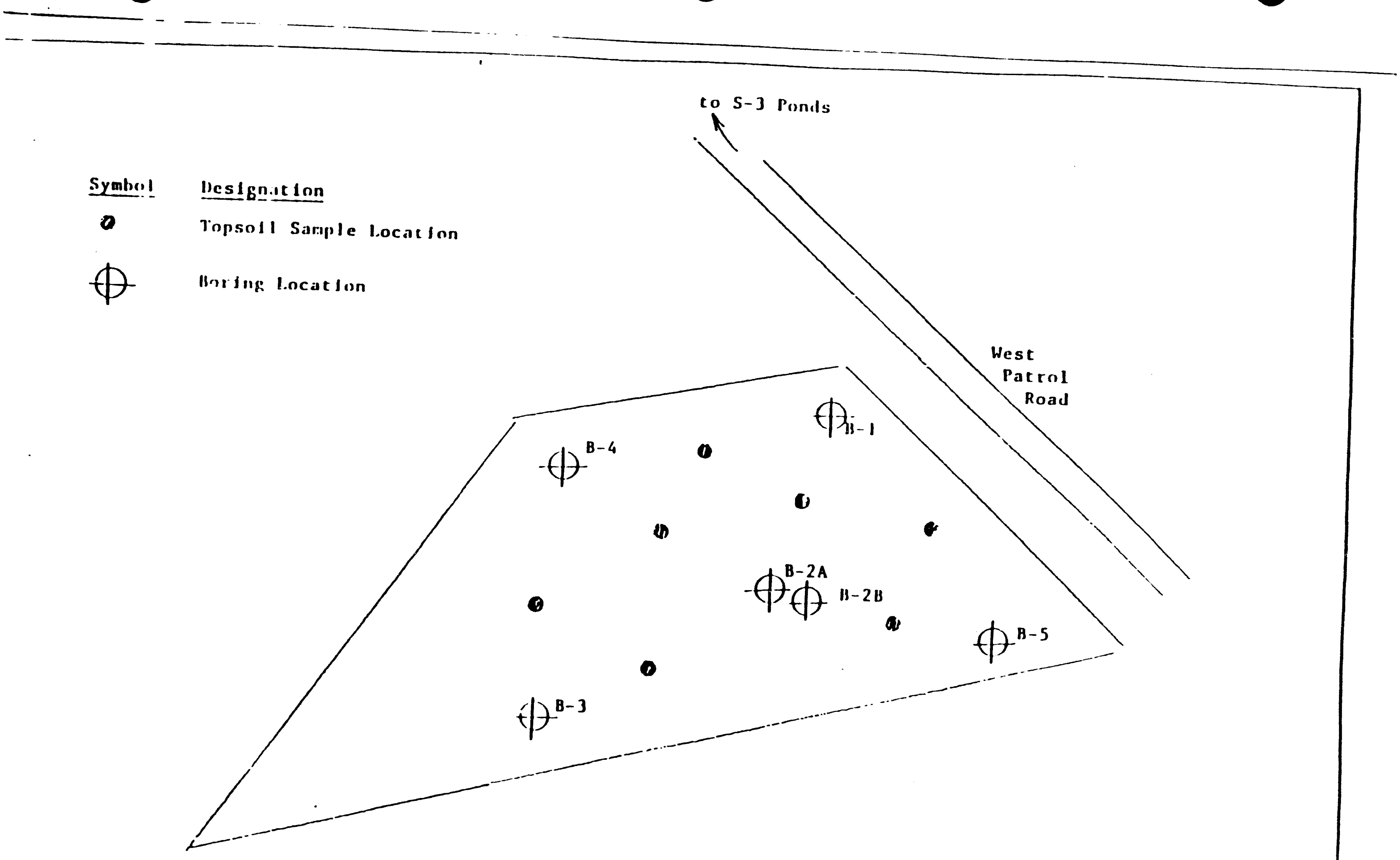
Chestnut Ridge Landfill @ Y-12
April 1, 1987

TABLE B-2: PERMEABILITY TEST DATA

Boring	Depth (ft)	Natural Water Content (%)	Wet Unit Weight (pcf)	Liquid Limit	Plasticity Index	Hydraulic Conductivity (cm/s)	Comments
1	20.0-22.0	29.3	124.6	51.6	23.1	5.80 x 10 EE-8	Undisturbed
1	40.0-42.0	27.4	120.9	71.3	52.2	2.35 x 10 EE-8	Remolded*
1	40.0-42.0	33.4	123.1	64.5	33.5	3.04 x 10 EE-8	Undisturbed
2A	20.0-22.0	25.3	130.3	54.8	25.9	7.42 x 10 EE-7	Undisturbed
2B	10.0-12.0	17.0	130.8	41.0	18.8	3.37 x 10 EE-8	Remolded*
2B	28.0-30.0	23.5	136.7	56.7	31.1	4.26 x 10 EE-8	Undisturbed
2B	38.0-40.0	29.2	133.4	56.2	32.0	1.30 x 10 EE-7	Undisturbed
2B	48.0-50.0	22.6	132.1	43.1	20.3	4.68 x 10 EE-8	Undisturbed
3	10.0-12.0	24.8	121.2	47.0	17.3	3.03 x 10 EE-6	Undisturbed
3	30.0-32.0	28.7	125.4	52.9	28.5	3.52 x 10 EE-8	Undisturbed
3	40.0-42.0	30.5	124.2	67.2	35.8	3.21 x 10 EE-7	Undisturbed
3	40.0-42.0	30.5	122.0	56.7	32.0	6.05 x 10 EE-8	Remolded*
4	10.0-12.0	23.3	120.3	51.5	21.5	3.60 x 10 EE-7	Undisturbed
4	18.0-20.0	27.3	120.2	58.6	29.3	1.52 x 10 EE-7	Undisturbed
4	28.0-30.0	35.9	124.9	63.3	35.2	3.86 x 10 EE-8	Undisturbed
4	38.0-40.0	23.8	122.1	57.7	29.2	3.80 x 10 EE-7	Undisturbed
4	42.0-44.0	28.1	126.0	64.1	35.8	2.20 x 10 EE-8	Remolded*
4	48.0-50.0	37.7	124.8	56.8	29.9	3.61 x 10 EE-7	Undisturbed
5	8.0-10.0	26.7	117.4	54.2	18.6	4.61 x 10 EE-7	Undisturbed
5	18.0-20.0	30.1	120.9	59.5	18.8	6.82 x 10 EE-7	Undisturbed
5	20.0-27.0	27.8	129.8	62.9	34.0	2.29 x 10 EE-8	Remolded*
5	28.0-30.0	22.2	121.9	60.1	22.6	7.91 x 10 EE-7	Undisturbed
5	38.0-40.0	23.9	118.3	64.0	33.1	3.83 x 10 EE-7	Undisturbed
5	48.0-50.0	29.8	117.0	65.8	37.0	4.40 x 10 EE-7	Undisturbed

*Sample remolded and compacted to 95% of standard Proctor (ASTM D698) Maximum Dry Density.

Note: All tests run @ greater than 98% saturation.



GEOTEK ENGINEERING COMPANY

Date: 3-26-87

Project: Chestnut Ridge Landfill @ Y-12

Scale:

APPROXIMATE BORING LOCATIONS

Y/SUB/86B-47970V

SOIL SAMPLING AND TESTING

PROPOSED

INDUSTRIAL WASTE LANDFILL IV

Y-12 PLANT

MAY 1987

Waste Transportation, Storage and
Disposal Department
Health, Safety, Environment and
Accountability Division

Document Prepared
by
Geotek Engineering Company
8321 Oak Ridge Highway
Knoxville, Tennessee 37931
Energy Systems Order No. UCC 86B-47970
Geotek Project No. 83-1370

for

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
Under Contract No. DE-AC05-84OR21400

Date of Issue: May 1987 Y/SUB/86B-47970V

SOIL SAMPLING AND TESTING

PROPOSED

INDUSTRIAL WASTE LANDFILL IV

Y-12 PLANT

This document was prepared by
Geotek Engineering Company
under subcontract to
Martin Marietta Energy Systems, Inc.

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
Under Contract No. DE-AC05-84OR21400

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GEOTEK
ENGINEERING COMPANY

April 1, 1987

Martin Marietta Energy Systems
Nuclear Division
P.O. Box M
Oak Ridge, Tennessee 37830

ATTN: Mr. A.F. Johnson

SUBJ: Proposed Chestnut Ridge Landfill @ Y-12
MMES Order No. UCC 86B-47970 Rel. No.
Geotek Project No. 83-1370

Dear Mr. Johnson:

We are pleased to submit our report documenting the soil drilling/sampling and laboratory testing services for the above-referenced project. Details of the project were coordinated with Mr. George Gillis of Martin Marietta Energy Systems.

We appreciate this opportunity to serve you and trust that the information provided in this report will satisfy your immediate requirements. Should you have any questions, or if we may be of further assistance in any way, please do not hesitate to contact us.

Yours very truly,

GEOTEK ENGINEERING COMPANY, INC.

Rami J. Mishu, P.E.
Principal Engineer
Knoxville Office

RJM/kb

2720 NOLENSVILLE ROAD
NASHVILLE, TENNESSEE 37211
(615) 256-6891

8321 OAK RIDGE HIGHWAY
KNOXVILLE, TENNESSEE 37931
(615) 690-0128

GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CHESTNUT RIDGE LANDFILL @ Y-12

INTRODUCTION

This report presents the results of our geotechnical drilling and testing services for a proposed landfill project on Chestnut Ridge at the DOE Y-12 facility in Oak Ridge, Tennessee. The project site layout is shown in Figure 1. The complete scope of these geotechnical services provided for this project is comprised of the following:

1. Drill several borings and obtain soil samples at continuous depth,
2. Obtain near-surface soil samples at various locations,
3. Conduct field permeability testing at selected borings,
4. Performing soil mechanics laboratory tests of samples obtained from the site, and
5. Submit a report documenting the field and laboratory test data.

FIELD INVESTIGATION

The field phase of work was conducted on between February 24 and March 9, 1987. A total of 6 borings were drilled at the site in the locations selected by Martin Marietta Energy Systems as shown in Figure 1 (Note: Boring No. 2B was drilled after Boring No. 2A encountered refusal at a relatively shallow depth). All borings were drilled into the soil with a Mobile B-61 truck-mounted drill rig using 6-in. continuous flight hollow-stem power augers in accordance with ASTM Specification D1452.

Continuous Standard Penetration Testing (SPT) was performed by driving a 1.4-in. I.D., 2-in. O.D. split-barrel sampler into the undisturbed soil by means of a 140-lb weight falling 30 in. The penetration resistance (N-value) in terms of blows per foot of penetration was logged. Samples of soil recovered in the penetration spoon were placed in air-tight containers and transported to Geotek's laboratory for and testing. Relatively undisturbed samples were obtained at various depths in the borings. The undisturbed soil samples were secured by 3-in. thin-wall Shelby tube samplers (ASTM Specification D1587). The tubes were then identified, sealed air-tight from both ends, and transported to the laboratory for general soil testing. Bulk samples of auger cuttings at various depth intervals were also obtained for testing representative soil samples. Near-surface soil and topsoil samples were obtained from several locations as shown in Figure 1. These samples were delivered to Martin Marietta Energy Systems personnel.

For purposes of field permeability testing, Boring No. 1 was converted to a temporary well after drilling was completed. PVC pipe with 2-in. diameter and 5-ft bottom perforated section was inserted and the perforations surrounded with the appropriate sand filter. Above the sand filter, an 18-in. bentonite clay seal was placed and the remaining annular space grouted to the surface. The well log is provided in Appendix A. Subsequent field permeability testing was performed using clean water injection under constant head pressure as per U.S. Earth Manual (E-19) procedures. After testing was completed, the well was backfilled with a soil/cement/bentonite mixture, casing cut below the ground surface, and the well covered with soil at the surface.

Final boring logs are included in Appendix A of this report. Field drilling logs, laboratory data and visual examination of samples by an engineer in our lab were used in preparation of these final logs. As soil conditions change with depth, the change is noted on the log at the approximate depth. The new description then applies for succeeding samples with depth.

LABORATORY TESTING

Laboratory tests were performed on selected soil samples estimated to be most representative of in-situ conditions. Most test procedures used were in accordance with specifications of the American Society of Testing and Materials (ASTM) and are described briefly herein. Permeability testing utilized Corps of Engineers procedures. All test data are included in the referenced tables and figures found in Appendix B of this report.

Atterberg limits tests were performed to determine the plasticity characteristics of the soil (ASTM Specification D4318). Results of the tests are shown in Table B-1 along with the natural moisture contents (ASTM Specification D2216). The Atterberg Limits are primarily classification tools, but when considered in conjunction with natural moisture contents, provide an indirect evaluation of soil consistency, permeability, and volume-change potential.

The soil particle size distribution was determined by a combination of a sieve analysis with wet washing of the soil and a hydrometer analysis of the soil fines (ASTM Specification D422 and D2217). The resulting soil gradations are plotted in Figures B-1 to B-11. Please note the gravel and coarse sand-size particles reflect the presence of chert fragments.

Laboratory hydraulic conductivity testing was performed utilizing Corps of Engineers Engineering Manual procedures (EM 1110-2-1906). All soil samples were inundated to at least 98 percent saturation before subjecting to flow at

10 to 20 psi constant head differential. Remolded samples were tested at 95% of the standard Proctor maximum dry density (ASTM D698). All test results are provided in Table B-2.

For purposes of permeability testing of re-molded specimens and also to evaluate the moisture-density compaction characteristics of the soils, the maximum dry densities and optimum moisture contents were determined for soil samples taken from various levels in each soil boring. Compaction tests were performed using standard Proctor procedures in accordance with ASTM Specification D698. Results of these tests are plotted in Figures B-12 to B-16 and summarized in Table B-3.

SUBSURFACE CONDITIONS

The subsurface profile described herein is based upon data obtained from the project borings drilled at the locations shown in Figure 1. Detailed sample descriptions are provided in Table B-1 and the boring logs (Appendix A).

The project site is moderately sloping and contains a ground cover of grass and shrubs with a few patches of small trees. The surficial layer encountered across most of this site is 6 to 10 inch topsoil stratum, however this material was removed from the actual boring location due to the necessary dozing operations.

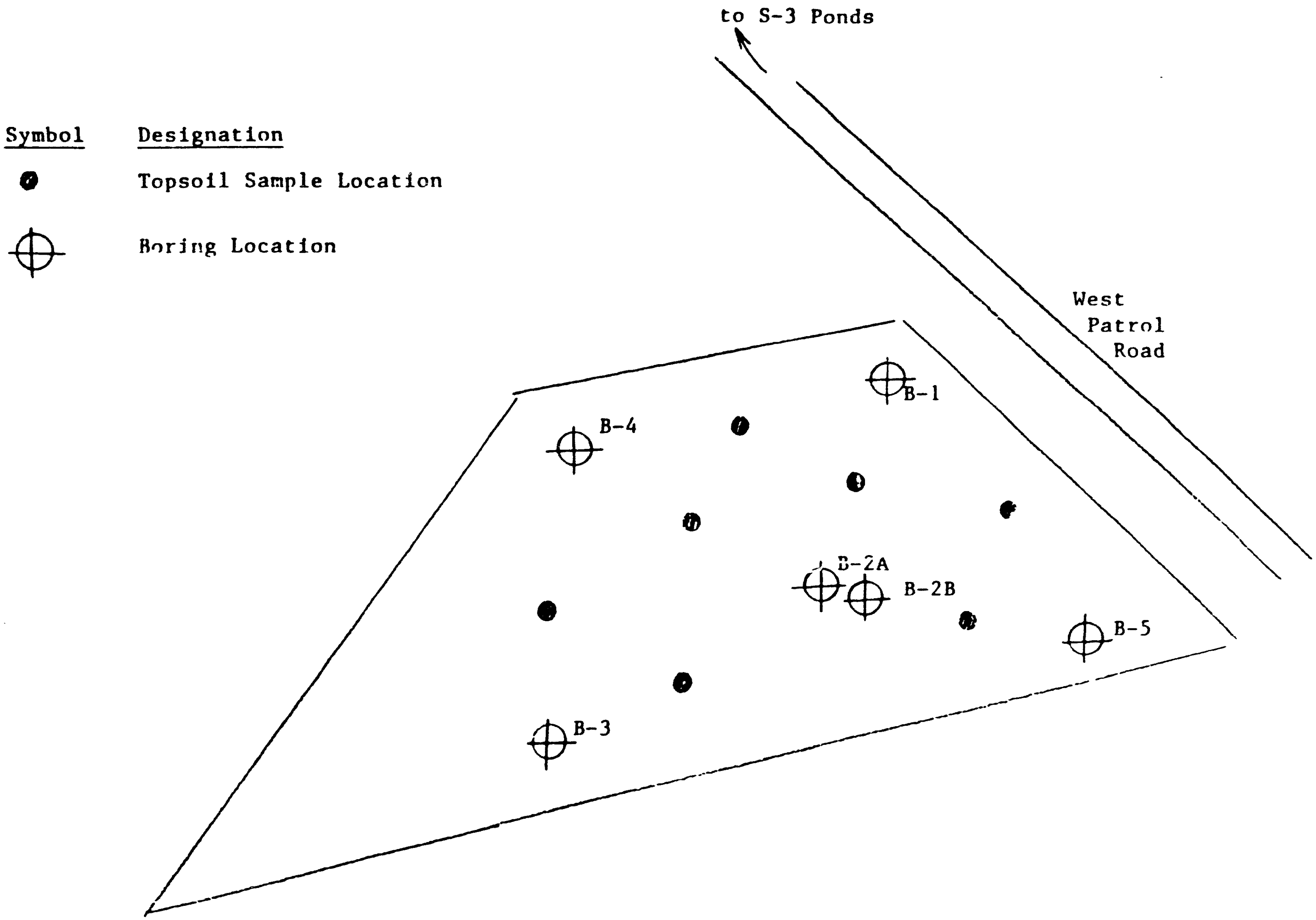
Below the surface layer, the soils are typically silty clays and clays with varying concentrations of chert fragments and occasional silt and sand seams. A general laboratory testing program was performed on these soils. Detailed test results are provided in Appendix B, and are also summarized on the following page for most samples.

Soil Classification: CLAY & SILTY CLAY (CH, MH, CL, ML)
Moisture Content: 18% to 35%
Liquid Limit: 37 to 68
Plasticity Index: 17 to 34
Standard Proctor Max. Dry Density: 95 to 105 pcf
Hydraulic Conductivity: 2.2 x 10 EE-8 to 7.4 x 10 EE-7

The one significant exception to the above-listed subsurface summary is the presence of a 2-ft thick silty sand seam was encountered at the 40 to 42 ft depth range in Boring No. 1. The field permeability test was selected for this boring with screen depth covering this sand zone. The resulting measured hydraulic conductivity under uniform flow condition was 2.1 x 10 EE-3 cm/sec.

Auger refusal was encountered in one of the borings (No. 2A) as shown in the boring log. An adjacent boring (No. 2B) was extended to a full depth of (50 ft). None of the other project borings encountered auger refusal, although very difficult and slow drilling was experienced through the more cherty zones typically found in the upper 10 to 20 ft of the subsurface.

Soil borings were dry-augered to full depth in an attempt to establish aerial ground-water conditions. Free water was not encountered in any of the borings.



GEOTEK ENGINEERING COMPANY

Date: 3-26-87

Project: Chestnut Ridge Landfill @ Y-12

Scale: NTS

APPROXIMATE BORING LOCATIONS

Drawing No. 1

APPENDIX A

BORING LOGS

GEOTEK
ENGINEERING COMPANY

8321 OAK RIDGE HIGHWAY
KNOXVILLE, TENNESSEE 379'
OFFICE (615) 690-0128

MONITOR WELL INSTALLATION DATA

Date Completed: March 4, 1987 Drillers: Hensley & Sisson

Monitor Well No. 1 Geologist/Engineer: F. Mishu

Drilling Method: Hollow Stem Augering

Drilling Fluid: None Geotek Project No. 83-1370

Monitor Well Screen: 2-in. I.D., Sch. 40 PVC, 0.010-in. slotted

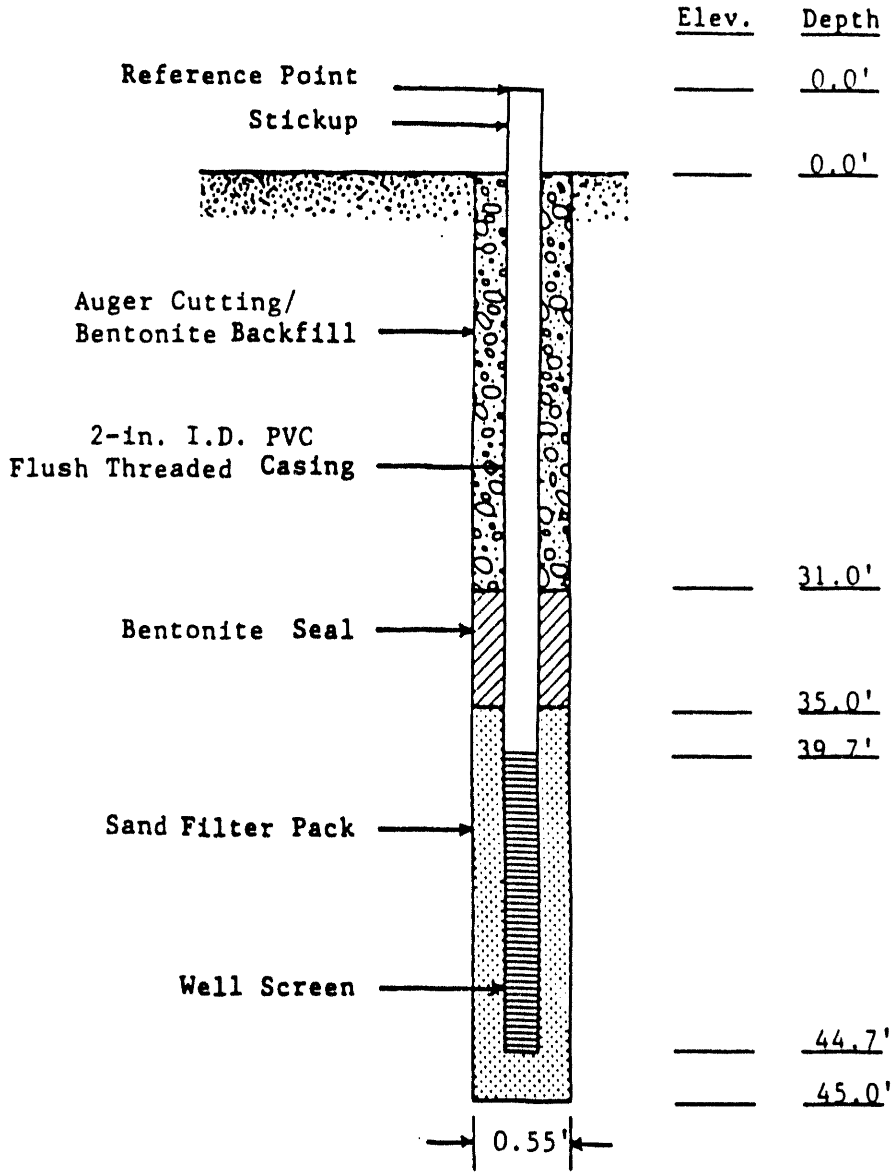
Method of Development: None Project: MMES Landfill # 4 @ Y-12

STRATIGRAPHY

Soil/Rock	Depth
Red Clay	0 - 40
Sand	40 - 42
Red Clay	42 - 46

WATER LEVEL READINGS

Date	Depth Below Reference Point	Elev.
2-4-87	Dry	



Comments:

Hole caved-in after removal of Hollow Stem Augers. Re-drilled hole an installed well through Hollow Stem Augers. Field permeability testing performed.

GEOTEK ENGINEERING COMPANY

8321 OAK RIDGE HIGHWAY
KNOXVILLE, TENNESSEE 37931
(615) 690-0128

Log Of Boring

Job No 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 1 Date 3-25-87 Sheet 1 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 2-24-87 Boring completed 2-24-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	2-24-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD %	Sample Type*	Sample No.	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	102.0	2		0		CLAY, reddish tan w/some silt & chert fragments
								4				
								4	8	1		
								5				
						N	102.0	15		2		
								17				
								22	39	3		
								26				
						N	104.0	7		4		
								8				
								14	22	5		
								41				
						N	106.0	5		6		
								13				
								14	27	7		
								22				
						N	108.0	17		8		
								16				
								28	44	9		
								21				
						S	110.0			10		SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
										11		
						N	112.0	10		12		CLAY, reddish tan w/some silt & chert fragments
								13				
								15	28	13		
								20				
						N	114.0	9		14		
								13				
								20	33	15		
								32				
						N	116.0	13		16		-little chert
								10				
								16	26	17		
								20				
						N	118.0	5		18		
								8				
								21	29	19		
								36		20		

* N = Standard Penetration S = Shelby Tube

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 1 Date 3-25-87 Sheet 2 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 2-24-87 Boring completed 2-24-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	2-24-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min.	% Drill Water Return	RQD %	Sample Type	Sample No.	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						S	120.0			20		SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
										21		
						N	122.0	4		22		CLAY, reddish tan w/some silt & chert fragments
								8				
								21	29	23		
								21				
						N	124.0	8		24		-little chert
								16				
								11	27	25		
								15				
						N	126.0	10		26		
								12				
								10	22	27		
								15				
						N	128.0	9		28		
								7				
								11	18	29		
								20				
						S	130.0			30		SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
										31		
						N	132.0	6		32		CLAY, reddish tan w/some silt & chert fragments
								8				
								9	17	33		
								11				
						N	134.0	15		34		-little chert
								12				
								12	24	35		
								12				
						N	136.0	7		36		
								8				
								10	18	37		
								14				
						N	138.0	8		38		
								10				
								11	21	39		
								12				
										40		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 1 Date 3-25-87 Sheet 3 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 2-24-87 Boring completed 2-24-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	2-24-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD%	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						S	140.0			40		SILTY SAND, brown w/silty clay
										41		
						N	142.0	19		42		
								17				
								27	44	43		
								20				
						N	144.0	29		44		CLAY, reddish tan w/some silt & chert fragments
								39				
								50/3	89+	45		
										46		Auger Refusal @ 46.0' End of Boring
										47		
										48		
										49		
										50		
										51		
										52		
										53		
										54		
										55		
										56		
										57		
										58		
										59		
										60		

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Log Of Boring

Job No 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 2A Date 3-25-87 Sheet 1 of 2
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 2-26-87 Boring completed 2-26-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	2-26-87

Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD %	Sample Type	Sample No	Blows per 6" Drive	N-Value	Depth in Feet	Graph	Description of soil or rock & notes on drilling operation
						N	200.0	6		0		SILTY CLAY, reddish tan w/chert fragments
								5				
								8	13	1		
								14				
						N	202.0	32		2		
								38				
								38	76	3		
								46				
						N	204.0	10		4		
								26				
								28	54	5		
								38				
						N	206.0	17		6		
								22				
								24	46	7		
								29				
						N	208.0	19		8		
								32				
								32	64	9		
								38				
						S	210.0			10		
										11		
						N	212.0	27		12		
								27				
								36	63	13		
								44				
						N	214.0	17		14		
								27				
								26	48	15		
								34				
						N	216.0	15		16		
								21				
								20	41	17		
								29				
						N	218.0	13		18		
								17				
								15	32	19		
								22		20		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 2A Date 3-25-87 Sheet 2 of 2
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 2-26-87 Boring completed 2-26-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	2-26-87

Length cored Ft	Recovery Ft	% Recovery	Drilling Time min.	% Drill Water Return	R Q D %	Sample Type*	Sample No.	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						S	220.0			20		SLIGHTLY SILTY CLAY, tannish red w/chert fragments
										21		
						N	222.0	15		22		
								19		23		-reddish brown
								26	45			
								28		24		
						N	224.0	15				
								50/5	50+	25		Auger Refusal @ 25.0' End of Boring
										26		
										27		
										28		
										29		
										30		
										31		
										32		
										33		
										34		
										35		
										36		
										37		
										38		
										39		
										40		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 2B Date 3-25-87 Sheet 1 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-6-87 Boring completed 3-6-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-6-87

Rock Data: Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD %	Soil Data: Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	200.0	4		0		SILTY CLAY, brown w/some topsoil & chert fragments
								5				
								6	11	1		
								8				
						N	202.0	5		2		
								6				
								8	14	3		
								9				
						N	204.0	5		4		
								6				-reddish brown w/o topsoil
								11	17	5		
								13				
						N	206.0	25		6		
								22				
								28	50	7		
								32				
						N	208.0	6		8		SLIGHTLY SILTY CLAY, tannish red w/chert fragments
								28				
								21	49	9		
								29				
						S	210.0			10		SILTY CLAY, tannish red w/chert fragments
										11		
						N	212.0	12		12		-tannish brown
								10				
								16	26	13		
								20				
						N	214.0	14		14		SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
								15				
								15	30	15		
								15				
						N	216.0	10		16		
								16				
								26	42	17		
								28				
						S	218.0			18		SILTY CLAY, reddish brown w/chert fragments
										19		
										20		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 2B Date 3-25-87 Sheet 2 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ___ Size ___ Drilling mud used ___
Boring begun 3-6-87 Boring completed 3-6-87
Ground Elevation ___ referred to ___ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-6-87

Rock Data: Length cored Ft	Recovery Ft	% Recovery	Drilling Time min.	% Drill Water Return	RQD %	Soil Data: Sample Type*	Sample No.	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	220.0	4		20		SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
								6		21		
								12	18			
								16				
						N	222.0	11		22		-tannish brown
								16				
								19	35	23		
								20				
						N	224.0	7		24		-brown
								10				
								11	21	25		
								13				
						N	226.0	8		26		SLIGHTLY SILTY CLAY, brownish red w/chert fragments
								12				
								12	24	27		
								16				
						S	228.0			28		SILTY CLAY, brownish red w/chert fragments
										29		
						N	230.0	9		30		SLIGHTLY SILTY CLAY, brownish red w/chert fragments
								11		31		
								11	22			
								14				
						N	232.0	11		32		-tannish brown
								11				
								15	26	33		
								17				
						N	234.0	8		34		CLAY, brownish red w/some silt & chert fragments
								9		35		
								12	21			
								16				
						N	236.0	11		36		SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
								11		37		
								14	25			
								18				
						S	238.0			38		
										39		
										40		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 2B Date 3-25-87 Sheet 3 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-6-87 Boring completed 3-6-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-6-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	R Q D %	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	240.0	8		40		SLIGHTLY SILTY CLAY, brown w/chert fragments
								11		41		
								15	26			
								17				
						N	242.0	7		42		-tannish brown
								10		43		
								14	24			
								19				
						N	244.0	9		44		
								10		45		
								11	21			
								14				
						N	246.0	8		46		
								12		47		
								17	29			
								20				
						N	248.0			48		SILTY CLAY, tannish brown w/chert fragments
										49		
										50		End of Boring @ 50.0'
										51		
										52		
										53		
										54		
										55		
										56		
										57		
										58		
										59		
										60		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 3 Date 3-25-87 Sheet 1 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-2-87 Boring completed 3-2-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-2-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD %	Sample Type*	Sample No.	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	300.0	5		0		SILTY CLAY, reddish tan w/chert fragments
								5				
								8	13	1		
								13				
						N	302.0	15		2		
								17				
								19	36	3		
								22				
						N	304.0	11		4		
								14				
								16	30	5		
								22				
						N	306.0	7		6		
								14				
								14	28	7		
								14				
						N	308.0	12		8		
								14				
								18	42	9		
								24				
						S	310.0			10		
										11		
						N	312.0	33		12		SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
								31				
								23	54	13		
								38				
						N	314.0	39		14		
								28				
								33	61	15		
								40				
						N	316.0	17		16		
								20				
								21	41	17		
								28				
						N	318.0	9		18		CLAY, reddish tan w/some silt & chert
								10				
								14	24	19		
								15		20		

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Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 3 Date 3-25-87 Sheet 2 of 2
Type of Boring 6" Auger Rig Mobile B-61
Casing used ______ Size ______ Drilling mud used ______
Boring begun 3-2-87 Boring completed 3-2-87
Ground Elevation ______ referred to ______ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-2-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min.	% Drill Water Return	R Q D %	Sample Type*	Sample No.	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						S	320.0			20		CLAY, reddish tan w/some silt & chert fragments
										21		
						N	322.0	13		22		
								14				
								21	35	23		
								33				
						N	324.0	12		24		
								14				
								28	42	25		
								32				
						N	326.0	19		26		SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
								19		27		
								22	41			
								28				
						N	328.0	16		28		
								14				
								22	36	29		
								28				
						S	330.0			30		
										31		
						N	332.0	13		32		
								12				
								16	28	33		
								20				
						N	334.0	12		34		
								12				
								13	25	35		
								18				
						N	336.0	10		36		
								11				
								14	25	37		
								18				
						N	338.0	14		38		CLAY, reddish tan w/some silt & chert fragments
								13				
								13	26	39		
								15		40		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-2-87

Boring No. 3 Date 3-25-87 Sheet 3 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-2-87 Boring completed 3-2-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD%	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						S	340.0			40		CLAY, reddish tan w/some silt & chert fragments
										41		
						N	342.0	9		42		
								14				
								15	29	43		
								18				
						N	344.0	9		44		
								10				
								12	22	45		
								18				
						N	346.0	12		46		
								15				
								16	31	47		
								18				
						S	348.0			48		
										49		
										50		End of Boring @ 50.0'
										51		
										52		
										53		
										54		
										55		
										56		
										57		
										58		
										59		
										60		

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Log Of Boring

Job No 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 4 Date 3-25-87 Sheet 1 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-4-87 Boring completed 3-4-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-4-87

Rock Data: Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	R Q D %	Soil Data: Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	400.0	4		0		SILTY CLAY, reddish brown w/ chert fragments
								4				
								5	9	1		
								10				
						N	402.0	12		2		
								13				
								15	28	3		
								19				
						N	404.0	8		4		SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
								13				
								16	29	5		
								25				
						N	406.0	4		6		SILTY CLAY, reddish brown w/chert fragments
								9				
								10	19	7		
								18				
						N	408.0	12		8		SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
								17				
								21	38	9		
								24				
						S	410.0			10		SILTY CLAY, tannish red w/chert fragments
										11		
						N	412.0	13		12		
								17				
								21	38	13		
								18				
						N	414.0	11		14		SLIGHLTY SILTY CLAY, tannish red w/chert fragments
								12				
								16	28	15		
								20				
						N	416.0	14		16		
								13				
								13	26	17		
								13				
						S	418.0			18		
										19		
										20		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 4 Date 3-25-87 Sheet 2 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-4-87 Boring completed 3-4-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-4-87

Length cored Ft	Recovery Ft	% Recovery	Drilling Time min.	% Drill Water Return	R O D %	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	420.0	7		20		SLIGHTLY SILTY CLAY, tannish red w/chert fragments
								12				
								16	28	21		
								16				
						N	422.0	7		22		
								11				
								13	24	23		
								16				
						N	424.0	8		24		CLAY, reddish brown w/some silt & chert fragments
								11				
								13	24	25		
								20				
						N	426.0	7		26		
								8				
								12	20	27		
								16				
						S	428.0			28		
										29		
						N	430.0	5		30		
								10				
								11	21	31		
								16				
						N	432.0	8		32		SLIGHTLY SILTY CLAY, tannish red w/chert fragments
								12				
								14	26	33		
								18				
						N	434.0	10		34		
								11				
								13	24	35		
								16				
						N	436.0	7		36		
								8				
								9	17	37		
								12				
						S	438.0			38		CLAY, tannish red & brown w/some silt & chert fragments
										39		
										40		

* N = Standard Penetration S = Shelby Tube

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KNOXVILLE, TENNESSEE 37931
(615) 690-0128

Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 4 Date 3-25-87 Sheet 3 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-4-87 Boring completed 3-4-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-4-87

Rock Data: Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	R Q D %	Soil Data: Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	440.0	6		40		CLAY, tannish red & brown w/some silt & chert fragments
								7				
								9	16	41		
								10				
						N	442.0	5		42		
								8		43		
								10	18			
								12				
						N	440.0	8		44		
								10		45		
								10	20			
								13				
						N	446.0	7		46		-reddish brown
								8		47		
								9	17			
								11				
						S	448.0			48		-reddish tan
										49		
										50		End of Boring @ 50.0'
										51		
										52		
										53		
										54		
										55		
										56		
										57		
										58		
										59		
										60		

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Log Of Boring

Job No 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 5 Date 3-25-87 Sheet 1 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-9-87 Boring completed 3-9-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-9-87

Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	R Q D %	Type*	No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	500.0	4		0		SILTY CLAY, tannish red w/chert fragments
								4				
								5	9	1		
								6				
						N	502.0	7		2		
								6				
								6	12	3		
								8				
						N	504.0	8		4		
								9				
								9	18	5		
								11				
						N	506.0	6		6		SLIGHTLY SILTY CLAY, tannish red w/chert fragments
								11				
								16	27	7		
								18				
						S	508.0			8		
										9		
						N	510.0	11		10		
								12				
								12	24	11		
								14				
						N	512.0	8		12		-reddish tan
								13				
								20	33	13		
								24				
						N	514.0	9		14		
								12				
								13	25	15		
								16				
						N	516.0	12		16		
								14				
								16	30	17		
								18				
						S	518.0			18		CLAY, reddish tan w/some silt & chert fragments
										19		
										20		

* N = Standard Penetration S = Shelby Tube

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 5 Date 3-25-87 Sheet 2 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-9-87 Boring completed 3-9-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-9-87

Rock Data						Soil Data						
Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD%	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	520.0	12		20		CLAY, reddish tan w/some silt & chert fragments
								17				
								17	34	21		
								19				
						N	522.0	15		22		
								16				
								17	33	23		
								20				
						N	524.0	14		24		
								14				
								16	30	25		
								18				
						N	526.0	10		26		
								12				
								13	25	27		
								16				
						S	528.0			28		
										29		
						N	530.0	12		30		
								16				
								19	35	31		
								23				
						N	532.0	9		32		
								10				
								12	22	33		
								13				
						N	534.0	10		34		
								12				
								12	24	35		
								14				
						N	536.0	12		36		
								14				
								15	29	37		
								18				
						S	538.0			38		
										39		
										40		

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Log Of Boring

Job No. 83-1370
Client Martin Marietta Energy Systems
Project Proposed Chestnut Ridge Landfill @ Y-12

Boring No. 5 Date 3-25-87 Sheet 3 of 3
Type of Boring 6" Auger Rig Mobile B-61
Casing used ____ Size ____ Drilling mud used ____
Boring begun 3-9-87 Boring completed 3-9-87
Ground Elevation ____ referred to ____ Datum
Field Party: Hensley & Sisson

Location of Boring:	See Figure
Water Level	Dry
Time	
Date	3-9-87

Rock Data: Length cored Ft	Recovery Ft	% Recovery	Drilling Time min	% Drill Water Return	RQD %	Soil Data: Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
						N	540.0	12		40		CLAY, reddish tan w/some silt & chert fragments
								20				
								22	42	41		
								25				
						N	542.0	20		42		
								22				
								26	48	43		
								29				
						N	544.0	17		44		
								19				
								23	42	45		
								32				
						N	546.0	20		46		
								22				
								26	48	47		
								30				
						S	548.0			48		
										49		
										50		End of Boring @ 50.0'
										51		
										52		
										53		
										54		
										55		
										56		
										57		
										58		
										59		
										60		

