Permit No. 18-04

Duke Power Company
Electric System Support
13339 Hagers Ferry Road
Huntersville, NC 28078-7929

DUKE POWER

Carmen Johnson
Fac/Perm/Co. ID # 18-04 | Date 1/24/12 | Doc ID# | DIN

April 24, 1996

Jim Coffey, Environmental Engineering Supervisor
Division of Solid Waste Management
Permitting Branch, Solid Waste Section
Department of Environment, Health, and Natural Resources

Subject: Marshall Solid Waste Permit 18-04
Marshall Steam Station, Catawba County
Industrial Landfill
File: GS 707.25

Duke Power Company, requests that the Marshall Steam Station landfill permit #18-04 be amended. The site would like to replace the currently approved landfill specification with the revised specification in attachment 1. This specification, MSS-0215.00-00-0001, Specification on Clearing, Constructing, Operating, and Closing Dry Flyash Landfill: Revision 4, April 1, 1996 reflects changes in technology, improved equipment and current engineering practices.

If you have questions on this information, please feel free to contact Grayling Vander Velde at (704) 875-5021.

Grayling Vander Velde, Scientist
Environmental Protection, Waste Management

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DIVISION OF SOLID WASTE MANAGEMENT
DATE 5/28/96 BY SWL

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DUKE POWER COMPANY

MARSHALL STEAM STATION

UNITS 1 - 4

MSS-0215.00-00-0001
Specification on Clearing, Constructing,
Operating, and Closing Dry Flyash Landfill

Revision Log:

1 _June 28, 1984 _____

2 _December 5, 1984_____

3 _December 16, 1986_____

4 _April 1, 1996_____

5 _____

6 _____

7 _____

8 _____

9 _____

10_____

Form 02548 (R8-89)

Form 301.2 Rev.10

VERIFICATION OF SPECIFICATION

Station and Unit Number: Marshall Steam Station, Units 1-4

Title of Specification: Specification on Clearing, Constructing, Operating, and Closing Dry Flyash Landfill

Specification Number: MSS-0215.00-00-0001

Revision: 4

This document specifies items related to QA CONDITION N/A. In accordance with established procedures, its quality has been assured. Signatures certify that the above specification was originated, checked, approved and inspected (or waived) as noted.

Signature also certifies that a review for determining potential impact to work performed per previous revisions was conducted for this revision.

Previous Work Impacted by this revision: ☐ Yes, See Attachment ☒ No

Prepared By: Mike Martin Date: 4/1/96

Checked By: _____ Date: _____

Approved By: By D. Boone Date: 4/1/96

Form 170.1 Rev. 0
26161 (9-82)

DESIGN SPECIFICATION NO. MSS-0215.00-00-0001

DATE Rev. 0 April 26, 1984

REVISION DESCRIPTION SHEET

REVISION NUMBER	PAGES REVISED AND DESCRIPTION
1	This revision, Rev. 1, was required so that a detail of the silt barriers to be used could be added to the Exhibit 1. Also, the max. elevations of the disposal areas was added. No part of the Specification text was revised for this revision.
2	Revised Appendix A, Exhibit I, and added Exhibit II to give details on Stilling Ponds, drainage ditches, berm surface ditches, and earth rims.
3	Revised Exhibits to show Part 3 of the landfill and revised Specification Text to reflect new revision of Exhibits.
4	Deleted reference to all Exhibits, added reference to Drawings M-10, M-10A, M-10B, M-10C, and M-10D, revised Appendix A (Erosion and Sedimentation Control Plan), deleted Appendix B (Materials for Grassing Requirements). Materials for Grassing Requirements are specified in Appendix A.

Duke Power Company
Specifications on Clearing, Constructing, Operating, and Closing Dry Flyash Landfill
Marshall Steam Station in Catawba County, N.C.

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4

GENERAL PROVISIONS

1.0 DEFINITIONS

The words and terms used in the Specification shall have the meanings given below:

Owner:	Duke Power Company, or its authorized representatives.
Engineer:	Duke Power Company' s Vice President, Fossil/Hydro Generation Department or his authorized representatives. 4
Inspector:	The person or persons authorized by the Engineer to inspect the Contractor's work and materials.
Contractor:	Monex Resources, Inc. (MRI), formerly Monier Resources, Inc. 4
Contract:	Fly Ash Disposal Agreement dated December 8, 1983 between Duke Power Company and Monier Resources, Incorporated (Monex Resources, Incorporated) as amended to date. 4
Specifications:	All of the terms and conditions contained (1) in the General and Detailed Provisions of this Specification, (2) in the amendments and revisions which may be made to them, and (3) in all written agreements, made or to be made, pertaining to the method and manner of performing the work or to the quantity and quality of the material to be furnished.
Drawings:	All of the drawings attached to this Specification as M-10, M-10A, M-10B, M-10C, M-10D, and those supplementary or additional drawings which the Engineer may issue later during work to clarify or further detail the contract drawings or work, including subsequent revisions which may be made to them. 4 4

2.0 PROJECT LOCATION

The project site for the contract work is located at Marshall Steam Station in Catawba County, North Carolina. Marshall Steam Station is located on N.C.

150. The disposal site is shown on the Drawings and the Monex Operating Area is located as shown in the Contract. 4

3.0 CONTRACT WORK DESCRIPTION AND PRINCIPAL WORK FEATURES

The work to be performed by the Contractor shall consist of furnishing all labor, materials, equipment, construction plant, tools, supplies, transportation and all other goods and/or services required to perform the Contract.

The principal work features listed below are a general outline and do not in any way limit the responsibility of the Contractor to perform all work required by the Contract.

The principal work features are as follows:

Clearing of Landfill site
Grubbing of Landfill site
Diversion and Care of Water
Disposal of Flyash in the Landfill
Closure of the Disposal Area

4.0 ESTIMATE OF QUANTITIES

All quantities of work mentioned in the specifications are approximate and may vary considerably from those measured during the course of actual work for purposes of payment. Payment will be made for work as agreed upon in the Contract.

Listed below is the estimated quantity of flyash to be produced at Marshall Steam Station: 4

Year	Dry Tonnage	Year	Dry Tonnage
1996	400,000	2001	470,000
1997	440,000	2002	490,000
1998	430,000	2003	470,000
1999	410,000	2004	450,000
2000	460,000	2005	490,000

5.0 MEASUREMENT OF QUANTITIES

Within thirty (30) days after the end of each calendar month, the Contractor shall provide the Owner with the following documentation: Copies of the Contractor's weight slips from a certified scale for those trucks weighed and a disposal summary containing such information as the Owner may request for all flyash disposed of in the disposal site during the preceding month.

6.0 SPECIFICATIONS AND DRAWINGS

This Specification and Drawings will show, explain or indicate the method or manner of performing the work and the type or class of materials to be used. Any work or material shown or mentioned in either the Specification or Drawings and not specifically shown or mentioned in the other, shall be accomplished or furnished by the Contractor as if shown or mentioned in both. | 4 | 4

Should disputes arise with respect to these Specifications or Drawings, or should discrepancies be found between two or more parts of the specification, or should there be questions relative to implications beyond specific descriptions, the Engineer's explanation and decision shall be final and binding. | 4

7.0 LINES AND GRADES

The Contractor shall establish baselines and benchmarks pertinent to the work and will furnish or indicate location and limit marks, including slope stakes, necessary for construction of the project. All such marks and stakes shall be carefully preserved by the Contractor, and the Contractor shall be responsible for the construction of work to those lines and grades. Lines and grades are subject to field verification by the Engineer.

8.0 PROPERTY USE AND DAMAGE

The property on which the project is to be built is or will be controlled by the Owner. All of the Contractor's operations on the Owner's premises, including the storage of materials, shall be confined to areas authorized by the Engineer.

9.0 ACCIDENTS AND ACCIDENT PREVENTION

The Contractor shall at all times comply with the latest OSHA Safety Regulations for the safety of persons engaged in any sort of work or business on the project sites.

The Contractor's safety program shall be subject to periodic review by the Engineer. The wearing of hard hats, safety glasses with side shields and safety shoes by all persons in areas in which work is in progress is mandatory. The Contractor shall be responsible for and shall enforce the wearing of such safety equipment by all his personnel.

All accidents involving injury to persons on the project sites or damage to property or equipment shall be reported immediately to the Engineer.

The Contractor shall furnish and maintain, at his own cost and expense and to the Engineer's satisfaction, all necessary guard fences, barricades, watchman and lights, and such other safeguards and facilities for protection of the work as may be required. In addition, the Contractor shall take all necessary precautions for the safety of his employees or others who may be on the work site and for the protection of property on the work site. All work performed by the Contractor on the Owner's premises shall comply with the latest revision of Safety and Health Regulations for Construction (29 C.F.R. 1926). The Contractor shall observe all rules and regulations of the State Board of Health, and all local health officials and shall take such precautions as are necessary to avoid unhealthy conditions. When explosives are used in the prosecution of the work, the Contractor shall observe the utmost care so as not to endanger life and property, and, whenever directed by the Engineer, the number and size of charges shall be reduced. All explosives shall be stored in a secure manner, and all such storage places shall be marked clearly "Dangerous - Explosives."

10.0 CONTRACTOR'S ADMINISTRATION OF OWN FORCES

The Contractor shall place in charge of the work on a daily basis a competent and reliable superintendent, who shall have the authority to act for the Contractor and who shall be accountable to the Engineer. The Contractor shall, at all times employ labor and equipment sufficient to accomplish the several classes of work to full completion in the manner and time specified. All personnel engaged in special or skilled work shall have sufficient experience in such work to properly and satisfactorily perform and operate the equipment involved.

Whenever the Contractor or the Contractor's superintendent is not present on any part of the site, the Contractor shall designate a responsible supervisory employee to interface with the Engineer.

The Contractor agrees to transfer any employee, agent or subcontractor working in the Contractor's operating area or disposal site if so requested by the Engineer, provided the Engineer has reasonable cause for such request.

11.0 UTILITY SERVICES

The Contractor shall make all arrangements necessary to secure and use any utility service, such as water, fuels, electric power and other similar or related services required for performance of the Contract. Access to utilities shall be provided by the Owner. The Owner shall be responsible for obtaining a burning permit when required.

12.0 MATERIALS AND QUALITY OF WORK

The Contractor is required to furnish all materials indicated or mentioned in the Specifications, or shown on the Drawings and any other material which is or may become necessary for construction and completion of the project, except for certain materials the Owner will furnish as designated in the Specifications or noted on the Drawings. | 4 | 4

The quality of all work of any kind or for any purpose shall be in accordance with the best engineering practice and highest industry standards and shall be satisfactory to the Engineer.

13.0 DAMAGED OR DEFECTIVE MATERIALS AND WORK

In the event the Contractor's work does not conform to the Specification or Drawings (including any amendments or changes thereto) or is defective or improperly performed, and in addition to any other remedies the Engineer may have, the Contractor will proceed expeditiously to modify and correct such work to the Engineer's satisfaction at no additional charge.

If any part of the work is damaged in any manner, except through the fault of the Owner, or should defects develop during construction or after completion but prior to final written acceptance of the work, the Contractor shall remedy such damage or defects in a manner satisfactory to the Engineer. Work to remedy damage or defects, except as noted and authorized by the Engineer, shall be done at the expense of the Contractor and there will be no compensation thereof.

If any material considered by the Engineer to be defective and unsuitable is used by the Contractor during construction or after completion but prior to final written acceptance of the work, the Contractor shall remove such material and replace in a manner with materials satisfactory to the Engineer. Work to remove and replace unsuitable or defective materials, except as noted and authorized by the Engineer, shall be done at the expense of the Contractor and there will be no compensation thereof.

14.0 DELAYS AND DIFFICULTIES

The Owner is not responsible for any damages, hindrances, difficulties or delays arising from rain, storms, floods, and other types of weather, no matter how extended the rising of creeks and rivers or filling of impoundments may be, or from similar contingencies. Contractor shall bear any expense caused by these damages, hindrances, difficulties or delays and there will be no compensation thereof.

15.0 ADDITIONAL OR CHANGED WORK

The Owner may make such written additions, deletions or alterations in the plans of construction, or in the quality of work, as he may consider necessary or desirable during the progress of the work to complete fully and acceptably the proposed work, provided that such written alterations are agreed upon by both the Owner and Contractor. Any changes shall have the prior written approval of the Engineer.

16.0 CLEANLINESS

The Contractor shall maintain the work and project grounds free from rubbish, debris and waste materials during all phases of the work. All trucks hauling flyash to the landfill shall be operated so that spilling of flyash from the trucks is prevented. The Contractor shall make daily inspections of the haul route to locate and cleanup any spillage of ash that may have occurred. In addition, provisions shall be made by the Contractor to prevent flyash from becoming wind-borne and thus creating a nuisance. 4

DETAILED PROVISIONS

17.0 CLEARING

17.1 SCOPE OF WORK

This item refers to the felling, cutting and removal of standing timber, underbrush and fallen trees from any areas on or near the project site as may be designated by the Engineer or shown on the Drawings. | 4

17.2 SPECIFICATIONS

Salable timber and pulpwood, if any, shall be cut and stockpiled as directed by the Engineer and will remain the property of the Owner. Any other trees or underbrush may be cleared by means of bulldozers or other equipment and any such materials shall be burned in small piles as directed by the Engineer (See Section 11 for burning permit). No clearing shall be performed until the Contractor has installed appropriate erosion and sediment control measures as detailed in Appendix A, and until the Contractor receives authorization from the Engineer. | 4

18.0 GRUBBING

18.1 SCOPE OF WORK

This item refers to the uprooting, dislodging, and disposal of grubbed material from the earth fill foundations, borrow pits, and any other areas within the landfill.

18.2 SPECIFICATIONS

The Contractor shall remove logs, stumps, roots and similar materials, and all stones of more than 12" in maximum dimension as directed by the Engineer.

Logs, stumps and other material shall be burned in small piles within the disposal area. The Engineer will direct disposition of materials that cannot be burned (See Section 11 for burning permit).

19.0 DIVERSION AND CARE OF WATER

19.1 SCOPE OF WORK

This item consists of all work required to protect the work from flooding during the construction of the principal features as defined in Section 3. In addition, this item also includes the work necessary to comply with the NC.

Sedimentation Pollution Control Act of 1973. See the attached Appendix A for details of the Erosion and Sedimentation Control Plan. This item also includes any diversion or impoundment of water for the convenience of the Contractor. | 4

19.2 SPECIFICATIONS

The Contractor shall implement the various features of the Erosion and Sedimentation Control Plan (Appendix A) as shown on the Drawings or as directed by the Engineer during disposal site construction and ash disposal operations so that the sediment and/or flyash content of stormwater runoff which drains to the Ash Basin is minimized. | 4

20.0 EARTH EXCAVATION

20.1 SCOPE OF WORK

This item consists of earth excavation for the following:

Fill for Final Cover over ash

In addition, this item shall include any other work requiring earth excavation as shown on the Drawings or that may be approved by the Engineer.

The term "Earth Excavation" shall be considered to include the removal, hauling and disposal of materials required to be excavated as directed by the Engineer. | 4

20.2 SPECIFICATIONS

All excavation for fill to be used for final cover over ash shall occur within the boundaries of the dry ash storage area. The minimum volume of excavation required shall be to provide the required depth of earth fill cover over the ash. The excavated fill shall be stockpiled within the disposal area for use as final cover when needed. A minimum of one (1) foot of soil shall be provided on horizontal surfaces and a minimum of two (2) feet of soil shall be provided on slopes steeper than five percent (5%) for seeding.

21.0 DISPOSAL OF FLYASH IN LANDFILL

21.1 SCOPE OF WORK

This item consists of all work required to transport the flyash from the Monex Operating Area to the landfill, disposal procedures in the landfill, procedures for dust control, and landfill testing requirements. | 4

21.2 SPECIFICATIONS

All flyash destined for the landfill shall be dampened using conventional pre-wetter systems to mix the flyash and water. The flyash shall then be loaded at fifteen percent (15%) to twenty percent (20%) moisture content into large vehicles. These vehicles shall be operated in a prudent manner and in accordance with speed limits and rules prescribed by the Owner. The Contractor shall use the route shown in the Contract for transporting flyash. flyash. Trucks shall make a full circle within the Contractor's operating area and proceed along the haul route to the landfill. Ash will be disposed in the landfill in the sequence shown in the Contract.

Prior to depositing flyash within the landfill the following shall be completed:

1. Clearing, grubbing and burning of logs, stumps, etc., within the active disposal zone.

2. Excavation and stockpiling of earth fill for use as cover.

3. Installation of ditches, culverts and under drainage systems as necessary to prevent surface runoff or ground water from interfering with placement of compacted flyash.

Flyash shall be placed and compacted in twelve (12) inch lifts or less. Compaction throughout the lift shall attain not less than ninety percent (90%) of the Standard Proctor Density, ASTM D 698-91, Procedure A. All compaction shall be done with moisture content of the flyash between five percent (5%) drier and five percent (5%) wetter than optimum moisture. The maximum height of ash stored in the landfill is shown on the Drawings. 4

An adequate well or surface water source shall be maintained so that the Contractor can control and suppress dust by spraying deposited flyash with water.

The Contractor shall perform at least one (1) field density test on the compacted flyash for every five thousand (5000) tons of flyash placed in the landfill in accordance with ASTM D2937-94. Test results shall be furnished to the Engineer and shall include location and elevation of the test sample. The Contractor shall insure integrity of the landfill slopes by insuring slopes are compacted, dressed, and seeded in accordance with the Erosion and Sedimentation Control Plan (Appendix A). 4

21.2.1 MOISTURE CONTROL

All compaction shall be done at moisture contents within the range given in the Specification. Regardless of source, materials that are too wet to permit proper compaction shall not be placed and compacted on an active disposal area until the moisture content is satisfactorily reduced. When material is too dry, each layer of the fill shall be sprinkled prior to its compaction. This water shall be worked into the material, by harrowing or otherwise, until a uniform distribution of moisture has been obtained. The amount of water so applied shall be sufficient to dampen the material to the required moisture content, and its application shall be so controlled that no free water will appear on the surface during the rolling process or afterwards. Should too much water be added to any part of the embankment so that the material is too wet to obtain the desired compaction, the rolling and all work on that section of the embankment shall be delayed until the moisture content of the material is reduced to within the specified limits. Water jets shall not be directed at the embankment with enough force to cause separation of materials. If it is found impractical to add sufficient moisture to materials on the fill, the materials shall be prewetted at the source. The Contractor shall have an adequate supply of water available at all times.

After dumping, the materials shall be spread by bulldozers, motor graders, scrapers, pans, or other approved means in approximately horizontal layers over the areas to be filled. Unless otherwise directed, the thickness of the layers, prior to compaction, shall be not more than 12". After a layer of fill material has been dumped and spread, it shall be mechanically blended, if required, to break up and blend the fill materials, or to obtain uniform moisture distribution. Each successive layer shall be compacted as outlined in the Specification.

21.2.2 PLACEMENT OF FILL MATERIAL

As soon as practical after starting construction of a fill, the central portion thereof shall be built and maintained slightly higher than the sides so that the top of the fill will drain freely toward the side slopes. The transverse grades on top of the fills shall not exceed three percent. The fill surfaces shall be maintained in a free draining condition throughout construction.

When the fills have been otherwise completed, the Contractor shall dress the slope surfaces to the required limits of fill as shown on the Drawings. 4

22.0 CLOSURE OF DISPOSAL AREA

22.1 SCOPE OF WORK

This item consists of all work required to close the landfill to the Owner's standard. It includes:

Placing earth fill over ash
Grassing
Drainage ditches

It is important to note that closure of the landfill shall be an ongoing process. Slopes shall be dressed and compacted to prevent erosion. Drainage ditches shall be placed to insure integrity of the landfill slopes. Earth cover shall be placed and compacted on the final slopes immediately after ash is placed and compacted. Grassing of slopes is to be accomplished as given in the Erosion and Sedimentation Control Plan (Appendix A). | 4

22.2 SPECIFICATIONS

The final geometry of the landfill is specified on the Drawings. The particular features that the Contractor must implement include the following: | 4

Landfill shall be completely grassed with minimum soil cover depths outlined in Section 20.2.

The slopes shall be no steeper than 3 horizontal to 1 vertical.

The landfill shall be benched at 40 feet (max.) elevation levels. | 4

The minimum number, locations, and details of drainage ditches and culverts are shown on the Drawings. Any additional drainage structures desired by the Contractor shall be reviewed and approved by the Engineer prior to installation.

22.2.1 PLACEMENT AND QUALITY OF EARTH FILL OVER ASH

The requirements for compacted earth fills are as follows:

1. The range of moisture contents shall be between five percent (5%) drier and five percent (5%) wetter than the optimum moisture content. | 4

2. A minimum of 90% of Standard Proctor Density (ASTM D 698-91) shall be achieved. Field density tests shall be performed in accordance with ASTM D 2937-94. | 4

The following materials shall not be placed in earth fills: | 4

Rocks larger than 12" in maximum dimension, excessively wet soil, logs, brush, roots larger than 1" in diameter, sod, perishable materials, snow, ice, frozen earth, or any other materials which are disapproved by the Engineer.

The Contractor shall excavate and remove from the fills, after its placement therein, material which the Engineer considers unsuitable. Such unsuitable material shall be disposed of as directed by the Engineer. | 4

For standards on moisture control, reference Section 21.2.1; for standards on placement of earth cover, reference Section 21.2.2.

22.2.2 GRASSING

Grassing shall consist of furnishing all that is required to establish and maintain a stand of grass adequate to protect earth slopes and other graded surfaces against erosion. Grassing shall be done on all slopes not otherwise protected and upon any graded surfaces designated by the Engineer. The Erosion and Sedimentation Control Plan (Appendix A) provides grassing requirements and specifications.

Limestone, fertilizer, seed, and mulch shall be applied as specified in the Erosion and Sedimentation Control Plan (Appendix A). If the Contractor's experience or development of more specific information about site soil conditions indicate needed changes or adjustments in the grassing requirements, such changes may be made subject to the approval of the Engineer. | 4

Specification No.: MSS-0215.00-00-0001
Revision 4: April 1, 1996
Appendix A

Duke Power Company

Marshall Steam Station

Dry Flyash Landfill

Erosion and Sedimentation Control Plan
April 1, 1996

Prepared by: Michael P. Martin, PE
North Carolina P.E. No. 13753

Mike Martin
4-1-96

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Appendix 1

Attachment B - Drawings

M-10	Landfills and Ash Basin - Plan
M-10A	Ash Landfill - Plan
M-10B	Ash Landfill - Sections and Details
M-10C	Ash Landfill - Sections and Details
M-10D	Ash Landfill - Erosion & Sediment Control Plan

NARRATIVE

Purpose

This erosion and sedimentation control plan is submitted as a revision of the original erosion and sediment control plan which was previously contained as Appendix A in Revisions 1, 2, and 3 of Duke Power Company Specification No. MSS-0215.00-00-0001 entitled Marshall Steam Station - Specification on Clearing, Constructing, Operating, and Closing Dry Flyash Landfill.

Project Description

Marshall Steam Station, a coal-fired electric generating facility, is owned and operated by Duke Power Company and is located in Catawba County, North Carolina (see Vicinity Map).

As a result of burning coal, two types of coal ash are produced - bottom ash and flyash. The bottom ash is collected, mixed with water, and the resulting slurry is pumped from the power plant through a pipeline to an existing settling pond commonly known as the Ash Basin. The Ash Basin is a water treatment facility and is regulated under the National Pollutant Discharge Elimination System by NPDES permit NC 0004987 (outfall 002).

During normal plant operations, flyash is collected in temporary storage silos located adjacent to the power plant. Flyash is removed from the silos on a continuous basis and some of it is distributed for off-site utilization. Flyash utilization includes using ash as an admixture in structural grade concrete, as an admixture in controlled low strength materials, as a structural fill material for site development, or for other beneficial purposes.

The purpose of this project is to provide a storage area for flyash that cannot be utilized. Flyash that cannot be utilized is taken from the silos and placed in the Dry Flyash Landfill which is regulated by the State of North Carolina as a Sanitary Landfill under Solid Waste Permit No. 18-04. The flyash is prewetted as it is discharged from the storage silos and hauled by truck to the Dry Flyash Landfill. It is placed in a controlled manner in order to achieve the desired compaction results (minimum 90% of Standard Proctor Density). Soil cover (2 feet on slopes steeper than 5% and 1 foot on slopes flatter than 5%) is provided over the flyash as placement of flyash reaches final grade.

Placement of flyash in the active area of the Dry Flyash Landfill (designated Ash Landfill - Phase II on drawing M-10A) began in March, 1986. The total flyash storage

capacity of Phase II is approximately 3,931,000 tons. As of January 1, 1996, approximately 2,626,000 tons of flyash had been placed in Phase II and the remaining storage capacity was 1,305,000 tons. The total area of Ash Landfill - Phase II as shown on the Drawings is 58.0 acres. At present, approximately 28.7 acres are at final grade and have been stabilized, 4.4 acres have remained undisturbed, and 24.9 acres are currently disturbed.