* N = Standard Penetration, S = Shelby Tube

APPENDIX B

LABORATORY TEST DATA

TABLE B-1: SOIL DESCRIPTION AND INDEX DATA

BORING NUMBER	DEPTH OF SAMPLE, ft	N-VALUE	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT	PLASTICITY INDEX	SOIL DESCRIPTION
1	0.0 - 2.0	8	33.4	65.8	37.4	CLAY, reddish tan w/some silt & chert fragments
	2.0 - 4.0	39	31.4			CLAY, reddish tan w/some silt & chert fragments
	4.0 - 6.0	22	34.3	61.2	33.1	CLAY, reddish tan w/some silt & chert fragments
	6.0 - 8.0	27	30.8			CLAY, reddish tan w/some silt & chert fragments
	8.0 -10.0	44	30.7	64.5	35.6	CLAY, reddish tan w/some silt & chert fragments
	10.0 -12.0		30.5	53.1	22.1	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	12.0 -14.0	28	29.8			CLAY, reddish tan w/some silt & chert fragments
	14.0 -16.0	33	32.5	62.1	35.2	CLAY, reddish tan w/some silt & chert fragments
	16.0 -18.0	26	28.5			CLAY, reddish tan w/some silt & chert fragments
	18.0 -20.0	29	29.2	72.5	42.9	CLAY, reddish tan w/some silt & chert fragments
	20.0 -22.0		29.3	51.6	23.1	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	22.0 -24.0	29	31.0			CLAY, reddish tan w/some silt & chert fragments
	24.0 -26.0	27	25.7	62.2	36.0	CLAY, reddish tan w/some silt & chert fragments
	26.0 -28.0	22	30.1			CLAY, reddish tan w/some silt & chert fragments
	28.0 -30.0	18	32.0	75.6	42.9	CLAY, reddish tan w/some silt & chert fragments
	30.0 -32.0		23.9	55.4	24.6	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	32.0 -34.0	17	41.3			CLAY, reddish tan w/some silt & chert fragments
	34.0 -36.0	24	33.9	79.2	49.9	CLAY, reddish tan w/some silt & chert fragments
	36.0 -38.0	18	30.1			CLAY, reddish tan w/some silt & chert fragments
	38.0 -40.0	21	32.5	61.6	34.2	CLAY, reddish tan w/some silt & chert fragments
	40.0 -42.0		33.4	64.5	33.5	CLAY, reddish tan w/some silt & chert fragments
	40.0 -42.0 (cuttings)		27.4	71.3	52.2	CLAY, reddish tan w/some silt & chert fragments
	42.0 -44.0	44	9.7			SILTY SAND, brown w/silty clay
	44.0 -45.3	89+	29.3	32.3	17.1	CLAY, reddish tan w/some silt & chert fragments
2A	0.0 - 2.0	13	23.9	37.4	12.4	SILTY CLAY, reddish tan w/chert fragments
	2.0 - 4.0	76	19.3			SILTY CLAY, reddish tan w/chert fragments
	4.0 - 6.0	54	20.3	44.0	19.4	SILTY CLAY, reddish tan w/chert fragments
	6.0 - 8.0	46	18.4			SILTY CLAY, reddish tan w/chert fragments
	8.0 -10.0	64	22.4	51.2	19.0	SILTY CLAY, reddish tan w/chert fragments
	10.0 -12.0		17.4	43.7	19.2	SILTY CLAY, reddish tan w/chert fragments
	12.0 -14.0	63	20.8			SILTY CLAY, reddish tan w/chert fragments
	14.0 -16.0	48	24.1	51.2	26.2	SILTY CLAY, reddish tan w/chert fragments
	16.0 -18.0	41	18.2			SILTY CLAY, reddish tan w/chert fragments
	18.0 -20.0	32	22.9	46.9	20.7	SILTY CLAY, reddish tan w/chert fragments
	20.0 -22.0		25.3	54.8	25.9	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	22.0 -24.0	45	23.0			SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	24.0 -26.0	65+	24.3	52.1	25.9	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments

TABLE B-1: SOIL DESCRIPTION AND INDEX DATA

BORING NUMBER	DEPTH OF SAMPLE, ft	N-VALUE	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT	PLASTICITY INDEX	SOIL DESCRIPTION
2B	0.0 - 2.0	11	18.8	22.5	6.9	SILTY CLAY, brown w/some topsoil & chert fragments
	2.0 - 4.0	14	19.7			SILTY CLAY, brown w/some topsoil & chert fragments
	4.0 - 6.0	17	23.4			SILTY CLAY, reddish brown w/chert fragments
	6.0 - 8.0	50	15.5			SILTY CLAY, reddish brown w/chert fragments
	8.0 -10.0	49	15.7	51.1	24.4	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	10.0 -12.0		17.0	44.1	23.9	SILTY CLAY, tannish red w/chert fragments
	10.0 -12.0 (cuttings)		17.0	41.0	18.8	SILTY CLAY, tannish red w/chert fragments
	12.0 -14.0	26	24.4			SILTY CLAY, tannish brown w/chert fragments
	14.0 -16.0	30	25.6	51.1	23.1	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	16.0 -18.0	42	27.4			SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	18.0 -20.0	32	27.0	42.6	21.2	SILTY CLAY, reddish brown w/chert fragments
	20.0 -22.0	18	29.0	51.1	21.5	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	22.0 -24.0	33	18.1			SLIGHTLY SILTY CLAY, tannish brown w/chert fragments
	24.0 -26.0	21	24.2			SLIGHTLY SILTY CLAY, brown w/chert fragments
	26.0 -28.0	24	21.6	52.1	26.2	SLIGHTLY SILTY CLAY, brownish red w/chert fragments
	28.0 -30.0		23.5	43.2	23.2	SILTY CLAY, brownish red w/chert fragments
	30.0 -32.0	22	33.7	56.7	31.1	SLIGHTLY SILTY CLAY, brownish red w/chert fragments
	32.0 -34.0	26	29.4			SLIGHTLY SILTY CLAY, tannish brown w/chert fragments
	34.0 -36.0	21	33.9	71.8	37.1	CLAY, brownish red w/some silt & chert fragments
	36.0 -38.0	25	21.4			SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	38.0 -40.0		29.2	56.2	32.0	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	40.0 -42.0	26	28.4	60.8	37.9	SLIGHTLY SILTY CLAY, brown w/chert fragments
	42.0 -44.0	24	30.0			SLIGHTLY SILTY CLAY, tannish brown w/chert fragments
	44.0 -46.0	21	28.8	55.4	26.3	SLIGHTLY SILTY CLAY, tannish brown w/chert fragments
	46.0 -48.0	29	27.5			SLIGHTLY SILTY CLAY, tannish brown w/chert fragments
	48.0 -50.0		22.6	43.1	20.3	SILTY CLAY, tannish brown w/chert fragments
3	0.0 - 2.0	13	23.3	44.8	18.7	SILTY CLAY, reddish tan w/chert fragments
	2.0 - 4.0	36	26.9	45.8	19.5	SILTY CLAY, reddish tan w/chert fragments
	4.0 - 6.0	30	24.1			SILTY CLAY, reddish tan w/chert fragments
	6.0 - 8.0	28	24.9	47.5	21.2	SILTY CLAY, reddish tan w/chert fragments
	8.0 -10.0	42	25.5			SILTY CLAY, reddish tan w/chert fragments
	10.0 -12.0		24.8	47.0	17.3	SILTY CLAY, reddish tan w/chert fragments
	12.0 -14.0	54	21.1	54.6	27.0	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	14.0 -16.0	61	25.1			SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	16.0 -18.0	41	24.6	56.8	27.9	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	18.0 -20.0	24	34.7	59.4	24.3	CLAY, reddish tan w/some silt & chert fragments
	20.0 -22.0		36.5	60.0	21.9	CLAY, reddish tan w/some silt & chert fragments
	22.0 -24.0	35	27.8	56.1	23.6	CLAY, reddish tan w/some silt & chert fragments
	24.0 -26.0	42	26.3			CLAY, reddish tan w/some wilt & chert fragments
	26.0 -28.0	41	23.2			SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	28.0 -30.0	36	27.0	54.3	29.9	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	30.0 -32.0		28.7	52.9	28.5	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments

TABLE B-1: SOIL DESCRIPTION AND INDEX DATA

BORING NUMBER	DEPTH OF SAMPLE, ft	N-VALUE	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT	PLASTICITY INDEX	SOIL DESCRIPTION
	32.0 -34.0	28	26.1			SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	34.0 -36.0	27	27.7	58.0	30.9	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	36.0 -38.0	25	25.6			SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	38.0 -40.0	26	32.8	64.9	36.7	CLAY, reddish tan w/some silt & chert fragments
	40.0 -42.0		30.5	67.2	35.8	CLAY, reddish tan w/some silt & chert fragments
	40.0 -42.0 (cuttings)		30.5	56.7	32.0	CLAY, reddish tan w/some silt & chert fragments
	42.0 -44.0	29	33.5			CLAY, reddish tan w/some silt & chert fragments
	44.0 -46.0	22	40.4	57.5	31.0	CLAY, reddish tan w/some silt & chert fragments
	46.0 -48.0	31	33.9			CLAY, reddish tan w/some silt & chert fragments
4	0.0 - 2.0	9	22.8	33.3	14.8	SILTY CLAY, reddish brown w/chert fragments
	2.0 - 4.0	28	26.6			SILTY CLAY, reddish brown w/chert fragments
	4.0 - 6.0	29	32.9	54.1	20.3	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	6.0 - 8.0	19	28.2			SILTY CLAY, reddish brown w/chert fragments
	8.0 -10.0	38	30.9	59.7	24.2	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
	10.0 -12.0		23.3	51.5	21.5	SILTY CLAY, tannish red w/chert fragments
	12.0 -14.0	38	27.7			SILTY CLAY, tannish red w/chert fragments
	14.0 -16.0	28	30.8	59.3	26.9	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	16.0 -18.0	26	34.3			SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	18.0 -20.0		27.3	58.6	29.3	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	20.0 -22.0	28	32.0	55.3	26.5	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	22.0 -24.0	24	23.3			SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	24.0 -26.0	24	35.9	68.9	36.3	CLAY, reddish brown w/some silt & chert fragments
	26.0 -28.0	20	35.2			CLAY, reddish brown w/some silt & chert fragments
	28.0 -30.0		35.9	63.3	35.2	CLAY, reddish brown w/some silt & chert fragments
	30.0 -32.0	21	34.1			CLAY, reddish brown w/some silt & chert fragments
	32.0 -34.0	26	32.5			SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	34.0 -36.0	24	30.3	55.5	26.1	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	36.0 -38.0	17	26.3			SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	38.0 -40.0		23.8	57.7	29.2	CLAY, tannish red & brown w/some silt & chert fragments
	40.0 -42.0	16	30.9	52.7	28.6	CLAY, tannish red & brown w/some silt & chert fragments
	42.0 -44.0	18	25.5	61.1	34.2	CLAY, tannish red & brown w/some silt & chert fragments
	42.0 -44.0 (cuttings)		28.1	64.1	35.8	CLAY, reddish tan & brown w/some silt & chert fragments
	44.0 -46.0	20	31.5	57.7	30.1	CLAY, tannish red & brown w/some silt & chert fragments
	46.0 -48.0	17	36.0			CLAY, reddish brown w/some silt & chert fragments
	48.0 -50.0		37.7	56.8	29.9	CLAY, reddish tan w/some silt & chert fragments

TABLE B-1: SOIL DESCRIPTION AND INDEX DATA

BORING NUMBER	DEPTH OF SAMPLE, ft	N-VALUE	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT	PLASTICITY INDEX	SOIL DESCRIPTION
5	0.0 - 2.0	9	29.6	48.2	16.3	SILTY CLAY, tannish red w/chert fragments
	2.0 - 4.0	12	23.8			SILTY CLAY, tannish red w/chert fragments
	4.0 - 6.0	18	24.6	49.0	17.8	SILTY CLAY, tannish red w/chert fragments
	6.0 - 8.0	27	27.1	51.6	18.9	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	8.0 -10.0		26.7	54.2	18.6	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	10.0 -12.0	24	22.6			SLIGHTLY SILTY CLAY, tannish red w/chert fragments
	12.0 -14.0	33	24.2	52.4	19.5	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	14.0 -16.0	25	26.2			SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	16.0 -18.0	30	23.1	54.6	18.9	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
	18.0 -20.0		30.1	59.5	18.8	CLAY, reddish tan w/some silt & chert fragments
	20.0 -22.0	34	29.1	63.9	28.9	CLAY, reddish tan w/some silt & chert fragments
	22.0 -24.0	33	28.6			CLAY, reddish tan w/some silt & chert fragments
	24.0 -26.0	30	22.6	58.7	25.8	CLAY, reddish tan w/some silt & chert fragments
	26.0 -28.0	25	23.1	58.6	23.2	CLAY, reddish tan w/some silt & chert fragments
	20.0 -27.0 (cuttings)		27.8	62.9	34.0	CLAY, reddish tan w/some silt & chert fragments
	28.0 -30.0		22.2	60.1	22.6	CLAY, reddish tan w/some silt & chert fragments
	30.0 -32.0	35	22.4	59.6	24.5	CLAY, reddish tan w/some silt & chert fragments
	32.0 -34.0	22	26,5			CLAY, reddish tan w/some silt & chert fragments
	34.0 -36.0	24	21.8	58.4	23.9	CLAY, reddish tan w/some silt & chert fragments
	36.0 -38.0	29	34.7			CLAY, reddish tan w/some silt & chert fragments
	38.0 -40.0		23.9	64.6	33.1	CLAY, reddish tan w/some silt & chert fragments
	40.0 -42.0	42	32.3	68.7	39.9	CLAY, reddish tan w/some silt & chert fragments
	42.0 -44.0	48	37.5	68.0	37.4	CLAY, reddish tan w/some silt & chert fragments
	44.0 -46.0	42	37.7			CLAY, reddish tan w/some silt & chert fragments
	46.0 -48.0	48	38.7			CLAY, reddish tan w/some silt & chert fragments
	48.0 -50.0		29.8	65.8	37.0	CLAY, reddish tan w/some silt & chert fragments

TABLE B-2: PERMEABILITY TEST DATA

Boring	Depth (ft)	Natural Water Content (%)	Wet Unit Weight (pcf)	Liquid Limit	Plasticity Index	Hydraulic Conductivity (cm/s)	Comments
1	20.0-22.0	29.3	124.6	51.6	23.1	5.80 x 10 EE-8	Undisturbed
1	40.0-42.0	27.4	120.9	71.3	52.2	2.35 x 10 EE-8	Remolded*
1	40.0-42.0	33.4	123.1	64.5	33.5	3.04 x 10 EE-8	Undisturbed
2A	20.0-22.0	25.3	130.3	54.8	25.9	7.42 x 10 EE-7	Undisturbed
2B	10.0-12.0	17.0	130.8	41.0	18.8	3.37 x 10 EE-8	Remolded*
2B	28.0-30.0	23.5	136.7	56.7	31.1	4.26 x 10 EE-8	Undisturbed
2B	38.0-40.0	29.2	133.4	56.2	32.0	1.30 x 10 EE-7	Undisturbed
2B	48.0-50.0	22.6	132.1	43.1	20.3	4.68 x 10 EE-8	Undisturbed
3	10.0-12.0	24.8	121.2	47.0	17.3	3.03 x 10 EE-6	Undisturbed
3	30.0-32.0	28.7	125.4	52.9	28.5	3.52 x 10 EE-8	Undisturbed
3	40.0-42.0	30.5	124.2	67.2	35.8	3.21 x 10 EE-7	Undisturbed
3	40.0-42.0	30.5	122.0	56.7	32.0	6.05 x 10 EE-8	Remolded*
4	10.0-12.0	23.3	120.3	51.5	21.5	3.60 x 10 EE-7	Undisturbed
4	18.0-20.0	27.3	120.2	58.6	29.3	1.52 x 10 EE-7	Undisturbed
4	28.0-30.0	35.9	124.9	63.3	35.2	3.86 x 10 EE-8	Undisturbed
4	38.0-40.0	23.8	122.1	57.7	29.2	3.80 x 10 EE-7	Undisturbed
4	42.0-44.0	28.1	126.0	64.1	35.8	2.20 x 10 EE-8	Remolded*
4	48.0-50.0	37.7	124.8	56.8	29.9	3.61 x 10 EE-7	Undisturbed
5	8.0-10.0	26.7	117.4	54.2	18.6	4.61 x 10 EE-7	Undisturbed
5	18.0-20.0	30.1	120.9	59.5	18.8	6.82 x 10 EE-7	Undisturbed
5	20.0-27.0	27.8	129.8	62.9	34.0	2.29 x 10 EE-8	Remolded*
5	28.0-30.0	22.2	121.9	60.1	22.6	7.91 x 10 EE-7	Undisturbed
5	38.0-40.0	23.9	118.3	64.0	33.1	3.83 x 10 EE-7	Undisturbed
5	48.0-50.0	29.8	117.0	65.8	37.0	4.40 x 10 EE-7	Undisturbed

*Sample remolded and compacted to 95% of standard Proctor (ASTM D698) Maximum Dry Density.

Note: All tests run @ greater than 98% saturation.

TABLE B-3: STANDARD PROCTOR (ASTM D698) TEST DATA

BORING NUMBER	DEPTH, ft	LIQUID LIMIT	PLASTICITY INDEX	MAXIMUM DRY DENSITY, pcf	OPTIMUM MOISTURE, %	SOIL DESCRIPTION
1	40.0-42.0	71.3	52.2	99.7	23.8	CLAY, reddish tan w/some silt & chert fragments
2B	10.0-12.0	41.0	18.8	105.2	17.0	SILTY CLAY, tannish red w/chert fragments
3	40.0-42.0	56.7	32.0	100.4	22.4	CLAY, reddish tan w/some silt & chert fragments
4	42.0-44.0	64.1	35.8	95.3	25.7	CLAY, reddish tan & brown w/some chert fragments
5	20.0-27.0	62.9	34.0	100.9	24.1	CLAY, reddish tan w/some silt & chert fragments

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FIG. B-1 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth, ft.	Line Symbol	Textural Classification
B1	10 - 12	———	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
B1	20 - 22	— —	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
		—·—	
		—··—	

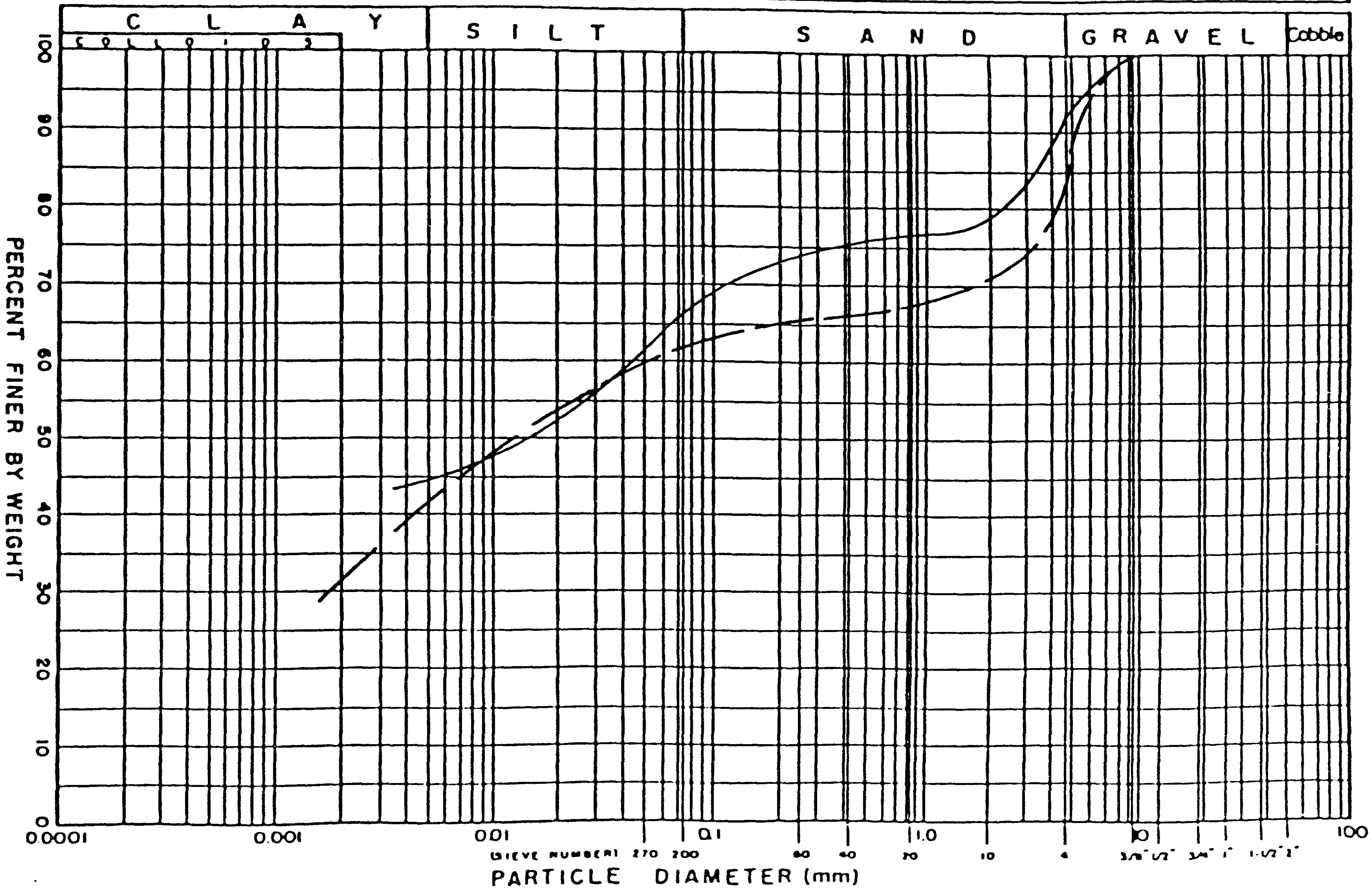

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FIG. B-2 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth, ft.	Line Symbol	Textural Classification
B1	30 - 32	————	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
B1	40 - 42	—— ——	CLAY, reddish tan w/some silt & chert fragments
		——·——	
		——··——	

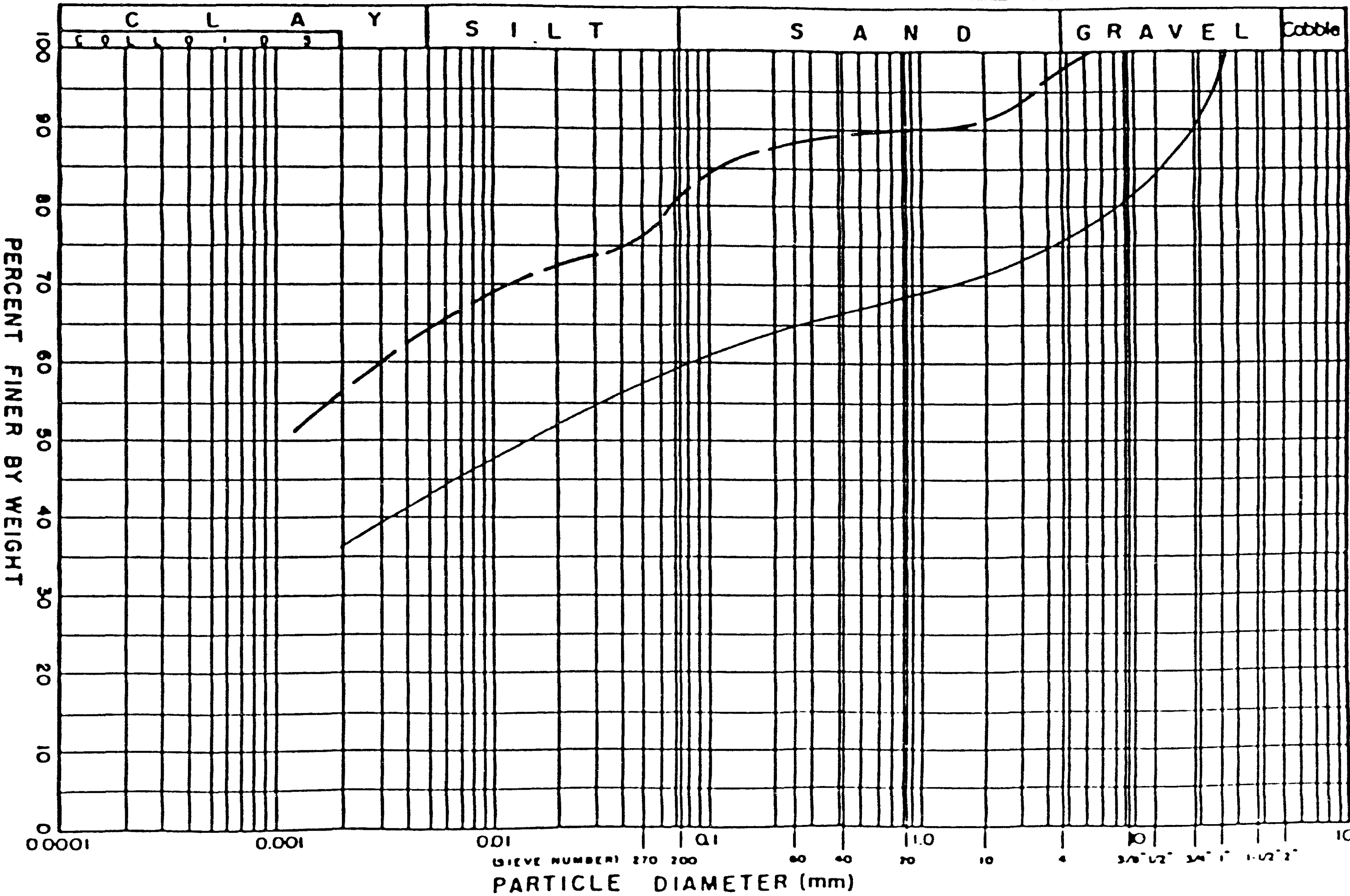

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FIG. B-3 **GRAIN SIZE DISTRIBUTION**

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth, ft.	Line Symbol	Textural Classification
B2A	10 - 12	———	SILTY CLAY, reddish tan w/chert fragments
B2A	20 - 22	— —	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
		—·—	
		—··—	

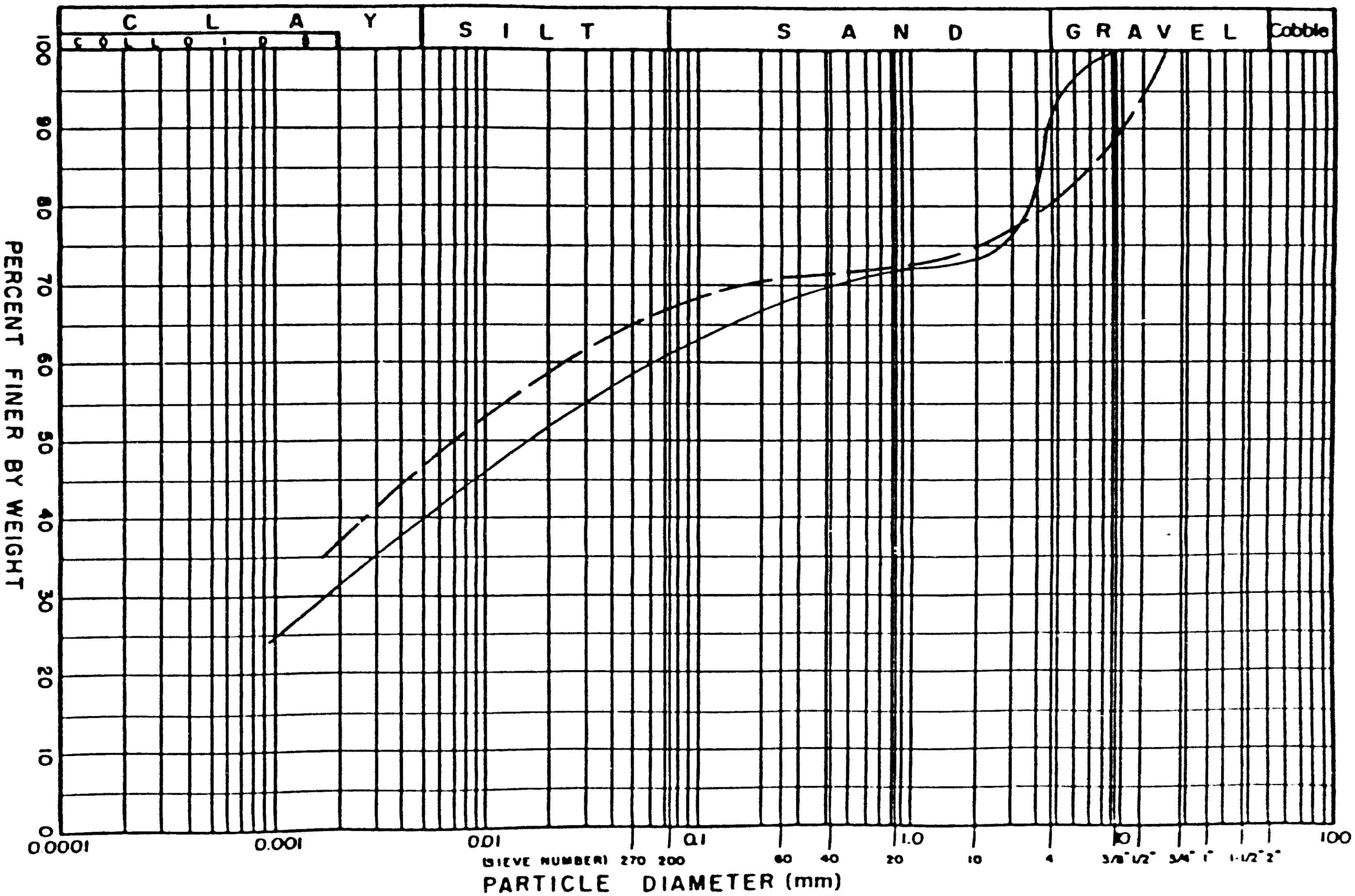

FIG. B-4 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth, ft.	Line Symbol	Textural Classification
B2B	10 - 12	————	SILTY CLAY, tannish red w/chert fragments
B2B	18 - 20	—— ——	SILTY CLAY, reddish brown w/chert fragments
B2B	28 - 30	——·——	SILTY CLAY, brownish red w/chert fragments
		——··——	

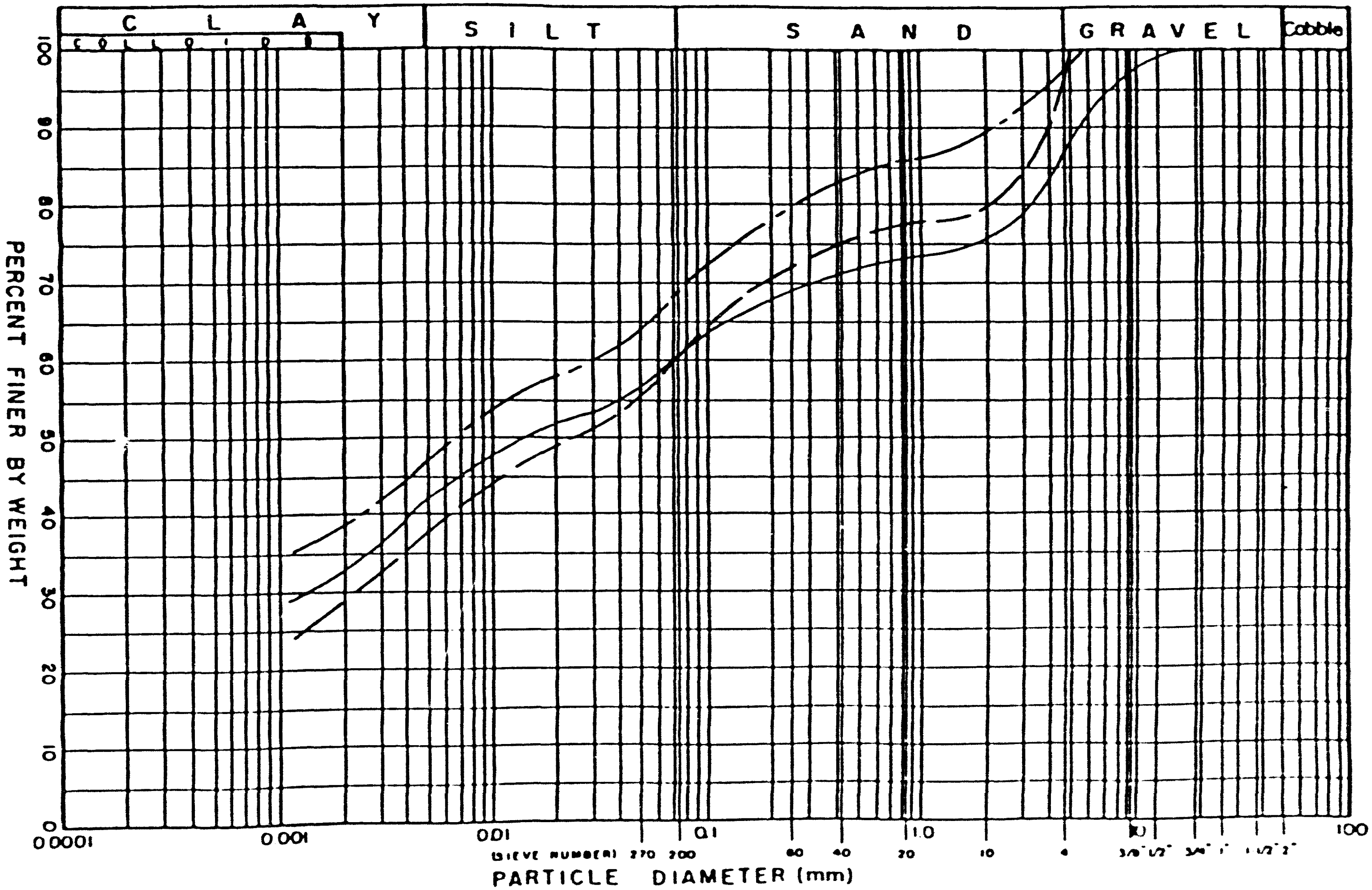

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FIG. B-5 **GRAIN SIZE DISTRIBUTION**

Geotek Project No. 83-1370 Date 3-23-87

Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth. ft.	Line Symbol	Textural Classification
B2B	38 - 40	———————	SLIGHTLY SILTY CLAY, reddish brown w/chert fragments
B2B	48 - 50	——— ———	SILTY CLAY, tannish brown w/chert fragments
		———·———	
		——··——	

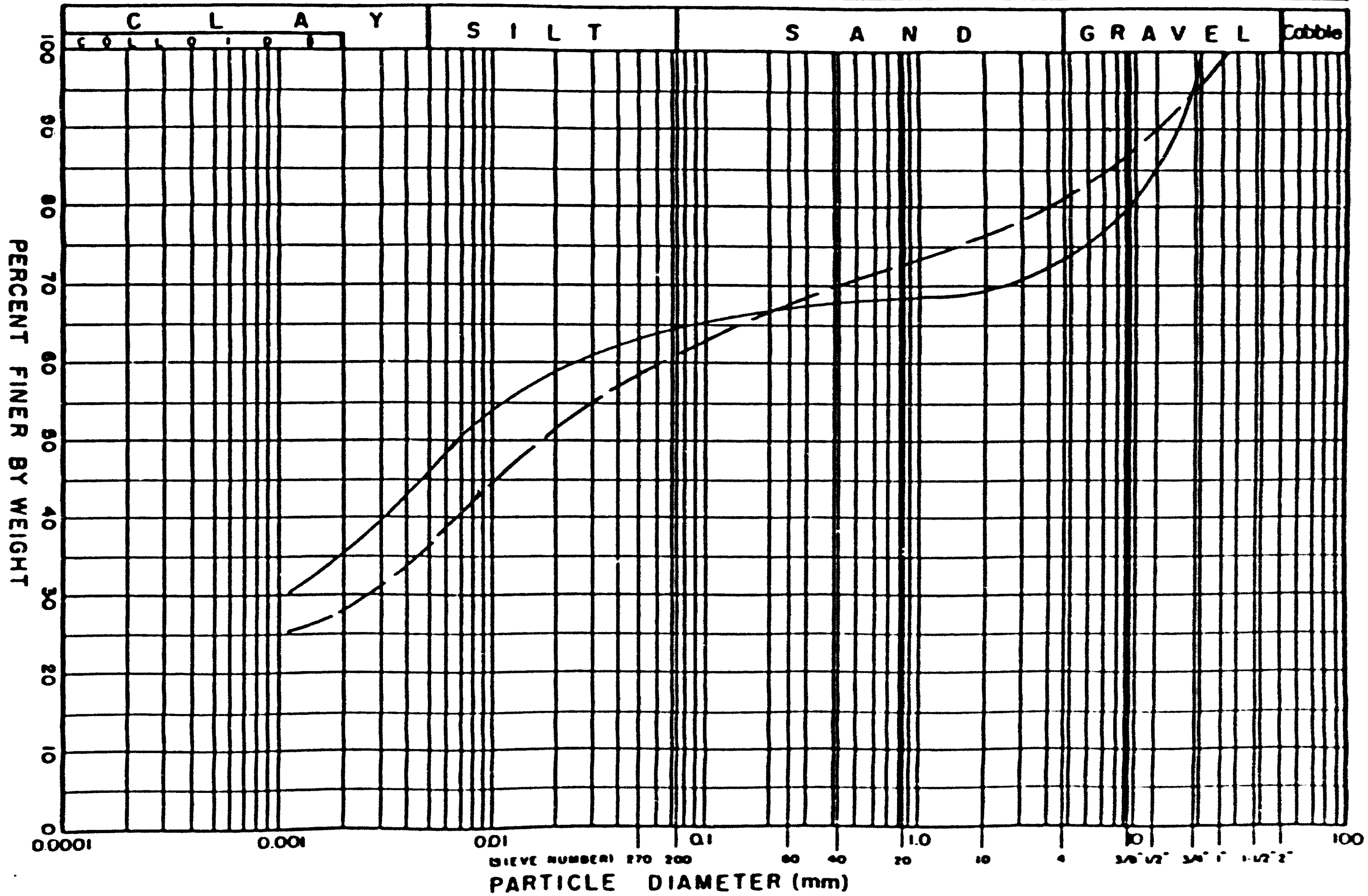

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FIG. B-6 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth, ft.	Line Symbol	Textural Classification
B3	10 - 12	————	SILTY CLAY, reddish tan w/chert fragments
B3	20 - 22	— — —	CLAY, reddish tan w/some silt & chert fragments
		— · —	
		— ·· —	

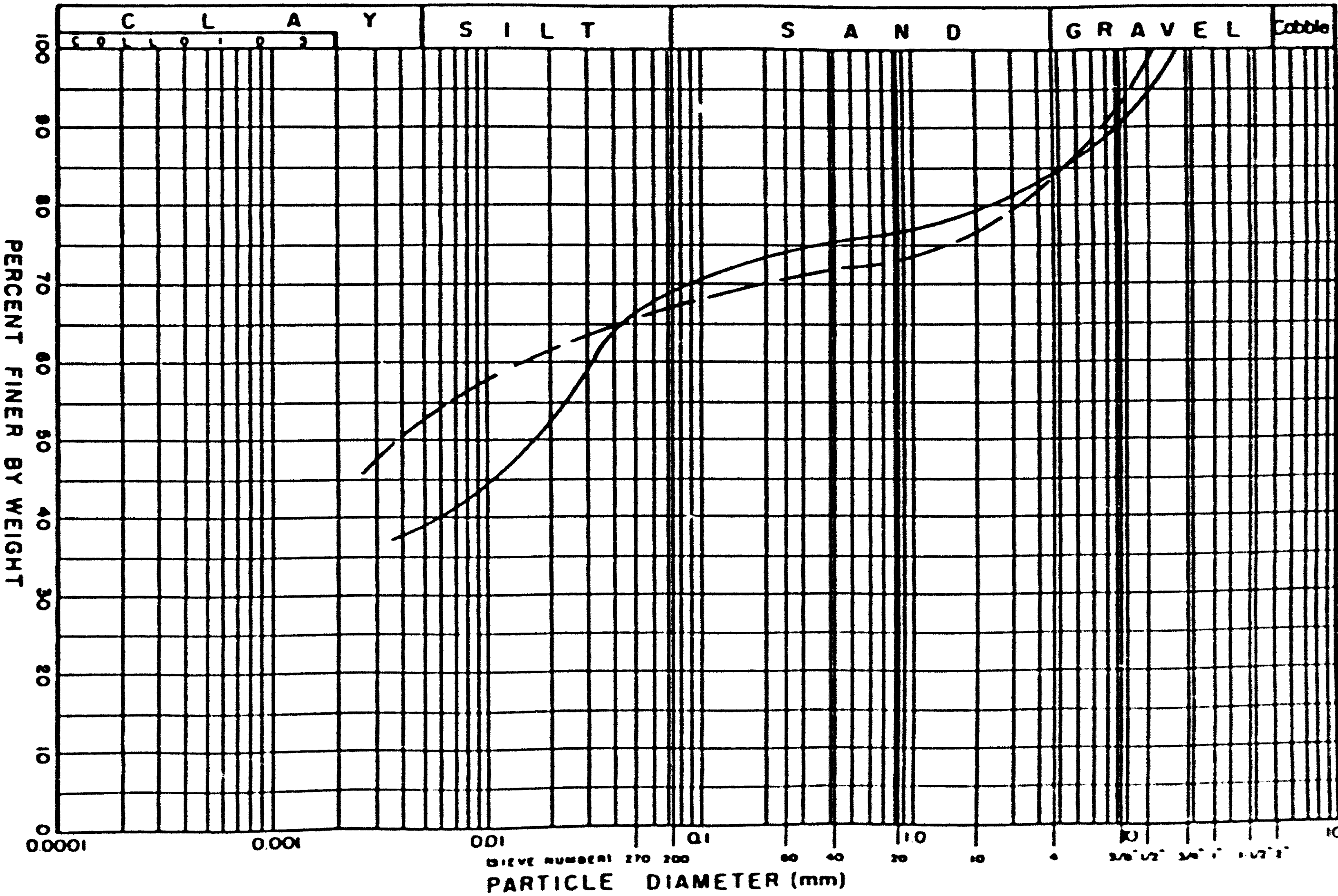

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FIG. B-7 **GRAIN SIZE DISTRIBUTION**

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth. ft.	Line Symbol	Textural Classification
B3	30 - 32	————	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
B3	40 - 42	— —	CLAY, reddish tan w/some silt & chert fragments
		—·—	
		—··—	

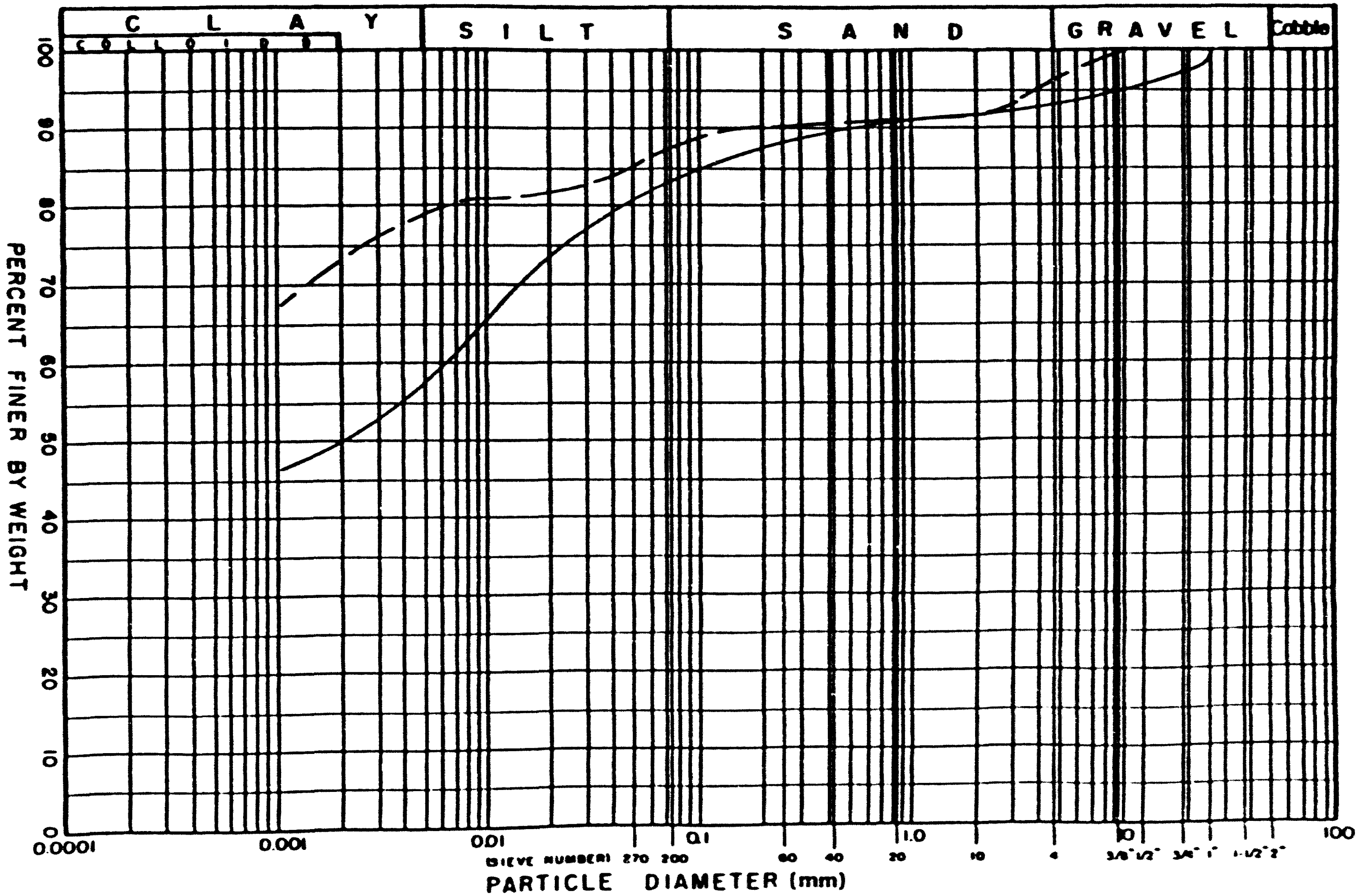

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FIG. B-8 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-24-87
Project Chestnut Ridge Landfill @ Y-12

Sample No.	Depth. ft.	Line Symbol	Textural Classification
B4	10 - 12	———	SILTY CLAY, tannish red w/chert fragments
B4	18 - 20	—— ——	SLIGHTLY SILTY CLAY, tannish red w/chert fragments
B4	28 - 30	—— · ——	CLAY, reddish brown w/some silt & chert fragments
		—— ·· ——	

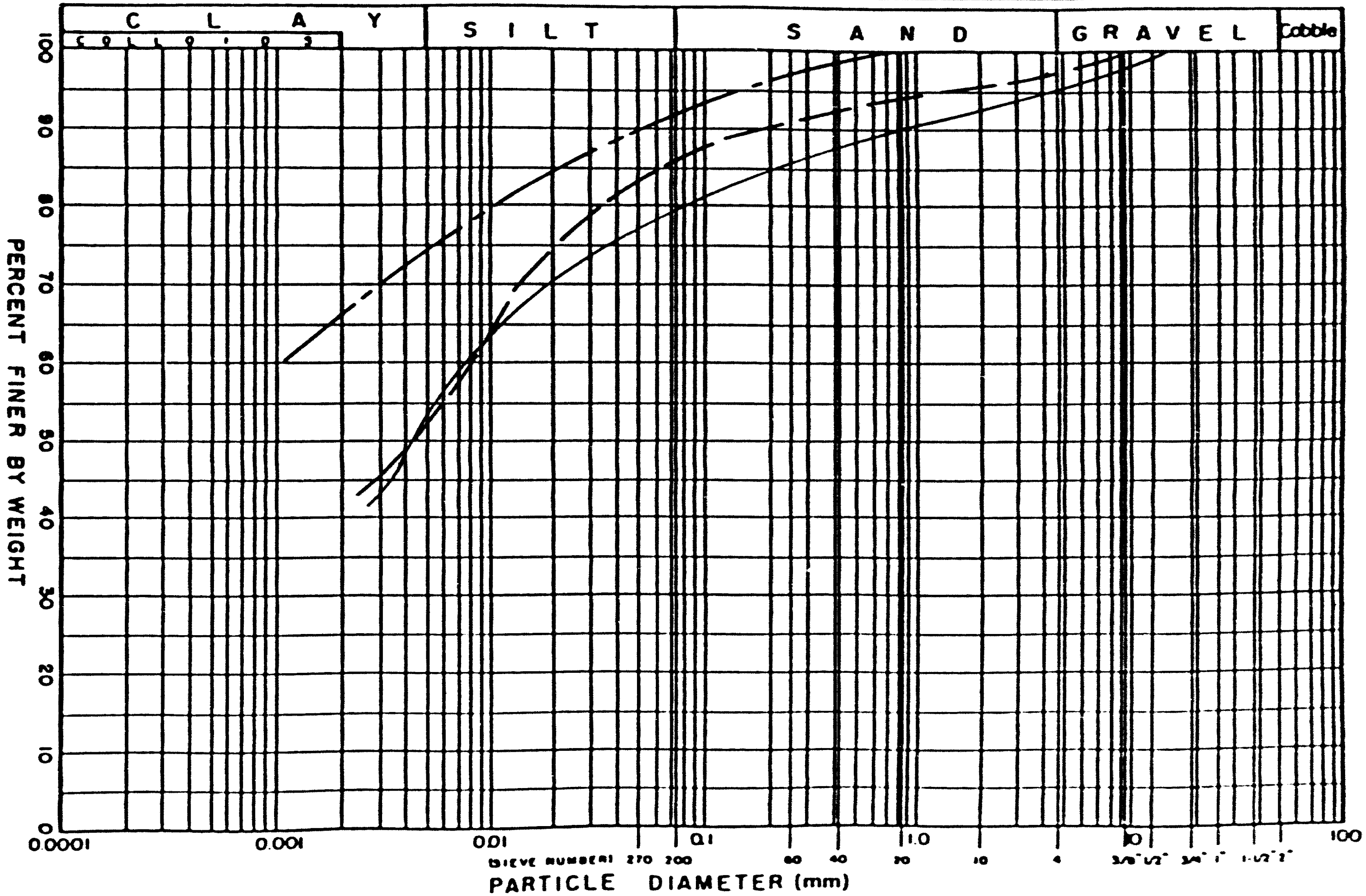

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FIG. B-9 **GRAIN SIZE DISTRIBUTION**

Geotek Project No. 83-1370 Date 3-24-87
Project Chestnut Ridge Landfill

Sample No	Depth, ft.	Line Symbol	Textural Classification
B4	38 - 40	————	CLAY, tannish red & brown w/some silt & chert fragments
B4	46 - 48	—— ——	CLAY, reddish brown w/some silt & chert fragments
B4	48 - 50	——·——	CLAY, reddish tan w/some silt & chert fragments
		——··——	

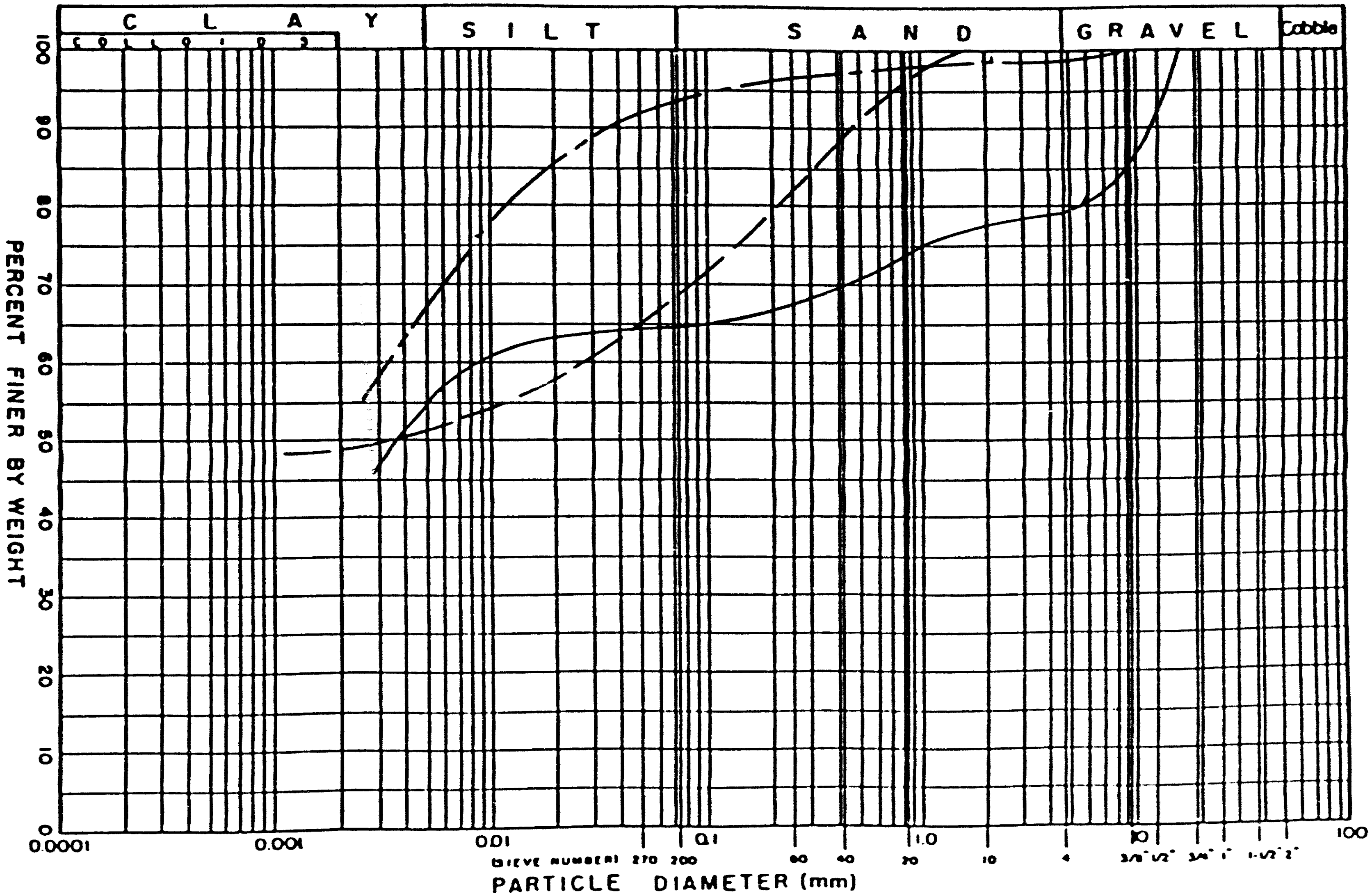

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FIG. B-10 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No	Depth, ft.	Line Symbol	Textural Classification
B5	8 - 10	———————	SLIGHTLY SILTY CLAY, reddish tan w/chert fragments
B5	18 - 20	—— ——	CLAY, reddish tan w/some silt & chert fragments
B5	28 - 30	——·——	CLAY, reddish tan w/some silt & chert fragments
		——··——	

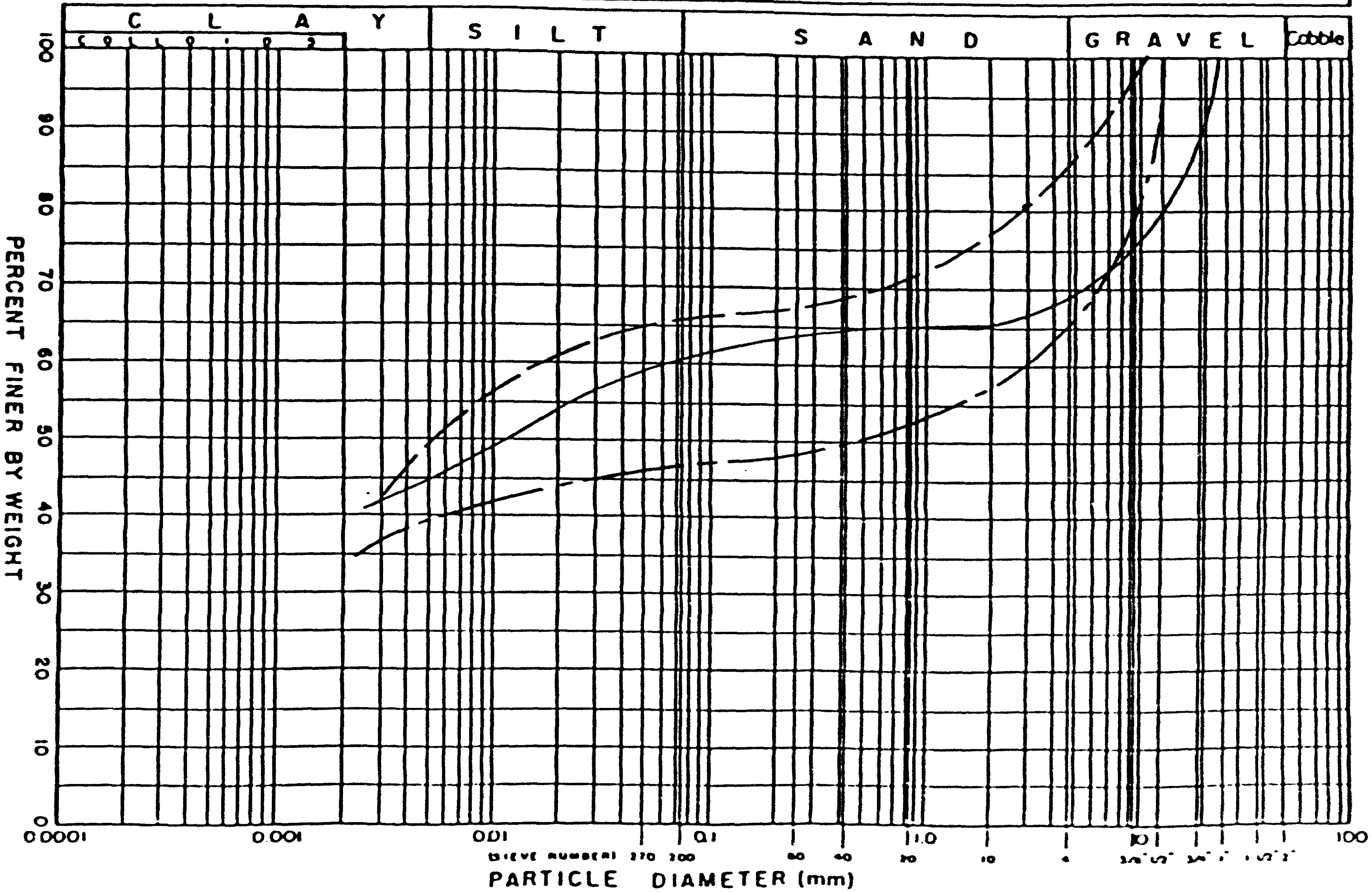

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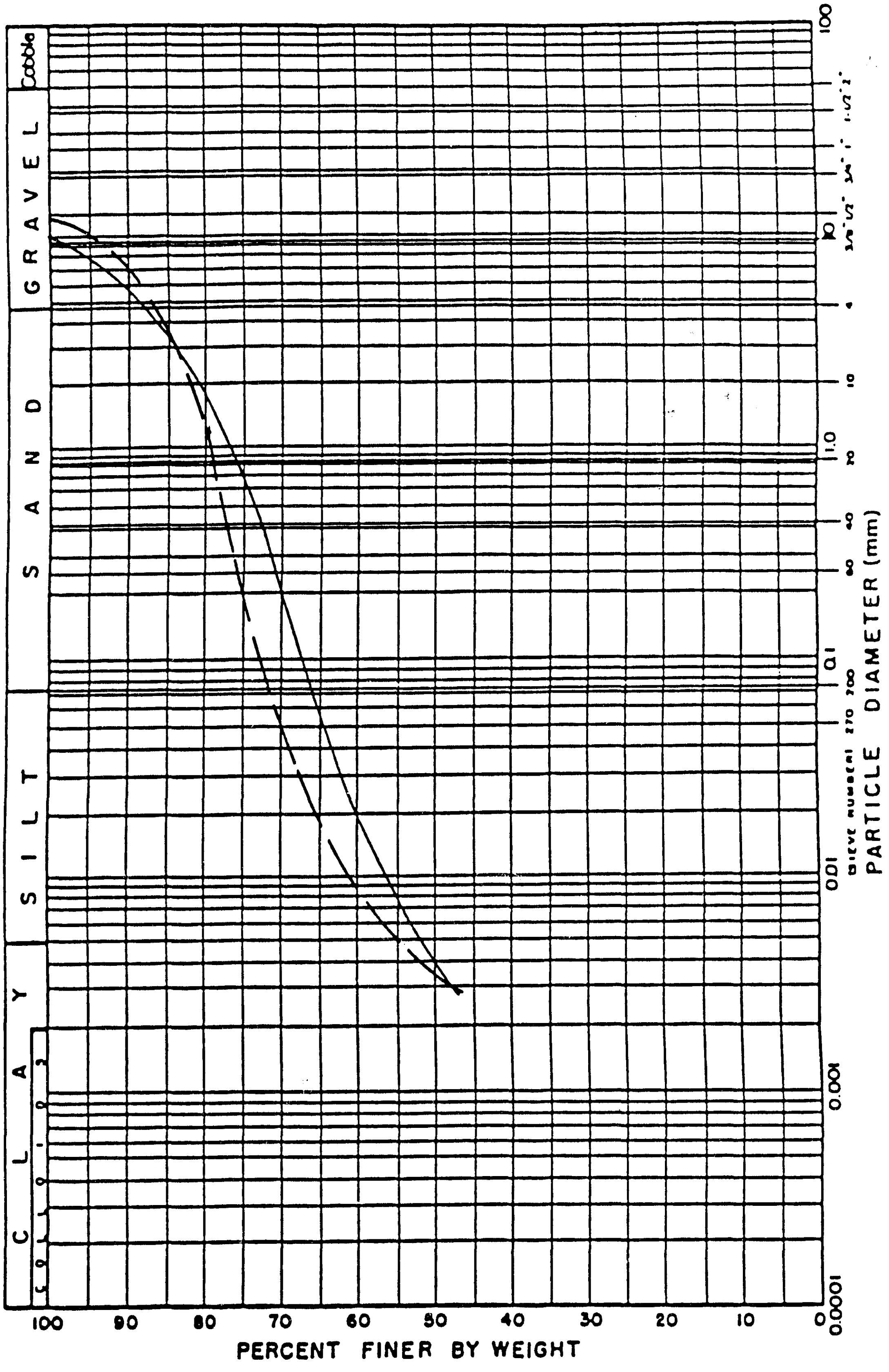
FIG. B-11 GRAIN SIZE DISTRIBUTION

Geotek Project No. 83-1370 Date 3-23-87
Project Chestnut Ridge Landfill @ Y-12

Sample No	Depth, ft.	Line Symbol	Textural Classification
B5	38 - 40	———	CLAY, reddish tan w/some silt & chert fragments
B5	48 - 50	— — —	CLAY, reddish tan w/some silt & chert fragments
		—·—	
		—··—	



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GEOTEK 615/690-0128
ENGINEERING COMPANY

MOISTURE — DENSITY RELATIONSHIP TEST

Project No: 83-1370

Date: 3-10-87 Report No:

Reported To: Martin Marietta Energy Systems

Project: Chestnut Ridge Landfill @ Y-12

Sample Identification: B1 @ 40.0' - 42.0'

CLAY, reddish tan w/some silt & chert fragments

Test Method: ASTM D698

By: J. Rayburn

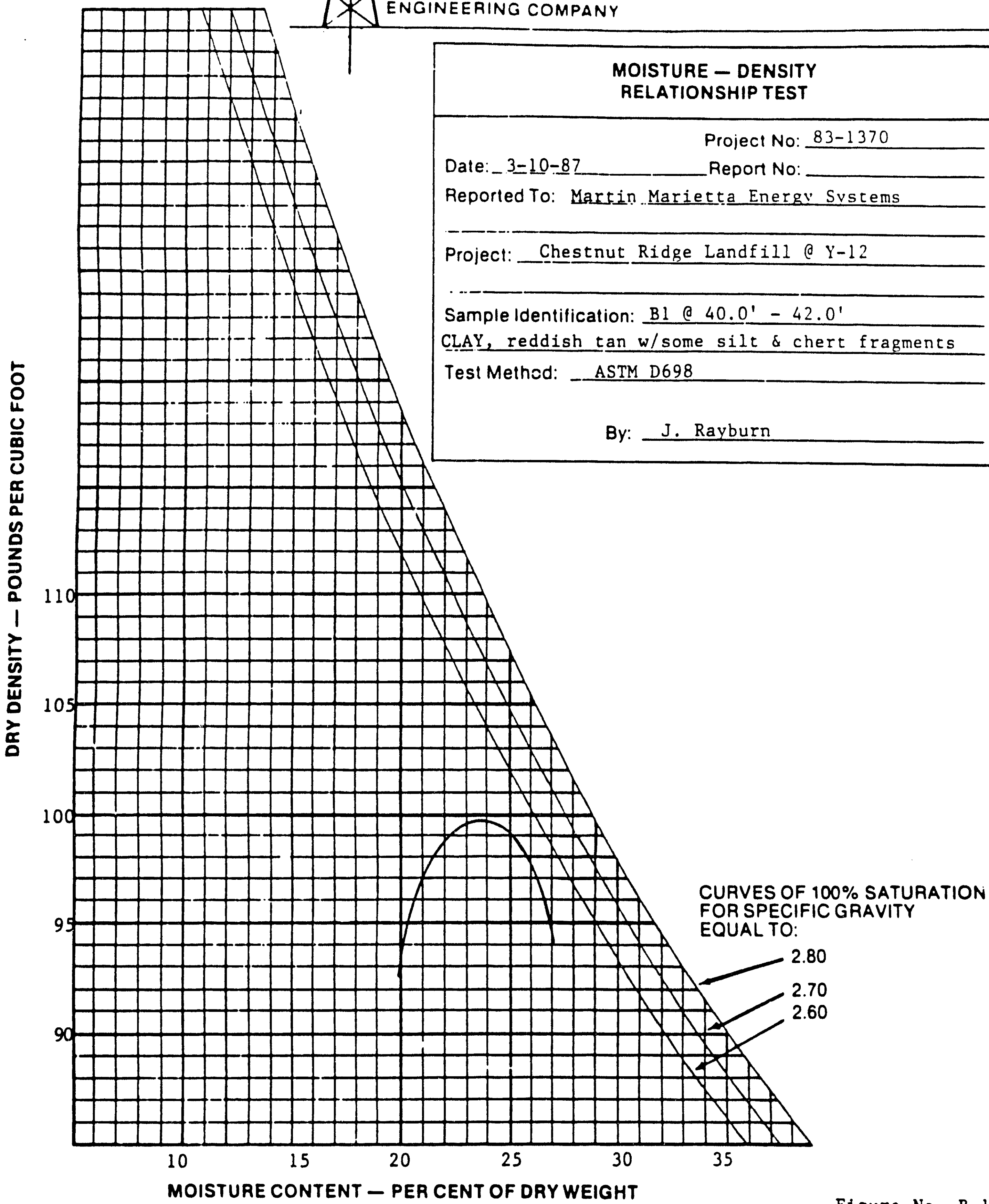

Figure No. B-12

MAXIMUM DRY DENSITY 99.7 Lbs./Cu. Ft.	OPTIMUM MOISTURE 23.8 %

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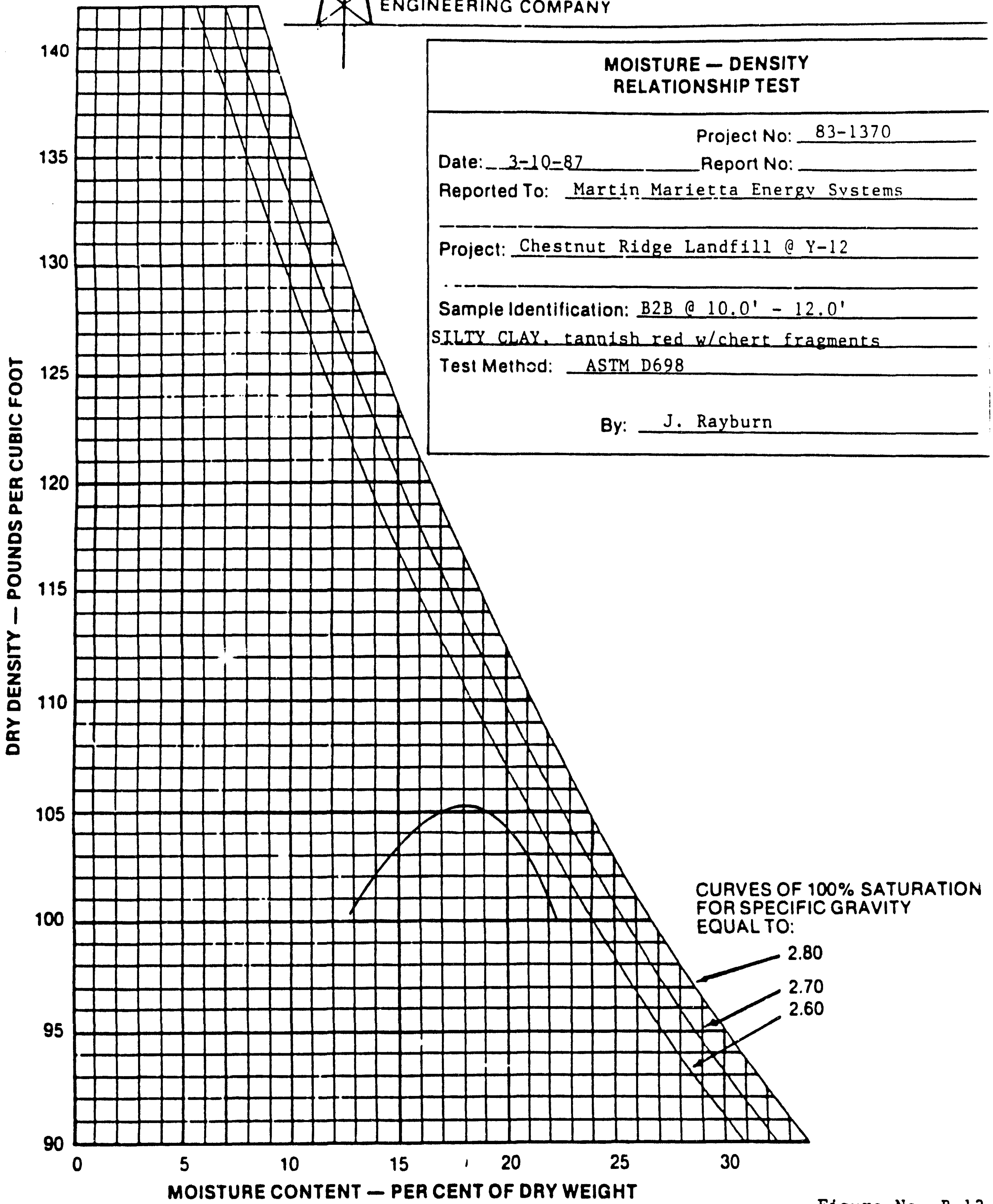

MOISTURE — DENSITY RELATIONSHIP TEST

Project No: 83-1370

Date: 3-10-87 Report No:

Reported To: Martin Marietta Energy Systems

Project: Chestnut Ridge Landfill @ Y-12

Sample Identification: B2B @ 10.0' - 12.0'

SILTY CLAY, tannish red w/chert fragments

Test Method: ASTM D698

By: J. Rayburn

Figure No. B-13

MAXIMUM DRY DENSITY 105.2 Lbs./Cu. Ft.	OPTIMUM MOISTURE 17.0 %

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ENGINEERING COMPANY

MOISTURE — DENSITY RELATIONSHIP TEST

Project No: 83-1370

Date: 3-2-87 Report No:

Reported To: Martin Marietta Energy Systems

Project: Chestnut Ridge Landfill @ Y-12

Sample Identification: B3 @ 40.0' - 42.0'

CLAY, reddish tan W/some silt & chert fragments

Test Method: ASTM D698

By: J. Rayburn

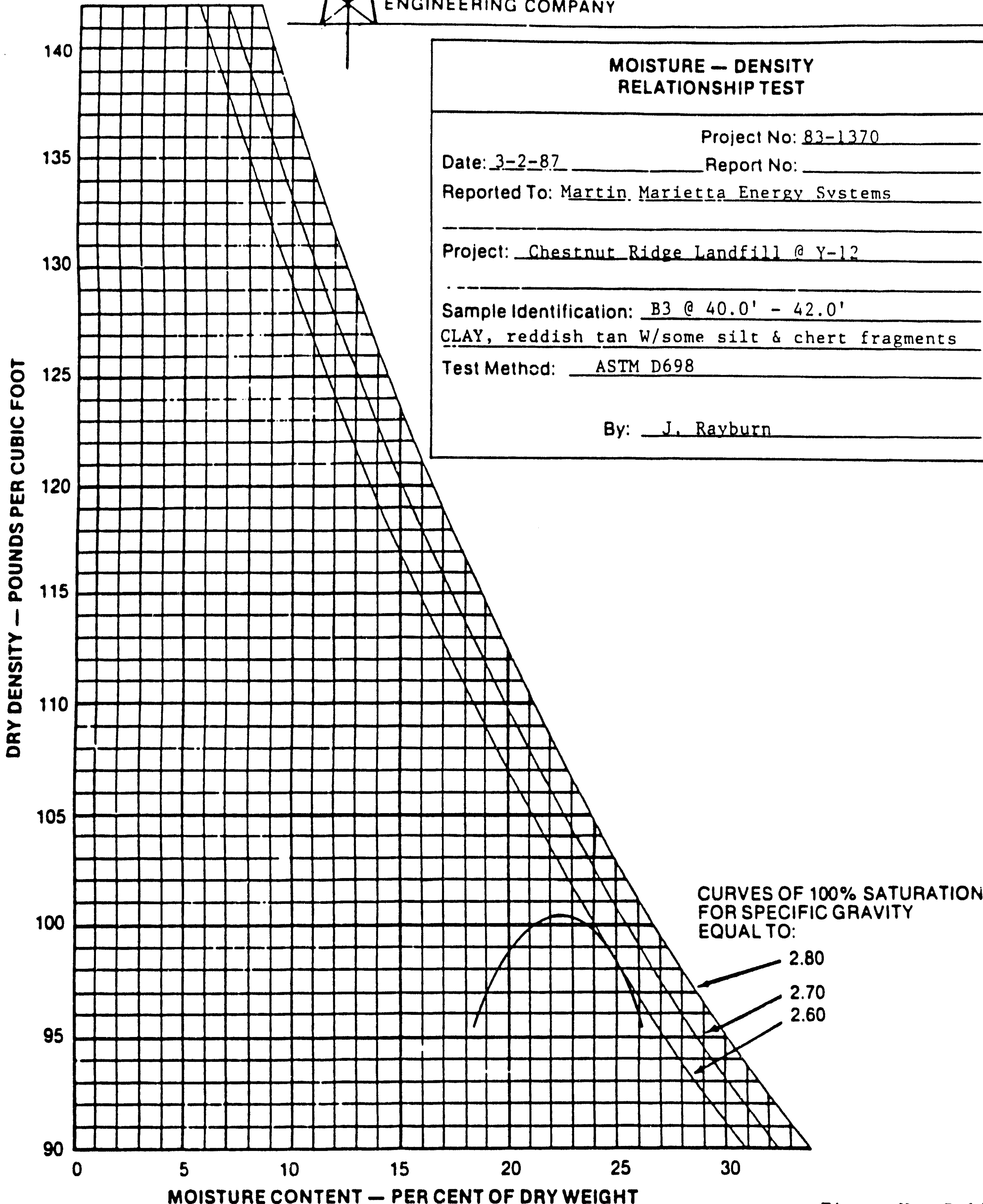

Figure No. B-14

MAXIMUM DRY DENSITY 100.4 Lbs./Cu. Ft.	OPTIMUM MOISTURE 22.4 %

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GEOTEK ENGINEERING COMPANY
615/690-0128

MOISTURE — DENSITY RELATIONSHIP TEST

Project No: 83-1370

Date: 3-10-87 Report No:

Reported To: Martin Marietta Energy Systems

Project: Chestnut Ridge Landfill @ Y-12

Sample Identification: B4 @ 42.0' - 44.0'