All stormwater runoff generated by Ash Landfill - Phase II is routed to the Ash Basin through a system of overland flow, drainage channels, and drainage culverts.

In addition to the ongoing operations in Ash Landfill - Phase II, there are three other flyash landfill areas associated with Solid Waste Permit No. 18-04. One area (approximately 15 acres) designated Ash Landfill - Phase I is located along the southeast corner of the Ash Basin (refer to drawing M-10). Approximately 280,000 tons of flyash were placed in Phase I between September, 1984 and March, 1986. Ash Landfill - Phase I has thus been completed and stabilized.

Another area (approximately 5 acres) is designated Ash Landfill - Phase III and is located northwest of Ash Landfill - Phase II across a cove of the Ash Basin. The final area that is currently permitted for ash disposal (approximately 8 acres) is designated Ash Landfill - Phase IV and is located east of Ash Landfill - Phase II across a cove of the Ash Basin. Refer to drawing M-10A for the locations of Phase III and Phase IV. At present, there are no plans to develop either Ash Landfill Phase III or Ash Landfill - Phase IV.

Site Description

The site is approximately 7000 feet north of the power plant (see Vicinity Map). The site consists of topography sloping toward the Ash Basin with grades ranging from approximately 3% to a maximum of 33% (3 horizontal to 1 vertical slopes on finished side slopes of the landfill). Prior to construction of Ash Landfill - Phase II, the land use within the boundary limit was mostly wooded. In addition, portions of Phase II (approximately 11.5 acres) currently lie in areas that previously were coves of the Ash Basin.

The southern and western boundary limits of the Ash Landfill - Phase II are adjacent to the Ash Basin. The northern boundary limit is adjacent to the Asbestos and Demolition Landfills. The eastern boundary limit extends approximately 150 feet beyond a cove of the Ash Basin which has been filled with ash as necessary to construct the landfill.

Adjacent Property

The area where work will be performed is located entirely on Duke Power Company Property. In addition, the existing sediment pond (Ash Basin) which receives all the stormwater runoff generated by the Landfill is located entirely on Duke Power Company Property.

Soils

The soils within the project area are mapped as Pacolet and Wilkes per the USDA Soil Conservation Service Soil Survey of Catawba County, North Carolina (October, 1975). In 1991, a subsurface investigation to support the design of a proposed embankment across the Ash Basin was undertaken. Data from 17 samples obtained from 4 soil borings performed in the vicinity of Landfill were reviewed. The boring logs indicate the surface soils (to depths of about 20 feet) are classified as a silty fine to medium sand. Gradation tests indicate the surface soils average approximately 30% (by weight) passing the number 200 sieve. Permeabilities of the soil are on the order of 10^{-6} cm / sec.

As stated above, construction of the Landfill began in 1984. As such, the areas that encompass the footprint of the landfill have either been brought to final grade or are currently being graded. Therefore, no groundwater is expected to be encountered as placement of ash in the landfill continues.

Planned Erosion and Sedimentation Control Practices

1. Land Grading (Practice 6.02)

Grading of the work area will be limited to constructing the Landfill, excavating cover material from within the Landfill limit, and installing drainage ditches and piping (refer to Drawings). Stormwater runoff will be routed to stable drainage culverts and channels which ultimately drain to the existing sediment basin (Ash Basin).

2. Surface Roughening (Practice 6.03)

To facilitate the establishment of vegetation, cut slopes will be surface roughened using tracked equipment. On fill slopes (3H:1V), the final 4 to 6 inches of cover material will be left loose and uncompacted.

3. Gravel Construction Entrance / Exit (Practice 6.06)

A combination gravel / paved construction haul road extends approximately 8,500 feet from the south limit of Ash Landfill - Phase II to the flyash storage silo area located adjacent to the power plant.

4. Permanent Seeding (Practice 6.11)

All fill slopes, cut slopes, vegetated channels, and otherwise disturbed areas will be seeded in accordance with the recommendations outlined in the "Erosion and Sediment Control Planning and Design Manual" for the Piedmont physiographic region of North Carolina. Refer to the Vegetative Plan for details.

5. Mulching (Practice 6.14)

Areas to be seeded will receive mulch in accordance with the permanent seeding (Practice 6.11) recommendations referenced in item 4 above.

6. Temporary Diversions (Practice 6.20)

Temporary diversions in the form of earth rims will be used to prevent stormwater runoff from flowing over the edge of the fill and onto the finished slopes below. This practice will minimize the amount of stormwater runoff that the finished slopes are subjected to during construction of the flyash landfill. The temporary diversions will route stormwater runoff to the existing sediment pond (Ash Basin). Refer to the Drawings for additional information.

7. Grass-Lined Channels (Practice 6.30)

Grass-lined channels will be used for berm ditches and for some of the ditches forming the perimeter of the ash landfill. The capacity of the grass-lined channels is assessed using the estimated stormwater runoff flow resulting from the 10-year storm using vegetative retardance class C. The long term stability of the grass-lined channels is evaluated using the estimated stormwater runoff velocity resulting from the 10-year storm assuming vegetative retardance class D. The need for a temporary liner is determined using the estimated stormwater runoff velocity resulting from the 2-year storm assuming bare earth conditions. If a temporary liner is required, the estimated tractive force acting on the liner due to the 2-year storm is calculated in order to assure integrity of the temporary liner.

8. Riprap and Paved Channels (Practice 6.31)

A riprap channel will be used to convey stormwater runoff along the west perimeter of the ash landfill to the existing sediment pond (Ash Basin). In addition, a riprap channel will be used along the haul road ramp which leads to the top of the landfill. The capacity and stability of the riprap channels are evaluated based on the estimated runoff resulting from the 10-year storm.

9. Outlet Stabilization Structure (Practice 6.41)

In order to resist high flow velocities, several outlet stabilization structures are to be installed. They are typically located at the discharge end of corrugated metal pipes (CMP's) which convey stormwater from berm to berm and subsequently to the existing sediment pond (Ash Basin).

10. Sediment Basin (Practice 6.61)

An existing permanent structure has been used and will continue to be used as a sediment basin for the project. The existing Ash Basin will trap sediment generated from the construction of the Dry Flyash Landfill. An earth embankment (commonly

known as the Ash Dike) forms the Ash Basin and was constructed in 1962. The Ash Basin has a total drainage area of approximately 1,195 acres (1,180 acres of natural drainage area and 15 acres of drainage area that is pumped to the Ash Basin). The surface area of the Ash Basin at normal operating level (approximately elevation 790 feet) is 102 acres (refer to calculations for additional details). The Ash Dike is under the jurisdiction of and is in compliance with the North Carolina Dam Safety Act.

11. Sediment Fence (Practice 6.62)

Sediment fence will be provided at the inlets of CMP's which drain the top of the flyash landfill (nominal elevation 915 feet).

CONSTRUCTION SCHEDULE

As described above, placement of flyash in the various flyash landfills began in 1984. Monex Resources, Inc. (formerly Monier Resources, Inc.) is currently under contract with Duke Power Company to construct and operate the Dry Flyash Landfill. In addition, Monex Resources has been under contract since the project began in 1984. It is difficult to predict the duration of the project, since estimates of power plant coal consumption, coal quality, and flyash utilization efforts must be made. Based on the best information available, it is projected that the Ash Landfill - Phase II has sufficient capacity to last until the year 2001. Refer to supporting calculations for additional information. All phases of the work shall be seeded, fertilized, and mulched upon completion of the work in accordance with the Vegetative Plan.

MAINTENANCE PLAN

1. All erosion and sediment control devices will be checked for stability and operation following every runoff-producing rainfall but at least once per week. Any necessary repairs will be made immediately to maintain all devices as designed.

2. The existing sediment basin (Ash Basin) is not expected to reach its capacity due to the construction of the Dry Flyash Landfill, therefore no removal of sediment from the basin is planned (refer to supporting calculations for additional information).

3. All seeded areas shall be fertilized, reseeded as necessary, and mulched according to specifications in the Vegetative Plan.

VEGETATIVE PLAN

The vegetative plan for the project appears below. The specifications are summarized in Table 1. The area descriptions and corresponding specifications are to be worked with the Drawings. The vegetative plan is provided for construction of the project; it includes maintenance provisions and should therefore be referred to for future maintenance work.

Seedbed Preparation (SP)

Final seedbed preparation in any area should commence only after final grading and installation of necessary erosion and sediment control features. Seeding should be applied to a freshly loosened seedbed that has not been sealed by rainfall or compacted by grading operation. When a hydraulic seeder is used, fertilizer and seed shall not be mixed more than 30 minutes prior to application. All soil amendments shall comply with applicable State law. Soil amendments should be applied as indicated by soil testing. In lieu of soil test results, refer to the specific Seedbed Preparation applications (SP-1, SP-2, etc.) listed below:

SP-1 Fill slopes or cut slopes, low maintenance

1. For fill slopes, leave the final 4 to 6 inches loose and uncompacted. For cut slopes, remove rock and debris and roughen the surface using tracked equipment.

2. Apply soil amendments as follows: 4000 lbs. per acre of ground agricultural limestone and 1000 lbs. per acre of 10-10-10 fertilizer.

SP-2 Gentle or flat slopes, low maintenance

1. Scarify to a depth of 4 inches and remove all rock and debris.

2. Apply soil amendments as follows: 4000 lbs. per acre of ground agricultural limestone and 1000 lbs. per acre of 10-10-10 fertilizer.

SP-3 Temporary Seedings

1. For surface preparation, same as item 1 above for steep slopes or gentle / flat slopes, whichever is applicable.

2. Apply soil amendments as follows: 4000 lbs. per acre of ground agricultural limestone and 750 lbs. per acre of 10-10-10 fertilizer.

Seeding Methods (SM)

All seeding shall be performed by hydroseeder. Limestone shall be blown onto slopes prior to hydroseeding. If an equipment breakdown of 1/2 to 2 hours occurs during hydroseeding, add 50 % more seed to the tank based on the proportion of remaining slurry. Beyond a 2 hour equipment breakdown, a full rate of new seed is required. Use only seed that is labeled and certified by the North Carolina Crop Improvement Association. All seeding shall be done on dry or moderately dry soil when the wind velocity is less than five miles per hour.

Mulch (MU)

Mulch shall be grain straw material. Straw shall be dry, unchopped, unweathered, and free of weeds. Seeding shall be done before mulching with straw.

MU-1 Fill slopes and cut slopes, low maintenance

Apply mulch at a rate of 4000 lbs. per acre. Mulch shall be anchored by tacking with asphalt, roving or netting.

MU-2 Gentle or flat slopes, low maintenance

Apply mulch at a rate of 4000 lbs. per acre. Mulch shall be anchored by tacking with asphalt, roving, netting, or by crimping with a mulch anchoring tool. A disk with blades set nearly straight may be used as a mulch anchoring tool.

MU-3 Grass-Lined Channels

Apply mulch at a rate of 4000 lbs. per acre. Use jute netting as a temporary liner and to anchor the mulch. The netting shall be staked / stapled over the top of the mulch to the limits shown on the drawings. Beyond the jute netting limits, mulch shall be anchored by tacking with asphalt, roving, or netting.

Maintenance

Refertilize vegetated areas in the second year unless growth is fully adequate. Eroded or otherwise damaged areas shall be reseeded, fertilized, and mulched immediately. For grass-lined channels, refertilize in late winter of the following year according to soil test results. In lieu of soil test results, apply 150 lbs. per acre of 10-10-10 fertilizer. Grass-lined channels should be mowed regularly to a height of 2 to 4 inches.

CONSTRUCTION / MAINTENANCE SPECIFICATIONS

The following are specifications for the Construction of the Dry Flyash Landfill at Marshall Steam Station. These specifications are to be worked with the Drawings.

1. Land Grading

A. Construct and maintain all erosion and sedimentation control practices and measures in accordance with the approved sedimentation control plan and construction schedule.

B. Ensure that fill material is free of brush, rubbish, logs, stumps, building debris, and other materials inappropriate for constructing stable fills.

C. Keep diversions and other water conveyance measures free of sediment during all phases of development.

D. Handle seeps or springs encountered during construction in accordance with the Engineer's recommendations.

E. Permanently stabilize all graded areas immediately after final grading is completed on each area.

Maintenance

Periodically check all graded areas and the supporting erosion and sedimentation control devices, especially after heavy rainfalls. Promptly remove all sediment from diversions and other drainage structures. If washouts or breaks occur, repair them immediately.

2. Surface Roughening

A. For fill slopes, leave the final 4 to 6 inches loose and uncompacted in order to provide a better environment for vegetation to be established.

B. For cut slopes, roughen the surface by operating tracked equipment up and down the slope such that grooves perpendicular to the slope are formed. Do not back-blade during the final grading operation.

3. Gravel Construction Entrance / Exit

As mentioned above, a combination gravel and paved construction haul road extending approximately 8,500 ft. from the flyash storage silo area to the Dry Flyash Landfill exists.

4. Permanent Seeding

Refer to the Vegetative Plan for construction specifications and maintenance items.

5. Mulching

Installation of temporary liners for grass-lined channels shall be in accordance with the manufacturer's instructions. In lieu of such instructions, installation of temporary liners in grass-lined channels shall be as follows:

A. Apply lime, fertilizer, seed, and mulch before laying the temporary liner.

B. Begin laying the temporary liner from the top of the channel and unroll it down the grade. Allow the liner to lay loosely on the soil but without wrinkles; do not stretch.

C. To secure the temporary liner, bury the upslope end in a slot or trench at least 6 inches deep, cover with soil, and tamp firmly. Anchor the liner every 12 inches across the top end and every 3 feet around the edges and bottom. Where 2 strips of temporary liner are laid side by side, the adjacent edges should be overlapped 3 inches

and stapled together. Each strip of liner should also be stapled down the center every 3 feet. Do not stretch the liner when applying staples.

D. To join two strips, cut a trench to anchor the end of the new (down slope) temporary liner. Overlap the end of the previous (up slope) roll 18 inches and staple every 12 inches just below the anchor slot.

Refer to the Vegetative Plan for additional mulch construction specifications and maintenance items.

6. Grass-Lined Channels

A. Remove all trees, brush, stumps, and other objectionable material from the foundation area and dispose of properly.

B. Excavate the channel and shape it to the neat lines and dimensions shown on the Drawings plus a 0.2 ft. overcut around the channel perimeter to allow for bulking during seedbed preparations.

C. Remove and properly dispose of all excess soil so that surface water may enter the channel freely.

D. Stabilize channel in accordance with the Vegetative Plan.

Maintenance

During the establishment period, check grass-lined channels after every rainfall. After grass is established, check grass-lined channels after every heavy rainfall, but at least once per week. Immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes. Remove all significant sediment accumulations to maintain the designed capacity. Keep the grass in a healthy condition at all times.

7. Riprap Channels

A. Clear the foundation area of trees, stumps, roots, loose rock, and other objectionable material.

B. Excavate the cross section to the lines and grades of the foundation of the channel as shown on the drawings. Bring over-excavated areas to grade by increasing the thickness of the riprap or by backfilling with moist soil compacted to the density of the surrounding material.

C. Filter fabric shall be a made from polypropylene and meet the following criteria:

- Equivalent Opening Size (EOS) no larger than U. S. standard sieve size 30,
- Total open area of filter shall not exceed 36%,
- Thickness shall be 20 to 60 mils,
- Grab strength shall be 90 to 120 lbs.,
- Shall conform to ASTM D-5034 or ASTM D-5035.

D. Place the filter directly on the prepared foundation beginning at the top of the channel and rolling the fabric down grade. Overlap the edges a minimum of 12 inches at all joints with the upstream layer overlapping the downstream layer.

E. Place a 6 inch layer of washed stone over the filter fabric prior to placing riprap.

F. All riprap shall be a graded mixture in accordance with the gradation limits shown on the Drawings. The riprap shall consist of field stone or quarry stone and shall be hard, angular, and of such quality that it will not break down on exposure to water or weathering. The minimum specific gravity of the stone shall be 2.5.

G. Place riprap as soon as filter fabric and washed stone are installed taking care not to dislodge or damage the fabric.

H. Riprap shall be placed to its full thickness in a manner that prevents segregation of stone sizes and results in a dense well graded mass of stone with a minimum of voids.

Maintenance

Inspect installation periodically and immediately repair scour areas and dislodged stones.

8. Outlet Stabilization Structure

A. For stone and filter materials, refer to previous section on riprap channels.

B. Excavate the subgrade for the filter and riprap in accordance with the lines and grades shown on the drawings. Compact any fill required in the subgrade to the density of the surrounding material. Low areas in the subgrade may also be filled by increasing the riprap thickness.

C. Construct the apron on flat grade with no overfall at the end. The top of the riprap at the downstream end of the apron shall be level with the receiving area or slightly below it.

D. If the alignment of the apron needs to be curved to meet field conditions, place the curve in the upstream section of the apron.

E. Immediately after apron installation, stabilize all disturbed areas with vegetation.

Maintenance

Inspect riprap outlet structures after heavy rains to see if erosion around or below the riprap has occurred or if stones have been dislodged. Immediately make repairs to prevent further damage.

9. Sediment Fence

A. Fabric material shall be a pervious sheet of nylon, polyester, or ethylene yarn - extra strength (50 lbs./inch minimum) - that contains ultraviolet ray inhibitors and stabilizers. Fabric should be sufficiently porous to provide adequate drainage of the temporary sediment pool. Burlap may be used for short-term applications, however it must be replaced at least every 60 days.

B. For staking material, use 2 x 4-inch wood or equivalent metal having an overall minimum length of 3 ft.

C. Space stakes evenly a maximum of 6 ft. apart and securely drive them into the ground approximately 18 inches deep.

D. Place the bottom 12 inches of the fabric in a trench and backfill the trench with at least 4 inches of crushed stone or 12 inches of compacted soil.

E. Fasten fabric securely to the stakes. Joints in the fabric material must be overlapped to the next stake.

Maintenance

Inspect the fabric barrier after each rain and make repairs as needed. Remove sediment as necessary to provide adequate storage volume for the next rain. Take care not to damage or undercut the fabric during sediment removal. When the contributing drainage area has been adequately stabilized, remove all materials and any unstable sediment and dispose of them properly. Bring the disturbed area to grade and smooth and compact it. Appropriately stabilize all bare areas around the inlet.

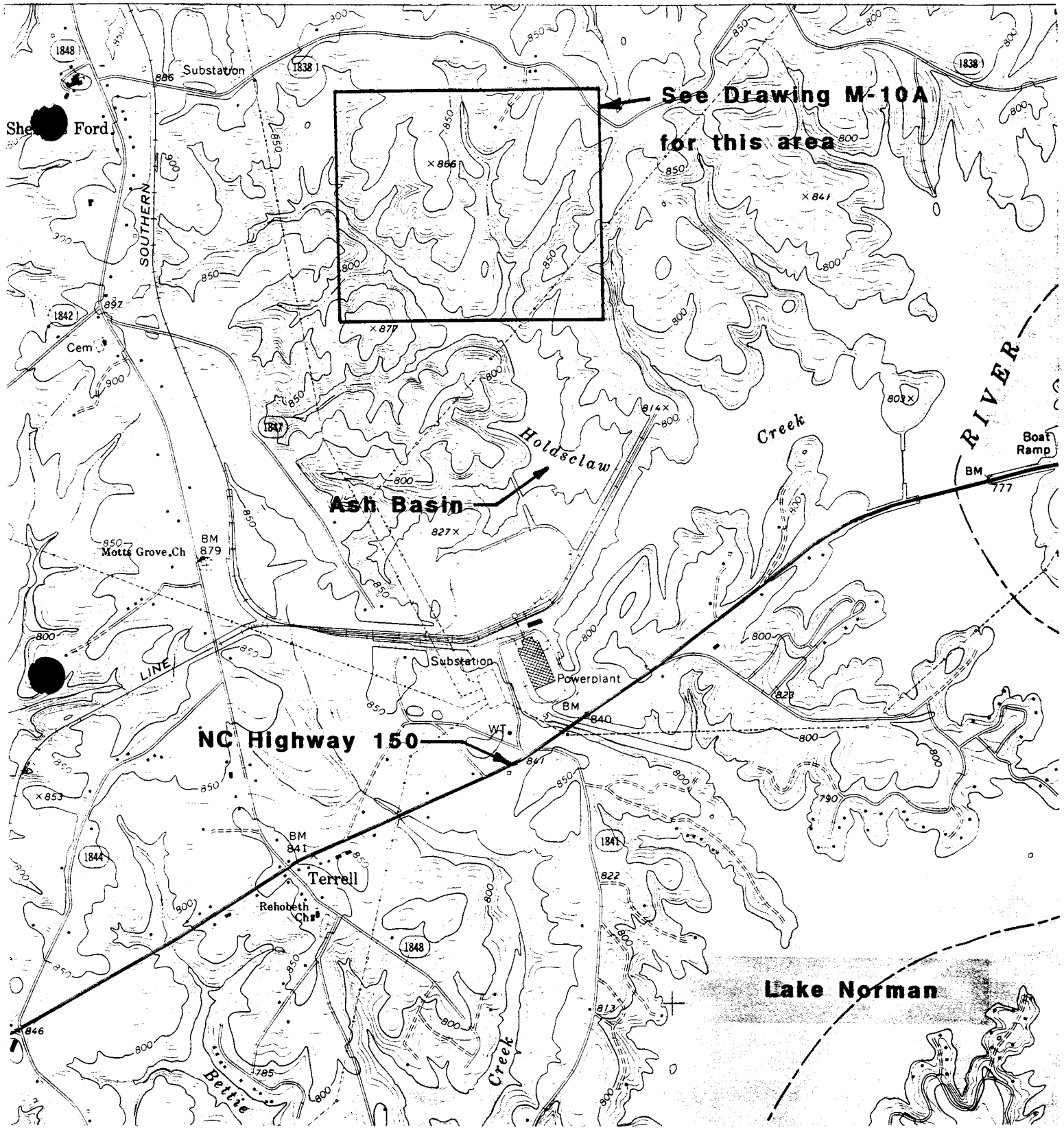
10. Sediment Basin

As described above, the sediment basin (Ash Basin) is existing. The basin's sediment storage capacity is much greater than that required for the construction of the Dry Flyash Landfill (revert to calculations for details). Construction / Maintenance Specifications are not applicable.

Marshall Steam Station - Dry Flyash Landfill
Erosion and Sedimentation Control Plan
Table 1 - Summary of Vegetative Plan (1)

Area # (2)	Area Description	Season (3)	Seeding Mixture (lbs/acre) Permanent	Temporary	Seedbed Preparation	Seeding Method	Mulch	Maintenance	Notes
1	Fill slopes and cut slopes (3H:1V and steeper), low maintenance	Spring or Fall	Tall Fescue 100 Sericea lespedeza 30 Kobe lespedeza 10		SP-1	SM	MU-1	MA	Refertilize in second growing season. After August 15, use unscarified sericea seed.
		Summer		Sudangrass 50	SP-3	SM	MU-1	MA	
		Winter		Rye 120	SP-3	SM	MU-1	MA	
2	Gentle or flat slopes, low maintenance	Spring or Fall	Tall Fescue 80 Sericea lespedeza 20 Kobe lespedeza 10		SP-2	SM	MU-2		Refertilize in second growing season. After August 15, use unscarified sericea seed.
		Summer		Sudangrass 50	SP-3	SM	MU-2	MA	
		Winter		Rye 120	SP-3	SM	MU-2	MA	
3	Grass-lined channels	Fall, Winter, or Spring	Tall Fescue 200 Rye 40		SP-2	SM	MU-3	MA	
		Summer	Tall Fescue 200 Sudangrass 15		SP-2	SM	MU-3	MA	

1. For specifications of seedbed preparation, seeding method, mulch, and maintenance, refer to pages 6 - 8.
2. Area numbers are to be worked with Erosion and Sedimentation Control Drawing M-10D.
3. Dates are as follows- Spring: 2/1 thru 4/15, Summer: 4/15 thru 8/20, Fall: 8/20 thru 10/25, Winter: 10/25 thru 2/1.



VICINITY MAP

Scale: 1 in. = 2000 ft.

N

ATTACHMENT A

SUPPORTING CALCULATIONS

Form 01077 (R7-89)

FORM 101.1	REVISION 13

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER Marshall Steam Station, Units 1-4

TITLE OF CALCULATION Ash Landfill

CALCULATION NUMBER _____

ORIGINALLY CONSISTING OF:

PAGES 1 THROUGH 54, 54.1, and pages 55-70

TOTAL ATTACHMENTS 1 TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES 1 TYPE I CALCULATION/ANALYSIS YES ☐ NO ☒

TYPE I REVIEW FREQUENCY _____

THESE ENGINEERING CALCULATIONS COVER QA CONDITION N/A ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY Mike Martin DATE 4-1-96

CHECKED BY _____ DATE _____

APPROVED BY Barry D. Bell DATE 4/1/96

ISSUED TO TECHNICAL SERVICES DIVISION _____ DATE _____

RECEIVED BY TECHNICAL SERVICES DIVISION _____ DATE _____

MICROFICHE ATTACHMENT LIST: ☐ Yes ☒ No SEE FORM 101.4

REV. NO.	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE

Marshall Steam Station
Flyash Landfill - Stormwater Drainage

By MPM

Sheet 1
Date 10/31/95

Introduction

The Flyash Landfill receives conditioned flyash which is collected from the flyash storage silos at Marshall Steam Station. The Flyash Landfill is regulated under North Carolina Solid Waste Permit No. 18-04. The design of the Flyash Landfill's stormwater drainage is performed in accordance with the "Erosion and Sediment Control Planning and Design Manual" developed for the State of North Carolina.