CLAY, reddish tan & brown w/some silt & chert fragments

Test Method: ASTM D698

By: J. Rayburn

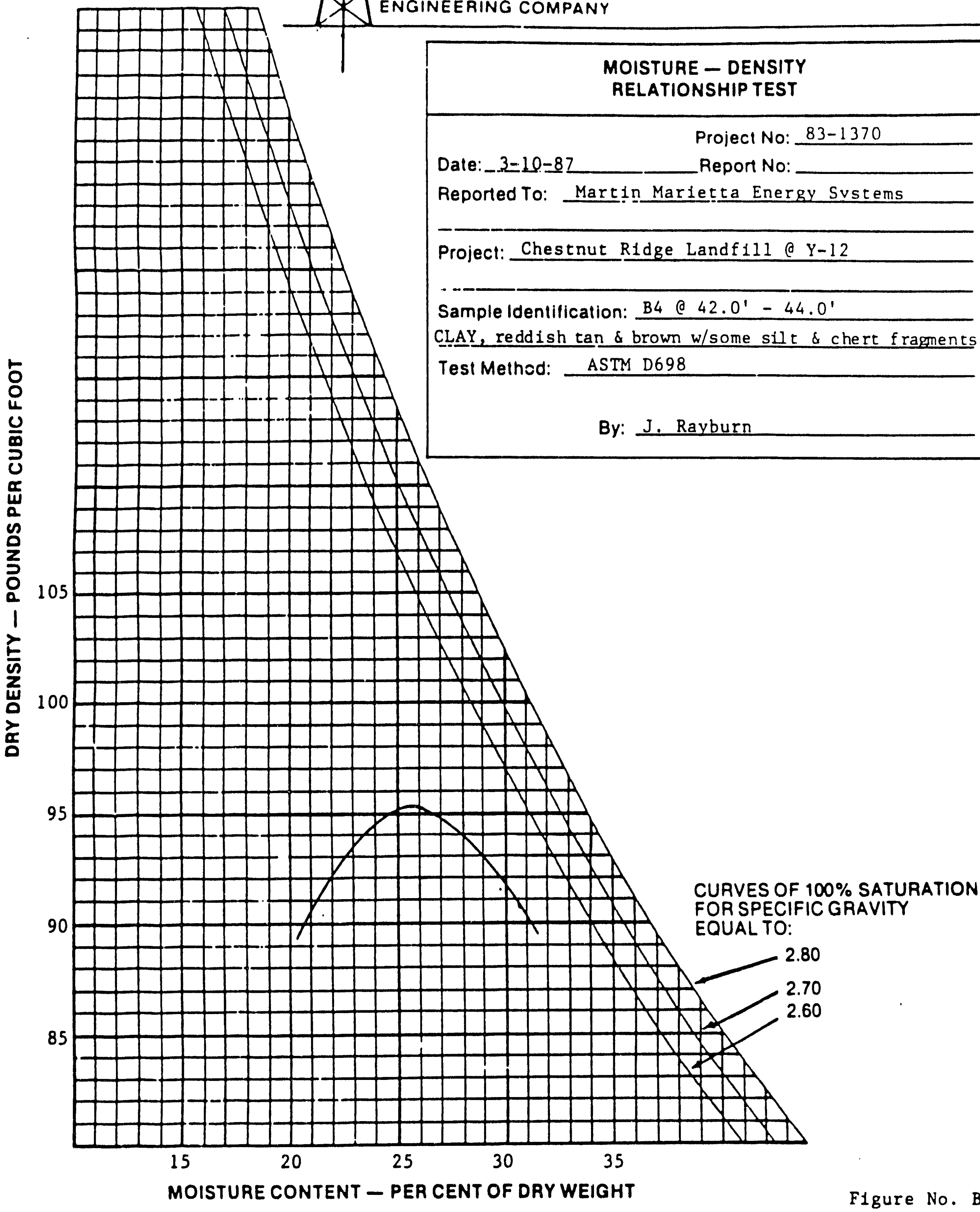

Figure No. B-15

MAXIMUM DRY DENSITY 95.3 Lbs./Cu. Ft.	OPTIMUM MOISTURE 25.7 %

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615/690-0128
ENGINEERING COMPANY

MOISTURE — DENSITY RELATIONSHIP TEST

Project No: 83-1370
Date: 3-10-87 Report No:
Reported To: Martin Marietta Energy Systems

Project: Chestnut Ridge Landfill @ Y-12

Sample Identification: B5 @ 20.0' - 27.0'
CLAY, reddish tan w/some silt & chert fragments
Test Method: ASTM D698

By: J. Rayburn

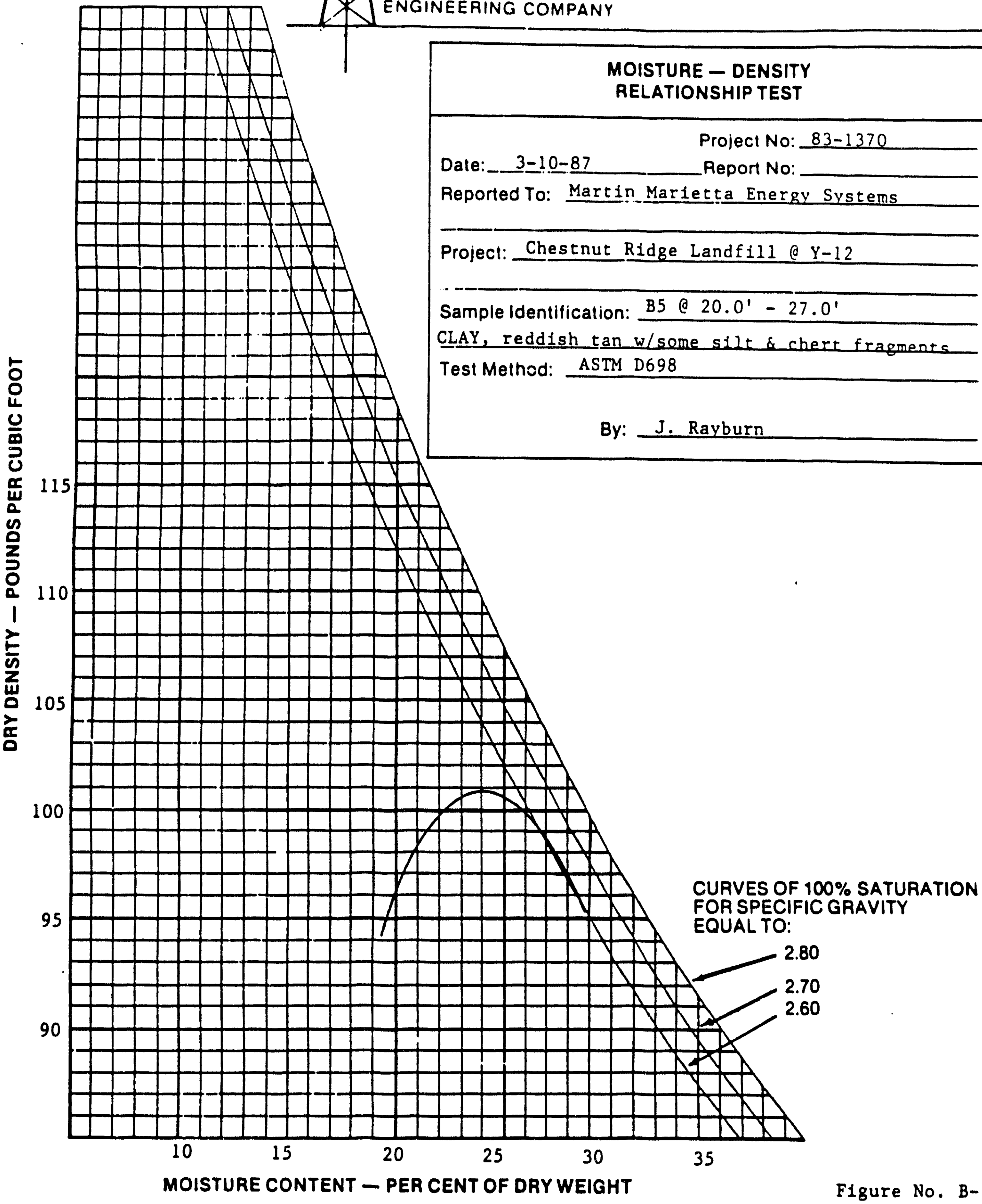


Figure No. B-16

MAXIMUM DRY DENSITY 100.9 Lbs./Cu. Ft.	OPTIMUM MOISTURE 24.1 %

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV			
ESO NO: WASTE VOLUME CALCS.	COMPUTED	DATE: 10/11/93 CHECKED BY	SHEET: 1 of

1) EST. Final Cover Volumes.

A. ℄ Separator Berm to West End

$A = 56.42^{\square''} = 141{,}050^{\square'} = 3.238$ Ac.
Est. Cover Vol. @ 3'-6" thk.

Vol. = $141{,}050^{\square'} \times 3.5'$ thk $\div 27$
= 18,284 C.Y.

B. ℄ Separator BERM to EAST END

$A = 13.83^{\square''} = 34{,}575^{\square'} = 0.794$ Ac.
Est. Cover @ 3'-6"

Vol. = $34{,}575^{\square'} \times 3.5'$ thk $\div 27$
= 4,482 CY

TOTAL Cover Vol = <u>22,766 C.Y.</u>

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV			
ESO NO: WASTE VOLUME CALCS.	COMPUTED	DATE: 9/13/93 CHECKED BY	SHEET: 1A of

1) Est Bot. & SIDE EXCAV. BELOW FIN. GRADE (West PORTION) for INITIAL Cover (1'), Leachate Bed (1') and Recompacted Clay Liner (2')

A. FROM BERM TO WEST END

1) Bottom AREA = 30.70□" = 76,750□' = 1.76 Ac.
Est. Bot. Excav. @ 4'-0" thk.
Vol. = 76,750 × 4 ÷ 27 = 11,222 CY.

2) SIDE Slopes Area = 56.20 − 30.70 = 25.50□"
= 63,750□' = 1.463 Ac.
Est. Side Slope Excav. @ 3'-0" thk
Vol. = 63,750□' × 3' ÷ 27 = 7083 CY.

B. Est. Vol. for 2' Recompacted Clay Layer
A = (76,750 + 63,750) × 2 ÷ 27 = 10,407 CY.
Vol. = 10,407 CY × 1.12 Shr.) = 11,656 CY.

2) Est. Bot. & Sideslope Excav. Below Fin. Grade (Phase I AREA)

A. From Berm to Temp. Berm (Ph. I)

1. Bottom Area = 10.50□" = 26,250□' = 0.60 Ac.
Est. Bot. Exc. @ 4'-0" thk.
Vol. = 26,250 × 4 ÷ 27 = 3889 CY.

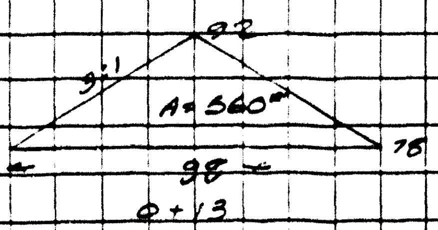
2. Side Slope AREA = 20.8 − 10.5 = 10.3□"
= 25,750□' = 0.59 Ac.
Est. Side Slope Excav. @ 3'-0" thk.
Vol. = 25,750□' × 3' thk ÷ 27 = 2861 CY.

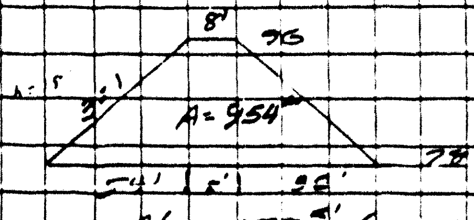
B. Est. Vol. for 2' Recompacted Clay Layer
A = (26,250 + 25,750) × 2 ÷ 27 = 3852 CY
Vol. = 3852 CY × 1.12 Shr = 4314 CY.

GENERAL DESIGN AND COMPUTATION SHEET

JOB		DATE	SHEET
LANDFILL IV			
WASTE VOLUME CALCS		10/11/93	2 of
ESO NO	COMPUTED A.A.B.	CHECKED BY	

4. Est Vol. Permanent Berm





Sta	Est. Area	Vol. C.Y.
0	0	
		165
0+19	686	
		516
0+30	954	
		4947
1+70	954	
1+70 Lt	477	
		221
1+95 Rt.	0	
170 Lt	477	
		406
193 Lt	477	
		106
2+05 Lt	0	

Σ = 6361 C.Y.

+12% Shr = 763

Σ = 7124 CY FILL REQD.

Est Area

L.F. Entry = 15.83

Bot. Area =

UCN-4032A
(5 2-84)

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV
ESO NO: WASTE VOLUME CALCS
DATE: 9/15/93
SHEET: 3 OF
COMPUTED: A.A.B.
CHECKED BY:

5.) Vol. between Fin. Grade Bot. & Top Cover Fin. G.
A. From Perm. BERM to WEST End

STA.	End AREA	VOL. - C.Y.
0+75	0	
		1416
1+00	3060	
		7368
1+50	4898	
		9365
2+00	5216	
		9650
2+50	5206	
		9587
3+00	5148	
		9433
3+50	5040	
		9212
4+00	4910	
		8994
4+50	4804	
		8800
5+00	4700 ✓	
		8359
5+50	4328 ✓	
		6874
6+00	3096 ✓	
		2866
6+50	0	

Σ = 91,924 C.Y.

UCN-4032A
(5 2-84)

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV
WASTE VOLUME CALCS.
DATE: 9/24/93
SHEET: 4 OF
ESO NO
COMPUTED: AAB
CHECKED BY

5) B. FROM PERM. BERM TO PHASE I LIMIT (temp. berm)

STA.	AREA	VOL.-C.Y.
4+83	0	
		5290
5+49	4328	
		160
5+50	4328	
		6874
6+00	3096	
		2867
6+50	0	

Σ = 15,191 C.Y. VOL. TOP. CAP to Fin. Grade Bottom.

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV
WASTE VOLUME CALCS
DATE: 9/14/93 SHEET: 5 of
ESO NO / COMPUTED: AAB / CHECKED BY:

5) C. FROM PERM. BERM to EAST END
Based on Orig. Bot. Sections from ACHW.
& Top Cover by MMES w/ Landfill Bndry
Elevs. based on Ebasco Cover Plan.
Vols. from Bot. Grade to Top Cover

STA.		END AREA.	VOL.-C.Y.
6+50		0	
	43		2968
6+93		3728	
	25		3314
7+18		3430	
	25		2881
7+43		2794	
	25		2390
7+68		2368	
	25		2001
7+93		1956	
	25		1543
8+18		1376	
	25		846
8+43		452	
	25		209
8+68		0	

$\Sigma = 16,152.$

6C) EST. WASTE VOL. - PERM. BERM TO EAST BNDRY.
1. VOL. TOP CAP TO ACHW Bot. GR. = 16,152 C.Y.
2. Vol. Cover = 4482 C.Y.
GROSS Vol. AIR Space = 11,670 C.Y.

Est. Waste/Cover Ratio at 2:1
∴ WASTE VOL. = 7780 C.Y.
∴ DAILY/INTERMED. COVER = 3890 C.Y.

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANFILL IV
WASTE VOLUME CALCS.
DATE: 6/29/93
SHEET: 6 OF
ESO NO
COMPUTED: AAB.
CHECKED BY

6) A. EST. WASTE VOL. – PERM BERM to WEST BNDRY.
1. Vol. Top Cap to Fin. Gr. Bot. = 91,924 C.Y.
2. Vol. Cover = 18,284 C.Y.
Gross Vol. = 73,640 C.Y.

Est. Waste / Cover Ratio of 2:1
Waste Vol. = 49,093 C.Y. *
Daily, Intermediate Cover = 24,547 C.Y.

6) B. Est. Waste Vol. – PERM. BERM to PHASE I LIM.
1. Vol. Top Cap. to Fin. Gr. Bot. = 15,191 C.Y.
2. Vol. COVER – A = 8.44" = 21,088 ′
VOL. = 21,088 × 3.5 ÷ 27 = 2,734 C.Y.
GROSS VOL. = 12,457 C.Y.

EST. WASTE / COVER RATIO of 2:1
∴ WASTE VOL. = 8,305 C.Y. *
∴ DAILY / Intermed. COVER = 4,152 C.Y.

* QUANTITY DOES NOT INCLUDE CUT OUT VOLS. FOR WINDOWS THRU INITIAL COVER

EST. TOTAL DAILY / INTERMED & FINAL COVER VOL. FOR ENTIRE L.F. IV = 22,766 + 24,547 + 3890
= 51,203 C.Y.

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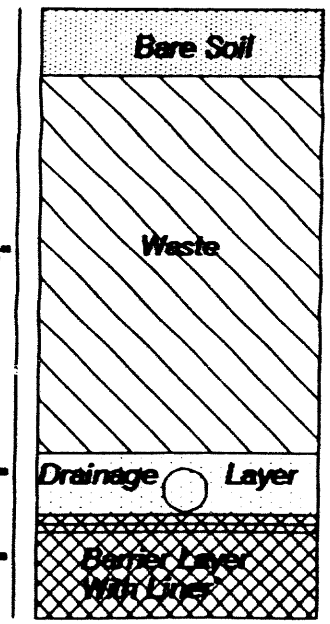
Description

The 3.2 acre site was modeled as an active landfill with four layer consisting of the following: (1) a cover layer, (2) a waste layer, (3) a drainage layer and (4) a barrier layer with a flexible membrane liner. Climatological data was generated by the HELP model for Knoxvill, Tn.

Below is the cross section used for the HELP 2 model



	Description	Layer Type	Soil Texture
6"	Bare Soil	Vertical Percolation	11
216"	Waste	Vertical Percolation	18
12"	Drainage Layer	Lateral Drainage	19
24"	Barrier Layer With Liner	Barrier w/Liner	16

Profile for Layer 3	
Porosity	0.3500
Field Capacity	0.1740
Wilting Point	0.1070
Initial Soil Water	0.1741
Sat. Hyd. Cond.	90.0
Drainage Length	100.0

GENERAL DESIGN AND COMPUTATION SHEET

JOB	DATE	SHEET
CALCULATION FOR LEACHATE STORAGE TANK		1 OF 1
ESO NO.	COMPUTED	CHECKED BY

MODELING RESULTS FROM HELP2
(ACTIVE LANDFILL)

- LATERAL DRAINAGE FROM LAYER 3 YIELDS 16,947 ft^3/yr

- RULE 1200-1-7-.04 (4) 7. (iii) (II)

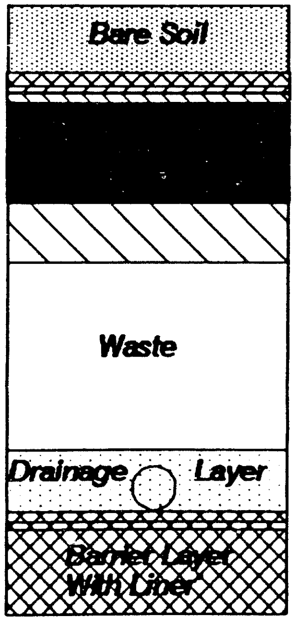
  HAVE SUFFICIENT CAPACITY TO STORE THE VOLUME OF LEACHATE EXPECTED TO BE GENERATED IN 30 DAYS, OR OTHER ADEQUATE PROVISIONS APPROVED BY THE COMMISSIONER;

$$16{,}947 \frac{ft^3}{yr} * 7.481 \frac{gal}{ft^3} * \frac{1\ yr}{365\ day} * 30 \frac{day}{month} = 10{,}420 \frac{gal}{month}$$

Description

The 3.2 acre site was modeled as a closed landfill with seven layer consisting of the following: (1) a vetetative layer, (2) a lateral drainage layer, (3) a barrier layer with a flexible membrane liner, (4) a vertical percolation layer, (5) a waste layer, (6) a drainage layer and (7) a barrier layer with a flexible membrane liner.

Below is the cross section used for the HELP 2 model



	Description	Layer Type	Soil Texture
18"	Bare Soil	Vertical Percolation	11
0.25"		Lateral Drainage	19
24"		Barrier w/Liner	16
12"		Vertical Percolation	11
216"	Waste	Vertical Percolation	18
12"	Drainage Layer	Lateral Drainage	19
24"	Barrier Layer With Liner	Barrier w/Liner	16

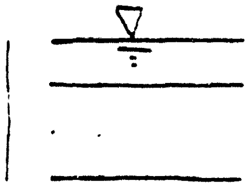
Profile for Layer 2

Porosity	0.90
Field Capacity	0.05
Wilting Point	0.02
Initial Soil Water	0.05
Sat. Hyd. Cond.	5.0
Drainage Length	100.0

GENERAL DESIGN AND COMPUTATION SHEET

JOB: Allowable Infiltration Through Final Cover | DATE: Feb. ... | SHEET of

ESO NO | COMPUTED | CHECKED BY



2' with 1×10^{-7} cm/s

DARCY'S LAW

$Q = KAi$ where
Q = Volume of water
K = Coeff. of permeability (ft/yr)
A = area (ft^2)
i = hydraulic gradient

$K = 1\times10^{-7}\frac{cm}{s} \times \frac{1\,in}{2.54\,cm} \times \frac{1\,ft}{12\,in} \times \frac{60\,sec}{1\,min} \times \frac{60\,min}{1\,hr} \times \frac{24\,hr}{1\,day} \times \frac{365\,day}{yr} = 0.1035\,\frac{ft}{yr}$

$A = 3.23\,acres \times 43,560\,\frac{ft^2}{acre} = 140,698\,ft^2$

$i = \Delta h/L = 3/2 = 1.5$

$Q = 0.1035\,\frac{ft}{yr} \times 140,698\,ft^2 \times 1.5 = 21,844\,ft^3/yr$

The final cover on the Class II Landfill must not allow an infiltration volume in excess of 21,845 ft^3/yr.

HELP2 modeling results for closed condition allows 90 ft^3/yr through cap.

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LANDFILL IV

SUMMARY OF STORM DRAINAGE AND SEDIMENTATION CALCULATIONS

The existing sedimentation basin for Landfill IV as designed and constructed was analyzed for stormwater and sedimentation adequacy. One design modification was assumed in the analysis and that was to add perforations in the riser pipe of the existing basin. The perforations would be 1 1/2" diameter holes in rows spaced at one foot vertically with 8 holes per row except for the two lower rows with 4 and 6 holes each respectively.

Based upon the Y-12 "Guidance for Erosion and Sediment Control Measures Applicable to Construction Projects at Y-12 Plant" dated May 1991, it was determined that the existing basin has more than adequate sediment capacity with 1560 C.Y. available and 315 C.Y. required. The above requirement is calculated on the basis that 67 C.Y. per acre of drainage area shall be available for sediment storage.

Using Soil Conservation Service methods incorporated into Haested Methods Quick TR-55 and Pond 2 software, the 4.7 Acre drainage area contributing to the sediment basin was analyzed for the 10, 25 and 100 year return frequency storms. With the perforated riser modification noted above, the principle spillway would not be used with outflows of 2.6 cfs., 3.3 cfs and 4.6 cfs for the respective design storms. The peak flow from a 10 year storm without detention would be 21 cfs. Proposed outfall rates are all less than the 10 year peak flow.

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV Sediment Basin
DATE: 5/21/93 | SHEET 1 of
ESO NO:
COMPUTED: AAB
CHECKED BY:

SEDIMENT BASIN VOLUME (As Designed)
Ref. Dwg. C2E 133303 by L.G.

Elev	Area	Incr. Vol. CF	Accum. Vol. CF	
1153.6	0			
		538		
1154	2691		538	0.37 AF Sediment Storage
		27,297	27,277 (US)	
1160	6408		27,835	
		14,292	0.967 AF	
1162	7884		42,127	1560 C.Y. Sediment Storage
		17,388		
1164	9504		59,516	0.47 AF Detention for Stormwater
		3,185	1.439 AF	
ES. 1164.33	9798		62,701	Emer. Spillway
		17,605		0.40A AF Spillway to Top
1166	11,286		80,306	Top Dike

SURFACE AREAS.

1. Tot. Area inside Active Landfill Bndry = 4.02 Ac
2. Area Inside Act. L.F. Bndry from Berm to West = 3.23 Ac.
3. Bottom L.F. Leachate Area = 2.62 Ac.

DRAINAGE AREA to 24" CMP @ S.W. Corner. Act.
Tot. Area Runoff = 4.02 + 0.66 = 4.68 Ac.
∴ 4.68 Ac. = Area to Sed. Basin.

Sub Areas:

Est. 50% Act. LF Area Bare Earth = 2.01 Ac
Est. 50% Act. L.F. Area Grass = 2.01 Ac
Gravel Rd. = 700' x 26' = 0.42 Ac
Grass Area Outside Act. LF = 0.24 Ac
Σ = 4.68 Ac.

Design 25 YR, 24 Hr.
[illegible] 24 Hr.

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GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV SEDIMENT BASIN	DATE: 5/25/93	SHEET 2 OF
ESO NO	COMPUTED: AAB	CHECKED BY

Vol. Sediment Basin to Prin. Spillway = 1560 CY

Tot. DRAINAGE AREA to SED. Basin = 4.7 Ac.

Per Y-12 "Guidance for Erosion & Sediment Control Measures Appl. to Constr. Proj's @ Y-12 Plant" dated May 1991 Allow for 67 CY/Ac. sediment Storage.

Vol. Req'd = 4.7 Ac @ 67 CY/Ac. = 315 CY.

Vol. Avail. to Prin. Spillway = 1560 CY.

∴ Sediment Storage Volume is OK.

GENERAL DESIGN AND COMPUTATION SHEET

JOB	DATE	SHEET
LANDFILL IV Sediment Basin	5/24/93	3 of

ESO NO	COMPUTED	CHECKED BY
	AAB	

Est. Perforated Riser Flow for Sediment Ponds.

A. Est. 8 Holes @ 1/2"Φ at each ft. depth Except lower 2 ft @ 4 & 6 Holes Resp.

$Q = CA\sqrt{2gh}$ $C = 0.6$ $A = 0.0123$ ft²/hole

Row #	Pond Depth	h	Q/hole	No. Holes	Q for Depth	Tot. Flow for Row
1	1	0	0	4	0	
	2	1	0.0592	4	0.2368	
	3	2	0.0838	4	0.3352	
	4	3	0.1026	4	0.4104	
	5	4	0.1184	4	0.4736	
	6	5	0.1324	4	0.5296	
	7	6	0.1451	4	0.5804	
	8	7	0.1567	4	0.6268	
	9	8	0.1675	4	0.6700	
	10	9	0.1777	4	0.7108	
2	2	0	0	6	0	
	3	1	0.0592	6	0.3552	
	4	2	0.0838	6	0.5028	
	5	3	0.1026	6	0.6156	
	6	4	0.1184	6	0.7104	
	7	5	0.1324	6	0.7944	
	8	6	0.1451	6	0.8706	
	9	7	0.1567	6	0.9402	
	10	8	0.1675	6	1.0050	
3	3	0	0	8	0	
	4	1	0.0592	8	0.4736	
	5	2	0.0838	8	0.6704	
	6	3	0.1026	8	0.8208	
	7	4	0.1184	8	0.9472	
	8	5	0.1324	8	1.0592	
	9	6	0.1451	8	1.1608	
	10	7	0.1567	8	1.2536	
4	4	0	0	8	0	
	5	1	0.0592	8	0.4736	
	6	2	0.0838	8	0.6704	
	7	3	0.1026	8	0.8208	
	8	4	0.1184	8	0.9472	
	9	5	0.1324	8	1.0592	
	10	6	0.1451	8	1.1608	

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV Sediment Basin.

DATE: 5/24/93 — SHEET: 4 of

ESO NO: — COMPUTED: AAB — CHECKED BY:

Row #	Pond Depth	h	Q/hole	No. Holes	Q for Depth
5	5	0	0	8	0
	6	1	0.0592	8	0.4736
	7	2	0.0838	8	0.6704
	8	3	0.1026	8	0.8208
	9	4	0.1184	8	0.9472
	10	5	0.1324	8	1.0592
6	6	0	0	8	0
	7	1	0.0592	8	0.4736
	8	2	0.0838	8	0.6704
	9	3	0.1026	8	0.8208
	10	4	0.1184	8	0.9472
7	7	0	0	8	0
	8	1	0.0592	8	0.4736
	9	2	0.0838	8	0.6704
	10	3	0.1026	8	0.8208
8	8	0	0	0	0
	9	1	0	0	0
	10	2	0	0	0

TOTAL FLOWS. thru Riser

Pond Depth	Tot. Flow
1'	0
2	0.2368
3	0.6904
4	1.3868
5	2.2332
6	3.2048
7.	4.2868
8	5.4686
9	6.2686
10	6.9574

Est. Tot. Flow thru Riser + Spillway

Spillway @ depth = 8.0

from Tab. 1, P.86 Knox Co.

Depth	Spill	Ris.	Tot.
8.5	6.0 +	5.87	= 11.8
9.0	17.1 +	6.27	= 23.37
9.5	22.5 +	6.61	= 29.11
10.0	26.1 +	6.96	= 33.06

- Tab. 2 p. 88

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Cut HARD. LF IV

GENERAL DESIGN AND COMPUTATION SHEET

JOB: LANDFILL IV Sediment Basin

DATE: 5/24/93 | SHEET: 5 of

ESO NO | COMPUTED: AAB | CHECKED BY

Compute Runoff Curve No. - Soil Group "C"

2.01 Ac. Newly Graded @ CN 91 = 182.91
2.01 Ac. Continuous Grass @ CN 71 = 142.71
0.42 Ac. GRAVEL RD @ CN 89 = 37.38
0.24 Ac. Grass (slopes) @ CN 74 = 17.76
4.68 Ac @ Avg. 81.36 Σ = 380.76
Use CN 81 Avg.

Intermed. Sediment Basin Volumes.

Elev.	Area.	Incr. Vol. - CF.	Accum. Vol. - CF.	
1154	2691			
		6498		
1156	3807		7036	0.1615 AF
		8820		
1158	5013		15,856	0.364
		11,421		
1160	6408		27,277	0.626

Compute Vol. Runoff from 10 yr. - 24 Hr. Storm
Runoff 2.81"
Area = 4.7 Ac.
Vol. = 2.81/12 × 4.7 = 1.10 A.F. Reqd.
0.97 AF. Avail. to
El. of Prin. Spillway

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Quick TR-55 Version: 4.04 S/N: 87011007

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN

CALCULATED 05-24-1993 13:38:28
DISK FILE : A:LFIV .GPD

Drainage Area	(acres)	4.7	0.0073 sq.mi.
Runoff Curve Number	(CN)	81	
Time of Concentration,Tc	(hrs)	0.1	
Rainfall Distribution	(Type)	II	
Pond and Swamp Areas	(%)		0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	10	25	
Rainfall, P, 24-hr (in)	4.8	5.5	
Initial Abstraction, Ia (in)	0.469	0.469	0.469
Ia/p Ratio	0.098	0.085	0.000
Unit Discharge, * qu (csm/in)	1010	1010	0
Runoff, Q (in)	2.81	3.43	0.00
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	21	25	0

Summary of Computations for qu

Ia/p	#1	0.100	0.100	0.000
C0	#1	2.553	2.553	0.000
C1	#1	-0.615	-0.615	0.000
C2	#1	-0.164	-0.164	0.000
qu (csm)	#1	1009.997	1009.997	0.000
Ia/p	#2	0.100	0.100	0.000
C0	#2	2.553	2.553	0.000
C1	#2	-0.615	-0.615	0.000
C2	#2	-0.164	-0.164	0.000
qu (csm)	#2	1009.997	1009.997	0.000
* qu (csm)		1010	1010	0

* 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.)

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-24-1993 14:49:41
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
25 YEAR STORM

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
AREA 1	4.70	81.0	0.10	0.00	5.50	3.43	.09 .10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 4.70 acres or 0.00734 sq.mi
Peak discharge = 25 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
AREA 1	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: 05-24-1993 14:49:41
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
25 YEAR STORM

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge (cfs)	Time to Peak at Composite Outfall (hrs)
AREA 1	25	12.1
Composite Watershed	25	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-24-1993 14:49:41
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
25 YEAR STORM

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
AREA 1	1	1	1	8	16	25	16	5	4
Total (cfs)	1	1	1	8	16	25	16	5	4

Subarea escription	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
AREA 1	3	3	2	2	2	1	1	1	1
Total (cfs)	3	3	2	2	2	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
AREA 1	1	1	1	1	1	1	1	1	0
Total (cfs)	1	1	1	1	1	1	1	1	0

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
AREA 1	0	0	0	0	0
Total (cfs)	0	0	0	0	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-24-1993 14:49:41
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
25 YEAR STORM

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	6	15.6	1
11.9	8	15.7	1
12.0	16	15.8	1
12.1	25	15.9	1
12.2	16	16.0	1
12.3	5	16.1	1
12.4	4	16.2	1
12.5	3	16.3	1
12.6	3	16.4	1
12.7	2	16.5	1
12.8	2	16.6	1
12.9	2	16.7	1
13.0	2	16.8	1
13.1	1	16.9	1
13.2	1	17.0	1
13.3	1	17.1	1
13.4	1	17.2	1
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
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: 05-24-1993 14:49:41
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
25 YEAR STORM

Time (hrs)	Flow (cfs)
18.6	0
18.7	0
18.8	0
18.9	0
19.0	0
19.1	0
19.2	0
19.3	0
19.4	0
19.5	0
19.6	0
19.7	0
19.8	0
19.9	0
20.0	0
20.1	0
20.2	0
20.3	0
20.4	0
20.5	0
20.6	0
20.7	0
20.8	0
20.9	0
21.0	0
21.1	0
21.2	0
21.3	0
21.4	0
21.5	0
21.6	0
21.7	0
21.8	0
21.9	0
22.0	0
22.1	0
22.2	0
22.3	0