Note that all stormwater runoff generated from the Flyash Landfill drains to the Ash Basin. The Ash Basin is a water treatment facility and is regulated under NPDES permit NC004987 (outfall 002).

The stormwater drainage system for the Marshall Flyash Landfill is designed to carry the peak flows resulting from the 10-year storm event. Peak flows are estimated using the Rational Method. Flow capacities and velocities are estimated using Manning's Equation. The design storm intensities are based on the duration - intensity curves developed for Charlotte, NC and appear in Figure 8.03g of Reference 1.

The drainage structures consist of berm ditches (designated as BD-x on sheet 65), perimeter ditches (designated as PD-x on sheet 65), corrugated metal pipe (CMP) and reinforced concrete pipe (RCP) culverts (designated as C-x on sheet 65), and outlet stabilization aprons.

For vegetated ditches, an allowable velocity for established vegetation of 4 feet per second (fps) is used (reference 1, Table 8.05a, Tall Fescue for channel slopes of 0-5% and 5-10%) for evaluating the 10-year storm event. Vegetative retardance class D is used to evaluate velocities and vegetative retardance class C is used to evaluate capacities of vegetated ditches.

The soils in the Flyash Landfill area are mapped as Pacolet and Wilkes (per SCS Soil Survey for Catawba County, North Carolina). Results of gradation tests on soils in the vicinity of the Flyash Landfill indicate the landfill cover material is approximately 70% sand, 25% silt and 5% clay. The material is a sandy clay loam per the USDA textural classification. In accordance with Table 8.05d of reference 1, a maximum permissible velocity for unprotected soils in channels of 2.5 fps is selected. Therefore, an allowable velocity of 2.5 fps is used for the 2-year storm event with bare earth (non-established vegetation) conditions. Temporary liners are specified for vegetated ditches when the velocity resulting from the 2-year storm exceeds 2.5 fps. The resulting tractive force acting on the temporary liner is determined and compared to the allowable tractive force in order to assure liner integrity.

Generally, velocities in culverts are high (due to steep slopes - 3H : 1V); approximately 10 to 20 fps. Accordingly, outlet stabilization aprons are specified where high velocities are calculated.

For riprap - lined ditches, the median stone size is selected based on the calculated tractive force acting on the ditch.

References

1. "Erosion and Sediment Control Planning and Design Manual", NC Sedimentation Control Commission, NC Dept. of Natural Resources and Community Development, and NC Agricultural Extension Service, Sept., 1988.

2. "1983 Maryland Standards and Specifications for Soil Erosion and Sediment Control"; Water Resources Administration, Soil Conservation Service, State Soil Conservation Committee; April, 1983.

3. "Elements of Urban Stormwater Design", H. R. Malcom, North Carolina State University, 1989.

4. "HEC-1 Flood Hydrograph Package Users Manual", US Army Corps of Engineers, Hydrologic Engineering Center, 1985.

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 2 Of ____

Subject Ash Landfill

By MPM Date 2/1/96

Prob No. ____ Checked By ____ Date ____

Determine remaining storage capacity of Ash Landfill and duration of project:

Placement of conditioned flyash in the Ash Landfill began in 1984. To date (through 12/31/95) approximately 2,906,000 tons of flyash have been placed in the Ash Landfill. In addition, as of 12/31/95, there exists approximately 1,305,000 tons of remaining Ash storage capacity in that portion of the landfill which is currently under construction (phase II).

Considering both the projected flyash production and an annual flyash utilization (recycling effort) of 200,000 tons [note: Flyash placed in landfill = total flyash produced minus flyash utilized]. Utilized flyash is that flyash which is marketed and/or sold as a concrete admixture, as a structural fill material, or as some other beneficial product], an estimate can be made on how long the Ash Landfill will be available to receive Ash. This estimate appears in graphical form on sheet 5 and it indicates that the Ash Landfill will be in operation until approximately the year 2001.

LFVOLUME.XLS

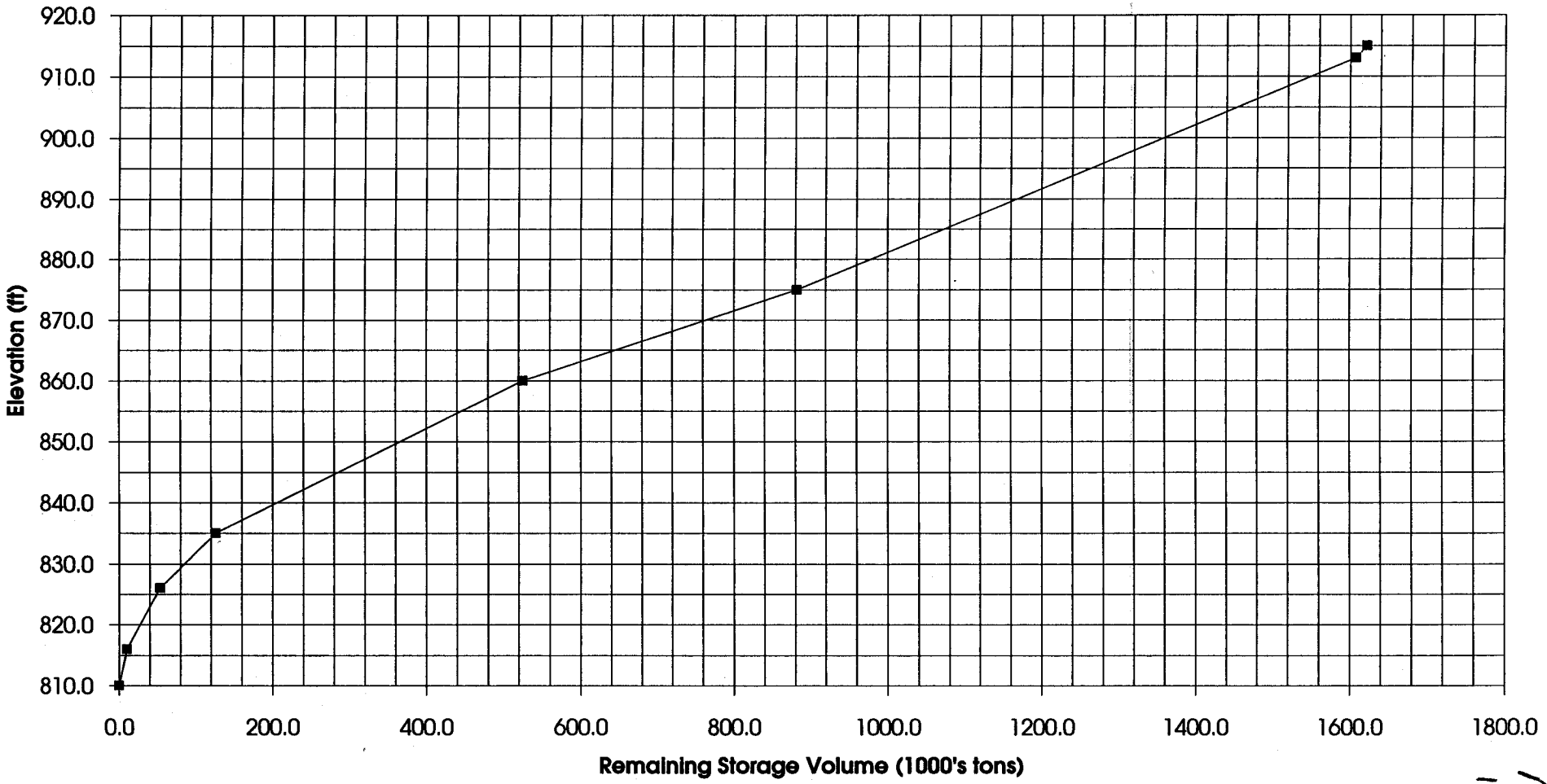
Sheet 3
MPM 10/31/95

Marshall Steam Station
Ash Landfill - Remaining Storage Capacity Based on February, 1994 Survey

Elev. Contour (ft)	Comments on Elevation Contour	Remaining Storage Area (Ac)	H (ft)	Incremental Storage (Ac-ft)	Cumulative Storage (Ac-ft)	Cumulative Storage (1000's tons)
810.0	bottom of existing fill	0.2				
			6.0	6.4	6.4	10.4
816.0	intermediate elevation	1.9				
			10.0	26.6	32.9	53.8
826.0	intermediate elevation	3.4				
			9.0	44.2	77.1	126.0
835.0	along outside of berm	6.4				
			0.0	0.0	77.1	126.0
835.0	along inside of berm	6.2				
			25.0	244.9	322.0	526.0
860.0	intermediate elevation	13.4				
			15.0	218.0	540.0	882.2
875.0	along outside of berm	15.7				
			0.0	0.0	540.0	882.2
875.0	along inside of berm	14.5				
			38.0	443.8	983.9	1607.2
913.0	approximate top elevation	8.9				
			2.0	8.9	992.8	1621.7
915.0	peak elevation	0.0				

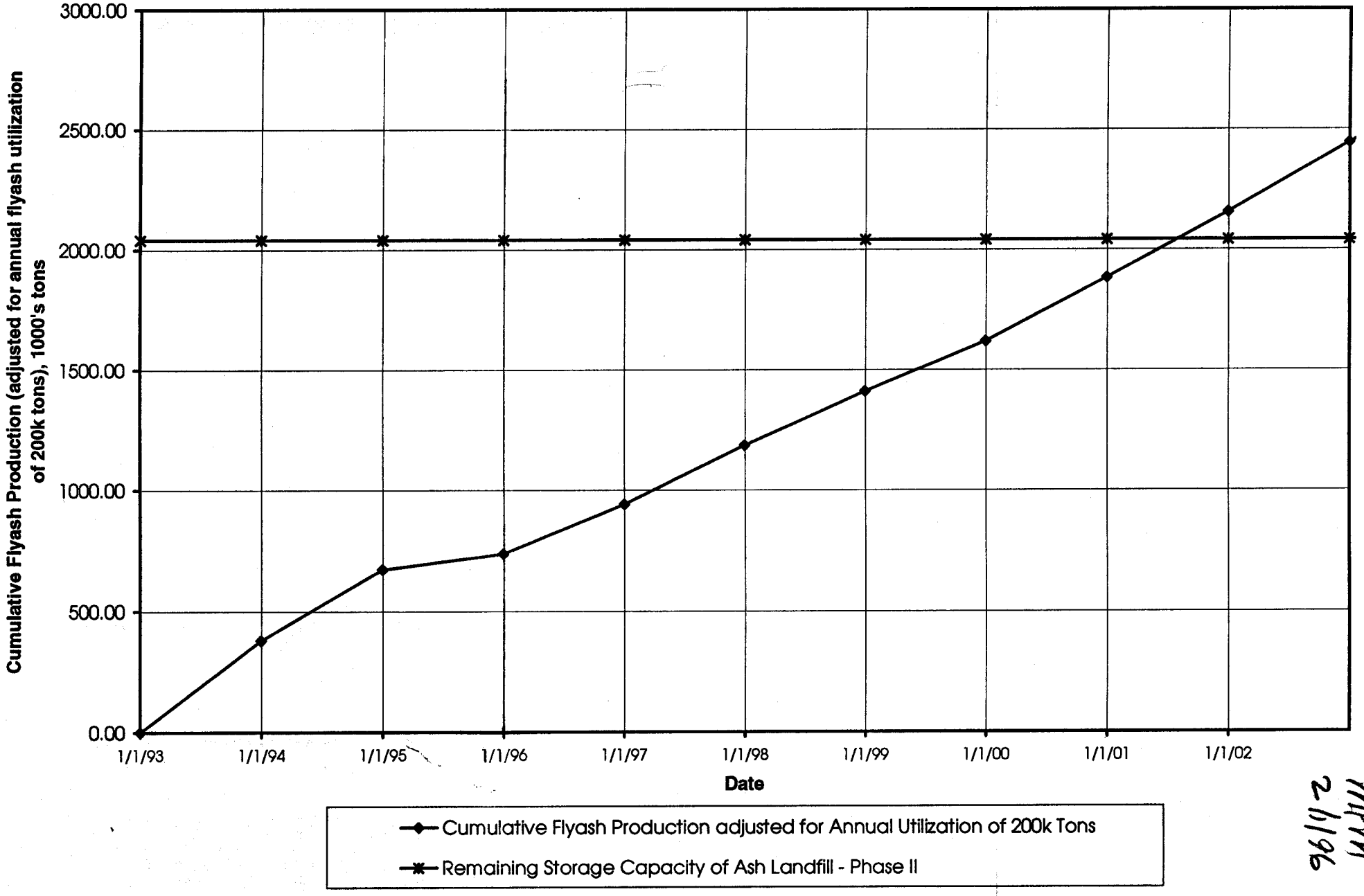
See sheet 64 for plan view

Marshall Ash Landfill: Remaining Storage Volume Based on February, 1994 Survey



Sheet 4
MPM
10/31/95

Marshall Flyash Landfill: Storage Capacity and Coal Consumption Projections



Sheet 5

MPM
2/1/96

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit ____ Rev. 0 File No. ____ Sheet 6 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Berm Ditches* - Determine times of concentrations & intensities

ref. 1, Fig. 8.03a → Tc

Berm Ditch*	L (ft)	H (ft)	Tc (minutes)	i_2 (in/hr)	i_{10} (in/hr)
BD-1	210	.005(210) = 1.1'	use 5	4.8	6.5
-2	350	.005(350) = 1.8'	5	4.8	6.5
-3	210	.005(210) = 1.1'	use 5	4.8	6.5
-4	500	.005(500) = 2.5'	7	4.1	5.9
-5	440	.005(440) = 2.2'	6	4.5	6.1
-6	230	.005(230) = 1.2'	use 5	4.8	6.5
-7	450	.005(450) = 2.3'	6	4.5	6.1
-8	140	.005(140) = 0.7'	use 5	4.8	6.5
-9	170	.005(170) = 0.9'	use 5	4.8	6.5
-10	450	.005(450) = 2.3'	6	4.5	6.1
-11	410	≈ 16'	use 5	4.8	6.5
-12	600	.005(600) = 3.0'	8	4.0	5.6
-13	330	.005(330) = 1.7'	5	4.8	6.5
-14	320	.005(320) = 1.6'	5	4.8	6.5
-15	220	.005(220) = 1.1'	use 5	4.8	6.5
-16	260	.005(260) = 1.3'	use 5	4.8	6.5
-17	390	.005(390) = 2.0'	6	4.5	6.1
-18	350	.005(350) = 1.8'	5	4.8	6.5
-19	410	.005(410) = 2.1'	6	4.5	6.1
-20	780	≈ 8'	8	4.0	5.6
-21	370	≈ 2'	5	4.8	6.5
-22	700	≈ 60'	use 5	4.8	6.5
-23	360	≈ 40'	use 5	4.8	6.5
-24	820	≈ 16' + .005(410) = 18'	6	4.5	6.1
BD-25	310	.005(310) = 1.6'	5	4.8	6.5
BD-26	400	830 - 804 = 26'	use 5	4.8	6.5

Ref 1, Fig. 8.03g

* see sht. 6B for locations of berm ditches

Sheet 7
MPM 10/31/95

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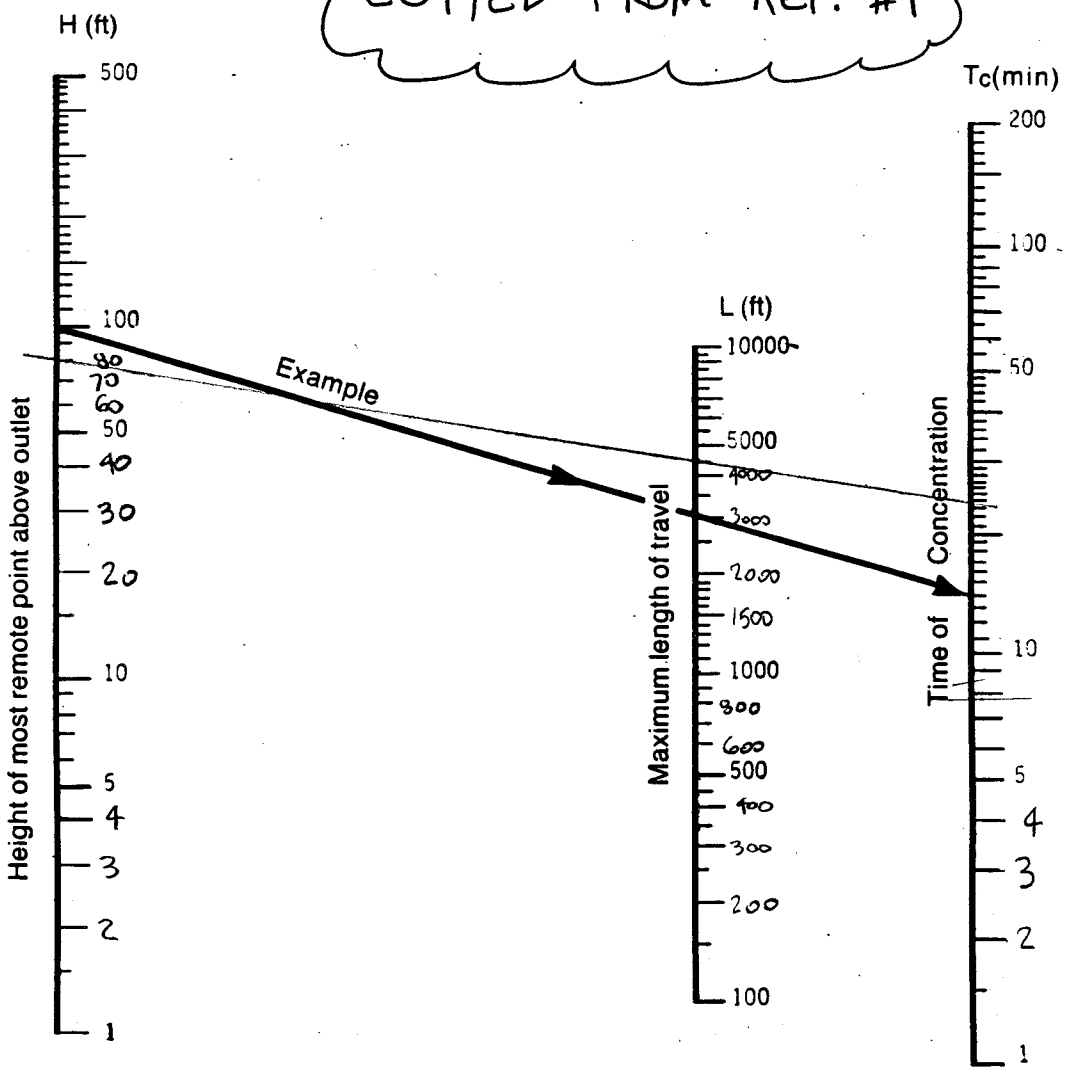


Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

COPIED FROM REF. #1

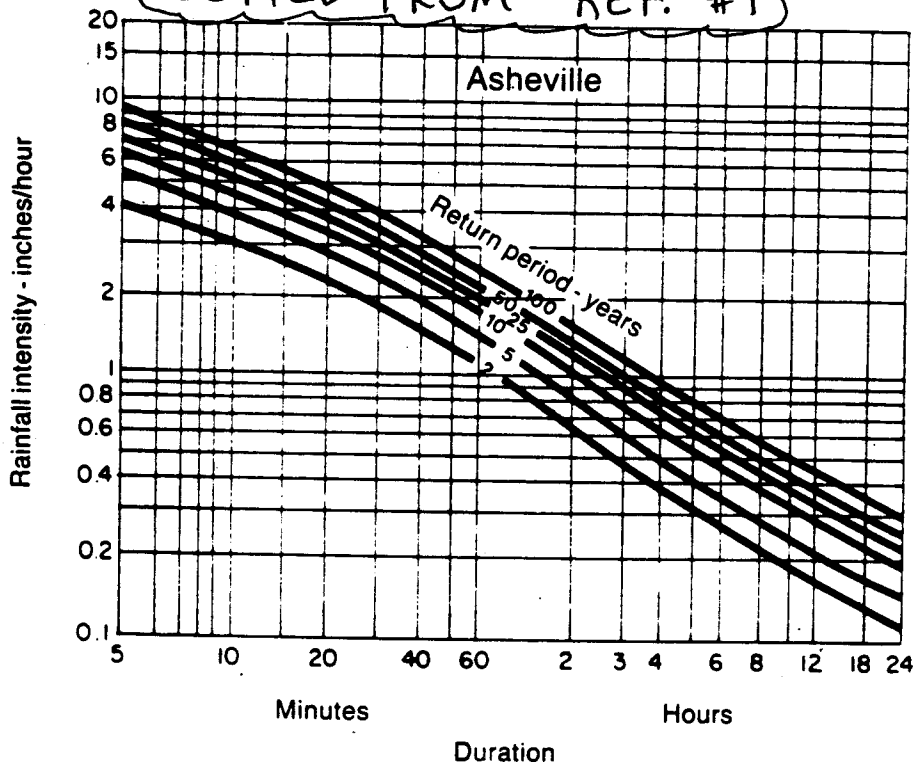


Figure 8.03f Rainfall intensity duration curves—Asheville.

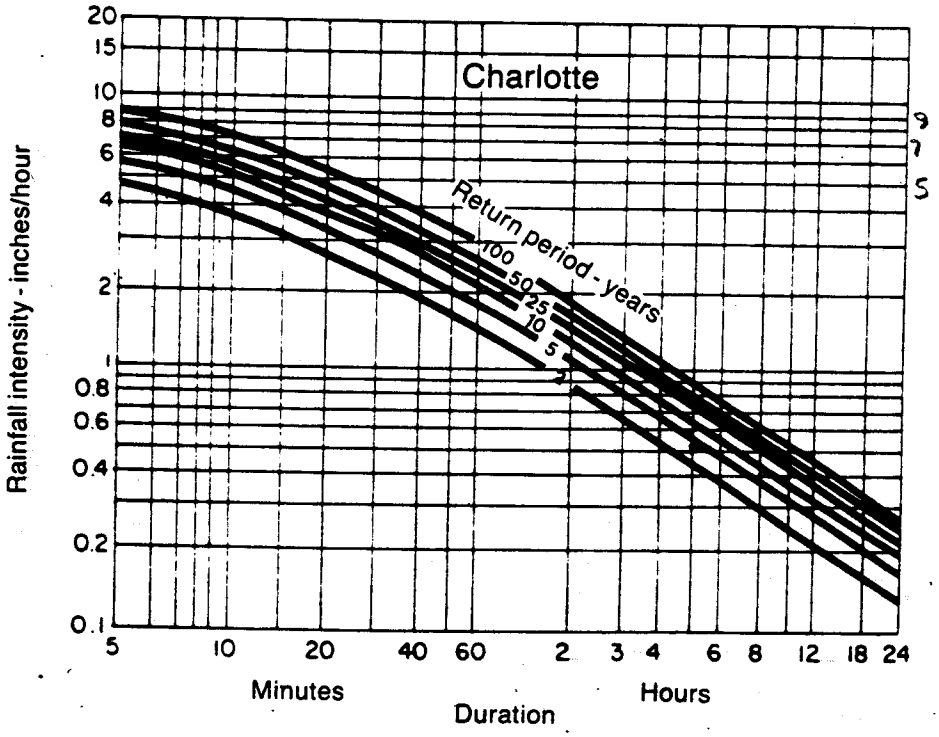


Figure 8.03g Rainfall intensity duration curves—Charlotte.

Marshall Steam Station
Dry Ash Storage Area
Summary of Storm Drainage Berm Ditches

Berm Ditch Designation	Berm Ditch Type	Sloped (3H : 1V) Drainage Area (Acres)	Berm/Flat Drainage Area (Acres)	Other Drainage Area (Acres)	Other Drainage Area C Value	Total Drainage Area (Acres)	Weighted C Value	Tc (minutes)	2-year storm		10-year storm	
									Intensity (in/hr)	Design Flow (cfs)	Intensity (in/hr)	Design Flow (cfs)
BD-1	1	0.40	0.14	0.00		0.5	0.44	5	4.8	1.1	6.5	1.5
BD-2	1	1.00	0.18	0.00		1.2	0.46	5	4.8	2.6	6.5	3.5
BD-3	1	0.55	0.10	0.00		0.7	0.46	5	4.8	1.4	6.5	2.0
BD-4	1	1.25	0.24	0.00		1.5	0.46	7	4.1	2.8	5.9	4.0
BD-5	1	1.00	0.22	0.00		1.2	0.45	6	4.5	2.5	6.1	3.4
BD-6	1	0.53	0.10	0.00		0.6	0.46	5	4.8	1.4	6.5	1.9
BD-7	1	1.22	0.20	0.00		1.4	0.46	6	4.5	3.0	6.1	4.0
BD-8	1	0.38	0.07	0.00		0.5	0.46	5	4.8	1.0	6.5	1.3
BD-9	1	0.32	0.14	0.00		0.5	0.42	5	4.8	0.9	6.5	1.3
BD-10	1	1.04	0.20	0.00		1.2	0.46	6	4.5	2.6	6.1	3.5
BD-11	1*	0.75	0.11	0.13	0.40	1.0	0.46	5	4.8	2.2	6.5	3.0
BD-12	1	1.06	0.50	0.00		1.6	0.42	8	4.0	2.6	5.6	3.7
BD-13	1	0.82	0.20	0.00		1.0	0.45	5	4.8	2.2	6.5	3.0
BD-14	1	0.91	0.23	0.00		1.1	0.45	5	4.8	2.5	6.5	3.3
BD-15	1	0.55	0.19	0.00		0.7	0.44	5	4.8	1.5	6.5	2.1
BD-16	1	0.56	0.19	0.00		0.8	0.44	5	4.8	1.6	6.5	2.1
BD-17	1	1.20	0.19	0.00		1.4	0.47	6	4.5	2.9	6.1	3.9
BD-18	1	0.77	0.15	0.00		0.9	0.46	5	4.8	2.0	6.5	2.7
BD-19	1	1.04	0.19	0.00		1.2	0.46	6	4.5	2.6	6.1	3.5
BD-20	1*	1.97	0.67	0.00		2.6	0.44	8	4.0	4.6	5.6	6.5
BD-21	1	0.77	0.31	0.00		1.1	0.43	5	4.8	2.2	6.5	3.0
BD-22	3	1.33	0.00	0.00		1.3	0.50	5	4.8	3.2	6.5	4.3
BD-23	3	0.83	0.00	0.00		0.8	0.50	5	4.8	2.0	6.5	2.7
BD-24	2	1.77	0.31	0.13	0.40	2.2	0.46	6	4.5	4.6	6.1	6.2
BD-25	1	0.50	0.14	0.00		0.6	0.45	5	4.8	1.4	6.5	1.9
BD-26	1*	0.47	0.00	0.30	0.40	0.8	0.46	5	4.8	1.7	6.5	2.3

Notes: 1. Use Rational Method to estimate stormwater runoff flows.
2. For sloped areas, use C value = 0.5 For flat areas, use C value = 0.25
3. 1* indicates berm ditch is Type 1, however slope of ditch is steeper than 0.5%.

Sheet 9
MDM 10/31/95

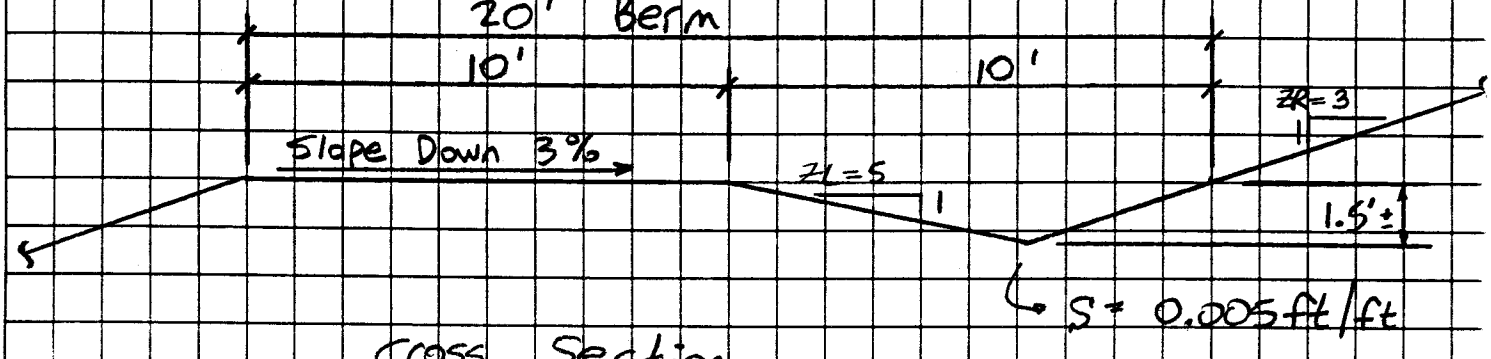
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 10 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Type 1 Berm Ditch (Grass Lined)



Cross Section

Type 1 Berm Ditch is applicable to the following Berm Ditches

* BD-1 thru BD-10
* BD-12 thru BD-19
* BD-21, BD-25

} Envelope design flows (see sht. 9) -
Q_2 = 3.0 cfs (BD-7)
Q_{10} = 4.0 cfs (BD-4, BD-7)

• Check capacity using Q_{10} and vegetative Retardance class C

let $d = 1.45'$

$A = \frac{1}{2}(Z_L + Z_R)\,d^2 = \frac{1}{2}(3+5)(1.45)^2 = 8.41\ ft^2$

$P_w = d(\sqrt{1+Z_L^2} + \sqrt{1+Z_R^2}) = 1.45(\sqrt{1+5^2} + \sqrt{1+3^2}) = 11.98\ ft$

$R = A/P_w = 8.41 / 11.98 = 0.702'$

$S = 0.005\ ft/ft$

Use Manning's Equation: $Q = \frac{1.49}{n} A R^{2/3} \sqrt{S}$

$Q = \frac{1.49}{0.175}(8.41)(.702)^{2/3}\sqrt{.005} = 4.0\ cfs = Q_{10}$ ✓

← assume $n = 0.175$

Verify $n = 0.175$: $V = Q/A = 4.0/8.41 = 0.48\ fps$

$VR = 0.48(.702) = 0.33 \Rightarrow \therefore n = 0.175$ ✓

(ref 1, Fig 8.05c, Retardance C)

∴ Type 1 Berm Ditch has adequate capacity for $Q_{10} = 4.0$ cfs

* see sht. 65 for locations of Berm Ditches

Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 11 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Type 1 Berm Ditch (Grass-Lined)

- Check Stability using Q_{10} and Vegetative Retardance Class D

Let $d = 1.20$ ft

Assume $n = 0.08$

$A = \frac{1}{2}(Z_L + Z_R)\,d^2 = \frac{1}{2}(3+5)(1.20)^2 = 5.76$ ft^2

$P_w = d\left(\sqrt{1+Z_L^2} + \sqrt{1+Z_R^2}\right) = 1.2\left(\sqrt{1+5^2} + \sqrt{1+3^2}\right) = 9.91$ ft

$R = A/P_w = 5.76/9.91 = 0.581$ ft

$S = 0.005$ ft/ft

Use Manning's Equation - $Q = \frac{1.49}{n} A R^{2/3}\sqrt{S}$

$Q = \frac{1.49}{.08}(5.76)(.581)^{2/3}\sqrt{.005} = 5.3$ cfs $> Q_{10} = 4.0$ cfs ✓

$V = Q/A = 5.3/5.76 = 0.92$ fps < 4.0 fps ✓

Verify $n = .08$: $VR = .92(.581) = 0.53 \Rightarrow n = 0.08$ ✓
(ref 1, Fig 8.05c, vegetative Retardance D)

∴ Type 1 Berm Ditch is stable for $Q_{10} = 4.0$ cfs

- Check need for temporary liner using Q_2 and Bare Earth

$Q = \frac{1.49}{n} A R^{2/3}\sqrt{S}$, let $d = 0.60$ ft

$n = 0.02$ (Bare earth condition)

$A = \frac{1}{2}(Z_L + Z_R)\,d^2 = \frac{1}{2}(3+5)(.60)^2 = 1.44$ ft^2

$P_w = d\left(\sqrt{1+Z_L^2} + \sqrt{1+Z_R^2}\right) = .60\left(\sqrt{1+5^2} + \sqrt{1+3^2}\right) = 4.96$ ft

$R = A/P_w = 1.44/4.96 = 0.29$ ft

$Q = \frac{1.49}{.02}(1.44)(.29)^{2/3}\sqrt{.005} = 3.3$ cfs $> Q_2 = 3.0$ cfs ✓

$V = Q/A = 3.3/1.44 = 2.3$ fps < 2.5 fps ✓

∴ Temporary Liner is not required for Type 1 Berm Ditch

Sheet 12
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 1 Berm Ditch - Bare Earth

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .005
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.6	0.01	0.0	0.5
0.15	0.9	0.02	0.1	0.6
0.23	1.2	0.03	0.2	0.6
0.30	1.5	0.05	0.5	0.7
0.38	1.7	0.06	0.9	0.7
0.45	1.9	0.07	1.5	0.7
0.52	2.1	0.08	2.3	0.7
0.60	2.3	0.09	3.3	0.7
0.67	2.5	0.10	4.6	0.8
0.75	2.7	0.11	6.0	0.8
0.82	2.9	0.12	7.8	0.8
0.90	3.0	0.14	9.8	0.8
0.97	3.2	0.15	12.1	0.8
1.05	3.4	0.16	14.8	0.8
1.13	3.5	0.17	17.8	0.8
1.20	3.7	0.18	21.1	0.8
1.28	3.8	0.19	24.8	0.8
1.35	4.0	0.20	28.9	0.9
1.43	4.1	0.22	33.4	0.9
1.50	4.3	0.23	38.3	0.9

Sheet 13
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 1 Berm Ditch - Retardance C

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .005
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.300	0.0	0.01	0.0	0.04
0.15	0.300	0.1	0.02	0.0	0.04
0.23	0.300	0.1	0.03	0.0	0.04
0.30	0.300	0.1	0.05	0.0	0.04
0.38	0.300	0.1	0.06	0.1	0.05
0.45	0.300	0.1	0.07	0.1	0.05
0.52	0.300	0.1	0.08	0.2	0.05
0.60	0.300	0.2	0.09	0.2	0.05
0.67	0.300	0.2	0.10	0.3	0.05
0.75	0.300	0.2	0.11	0.4	0.05
0.82	0.300	0.2	0.12	0.5	0.05
0.90	0.300	0.2	0.14	0.7	0.05
0.97	0.300	0.2	0.15	0.8	0.05
1.05	0.293	0.2	0.16	1.0	0.06
1.13	0.286	0.2	0.17	1.2	0.06
1.20	0.279	0.3	0.18	1.5	0.06
1.28	0.270	0.3	0.19	1.9	0.06
1.35	0.258	0.3	0.20	2.3	0.07
1.43	0.177	0.5	0.22	3.8	0.10
1.50	0.171	0.5	0.23	4.5	0.10

Sheet 14
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 1 Berm Ditch - Retardance D

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .005
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.200	0.1	0.01	0.0	0.05
0.15	0.200	0.1	0.02	0.0	0.06
0.23	0.200	0.1	0.03	0.0	0.06
0.30	0.200	0.1	0.05	0.1	0.07
0.38	0.200	0.2	0.06	0.1	0.07
0.45	0.200	0.2	0.07	0.2	0.07
0.52	0.200	0.2	0.08	0.2	0.07
0.60	0.200	0.2	0.09	0.3	0.07
0.67	0.200	0.2	0.10	0.5	0.08
0.75	0.200	0.3	0.11	0.6	0.08
0.82	0.190	0.3	0.12	0.8	0.08
0.90	0.175	0.3	0.14	1.1	0.09
0.97	0.153	0.4	0.15	1.6	0.11
1.05	0.101	0.7	0.16	3.0	0.16
1.13	0.093	0.8	0.17	3.8	0.18
1.20	0.081	0.9	0.18	5.2	0.21
1.28	0.072	1.1	0.19	7.0	0.24
1.35	0.067	1.2	0.20	8.7	0.26
1.43	0.062	1.3	0.22	10.9	0.28
1.50	0.058	1.5	0.23	13.3	0.30

Form 00184 (R4-88)

DUKE POWER COMPANY

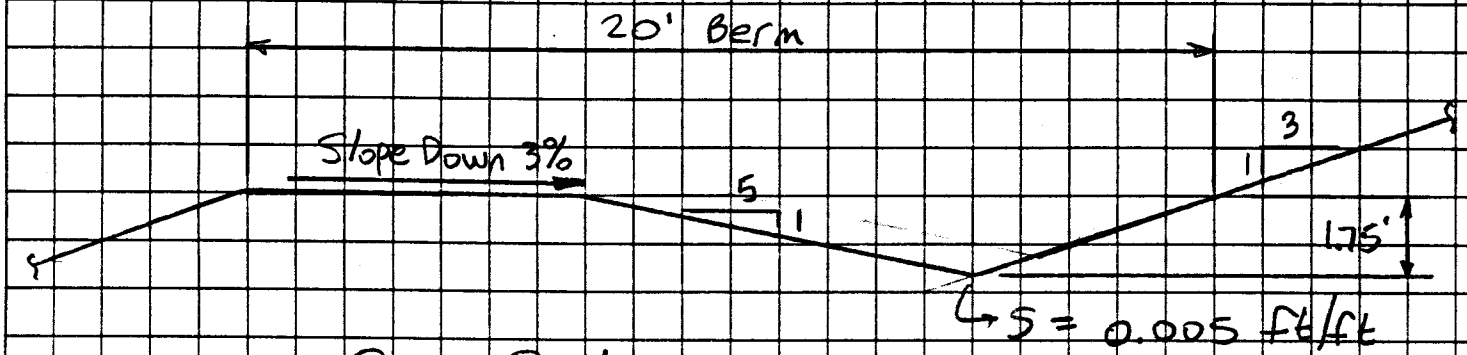
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 15 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Type 2 Berm Ditch (Grass-Lined)



Cross Section

Type 2 Berm Ditch is applicable for Berm Ditch BD-24
See sht. 65 for location of BD-24

$Q_2 = 4.6$ cfs, $Q_{10} = 6.2$ cfs (See sht. 9)

- Check capacity using Q_{10} and vegetative retardance C
  for $d = 1.66'$, $Q = 6.5$ cfs $> Q_{10} = 6.2$ cfs ✓ (see sht. 16)
- Check stability using Q_{10} and vegetative retardance D
  for $d = 1.31'$, $Q = 7.8$ cfs $> Q_{10} = 6.2$ cfs ✓, $V = 1.1$ fps < 4.0 fps ✓ (see sht. 17)
- Consider need for temporary liner using Q_2 and bare earth-
  for $d = 0.70'$, $Q = 5.0$ cfs $> Q_2 = 4.6$ cfs ✓, $V = 2.6$ cfs ≈ 2.5 cfs ✓ (See sht. 18)

Note: Berm Ditch BD-24 is existing and is stable.

Sheet 16
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 2 Berm Ditch = Retardance C

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .005
Overall Depth of Channel, H (ft) = 1.75
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.09	0.300	0.0	0.01	0.0	0.04
0.17	0.300	0.1	0.03	0.0	0.04
0.26	0.300	0.1	0.04	0.0	0.04
0.35	0.300	0.1	0.05	0.1	0.05
0.44	0.300	0.1	0.07	0.1	0.05
0.52	0.300	0.1	0.08	0.2	0.05
0.61	0.300	0.2	0.09	0.2	0.05
0.70	0.300	0.2	0.11	0.3	0.05
0.79	0.300	0.2	0.12	0.5	0.05
0.87	0.300	0.2	0.13	0.6	0.05
0.96	0.300	0.2	0.15	0.8	0.05
1.05	0.293	0.2	0.16	1.0	0.06
1.14	0.285	0.2	0.17	1.3	0.06
1.22	0.276	0.3	0.19	1.6	0.06
1.31	0.264	0.3	0.20	2.0	0.06
1.40	0.179	0.5	0.21	3.6	0.10
1.49	0.172	0.5	0.22	4.4	0.10
1.57	0.165	0.5	0.24	5.3	0.11
1.66	0.156	0.6	0.25	6.5	0.11
1.75	0.145	0.7	0.26	8.0	0.12
1.84	0.082	1.2	0.28	16.2	0.22

Sheet 17
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 2 Berm Ditch - Retardance D

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .005
Overall Depth of Channel, H (ft) = 1.75
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.09	0.200	0.1	0.01	0.0	0.05
0.17	0.200	0.1	0.03	0.0	0.06
0.26	0.200	0.1	0.04	0.0	0.06
0.35	0.200	0.2	0.05	0.1	0.07
0.44	0.200	0.2	0.07	0.1	0.07
0.52	0.200	0.2	0.08	0.2	0.07
0.61	0.200	0.2	0.09	0.4	0.07
0.70	0.200	0.3	0.11	0.5	0.08
0.79	0.196	0.3	0.12	0.7	0.08
0.87	0.181	0.3	0.13	1.0	0.09
0.96	0.159	0.4	0.15	1.5	0.10
1.05	0.101	0.7	0.16	3.0	0.16
1.14	0.092	0.8	0.17	4.0	0.18
1.22	0.074	1.0	0.19	6.1	0.23
1.31	0.070	1.1	0.20	7.8	0.25
1.40	0.064	1.3	0.21	10.0	0.27
1.49	0.058	1.5	0.22	12.9	0.30
1.57	0.056	1.6	0.24	15.6	0.31
1.66	0.054	1.7	0.25	18.9	0.33
1.75	0.051	1.9	0.26	22.9	0.35
1.84	0.047	2.1	0.28	28.2	0.38

Sheet 18
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 2 Berm Ditch - Bare Earth

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .005
Overall Depth of Channel, H (ft) = 1.75
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.09	0.6	0.01	0.0	0.5
0.17	1.0	0.03	0.1	0.6
0.26	1.3	0.04	0.4	0.6
0.35	1.6	0.05	0.8	0.7
0.44	1.9	0.07	1.4	0.7
0.52	2.1	0.08	2.3	0.7
0.61	2.3	0.09	3.5	0.7
0.70	2.6	0.11	5.0	0.8
0.79	2.8	0.12	6.9	0.8
0.87	3.0	0.13	9.1	0.8
0.96	3.2	0.15	11.7	0.8
1.05	3.4	0.16	14.8	0.8
1.14	3.5	0.17	18.3	0.8
1.22	3.7	0.19	22.3	0.8
1.31	3.9	0.20	26.8	0.8
1.40	4.1	0.21	31.9	0.9
1.49	4.2	0.22	37.5	0.9
1.57	4.4	0.24	43.6	0.9
1.66	4.6	0.25	50.4	0.9
1.75	4.7	0.26	57.8	0.9
1.84	4.9	0.28	65.8	0.9

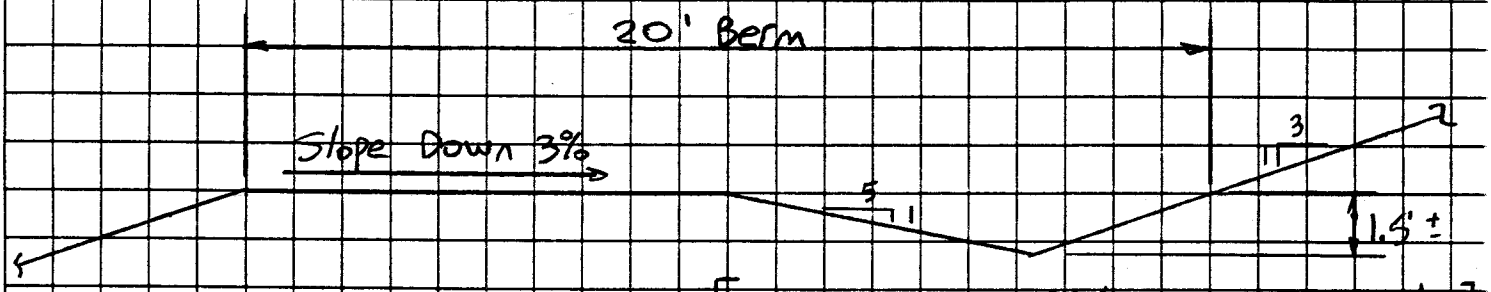
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 19 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Berm Ditch BD-11 Evaluate Type I Berm Ditch Cross Section -



Cross Section [$S = \Delta Y/\Delta X \approx 12'/260' = 0.046$ ft/ft]

This cross section & slope is applicable for Berm Ditch BD-11 See sht. 65 for location of BD-11

$Q_2 = 2.2$ cfs, $Q_{10} = 3.0$ cfs (See sht. 9)

- Check capacity using Q_{10} and vegetative Retardance C -

for $d = 0.90'$, $Q = 4.1$ cfs $> Q_{10} = 3.0$ cfs ✓ (See sht. 20)

- Check stability using Q_{10} and vegetative Retardance D -

for $d = 0.67'$, $Q = 4.0$ cfs $> Q_{10} = 3.0$ cfs ✓
$V = 2.2$ fps < 4.0 fps ✓ } (See sheet 21)

- Consider need for temporary liner using Q_2 and bare earth conditions -

for $d = 0.38'$, $Q = 2.9$ cfs $> Q_2 = 2.2$ cfs
$V = 5.1 > 2.5$ fps } (See sheet 22)

Note: Berm Ditch BD-11 is existing and is stable ∴ there is no need to disturb established vegetation for installation of temporary liner.

Sheet 20
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 1 Berm Ditch - Retardance C (BD-11)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .046
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.300	0.1	0.10	0.0	0.11
0.15	0.300	0.2	0.21	0.0	0.12
0.23	0.300	0.2	0.31	0.0	0.13
0.30	0.300	0.3	0.42	0.1	0.13
0.38	0.300	0.3	0.52	0.2	0.14
0.45	0.300	0.4	0.63	0.3	0.14
0.52	0.296	0.4	0.73	0.5	0.15
0.60	0.282	0.5	0.83	0.7	0.16
0.67	0.264	0.6	0.94	1.1	0.18
0.75	0.174	0.9	1.04	2.1	0.27
0.82	0.162	1.1	1.15	2.9	0.29
0.90	0.145	1.3	1.25	4.1	0.34
0.97	0.079	2.5	1.36	9.3	0.62
1.05	0.069	3.0	1.46	13.1	0.72
1.13	0.054	3.9	1.56	19.9	0.92
1.20	0.052	4.3	1.67	24.6	0.97
1.28	0.049	4.7	1.77	30.2	1.03
1.35	0.046	5.2	1.88	37.8	1.11
1.43	0.042	5.9	1.98	48.3	1.24
1.50	0.041	6.3	2.08	56.9	1.29

Sheet 21
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type I Berm Ditch - Retardance D (BD-11)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .046
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.200	0.2	0.10	0.0	0.16
0.15	0.200	0.3	0.21	0.0	0.18
0.23	0.200	0.4	0.31	0.1	0.19
0.30	0.200	0.4	0.42	0.2	0.20
0.38	0.200	0.5	0.52	0.3	0.21
0.45	0.181	0.6	0.63	0.5	0.24
0.52	0.103	1.2	0.73	1.4	0.43
0.60	0.088	1.6	0.83	2.3	0.52
0.67	0.070	2.2	0.94	4.0	0.67
0.75	0.059	2.8	1.04	6.2	0.80
0.82	0.055	3.1	1.15	8.6	0.86
0.90	0.051	3.6	1.25	11.8	0.96
0.97	0.045	4.3	1.36	16.4	1.09
1.05	0.044	4.6	1.46	20.5	1.13
1.13	0.042	5.1	1.56	25.6	1.19
1.20	0.040	5.5	1.67	31.6	1.25
1.28	0.038	6.1	1.77	39.4	1.34
1.35	0.037	6.5	1.88	47.5	1.40
1.43	0.036	6.8	1.98	55.6	1.43
1.50	0.036	7.2	2.08	64.7	1.46

Sheet 22
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 2 Berm Ditch - Bare Earth
1 (BD-11)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .046
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	1.8	0.10	0.0	1.6
0.15	2.8	0.21	0.3	1.8
0.23	3.6	0.31	0.7	1.9
0.30	4.4	0.42	1.6	2.0
0.38	5.1	0.52	2.9	2.1
0.45	5.8	0.63	4.7	2.1
0.52	6.4	0.73	7.1	2.2
0.60	7.0	0.83	10.1	2.3
0.67	7.6	0.94	13.8	2.3
0.75	8.1	1.04	18.3	2.3
0.82	8.7	1.15	23.6	2.4
0.90	9.2	1.25	29.7	2.4
0.97	9.7	1.36	36.8	2.4
1.05	10.2	1.46	44.9	2.5
1.13	10.7	1.56	53.9	2.5
1.20	11.1	1.67	64.1	2.5
1.28	11.6	1.77	75.3	2.6
1.35	12.0	1.88	87.7	2.6
1.43	12.5	1.98	101.3	2.6
1.50	12.9	2.08	116.2	2.6