Time (hrs)	Flow (cfs)
22.4	0
22.5	0
22.6	0
22.7	0
22.8	0
22.9	0
23.0	0
23.1	0
23.2	0
23.3	0
23.4	0
23.5	0
23.6	0
23.7	0
23.8	0
23.9	0
24.0	0
24.1	0
24.2	0
24.3	0
24.4	0
24.5	0
24.6	0
24.7	0
24.8	0
24.9	0
25.0	0
25.1	0
25.2	0
25.3	0
25.4	0
25.5	0
25.6	0
25.7	0
25.8	0
25.9	0

```
****************************************
*                                      *
*  LANDFILL IV ACTIVE LANDFILL BNDRY.  *
*                                      *
*                                      *
*                                      *
*                                      *
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```

EXECUTED 05-24-1993 14:51:51
Disk Files: A:LFIVD .PND ; A:LFIVO .HYD

INITIAL CONDITIONS
Elevation = 1154.00 ft
Outflow = 0.0 cfs

GIVEN POND DATA / COMPUTATIONS

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + 0 (cfs)
1154.00	0.0	0.01	2.9	2.9
1156.00	0.2	0.16	39.0	39.2
1158.00	1.4	0.36	88.1	89.5
1160.00	3.2	0.63	151.5	154.7
1162.00	5.5	0.97	234.0	239.5
1164.00	30.0	1.44	348.2	378.2
1166.00	51.0	1.84	446.2	497.2

Time increment (t) = 0.100 hrs.

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:51:51
Outflow Hydrograph: A:LFIVDO .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	1.0	-----	2.9	2.9	0.0	1154.00
11.100	1.0	2.0	4.9	4.9	0.0	1154.11
11.200	1.0	2.0	6.8	6.9	0.0	1154.22
11.300	1.0	2.0	8.7	8.8	0.0	1154.33
11.400	1.0	2.0	10.6	10.7	0.1	1154.43
11.500	1.0	2.0	12.5	12.6	0.1	1154.54
11.600	1.0	2.0	14.4	14.5	0.1	1154.64
11.700	3.0	4.0	18.2	18.4	0.1	1154.85
11.800	6.0	9.0	26.8	27.2	0.2	1155.34
11.900	8.0	14.0	40.3	40.8	0.3	1156.06
12.000	16.0	24.0	62.7	64.3	0.8	1157.00
12.100	25.0	41.0	100.1	103.7	1.8	1158.43
12.200	16.0	41.0	135.4	141.1	2.8	1159.58
12.300	5.0	21.0	149.9	156.4	3.2	1160.04
12.400	4.0	9.0	152.3	158.9	3.3	1160.10
12.500	3.0	7.0	152.7	159.3	3.3	1160.11
12.600	3.0	6.0	152.1	158.7	3.3	1160.09
12.700	2.0	5.0	150.5	157.1	3.3	1160.06
12.800	2.0	4.0	148.1	154.5	3.2	1160.00
12.900	2.0	4.0	145.9	152.1	3.1	1159.92
13.000	2.0	4.0	143.7	149.9	3.1	1159.85
13.100	2.0	4.0	141.7	147.7	3.0	1159.79
13.200	1.0	3.0	138.9	144.7	2.9	1159.69
13.300	1.0	2.0	135.3	140.9	2.8	1159.58
13.400	1.0	2.0	131.8	137.3	2.7	1159.47
13.500	1.0	2.0	128.6	133.8	2.6	1159.36
13.600	1.0	2.0	125.5	130.6	2.5	1159.26
13.700	1.0	2.0	122.6	127.5	2.4	1159.17
13.800	1.0	2.0	119.9	124.6	2.4	1159.08
13.900	1.0	2.0	117.3	121.9	2.3	1158.99
14.000	1.0	2.0	114.9	119.3	2.2	1158.92
14.100	1.0	2.0	112.6	116.9	2.2	1158.84
14.200	1.0	2.0	110.4	114.6	2.1	1158.77
14.300	1.0	2.0	108.4	112.4	2.0	1158.70
14.400	1.0	2.0	106.4	110.4	2.0	1158.64
14.500	1.0	2.0	104.6	108.4	1.9	1158.58
14.600	1.0	2.0	102.9	106.6	1.9	1158.52
14.700	1.0	2.0	101.2	104.9	1.8	1158.47
14.800	1.0	2.0	99.7	103.2	1.8	1158.42
14.900	1.0	2.0	98.2	101.7	1.7	1158.37
15.000	1.0	2.0	96.8	100.2	1.7	1158.33
15.100	1.0	2.0	95.5	98.8	1.6	1158.29
5.200	1.0	2.0	94.3	97.5	1.6	1158.25
15.300	1.0	2.0	93.2	96.3	1.6	1158.21
15.400	1.0	2.0	92.1	95.2	1.5	1158.17

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:51:51
Outflow Hydrograph: A:LFIVDO .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	1.0	2.0	91.0	94.1	1.5	1158.14
15.600	1.0	2.0	90.1	93.0	1.5	1158.11
15.700	1.0	2.0	89.1	92.1	1.5	1158.08
15.800	1.0	2.0	88.3	91.1	1.4	1158.05
15.900	1.0	2.0	87.4	90.3	1.4	1158.02
16.000	1.0	2.0	86.7	89.4	1.4	1158.00
16.100	1.0	2.0	85.9	88.7	1.4	1157.97
16.200	1.0	2.0	85.2	87.9	1.4	1157.94
16.300	1.0	2.0	84.5	87.2	1.3	1157.91
16.400	1.0	2.0	83.9	86.5	1.3	1157.88
16.500	1.0	2.0	83.3	85.9	1.3	1157.86
16.600	1.0	2.0	82.7	85.3	1.3	1157.83
16.700	1.0	2.0	82.1	84.7	1.3	1157.81
16.800	1.0	2.0	81.6	84.1	1.3	1157.79
16.900	1.0	2.0	81.1	83.6	1.3	1157.77
17.000	1.0	2.0	80.6	83.1	1.2	1157.75
17.100	1.0	2.0	80.1	82.6	1.2	1157.73
17.200	1.0	2.0	79.7	82.1	1.2	1157.71
17.300	0.0	1.0	78.3	80.7	1.2	1157.65
17.400	0.0	0.0	76.0	78.3	1.1	1157.56
17.500	0.0	0.0	73.9	76.0	1.1	1157.47
17.600	0.0	0.0	71.8	73.9	1.0	1157.38
17.700	0.0	0.0	69.8	71.8	1.0	1157.30
17.800	0.0	0.0	67.9	69.8	0.9	1157.22
17.900	0.0	0.0	66.2	67.9	0.9	1157.14
18.000	0.0	0.0	64.4	66.2	0.9	1157.07
18.100	0.0	0.0	62.8	64.4	0.8	1157.00
18.200	0.0	0.0	61.2	62.8	0.8	1156.94
18.300	0.0	0.0	59.8	61.2	0.7	1156.88
18.400	0.0	0.0	58.3	59.8	0.7	1156.82
18.500	0.0	0.0	57.0	58.3	0.7	1156.76
18.600	0.0	0.0	55.7	57.0	0.6	1156.71
18.700	0.0	0.0	54.5	55.7	0.6	1156.66
18.800	0.0	0.0	53.3	54.5	0.6	1156.61
18.900	0.0	0.0	52.2	53.3	0.6	1156.56
19.000	0.0	0.0	51.1	52.2	0.5	1156.52
19.100	0.0	0.0	50.1	51.1	0.5	1156.47
19.200	0.0	0.0	49.1	50.1	0.5	1156.43
19.300	0.0	0.0	48.1	49.1	0.5	1156.39
19.400	0.0	0.0	47.3	48.1	0.4	1156.36
19.500	0.0	0.0	46.4	47.3	0.4	1156.32
19.600	0.0	0.0	45.6	46.4	0.4	1156.29
19.700	0.0	0.0	44.8	45.6	0.4	1156.25
19.800	0.0	0.0	44.1	44.8	0.4	1156.22
19.900	0.0	0.0	43.4	44.1	0.4	1156.19
20.000	0.0	0.0	42.7	43.4	0.3	1156.17

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:51:51
Outflow Hydrograph: A:LFIVDO .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	0.0	0.0	42.1	42.7	0.3	1156.14
20.200	0.0	0.0	41.5	42.1	0.3	1156.11
20.300	0.0	0.0	40.9	41.5	0.3	1156.09
20.400	0.0	0.0	40.3	40.9	0.3	1156.07
20.500	0.0	0.0	39.8	40.3	0.3	1156.04
20.600	0.0	0.0	39.3	39.8	0.3	1156.02
20.700	0.0	0.0	38.8	39.3	0.2	1156.00
20.800	0.0	0.0	38.3	38.8	0.2	1155.98
20.900	0.0	0.0	37.9	38.3	0.2	1155.95
21.000	0.0	0.0	37.4	37.9	0.2	1155.93
21.100	0.0	0.0	36.9	37.4	0.2	1155.90
21.200	0.0	0.0	36.5	36.9	0.2	1155.88
21.300	0.0	0.0	36.0	36.5	0.2	1155.85
21.400	0.0	0.0	35.6	36.0	0.2	1155.83
21.500	0.0	0.0	35.2	35.6	0.2	1155.80
21.600	0.0	0.0	34.7	35.2	0.2	1155.78
21.700	0.0	0.0	34.3	34.7	0.2	1155.75
1.800	0.0	0.0	33.9	34.3	0.2	1155.73
21.900	0.0	0.0	33.5	33.9	0.2	1155.71
22.000	0.0	0.0	33.1	33.5	0.2	1155.69
22.100	0.0	0.0	32.7	33.1	0.2	1155.66
22.200	0.0	0.0	32.3	32.7	0.2	1155.64
22.300	0.0	0.0	31.9	32.3	0.2	1155.62
22.400	0.0	0.0	31.5	31.9	0.2	1155.60
22.500	0.0	0.0	31.2	31.5	0.2	1155.58
22.600	0.0	0.0	30.8	31.2	0.2	1155.56
22.700	0.0	0.0	30.4	30.8	0.2	1155.54
22.800	0.0	0.0	30.0	30.4	0.2	1155.52
22.900	0.0	0.0	29.7	30.0	0.2	1155.50
23.000	0.0	0.0	29.3	29.7	0.2	1155.48
23.100	0.0	0.0	29.0	29.3	0.2	1155.46
23.200	0.0	0.0	28.6	29.0	0.2	1155.44
23.300	0.0	0.0	28.3	28.6	0.2	1155.42
23.400	0.0	0.0	28.0	28.3	0.2	1155.40
23.500	0.0	0.0	27.6	28.0	0.2	1155.38
23.600	0.0	0.0	27.3	27.6	0.2	1155.36
23.700	0.0	0.0	27.0	27.3	0.2	1155.34
23.800	0.0	0.0	26.7	27.0	0.2	1155.33
23.900	0.0	0.0	26.3	26.7	0.2	1155.31
24.000	0.0	0.0	26.0	26.3	0.2	1155.29
24.100	0.0	0.0	25.7	26.0	0.2	1155.27
24.200	0.0	0.0	25.4	25.7	0.2	1155.26
24.300	0.0	0.0	25.1	25.4	0.1	1155.24
4.400	0.0	0.0	24.8	25.1	0.1	1155.22
24.500	0.0	0.0	24.5	24.8	0.1	1155.21
24.600	0.0	0.0	24.3	24.5	0.1	1155.19

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:51:51
Outflow Hydrograph: A:LFIVDO .HYD

INFLOW HYDROGRAPH / ROUTING COMPUTATIONS

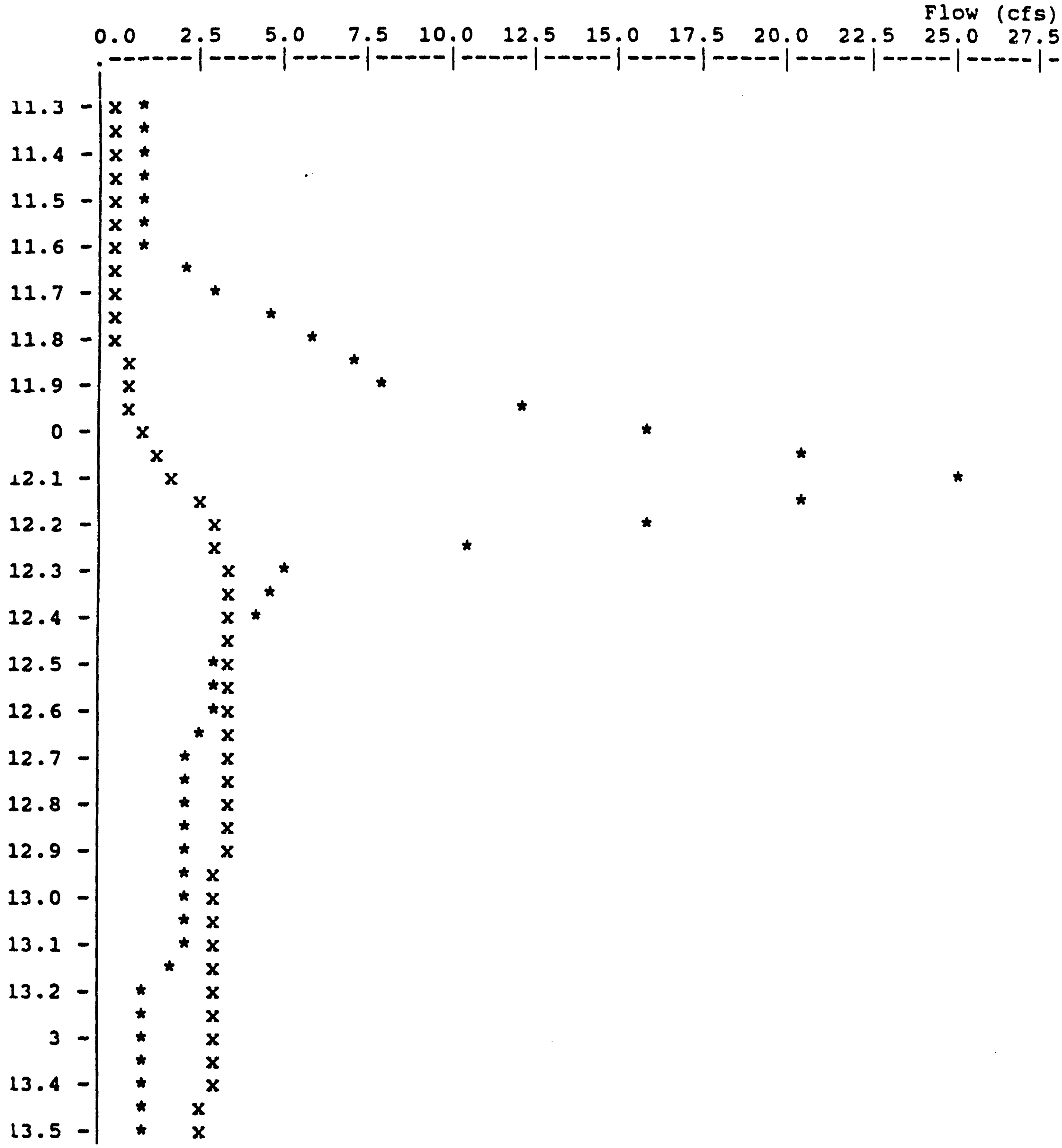
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.0	0.0	24.0	24.3	0.1	1155.18
24.800	0.0	0.0	23.7	24.0	0.1	1155.16
24.900	0.0	0.0	23.4	23.7	0.1	1155.15
25.000	0.0	0.0	23.2	23.4	0.1	1155.13
25.100	0.0	0.0	22.9	23.2	0.1	1155.12
25.200	0.0	0.0	22.6	22.9	0.1	1155.10
25.300	0.0	0.0	22.4	22.6	0.1	1155.09
25.400	0.0	0.0	22.1	22.4	0.1	1155.07
25.500	0.0	0.0	21.9	22.1	0.1	1155.06
25.600	0.0	0.0	21.6	21.9	0.1	1155.04
25.700	0.0	0.0	21.4	21.6	0.1	1155.03
25.800	0.0	0.0	21.1	21.4	0.1	1155.02
25.900	0.0	0.0	20.9	21.1	0.1	1155.00

Peak Inflow = 25.0 cfs
Peak Outflow = 3.3 cfs
Peak Elevation = 1160.11 ft

Pond File: A:LFIVD .PND
Inflow Hydrograph: A:LFIVO .HYD
Outflow Hydrograph: A:LFIVDO .HYD

EXECUTED: 05-24-1993
14:51:51

Peak Inflow = 25.0 cfs
Peak Outflow = 3.3 cfs
Peak Elevation = 1160.11 ft



TIME
(hrs)

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*  Inflow hydrograph  ---> A:LFIVO   .HYD
x  Outflow hydrograph ---> A:LFIVDO  .HYD
```

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-24-1993 13:46:56
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN

10 YR STORM

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
AREA 1	4.70	81.0	0.10	0.00	4.80	2.81	.1	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 4.70 acres or 0.00734 sq.mi
Peak discharge = 21 cfs

>>>> Computer Modifications of Input Parameters <<<<<

	Input Values		Rounded Values		Ia/p	
Subarea Description	Tc (hr)	* Tt (hr)	Tc (hr)	* Tt (hr)	Interpolated (Yes/No)	Ia/p Messages
AREA 1	0.10	0.00	**	**	No	--

* 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: 05-24-1993 13:46:56
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge (cfs)	Time to Peak at Composite Outfall (hrs)
AREA 1	21	12.1
Composite Watershed	21	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-24-1993 13:46:56
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN

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
AREA 1	0	1	1	7	13	21	13	4	3
Total (cfs)	0	1	1	7	13	21	13	4	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
AREA 1	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
AREA 1	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
AREA 1	0	0	0	0	0
Total (cfs)	0	0	0	0	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-24-1993 13:46:56
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN

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	3	15.5	1
11.8	5	15.6	1
11.9	7	15.7	1
12.0	13	15.8	0
12.1	21	15.9	0
12.2	13	16.0	0
12.3	4	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
14.6	1	18.4	0
14.7	1	18.5	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

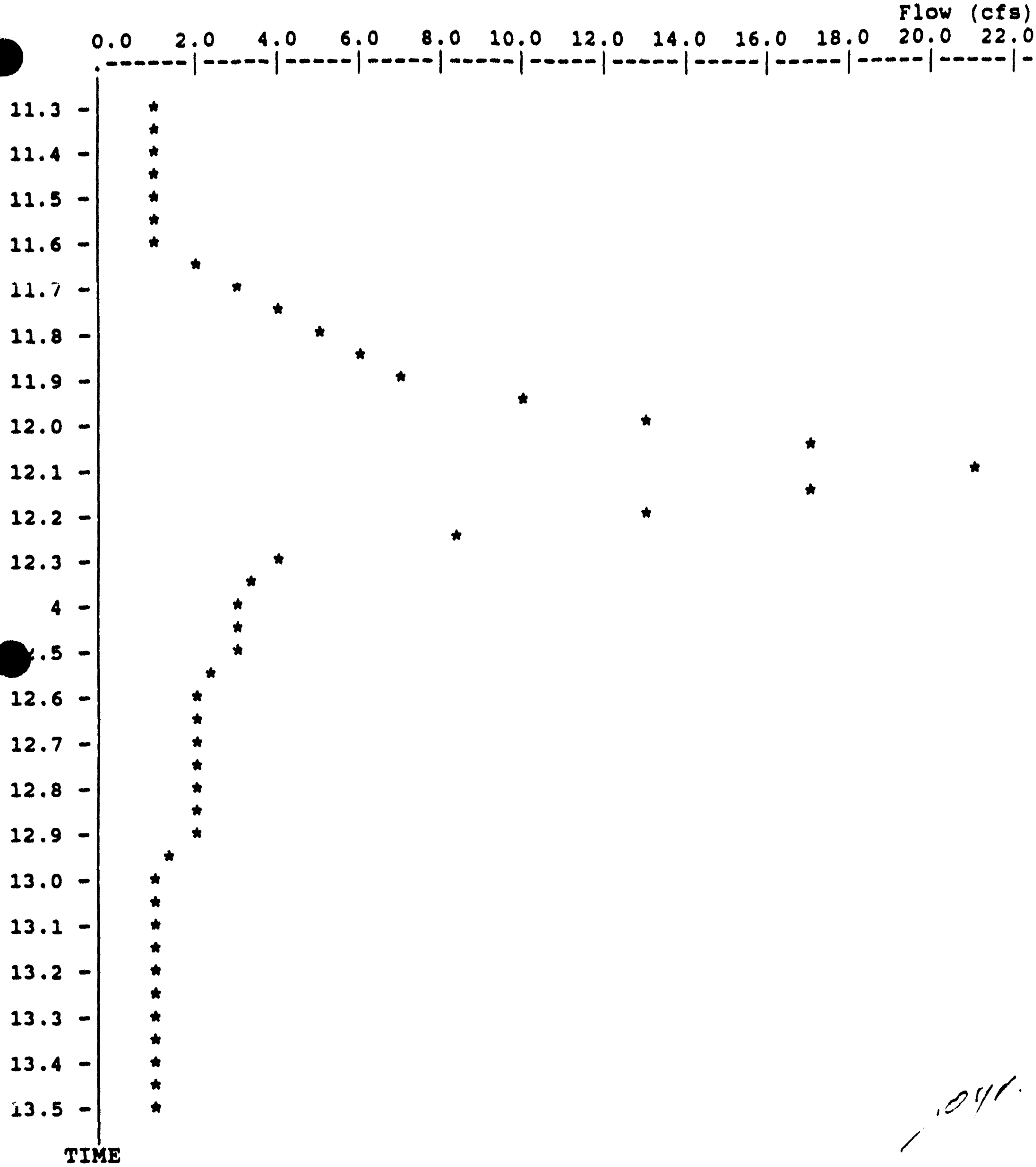
Executed: 05-24-1993 13:46:56
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN

Time (hrs)	Flow (cfs)
18.6	0
18.7	0
18.8	0
18.9	0
19.0	0
19.1	0
19.2	0
19.3	0
19.4	0
19.5	0
19.6	0
19.7	0
19.8	0
19.9	0
20.0	0
20.1	0
20.2	0
20.3	0
20.4	0
20.5	0
20.6	0
20.7	0
20.8	0
20.9	0
21.0	0
21.1	0
21.2	0
21.3	0
21.4	0
21.5	0
21.6	0
21.7	0
21.8	0
21.9	0
22.0	0
22.1	0
22.2	0
22.3	0

Time (hrs)	Flow (cfs)
22.4	0
22.5	0
22.6	0
22.7	0
22.8	0
22.9	0
23.0	0
23.1	0
23.2	0
23.3	0
23.4	0
23.5	0
23.6	0
23.7	0
23.8	0
23.9	0
24.0	0
24.1	0
24.2	0
24.3	0
24.4	0
24.5	0
24.6	0
24.7	0
24.8	0
24.9	0
25.0	0
25.1	0
25.2	0
25.3	0
25.4	0
25.5	0
25.6	0
25.7	0
25.8	0
25.9	0

Quick TR-55 Version: 4.04 S/N: 87011007



.041

(hrs) * Hydrograph file ---> A:LFIVO .HYD Qmax = 21.0 cfs

AIIM

Association for Information and Image Management
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

3 of 4

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*                                      *
*  LANDFILL IV ACTIVE LANDFILL BNDRY.  *
*                                      *
*                                      *
*                                      *
*                                      *
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EXECUTED 05-24-1993 14:30:09
Disk Files: A:LFIVD .PND ; A:LFIVO .HYD

INITIAL CONDITIONS
Elevation = 1154.00 ft
Outflow = 0.0 cfs

GIVEN POND DATA / COMPUTATIONS

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + 0 (cfs)
1154.00	0.0	0.01	2.9	2.9
1156.00	0.2	0.16	39.0	39.2
1158.00	1.4	0.36	88.1	89.5
1160.00	3.2	0.63	151.5	154.7
1162.00	5.5	0.97	234.0	239.5
1164.00	30.0	1.44	348.2	378.2
1166.00	51.0	1.84	446.2	497.2

Time increment (t) = 0.100 hrs.

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:30:09
Outflow Hydrograph: A:LFIVDO .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	0.0	-----	2.9	2.9	0.0	1154.00
11.100	0.0	0.0	2.9	2.9	0.0	1154.00
11.200	1.0	1.0	3.9	3.9	0.0	1154.06
11.300	1.0	2.0	5.9	5.9	0.0	1154.16
11.400	1.0	2.0	7.8	7.9	0.0	1154.27
11.500	1.0	2.0	9.7	9.8	0.0	1154.38
11.600	1.0	2.0	11.6	11.7	0.1	1154.48
11.700	3.0	4.0	15.4	15.6	0.1	1154.70
11.800	5.0	8.0	23.1	23.4	0.1	1155.13
11.900	7.0	12.0	34.7	35.1	0.2	1155.78
12.000	13.0	20.0	53.5	54.7	0.6	1156.62
12.100	21.0	34.0	84.8	87.5	1.3	1157.92
12.200	13.0	34.0	114.4	118.8	2.2	1158.90
12.300	4.0	17.0	126.3	131.4	2.6	1159.29
12.400	3.0	7.0	128.1	133.3	2.6	1159.34
12.500	3.0	6.0	128.8	134.1	2.6	1159.37
12.600	2.0	5.0	128.6	133.8	2.6	1159.36
12.700	2.0	4.0	127.4	132.6	2.6	1159.32
12.800	2.0	4.0	126.3	131.4	2.6	1159.29
12.900	2.0	4.0	125.3	130.3	2.5	1159.25
13.000	1.0	3.0	123.3	128.3	2.5	1159.19
13.100	1.0	2.0	120.6	125.3	2.4	1159.10
13.200	1.0	2.0	118.0	122.6	2.3	1159.01
13.300	1.0	2.0	115.5	120.0	2.2	1158.93
13.400	1.0	2.0	113.1	117.5	2.2	1158.86
13.500	1.0	2.0	110.9	115.1	2.1	1158.79
13.600	1.0	2.0	108.9	112.9	2.0	1158.72
13.700	1.0	2.0	106.9	110.9	2.0	1158.66
13.800	1.0	2.0	105.0	108.9	1.9	1158.60
13.900	1.0	2.0	103.3	107.0	1.9	1158.54
14.000	1.0	2.0	101.6	105.3	1.8	1158.48
14.100	1.0	2.0	100.1	103.6	1.8	1158.43
14.200	1.0	2.0	98.6	102.1	1.7	1158.39
14.300	1.0	2.0	97.2	100.6	1.7	1158.34
14.400	1.0	2.0	95.9	99.2	1.7	1158.30
14.500	1.0	2.0	94.6	97.9	1.6	1158.26
14.600	1.0	2.0	93.4	96.6	1.6	1158.22
14.700	1.0	2.0	92.3	95.4	1.6	1158.18
14.800	1.0	2.0	91.3	94.3	1.5	1158.15
14.900	1.0	2.0	90.3	93.3	1.5	1158.12
15.000	1.0	2.0	89.4	92.3	1.5	1158.09
15.100	1.0	2.0	88.5	91.4	1.4	1158.06
15.200	1.0	2.0	87.6	90.5	1.4	1158.03
15.300	1.0	2.0	86.8	89.6	1.4	1158.00
15.400	1.0	2.0	86.1	88.8	1.4	1157.97

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:30:09
Outflow Hydrograph: A:LFIVDO .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	1.0	2.0	85.4	88.1	1.4	1157.94
15.600	1.0	2.0	84.7	87.4	1.3	1157.92
15.700	1.0	2.0	84.0	86.7	1.3	1157.89
15.800	0.0	1.0	82.5	85.0	1.3	1157.82
15.900	0.0	0.0	80.0	82.5	1.2	1157.72
16.000	0.0	0.0	77.7	80.0	1.2	1157.62
16.100	0.0	0.0	75.4	77.7	1.1	1157.53
16.200	0.0	0.0	73.3	75.4	1.1	1157.44
16.300	0.0	0.0	71.2	73.3	1.0	1157.36
16.400	0.0	0.0	69.3	71.2	1.0	1157.27
16.500	0.0	0.0	67.4	69.3	0.9	1157.20
16.600	0.0	0.0	65.7	67.4	0.9	1157.12
16.700	0.0	0.0	64.0	65.7	0.8	1157.05
16.800	0.0	0.0	62.4	64.0	0.8	1156.99
16.900	0.0	0.0	60.8	62.4	0.8	1156.92
17.000	0.0	0.0	59.4	60.8	0.7	1156.86
17.100	0.0	0.0	58.0	59.4	0.7	1156.80
17.200	0.0	0.0	56.6	58.0	0.7	1156.75
17.300	0.0	0.0	55.3	56.6	0.6	1156.69
17.400	0.0	0.0	54.1	55.3	0.6	1156.64
17.500	0.0	0.0	53.0	54.1	0.6	1156.59
17.600	0.0	0.0	51.8	53.0	0.6	1156.55
17.700	0.0	0.0	50.8	51.8	0.5	1156.50
17.800	0.0	0.0	49.8	50.8	0.5	1156.46
17.900	0.0	0.0	48.8	49.8	0.5	1156.42
18.000	0.0	0.0	47.9	48.8	0.5	1156.38
18.100	0.0	0.0	47.0	47.9	0.4	1156.35
18.200	0.0	0.0	46.2	47.0	0.4	1156.31
18.300	0.0	0.0	45.4	46.2	0.4	1156.28
18.400	0.0	0.0	44.6	45.4	0.4	1156.25
18.500	0.0	0.0	43.9	44.6	0.4	1156.22
18.600	0.0	0.0	43.2	43.9	0.3	1156.19
18.700	0.0	0.0	42.5	43.2	0.3	1156.16
18.800	0.0	0.0	41.9	42.5	0.3	1156.13
18.900	0.0	0.0	41.3	41.9	0.3	1156.11
19.000	0.0	0.0	40.7	41.3	0.3	1156.08
19.100	0.0	0.0	40.2	40.7	0.3	1156.06
19.200	0.0	0.0	39.6	40.2	0.3	1156.04
19.300	0.0	0.0	39.1	39.6	0.3	1156.02
19.400	0.0	0.0	38.7	39.1	0.2	1156.00
19.500	0.0	0.0	38.2	38.7	0.2	1155.97
19.600	0.0	0.0	37.7	38.2	0.2	1155.94
19.700	0.0	0.0	37.3	37.7	0.2	1155.92
19.800	0.0	0.0	36.8	37.3	0.2	1155.89
19.900	0.0	0.0	36.4	36.8	0.2	1155.87
20.000	0.0	0.0	35.9	36.4	0.2	1155.84

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:30:09
Outflow Hydrograph: A:LFIVDO .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	0.0	0.0	35.5	35.9	0.2	1155.82
20.200	0.0	0.0	35.1	35.5	0.2	1155.80
20.300	0.0	0.0	34.6	35.1	0.2	1155.77
20.400	0.0	0.0	34.2	34.6	0.2	1155.75
20.500	0.0	0.0	33.8	34.2	0.2	1155.72
20.600	0.0	0.0	33.4	33.8	0.2	1155.70
20.700	0.0	0.0	33.0	33.4	0.2	1155.68
20.800	0.0	0.0	32.6	33.0	0.2	1155.66
20.900	0.0	0.0	32.2	32.6	0.2	1155.64
21.000	0.0	0.0	31.8	32.2	0.2	1155.61
21.100	0.0	0.0	31.4	31.8	0.2	1155.59
21.200	0.0	0.0	31.0	31.4	0.2	1155.57
21.300	0.0	0.0	30.7	31.0	0.2	1155.55
21.400	0.0	0.0	30.3	30.7	0.2	1155.53
21.500	0.0	0.0	29.9	30.3	0.2	1155.51
21.600	0.0	0.0	29.6	29.9	0.2	1155.49
21.700	0.0	0.0	29.2	29.6	0.2	1155.47
21.800	0.0	0.0	28.9	29.2	0.2	1155.45
21.900	0.0	0.0	28.5	28.9	0.2	1155.43
22.000	0.0	0.0	28.2	28.5	0.2	1155.41
22.100	0.0	0.0	27.9	28.2	0.2	1155.39
22.200	0.0	0.0	27.5	27.9	0.2	1155.38
22.300	0.0	0.0	27.2	27.5	0.2	1155.36
22.400	0.0	0.0	26.9	27.2	0.2	1155.34
22.500	0.0	0.0	26.6	26.9	0.2	1155.32
22.600	0.0	0.0	26.3	26.6	0.2	1155.30
22.700	0.0	0.0	26.0	26.3	0.2	1155.29
22.800	0.0	0.0	25.6	26.0	0.2	1155.27
22.900	0.0	0.0	25.3	25.6	0.2	1155.25
23.000	0.0	0.0	25.1	25.3	0.1	1155.24
23.100	0.0	0.0	24.8	25.1	0.1	1155.22
23.200	0.0	0.0	24.5	24.8	0.1	1155.20
23.300	0.0	0.0	24.2	24.5	0.1	1155.19
23.400	0.0	0.0	23.9	24.2	0.1	1155.17
23.500	0.0	0.0	23.6	23.9	0.1	1155.16
23.600	0.0	0.0	23.4	23.6	0.1	1155.14
23.700	0.0	0.0	23.1	23.4	0.1	1155.13
23.800	0.0	0.0	22.8	23.1	0.1	1155.11
23.900	0.0	0.0	22.6	22.8	0.1	1155.10
24.000	0.0	0.0	22.3	22.6	0.1	1155.08
24.100	0.0	0.0	22.0	22.3	0.1	1155.07
24.200	0.0	0.0	21.8	22.0	0.1	1155.05
24.300	0.0	0.0	21.5	21.8	0.1	1155.04
4.400	0.0	0.0	21.3	21.5	0.1	1155.03
24.500	0.0	0.0	21.0	21.3	0.1	1155.01
24.600	0.0	0.0	20.8	21.0	0.1	1155.00

Pond File: A:LFIVD .PND EXECUTED: 05-24-1993
Inflow Hydrograph: A:LFIVO .HYD 14:30:09
Outflow Hydrograph: A:LFIVDO .HYD

INFLOW HYDROGRAPH / ROUTING COMPUTATIONS

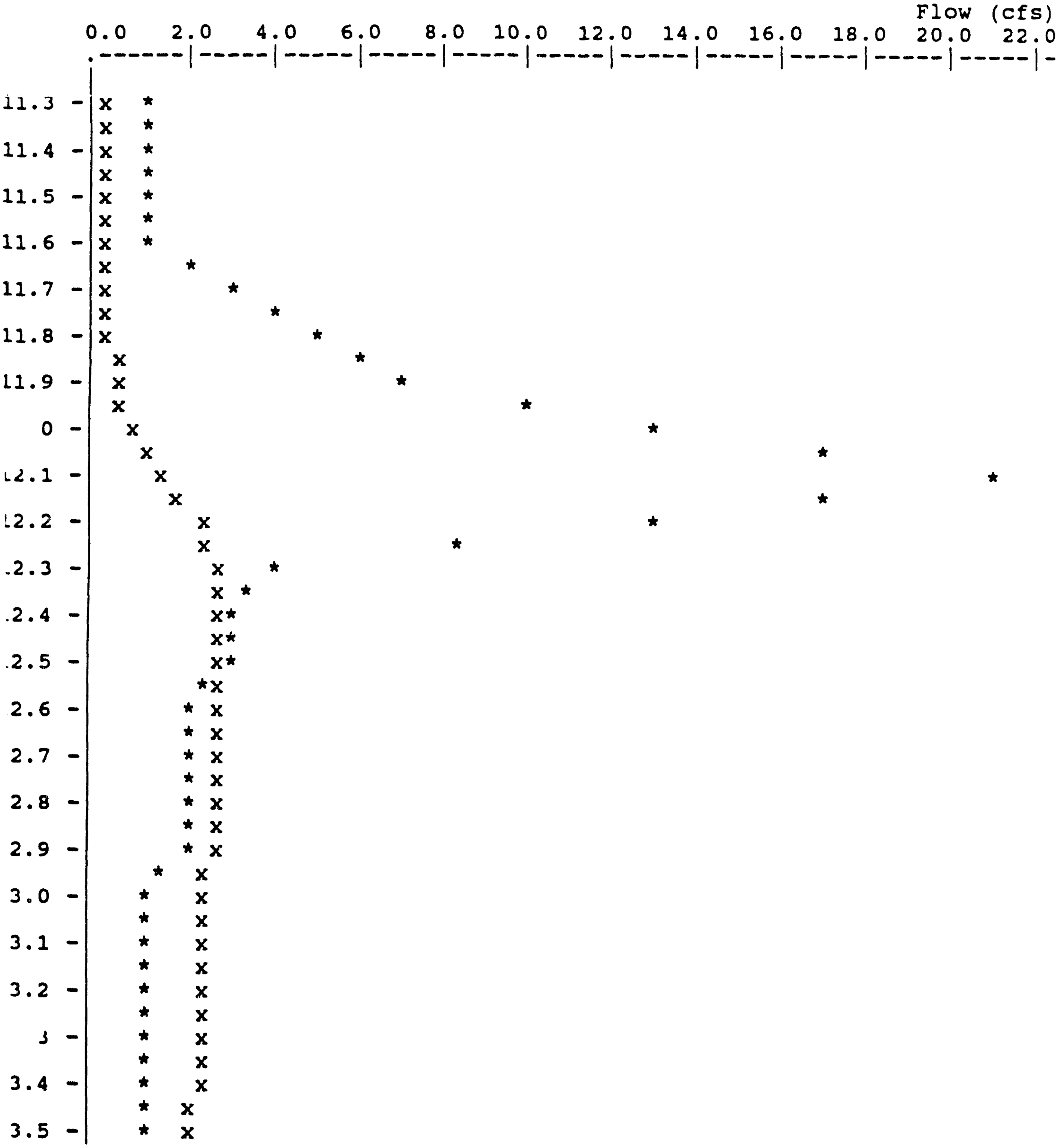
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.0	0.0	20.6	20.8	0.1	1154.99
24.800	0.0	0.0	20.3	20.6	0.1	1154.97
24.900	0.0	0.0	20.1	20.3	0.1	1154.96
25.000	0.0	0.0	19.9	20.1	0.1	1154.95
25.100	0.0	0.0	19.7	19.9	0.1	1154.94
25.200	0.0	0.0	19.4	19.7	0.1	1154.92
25.300	0.0	0.0	19.2	19.4	0.1	1154.91
25.400	0.0	0.0	19.0	19.2	0.1	1154.90
25.500	0.0	0.0	18.8	19.0	0.1	1154.89
25.600	0.0	0.0	18.6	18.8	0.1	1154.87
25.700	0.0	0.0	18.4	18.6	0.1	1154.86
25.800	0.0	0.0	18.2	18.4	0.1	1154.85
25.900	0.0	0.0	18.0	18.2	0.1	1154.84

Peak Inflow = 21.0 cfs
Peak Outflow = 2.6 cfs
Peak Elevation = 1159.37 ft

Pond File: A:LFIVD .PND
Inflow Hydrograph: A:LFIVO .HYD
Outflow Hydrograph: A:LFIVDO .HYD

EXECUTED: 05-24-1993
14:30:09

Peak Inflow = 21.0 cfs
Peak Outflow = 2.6 cfs
Peak Elevation = 1159.37 ft



TIME
(hrs)

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* Inflow hydrograph  ---> A:LFIVO    .HYD
x Outflow hydrograph ---> A:LFIVDO   .HYD
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TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-25-1993 09:48:15
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
100 YEAR STORM

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
AREA 1	4.70	81.0	0.10	0.00	6.50	4.34	.07 .10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 4.70 acres or 0.00734 sq.mi
Peak discharge = 32 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
AREA 1	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: 05-25-1993 09:48:15
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
100 YEAR STORM

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge (cfs)	Time to Peak at Composite Outfall (hrs)
AREA 1	32	12.1
Composite Watershed	32	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-25-1993 09:48:15
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
100 YEAR STORM

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
AREA 1	1	1	2	11	21	32	20	7	5
Total (cfs)	1	1	2	11	21	32	20	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
AREA 1	4	3	3	2	2	2	2	1	1
Total (cfs)	4	3	3	2	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
AREA 1	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
AREA 1	1	0	0	0	0
Total (cfs)	1	0	0	0	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-25-1993 09:48:15
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
100 YEAR STORM

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	21	15.8	1
12.1	32	15.9	1
12.2	20	16.0	1
12.3	7	16.1	1
12.4	5	16.2	1
12.5	4	16.3	1
12.6	3	16.4	1
12.7	3	16.5	1
12.8	2	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
14.6	1	18.4	1
14.7	1	18.5	1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 05-25-1993 09:48:15
Watershed File --> A:LFIV .WSD Hydrograph File --> A:LFIVO .HYD

LANDFILL IV ACTIVE WATERSHED AREA TO SEDIMENT BASIN
100 YEAR STORM

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		

LANDFILL IV ACTIVE LANDFILL BNDRY.

EXECUTED 05-25-1993 09:50:59
Disk Files: A:LFIVD .PND ; A:LFIVO .HYD

INITIAL CONDITIONS
Elevation = 1154.00 ft
Outflow = 0.0 cfs

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
1154.00	0.0	0.01
1156.00	0.2	0.16
1158.00	1.4	0.36
1160.00	3.2	0.63
1162.00	5.5	0.97
1164.00	30.0	1.44
1166.00	51.0	1.84

COMPUTATIONS

2S/t (cfs)	2S/t + 0 (cfs)
2.9	2.9
39.0	39.2
88.1	89.5
151.5	154.7
234.0	239.5
348.2	378.2
446.2	497.2

Time increment (t) = 0.100 hrs.