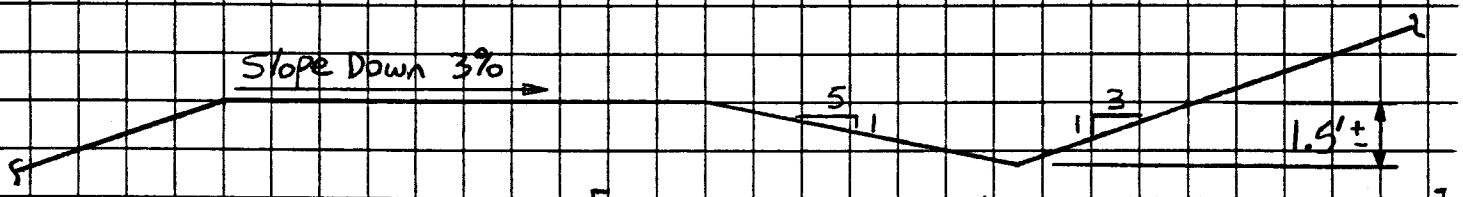
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 23 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Berm Ditch BD-20 Evaluate Type 1 Berm Ditch x-section-



Cross Section [$S' = \Delta Y/\Delta X \approx 8'/265' = 0.030$ ft/ft]

This cross section slope is applicable for Berm Ditch BD-20
see sheet 65 for location of BD-20

$Q2 = 4.6$ cfs, $Q_{10} = 6.5$ cfs

- Check capacity using Q_{10} and vegetative Retardance C -
  for $d = 1.05'$, $Q = 8.7$ cfs $> Q_{10} = 6.5$ cfs ✓ (sheet 24)
- Check stability using Q_{10} and vegetative retardance D -
  for $d = 0.92$ ft, $Q = 8.5$ cfs $> Q_{10} = 6.5$ cfs ✓ (sheet 25)
  $V = 2.6$ fps < 4.0 fps ✓
- Consider need for temporary liner using Q2 and bare earth conditions -
  for $d = 0.52'$, $Q = 5.7$ cfs $> Q2 = 4.6$ cfs } (sheet 26)
  $V = 5.2$ fps > 2.5 fps

Note: Berm Ditch BD-20 is existing and is stable ∴ there is no need to disturb established vegetation for installation of temporary liner

Sheet 24
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 1 Berm Ditch - Retardance C (B0-20)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .03
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.300	0.1	0.07	0.0	0.09
0.15	0.300	0.1	0.14	0.0	0.10
0.23	0.300	0.2	0.20	0.0	0.10
0.30	0.300	0.2	0.27	0.1	0.11
0.38	0.300	0.3	0.34	0.2	0.11
0.45	0.300	0.3	0.41	0.3	0.12
0.52	0.300	0.3	0.48	0.4	0.12
0.60	0.295	0.4	0.54	0.6	0.12
0.67	0.283	0.4	0.61	0.8	0.13
0.75	0.268	0.5	0.68	1.1	0.14
0.82	0.178	0.8	0.75	2.2	0.22
0.90	0.168	0.9	0.82	2.9	0.23
0.97	0.156	1.0	0.88	3.8	0.26
1.05	0.084	2.0	0.95	8.7	0.48
1.13	0.078	2.2	1.02	11.3	0.52
1.20	0.068	2.7	1.09	15.3	0.61
1.28	0.054	3.4	1.16	22.4	0.76
1.35	0.052	3.7	1.22	27.0	0.80
1.43	0.050	4.0	1.29	32.4	0.83
1.50	0.047	4.4	1.36	39.4	0.89

Sheet 25
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: ~~Type A~~ 1 Berm Ditch - Retardance D (BD-20)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .03
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.200	0.1	0.07	0.0	0.13
0.15	0.200	0.2	0.14	0.0	0.14
0.23	0.200	0.3	0.20	0.1	0.15
0.30	0.200	0.4	0.27	0.1	0.16
0.38	0.200	0.4	0.34	0.2	0.17
0.45	0.199	0.5	0.41	0.4	0.18
0.52	0.176	0.6	0.48	0.7	0.20
0.60	0.103	1.1	0.54	1.6	0.36
0.67	0.089	1.4	0.61	2.5	0.42
0.75	0.071	1.9	0.68	4.2	0.53
0.82	0.063	2.2	0.75	6.1	0.61
0.90	0.057	2.6	0.82	8.5	0.69
0.97	0.054	2.9	0.88	11.2	0.74
1.05	0.049	3.4	0.95	14.9	0.82
1.13	0.045	3.8	1.02	19.4	0.90
1.20	0.043	4.1	1.09	23.7	0.94
1.28	0.042	4.4	1.16	28.8	0.98
1.35	0.041	4.8	1.22	34.7	1.02
1.43	0.039	5.2	1.29	42.1	1.08
1.50	0.037	5.6	1.36	50.7	1.15

Sheet 26
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type I Berm Ditch Bare Earth Conditions (80-20)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .03
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	1.4	0.07	0.0	1.3
0.15	2.2	0.14	0.2	1.4
0.23	2.9	0.20	0.6	1.5
0.30	3.6	0.27	1.3	1.6
0.38	4.1	0.34	2.3	1.7
0.45	4.7	0.41	3.8	1.7
0.52	5.2	0.48	5.7	1.8
0.60	5.7	0.54	8.1	1.8
0.67	6.1	0.61	11.2	1.9
0.75	6.6	0.68	14.8	1.9
0.82	7.0	0.75	19.0	1.9
0.90	7.4	0.82	24.0	1.9
0.97	7.8	0.88	29.7	2.0
1.05	8.2	0.95	36.2	2.0
1.13	8.6	1.02	43.6	2.0
1.20	9.0	1.09	51.7	2.0
1.28	9.4	1.16	60.8	2.1
1.35	9.7	1.22	70.8	2.1
1.43	10.1	1.29	81.8	2.1
1.50	10.4	1.36	93.8	2.1

Form 00184 (R4-88)

DUKE POWER COMPANY

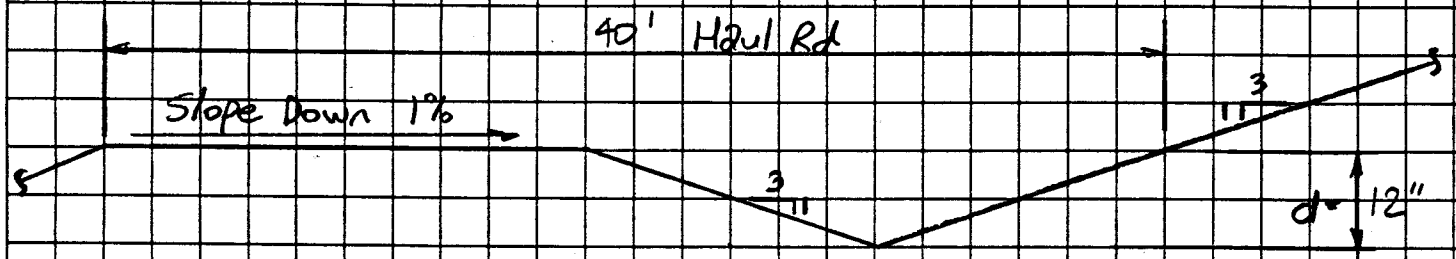
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 27 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Type 3 Berm Ditch



Cross Section $S = 0.11$ ft/ft

Type 3 Berm Ditch is applicable for Berm Ditches BD-22, BD-23

$Q_2 = 3.2$ cfs, $Q_{10} = 4.3$ cfs (see sht. 2)

Since longitudinal slope is steep (11%), specify riprap-lined channel

$Q = \frac{1.49}{n} A R^{2/3} \sqrt{S}$, try $d_{50} = 6"$ and depth $= 0.65'$

n = function of stone size and depth of flow } ref 2, Fig 16

$= d^{1/6} / [21.6 * \log_{10}(d/d_{50}) + 14]$

$= .65^{1/6} / [21.6 * \log_{10}(.65/.50) + 14]$

$n = 0.057$

$A = Zd^2 = 3.0(.65)^2 = 1.27$ ft^2

$P_w = 2d\sqrt{1+Z^2} = 2(.65)\sqrt{1+3^2} = 4.11$ ft

$R = A/P_w = 1.27/4.11 = 0.309$

$Q = \frac{1.49}{0.057}(1.27)(.309)^{2/3}\sqrt{.11} = 5.0$ cfs $> Q_{10} = 4.3$ cfs ✓

Tractive Force $= \tau = \gamma RS = 62.4(.309)(.11) = 2.12$ psf

Allowable $\tau = 2.50$ psf > 2.12 psf ✓

(ref. 1, Table 8.05g)

Sheet 28
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Lanfill
Description: Type B Berm Ditch - Riprap d50 = 6" 3

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 3
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .11
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 1 (1 = Riprap, 2=Vegetation, 3=Other)
d50 of riprap, d50 (ft) = .5
Specific gravity of riprap, SG = 2.65
Riprap angle of internal friction, phi (degrees) = 40

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number	Channel Bed Stability Safety Factor	Channel Wall Stability Safety Factor
0.05	-.080	-0.5	0.16	-0.0	-.57	5.05	2.29
0.10	-.620	-0.1	0.33	-0.0	-.08	3.78	2.08
0.15	0.269	0.3	0.49	0.0	0.20	3.02	1.90
0.20	0.141	0.7	0.65	0.1	0.40	2.51	1.74
0.25	0.106	1.1	0.81	0.2	0.56	2.15	1.60
0.30	0.089	1.5	0.98	0.4	0.69	1.88	1.47
0.35	0.079	1.9	1.14	0.7	0.80	1.67	1.36
0.40	0.072	2.3	1.30	1.1	0.89	1.50	1.27
0.45	0.067	2.6	1.47	1.6	0.97	1.37	1.18
0.50	0.064	3.0	1.63	2.2	1.05	1.25	1.10
0.55	0.061	3.3	1.79	3.0	1.12	1.15	1.03
0.60	0.058	3.7	1.95	3.9	1.18	1.07	0.97
0.65	0.057	4.0	2.12	5.1	1.23	1.00	0.92
0.70	0.055	4.3	2.28	6.3	1.28	0.94	0.87
0.75	0.054	4.6	2.44	7.8	1.33	0.88	0.82
0.80	0.052	4.9	2.60	9.5	1.38	0.83	0.78
0.85	0.051	5.3	2.77	11.4	1.42	0.79	0.75
0.90	0.050	5.6	2.93	13.5	1.46	0.75	0.71
0.95	0.050	5.9	3.09	15.9	1.50	0.71	0.68
1.00	0.049	6.2	3.26	18.5	1.54	0.68	0.65

Form 00184 (R4-88)

DUKE POWER COMPANY

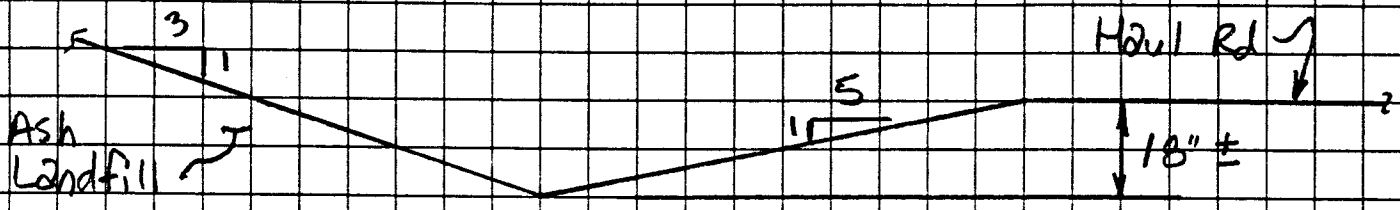
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 29 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Berm Ditch BD-26* Evaluate Type I Berm Ditch x-section



$S' \approx [(830-804)/400] = 0.065$ ft/ft

Cross Section

$Q_2 = 1.7$ cfs, $Q_{10} = 2.3$ cfs (see sheet 9)

- Check capacity using Q_{10} and vegetative retardance class C

  @ $d = 0.75'$, $Q = 2.7$ cfs > $Q_{10} = 2.3$ cfs ✓ (sheet 30)

- Check stability using Q_{10} and vegetative retardance Class D

  @ $d = 0.55'$, $Q = 2.3$ cfs $= Q_{10} = 2.3$ cfs ✓
  $V = 1.9$ fps < 4.0 fps ✓ (sheet 31)

- Evaluate need for temporary liner using Q_2 and bare earth conditions-

  @ $d = 0.30'$, $Q = 1.9$ cfs > $Q_2 = 1.7$ cfs ✓
  $V = 5.2$ fps > 2.5 fps (sheet 32)

Note that Berm Ditch BD-26 is existing and is stable ∴ it is not practical to disturb vegetation for installation of temporary liner.

* See sheet 65 for location of Berm Ditch BD-26

Sheet 30
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type I Berm Ditch - Retardance C

1 (BD-26)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .065
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	0.300	0.1	0.10	0.0	0.12
0.10	0.300	0.2	0.20	0.0	0.13
0.15	0.300	0.2	0.29	0.0	0.14
0.20	0.300	0.3	0.39	0.0	0.15
0.25	0.300	0.3	0.49	0.1	0.15
0.30	0.300	0.3	0.59	0.1	0.16
0.35	0.300	0.4	0.69	0.2	0.16
0.40	0.300	0.4	0.79	0.3	0.17
0.45	0.300	0.5	0.88	0.4	0.17
0.50	0.291	0.5	0.98	0.5	0.18
0.55	0.280	0.6	1.08	0.7	0.19
0.60	0.267	0.6	1.18	0.9	0.20
0.65	0.178	1.0	1.28	1.7	0.31
0.70	0.171	1.1	1.37	2.1	0.32
0.75	0.161	1.2	1.47	2.7	0.35
0.80	0.149	1.4	1.57	3.5	0.38
0.85	0.082	2.6	1.67	7.4	0.70
0.90	0.077	2.9	1.77	9.3	0.75
0.95	0.069	3.3	1.87	12.0	0.85
1.00	0.055	4.3	1.96	17.0	1.06

Sheet 31
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: ~~Type 1 Berm Ditch - Retardance D~~ 1 (BD-26)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .065
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	0.200	0.2	0.10	0.0	0.18
0.10	0.200	0.3	0.20	0.0	0.20
0.15	0.200	0.3	0.29	0.0	0.21
0.20	0.200	0.4	0.39	0.1	0.22
0.25	0.200	0.5	0.49	0.1	0.23
0.30	0.200	0.5	0.59	0.2	0.24
0.35	0.200	0.6	0.69	0.3	0.25
0.40	0.183	0.7	0.79	0.4	0.27
0.45	0.154	0.9	0.88	0.7	0.33
0.50	0.098	1.5	0.98	1.5	0.54
0.55	0.084	1.9	1.08	2.3	0.63
0.60	0.071	2.4	1.18	3.4	0.77
0.65	0.064	2.8	1.28	4.7	0.86
0.70	0.058	3.2	1.37	6.3	0.96
0.75	0.055	3.5	1.47	7.9	1.02
0.80	0.052	3.9	1.57	10.1	1.10
0.85	0.047	4.5	1.67	13.0	1.22
0.90	0.044	4.9	1.77	15.9	1.29
0.95	0.043	5.2	1.87	18.7	1.32
1.00	0.042	5.5	1.96	22.1	1.38

Sheet 32
mpm 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 1 Berm Ditch - Bare Earth (BD-2G)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 5
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .065
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	1.6	0.10	0.0	1.8
0.10	2.5	0.20	0.1	2.0
0.15	3.3	0.29	0.3	2.1
0.20	4.0	0.39	0.6	2.2
0.25	4.6	0.49	1.2	2.3
0.30	5.2	0.59	1.9	2.4
0.35	5.8	0.69	2.8	2.4
0.40	6.4	0.79	4.1	2.5
0.45	6.9	0.88	5.6	2.6
0.50	7.4	0.98	7.4	2.6
0.55	7.9	1.08	9.5	2.6
0.60	8.3	1.18	12.0	2.7
0.65	8.8	1.28	14.8	2.7
0.70	9.2	1.37	18.1	2.7
0.75	9.7	1.47	21.7	2.8
0.80	10.1	1.57	25.8	2.8
0.85	10.5	1.67	30.4	2.8
0.90	10.9	1.77	35.4	2.9
0.95	11.3	1.87	40.8	2.9
1.00	11.7	1.96	46.8	2.9

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 33 Of ____

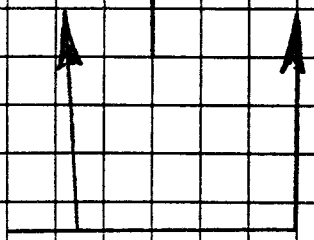
Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

*Perimeter Ditches - Determine times of concentrations and intensities - ref. 1, Fig. 8.03a

Perimeter Ditch *	L (ft)	H (ft)	Tc (minutes)	i_2 (in/hr)	i_{10} (in/hr)
PD-1	570	850-807=43	use 5	4.8	6.5
PD-2	850	915-849=66	use 5	4.8	6.5
PD-3	1010	915-842=73	use 5	4.8	6.5
PD-4	1500	915-799=116	6	4.5	6.1



ref 1, Fig 8.03g

* See sheet 65 for location of perimeter ditches

Marshall Steam Station
Dry Ash Storage Area
Summary of Storm Drainage Perimeter Ditches

Perimeter Ditch Designation	Perimeter Ditch Slope (ft/ft)	Sloped (3H : 1V) Drainage Area (Acres)	Berm/Flat Drainage Area (Acres)	Other Drainage Area (Acres)	Other Drainage Area C Value	Total Drainage Area (Acres)	Weighted C Value	Tc (minutes)	2-year storm		10-year storm	
									Intensity (in/hr)	Design Flow (cfs)	Intensity (in/hr)	Design Flow (cfs)
PD-1	0.075	0.86	0.00	2.03	0.40	2.9	0.43	5	4.8	6.0	6.5	8.1
PD-2	0.033	1.54	0.00	0.20	0.30	1.7	0.48	5	4.8	4.0	6.5	5.4
PD-3	0.043	2.90	0.34	0.20	0.30	3.4	0.46	5	4.8	7.7	6.5	10.4
PD-4	0.12	3.95	0.34	0.20	0.30	4.5	0.47	6	4.5	9.5	6.1	12.9

Notes: 1. Use Rational Method to estimate stormwater runoff flows.
2. For sloped areas, use C value = 0.5 For flat areas, use C value = 0.25

Sheet 34
MPM 10/31/95

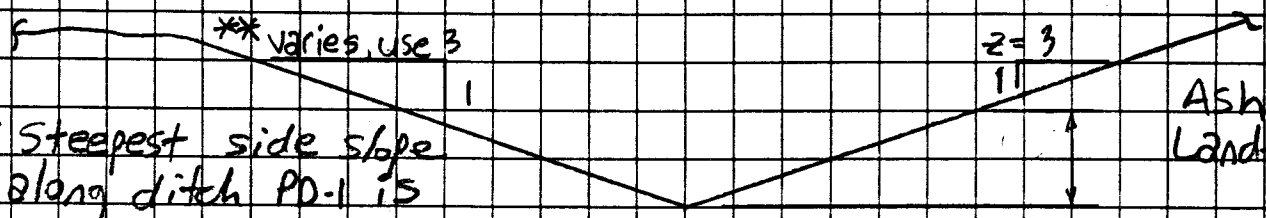
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 35 Of ____

Subject Ash Landfill - Stormwater Drainage

By M PM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

*Perimeter Ditch PD-1 Grass-Lined



** Steepest side slope along ditch PD-1 is ≈3H:1V, use z=3

Cross Section

$S' = [(850-808)/560] = 0.075$ ft/ft

$Q_2 = 6.0$ cfs $Q_{10} = 8.1$ cfs (see sht. 34)

- Check capacity using Q_{10} and vegetative retardance C

  for $d = 0.95'$, $Q = 10.6$ cfs > $Q_{10} = 8.1$ cfs (sht. 36)

- Check stability using Q_{10} and vegetative retardance D

  for $d = 0.80'$, $Q = 8.2$ cfs > $Q_{10} = 8.1$ cfs (sht. 37)
  $V = 4.3$ fps ≈ 4.0 fps

- Evaluate need for temporary liner using Q_2 and Bare Earth conditions

  for $d = 0.50'$, $Q = 5.9$ cfs ≈ $Q_2 = 6.0$ cfs } (sht. 38)
  $V = 7.8$ fps >> 2.5 fps

  However, ditch PD-1 is existing and is stable.
  ∴ there is no need to disturb established vegetation for installation of temporary liner.

*see sht. 65 for location of PD-1

Sheet 36
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-1 Retardance C

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 3
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .075
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	0.300	0.1	0.11	0.0	0.13
0.10	0.300	0.2	0.22	0.0	0.14
0.15	0.300	0.2	0.33	0.0	0.15
0.20	0.300	0.3	0.44	0.0	0.16
0.25	0.300	0.3	0.55	0.1	0.16
0.30	0.300	0.4	0.67	0.1	0.17
0.35	0.300	0.4	0.78	0.2	0.17
0.40	0.300	0.4	0.89	0.2	0.18
0.45	0.298	0.5	1.00	0.3	0.18
0.50	0.288	0.5	1.11	0.4	0.19
0.55	0.277	0.6	1.22	0.5	0.20
0.60	0.263	0.7	1.33	0.7	0.22
0.65	0.176	1.1	1.44	1.3	0.33
0.70	0.168	1.2	1.55	1.7	0.35
0.75	0.157	1.3	1.66	2.2	0.38
0.80	0.142	1.5	1.78	2.9	0.42
0.85	0.081	2.8	1.89	6.0	0.75
0.90	0.074	3.2	2.00	7.7	0.83
0.95	0.062	3.9	2.11	10.6	1.00
1.00	0.054	4.6	2.22	13.8	1.14

Sheet 37
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-1 Retardance D

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 3
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .075
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	0.200	0.2	0.11	0.0	0.19
0.10	0.200	0.3	0.22	0.0	0.21
0.15	0.200	0.4	0.33	0.0	0.23
0.20	0.200	0.4	0.44	0.1	0.24
0.25	0.200	0.5	0.55	0.1	0.25
0.30	0.200	0.6	0.67	0.2	0.25
0.35	0.198	0.6	0.78	0.2	0.26
0.40	0.179	0.8	0.89	0.4	0.30
0.45	0.144	1.0	1.00	0.6	0.38
0.50	0.096	1.6	1.11	1.2	0.58
0.55	0.077	2.2	1.22	2.0	0.73
0.60	0.069	2.6	1.33	2.8	0.83
0.65	0.061	3.1	1.44	3.9	0.95
0.70	0.057	3.5	1.55	5.1	1.03
0.75	0.054	3.8	1.66	6.4	1.10
0.80	0.050	4.3	1.78	8.2	1.19
0.85	0.045	4.9	1.89	10.7	1.34
0.90	0.044	5.2	2.00	12.7	1.37
0.95	0.043	5.5	2.11	15.0	1.41
1.00	0.042	5.9	2.22	17.8	1.48

Sheet 38
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimiter Ditch PD-1 Bare Earth

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 3
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .075
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	1.7	0.11	0.0	1.9
0.10	2.7	0.22	0.1	2.1
0.15	3.5	0.33	0.2	2.3
0.20	4.2	0.44	0.5	2.4
0.25	4.9	0.55	0.9	2.5
0.30	5.6	0.67	1.5	2.5
0.35	6.2	0.78	2.3	2.6
0.40	6.7	0.89	3.2	2.7
0.45	7.3	1.00	4.4	2.7
0.50	7.8	1.11	5.9	2.8
0.55	8.3	1.22	7.6	2.8
0.60	8.8	1.33	9.5	2.8
0.65	9.3	1.44	11.8	2.9
0.70	9.8	1.55	14.4	2.9
0.75	10.2	1.66	17.3	2.9
0.80	10.7	1.78	20.5	3.0
0.85	11.1	1.89	24.1	3.0
0.90	11.6	2.00	28.1	3.0
0.95	12.0	2.11	32.5	3.1
1.00	12.4	2.22	37.2	3.1

Form 00184 (R4-88)

DUKE POWER COMPANY

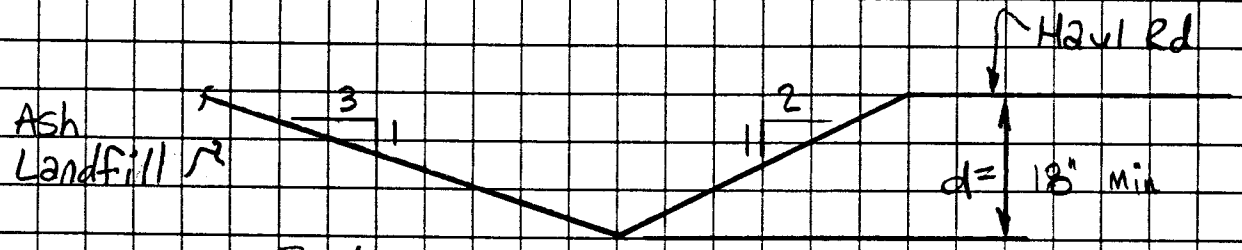
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 39 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Perimeter Ditch PD-2 *



Cross Section

$S' = [(856 - 849)/210] = 0.033 ft/ft$

$Q_2 = 4.0$ cfs, $Q_{10} = 5.4$ cfs (Sheet 34)

- Check capacity using Q_{10} and Vegetative Retardance Class C

  @ $d = 1.13'$, $Q = 7.1$ cfs > $Q_{10} = 5.4$ cfs ✓ (Sheet 40)

- Check stability using Q_{10} and Vegetative Retardance Class D

  @ $d = 0.90'$, $Q = 5.4$ cfs = $Q_{10} = 5.4$ cfs ✓ (Sheet 41)
  $V = 2.6$ fps < 4.0 fps ✓

- Evaluate need for temporary liner - use Q_2 and Bare Earth conditions

  @ $d = 0.60'$, $Q = 5.2$ cfs > $Q_2 = 4.0$ cfs (Sheet 42)
  $V = 5.8$ fps > 2.5 fps ∴ should provide temporary liner

  Try Fiberglass Roving - @ $d = 0.55'$ $Q = 3.9$ cfs ≈ Q_2
  τ = tractive force = 0.53 psf (Sheet 44)

  Allowable $\tau = 0.60$ psf > 0.53 psf ✓
  ← ref 1, Table 8.05g

* see sheet 65 for location of Perimeter Ditch PD-2

sheet 40
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-2 Retardance C

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 2
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .0333
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = C

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.300	0.1	0.07	0.0	0.09
0.15	0.300	0.2	0.14	0.0	0.10
0.23	0.300	0.2	0.22	0.0	0.11
0.30	0.300	0.2	0.29	0.1	0.11
0.38	0.300	0.3	0.36	0.1	0.11
0.45	0.300	0.3	0.43	0.2	0.12
0.52	0.300	0.4	0.51	0.2	0.12
0.60	0.296	0.4	0.58	0.4	0.13
0.67	0.285	0.4	0.65	0.5	0.13
0.75	0.271	0.5	0.72	0.7	0.14
0.82	0.179	0.8	0.79	1.4	0.22
0.90	0.170	0.9	0.87	1.8	0.24
0.97	0.158	1.0	0.94	2.4	0.26
1.05	0.141	1.2	1.01	3.3	0.29
1.13	0.079	2.2	1.08	7.1	0.52
1.20	0.071	2.6	1.15	9.4	0.59
1.28	0.055	3.5	1.23	14.1	0.77
1.35	0.053	3.7	1.30	17.0	0.80
1.43	0.051	4.0	1.37	20.5	0.84
1.50	0.048	4.4	1.44	24.8	0.90

Sheet 91
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-2 Retardance D

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 2
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .0333
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 2 (1 = Riprap, 2=Vegetation, 3=Other)
Vegetative Retardance Class, RC$ = D

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	0.200	0.1	0.07	0.0	0.13
0.15	0.200	0.2	0.14	0.0	0.15
0.23	0.200	0.3	0.22	0.0	0.16
0.30	0.200	0.4	0.29	0.1	0.17
0.38	0.200	0.4	0.36	0.1	0.17
0.45	0.200	0.5	0.43	0.2	0.18
0.52	0.178	0.6	0.51	0.4	0.21
0.60	0.104	1.1	0.58	1.0	0.36
0.67	0.091	1.4	0.65	1.6	0.42
0.75	0.072	1.9	0.72	2.6	0.54
0.82	0.065	2.2	0.79	3.8	0.61
0.90	0.058	2.6	0.87	5.4	0.70
0.97	0.054	3.0	0.94	7.1	0.75
1.05	0.050	3.4	1.01	9.3	0.82
1.13	0.045	3.9	1.08	12.4	0.92
1.20	0.044	4.2	1.15	15.1	0.95
1.28	0.042	4.5	1.23	18.3	0.99
1.35	0.041	4.8	1.30	22.0	1.04
1.43	0.039	5.2	1.37	26.6	1.09
1.50	0.037	5.7	1.44	32.0	1.16

Sheet 42
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-2 Bare Earth

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 2
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .0333
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .02

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.08	1.4	0.07	0.0	1.3
0.15	2.3	0.14	0.1	1.5
0.23	3.0	0.22	0.4	1.6
0.30	3.6	0.29	0.8	1.7
0.38	4.2	0.36	1.5	1.7
0.45	4.8	0.43	2.4	1.8
0.52	5.3	0.51	3.6	1.8
0.60	5.8	0.58	5.2	1.9
0.67	6.3	0.65	7.1	1.9
0.75	6.7	0.72	9.4	1.9
0.82	7.2	0.79	12.2	2.0
0.90	7.6	0.87	15.4	2.0
0.97	8.0	0.94	19.0	2.0
1.05	8.4	1.01	23.2	2.0
1.13	8.8	1.08	27.8	2.1
1.20	9.2	1.15	33.1	2.1
1.28	9.6	1.23	38.9	2.1
1.35	9.9	1.30	45.3	2.1
1.43	10.3	1.37	52.3	2.2
1.50	10.7	1.44	60.0	2.2

Sheet 43
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-2 Jute Net Liner

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 2
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .0333
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .022

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	1.0	0.05	0.0	1.1
0.10	1.6	0.10	0.0	1.3
0.15	2.1	0.14	0.1	1.3
0.20	2.5	0.19	0.3	1.4
0.25	2.9	0.24	0.5	1.5
0.30	3.3	0.29	0.7	1.5
0.35	3.7	0.34	1.1	1.5
0.40	4.0	0.38	1.6	1.6
0.45	4.3	0.43	2.2	1.6
0.50	4.7	0.48	2.9	1.6
0.55	5.0	0.53	3.8	1.7
0.60	5.3	0.58	4.7	1.7
0.65	5.5	0.63	5.9	1.7
0.70	5.8	0.67	7.1	1.7
0.75	6.1	0.72	8.6	1.8
0.80	6.4	0.77	10.2	1.8
0.85	6.6	0.82	12.0	1.8
0.90	6.9	0.87	14.0	1.8
0.95	7.1	0.91	16.1	1.8
1.00	7.4	0.96	18.5	1.8

Use Fiberglass Roving

Sheet 44
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-2 E'glass Roving

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 2
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .0333
Overall Depth of Channel, H (ft) = 1
Channel Lining Category, CLC = 3 (1 = Riprap, 2=Vegetation, 3=Other)
Constant Manning's n = .021

**********Results**********

Channel Flow Depth (ft)	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number
0.05	1.1	0.05	0.0	1.2
0.10	1.7	0.10	0.0	1.3
0.15	2.2	0.14	0.1	1.4
0.20	2.6	0.19	0.3	1.5
0.25	3.1	0.24	0.5	1.5
0.30	3.5	0.29	0.8	1.6
0.35	3.8	0.34	1.2	1.6
0.40	4.2	0.38	1.7	1.7
0.45	4.5	0.43	2.3	1.7
0.50	4.9	0.48	3.0	1.7
0.55	5.2	0.53	3.9	1.7
0.60	5.5	0.58	5.0	1.8
0.65	5.8	0.63	6.1	1.8
0.70	6.1	0.67	7.5	1.8
0.75	6.4	0.72	9.0	1.8
0.80	6.7	0.77	10.7	1.9
0.85	7.0	0.82	12.6	1.9
0.90	7.2	0.87	14.6	1.9
0.95	7.5	0.91	16.9	1.9
1.00	7.7	0.96	19.4	1.9

Form 00184 (R4-88)

DUKE POWER COMPANY

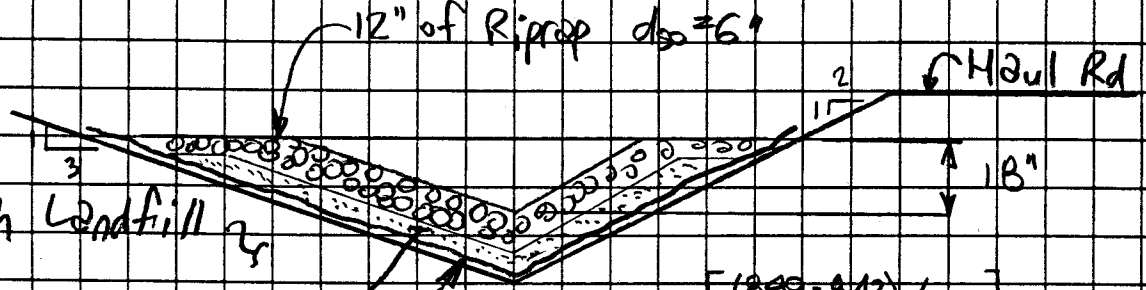
Station Marshall Unit 1-4 Rev. File No. Sheet 45 Of

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. Checked By Date

Perimeter Ditch PD-3 - use riprap due to culvert C15 discharging to PD-3 at high velocity



Cross Section

$S = [(849-842)/160'] = 0.044$ ft/ft

- Q_{10} = 10.4 cfs (sheet 34)
- @ d = 1.05', Q = 11.1 cfs > Q_{10} = 10.4 cfs } (sheet 46)
  τ = 1.34 psf
  Allowable τ = 2.5 psf > 1.34 psf OK
  (Ref. 1, Table 8.05g)

See sht. 65 for location of PD-3

Sheet 46

MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Perimeter Ditch PD-3 (Riprap)

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 2
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .044
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 1 (1 = Riprap, 2=Vegetation, 3=Other)
d50 of riprap, d50 (ft) = .5
Specific gravity of riprap, SG = 2.65
Riprap angle of internal friction, phi (degrees) = 38

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number	Channel Bed Stability Safety Factor	Channel Wall Stability Safety Factor
0.08	-.171	-0.2	0.10	-0.0	-.18	%10.50	1.51
0.15	0.269	0.2	0.19	0.0	0.13	7.45	1.46
0.23	0.120	0.6	0.29	0.1	0.30	5.78	1.41
0.30	0.089	0.9	0.38	0.2	0.43	4.72	1.36
0.38	0.075	1.3	0.48	0.5	0.53	3.98	1.31
0.45	0.067	1.6	0.57	0.8	0.61	3.45	1.27
0.52	0.062	2.0	0.67	1.4	0.67	3.04	1.23
0.60	0.058	2.3	0.76	2.0	0.73	2.72	1.19
0.67	0.056	2.6	0.86	2.9	0.78	2.46	1.15
0.75	0.054	2.9	0.95	4.1	0.83	2.24	1.11
0.82	0.052	3.2	1.05	5.4	0.87	2.06	1.07
0.90	0.050	3.5	1.14	7.0	0.91	1.91	1.04
0.97	0.049	3.7	1.24	8.9	0.94	1.78	1.01
1.05	0.048	4.0	1.34	11.1	0.98	1.66	0.98
1.13	0.047	4.3	1.43	13.6	1.01	1.56	0.95
1.20	0.046	4.6	1.53	16.4	1.04	1.47	0.92
1.28	0.046	4.8	1.62	19.6	1.06	1.39	0.89
1.35	0.045	5.1	1.72	23.1	1.09	1.32	0.87
1.43	0.045	5.3	1.81	27.0	1.11	1.26	0.84
1.50	0.044	5.6	1.91	31.3	1.13	1.20	0.82

Form 00184 (R4-88)

DUKE POWER COMPANY

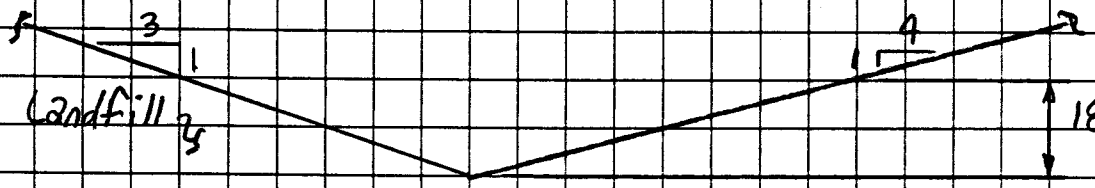
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 47 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Perimeter Ditch PD-4 * (Riprap - Lined)



Cross Section

$S = [(842-800)/350] = 0.12$ ft/ft

$Q_2 = 9.5$ cfs, $Q_{10} = 12.9$ cfs (Sheet 39)

Since longitudinal slope of ditch is relatively steep (12%), provide riprap as lining material

Use $d_{50} = 9"$

@ $d = 0.90'$, $Q = 13.4$ cfs > $Q_{10} = 12.9$ cfs ↵ } (Sheet 48)
$\tau = 3.24$ psf

Allowable Tractive force = 3.80 psf > $\tau = 3.51$ psf ↵

*See sheet 65 for location of Perimeter Ditch PD-4

Sheet 4B
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: [redacted]

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 4
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .12
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 1 (1 = Riprap, 2=Vegetation, 3=Other)
d50 of riprap, d50 (ft) = .75
Specific gravity of riprap, SG = 2.65
Riprap angle of internal friction, phi (degrees) = 38

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number	Channel Bed Stability Safety Factor	Channel Wall Stability Safety Factor
0.08	-.085	-0.7	0.27	-0.0	-.60	4.40	2.12
0.15	-.664	-0.1	0.54	-0.0	-.09	3.32	1.92
0.23	0.288	0.4	0.81	0.1	0.21	2.66	1.75
0.30	0.151	0.9	1.08	0.3	0.43	2.23	1.60
0.38	0.113	1.5	1.35	0.7	0.59	1.91	1.47
0.45	0.095	2.0	1.62	1.4	0.73	1.68	1.35
0.52	0.084	2.4	1.89	2.4	0.84	1.49	1.25
0.60	0.077	2.9	2.16	3.7	0.94	1.34	1.16
0.67	0.072	3.4	2.43	5.4	1.03	1.22	1.08
0.75	0.068	3.8	2.70	7.6	1.10	1.12	1.00
0.82	0.065	4.3	2.97	10.2	1.17	1.03	0.94
0.90	0.063	4.7	3.24	13.4	1.24	0.96	0.88
0.97	0.060	5.1	3.51	17.1	1.30	0.90	0.83
1.05	0.059	5.6	3.78	21.5	1.35	0.84	0.79
1.13	0.057	6.0	4.05	26.5	1.40	0.79	0.75
1.20	0.056	6.4	4.32	32.2	1.45	0.75	0.71
1.28	0.055	6.8	4.59	38.6	1.50	0.71	0.68
1.35	0.054	7.2	4.86	45.8	1.54	0.67	0.65
1.43	0.053	7.6	5.13	53.8	1.58	0.64	0.62
1.50	0.052	7.9	5.40	62.6	1.62	0.61	0.59

Sheet 49
MPM 10/31/95

*******Project Data*******

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: [redacted]

→ use 9" Riprap

*******Input Data*******

Left channel bank slope, ZL (ZL Horiz : 1.0 Vert) = 3
Right channel bank slope, ZR (ZR Horiz : 1.0 Vert) = 4
Channel base width, B (ft) = 0
Slope of Channel Bed, S (ft/ft) = .12
Overall Depth of Channel, H (ft) = 1.5
Channel Lining Category, CLC = 1 (1 = Riprap, 2=Vegetation, 3=Other)
d50 of riprap, d50 (ft) = 1
Specific gravity of riprap, SG = 2.65
Riprap angle of internal friction, phi (degrees) = 38

**********Results**********

Channel Flow Depth (ft)	Manning's n	Average Velocity (fps)	Tractive Force (psf)	Flow (cfs)	Froude Number	Channel Bed Stability Safety Factor	Channel Wall Stability Safety Factor
0.08	-.063	-0.9	0.27	-0.0	-.81	4.78	2.17
0.15	-.192	-0.5	0.54	-0.0	-.30	3.78	2.02
0.23	%109.144	0.0	0.81	0.0	0.00	3.13	1.88
0.30	0.302	0.5	1.08	0.1	0.21	2.66	1.75
0.38	0.177	0.9	1.35	0.5	0.38	2.32	1.64
0.45	0.134	1.4	1.62	1.0	0.51	2.06	1.53
0.52	0.113	1.8	1.89	1.8	0.63	1.85	1.44
0.60	0.100	2.3	2.16	2.8	0.73	1.68	1.35
0.67	0.091	2.7	2.43	4.3	0.81	1.53	1.27
0.75	0.084	3.1	2.70	6.1	0.89	1.41	1.20
0.82	0.079	3.5	2.97	8.4	0.96	1.31	1.14
0.90	0.076	3.9	3.24	11.1	1.03	1.22	1.08
0.97	0.072	4.3	3.51	14.3	1.09	1.14	1.02
1.05	0.070	4.7	3.78	18.1	1.14	1.08	0.97
1.13	0.068	5.1	4.05	22.5	1.19	1.02	0.93
1.20	0.066	5.4	4.32	27.5	1.24	0.96	0.88
1.28	0.064	5.8	4.59	33.1	1.28	0.91	0.85
1.35	0.063	6.2	4.86	39.4	1.33	0.87	0.81
1.43	0.061	6.5	5.13	46.5	1.37	0.83	0.78
1.50	0.060	6.9	5.40	54.4	1.40	0.79	0.75

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 50 Of ____

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Culverts * - Determine Times of Concentration & Intensities

Ref 1, Fig 8.03a →

Culvert	L (ft)	H (ft)	T_c (minutes)	i_2 (in/hr)	i_{10} (in/hr)
C1	500	.005(500) = 2.5	7	4.1	5.9
C2	use 500	use 2.5	7	4.1	5.9
C3	use 500	use 2.5	7	4.1	5.9
C4	330	.005(330) = 1.7	5	4.8	6.5
C5	use 330	use 1.7	5	4.8	6.5
C6	use 330	use 1.7	5	4.8	6.5
C7	380	.005(380) = 1.9	5	4.8	6.5
C8	480	.005(480) = 2.4	7	4.1	5.9
C9	use 480	use 2.4	7	4.1	5.9
C11	use 480	use 2.4	7	4.1	5.9
C12	340	.005(340) = 1.7	5	4.8	6.5
C13	use 340	use 1.7	5	4.8	6.5
C14	use 340	use 1.7	5	4.8	6.5
C15	430	.005(430) = 2.2	6	4.5	6.1
C16	640	.005(640) = 3.2	8	4.0	5.6
C17	use 640	use 3.2	8	4.0	5.6
C18	1010	915 - 799 = 116	use 5	4.8	6.5
C19	400	830 - 804 = 26	use 5	4.8	6.5
C20**					

Ref 1, Fig 8.03g →

* see sheet 65 for culvert locations

** see sheet 55 for assessment of culvert C20

Marshall Steam Station
Dry Ash Landfill
Summary of Storm Drainage Culverts

Culvert Designation	Culvert Type	Sloped (3H : 1V) Drainage Area (Acres)	Berm/Flat Drainage Area (Acres)	Other Drainage Area (Acres)	Other Drainage Area C Value	Total Drainage Area (Acres)	Weighted C Value	Tc (minutes)	2-year storm			10-year storm		
									Intensity (in/hr)	Design Flow (cfs)	Approx. Velocity (fps)	Intensity (in/hr)	Design Flow (cfs)	Approx. Velocity (fps)
C1	1	0.00	2.52	0.00	0.00	2.5	0.25	7	4.1	2.6	11	5.9	3.7	12
C2*	1	1.40	2.84	0.00	0.00	4.2	0.33	7	4.1	5.8	14	5.9	8.3	15
C3*	2	3.13	3.27	0.00	0.00	6.4	0.37	7	4.1	9.8	16	5.9	14.1	17
C4	1	0.00	1.74	0.00	0.00	1.7	0.25	5	4.8	2.1	10	6.5	2.8	11
C5*	1	1.80	2.08	0.00	0.00	3.9	0.37	5	4.8	6.8	14	6.5	9.2	16
C6*	2	2.91	2.46	0.00	0.00	5.4	0.39	5	4.8	9.9	16	6.5	13.5	17
C7	1	1.97	0.34	0.00	0.00	2.3	0.46	5	4.8	5.1	13	6.5	7.0	14
C8	1	0.00	2.43	0.00	0.00	2.4	0.25	7	4.1	2.5	10	5.9	3.6	12
C9	1	1.53	2.75	0.00	0.00	4.3	0.34	7	4.1	6.0	14	5.9	8.6	15
C11*	1	4.54	2.94	0.67	0.40	8.2	0.40	7	4.1	13.4	17	5.9	19.3	19
C12	1	0.00	2.26	0.00	0.00	2.3	0.25	5	4.8	2.7	11	6.5	3.7	12
C13	1	1.60	2.53	0.00	0.00	4.1	0.35	5	4.8	6.9	14	6.5	9.3	16
C14*	1	2.37	2.84	0.00	0.00	5.2	0.36	5	4.8	9.1	15	6.5	12.3	17
C15	1	1.36	0.34	0.00	0.00	1.7	0.45	6	4.5	3.4	12	6.1	4.7	13
C16*	1	1.06	0.50	0.00	0.00	1.6	0.42	8	4.0	2.6	11	5.6	3.7	12
C17*	2	3.33	0.84	0.24	0.40	4.4	0.45	8	4.0	7.9	14	5.6	11.0	16
C18	3	2.90	0.34	0.30	0.40	3.5	0.47	5	4.8	7.9	5	6.5	10.8	6
C19*	5	0.47	0.00	0.30	0.40	0.8	0.46	5	4.8	1.7	5	6.5	2.3	6
C20	4	See sheet 55 for assessment of Culvert C20.												

Notes:
1. Culverts existing as of October, 1995 are designated with *.
2. Rational Method is used to estimate flows, Manning's equation is used to estimate velocities.
3. For sloped areas, use C value = 0.5 For flat areas, use C value = 0.25
4. Refer to table at right for Culvert Types:

Culvert Type	Size (inches)	Pipe Material	Slope (%)
1	24	CMP	33 (3H:1V)
2	30	CMP	33 (3H:1V)
3	24	CMP	2
4	48	CMP	0.5
5	24	CMP	7

Sheet 51
MPM 10/31/95

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type II Culvert (24" CMP S=33%)

Sheet 52
MLM 10/31/95

****INPUT DATA***

Units are English

Pipe Diameter = 24 (in for English units, mm for SI units)
Pipe Slope = .33 (ft/ft or meters/meter)
Manning's n value = .024

*****RESULTS*****

Depth of Flow (ft or meters)	Velocity of Flow (fps or mps)	Flow (cfs or cms)	Froude Number
0.050	3.65	0.08	3.52
0.100	5.76	0.34	3.91
0.150	7.48	0.80	4.14
0.200	8.99	1.47	4.29
0.250	10.34	2.34	4.40
0.300	11.58	3.42	4.49
0.350	12.72	4.70	4.55
0.400	13.78	6.16	4.59
0.450	14.77	7.82	4.63
0.500	15.70	9.64	4.65
0.550	16.57	11.64	4.66
0.600	17.39	13.78	4.66
0.650	18.16	16.08	4.66
0.700	18.89	18.51	4.64
0.750	19.57	21.06	4.63
0.800	20.21	23.72	4.60
0.850	20.82	26.48	4.57
0.900	21.38	29.32	4.54
0.950	21.91	32.23	4.50
1.000	22.41	35.20	4.46
1.050	22.86	38.20	4.41
1.100	23.29	41.23	4.35
1.150	23.68	44.26	4.29
1.200	24.03	47.29	4.23
1.250	24.35	50.29	4.15
1.300	24.63	53.24	4.08
1.350	24.88	56.13	4.00
1.400	25.09	58.93	3.91
1.450	25.26	61.63	3.81
1.500	25.40	64.19	3.71
1.550	25.49	66.59	3.59
1.600	25.54	68.81	3.47
1.650	25.54	70.80	3.33
1.700	25.49	72.53	3.18
1.750	25.37	73.96	3.01
1.800	25.19	75.02	2.82
1.850	24.92	75.63	2.59
1.900	24.53	75.64	2.30
1.950	23.95	74.74	1.89
2.000	22.41	70.41	0.11
2.050	22.41	70.41	0.11

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: [redacted]

Sheet 53
MPM 10/31/95

****INPUT DATA***

Units are English

Pipe Diameter = 30 (in for English units, mm for SI units)
Pipe Slope = .33 (ft/ft or meters/meter)
Manning's n value = .024

*****RESULTS*****

Depth of Flow (ft or meters)	Velocity of Flow (fps or mps)	Flow (cfs or cms)	Froude Number
0.063	4.24	0.14	3.65
0.125	6.68	0.61	4.06
0.188	8.68	1.45	4.29
0.250	10.43	2.66	4.45
0.313	12.00	4.25	4.57
0.375	13.44	6.20	4.66
0.438	14.76	8.52	4.72
0.500	15.99	11.18	4.77
0.563	17.14	14.17	4.80
0.625	18.22	17.48	4.82
0.688	19.23	21.10	4.83
0.750	20.18	24.99	4.84
0.813	21.07	29.15	4.83
0.875	21.92	33.56	4.82
0.938	22.71	38.18	4.80
1.000	23.46	43.01	4.78
1.063	24.16	48.01	4.75
1.125	24.81	53.16	4.71
1.188	25.43	58.44	4.67
1.250	26.00	63.81	4.62
1.313	26.53	69.26	4.57
1.375	27.02	74.75	4.52
1.438	27.47	80.26	4.45
1.500	27.88	85.75	4.39
1.563	28.25	91.18	4.31
1.625	28.58	96.54	4.23
1.688	28.87	101.78	4.15
1.750	29.11	106.86	4.05
1.813	29.32	111.74	3.95
1.875	29.47	116.38	3.85
1.938	29.58	120.74	3.73
2.000	29.63	124.75	3.60
2.063	29.63	128.37	3.46
2.125	29.57	131.51	3.30
2.188	29.44	134.10	3.13
2.250	29.23	136.03	2.92
2.313	28.92	137.12	2.69
2.375	28.47	137.14	2.39
2.438	27.79	135.51	1.96
2.500	26.00	127.63	0.01
2.563	26.00	127.63	0.01