POND-2 Version: 4.03 S/N: 88020702

Pond File: A:LFIVD .PND EXECUTED: 05-25-1993
.flow Hydrograph: A:LFIVO .HYD 09:50:59
Outflow Hydrograph: A:LFIVDO .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	1.0	-----	2.9	2.9	0.0	1154.00
11.100	1.0	2.0	4.9	4.9	0.0	1154.11
11.200	1.0	2.0	6.8	6.9	0.0	1154.22
11.300	1.0	2.0	8.7	8.8	0.0	1154.33
11.400	1.0	2.0	10.6	10.7	0.1	1154.43
11.500	2.0	3.0	13.5	13.6	0.1	1154.59
11.600	2.0	4.0	17.3	17.5	0.1	1154.80
11.700	5.0	7.0	24.0	24.3	0.1	1155.18
11.800	8.0	13.0	36.6	37.0	0.2	1155.88
11.900	11.0	19.0	54.3	55.6	0.6	1156.65
12.000	21.0	32.0	83.7	86.3	1.3	1157.88
12.100	32.0	53.0	131.3	136.7	2.7	1159.45
12.200	20.0	52.0	175.4	183.3	4.0	1160.67
12.300	7.0	27.0	193.4	202.4	4.5	1161.12
12.400	5.0	12.0	196.3	205.4	4.6	1161.20
12.500	4.0	9.0	196.2	205.3	4.6	1161.19
12.600	3.0	7.0	194.2	203.2	4.5	1161.14
2.700	3.0	6.0	191.4	200.2	4.4	1161.07
12.800	2.0	5.0	187.7	196.4	4.3	1160.98
12.900	2.0	4.0	183.3	191.7	4.2	1160.87
13.000	2.0	4.0	179.2	187.3	4.1	1160.77
13.100	2.0	4.0	175.3	183.2	4.0	1160.67
13.200	2.0	4.0	171.6	179.3	3.9	1160.58
13.300	2.0	4.0	168.0	175.6	3.8	1160.49
13.400	2.0	4.0	164.7	172.0	3.7	1160.41
13.500	2.0	4.0	161.6	168.7	3.6	1160.33
13.600	1.0	3.0	157.6	164.6	3.5	1160.23
13.700	1.0	2.0	153.0	159.6	3.3	1160.12
13.800	1.0	2.0	148.6	155.0	3.2	1160.01
13.900	1.0	2.0	144.4	150.6	3.1	1159.87
14.000	1.0	2.0	140.4	146.4	3.0	1159.75
14.100	1.0	2.0	136.7	142.4	2.9	1159.62
14.200	1.0	2.0	133.2	138.7	2.8	1159.51
14.300	1.0	2.0	129.9	135.2	2.7	1159.40
14.400	1.0	2.0	126.8	131.9	2.6	1159.30
14.500	1.0	2.0	123.8	128.8	2.5	1159.20
14.600	1.0	2.0	121.0	125.8	2.4	1159.11
14.700	1.0	2.0	118.4	123.0	2.3	1159.03
14.800	1.0	2.0	115.9	120.4	2.2	1158.95
14.900	1.0	2.0	113.5	117.9	2.2	1158.87
15.000	1.0	2.0	111.3	115.5	2.1	1158.80
15.100	1.0	2.0	109.2	113.3	2.1	1158.73
15.200	1.0	2.0	107.2	111.2	2.0	1158.67
5.300	1.0	2.0	105.3	109.2	1.9	1158.60
15.400	1.0	2.0	103.6	107.3	1.9	1158.55

Pond File: A:LFIVD .PND EXECUTED: 05-25-1993
Inflow Hydrograph: A:LFIVO .HYD 09:50:59
Outflow Hydrograph: A:LFIVDO .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	1.0	2.0	101.9	105.6	1.8	1158.49
15.600	1.0	2.0	100.3	103.9	1.8	1158.44
15.700	1.0	2.0	98.8	102.3	1.7	1158.39
15.800	1.0	2.0	97.4	100.8	1.7	1158.35
15.900	1.0	2.0	96.1	99.4	1.7	1158.30
16.000	1.0	2.0	94.8	98.1	1.6	1158.26
16.100	1.0	2.0	93.6	96.8	1.6	1158.22
16.200	1.0	2.0	92.5	95.6	1.6	1158.19
16.300	1.0	2.0	91.4	94.5	1.5	1158.15
16.400	1.0	2.0	90.4	93.4	1.5	1158.12
16.500	1.0	2.0	89.5	92.4	1.5	1158.09
16.600	1.0	2.0	88.6	91.5	1.4	1158.06
16.700	1.0	2.0	87.8	90.6	1.4	1158.03
16.800	1.0	2.0	87.0	89.8	1.4	1158.01
16.900	1.0	2.0	86.2	89.0	1.4	1157.98
17.000	1.0	2.0	85.5	88.2	1.4	1157.95
17.100	1.0	2.0	84.8	87.5	1.3	1157.92
17.200	1.0	2.0	84.1	86.8	1.3	1157.89
17.300	1.0	2.0	83.5	86.1	1.3	1157.87
17.400	1.0	2.0	82.9	85.5	1.3	1157.84
17.500	1.0	2.0	82.3	84.9	1.3	1157.82
17.600	1.0	2.0	81.8	84.3	1.3	1157.80
17.700	1.0	2.0	81.3	83.8	1.3	1157.77
17.800	1.0	2.0	80.8	83.3	1.2	1157.75
17.900	1.0	2.0	80.3	82.8	1.2	1157.73
18.000	1.0	2.0	79.9	82.3	1.2	1157.71
18.100	1.0	2.0	79.4	81.9	1.2	1157.70
18.200	1.0	2.0	79.0	81.4	1.2	1157.68
18.300	1.0	2.0	78.6	81.0	1.2	1157.66
18.400	1.0	2.0	78.2	80.6	1.2	1157.65
18.500	0.0	1.0	76.9	79.2	1.2	1157.59
18.600	0.0	0.0	74.7	76.9	1.1	1157.50
18.700	0.0	0.0	72.6	74.7	1.1	1157.41
18.800	0.0	0.0	70.6	72.6	1.0	1157.33
18.900	0.0	0.0	68.7	70.6	1.0	1157.25
19.000	0.0	0.0	66.9	68.7	0.9	1157.17
19.100	0.0	0.0	65.1	66.9	0.9	1157.10
19.200	0.0	0.0	63.5	65.1	0.8	1157.03
19.300	0.0	0.0	61.9	63.5	0.8	1156.96
19.400	0.0	0.0	60.4	61.9	0.8	1156.90
19.500	0.0	0.0	58.9	60.4	0.7	1156.84
19.600	0.0	0.0	57.5	58.9	0.7	1156.78
19.700	0.0	0.0	56.2	57.5	0.7	1156.73
.800	0.0	0.0	54.9	56.2	0.6	1156.68
19.900	0.0	0.0	53.7	54.9	0.6	1156.63
20.000	0.0	0.0	52.6	53.7	0.6	1156.58

Pond File: A:LFIVD .PND EXECUTED: 05-25-1993
Inflow Hydrograph: A:LFIVO .HYD 09:50:59
Outflow Hydrograph: A:LFIVDO .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	0.0	0.0	51.5	52.6	0.5	1156.53
20.200	0.0	0.0	50.5	51.5	0.5	1156.49
20.300	0.0	0.0	49.5	50.5	0.5	1156.45
20.400	0.0	0.0	48.5	49.5	0.5	1156.41
20.500	0.0	0.0	47.6	48.5	0.5	1156.37
20.600	0.0	0.0	46.7	47.6	0.4	1156.33
20.700	0.0	0.0	45.9	46.7	0.4	1156.30
20.800	0.0	0.0	45.1	45.9	0.4	1156.27
20.900	0.0	0.0	44.4	45.1	0.4	1156.24
21.000	0.0	0.0	43.7	44.4	0.4	1156.21
21.100	0.0	0.0	43.0	43.7	0.3	1156.18
21.200	0.0	0.0	42.3	43.0	0.3	1156.15
21.300	0.0	0.0	41.7	42.3	0.3	1156.12
21.400	0.0	0.0	41.1	41.7	0.3	1156.10
21.500	0.0	0.0	40.5	41.1	0.3	1156.08
21.600	0.0	0.0	40.0	40.5	0.3	1156.05
21.700	0.0	0.0	39.5	40.0	0.3	1156.03
21.800	0.0	0.0	39.0	39.5	0.2	1156.01
21.900	0.0	0.0	38.5	39.0	0.2	1155.99
22.000	0.0	0.0	38.0	38.5	0.2	1155.96
22.100	0.0	0.0	37.6	38.0	0.2	1155.94
22.200	0.0	0.0	37.1	37.6	0.2	1155.91
22.300	0.0	0.0	36.7	37.1	0.2	1155.89
22.400	0.0	0.0	36.2	36.7	0.2	1155.86
22.500	0.0	0.0	35.8	36.2	0.2	1155.84
22.600	0.0	0.0	35.3	35.8	0.2	1155.81
22.700	0.0	0.0	34.9	35.3	0.2	1155.79
22.800	0.0	0.0	34.5	34.9	0.2	1155.76
22.900	0.0	0.0	34.1	34.5	0.2	1155.74
23.000	0.0	0.0	33.7	34.1	0.2	1155.72
23.100	0.0	0.0	33.3	33.7	0.2	1155.69
23.200	0.0	0.0	32.9	33.3	0.2	1155.67
23.300	0.0	0.0	32.5	32.9	0.2	1155.65
23.400	0.0	0.0	32.1	32.5	0.2	1155.63
23.500	0.0	0.0	31.7	32.1	0.2	1155.61
23.600	0.0	0.0	31.3	31.7	0.2	1155.59
23.700	0.0	0.0	30.9	31.3	0.2	1155.56
23.800	0.0	0.0	30.6	30.9	0.2	1155.54
23.900	0.0	0.0	30.2	30.6	0.2	1155.52
24.000	0.0	0.0	29.8	30.2	0.2	1155.50
24.100	0.0	0.0	29.5	29.8	0.2	1155.48
24.200	0.0	0.0	29.1	29.5	0.2	1155.46
24.300	0.0	0.0	28.8	29.1	0.2	1155.44
24.400	0.0	0.0	28.4	28.8	0.2	1155.43
24.500	0.0	0.0	28.1	28.4	0.2	1155.41
24.600	0.0	0.0	27.8	28.1	0.2	1155.39

Pond File: A:LFIVD .PND EXECUTED: 05-25-1993
Inflow Hydrograph: A:LFIVO .HYD 09:50:59
Outflow Hydrograph: A:LFIVDO .HYD

INFLOW HYDROGRAPH / ROUTING COMPUTATIONS

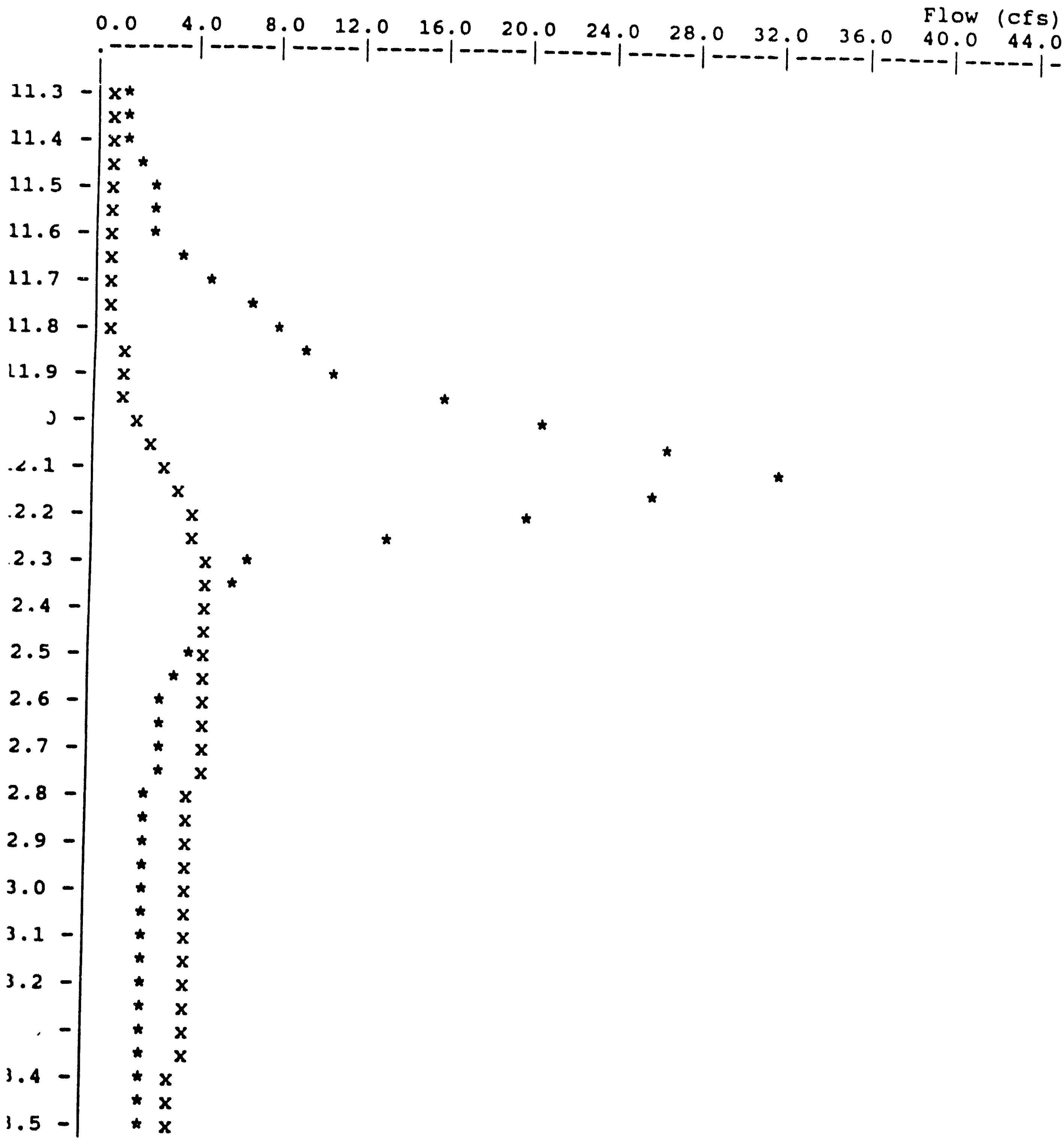
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.0	0.0	27.4	27.8	0.2	1155.37
24.800	0.0	0.0	27.1	27.4	0.2	1155.35
24.900	0.0	0.0	26.8	27.1	0.2	1155.33
25.000	0.0	0.0	26.5	26.8	0.2	1155.32
25.100	0.0	0.0	26.2	26.5	0.2	1155.30
25.200	0.0	0.0	25.9	26.2	0.2	1155.28
25.300	0.0	0.0	25.6	25.9	0.2	1155.26
25.400	0.0	0.0	25.3	25.6	0.1	1155.25
25.500	0.0	0.0	25.0	25.3	0.1	1155.23
25.600	0.0	0.0	24.7	25.0	0.1	1155.22
25.700	0.0	0.0	24.4	24.7	0.1	1155.20
25.800	0.0	0.0	24.1	24.4	0.1	1155.18
25.900	0.0	0.0	23.8	24.1	0.1	1155.17

Peak Inflow = 32.0 cfs
Peak Outflow = 4.6 cfs
Peak Elevation = 1161.20 ft

Pond File: A:LFIVD .PND
Inflow Hydrograph: A:LFIVO .HYD
Outflow Hydrograph: A:LFIVDO .HYD

EXECUTED: 05-25-1993
09:50:59

Peak Inflow = 32.0 cfs
Peak Outflow = 4.6 cfs
Peak Elevation = 1161.20 ft



TIME
(hrs)

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*  Inflow hydrograph  ---> A:LFIVO    .HYD
x  Outflow hydrograph ---> A:LFIVDO   .HYD
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Construction Quality Control

The following plans are to be used for quality control during composite liner installation and again during final closure. Overall project quality control will be the responsibility of the Construction Quality Control (CQC) Officer. The officer will ensure that all aspects of the landfill liner and closure cap are installed in accordance with the requirements of Project drawings and specifications. The CQC officer will be a registered Engineer in the State of Tennessee experienced in the inspection of construction projects.

Installation of the low permeability clay layers and geosynthetic materials will be inspected by Construction Quality Control (CQC) Inspectors. Inspector qualifications, responsibilities, activities, and sampling strategies are detailed in the Construction Quality Control Procedures for Soils and Geosynthetic Materials. Final reports will be issued by each inspector which summarize test results and document compliance with project requirements.

The CQC Officer will monitor the contractors work and inspection activities performed by the CQC inspector. After reviewing all final reports, the CQC officer will issue a letter stating that the landfill liner or closure cap is installed in accordance with project requirements.

Construction Quality Control Procedures for Soils

Industrial Landfill IV
Y-12 Plant

Oak Ridge, Tennessee

Prepared By

Civil, Site and Waste Management Design
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee

Table of Contents

FOREWORD

Industrial Waste Landfill IV is an existing unlined landfill located on Chestnut Ridge south of the Y-12 Plant. It is currently classified under Tennessee Department of Environment and Conservation/Division of Solid Waste Management (TDEC/DSWM) as a Class II disposal unit. Modifications to the landfill are being made to bring the landfill into compliance with revised TDEC/DSWM regulations. The modifications to the landfill include separating the unlined area which is currently accepting waste from future disposal areas by an earth berm and lining an initial section of the future disposal area. The section to be lined is approximately 100 feet by 220 feet and will consist of a composite liner, leachate collection system and gas migration controls. Soil will be used for the construction of the earth berm, a landfill liner, roads and drainage channels.

The Construction Quality Control Procedures for Soils for Industrial Landfill IV outlines the construction quality control activities provided by the Construction Quality Control Inspection Personnel (CQC Inspector). This document also defines construction quality control procedures and quality assurance documentation for the placement and compaction of soil fill.

The Construction Quality Control Procedure for Soils presents guidelines for the following five general elements:

1. Required qualifications of construction quality control personnel.

2. Specific responsibilities for the construction quality control personnel.

3. Types of inspections (observations and tests) to be performed as part of construction quality control activities.

4. Sampling strategies (including sampling frequency, size, and location; acceptance and rejection criteria; and corrective action implementation).

5. Documentation of construction quality control activities.

SECTION 1: CQC PERSONNEL QUALIFICATIONS

Section 1A - Personnel

The Construction Quality Control personnel for this project shall be as described below.

A. CQC Inspection Personnel -- shall possess adequate formal academic training and sufficient practical, technical and administrative experience to execute and record inspection activities successfully. This should include demonstrated knowledge of specific field practices relating to construction techniques used for placement and compaction of soil fill including test methods, test equipment, documentation procedures, and site safety.

B. The technical and administrative personnel shall possess adequate formal academic training in engineering, engineering geology or closely associated disciplines and possess sufficient practical, technical and managerial experience to successfully oversee and implement construction quality control.

C. All technical and inspection personnel shall work under the direct supervision of an engineer registered in the state of Tennessee in accordance with the requirements of Rule 1200-1-7-.04(1)(C) of the State of Tennessee Department of Environment and Conservation governing solid waste disposal facilities.

SECTION 2: RESPONSIBILITIES OF THE CQC PERSONNEL

Section 2A - Specific Responsibilities

For the CQC Inspection Personnel, specific responsibilities include:

A. Performing independent on-site inspection of the work in progress to assess compliance with the facility plans and specifications.

B. Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by this CQC procedure document.

C. Reporting results of all inspections including work that is not of acceptable quality or that fails to meet the specified design. Recommending corrective measures for unacceptable work.

SECTION 3: SOIL CONSTRUCTION INSPECTION ACTIVITIES

The following Sections identify and describe the observations and tests that will be used to evaluate field conformance with the design plans, and specifications for soil placement and compaction.

Section 3A -- Project Meeting

Periodic meetings shall be held as required at the request of the Construction Manager during the life of the project to strengthen responsibility and authority and enhance communication between personnel responsible for designing, inspecting and constructing the landfill liner or final cap system.

Section 3B -- General Preconstruction Activities

CQC Inspection Personnel will review soils data and site conditions prior to commencement of construction activities.

A. Liner Soil:

The area to be lined will be excavated, replaced in lifts not to exceed 6 inches compacted to create a low-permeability clay liner a minimum of 24 inches thick. The bulk of the soil used for the liner shall be on-site soil. Any additional soil required for backfill shall be either on-site soils or borrow soil which meets all spec requirements. Extensive testing has been performed on Chestnut Ridge soils and test information will be made available to the CQC Inspection personnel.

B. Material Inspection:

Soil fill materials shall be inspected for uniformity and consistency with project specifications. Material inspection begins as a preconstruction activity and continues throughout the construction period. Materials obtained at the project site can be inspected as the material is excavated. All unsuitable material shall be rejected. It is the CQC inspector's responsibility to notify the Construction Manager immediately of any unsuitable material. It may be necessary for inspection personnel to guide excavating equipment to avoid or segregate substandard soil material as it is excavated. CQC Inspection Personnel shall observe segregation operations carefully and continuously.

Initial inspection of the soil can be largely visual; however, CQC Inspection Personnel must be experienced with visual-manual soil classification techniques. In addition to observations, a sufficient number of soil tests shall be performed by the CQC

Inspection personnel to properly identify the soil, understand its compaction characteristics, and ensure that the soil meets the project specifications. Testing shall be as required, and may include the following: soil moisture-density relationships, and natural moisture content.

C. Reference Documents:

1. Project Specifications:

Industrial Landfill IV, Y-12
Martin Marietta Energy Systems
Oak Ridge, Tennessee

2. Borrow Area Soil Test Reports

Proposed Three Plant Borrow Area, Bear Creek Road
Oak Ridge, Tennessee; 12/21/87 (GA File No. 87-0372K)
Engineering, Design & Geosciences Group, Inc.
Knoxville, Tn. (now OGDEN)

Supplemental Fill Soil Exploration, Y-12 West Borrow Area Soils, Oak Ridge, Tennessee; 10/23/90
(Westinghouse Project No. 1401-88-013-I)
Westinghouse Environmental and Geotechnical Services, Inc., Blountville, Tennessee.

Permeability of Compacted Soils from the East and West Borrow Areas, Y-12 Plant, Oak Ridge, Tennessee. 3/27/89
Dr. David Daniel, Civil Engineer, Univ. of Texas,
Austin, Texas.

Results of Hydraulic Conductivity Tests and Recommended Water Content-Dry Density Criteria for Potential Borrow Soils, Dr. David Daniel, Civil Engineer, Univ. of Texas, Austin, Texas.

D. Soil Moisture Modification

It is very unlikely that moisture modification of soils will be required. The average natural soil moisture is near optimum for compaction. However, if there are extremely wet or dry conditions, some modification of moisture content may be required. If so, moisture adjustments will be made in the soil by the Construction Contractor under direction of the CQC Inspector.

Material requiring moisture adjustment shall be stockpiled and the moisture content adjusted by aeration for drying or by adding moisture. The CQC inspector shall direct the moisture adjustment to produce a uniform soil fill material of known moisture content which satisfies the project plans and specifications. The stockpiled material shall be well blended and allowed to cure overnight for placement the following day.

E. Rock Removal:

Chert fragments are found throughout Chestnut Ridge soils. The chert ranges in size from large nodules which may be several feet in diameter to small gravel size. For the low-permeability soil liner the maximum chert size is 2 inches. The CQC Inspector shall verify that the Construction contractor has removed off-spec materials.

Section 3C -- Inspection Activities During Construction

In this section, a description is presented of the inspection activities (observations and tests) to be performed during the soil fill construction.

A. General:

The CQC Inspector shall confirm that the placement of the fill is in accordance with the project plans and specifications. The CQC inspector shall employ a combination of continuous observation during all periods and phases of construction activity and testing. In-place density tests with companion moisture content tests shall be performed. A sufficient number of in-place density tests shall be performed on site to demonstrate the uniformity of the fill.

B. Visual Inspection:

Visual inspection of the placement of fill soil shall confirm the following:

1. Removal of roots, rocks, rubbish, or out of specification material from fill materials.

2. Identification of changes in soil characteristics necessitating a change in construction operations and/or specifications.

3. Adequate spreading of soil material to obtain complete coverage and the specified loose lift thickness.

4. Adequate spreading and incorporation of water to obtain full penetration through clods and uniform distribution of the specified water content.

5. Procedures for plowing, blading, and aerating soil to adjust excessively high moisture contents.

6. Procedures to prevent significant water loss and desiccation cracking before and after compaction (ie. walking with dozer tracks at the end of a work day).

7. Uniformity of coverage by compaction equipment, especially at compacted fill edges, in equipment turnaround areas, and at the tops and bottoms of slopes.

8. Consistent achievement of the specified soil density and water content throughout each completed lift.

9. Repair of penetrations or holes resulting from the collection of undisturbed soil samples or the use of density and moisture tests using the same materials and methods used for repairs on the test fill or as previously approved.

10. Adequate tying-together of repaired and undisturbed sections of the fill.

11. Use of methods sufficient to tie the fill lifts together.

C. Weather:

Since the compaction process can be affected by climatic conditions, changes in the placement and compaction process will be required during changing conditions. Weather conditions should be observed and recorded by CQC personnel, and appropriate actions should be taken when unsuitable weather conditions exist.

D. Test Methods for Fill:

Various testing methods will be utilized throughout the construction phase. The following paragraphs will identify and briefly describe acceptable sampling and testing methods.

1. Stove Moisture Method: Stove moisture testing would be performed in accordance with accepted field standards described as follows:

   A representative soil sample is obtained and thoroughly mixed. A minimum 200 gram sample is weighed. The sample is placed in a drying pan and dried over a low heat in a consistent manner. The drying process is completed when moisture condensation cannot be seen on a piece of glass placed over the heated soil. After the sample is properly dried, the sample is weighed in a dry condition and the percent moisture is calculated as described in the oven dry method (ASTM D2216 specifications).

2. Nuclear Moisture Method: Nuclear moisture content testing would be performed through the use of nuclear equipment. This moisture test method is defined in ASTM D 3017-72. This method provides rapid moisture content results. Moisture content tests by the nuclear method with properly calibrated equipment have proved very accurate on Chestnut Ridge soils when compared with oven dry methods.

3. Oven Moisture Method: Oven moisture content testing has been used to confirm other more rapid test method results. Oven dry moisture content testing shall be performed in accordance with ASTM D2216 specifications.

4. Three different methods may be used in determination of in-place fill densities on the site. These methods are discussed in the following paragraph

   a. Sand Cone Density Method: Sand cone density test would be performed in accordance with ASTM D1556 specifications.

   b. Drive Tube Density Method: Drive tube density testing methods would be performed in accordance with ASTM D2937 specifications.

   c. Nuclear Density Method: Nuclear density tests would be performed using a Nuclear density meter. This method utilizes the physical properties of low-level radiation passing through substances of varying density and moisture. This test method is described in ASTM D2922 specifications. Nuclear Density Methods shall not be used in narrow trenches or other location where fill geometry could distort the nuclear gage results.

E. Field Density Test Results:

Field density test results must meet or exceed the minimum values in the project specifications. In the event of a failed field density test, the CQC Inspector shall inform the Construction Manager's representative immediately. No additional lifts of soil may be placed in the area. The area shall be reworked and retested to produce a passing test. In areas where failing tests are encountered, remedial work shall be visually observed and/or retested for compliance with project specifications.

F. Logs and Reports:

The CQC Inspector shall keep a daily log and shall compile a final project report. The daily log shall describe weather conditions, visual observations, borrow area activities, soil placement and compaction, testing, unusual occurrences and direction given to the CM and/or the Construction Contractor.

Results of all tests performed by the CQC Inspector shall be given to the CM and to the Construction Contractor as soon as available.

The final report of soil inspection and testing shall be prepared by the CQC Inspector at the conclusion of the construction. The report shall consist of a cover letter, test results, and visual observation results. The cover letter shall provide a general description of the quality of the fill placement, unusual occurrences, deviations from the specifications, and general summary of the test results. Test results shall be formally presented with sketches showing the approximate locations of field density tests and tabular test results. Individual test forms shall be attached as an appendix.

Six bound copies of the final report shall be delivered to the CM no later than 2 calendar weeks after the completion of the placement of soil over the site.

SECTION 4: SAMPLING STRATEGIES

Section 4A. -- Fill for Recontouring the Site

This section presents information used in the selection and implementation of the sampling strategy for evaluating construction quality.

A. Sampling for guidance testing shall be performed as materials are excavated for use as fill. CQC Inspection Personnel shall continuously inspect the excavation process to observe any variations of the borrow materials. Sequential sampling of at least 1 sample per 5000 cubic yards of material shall be performed and the sample shall be tested for conformance to project requirements. The CQC Inspection Personnel may select additional samples if visual observations indicate variations in the material. The guidance testing shall be performed to permit the contractor a means of adjusting stockpile construction means and methods.

B. During fill placement, lift thickness, field densities and companion moisture contents shall be tested at locations selected by the CQC Inspector. Confirming that the in-place density and companion moisture content produces points which are in accordance with the specifications shall form the basis of accept/reject for the lift and area. The CQC Inspector shall perform a minimum of 1 test per 5000 square feet per each lift. A minimum of one in-place density test should be performed for each day's fill placement.

APPENDIX A

LINES OF RESPONSIBILITY

APPENDIX A

LINES OF RESPONSIBILITY

OPERATING CONTRACTOR FOR OWNER:	MARTIN MARIETTA ENERGY SYSTEMS (MMES)
DESIGN AND CONSTRUCTION ENGINEER:	MMES
CONSTRUCTION MANAGER:	MK FERGUSON (MKF)
CQC OFFICER:	PROFESSIONAL ENGINEER IN TENNESSEE
LINER CQC PERSONNEL:	SUBCONTRACTOR TO MKF
CONSTRUCTOR:	MKF/MKF SUBS

The Construction Manager's CQC inspector is performing the function of Construction Quality Control for the low permeability clay liner. The CQC inspector has the responsibility for density testing, soil classification and ensure proper compaction technique. The responsibility and authority for the low permeability testing and inspection belongs to the Construction Manager, MKF. Technical assistance is provided by MMES. The CQC inspection personnel shall interface directly with the constructor to assure soil liner is in accordance with the specifications. The CQC Officer will monitor the inspection activities and provide final documentation that the work was preformed in accordance with project requirements.

For example, if the soil liner does not meet permeability requirements, the CQC Officer shall recommend a repair/retest procedure to the construction manager and constructor. If the constructor implements the reconditioning procedure the CQC personnel shall record the rework in their daily logs. If the constructor does not perform the reconditioning, Construction Engineering and the Operating Contractor (MMES) shall be informed and appropriate actions taken.

Construction Quality Control Procedures for Geosynthetic Materials

Industrial Landfill IV
Y-12 Plant

Oak Ridge, Tennessee

Prepared By

Civil, Site and Waste Management Design
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee

Table of Contents

FOREWORD

Industrial Waste Landfill IV is an existing unlined landfill located on Chestnut Ridge south of the Y-12 Plant. It is currently classified under Tennessee Department of Environment and Conservation/Division of Solid Waste Management (TDEC/DSWM) as a Class II disposal unit. Modifications to the landfill are being made to bring the landfill into compliance with revised TDEC/DSWM regulations. The modifications to the landfill include separating the unlined area which is currently accepting waste from future disposal areas by an earth berm and lining an initial section of the future disposal. The section to be lined is approximately 100 feet by 220 feet and will consist of a composite liner, leachate collection system and gas migration controls.

Geosynthetic materials will be used for the construction of the composite liner and leachate collection systems. The geosynthetic materials (from the bottom to the top) of the composite liner are:
a 45 mil reinforced polypropylene geomembrane liner, an 8 oz/sq yd nonwoven geotextile fabric and a .20 inch thick polyethylene geonet.

The Construction Quality Control Procedures for Geosynthetic Materials for Industrial Landfill IV outlines the construction quality control activities provided by the Construction Quality Control Inspection Personnel (CQC Inspector). This document also defines construction quality control procedures and quality assurance documentation for the fabrication and installation of geosynthetics.

The Construction Quality Control Procedure for Geosynthetic Materials presents guidelines for the following five general elements:

1. Qualifications of construction quality control personnel.

2. Specific responsibilities for the construction quality control personnel.

3. Types of inspections (observations and tests) to be performed as part of construction quality control activities.

4. Sampling strategies (including sampling frequency, size, and location; acceptance and rejection criteria; and corrective action implementation).

5. Documentation of construction quality control activities.

SECTION 1: CQC PERSONNEL QUALIFICATIONS

Section 1A - Personnel

The Construction Quality Control personnel for this project shall be as described below.

A. CQC Inspection Personnel -- shall possess adequate formal academic training and possess sufficient practical technical and administrative experience to execute and record inspection activities successfully. This should includ demonstrated knowledge of specific field practices relating to construction techniques used for installation of geosynthetics, anchorage of geosynthetics, and seaming of geosynthetics. The CQC Inspector shall possess a thorough knowledge of geosynthetics testing procedures and sufficient field and laboratory experience to perform the required testing, inspection, and documentation.

B. The technical and administrative personnel shall possess adequate formal academic training in engineering or closely associated disciplines and possess sufficient practical, technical and managerial experience to successfully oversee and implement construction quality control.

C. All technical and inspection personnel shall work under the direct supervision of an engineer registered in the state of Tennessee in accordance with the requirements of Rule 1200-1-7-.04(1)(C) of the State of Tennessee Department of Environment and Conservation governing solid waste disposal facilities.

SECTION 2: RESPONSIBILITIES OF THE CQC PERSONNEL

Section 2A - Specific Responsibilities

For the CQC Inspection Personnel, specific responsibilities include:

A. Performing independent inspection of factory fabrication of the geomembrane to assess compliance with plans and specifications.

B. Performing independent on-site inspection of the work in progress to assess compliance with plans and specifications.

C. Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by this CQC procedure document.

D. Reporting results of all inspections including work that is not of acceptable quality or that fails to meet the specified design. Recommending corrective measures for unacceptable work.

SECTION 3: GEOSYNTHETICS CONSTRUCTION INSPECTION ACTIVITIES

The following Sections identify and describe the observations and tests that will be used to evaluate conformance with the design plans, and specifications for geosynthetic materials

Section 3A -- Project Meetings

Periodic meetings shall be held as required at the request of the Construction Manager during the life of the project to strengthen responsibility and authority and enhance communication between personnel responsible for designing, inspecting and constructing the industrial waste liner system.

Section 3B -- Material Inspection

This subsection describes the inspection activities to be provided by CQC Inspection Personnel. Inspection activities are separated into preconstruction activities, construction inspection, construction testing and reporting.

A. Preconstruction Inspection Activities

Preconstruction activities are limited to geomembrane inspection and testing. Geomembrane inspection includes review of raw materials and roll stock test results provided by the manufacturer; inspection of fabrication operations, and final product quality; observations related to transportation, handling, and storage of the membrane; inspection of foundation preparation; and evaluation of the personnel and equipment to be used to install the geomembrane. These activities are discussed in the following paragraphs.

1. Geomembrane Manufacture: Quality assurance for geomembrane manufacture shall begin with the review of the manufacturer's mill certification for the polymer raw materials. The supplier shall provide documentation that the raw materials comply with the manufacturer's product properties and performance requirements. Other types of raw materials that may be used in the production of specific membrane types include additives and reinforcing materials. These types of materials shall be manufactured under the vendor's quality control/quality assurance program and a certification indicating that they meet the performance specifications shall be provided. The compounding ingredients used in producing membrane liners should be first quality, virgin material. Each manufacturer shall have a manufacturing quality control program based on the manufacturing method used and the type of membrane being produced. The CQC Inspector shall verify that the raw materials and the roll stock produced from the raw materials is in accordance

with the project specifications.

The geomembrane roll stock shall be tested by the manufacturer and these test results reviewed by the CQC Inspection Personnel for compliance with the material properties required by the project specifications and described in the following table:

MATERIAL PROPERTIES - REINFORCED POLYPROPYLENE (PP-R)

PROPERTY	TEST METHOD	SUPPORTED (S) TYPE
Gauge (Nominal)	--	45
Plies, Reinforcing 10 x 10 1,000d polyester scrim		1
Thickness, mils minimum	ASTM D751	
1. Overall	Optical Method	41
2. Over Scrim	(Ref: Appendix A, NSF)	11
Breaking Strength-Fabric (pounds, minimum)	ASTM D751 Method A (Grab Method)	220
Tear Strength (pounds, minimum)	ASTM D751 Method B Tongue Tear	55
Puncture Resistance (lbs.)	FTMS 101°C, Method 2031	210
Low Temperature (°F)	ASTM D2136 (1/8 inch mandrel, 4 hours, pass)	-40
Dimensional Stability (each direction percent change maximum)	ASTM D1204 180°F, 1 hour	1.0
Volatile Loss (percent loss maximum)	ASTM D1203 Method A, 30 mil sheet	0.5

Hydrostatic Resistance (pounds/square inch, minimum)	ASTM D751 Method A, Procedure 1	250
Ply Adhesion (Each direction pounds/inch width, minimum)	ASTM D413 Machine Method Type A	20
a. 40-mil unsupported sheet	ASTM D3083 (per ASTM paragraph 9.5)	
1. Breaking strength		5
2. Elongation at break		15
3. Modulus at 100% elongation		15
b. Membrane fabric breaking strength	ASTM D751, Method A	15
Water Absorption (maximum % weight change, unsupported short)	ASTM D471, 70°F	<1%
UV Resistance	a) Florida Exposure b) ASTM G26 Xenon Arc method, 63°C	pass-1 yr. Exposure pass-3,000 hours
Stress Cracking Resistance (minimum hours with no failure)	ASTM D1693	pass-3,000 hours

2. Geomembrane Fabrication: Geomembrane panels shall be assembled from roll goods according to a field layout (Fabrication Plan) submitted by the Geomembrane Fabricator or Installer and approved by the Construction Manager or his representative. Any changes shall be approved by the Construction Manager as required by project specifications.

   The CQC Inspector shall travel to the Fabricator's shop to inspect the roll stock and the shop seaming operation. All seams shall be 100 percent visually inspected (inspection of 100% of one side of a seam is acceptable when coupled with non-destructive testing, as long as the inspector is confident that the seaming techniques are generally acceptable) and the inspection form shown in Exhibit 2.02-2a of the project specifications shall be completed. The seams shall be 100 percent nondestructively tested. In addition, one seam sample per each 200 linear feet of shop seam shall be destructively tested for compliance with the seam requirements listed below and in the project specifications. In the event of a failed test, a sample from 10 ft in each direction along the seam shall be tested. If it is determined that the failed test is an isolated incident appropriate repairs to the geomembrane panels shall be made and the situation described in the CQC Inspector's logs. If there is a pattern of failed tests the CQC Inspector shall so notify the CM and an investigation will be conducted to determine the cause of the repetitive failures. The CM shall be notified immediately of any failed test.

FACTORY SEAM REQUIREMENTS[1]

Bonded Seam Strength (factory seam, breaking factor, lbs./width)	ASTM D751 (As modified in Appendix A, NSF)	200
Peel Adhesion (pounds per inch minimum)	ASTM D413 (As modified in Appendix A, NSF)	30

[1]Factory seam requirements are the responsibility of the fabricator.

3. Geomembrane Shipping, Handling, and Storage: The CQC inspector shall verify that geomembrane rolling or folding, shipping, handling, and storage is performed in accordance to procedures outlined in the project specifications and accepted industry practice. The CQC inspector shall notify the Construction Manager immediately of any deficiency in the shop fabrication, handling or shipping methods.

Section 3C -- Construction Activities

A. Geonet and Filter Fabric Installation:

Inspection activities during leachate collection layer installation shall include the following:

1. Checking that delivery tickets and geotextile and geonet manufacturer's roll numbers match those documented by mill certification data to document that the synthetic material received on-site meets the project specifications. Identifying and retaining labels from each roll or pallet. Further, the position of each roll or pallet of material shall be generally noted on a final inspection drawing.

2. Observations of the weather conditions (i.e., temperature, humidity, precipitation, and wind) to verify that they are acceptable for placement of geosynthetics per project specifications.

3. Measurements to confirm that required overlaps of adjacent geotextile and geonet sheets were achieved, that proper seaming or ties as appropriate were used, and that the materials where placed in a relaxed (non-stressed) state.

As each geotextile and geonet panel is placed, it shall be inspected for tears, punctures, thin spots, and deformities. This shall be accomplished by visually inspecting as the seaming and panel tying is being done. Any defects noted shall be marked on the geotextile or geonet for repair.

The overall quality of geotextile and geonet installation can be affected by the weather conditions during which it is installed. If the weather becomes unacceptable for installation of geosynthetics, the CQC installation personnel shall recommend stopping the installation until conditions again become favorable.

B. Geomembrane Installation:

Inspection activities during geomembrane installation shall include the following:

1. Checking delivery tickets to document that the geomembrane panels received match those inspected in the Fabricator's shop.

2. Observation to verify that the geomembrane placement plan was followed. Further, the position of each panel or pallet of material shall be noted on a final installation drawing.

3. Observations of the weather conditions (i.e., temperature, humidity, precipitation, and wind) to verify that they are acceptable for membrane placement and seaming per project specifications.

4. Observations and measurements of the anchor trench for compliance with the specifications.

5. Observations to confirm that the pipe/liner penetration is installed as

specified. The pipe/liner penetration shall be verified for appropriate clamp and caulking use, for appropriate material, for good seaming, and for good housekeeping practices.

6. Measurements to confirm that required overlaps of adjacent membrane sheets were achieved, that proper temporary anchorage was used (e.g., sand bags or tires), that specified temporary and final seaming materials/techniques were used, and that the geomembrane was placed in a relaxed (nonstressed) state.

As each geomembrane panel is placed, it shall be visually inspected for tears, punctures, and thin spots. To accomplish this, the panels shall be inspected by CQC Inspection Personnel during field seaming operations, in such a way that the entire surface, including all factory seams, is inspected. For geomembranes that are fabricated from roll stock widths of about 5 feet, the procedure used to detect membrane defects is to walk along each roll stock width and inspect the entire length of the sheet. Any defects shall be marked on the synthetic membrane for repair.

The overall quality of a geomembrane liner installation can be affected by the weather conditions during which it is installed. If the weather becomes unacceptable for installation of the liner, the CQC inspection personnel shall recommend stopping the membrane installation until conditions again become favorable.

C. Geomembrane Field Seaming Inspection:

Inspection activities that shall be documented during field seaming operations include:

1. Observation to verify that the membrane is free from dirt, dust and moisture.

2. Observations to verify that the seaming materials and equipment are as specified.

3. Observations and tests to verify that a firm foundation is available for seaming as required by project specifications.

4. Observations of weather conditions (e.g., temperature, humidity, and wind) to verify that they are acceptable for seaming.

5. Measurements of temperature, pressure, and speed of seaming, when applicable, to verify that they are as specified (e.g., gauges and dials should be checked and readings recorded).

6. Observations to verify that the geomembrane is not damaged by equipment or personnel during the seaming process.

7. Documentation of inspection activities shall be in accordance with sections in this document.

After field seams are installed, they shall be inspected to verify that a bond is formed. The CQC Inspector shall visually inspect all field seams and shall witness the Vacuum Box testing performed by the installer using the Vacuum Box method outlined in the project specifications.

All repairs shall be performed as soon as possible and in accordance with the project specifications. Each repair shall be nondestructively tested for continuity. All repairs including locations, type, and method used shall be documented.

D. Anchors and Seal Installation:

At locations where the design calls for penetrations (e.g., structures and pipes) in the geomembrane liner, CQC personnel shall verify that the seals around such penetrations are as required by design specifications. Specific inspections that shall be made on all seals or anchors include:

1. Observations and tests to verify that the sealing systems (i.e., pipe boots) were installed as specified and in the proper locations.

2. Observations to verify that all objects that may be placed adjacent to the synthetic membrane (i.e., batter bars, soil in an anchor trench, and concrete structures) are smooth and free of objects or conditions that may damage the membrane.

3. Observations and tests to verify that all seals and anchors are complete (i.e., no gaps or areas of uncompacted backfill).

SECTION 4: DOCUMENTATION

This section identifies and describes the principle documentation and record keeping procedures to be utilized for this project.

Section 5A: Daily Record Keeping:

Daily reporting procedures shall include preparation of a summary report with supporting inspection data sheets and, when appropriate, problem identification and corrective measures reports.

A. Daily Summary Report:

The summary reports shall include the following information:

1. Unique identifying sheet number for cross-referencing and document control.

2. Date, project name, location, and project number.

3. Data on weather conditions.

4. Reports on any meetings and their results.

5. Descriptions of areas of work (blocks) being inspected and documented.

6. Description of off-site materials received, including any quality verification (vendor certification) documentation.

B. Inspection Data Sheets:

All observations, and field and/or laboratory tests shall be recorded on an inspection data sheet. The inspection data sheets shall include the following information:

1. Unique identifying sheet number for cross-referencing and document control.
2. Description or title of the inspection activity.
3. Location of the inspection activity or location from which the sample increment was obtained.
4. Type of inspection activity; procedure used (reference standard method when appropriate).
5. Recorded observation or test data, with all necessary calculations.
6. Results of the inspection activity; comparison with specification requirements.
7. Personnel involved in the inspection activity.
8. Signature of the appropriate CQC Inspection Personnel.
9. Time and date of observation/check/test.
10. Repair, re-work, removal, replacement or action to rectify discrepancy.

The preceding will be formulated into checklists and data sheets. See Appendix A for an example of Inspection Data Sheet.

C. Problem Identification and Corrective Measures Reports:

A problem is defined herein as material or workmanship that does not meet the specified design. Problem Identification and Corrective Measures Reports shall be cross-referenced to specific inspection data sheets where the problem was identified. They shall include the following information:

1. Unique identifying sheet number for cross-referencing and document control.
2. Detailed description of the problem.
3. Location of problem.
4. Probable cause.
5. How and when the problem was located (reference to inspection data sheets).
6. Estimation of how long problem has existed.
7. Suggested corrective measure.
8. Documentation of correction (reference to inspection data sheets).
9. Final results.
10. Suggested methods to prevent similar problems.
11. Signature of the appropriate CQC Inspection Personnel.

Copies of these reports shall be forwarded to the Construction Manager. These reports shall not be submitted to the permitting agency, unless authorized and requested to do so.

D. Liner Component Evaluation and Acceptance Reports:

Some liner system components have several quality characteristics, or parameters, that are specified to be observed or tested, each by a different observation or test, with the observations and/or tests recorded on different data sheets. At the completion of each component, these data sheets shall be organized into a liner component evaluation report. These liner component evaluation and acceptance reports may then be used to summarize all of the site construction activities. These summary reports shall be prepared by the CQC Inspection Personnel and include the following information:

1. Unique identifying sheet number for cross-referencing and document control.

2. Description of the overall liner component (use project coordinate system to identify areas, and appropriate identifiers for other units of material or work).

3. Quality characteristic being evaluated; references to design criteria, plans, and specifications.

4. Sampling requirements for the inspected components and the method of sampling selection.

5. Sample item location (describe by project coordinates or by a location sketch on the reverse of the sheet).

6. Inspections made (define procedure by name or other identifiers; give unique identifying sheet number for inspection data sheets).

7. Summary of inspection results (give averages and, if available, the standard deviation for each quality characteristics).

8. Define acceptance criteria (compare component inspection data with design specification requirements; indicate compliance or non-compliance; in the event of non-compliance, identify documentation that gives reasons for acceptance outside of the specified design).

The liner component evaluation and acceptance reports shall indicate that the materials and construction processes comply with specified design. These reports shall be included in the project records, submitted to the facility Construction/Manager, and, if requested, submitted to the permitting agency.

E. Project Summary Report:

Provide at the end of the project a final report which includes all other reports and summarizes the project.

APPENDIX A

INSPECTION DATA SHEETS

EXHIBIT 3.01-3a

SUBGRADE INSPECTION CHECKLIST

Date ______________________________

Project ______________________________

Location ______________________________

Area Examined ______________________________

	Acceptable	Not Acceptable Comments
Rodents	________	______________________
Soil Type	________	______________________
Soil Moisture	________	______________________
Density	________	______________________
Uniformity	________	______________________
Grading	________	______________________
Rocks	________	______________________
Roots	________	______________________
Vegetation	________	______________________
Rubble	________	______________________
Protrusion	________	______________________
Cracks	________	______________________

______________________________ Inspector

______________ Date

EXHIBIT 3.01-3b

CERTIFICATE OF ACCEPTANCE
OF SOIL SUBGRADE BY INSTALLER

Name ____

Project ____

Location ____

Area Accepted ______________________________________

Authorized Representative ___________________________

I the Undersigned, duly authorized representative of ____________________________ do hereby accept the soil subgrade as being acceptable for the placement of a geomembrane liner.

Name	Title
Signature	Date

Certificate Accepted by CQA Inspector and Construction Manager

CQA Inspector:

Name	Title
Signature	Date

Construction Manager:

Name	Title
Signature	Date

EXHIBIT 3.03-1a

GEOMEMBRANE INSTALLATION INSPECTION

Date ____

Project ____

Location ____

Installer ____

Geomembrane Type and Manufacturer ____________________

	Acceptable	Not Acceptable Comments
Weather	________	________________
Panel Markings	________	________________
Shipping Protection	________	________________
Panel Placement	________	________________
Panel Fit	________	________________
Field Seam Samples		
Numbered	________	________________
Lab Results	________	________________
Air Lance Test		
Pressure	________	________________
Nozzle Diameter	________	________________
Results	________	________________
Vacuum Test		
Pressure	________	________________
Time	________	________________
Results	________	________________
Repairs		
Numbered	________	________________

Mapped	__________	____________________
Penetrations		
Location	__________	____________________
Air Lanced	__________	____________________
Anchors		
Location	__________	____________________
Depth	__________	____________________
Compaction	__________	____________________

Inspector ____

APPENDIX B

LINES OF RESPONSIBILITY

APPENDIX B

LINES OF RESPONSIBILITY

OPERATING CONTRACTOR FOR OWNER:	MARTIN MARIETTA ENERGY SYSTEMS (MMES)
DESIGN AND CONSTRUCTION ENGINEER:	MMES
CONSTRUCTION MANAGER:	MK FERGUSON (MKF)
CQC OFFICER:	PROFESSIONAL ENGINEER IN TENNESSEE
LINER CQC PERSONNEL:	SUBCONTRACTOR TO MKF
CONSTRUCTOR:	MKF/MKF SUBS

The Construction Manager's subcontract testing laboratory is performing the function of Construction Quality Control for the geosynthetic materials making up the composite liner system. The CQC inspector has the responsibility for testing and inspection of the geosynthetics shop fabrication, installation and field seaming. The responsibility and authority for the geosynthetics testing and inspection belongs to the Construction Manager, MKF. Technical assistance is provided by MMES. The CQC inspection personnel shall interface directly with the constructor to assure a high quality installation in accordance with the specifications. The CQC Officer will monitor the inspection activities and privide final documentation that the work was installed in accordance with project requirements.

For example, if a seam test does not meet the requirements, the CQC Officer shall recommend a repair/retest procedure to the construction manager and constructor. If the constructor implements the reconditioning procedure the CQC personnel shall record the rework in their daily logs. If the constructor does not perform the reconditioning, Construction Engineering and the Operating Contractor (MMES) shall be informed and appropriate actions taken.

DIVISION 2 - SITE WORK

SITE WORK

CONTENTS

SECTION 02220

EXCAVATING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes the removal and stockpiling of top soil. Excavation and compaction of fill and backfill to the subgrade. The definition and requirements of rock excavation.

Definition of terms:

1) Earth Excavation: The removal of material to the lines, elevations, and dimensions shown on the drawings and disposition of all materials encountered in the grading and excavation work except that classified as rock.

2) Rock Excavation: The removal of materials classified as rock and disposal of the excavated material as specified herein and in conformity with the lines, grades, and dimensions shown on the drawings. To be classified as rock the material must be boulders of 9 ft^3 or more in volume, solid or ledgerock, or other hard material in place that cannot be excavated by power shovels or bulldozers equipped with ripping points. In addition the material must exceed a value of 3 on the Mohs' hardness scale. Material classified as rock shall be removed by drilling and feathering, bull point wedging, or other suitable means. Use of explosives will not be allowed.

3) Unauthorized Excavation: Excavation not required by the specifications or drawings or not authorized in writing by the Construction Manager.

4) Fill: Earth or other material as specified, used to bring an existing grade to a specified grade. No concrete or masonry product shall be permitted as fill material.

5) Backfill: Earth, crushed stone, or other materials as specified used to replace material excavated during construction. Backfill shall be spread and compacted in the same manner as fill.

6) Subgrade: The compacted fill or backfill of embankments or the undisturbed soil of cut sections which supports the base course and wearing surface.

7) Undercutting: Removal of soft or undesirable materials determined by the Construction Manager encountered in the

undisturbed subgrade below grades specified for excavation.

8) Spot Subgrade Reinforcement: Placing approved fill or backfill in areas where authorized undercutting has been performed.

9) Shoring: A structure such as a metal hydraulic, mechanical, or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

10) Topsoil: A natural, friable, fertile, fine sandy loam surface soil which produces heavy growths of vegetation.

1.02 REFERENCES

A. Military Standards

MIL-STD-619B, Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations.

B. American Society of Testing Materials (ASTM) Annual Book of Standards

1) ASTM D-698, Moisture-Density Relation of Soils Using a 5.5-lb (2.5 kg) Rammer and a 12-in. (305 mm) Drop.

2) ASTM D-1241, Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

3) ASTM D-1557, Moisture-Density Relation of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop.

4) ASTM D-2922, Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).

5) ASTM D-3017, Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods (Shallow Method).

C. Occupational Safety and Health Act (OSHA) Code of Federal Regulations 29 CFR Part 1926.650, .651, and .652, latest revision.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Satisfactory materials used for fill or backfill, with exception of the compacted clay liner, are those classified by Military Standard MIL-STD-619 as GW, GP, SW, GM, GC, CL, SP, SM, SC, CH, ML, or MH.

B. Satisfactory Type A material for use in the compacted clay liner shall be as defined by David E. Daniel (ref. report for Martin Marietta Energy Systems dated October 12, 1992). Type A soil consists of a natural occurring mixture of red sandy clay and tan clayey silt having a Standard Proctor (ASTM D698) maximum dry density greater than or equal to 85 pcf. This soil type has typical properties of Liquid Limit at 55%, Plasticity Index at 30%, Optimum Water Content at 25% and average Max. Dry Unit Wt. of 96 pcf based on Standard Proctor compaction although actual values may vary.

C. Unsatisfactory materials include rock excavation and materials classified by Military Standard MIL-STD-619 as PT, OH, or OL and shall not be used for fill or backfill.

D. Earth: Satisfactory material of such gradation and moisture content that it will compact to the specified density and remain stable under the final conditions of use. Earth shall be free of organic matter and fragments of rock or slag exceeding 3 in. in dimension and may be earth excavation or borrow. Borrow shall be from designated locations.

E. Sand: Natural sand or crushed stone passing a No. 10 sieve and conforming to gradation requirements of ASTM D-1241, Fine Aggregate.

F. Stabilized Aggregate Base: In accordance with Sect. 02505, Stabilized Aggregate Base Course.

G. Topsoil: A natural, friable soil representative of productive soils.

H. Geotextile Fabric: In accordance with Sect. 02276, Geotextile Filter Fabric.

I. Topsoil in accordance with the Tennessee Department of Highways "Standard Specifications for Road and Bridge Construction," latest edition, Sect. 802.02.

J. Topsoil shall be free of subsoil, clay or impurities, plants, weeds, and roots.

2.02 EQUIPMENT

A. Maintain compaction equipment in satisfactory operating condition at all times. Use compaction equipment capable of achieving the degree of compaction specified. Special equipment is required for compaction of clay liner.

B. Power tampers for use in restricted areas shall be of a type and size suitable to perform the required compaction.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that the subgrade is not soft, spongy, or composed of otherwise unstable materials. If unstable materials are encountered, stop work and notify the Construction Manager.

B. Verify that areas to be backfilled are free of debris, snow, ice, or water and the surfaces are not frozen.

3.02 PREPARATION

A. Clear the work area of obstructions as indicated on the drawings.

B. Strip and stockpile topsoil.

3.03 INSTALLATION/APPLICATION/ERECTION

A. Excavation

1) Carry excavation through whatever materials are encountered to depths shown on the drawings. Remove all existing fill and other unsatisfactory materials within the limits of excavation as indicated on the drawings.

2) Remove excavated material not required or not suitable for backfill from the site to the disposal area.

3) Backfill unauthorized excavation at the Contractor's expense with compacted earth, sand, crushed stone, or concrete. Compaction shall meet the requirements for fill.

B. Compaction

1) The moisture content of the material being compacted shall meet the following conditions.

a. The moisture content shall be within the range of values at which 95% of the maximum density can be obtained as indicated by the moisture-density relationship curve.

b. The moisture content shall not exceed the optimum moisture content to the extent that the material pumps under loads applied by a fully loaded tandem-axle dump truck.

2) Do not compact any section of the fill containing material

which is too wet or dry until the moisture content of the material is brought within required limits. Remove and replace with material having acceptable moisture content. Such removal and replacement shall be by and at the expense of the Contractor.

3) If the desired compaction of any portion of fill is not obtained by the initial number of passes, additional passes shall be made over surface area of such affected portions of the fill until the desired degree of compaction has been attained.

4) Compact all fill not accessible to self propelled or towed compactors by hand-operated power tampers or other approved means to the specified density.

C. Fill and Backfill

1) Do not place fill material when weather conditions, condition of the subgrade, or condition of the fill material precludes obtaining the specified compaction. Do not use frozen material for fill and fill material shall not be placed on or against frozen surfaces.

2) Maintain excavations free from water and dispose of the excess water by approved methods. Report spring or seepage water encountered in the excavation to the Construction Manager.

3) Maintain newly graded areas until final acceptance. Restore areas showing settlement or washes to specified grades at no additional cost to the Government prior to final acceptance.

4) Provide temporary shoring and bracing as necessary to safely support excavation. Remove shoring and bracing from excavation as backfilling progresses. Shoring, in accordance with OSHA 29 CFR 1926, Subpart P, latest revision, Safety Regulations.

5) Provide erosion and sediment control to minimize erosion and the transport of sediment beyond the limits of the Contractor's work area. Methods of control shall conform to Sect. 02270, Slope Protection and Erosion Control.

D. Topsoil

1) Scarify subsoil of area to receive topsoil to a depth of 2 in.

2) Areas to receive new topsoil shall be finished with a uniform layer of topsoil 4 in. thick. Topsoil material shall be from stockpiled material or approved borrow. Bond to the subsoil by rolling with a light roller or by tamping. Hand rake the surface.

3) Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles, and contours.

4) No topsoil shall be placed until seeding can immediately follow the topsoil placement. The seeding season and seeding requirements shall conform to Sect. 02936, Seeding.

5) Maintain newly graded topsoiled areas until final acceptance. Restore areas showing settlement or washes to the specified grades at no additional cost.

3.04 FIELD QUALITY CONTROL

A. Testing

1) Compact fill and backfill under roads, structures, and all other areas except compacted clay liner to a minimum of 95% of maximum dry density at the optimum moisture content, as determined in accordance with the provisions of ASTM D-698. The required compaction shall be verified by in-place density tests using ASTM D-2922 or other approved ASTM in-place density test. Maximum density determination and in-place density tests will be performed by the Construction Manager.

2) Compact clay liner in accordance with Paragraph 3.06 of this Section.

3) Maintain moisture content of backfill materials to attain required compaction density. Testing for moisture content shall be in accordance with ASTM D-698. Testing will be performed by the Construction Manager.

B. The top of the subgrade shall be a uniformly smooth grade surface without high or low points and shall not be more than 0.10 ft above or below specified grades. Bind thin layers of added materials to the material in place by scarifying and recompacting.

3.05 PROTECTION

Protect existing utility lines and structures in the work area and existing roadway structures, seeded areas, and other features adjacent to the work area during construction activities. Provide adequate shoring and bracing as required to protect and maintain the stability of previously constructed structures and facilities.

3.06 COMPACTED CLAY SOIL LINER

A. Fill material for the construction of the compacted clay liner shall come from on-site excavations. The fill material shall be placed and compacted such that the moisture content and density are maintained within the acceptable zone for the appropriate soil type as shown in Figure 1. The following method of accomplishment describes how the above shall be performed in the field.

B. Method of Accomplishment:

Prior to hauling and placement of the borrow soil, a qualified soils technician or engineer provided by the Company shall evaluate the soil and determine the soil type. The technician or engineer will perform one-point Proctor tests or other tests required to identify the soil type. Once the soil type has been identified, the soil shall be placed by the Seller such that the dry unit weight and the moisture content of the soil produce a point which falls within the acceptable zone for that soil type.

Placement of Low-permeability Soil: When the soil is placed, the Seller shall remove chert fragments in excess of 2 inches in any direction and dispose in an on-site unsuitable rock area to be provided by the Company's Representative. The soil shall be placed and compacted utilizing a footed roller with feet that have a minimum length of 6 inches. The roller shall have a minimum static weight of 30,000 pounds. A minimum of six passes of the compaction equipment per lift is required. If necessary, water should be periodically sprayed onto the completed lift to prevent drying. The Seller is responsible for maintaining each lift and the completed fill until covered. Soil lift thickness shall be a maximum of 9 inches loose and 6 inches compacted.

C. Field Testing and Quality Assurance: The Seller will provide construction quality assurance and follow procedures as outlined in the approved Construction Quality Plan for this project. A minimum of one field compaction test per 5,000 sq ft per each lift of soil shall be conducted by the Company Representative's testing laboratory. If the field density test points do not fall within the acceptable zone, the location will be reworked by Seller and retested until the acceptable zone is achieved. No fill material shall be placed when weather precludes obtaining the specified compaction. Frozen material shall not be used to fill and fill materials shall not be placed against frozen surfaces.

D. The final thickness of this layer shall be as indicated on the drawings.

At the end of each day and as required by the company's representative, each lift of low-permeability soil shall be rolled with a smooth steel-drum roller to seal the surface. Prior to placing the next lift of soil, the surface of the previous compacted lift shall be scarified with a disk to a minimum depth of 1 inch to ensure good bonding between lifts.

END OF SECTION

SECTION 02223

EXCAVATING, BACKFILLING, AND COMPACTING FOR STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes excavation, fill, and backfill required to meet grades and elevation for building construction.

1.02 RELATED WORK

A. Section 02505, Stabilized Aggregate Base Course

B. Section 02276, Geotextile Fabric for Subsurface Drainage Applications

1.03 REFERENCES

A. American Society of Testing and Materials (ASTM) Annual Book of Standards

1) ASTM C-136, Sieve Analysis of Fine and Coarse Aggregate.

2) ASTM D-698, Moisture Density Relation of Soils and Soil Aggregate Mixture Using 5.5-lb (2.5-kg) Rammer and 12-in. (305-mm) Drop.

3) ASTM D-1241, Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.

4) ASTM D-2922, Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).

5) ASTM D-3017, Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods (Shallow Depth).

B. Occupational Safety and Health Act (OSHA) Code of Federal Regulation, 29 CFR Part 1926.650, .651, and .652, latest revision.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Select Fill and Backfill Materials

1) Coarse Stone: Angular, crushed, free of shale, clay, friable materials, and debris; graded in accordance with ASTM C-136 within the following limits: size No. 57

stone.

2) Stabilized Aggregate Base Course: In accordance with Sect. 02505, Stabilized Aggregate Base Course.

3) Sand: Natural river, bank, or manufactured sand; washed, free of silt, clay, loam, friable, or soluble materials, and organic matter; graded in accordance with ASTM D-1241-68, Fine Aggregate.

B. Common Fill and Backfill Materials

Subsoil: Reused; free of gravel larger than 3 in. size, material with an expansion index less than 20, and debris, roots, and vegetation. Satisfactory borrow shall consist of any material classified by the United Classification System as GW, GP, GM, GC, SW, or SP.

C. Accessories

Geotextile Fabric: In accordance with Sect. 02276, Geotextile Fabric For Subsurface Drainage Applications.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify stockpiled fill to be reused is acceptable.

B. Verify areas to be backfilled are free of debris, snow, ice, or water and that ground surfaces are not frozen.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Excavation

1) Excavate subsoil required for building foundations, construction operations, and other work. Maintain a minimum of 2-ft working space around the structure.

2) Do not excavate in the vicinity of existing buildings and structures below the existing foundations until underpinning and shoring have been installed. Protect or replace existing structures, piping, or foundations which are to be incorporated into the final work.

3) Remove rock under footings 8 in. below the bottom of the footings and backfill to the bottom of the footings with well compacted sand or crushed stone.

4) Protect excavation by shoring, bracing, sheet piling,

underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation. Protection shall be in accordance with OSHA Safety Regulation, 29 CFR 1926.652, latest edition.

B. Fill

1) Place Geotextile Fabric according to Sect. 02276, Geotextile Fabric for Subsurface Drainage Applications.

2) All areas receiving fill shall be cleared, scarified to a depth of 6 in., brought to optimum moisture content, and compacted to density requirements.

3) Spread material to be compacted in layers that will not exceed 6 in. after compaction.

4) Employ a placement method that does not disturb or damage structures and utilities in trenches.

5) Cut out soft areas of subgrade not readily capable of in-situ compaction. Backfill to a density equal to the requirement for subsequent backfill material.

6) The moisture content of the material being compacted shall meet the following conditions.

   a. The moisture content shall be within the range of values at which 95% of the maximum density can be obtained as indicated by the moisture-density relationship curve.

   b. The moisture content shall not exceed the optimum moisture content to the extent that the material pumps under loads applied by a fully loaded tandem-axle dump truck.

7) Backfill against supported foundation walls. Backfill simultaneously on each side of unsupported foundation walls.

3.03 FIELD QUALITY CONTROL

A. Tolerances

Top Surface of Backfilling: ±1 in.

B. Tests

1) Compact fill and backfill to a minimum of 95% of maximum dry density at the optimum moisture content, as determined in accordance with the provisions of ASTM D-698. The required compaction shall be verified by in-place density tests using ASTM D-2922 or other approved in-place density test. Maximum density determination and in-place density tests will be performed by the Construction Manager.

2) Maintain moisture content of backfilled materials to attain required compaction density. Testing for moisture content shall be in accordance with ASTM D-3017. Testing will be performed by the Construction Manager.

3) Testing requirements for stabilized Aggregate Base course in accordance with Sect. 02505, Stabilized Aggregate Base Course.

END OF SECTION

SECTION 02225

EXCAVATING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes excavation of trenches for utilities, compaction of bed and fill over utilities to subgrade elevation, and compaction and backfill requirements.

1.02 REFERENCES

A. Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, March 1, 1981

B. Occupational Safety and Health Act (OSHA) Code of Federal Regulations 29 CFR Part 1926.650, .651, and .652, latest revision

C. American Society of Testing and Materials (ASTM) Annual Book of Standards

1) ASTM D-698, Moisture-Density Relation of Soils Using a 5.5-lb (2.5 kg) Rammer and an 12-in. (305 mm) Drop.

2) ASTM D-1241, Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.

3) ASTM D-2922, Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).

4) ASTM D-3017, Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods (Shallow Depth).

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials for Backfill: Free of clods of earth, boulders, broken rock, or concrete exceeding 3 in. in largest dimension or organic or vegetable matter, rubbish, or other unsuitable material.

B. Backfill Materials Under Land and Landscaping - Earth or Sand: Sand shall be natural sand or crushed stone passing a No. 10 sieve and conforming to gradation requirements of ASTM D-1241.

C. Backfill Materials Under Roads and Structures: Stabilized aggregate base to limit settlement. Stabilized aggregate base shall begin 2.5 ft from the facility or road and end 2.5 ft beyond the facility and shall be compacted in 6-in.-deep horizontal layers using hand-maneuvered power compacting tools. Stabilized aggregate base shall conform to Sect. 02236, Stabilized Aggregate Base Course.

D. Bedding Materials: Class B as defined by the Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction, March 1, 1981, Sect. 204.04.

E. Top Soil: In accordance with Sect. 02220, Excavating, Backfilling, and Compacting.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify fill materials to be reused are acceptable. Use unfrozen material.

B. Verify areas to be backfilled are free of debris, snow, ice, or water and surfaces are not frozen.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stockpile excavated materials in areas designated on site and remove excess materials not being used from site.

C. Grade excavation top perimeter to prevent surface water run-off into excavation. Keep the trench bottom free of standing water. Provide side drainage ditches along the trench bottom or dewatering pumps as required. Direct discharge of water collected in the trench to surface drainage channels approved by the Construction Manager.

D. Notify the Construction Manager of unexpected subsurface conditions and discontinue work in affected area until notification to resume work.

3.03 INSTALLATION/APPLICATION/ERECTION

A. Excavation

1) Excavate trenches to a width necessary for proper installation of pipe or other utility to be accommodated. Clearance between pipe and trench walls, except where otherwise specified or indicated on the drawings, shall be 6 in. wider for trenches less than 2 ft deep and 12 in. for trenches more than 2 ft deep.

2) Grade bottom of trench to provide uniform bearing and support for the utility either on undisturbed soil or properly compacted backfill throughout its entire length except where it is necessary to excavate for bell or coupling hole and for proper sealing or pipe joints.

3) Hand excavate for bell and spigot after the trench has been fine graded.

4) Remove and replace soft, spongy, or otherwise unstable materials encountered at the elevation of the pipe which will not provide a firm foundation for the pipe. Replace according to Sect. 02220, Excavating, Backfilling, and Compacting.

5) Backfill unauthorized excavation at the Contractor's expense with compacted earth, sand, crushed stone, or concrete as directed. Compaction shall meet the requirements for fill.

B. Backfill

1) Promptly backfill utility trenches and around utility structures after all required tests on the utilities have been completed and compaction requirements verified.

2) Deposit bedding material in 6-in. layers and carefully ram or tamp until the utility has a cover of not less than 1 ft. The remainder of the backfill shall be placed in horizontal layers 6 in. in depth and compacted by hand maneuvered power compaction tools to a density equal to that of the surrounding earth.

3) Remove temporary blocking or cribbing material used to support the pipe, conduit, etc., before backfilling.

4) The moisture content of the material being compacted shall meet the following conditions.

a. The moisture content shall be within the range of values at which 95% of the maximum density can be obtained as indicated by the moisture-density relationship curve.

b. The moisture content shall not exceed the optimum moisture content to the extent that the material pumps under loads applied by a fully loaded tandem-axle dump truck.

C. General

1) Employ a placement method that does not disturb or damage pipe, foundation perimeter drainage, or trench.

2) In areas where paving, top soiling, or sodding is to be done, stop the fill or backfill the required distance below finish grade to permit installation of these items.

3) Support pipe during placement and compaction of bedding fill.

3.04 FIELD QUALITY CONTROL

A. Tolerances

1) Tolerance of Top Surface of Backfilling Under Paved Areas: ±1 in. from required elevations.

2) Tolerance of Top Surface of General Backfilling: ±1 in. from required elevations.

B. Testing

1) Compact fill and backfill under roads and structures to a minimum of 95% of maximum dry density at the optimum moisture content as determined in accordance with the provisions of ASTM D-698. The required compaction shall be verified by in-place density tests using ASTM D-2922 or other approved ASTM in-place density test. Maximum density determination and in-place density tests will be performed by the Construction Manager.

2) Compact fill and backfill under yards and grounds to a minimum of 90% of maximum dry density at the optimum moisture content as determined in accordance with the provisions of ASTM D-698. The required compaction shall be verified by in-place density tests using ASTM D-2922 or other approved ASTM in-place density test. Maximum density determination and in-place density tests will be performed by the Construction Manager.

3) Testing requirements for Stabilized Aggregate Base Course in accordance with Sect. 02505, Stabilized Aggregate Base Course.

4) Testing for moisture content shall be in accordance with ASTM D-698. Testing will be performed by the Construction Manager.

3.05 PROTECTION

A. Protect excavation by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in of loose soil from falling into excavation. Protection shall be in accordance with OSHA Safety Regulation, 29 CFR 1926.652, latest revision.

1) Trenches more than 5 ft high shall be shored, laid back to a stable slope, or provide some other equivalent means of protection.

2) Refer to 29 CFR 1926.652, Appendices A and B, OSHA Code of Federal Regulations, for the latest revision as a guide to minimum requirements for slopes that are laid back.

3) Refer to 29 CFR 1926.652, Appendix C, OSHA Code of Federal Regulations, for the latest revision as a guide to minimum requirements for shoring or bracing.

4) Trenches less than 5 ft in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.

5) Employees required to be in trenches 4 ft deep or more shall have an adequate means of exit, so as to require no more than 25 ft of lateral travel.

B. Trenches over 4 ft shall be evaluated by the Construction Manager for "Confined Space Entry" requirements.

END OF SECTION

SECTION 02270

SLOPE PROTECTION AND EROSION CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes temporary control measures for slope protection and controls to reduce erosion, sedimentation, and water pollution through the use of sediment basins, fiber mats, mulches, grasses, temporary silt fences, and other control devices.

1.02 REFERENCES

A. Tennessee Department of Transportation (TDOT) - Bureau of Highways, "Standard Specifications for Road and Bridge Construction."

Subsection 918.27, Filter Cloth.

Subsection 918.18, Mulch Material.

B. American Society for Testing and Materials (ASTM) Annual Book of Standards

ASTM D-751, Coated Fabrics.

ASTM D-1682, Breaking Load and Elongation of Textile Fabrics.

1.03 SUBMITTALS

Submit product data verifying conformance to this specification.

1.04 PROJECT/SITE CONDITIONS

Coordinate the temporary pollution control provisions with the permanent erosion control features to assure economical, effective, and continuous erosion control throughout the construction and postconstruction period.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Silt Fences

Preassembled silt fencing with an industrial netting manufactured for the specific purpose of silt control with geotextile filter fabric to meet the requirements of TDOT Specification, Subsection 918.27.

B. Mulching Material

Mulching material shall be in accordance with Sect. 02936, Seeding.

C. Jute Mesh

In accordance with TDOT Specification, Subsection 918.19.

D. Excelsior Matting

In accordance with TDOT Specification, Subsection 918.28.

E. Straw Bale Barriers

Baled hay or straw containing 5 ft^3 or more of material. Bales shall be securely bound.

PART 3 - EXECUTION

3.01 PREPARATION

A. Site Preparation: The site shall be prepared in accordance with good engineering practices for the installation of engineering filter fabrics and other surface control features. The surface shall be compacted and pockets of soft soil removed and replaced with compacted earth material to provide a consistently uniform and stable surface in accordance with Sect. 02220, Excavating, Backfilling and Compacting.

3.02 INSTALLATION/APPLICATION/ERECTION

A. General

1) Control surface water runoff on-site and provide temporary soil stabilization measures as required to prevent the removal of soil by the action of either water or wind, more commonly known as erosion. Protect land areas adjacent to the work site from sedimentation by the installation of erosion and sediment control measures. Install, as a first step in the construction operation, sediment basins and traps, perimeter barriers, and other measures intended to deter erosion and the transport of sediment associated with construction activities. Make such measures functional before upslope land disturbance takes place.

2) Seed and mulch within 15 days of installation of earthen structures, such as dams, berms, and diversions.

B. Silt Fences

1) Install silt fence as indicated on the plans and at natural drainage areas] as to reduce the quantity of sediment and flow velocities to downstream areas.

2) Install the preassembled silt fence in accordance with the manufacturer specifications.

C. Straw Bale Barriers

1) Install straw bale barriers consisting of a row of entrenched and anchored hay or straw bales as indicated on the plans.

2) All bales shall be wire bound or string tied. Install bales so that the bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. Excavate a trench the width of the bale and a length of the proposed barrier to a minimum depth of 4 in. Place bales in the trench and fill the gaps with loose straw to prevent water from escaping between the bales. Anchor each bale with at least two stakes or re-bars driven through the bale to a depth of 1.5 to 2 ft in the ground. Drive the first stake in each bale toward the previously laid bale to force the bales together. After the bales are staked and chinked, backfill the excavated soil against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 in. against the uphill side of the barrier.

a. Channel Flow: Place bales at locations indicated, or as specified herein, in a single row, lengthwise, oriented perpendicular to the contour, with ends of adjacent bales tightly abutting one another. Extend the barrier to such a length to assure that sediment-laden runoff will flow either through or over the barrier but not around it.

b. Sheet Flow: Place bales at locations indicated, or as specified herein, in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.

3.03 MAINTENANCE

A. Silt Fences

Inspect immediately after each rainfall and at least daily during prolonged rainfall. Provide any required repairs immediately. Should the fabric decompose or become ineffective and still be necessary, replace the fabric promptly. As a minimum, remove sediment when deposits reach approximately one-half the height of the barrier. Dispose of the sediment as directed by the Construction Manager. Maintain the fabric silt fence until all upslope soils are permanently stabilized.

B. Straw Bale Barriers

Inspect straw bale barriers immediately after each rainfall and at least daily during prolonged rainfall. Pay close attention to the repair of damaged bales, end runs, and undercutting beneath bales. Accomplish necessary repairs to barriers or replacement of bales promptly. Sediment shall be removed when the level of deposition reaches approximately one-half the height of the lowest point of the barrier. Dispose of the sediment as directed by the Construction Manager. Maintain the barrier until all upslope soils are permanently stabilized.

C. Sediment Basins

Repair all damage caused by soil erosion or construction equipment at or before end of each working day. Remove sediment from the basin when it reaches the specified distance below the top of the riser. Dispose of the sediment as directed by the Construction Manager. Maintain the basin until all upslope soils are permanently stabilized.

END OF SECTION

SECTION 02276

GEOTEXTILE FILTER FABRIC

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes the use of geotextile filter fabric in subsurface drainage applications such as under rip-rap, lining trenches, leachate drainage systems, french drains, or other applications in which fabric serves as a filter/separator. The fabric shall provide a permeable barrier between gravel or sand and clay soils allowing water to pass while retaining the soil.

Definitions

1) Geotextile Separation: A fabric barrier placed between dissimilar materials so that the integrity of both materials can remain intact or be improved.

2) Geotextile Filtration: The movement of liquid through the fabric while retaining the soil on the upstream side of the fabric.

3) Planar Flow (Transmissivity): The movement of liquid in the plane of a fabric.

4) Polymer: Plastic materials composed of numerous cross-linked molecules.

5) Polypropylene: A polymeric compound used to make some geotextile fabrics.

6) Polyester: A polymeric compound used to make some geotextile fabrics. Polyester fabrics are stronger and more stable than polypropylene fabrics of the same unit weight.

7) Nonwoven Fabric: Fabrics made by extruding and spraying fibers onto a moving conveyor belt to form a continuous web. The fabrics are then bonded by melt-bonding, resin-bonding, or needle punching. Nonwoven fabrics are nondirectional and have equal properties in all directions.

8) Woven Fabrics: Fabrics made by weaving polymeric threads on a loom. The properties of woven fabrics vary with direction.

9) Ultra Violet (UV): UV light, a component of sunlight, breaks down polymeric materials over time. Some polymers are stabilized against UV degradation.

1.02 QUALITY ASSURANCE

Manufacturer's Material Certification

A competent laboratory must be maintained by the producer of the fabric at the point of manufacture to insure quality control in accordance with American Society for Testing and Materials (ASTM) testing procedures. That laboratory shall maintain records of its quality control results and provide, prior to shipment, a manufacturer's certificate. The certificate shall include the name of manufacturer, chemical composition, product description, statement of compliance to specification requirements, and signature of authorized official attesting to the information required. The manufacturer's certification shall be submitted to the construction manager along with the quality control test results, labled by roll numbers, which demonstrate that the roll goods meet the specifications.

1.03 REFERENCES

ASTM Annual Book of Standards

1) ASTM D-4632, Breaking Load and Elongation of Geotextiles (Grab Method).

2) ASTM D-3786, Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.

3) ASTM D-3787, Bursting Strength of Knitted Goods, Constant-Rate-of-Traverse (CRT), Ball Burst Test.

4) ASTM D-4491, Water Permeability of Geotextiles by Permittivity.

5) ASTM D-4533, Trapezoidal Tearing Strength of Geotextiles.

1.04 SUBMITTALS

A. Submit Manufacturer's Material Certification as described in para. 1.03.

B. Submit manufacturer's literature to show filter fabric is in accordance with these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fabric

1) A nonwoven fabric consisting of continuous chain polymeric filaments or yarns of polypropylene or polyester, heat-bonded or needle-punched.

2) The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew and rot resistant, insect and rodent resistant, and conform to the properties in the attached table.

3) The minimum average roll value for strength properties of any individual roll tested from the manufacturing lot or lots of a particular shipment shall be in excess of the minimum average roll value stipulated in this specification.

4) Physical requirements for geotextile fabrics shall be:

Weight	8 oz. per Sq. Yd.
Grab Strength, lbs	200 per ASTM D-4632
Elongation %	50 per ASTM D-4632
Puncture Strength	95 per ASTM D-3787
Burst Strength	290 per ASTM D-3786
Trapezodial Tear	85 per ASTM D-4533
Apparent Opening Size	120-70 U.S. Std. Sieve Size
Coeff. of Perm. - k	0.4 cm/sec
Vert. Water Flows	100 gpm/sf per ASTM D-4491
UV Resistance	70% Str. Ret. per ASTM D-4355

B. Packaging and Identification Requirements

1) Provide geotechnical fabric in rolls wrapped with protective covering to protect the fabric from mud, dirt, UV, dust, and debris. The fabric shall be free of defects or flaws which significantly affect its physical properties.

2) Number each roll of fabric in a shipment with a number or symbol to identify that production run.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify the grades and elevations are correct.

B. Verify that the subgrade does not contain unsuitable, unstable, or soft material. The subgrade shall be free from mud or soft soil materials which would choke fabric openings. Subgrade preparation in accordance with Sect. 02220, Excavating, Backfilling, and Compacting. If unstable materials are encountered, stop work and notify the Construction Manager.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Install the geotextile fabric to the limits and grades indicated on the plans.

B. Sew seams in the field with nylon thread at a stitch density of at least 5 stitches per in. and two rows of single thread stitches or one row of double-thread stitches. Overlaps when necessary shall be 18 in. minimum.

C. Utilize sand bags or other weight for temporary anchoring.

D. Backfill material placed directly on the fabric shall be free from mud or soft soil material which will choke fabric openings. Place backfill soil onto geotextile fabric carefully to avoid damage to the fabric by heavy equipment blades, buckets or tracks. The initial lift of soil upon the fabric shall be a minimum of 6 in. uncompacted and be compacted with equipment which will not penetrate the soil layer and damage the fabric.

E. Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

F. Place a geotextile patch over any damaged area and extend 3 ft beyond the perimeter of the tear or damage.

END OF SECTION

SECTION 02505

STABILIZED AGGREGATE BASE COURSE

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes the compaction and installation requirements of stabilized aggregate base course for roads, driveways, and parking areas as a wearing surface and as a subbase for asphaltic concrete paving.

Definitions

1) Stabilized Aggregate Base Course: Stabilized aggregate base course shall consist of premixed base materials of crushed stone mixed with binder material and water and is compacted in layers on a previously prepared subgrade to a finished thickness and in areas specified on the drawings.

2) Mineral Aggregate Base: The same as Stabilized Aggregate Base Course.

3) Crusher Run: The same as Stabilized Aggregate Base Course.