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 3 Culvert 24"CMP S-23

Sheet 54
MPM 10/31/95

****INPUT DATA***

Units are English

Pipe Diameter = 24 (in for English units, mm for SI units)
Pipe Slope = .02 (ft/ft or meters/meter)
Manning's n value = .024

*****RESULTS*****

Depth of Flow (ft or meters)	Velocity of Flow (fps or mps)	Flow (cfs or cms)	Froude Number
0.050	0.90	0.02	0.87
0.100	1.42	0.08	0.96
0.150	1.84	0.20	1.02
0.200	2.21	0.36	1.06
0.250	2.55	0.58	1.08
0.300	2.85	0.84	1.10
0.350	3.13	1.16	1.12
0.400	3.39	1.52	1.13
0.450	3.64	1.92	1.14
0.500	3.86	2.37	1.14
0.550	4.08	2.86	1.15
0.600	4.28	3.39	1.15
0.650	4.47	3.96	1.15
0.700	4.65	4.56	1.14
0.750	4.82	5.18	1.14
0.800	4.98	5.84	1.13
0.850	5.12	6.52	1.13
0.900	5.26	7.22	1.12
0.950	5.39	7.93	1.11
1.000	5.52	8.66	1.10
1.050	5.63	9.40	1.08
1.100	5.73	10.15	1.07
1.150	5.83	10.90	1.06
1.200	5.92	11.64	1.04
1.250	5.99	12.38	1.02
1.300	6.06	13.11	1.00
1.350	6.12	13.82	0.98
1.400	6.18	14.51	0.96
1.450	6.22	15.17	0.94
1.500	6.25	15.80	0.91
1.550	6.28	16.39	0.88
1.600	6.29	16.94	0.85
1.650	6.29	17.43	0.82
1.700	6.27	17.86	0.78
1.750	6.25	18.21	0.74
1.800	6.20	18.47	0.69
1.850	6.14	18.62	0.64
1.900	6.04	18.62	0.57
1.950	5.90	18.40	0.46
2.000	5.52	17.33	0.03

Station / Location: Marshall Steam Station
Project: Ash Landfill
Description: Type 5 Culvert (24"CMP S=7%)

Sheet 54.1
MPM 10/31/95

****INPUT DATA***

Units are English

Pipe Diameter = 24 (in for English units, mm for SI units)
Pipe Slope = .07 (ft/ft or meters/meter)
Manning's n value = .024

*****RESULTS*****

Depth of Flow (ft or meters)	Velocity of Flow (fps or mps)	Flow (cfs or cms)	Froude Number
0.050	1.68	0.04	1.62
0.100	2.65	0.16	1.80
0.150	3.45	0.37	1.90
0.200	4.14	0.68	1.98
0.250	4.76	1.08	2.03
0.300	5.33	1.58	2.07
0.350	5.86	2.16	2.09
0.400	6.35	2.84	2.12
0.450	6.80	3.60	2.13
0.500	7.23	4.44	2.14
0.550	7.63	5.36	2.14
0.600	8.01	6.35	2.15
0.650	8.36	7.41	2.14
0.700	8.70	8.52	2.14
0.750	9.01	9.70	2.13
0.800	9.31	10.92	2.12
0.850	9.59	12.20	2.11
0.900	9.85	13.50	2.09
0.950	10.09	14.84	2.07
1.000	10.32	16.21	2.05
1.050	10.53	17.59	2.03
1.100	10.73	18.99	2.00
1.150	10.90	20.39	1.98
1.200	11.07	21.78	1.95
1.250	11.21	23.16	1.91
1.300	11.34	24.52	1.88
1.350	11.46	25.85	1.84
1.400	11.56	27.14	1.80
1.450	11.64	28.38	1.75
1.500	11.70	29.56	1.71
1.550	11.74	30.67	1.65
1.600	11.76	31.69	1.60
1.650	11.76	32.61	1.53
1.700	11.74	33.41	1.47
1.750	11.69	34.06	1.39
1.800	11.60	34.55	1.30
1.850	11.48	34.83	1.19
1.900	11.30	34.84	1.06
1.950	11.03	34.42	0.87
2.000	10.32	32.43	0.05

Culvert C-20

Culvert C-20 drains approximately 192 Acres (refer to next sheet)

In order to assess the capacity of culvert C-20, a 100year 24 hr storm will be routed through the drainage area. US Army Corps of Engineers Computer Program HEC-1 is used to perform the storm routing (ref attachment 1 for HEC-1 output).

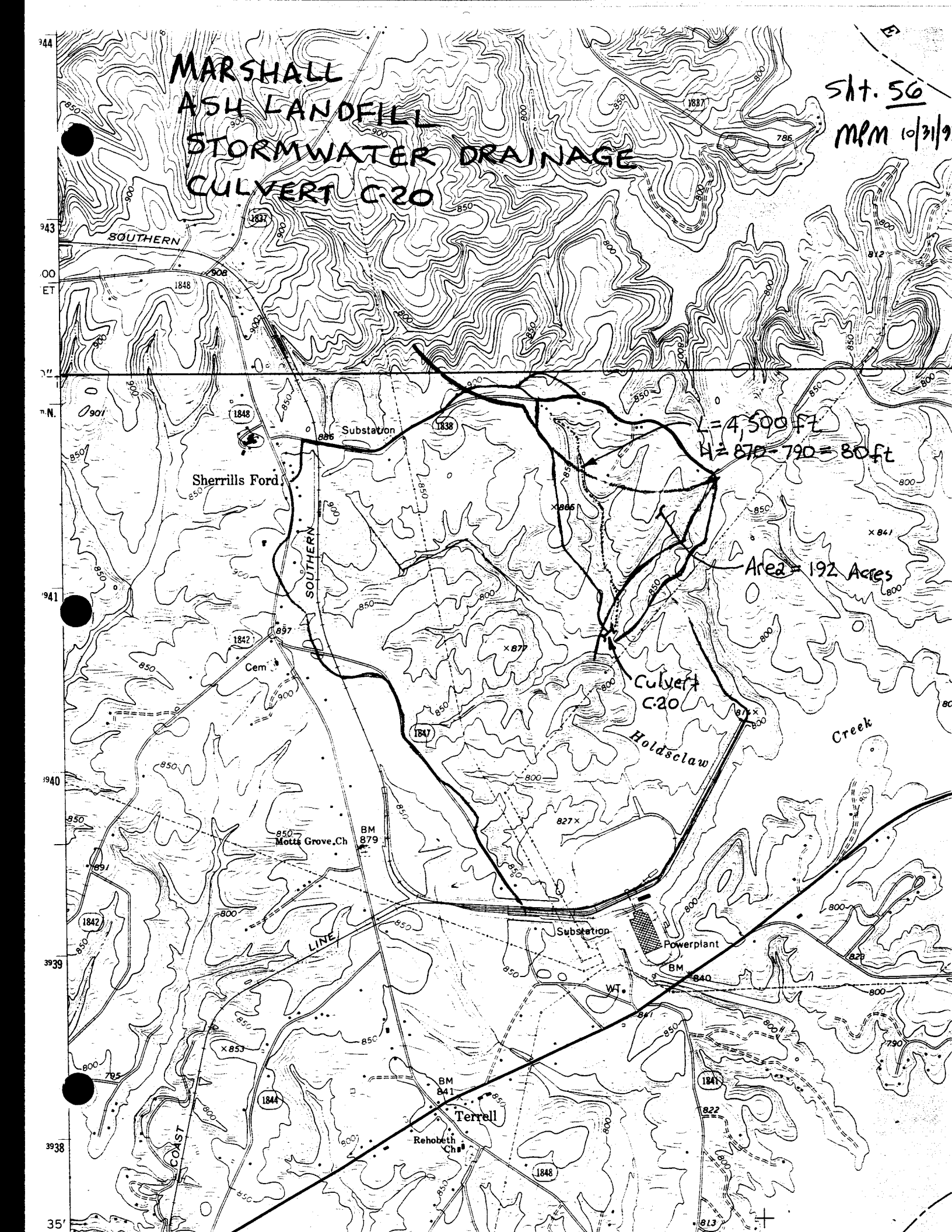
The following input is required for this particular analysis (refer to sheet 61 for HEC-1 input file) -

refer to sheet:

- Drainage Area and runoff Curve Number ——— 56, 57
- Precipitation Distribution ——— 58
- SCS Lag Time ——— 59
- Stage/Storage Relationship for Cove upstream of Culvert C-20 ——— 67
- Stage/Discharge Relationship for Culvert C-20 ——— 60

Results:

The Maximum Headwater Elev. reached is 797.1 ft which is approximately 8.6 ft above the inlet invert. Also, HW elev of 797.1' provides approx 3 ft of free board along haul road. This is acceptable.


MARSHALL
ASH LANDFILL
STORMWATER DRAINAGE
CULVERT C-20
Sht. 56
MPM 10/31/9
L=4,500 ft
H=870-790=80 ft
Area=192 Acres
Culvert
C-20
SOUTHERN
Substation
Sherrills Ford
Cem
Holdsclaw
Creek
Motts Grove Ch
BM
879
Powerplant
BM
840
WT
LINE
COAST
BM
841
Terrell
Rehobeth
Ch
1837
1848
1838
1842
1847
1844
1841
1848
850
800
900
790
812
813
822
823
827
866
877
897
901
908
786
853
795
891
944
943
941
940
939
938
35'

Marshall Steam Station
Estimate Volume of Runoff to Ash Basin for Various Rainfall Amounts

Area	Drainage Area (Acres)	SCS Curve Number	Runoff Volume (Acre-ft) 24-hr Rainfall (inches) 0.5	24-hr Rainfall (inches) 1.0	24-hr Rainfall (inches) 1.5	24-hr Rainfall (inches) 2.0	24-hr Rainfall (inches) 3.0	24-hr Rainfall (inches) 4.0	24-hr Rainfall (inches) 5.0	24-hr Rainfall (inches) 6.0	24-hr Rainfall (inches) 7.0	Drainage Area x Curve Number
Yard Sump #1 (@ coal transfer)	7.2	76	0.00	0.02	0.11	0.25	0.61	1.04	1.52	2.03	2.55	547.2
Yard Sump #2 (@ Unit 1 stack)	7.5	97	0.16	0.44	0.74	1.04	1.66	2.28	2.90	3.53	4.15	727.5
Coal Pile (inside loop track)	33.0	85	0.03	0.48	1.24	2.19	4.37	6.76	9.26	11.83	14.44	2805
Ash Pond	82.3	100	3.43	6.86	10.29	13.72	20.58	27.43	34.29	41.15	48.01	8230
Landfills	84.5	74	0.00	0.16	1.04	2.46	6.40	11.24	16.65	22.43	28.46	6253
Ash Basin Upstream of Pond	110.8	68	0.00	0.01	0.55	1.80	5.79	11.13	17.35	24.20	31.49	7534.4
Open Space NE of Ash Basin	65.1	69	0.00	0.01	0.39	1.18	3.63	6.87	10.62	14.72	19.06	4491.9
Wooded Areas NE of Ash Basin	27.0	60	0.00	0.00	0.01	0.14	0.75	1.71	2.93	4.32	5.86	1620
Wooded Areas West of Ash Basin	135.5	60	0.00	0.00	0.05	0.68	3.76	8.60	14.69	21.70	29.40	8130
Open Areas West of Ash Basin	240.0	69	0.00	0.04	1.42	4.34	13.39	25.33	39.15	54.25	70.28	16560
Remaining Wooded Areas	241.1	60	0.00	0.00	0.08	1.22	6.70	15.31	26.14	38.61	52.31	14466
Remaining Open Areas	160.7	69	0.00	0.03	0.95	2.90	8.97	16.96	26.21	36.33	47.06	11088.3
Total --->	1,194.7		3.6	8.1	16.9	31.9	76.6	134.7	201.7	275.1	353.1	82,453.3

Notes:
1. Natural drainage area of Ash Basin is approximately 1,180 acres. Yard Sumps 1 and 2 drain an additional 14.7 acres to the Ash Basin.
2. Average annual rainfall is approximately 49.0 inches.
3. Soils around Marshall Station are classified as Hydrologic Soil Group B (refer to Catawba County Soil Survey by USDA Soil Conservation Service).
4. Estimated runoff volume is calculated in accordance with SCS document TR-55.

Weighted Curve Number = 69

84.5Ac + 65.1 + 27.0 = 176.6Ac ≈ 192 Acres of Culvert C-20
These 3 areas approximately represent the 192 Acre drainage area of culvert C-20
Weighted Curve Number = [84.5(74) + 65.1(69) + 27.0(60)] / 176.6 = 70.0
use CN = 70

Sheet 57 MPM 4/14/95

Marshall Steam Station
Ordinates of SCS 24-hr, type II rainfall cumulative distribution

10 yr Storm → 100 yr Storm → MSBASIN3.XLS

Sht. 58
MPN
10/31/95

Time (hrs)	Ordinate Multiplier	24-hr Rainfall (in) 1.00	24-hr Rainfall (in) 2.00	24-hr Rainfall (in) 3.00	24-hr Rainfall (in) 4.00	24-hr Rainfall (in) 5.00	24-hr Rainfall (in) 6.00	24-hr Rainfall (in) 7.00	24-hr Rainfall (in) 10.00
0.0	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.005	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05
1.0	0.011	0.01	0.02	0.03	0.04	0.06	0.07	0.08	0.11
1.5	0.017	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.17
2.0	0.023	0.02	0.05	0.07	0.09	0.12	0.14	0.16	0.23
2.5	0.029	0.03	0.06	0.09	0.12	0.15	0.17	0.20	0.29
3.0	0.035	0.04	0.07	0.11	0.14	0.18	0.21	0.25	0.35
3.5	0.041	0.04	0.08	0.12	0.16	0.21	0.25	0.29	0.41
4.0	0.048	0.05	0.10	0.14	0.19	0.24	0.29	0.34	0.48
4.5	0.056	0.06	0.11	0.17	0.22	0.28	0.34	0.39	0.56
5.0	0.064	0.06	0.13	0.19	0.26	0.32	0.38	0.45	0.64
5.5	0.072	0.07	0.14	0.22	0.29	0.36	0.43	0.50	0.72
6.0	0.080	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.80
6.5	0.090	0.09	0.18	0.27	0.36	0.45	0.54	0.63	0.90
7.0	0.100	0.10	0.20	0.30	0.40	0.50	0.60	0.70	1.00
7.5	0.110	0.11	0.22	0.33	0.44	0.55	0.66	0.77	1.10
8.0	0.120	0.12	0.24	0.36	0.48	0.60	0.72	0.84	1.20
8.5	0.133	0.13	0.27	0.40	0.53	0.67	0.80	0.93	1.33
9.0	0.147	0.15	0.29	0.44	0.59	0.74	0.88	1.03	1.47
9.5	0.163	0.16	0.33	0.49	0.65	0.82	0.98	1.14	1.63
10.0	0.181	0.18	0.36	0.54	0.72	0.91	1.09	1.27	1.81
10.5	0.203	0.20	0.41	0.61	0.81	1.02	1.22	1.42	2.03
11.0	0.236	0.24	0.47	0.71	0.94	1.18	1.42	1.65	2.36
11.5	0.283	0.28	0.57	0.85	1.13	1.42	1.70	1.98	2.83
12.0	0.663	0.66	1.33	1.99	2.65	3.32	3.98	4.64	6.63
12.5	0.735	0.74	1.47	2.21	2.94	3.68	4.41	5.15	7.35
13.0	0.776	0.78	1.55	2.33	3.10	3.88	4.66	5.43	7.76
13.5	0.804	0.80	1.61	2.41	3.22	4.02	4.82	5.63	8.04
14.0	0.825	0.83	1.65	2.48	3.30	4.13	4.95	5.78	8.25
14.5	0.842	0.84	1.68	2.53	3.37	4.21	5.05	5.89	8.42
15.0	0.856	0.86	1.71	2.57	3.42	4.28	5.14	5.99	8.56
15.5	0.869	0.87	1.74	2.61	3.48	4.35	5.21	6.08	8.69
16.0	0.881	0.88	1.76	2.64	3.52	4.41	5.29	6.17	8.81
16.5	0.893	0.89	1.79	2.68	3.57	4.47	5.36	6.25	8.93
17.0	0.903	0.90	1.81	2.71	3.61	4.52	5.42	6.32	9.03
17.5	0.913	0.91	1.83	2.74	3.65	4.57	5.48	6.39	9.13
18.0	0.922	0.92	1.84	2.77	3.69	4.61	5.53	6.45	9.22
18.5	0.930	0.93	1.86	2.79	3.72	4.65	5.58	6.51	9.30
19.0	0.938	0.94	1.88	2.81	3.75	4.69	5.63	6.57	9.38
19.5	0.946	0.95	1.89	2.84	3.78	4.73	5.68	6.62	9.46
20.0	0.953	0.95	1.91	2.86	3.81	4.77	5.72	6.67	9.53
20.5	0.959	0.96	1.92	2.88	3.84	4.80	5.75	6.71	9.59
21.0	0.965	0.97	1.93	2.90	3.86	4.83	5.79	6.76	9.65
21.5	0.971	0.97	1.94	2.91	3.88	4.86	5.83	6.80	9.71
22.0	0.977	0.98	1.95	2.93	3.91	4.89	5.86	6.84	9.77
22.5	0.983	0.98	1.97	2.95	3.93	4.92	5.90	6.88	9.83
23.0	0.989	0.99	1.98	2.97	3.96	4.95	5.93	6.92	9.89
23.5	0.995	1.00	1.99	2.99	3.98	4.98	5.97	6.97	9.95
24.0	1.000	1.00	2.00	3.00	4.00	5.00	6.00	7.00	10.00

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit 1-4 Rev. 0 File No. Sheet 59 Of

Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

Prob No. Checked By Date

Culvert C20

Drainage Area = 192 Acres = 192/640 = 0.30 sq. miles

Use $C_N = 70$

Estimate Lag Time w/ SCS lag time equation -

$$t_l = L^{0.8}(S+1)^{.7} / 1900\sqrt{Y} \quad (hrs)$$

L = Hydraulic Length, ft = 4,500

S = Watershed retention factor = $(1000/C_N) - 10$

$= (1000/70) - 10 = 4.29$"

Y = Avg. watershed slope %

try $Y = \Delta H / L = (870-790)/4500 = 0.018$ ft/ft

$= 1.8\%$

use $Y = 4\%$ (conservative)

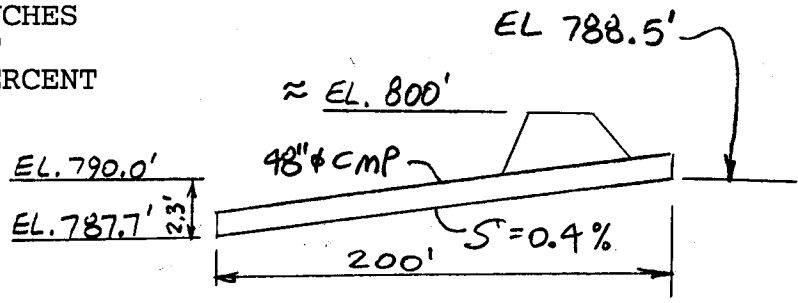
$$t_l = 4500^{.8}(4.29+1)^{.7} / 1900\sqrt{4}$$

$t_l =$ 0.71 hrs

MPM 10/31/95

****
***** *****
***** CULVERT RATING CURVE *****
***** CULVERT C20 *****
****

*** USER INPUT DATA ***
PIPE DIAMETER = 48.0 INCHES
PIPE LENGTH = 200.0 FEET
CULVERT SLOPE = .40 PERCENT
MANNING N-VALUE = .024
K-ENTRANCE = .50
ALLOWABLE HW = 15.0 FT
TAILWATER TW = 2.3 FT



*** PROGRAM OUTPUT ***

HW ELEV.	HEADWATER (FT)	TAILWATER (FT)	OUTFLOW (CFS)	CASE	CONTROL
788.5	.00	.00	0		
	1.71	2.30	10.00	2	OUTLET
	2.13	2.30	20.00	2	OUTLET
791.1	2.57	2.30	30.00	2	OUTLET
	2.96	2.30	40.00	2	OUTLET
791.8	3.34	2.30	50.00	2	OUTLET
	3.71	2.30	60.00	1	OUTLET
792.7	4.16*	2.30	70.00	1	OUTLET
	5.24*	2.30	80.00	6	OUTLET
794.4	5.87*	2.30	90.00	6	OUTLET
	6.57	2.30	100.00	6	OUTLET
795.9	7.35	2.30	110.00	6	OUTLET
	8.22	2.30	120.00	6	OUTLET
797.7	9.17	2.30	130.00	6	OUTLET
	10.20	2.30	140.00	6	OUTLET
799.8	11.33	2.30	150.00	6	OUTLET
	12.55	2.30	160.00	6	OUTLET
	13.85	2.30	170.00	6	OUTLET
	15.23	2.30	180.00	6	OUTLET

---

* indicates transition region from nonsubmerged to submerged inlet. Check these values as it may be necessary to smooth the data.

```
ID              Marshall Ash Landfill Stormwater Drainage
ID                  Design Storm:  7.0", 24 hr duration (100 yr storm)
ID                   Culvert C20:  48" diameter CMP
ID                 Input Filename:  MS100.IN
*[redacted]GRAM
*FREE
*
*   Time Specifications
IT  10   0   0  300  0   0
*
*   Output Control
IO  3   2
*
*   Time Specification
IN  30
*
*   Identify Culvert C20 Drainage Area Computation
KK  C20
*
*   Culvert C20 Drainage Area (sq mi)
BA  0.30
*
*   Cumulative Precipitation (in)
PB  0
PC    0.00    0.04    0.08    0.12    0.16    0.20    0.25    0.29    0.34
PC    0.39    0.45    0.50    0.56    0.63    0.70    0.77    0.84    0.93
PC    1.03    1.14    1.27    1.42    1.65    1.98    4.64    5.15    5.43
PC    5.63    5.78    5.89    5.99    6.08    6.17    6.25    6.32    6.39
PC    6.45    6.51    6.57    6.62    6.67    6.71    6.76    6.80    6.84
P[redacted]   6.88    6.92    6.97    7.00
*
*   Specify Loss Rate Data (Use CN = 70)
LS  0  70  0
*
*   SCS Lag Time (hrs)
UD  0.71
*
*   Identify Cove of Culvert C20 Storage and Discharge Rating Computation
KK  DISC1
KM  Route Flow Thru Culvert C20
*
*   Culvert C20 Routing Data
*
*   Specify Initial Conditions in Cove
RS  1  ELEV  790.0  0
*
*   Specify Culvert C20 Cove Area (Ac) & Elevation (ft) Data
SA    0.0   0.05    0.97     5.8    11.1    16.4
SE  790.0  792.0   794.0   796.0   798.0   800.0
*
*   Specify Culvert C20 Discharge (cfs) & Elevation (ft) Data
*   Use Tailwater Elev in Ash Basin = 790.0 ft.
*
SQ   0.0   30.0   50.0   70.0   90.0  110.0  130.0  150.0
SE 788.5  791.1  791.8  792.7  794.4  795.9  797.7  799.8
Z[redacted]
```

MPM 10/31/95

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit Rev. File No. Sheet 62 Of

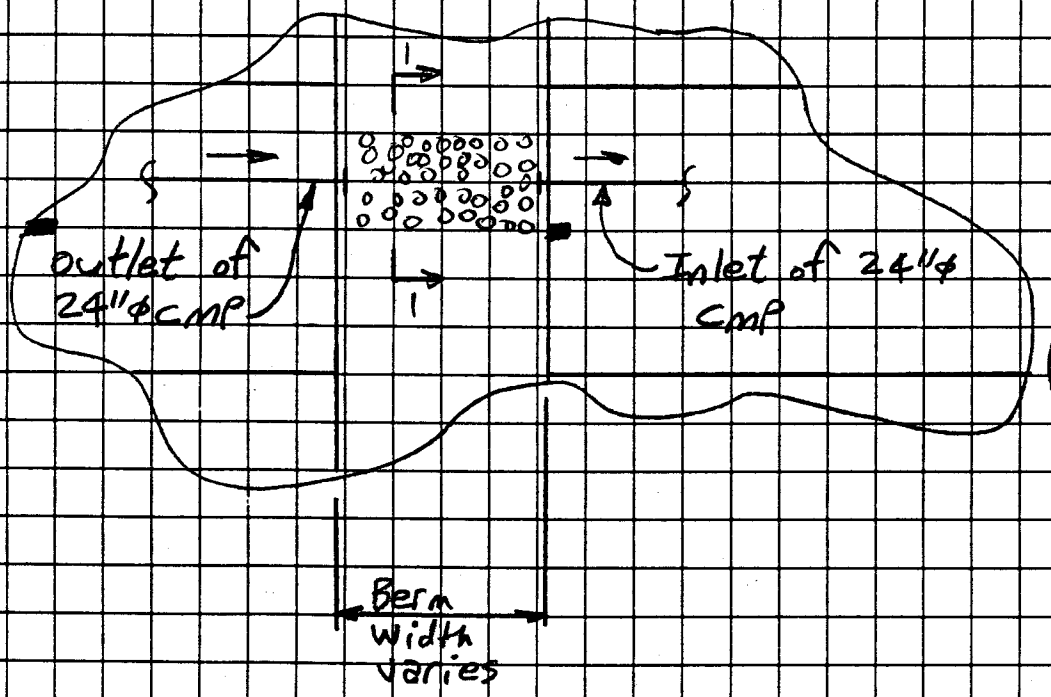
Subject Ash Landfill - Stormwater Drainage