4) Crushed Stone: An aggregate mixture conforming to American Association of State Highways and Transportation Officials Standard Specification M-147, latest revision, Gradation C.

5) No. 57 Stone: Clean, uniformly graded stone. Not a substitute for stabilized aggregate base course.

1.02 REFERENCES

A. Tennessee Department of Highways "Standard Specifications for Road and Bridge Construction," latest edition, Sect. 303.

B. American Society of Testing and Materials (ASTM) Annual Book of Standards

1) ASTM C-128, Specific Gravity and Absorption of Fine Aggregate.

2) ASTM C-127, Specific Gravity and Absorption of Coarse Aggregate.

3) ASTM D-1241, Materials for Aggregate and Soil-Aggregate

Subbase, Base and Surface Course.

4) ASTM D-2922, Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).

5) ASTM D-4253, Test Methods for Maximum Index Density of Soils Using a Vibratory Table.

6) ASTM D-4254, Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

PART 2 - PRODUCTS

2.01 MATERIALS

In accordance with the Tennessee Department of Highways "Standard Specifications for Road and Bridge Construction," latest edition, Sect. 303. Stabilized aggregate base shall be Class A aggregate, Grading D.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify the grades and elevations are correct.

B. Verify the subgrade is not soft, spongy, or composed of otherwise unstable materials. If unstable materials are encountered, stop work and notify the Construction Manager.

3.02 INSTALLATION/APPLICATION/ERECTION

A. The method of construction and workmanship shall be in accordance with the Tennessee Department of Highways "Standard Specifications for Road and Bridge Construction," latest edition, Sect. 303.

B. Prepare the subgrade according to Sect. 02220, Excavating, Backfilling, and Compacting.

C. When additional base material is to be added to existing stabilized aggregate base, scarify the existing base to a depth of 3 in. Add new stabilized aggregate base material and thoroughly mix with the old material by blading and compaction continued as for new aggregate base.

D. Maintain the finished base course in a condition meeting the specified requirements until installation of asphaltic concrete surfacing or final acceptance.

E. Compact stabilized aggregate base to an average dry density of not less than 100% of theoretical density based upon 83% of the solid volume.

3.03 FIELD QUALITY CONTROL

A. Compact each layer to minimum of 100% of maximum density as determined by ASTM D-1557. The required compaction shall be verified by in-place density tests using ASTM D-2922 or other approved ASTM in-place density test. In-place density tests will be performed by the Construction Manager.

[Choose Item A above for parking areas, roads, and under slabs. Choose Item A below for heavily traveled roads.]

A. Compact each layer to an average dry density of not less than 100% of theoretical density based upon 83% of the solid volume. No individual test shall be less than 97% of the theoretical density. The density will be verified by in-place density tests using ASTM D-2922. Maximum density determination and in-place density tests will be performed by the Construction Manager.

B. The surface of the top layer shall not show any deviation in excess of 3/8 in. when tested with a 10-ft straight edge applied parallel to and at right angles to the center line of the paved area.

END OF SECTION

SECTION 02598

SYNTHETIC LINER

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Applicable Standards: Conform to the following standards:

ASTM D4437-84	Standard Practice for Determining the Integrity of Field Seams Used In Joining Flexible Polymeric Sheet Geomembranes
ASTM D412	Rubber Properties in Tension, Test For (Unreinforced Membrane Only)
ASTM D413	Test Methods for Rubber Property-adhesion to Flexible Substrate
ASTM D2136	Coated Fabrics - Low Temperature Bend Test

1.02 SUBMITTALS

A. Submit the following in accordance with General Conditions.

1. Manufacturer's Literature: Materials description and recommendedinstallation instructions from the manufacturer.

2. Samples: Samples of each type of liner material and seam.

3. Shop Drawings: The fabricator shall furnish a proposed geomembrane panel layout which is to be approved in writing by the Construction Manager prior to the installation. The drawings shall show the extent, the direction of factory seams and the size of panels, as well as the location of test coupons, consistent with the requirements of the project specifications. These details shall include the recommended termination details of the geomembrane. Except for special requirements due to configuration and/or terminating the geomembrane, maximum use of large size panels shall be made to reduce field seaming to a minimum. Number or letter panels and cross reference surrounding panels.

1.03 PRODUCT SHIPPING, HANDLING AND STORAGE

A. Shipping:

1. Each factory fabricated panel shall be accordion-folded or rolled

onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each panel shall be given prominent and unique identifying markings indicating the proper direction of unrolling and/or unfolding to facilitate layout and positioning in the field. The panels shall be packaged in heavy cardboard or wood crates fully enclosed and protected to prevent damage during shipment and each crate is to be prominently marked in the same fashion as the panels within.

2. Each panel should be marked to show the following minimum information:

- Name of manufacturer/fabricator
- Product type
- Physical dimensions (length and width)
- Panel number of placement according to the design layout pattern/shop drawing
- Direction for unrolling or unfolding the membrane

B. Handling:

1. When the synthetic liner is delivered to the construction site, it shall be inspected to confirm that it is the material that was specified, (visually compare to samples) and that it is not damaged. Inspection activities will ensure, with a reasonable degree of certainty, that the completed facility meets or exceeds design criteria, plans, and specifications by preventing, detecting, and correcting the following:

- Puncture from nails or splinters
- Tears from operation of equipment or inadequate packaging
- Exposure to temperature extremes resulting in unusable material
- Blocking: the bonding together of adjacent membrane layers, which may be caused by excessive heat
- Crumpling or tearing from inadequate packaging support

2. When damage to a crate has occurred, careful examination of the underlying material by the Construction Manager's independent inspector is required. If damage is found, the Construction Manager shall carefully examine the entire shipment for damage. Any damage noted shall be marked for replacement or repair in accordance with 3.02D.

C. Storage:

1. Onsite storage of the synthetic membrane liner should be in a secure area with provisions for shelter from adverse weather and be as brief as possible. Until needed, packaged factory fabricated panels shall be stored in their original unopened crates in a dry area, and protected from the direct heat of the sun, where possible. Pallets

may not be stacked.

PART 2 - PRODUCTS

2.01 LINER MATERIAL CHARACTERISTICS

The geomembrane material shall be a 45 mil thick, scrim-reinforced, polypropylene, per Table 1 below. The geomembrane shall be manufactured by the calendering process, consisting of first quality ingredients, suitably compounded of which polypropylene is the principal resin. The finished compound shall be uniform in color, thickness, size and surface texture. The finished membrane shall consist of two (2) plies of polypropylene (PP) laminated over one (1)ply of reinforcing scrim. The reinforcing scrim shall be a 10 x 10 1,000 denier polyester scrim with yarn strands having a twist of 2 to 2 1/2 turns per inch in the fill direction to create an open-type weave that permits strike-through of the PP. The PP shall fully encapsulate the scrim and shall extend a minimum of 1/8" beyond the reinforcing scrim roll edges. Exposed fabric along the longitudinal edges of the roll stock shall not be permitted. The finished membrane shall meet or exceed the physical property values as shown in the following table:

TABLE 1

MATERIAL PROPERTIES - REINFORCED POLYPROPYLENE (PP-R)

PROPERTY	TEST METHOD	SUPPORTED (S) TYPE
Gage (Mils, Nominal)	--	45
Plies, Reinforcing 10 x 10 1,000d polyester scrim	--	1
Thickness, mils minimum	ASTM D751	
1. Overall		41
2. Over Scrim (Optical Method) (Reference Appendix A, NSF)		11
Breaking Strength-Fabric (pounds, minimum) (Grab Method)	ASTM D751 Method A	250
Tear Strength (pounds, minimum) Tongue Tear	ASTM D751 Method B	55

uncture Resistance (lbs.)	FTMS 101°C, Method 2031	210
Low Temperature (°F)	ASTM D2136 (1/8 inch mandrel, 4 hours, pass)	-40
Dimensional Stability (each direction percent change maximum)	ASTM D1204 180°F, 1 hour	1.0
Volatile Loss (percent loss maximum) 30-mil sheet	ASTM D1203 Method A,	0.5
Hydrostatic Resistance (pounds/square inch, minimum)	ASTM D751 Method A, Procedure 1	250
Ply Adhesion (Each direction pounds/inch width, minimum)	ASTM D413 Machine Method Type A	35
Resistance to soil burial (maximum % change from original values)		
a. 40-mil unsupported sheet	ASTM D3083 (per ASTM paragraph 9.5)	
1. Breaking strength		5%
2. Elongation at break		15%
3. Modulus at 100% elongation		15%
b. Membrane fabric breaking strength	ASTM D751, Method A	15
Water Absorption (maximum % weight change, unsupported short)	ASTM D471, 70°F	<1%
UV Resistance	a) Florida Exposure b) ASTM G26 Xenon Arc method, 63°C	pass-1 yr. Exposure pass-3,000 hours
Stress Cracking Resistance (minimum hours with no failure)	ASTM D1693	pass-3,000 hours

FACTORY SEAM REQUIREMENTS[1]

Bonded Seam Strength (factory seam, breaking factor, lbs./width)	ASTM D751 (As modified in Appendix A, NSF)	200
Peel Adhesion (pounds per inch minimum)	ASTM D413 (As modified in Appendix A, NSF)	30

[1]Factory seams are the responsibility of the fabricator.

2.02 FABRICATION

A. Quality assurance for synthetic liner manufacture should begin with the testing of the polymer raw materials. The supplier shall provide documentation that the raw materials comply with the manufacturer's product properties and performance requirements. Other types of raw materials that may be used in the production of specific membrane types include additives and reinforcing materials. These types of materials should be manufactured under the vendor's quality control/quality assurance program and a certification indicating that they meet the performance specifications should be provided.

B. The compounding ingredients used in producing membrane liners should be first quality, virgin material meeting specific public health and safety requirements as well as providing durable and effective formulations for liner applications. Each manufacturer shall have a manufacturing quality management program based on the manufacturing method used and the type of membrane being produced.

C. The manufacturer shall certify that all rolls of membrane supplied for the project meet the product specifications and all vendor published certifications. The certification form in Exhibit 2.02-1a should be completed by the membrane manufacturer and submitted along with test results, labled by roll number, which demonstrate that the roll goods meet the product specifications.

D. Blankets or panels should be assembled from roll goods according to the manufacturer's field layout. Each panel shall be continuous from the top anchor trench to the bottom anchor trench. No horizontal panel seams shall be allowed on the slope. Horizontal seams within a panel shall be allowed as long as seams for adjoining rolls are not adjacent.

E. The manufacturer shall supply a list of not less than 5 projects and not less than 500,000 square feet of polypropylene lining which has been successfully installed. The project list shall show the name, address and telephone number of an appropriate party to contact in each case.

F. All factory seams shall be made by hot-air or hot-wedge method. All factory seams shall have a minimum scrim-to-scrim overlap of 1" when fabricated. Fabricated seams found to have less than the specified minimum overlap shall be repaired by adding an overlap or cap strip which does provide the minimum specified overlap or will be rejected. Factory seams shall be fully bonded across the entire scrim-to-scrim lapped area. All seams shall be made so that the thermal fusion bond extends fully to the top edge of the sheet so that no loose edges are present on the top side of the sheet.

G. All factory seams will be 100 percent visually inspected by the Construction Manager's independent inspector and the inspection form shown in Exhibit 2.02-2a will be completed.

H. No defective seams or exposed scrim will be allowed. The fabricator shall stop production of panels used in this work and shall repair the seam, rectifying the cause of the defect prior to continuing the seaming process. All exposed scrim edges shall be "flood-coated" with a polypropylene edge sealant. All indicated repairs shall be made by the geomembrane fabricator before the panels are packaged for shipment.

I. In addition to visual inspection, a 48 inch (1.2M) sample shall be taken from each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Destructive seams should be taken from the trench areas and repaired in accordance with 3.02D, this Section. Test specimens shall be cut at quarter points from each 48 inch seam sample (a total of three places) and tested for factory seam strength and peel adhesion. The fabricator shall provide the test results to the Construction Manager for the following upon request.

1. Bonded Seam Strength - The seam strength shall be tested in accordance with ASTM D751, as modified by NSF 54, and shall have tensile strength equal to 80% of the value specified for the parent material tested in the same manner.

2. Peel Adhesion - The peel adhesion shall be tested in accordance with ASTM D413 and shall provide a "film tearing bond" when tested. A "film tearing bond" is considered to be a bond sufficiently strong where the failure of the seam will not itched at the bonded surfaces. A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the PP material and/or seams as appropriate.

PART 3 - EXECUTION

3.01 PREWORK

A. The membrane is to be installed over the existing ground. The existing ground should be prepared by grading smooth, removing any protruding rocks, and steel drum rolling the surface. The installer's representative and the Construction Manager's independent inspector should observe the supporting surface area for evidence of settling, rocks, sticks, roots, or other materials which could damage the geomembrane.

B. The Certificate of Acceptance for the supporting surface is to be signed by the membrane installer, and the Construction Manager's independent inspector per Construction Quality Control documents.

3.02 INSTALLATION

A. General

The geomembrane shall be placed over the prepared surface in such a manner as to insure minimum handling and in accordance with the approved shop drawings. The lining shall be sealed to all concrete structures and other openings in accordance with details shown on the plan and shop drawings. Any deviations or changes from this specification, by the Contractor, shall be submitted to the Construction Manager for approval. Accordingly, all changes that have not been reviewed and approved by the Construction Manager, may be rejected by the Construction Manager. The geomembrane lining shall be closely fitted and sealed around all inlets, outlets and other projections through the lining, using prefabricated fittings where possible, as shown in the construction details. Liner sheets, damaged from any cause, shall be removed, repaired or covered with additional sheeting. Materials, equipment or other items shall not be dragged across the surface of the liner or be allowed to slide down slopes on lining. All parties walking or working on the PP lining material shall wear soft-sole shoes. Where the perimeter of the liner extends into the riprap ditches the riprap shall be removed, the liner placed and the riprap replaced over the liner.

B. Field Joints

Lap joints shall be used to seal factory fabricated sheets together in the field. The lap joint shall be formed by lapping the edges of the sheets four (4) to six (6) inches. The contact surfaces of the sheets shall be wiped clean of all dirt, dust, moisture and other foreign matter. A minimum one (1) scrim-to-scrim bond shall apply to all field seams.

Extreme care should be taken throughout the work to avoid fishmouths, wrinkles, folds or pleats in the seam area. Where fishmouths do occur, they should be slit out far enough from the seam to dissipate them, lapped, seamed together in the lapped area and patched.

C. Joints to Structures

Securing the lining to structures shall be in accordance with those details shown on the drawings submitted by the Contractor and approved by the Construction Manager.

D. Repairs to the Liner

Any necessary repairs to the liner shall be patched with the liner material itself. Use a patch with rounded corners, large enough to extend 6 inches in all directions from the puncture. Apply as above for lap joints.

E. The Contractor shall furnish a sufficient number of temporary anchors to prevent damage to the liner due to wind or other forces. The liner shall be secured at all times to hold it down during high winds.

3.03 QUALITY ASSURANCE

A. Shipping and Storage of Liner Material

The liner material shall be kept dry and out of direct sunlight until installation.

B. Liner Repairability

The liner material must be repairable. This will require welding new liner panels to the then aged liner panels installed by this contract. Therefore, the panels must be weldable (fusible) in the future. The Contractor shall certify that this will be possible and submit a procedure for liner repairs.

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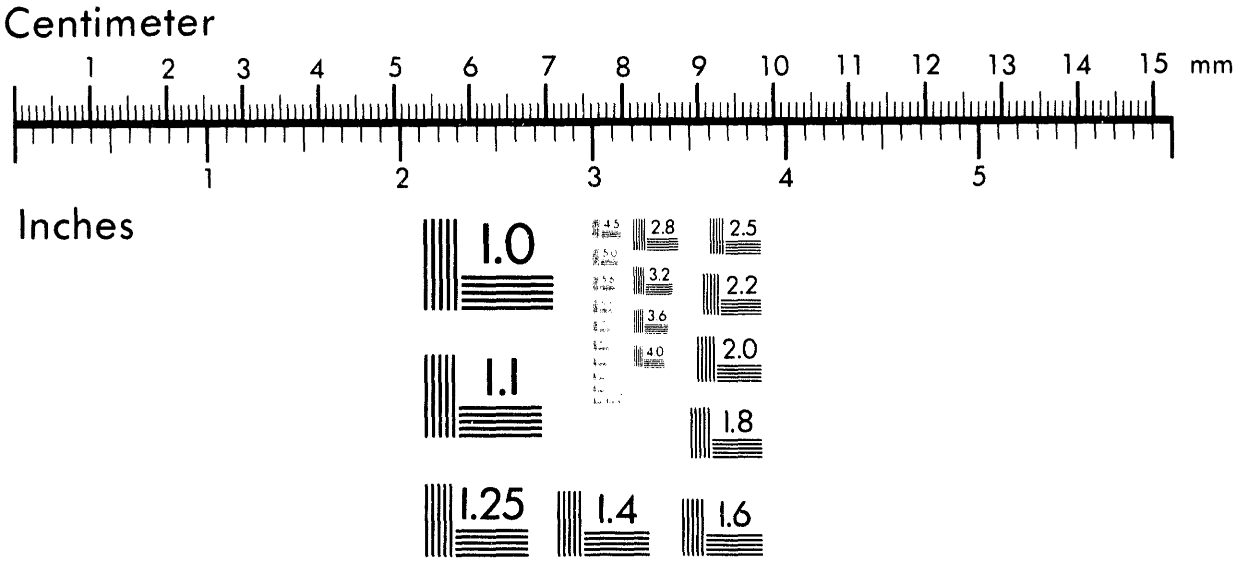

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C. Testing of Liner

The Contractor shall provide the necessary personnel and equipment to perform the following:

1. The completed installation shall be cleaned of all debris, construction material, etc.

2. All field welds (not factory welds) and repair patches shall pass a vacuum box test at a negative pressure of 5 psi along with destructive tests of companion samples, performed by the Contractor and witnessed by the Construction Manager in the field. A definitive log, with sign-offs, shall be maintained. The log shall show all seams and repairs that passed testing and shall be approved by the Construction Manager.

3.04 WARRANTY

A. The Contractor shall provide a minimum of 2 years warranty covering installation of the liner.

B. The fabricator shall provide a minimum of 5 years prorated warranty.

C. The liner manufacturer shall provide a 10 year prorated warranty.

3.05 INSPECTION

A. Inspection activities during liner placement will be performed by an independent QA/QC inspector and include the following:

1. Checking delivery tickets and synthetic membrane manufacturers' quality control reports to verify that the synthetic membrane rolls received onsite meet the project specifications. In addition, it is usually good practice to take the identifying labels from each roll or pallet and save them for future reference. Further, the position of each roll or pallet of material should be noted on a final installation drawing.

2. Inspection should ensure that the synthetic liner placement plan was followed.

3. Observations of the weather conditions (i.e., temperature humidity, precipitation, and wind) to ensure that they are acceptable for membrane placement and seaming. The acceptable temperature range for membrane placement and seaming is 35 degrees F to 105 degrees F measured 2 feet above the membrane. Membrane shall not be placed during any precipitation, with excessive moisture on the subgrade or over any standing water.

4. Observations and measurements of the anchor trench to ensure that the lines and width are as specified in design drawings. If the trench is excavated in soil that is susceptible to desiccation, only that trench length that is required for 1 day's work should be excavated. Consideration should be given to using a temporary liner in the trench to prevent desiccation. Trench corners should be rounded to prevent stressing the membrane. Good housekeeping practices should be used in the trenching operation by not allowing any loose soil material in the trench or on the downhill side of the trench. Backfilling of the trench should be performed as soon as possible and compacted with care so as not to damage the synthetic liner.

5. Observations and tests to confirm that all designed liner penetrations and liner connections are installed as specified. Liner penetrations should be verified for appropriate clamp and caulking use, for appropriate material, for good seaming, and for good housekeeping practices.

6. Measurements to confirm that required overlaps of adjacent membrane sheets were achieved, that proper temporary anchorage was used (e.g., sand bags or tires), that specified temporary and final seaming materials/techniques were used, and that the blanket was placed in a relaxed (nonstressed) state.

B. As each synthetic membrane panel is placed, it should be visually inspected for tears, punctures, and thin spots. The inspector should also inspect any factory seams to ensure that they are adequate. To accomplish this, the panels should be traversed by the inspector in such a way that the entire surface, including all factory seams, is inspected. The normal procedure used to detect membrane defects is to walk along each roll stock width and inspect the entire length of the sheet. Any defects should be marked on the synthetic membrane for repair.

C. The overall quality of a synthetic liner installation can be affected by the weather conditions during which it was installed. The inspector should be aware of all of these factors and the effects they may have on the specific membrane type and seaming procedure being used. If the weather becomes unacceptable for installation of the liner, the inspector should stop the membrane installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.

D. Inspection activities during synthetic liner placement will help ensure, with a reasonable degree of certainty, that the completed facility meets or exceeds all design criteria, plans, and specifications, by preventing, detecting, and correcting the following:

1. Liner damage from adverse weather conditions, inadequate temporary anchoring, or rough handling.

2. Improper liner placement (if the placement plan is not followed) and, as a result, inadequate coverage with the available materials or an excess number of field seams.

3. Inadequate sheet overlap, possibly resulting in poor quality seams.

4. Nonwelded or nonseamed sections.

5. Inadequate seam strength.

6. Seam gaps or weak spots resulting from the presence of dirt or dust.

7. Less-than specified seam strength resulting from the use of unspecified materials, improperly operating equipment, insufficient pressure, ambient temperature extremes, or insufficient dwell time.

8. Liner damage caused by cleaning or bonding solvents and seaming equipment. Liner damage may also result from walking on the membrane while wearing improper footwear or from the improper disposal of cigarette butts. Smoking shall not be allowed on site. Solvents may be used for cleaning only.

E. Inspection activities that should be documented during membrane seaming operations include:

1. Observations to ensure that the membrane is free from dirt, dust and moisture.

2. Observations to ensure that the seaming materials and equipment are as specified.

3. Observations and tests to ensure that a firm foundation is available for seaming.

4. Observations for weather conditions to ensure that they are acceptable for seaming.

5. Observations to ensure that the membrane is not damaged by equipment or personnel during the seaming process.

F. After field seams are installed, they shall be inspected to ensure that a homogeneous bond was formed. Nondestructive tests should be performed on 100 percent of the field seams. All testing shall be performed by and independent certified commercial testing laboratory furnished by the Construction Manager. Testing performed by the manufacturer's or supplier's testing laboratory shall not be accepted for compliance with these specifications. Failed seams shall be recorded as to location and seaming crew. The data should be reviewed for possible patterns. Repairs should be made in accordance with approved techniques and retested to verify their integrity. Any doubtful areas shall be tested with a vacuum seam tester or other device as approved by the Construction Manager.

G. All field seams and repair patches shall be tested using a vacuum box at a negative pressure of 5 psi. A Geomembrane Installation Inspection Report, with signoffs, shall be maintained.

H. One companion field seam per field panel will be prepared on site by the seaming personnel and tested by an independent laboratory for bonded seam strength in accordance with ASTM D751, and a peel adhesion test in accordance with ASTM D413 (machine method). The companion field sample shall be taken at the same time the field seam is being constructed. The minimum acceptable value for the bonded seam strength test is 200 pounds/inch width. The minimum acceptable value for the peel adhesion test is 40 pounds/inch width. Field samples shall be forwarded to the laboratory on the same day they are prepared.

If a seam test fails, an additional test specimen shall be prepared from the same coupon as the failed test specimen. If the retest fails to achieve adequate strength, the Construction Manager shall be notified and a suitable remedy shall be determined.

End of Section
Except for Attached Exhibit

EXHIBIT 2.02-1a

MANUFACTURER'S CERTIFICATION

Date ______________________________

Project ______________________________

Location ______________________________

The rolls of ______________________ membrane listed below were supplied to
______________________________________ for use in the subject project;
____________. All rolls supplied meet our minimum published specifications
for this project and the project specifications. All raw materials are original, first quality.

Signed:

____

Roll Numbers:

EXHIBIT 2.02-2a

FACTORY SEAM INSPECTION REPORT

(To Be Completed By Construction Manager's Independent Inspector)

Panel No. ______________________________

Panel Size ______________________________

SL Roll Numbers ___________________________________

Seam No.	Seamer	Temperature Humidity	Visible Bead	Loose Flaps	Seam Width	ok
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

______________________________ Inspector

______________ Date

SECTION 02605

LEACHATE AND SANITARY MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION

This Section includes standard/drop, leachate sewer, and area inlet manholes.

1.02 RELATED WORK

A. Section 02223, Excavating, Backfilling and Compacting for Structures.

B. Division 3, Concrete.

1.03 REFERENCES

A. American Society of Testing Materials (ASTM)

1. ASTM A48, Gray Iron Castings

2. ASTM C478, Precast Reinforced Concrete Manhole Sections.

3. ASTM D4101, Specification for Propylene Plastic Injection and Extrusion Materials.

1.04 SUBMITTALS

A. Submit as specified in Division 1 for precast manholes.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete: Reinforced, 4000 psi. Conform to DIVISION 3

B. Castings:

1.0 Manhole steps
a. ASTM A48, Class 30B, as manufactured by Neenah R-1982-H of J or approved equal.
b. Type II Steel reinforced

polypropylene plastic or rubber as approved by Company Representative conforming to ASTM D4101.

2.0 Manhole frames and covers.
a. ASTM A48, Class 30B, pattern as specified for each structure under PART 3, this Section.
b. Interchangeable within same pattern.

3.0 Conform to drawings in all essentials of design. Weight shall be within 10 percent of that listed for pattern.

4.0 Machine-bearing surfaces to provide even seating.

PART III - EXECUTION

3.01 MANHOLES:

A. Design and construct as follows:
1.0 Precast Manhole with precast concrete base. Precast manhole shall conform to ASTM C478 (with rubber "O"-ring to concrete joint).
2.0 Conform to drawings.
3.0 Caulk and repair any leaks or remove entire work and build to obtain watertight construction.

B. Manhole Frames and Cover:
1.0 Shall be Neenah 1736 or approved equal.
2.0 Set frame level to proper grade of full bed of nonshrink mortar.

C. Connections:
1.0 Grout around pipes with non-metallic nonshrink grout.
2.0 Install all piping using a flexible rubber entrance hole gasket joint of pattern approved by the Company Representative.
3.0 Place pipe stub in manhole wall with bell or coupling outside manhole wall to provide flexible joint as indicated.

D. Invert Channels:
1.0 Form invert channel with 3000 psi Type II Portland cement concrete.
2.0 Make changes in direction of flow with smooth curves of as large a radius as size of manhole permits.
3.0 Make changes in size and grade smoothly and uniformly.

4.0 Slope floor of manhole adjacent to channels as indicated.
5.0 Finish channel bottom smoothly without roughness, irregularity or pockets.

E. Waterproofing:
1.0 Apply bituminous coating to exterior walls on all manholes from base to finish grade.
2.0 Apply coating in two coats to minimum 12 mils dry film thickness per coat.

3.02 LEACHATE LIFT STATION

A. Design: Same as specified for manholes except base shall be precast concrete and integral with first riser section.

B. Connections shall be as specified for manholes.

C. Dampproofing: As specified in 3.01(E) above.

END OF SECTION

SECTION 02610

LEACHATE PIPE SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes the material and installation of a leachate collection system.

1.02 QUALITY ASSURANCE

A. Furnish materials of quality required by American Society for Testing (ASTM) standards or other approved standards and specifications.

B. Install system in accordance with the requirements of the "Standard Plumbing Code, Southern Building Code Congress International, Inc."

1.03 REFERENCES

A. ASTM Annual Book of Standards.

1) ASTM A-74, Cast Iron Soil Pipe and Fittings.

2) ASTM F-477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

3) ASTM D-3212, Joints for Drain and Sewer Plastic Pipe using Flexible Elastomeric Seals.

4) ASTM D-2564, Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.

5) ASTM D-2321, Underground Installation of Flexible Thermoplastic Sewer Pipe.

6) ASTM F-402, Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings.

B. American National Standards Institute (ANSI) A21.4 and A21.11.

C. American Water Works Association (AWWA) Specification C111.

1.04 SUBMITTALS

Survey all piping before backfilling. Submit as-built drawings and survey field notes showing coordinates and invert elevations of all underground leachate piping to the Construction Manager. In addition, mail a copy to the following address:

Civil, Site, and Waste Management Design Department
Martin Marietta Energy Systems, Inc.
P. O. Box 2003
MS 7233
Oak Ridge, Tennessee 37831-7233
Attn: As-Built Data

1.05 DELIVERY, STORAGE, AND HANDLING

Deliver piping, fittings, and valves to the site in a clean and protected condition. Maintain end seals of pipe and valves and flange covers in place and remove only as necessary for cleaning, fabrication, erection, or inspection. Exercise care in the handling and storage of all piping materials and prefabrication so that contamination by moisture, grease, dirt, or injurious foreign matter does not occur.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Polyvinyl Chloride (PVC) Leachate Collection Pipe

1) Perforated and non-perforated PVC pipe shall conform to ASTM D2241 for pipes with smooth interior and exterior. PVC piping to be as specified and modified herein.

2) Minimum wall thickness of pipe shall be SDR-21.

3) Joints:

a.
Compression type with the elastomeric ring confined in the annular space between the bell end or socket and the spigot end of the pipe.

b.
Elastomeric gasket ring joints shall conform to the requirements of ASTM F477. Gaskets shall be neoprene or other synthetic rubber material.

c.
Plain end of pipe shall be marked with a reference line to facilitate assembly inspection.

4) Pipe Bedding material shall extend a minimum of 6 inches above the top of pipe as specified in Section 0225.

5) Pipe, fittings, and specials shall be marked conforming to the applicable standard specification under which the pipe is manufactured or as otherwise specified.

6) Perforated pipe shall have one-half inch diameter holes spaced in rows at 4 holes per foot within the lower 120° segment of the pipe circumference.

PART 3 - EXECUTION

3.01 INSPECTION

Before backfilling, inspect to make sure that the pipe lies evenly on the bottom of the ditch, that no debris is present, that joints are not covered until tests are complete, that all tests have been made, and that as-built surveying is complete.

3.02 INSTALLATION/APPLICATION/ERECTION

A. General

1) Detailed requirements for trenching and backfilling in accordance with Sect. 02225, Excavating, Backfilling, and Compacting for Utilities.

2) Lay pipe in trenches true to line and grade. Conduit installation shall proceed upstream with the bell ends upstream. Join sections in such a manner that there will be as little unevenness as possible along the inside of the conduit. Support pipe evenly and firmly across the underside, up to the spring line, and above to furnish lateral pressure against the sides of the pipe.

3) Cut pipe and tubing accurately. Use tube or pipe cutters or other approved methods. Ream all cuts to remove burrs. Remove any objectionable defects by machining, chipping, or grinding.

4) The pipe shall be lowered into the ditch without unnecessary strain so that the pipe is centered in the ditch. Only approved equipment shall be used to handle and lay the pipe. Chain or wire-rope slings shall not be use.

B. Plastic Sewer Pipe

Plastic sewer pipe installation shall be in accordance with the recommended practices of ASTM D-2321.

3.03 ADJUSTING AND CLEANING

Prior to erection, the inside of all pipe and fittings (including the external surfaces of spigot ends) shall be cleaned of dirt and foreign materials. After installation but prior to backfilling, all drain lines shall be cleaned free of foreign deposits and inspected for broken or cracked pipe and fittings. Defective pipe or fittings shall be replaced.

END OF SECTION

SECTION 02720

STORM DRAINS

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes the materials and installation of storm drains five feet outside the building line. The maximum temperature is 160°F.

1.02 QUALITY ASSURANCE

A. Furnish materials of quality required by American Society of Testing Materials (ASTM) standards or other approved standards and specifications.

B. Install system in accordance with the requirements of the "Standard Plumbing Code, Southern Building Code Congress International, Inc."

1.03 REFERENCES

A. ASTM Annual Book of Standards.

1) ASTM C-76, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

2) ASTM C-443, Joints for Circular Concrete Sewer and Culvert Pipe using Rubber Gaskets.

3) ASTM C-14, Concrete Sewer, Storm Drain, and Culvert Pipe.

B. American Association of State Highways and Transportation Officials (AASHTO).

1.04 SUBMITTALS

Survey all piping before backfilling. Submit as-built drawings and survey field notes showing coordinates and invert elevations of all underground storm drain piping to the Construction Manager. In addition, mail a copy to the following address:

Civil, Site, and Waste Management Design Department
Martin Marietta Energy Systems, Inc.
P. O. Box 2003
MS 7233
Oak Ridge, Tennessee 37831-7233
Attn: As-Built Data

1.05 DELIVERY, STORAGE, AND HANDLING

Deliver piping, fittings, and valves to the site in a clean and protected condition. Maintain end seals of pipe and valves and flange covers in place and remove only as necessary for cleaning, fabrication, erection, or inspection. Exercise care in the handling and storage of all piping materials and prefabrication so that contamination by moisture, grease, dirt, or injurious foreign matter does not occur.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforced concrete sewer pipe in accordance with ASTM C-76, Class III, wall B, with joints for circular concrete sewer and culvert pipe using flexible, watertight, rubber gaskets per ASTM C-443.

B. Corrugated metal culvert pipe shall conform to AASHTO M36 and shall be full-circle, lock-seam type. End sections shall be galvanized metal with toe plates. Coupling bands shall conform to AASHTO M36.

PART 3 - EXECUTION

3.01 INSPECTION

Before backfilling, inspect to make sure that the pipe lies evenly on the bottom of the ditch, that no debris is present, that joints are not covered until tests are complete, that all tests have been made, and that as-built surveying is complete.

3.02 INSTALLATION/APPLICATION/ERECTION

A. General

1) Detailed requirements for trenching and backfilling in accordance with Sect. 02225, Excavating, Backfilling, and Compacting for Utilities.

2) Lay pipe in trenches true to line and grade. Conduit installation shall proceed upstream with the bell ends upstream. Join sections in such a manner that there will be as little unevenness as possible along the inside of the conduit. Support pipe evenly and firmly across the underside, up to the spring line, and above to furnish lateral pressure against the sides of the pipe.

3) Cut pipe and tubing accurately. Use tube or pipe cutters

or other approved methods. Ream all cuts to remove burrs. Remove any objectionable defects by machining, chipping, or grinding.

4) Lower pipe into the ditch without unnecessary strain so that the pipe is centered in the ditch. Use only approved equipment to handle and lay the pipe. Do not use chain or wire-rope slings.

B. Reinforced Concrete

Joints for reinforced concrete sewer pipe shall be made with factory applied compression joints made up of using rubber O-ring gaskets in accordance with ASTM C-443.

3.03 FIELD QUALITY CONTROL

A. Tests of storm sewers shall be make by lamping from one manhole to another. Each run of sewer piping between manholes shall show a full circle of light upon visual inspection. The Contractor shall perform this test.

3.04 ADJUSTING AND CLEANING

Prior to erection, the inside of all pipe and fittings (including the external surfaces of spigot ends) shall be cleaned of dirt and foreign materials. After installation but prior to backfilling, all drain lines shall be cleaned free of foreign deposits and inspected for broken or cracked pipe and fittings. Defective pipe or fittings shall be replaced.

END OF SECTION

SECTION 02936

SEEDING

PART 1 - GENERAL

1.01 DESCRIPTION

This work includes seeding, fertilizing, and liming.

1.02 QUALITY ASSURANCE

Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.03 REFERENCES

Tennessee Department of Transportation (TDOT), Bureau of Highways, Standard Specifications for Road and Bridge Construction, latest edition.

1) Subsection 918.14, Grass Seed

2) Subsection 918.15, Commercial Fertilizer

3) Subsection 805, Erosion Control Matting

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Seed Mixture

1) Seed Mixture: In accordance with the requirements of the Tennessee Department of Agriculture and TDOT Specification, Sect. 918.14. The percentages forming the group shall be as set out below.

Seed	Quantity % by Weight	Seeding Dates

Group A

Kentucky 31 Fescue	80	Feb. 1-July 1
English Rye	5	
Korean Lespedeza	15	

Group B

Kentucky 31 Fescue	55	June 1- Aug. 15
English Rye	20	
Korean Lespedeza	15	
German Millet	10	

Group C

Kentucky 31 Fescue	70	Aug. 1-Dec. 1
English Rye	20	
White Clover	10	

Group C1

Crown Vetch	25	Feb. 1-Dec. 1
Kentucky 31 Fescue	70	
English Rye	5	

B. Topsoil

Topsoil in accordance with Sect. 02220, Excavating, Backfilling, and Compacting.

C. Accessories

1) Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

a. All straw mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.

b. Straw shall be suitable for spreading with standard mulch blower equipment.

2) Fertilizer: Standard commercial fertilizer conforming to the requirements of TDOT Specification, Subsection 918.15 with the guarantee of analysis conforming to a 6-12-12 formula. The fertilizer shall be uniform in composition, free flowing, and suitable for application with approved equipment.

3) Agricultural Limestone: Agricultural Limestone shall contain not less than 85% of calcium carbonate and magnesium carbonate combined and be crushed so that at least 85% will pass the No. 10 mesh sieve and 50% through a 40 Mesh Sieve.

4) Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass.

5) Erosion Control Matting: Shall be in accordance with TDOT Specification, Sect. 805 and shall meet the requirements of the following Subsections of Div. III, Materials:

Material	Subsection
Jute Mesh	918.19
Excelsior Matting	918.28
Erosion Control Fabric	918.29
Staples	918.19

PART 3 - EXECUTION

3.01 INSPECTION

Verify that prepared soil base is ready to receive the work of this section and that the final dressing is within reasonably close conformity to the lines, grades, and cross-sections.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Fertilizing and Limestone

1) Apply commercial Grade 6-12-12 fertilizer at a rate of not less than 20 lb/1000 ft^2 and agricultural limestone at a rate of not less than 75 lb/1000 ft^2.

2) Apply after smooth raking of topsoil.

3) Do not apply fertilizer at same time or with the same machine used to apply seed.

4) Uniformly incorporate into the soil for a depth of approximately 1/2 in.

5) Lightly water to aid the dissipation of fertilizer.

B. Seeding

1) Apply seed at a rate of 3 lb/1000 ft^2 evenly in two intersecting directions. Rake in lightly. Do not seed area in excess of that which can be mulched on same day.

2) Do not sow immediately following rain, when ground is too dry, or during windy periods.

3) Immediately following seeding, apply mulch uniformly.

4) Apply water with a fine spray immediately after each area has been mulched. Saturate to 2 in. of soil.

D. Seed Protection

1) Cover seeded slopes where grade is 4 in./foot or greater or other areas at locations shown on the plans with erosion fabric control matting.

2) The placing and securing of either jute mesh, excelsior matting, erosion control fabric, or other approved matting on previously shaped and seeded channels, slopes, or other areas and locations shown on the plans and shall be in accordance with the construction requirements of TDOT Specification, Sect. 805.

E. Maintenance

1) Maintain newly graded and topsoiled and seeded areas until final acceptance. Restore areas showing settlement or washes to the specified grades at no additional cost. Newly seeded areas shall be watered as necessary or reseeded until an acceptable stand of grass has been achieved at no additional expense.

2) Immediately remove clippings after mowing and trimming.

3) Water to prevent grass and soil from drying out.

4) Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

5) Immediately reseed areas which show bare spots.

6) Protect seeded areas with warning signs during maintenance period.

END OF SECTION