By MPM Date 10/31/95

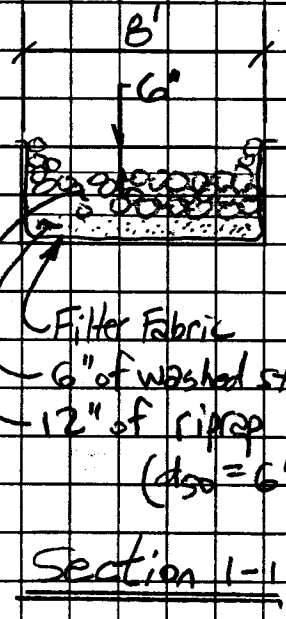
Prob No. Checked By Date

Outlet Stabilization Apron - Type 1

Type 1 outlet stabilization Apron is applicable for the outlet end of culverts C1, C2, C4, C5, C8, C9, C12, C13, C16



PLAN



Section 1-1

$Q_{2\ max}$ = 6.9 cfs, $V_{2\ max}$ = 14 fps
$Q_{10\ max}$ = 9.3 cfs, $V_{10\ max}$ = 16 fps
} culvert C-13, see sht. 51

- Per ref 1, Appendix 8.06 → use minimum tailwater conditions
- Per Fig. 8.06a, use d_{50} = 0.5 ft = 6"
- Flow will be channelized in order to route discharge to inlet of next culvert

Form 00184 (R4-88)

DUKE POWER COMPANY

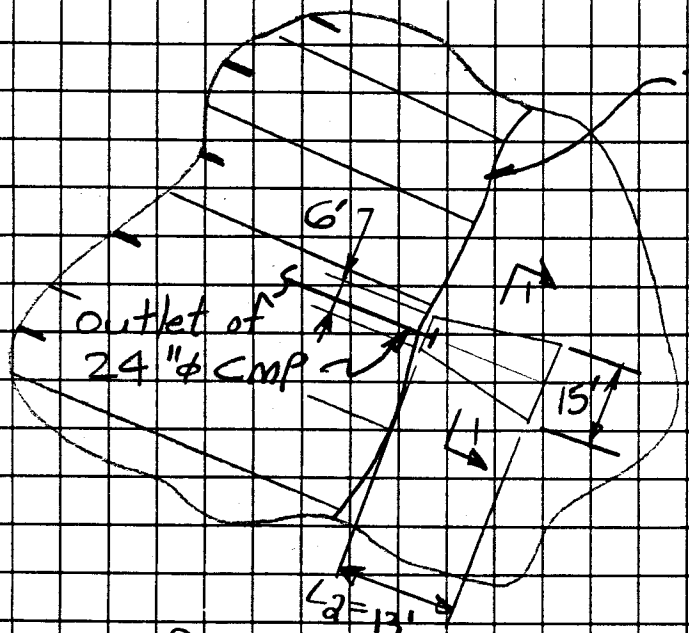
Station Marshall Unit Rev. File No. Sheet 63 Of

Subject Ash Landfill - Stormwater Drainage

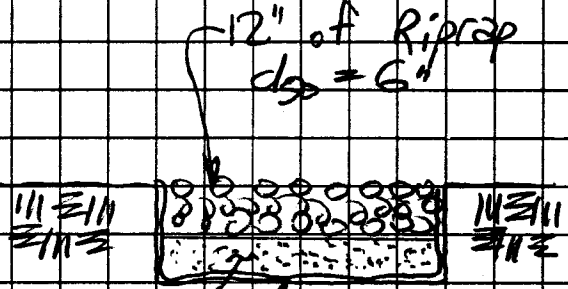
By MPM Date 10/31/95

Prob No. Checked By Date

Outlet Stabilization Apron - Type 2 - applicable for outlet of culvert C7, C19



PLAN



Section 1-1

Q_2 = 5.1 cfs V_2 = 13 fps
Q_{10} = 7.0 cfs V_{10} = 14 fps
} see sheet 51, culvert C7

- Per ref. 1, Appendix 8.05g - use minimum Tailwater conditions -
- Per Fig. 8.06 G.2, use d_{50} = 0.5' = 6"
  use L_2 = 13 ft as shown above

Form 00184 (R4-88)

DUKE POWER COMPANY

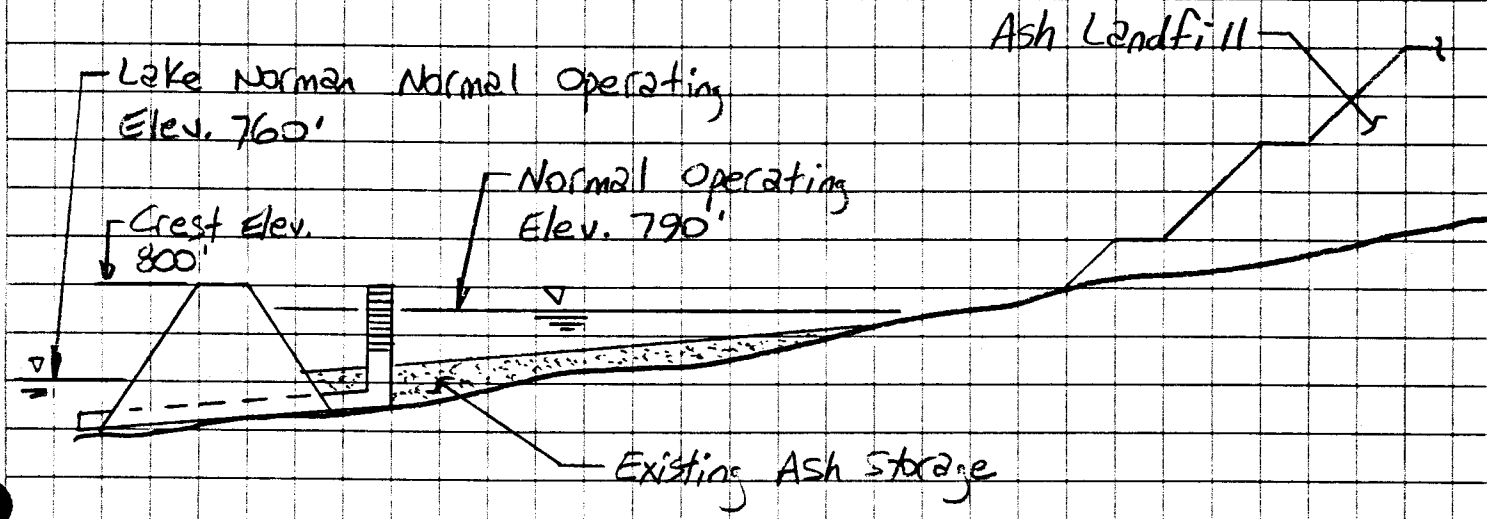
Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 67 Of ____

Subject Ash Landfill

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Determine Sediment Storage Capacity of Existing Sediment Pond (Ash Basin) -



Cross Section - Marshall Ash Landfill and Ash Basin

Note: Cross Section above is not to scale and is intended to be a schematic only

A physical survey of the ash basin (including underwater areas) was performed in February, 1994. The results of the survey are shown in graphical form on sheet 73. At the normal operating level of the Ash Basin, approximately 986.8 Ac-ft of storage was available as of 2/2/94 (time of survey). For the time period of 2/94 → 9/30/95, 41,200 tons of ash have been sluiced to the Ash Basin

$$41{,}200 \times \frac{2000\,lbs}{ton} \times \frac{1\,ft^3}{55\,lbs} \times \frac{1\,Acre}{43560\,ft^2} = 34.4\ Ac\text{-}ft$$

Form 00184 (R4-88)

DUKE POWER COMPANY

Station Marshall Unit ____ Rev. ____ File No. ____ Sheet 68 Of ____

Subject Ash Landfill

By MPM Date 10/31/95

Prob No. ____ Checked By ____ Date ____

Determine Sediment Storage Capacity of Existing Sediment Pond (Ash Basin) -

For the years 1990 thru 1994, the average annual quantity of ash sluiced to the ash basin has been approximately 27,000 tons. Use this figure to estimate future ash to basin. This should be conservative since an ash reclaim operation has been established which will reduce the ash to basin rate.

786.8 Ac-ft		storage available 2/2/94
- 34.4 Ac-ft		ash to basin 2/94 - 9/30/95
- 5.6 Ac-ft		projected ash to basin 10/1/95-12/31/95
5yrs @ 22.6Ac-ft/yr =	- 113.2 Ac-ft	projected ash to basin: 1996-2000
	833.6 Ac-ft	projected storage available at end of yr 2000

The "footprint" of the ash landfill covers approximately 46 acres. Conservatively estimate potential sediment yield using entire 46 acres.

Potential Sediment yield = 1800 ft³/acre
= 1800 (46)
= 82,800 ft³
= 1.9 Ac-ft

1.9 Ac-ft << projected storage capacity of Ash Basin at year end 2000 = 833.6 Ac-ft

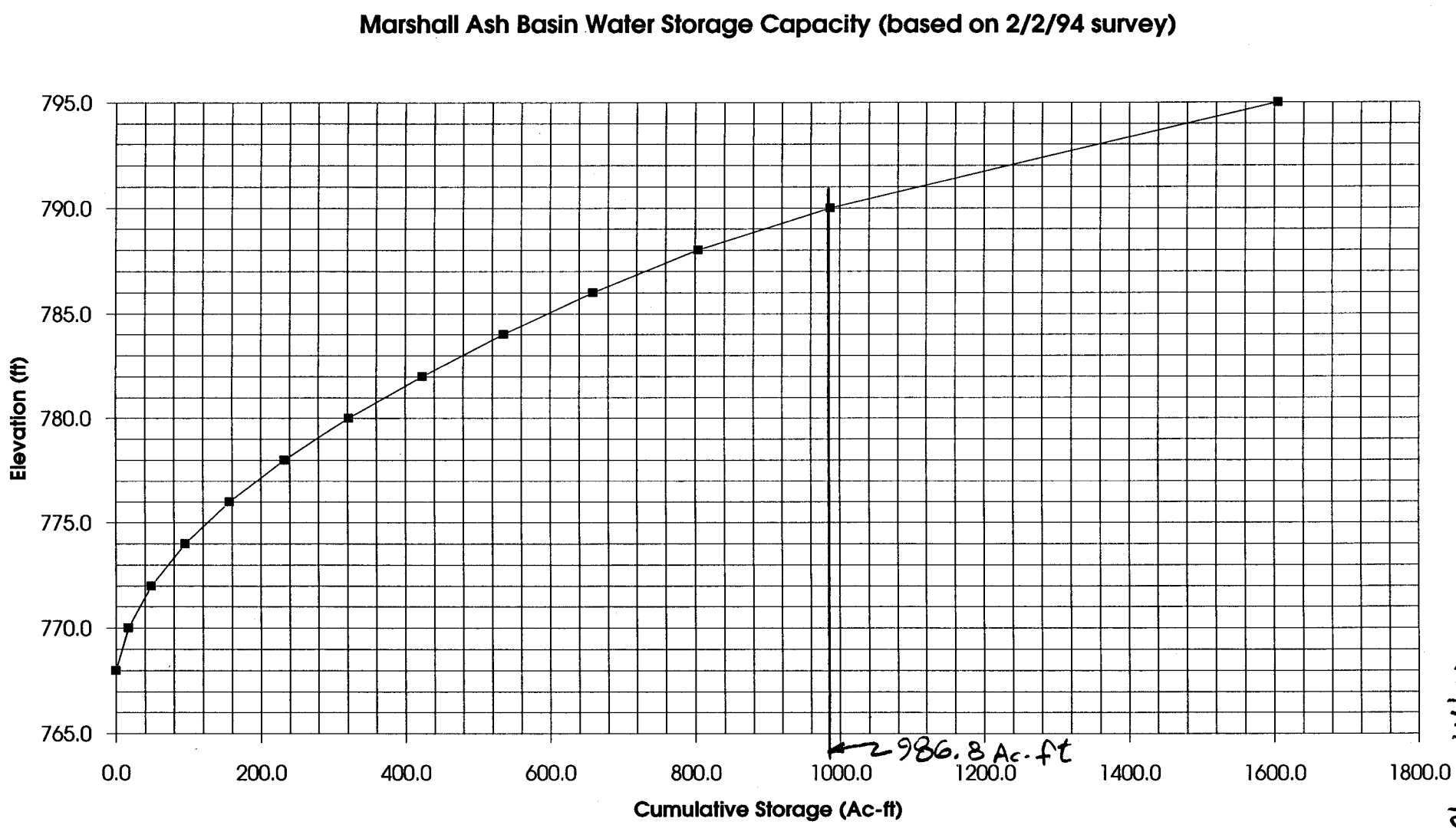
projected life of landfill

∴ Existing sediment pond (ash basin) is adequate for projected sediment yield

Sheet 69
MM 10/31/95

Marshall Steam Station
Ash Basin Stage - Storage Data
(Water Storage Capacity Based on 2/2/94 Physical Survey)

Elevation (ft)	Area (Ac)	Height (ft)	Incremental Storage (Ac - ft)	Cumulative Storage (Ac - ft)
768.0	4.9		0.0	0.0
		2.0		
770.0	12.4		17.3	17.3
		2.0		
772.0	19.5		31.9	49.1
		2.0		
774.0	27.0		46.5	95.6
		2.0		
776.0	34.6		61.6	157.2
		2.0		
778.0	41.2		75.8	233.0
		2.0		
780.0	48.1		89.3	322.2
		2.0		
782.0	53.5		101.6	423.8
		2.0		
784.0	58.4		111.9	535.8
		2.0		
786.0	65.2		123.6	659.4
		2.0		
788.0	80.2		145.4	804.8
		2.0		
790.0	101.8		182.0	986.8
		5.0		
795.0	145.4		618.0	1604.8



Sheet 70
MPM 10/31/95

Marshall Ash Landfill
Appendix 1 p. 1 of 13

1 ****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

1 HEC-1 INPUT PAGE 1

```
      LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

        1           ID              Marshall Ash Landfill Stormwater Drainage
        2           ID                  Design Storm:  7.0", 24 hr duration (100 yr storm)
        3           ID                   Culvert C20:  48" diameter CMP
        4           ID                Input Filename:  MS100.IN
                    *DIAGRAM
*** FREE ***
                    *
                    *   Time Specifications
        5           IT     10       0       0     300       0       0
                    *
                    *   Output Control
        6           IO      3       2
                    *
                    *   Time Specification
        7           IN     30
                    *
                    *   Identify Culvert C20 Drainage Area Computation

        8           KK    C20
                    *
                    *   Culvert C20 Drainage Area (sq mi)
        9           BA   0.30
                    *
                    *   Cumulative Precipitation (in)
       10           PB      0
       11           PC   0.00   0.04   0.08   0.12   0.16   0.20   0.25   0.29   0.34   0.39
       12           PC   0.45   0.50   0.56   0.63   0.70   0.77   0.84   0.93   1.03   1.14
       13           PC   1.27   1.42   1.65   1.98   4.64   5.15   5.43   5.63   5.78   5.89
       14           PC   5.99   6.08   6.17   6.25   6.32   6.39   6.45   6.51   6.57   6.62
       15           PC   6.67   6.71   6.76   6.80   6.84   6.88   6.92   6.97   7.00
                    *
                    *   Specify Loss Rate Data (Use CN = 70)
       16           LS      0     70       0
                    *
                    *   SCS Lag Time (hrs)
       17           UD   0.71
                    *
                    *   Identify Cove of Culvert C20 Storage and Discharge Rating Computation

       18           KK   DISC1
       19           KM    Route Flow Thru Culvert C20
                    *
                    *   Culvert C20 Routing Data
                    *
                    *   Specify Initial Conditions in Cove
       20           RS      1    ELEV   790.0       0
                    *
                    *   Specify Culvert C20 Cove Area (Ac) & Elevation (ft) Data
       21           SA    0.0    0.05   0.97    5.8    11.1    16.4
       22           SE  790.0   792.0  794.0   796.0   798.0   800.0
                    *
                    *   Specify Culvert C20 Discharge (cfs) & Elevation (ft) Data
                    *   Use Tailwater Elev in Ash Basin = 790.0 ft.
                    *
       23           SQ    0.0   30.0   50.0   70.0   90.0   110.0   130.0   150.0
```

Marshall Ash Landfill
Appendix 1 p. 2 of 13

```
1                                                HEC-1 INPUT                                                PAGE  2

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            24          SE   788.5   791.1   791.8   792.7   794.4   795.9   797.7   799.8
            25          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     8        C20
               V
               V
    18       DISC1

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1                                                                    ****
                                FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
                U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
                                                                    ****



                                        Marshall Ash Landfill Stormwater Drainage
                                           Design Storm:  7.0", 24 hr duration (100 yr storm)
                                            Culvert C20:  48" diameter CMP
                                          Input Filename:  MS100.IN

    6 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           2  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          10  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        0150  ENDING TIME

                   COMPUTATION INTERVAL     .17 HOURS
                        TOTAL TIME BASE   49.83 HOURS

          ENGLISH UNITS


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
    8 KK    *      C20   *
            *            *
            **************

    7 IN          TIME DATA FOR INPUT TIME SERIES
                        JXMIN          30  TIME INTERVAL IN MINUTES
                       JXDATE      1    0  STARTING DATE
                       JXTIME           0  STARTING TIME

                SUBBASIN RUNOFF DATA

    9 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .30  SUBBASIN AREA

                  PRECIPITATION DATA

   10 PB                STORM        7.00  BASIN TOTAL PRECIPITATION
```

11 PI INCREMENTAL PRECIPITATION PATTERN

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.02	.02	.02	.01	.01
.01	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.03	.03
.03	.03	.03	.03	.04	.04	.04	.04	.04	.04
.05	.05	.05	.08	.08	.08	.11	.11	.11	.89
.89	.89	.17	.17	.17	.09	.09	.09	.07	.07
.07	.05	.05	.05	.04	.04	.04	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.01	.01	.01	.02	.02	.02	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.02	.02
.02	.01	.01	.01						

16 LS SCS LOSS RATE

STRTL	.86	INITIAL ABSTRACTION
CRVNBR	70.00	CURVE NUMBER
RTIMP	.00	PERCENT IMPERVIOUS AREA

17 UD SCS DIMENSIONLESS UNITGRAPH

TLAG	.71	LAG

***

UNIT HYDROGRAPH
23 END-OF-PERIOD ORDINATES

20.	63.	130.	174.	182.	162.	130.	88.	61.	44.
32.	22.	16.	11.	8.	6.	4.	3.	2.	2.
1.	1.	0.							

*** *** *** *** ***

HYDROGRAPH AT STATION C20

TOTAL RAINFALL = 7.00, TOTAL LOSS = 3.38, TOTAL EXCESS = 3.62

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	49.83-HR
+	(CFS)	(HR)				
			(CFS)			
+	307.	12.50	94.	29.	14.	14.
			(INCHES) 2.921	3.618	3.618	3.618
			(AC-FT) 47.	58.	58.	58.

CUMULATIVE AREA = .30 SQ MI

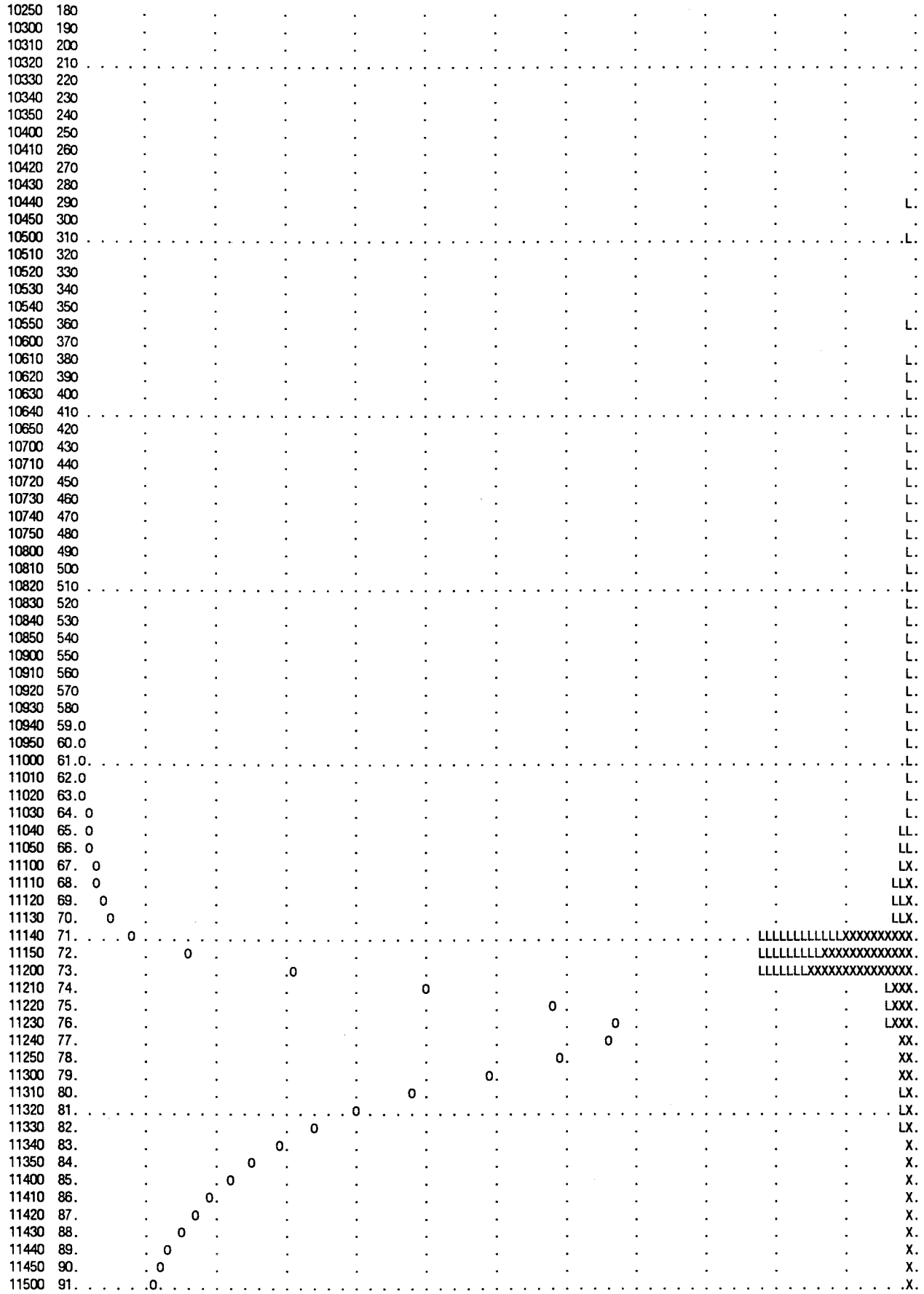
1 STATION C20

(O) OUTFLOW

0.	40.	80.	120.	160.	200.	240.	280.	320.	0.	0.	0.	0.
										(L) PRECIP,	(X) EXCESS	
.0	.0	.0	.0	.0	.0	.0	.0	.0	1.2	.8	.4	.0

DAHRMN PER

10000	10	---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
10010	20	. . . . .
10020	30	. . . . .
10030	40	. . . . .
10040	50	. . . . .
10050	60	. . . . .
10100	70	. . . . .
10110	80	. . . . .
10120	90	. . . . .
10130	100	. . . . .
10140	110	. . . . .
10150	120	. . . . .
10200	130	. . . . .
10210	140	. . . . .
10220	150	. . . . .
10230	160	. . . . .
10240	170	. . . . .


10250 180
10300 190
10310 200
10320 210
10330 220
10340 230
10350 240
10400 250
10410 260
10420 270
10430 280
10440 290
10450 300
10500 310
10510 320
10520 330
10530 340
10540 350
10550 360
10600 370
10610 380
10620 390
10630 400
10640 410
10650 420
10700 430
10710 440
10720 450
10730 460
10740 470
10750 480
10800 490
10810 500
10820 510
10830 520
10840 530
10850 540
10900 550
10910 560
10920 570
10930 580
10940 59.0
10950 60.0
11000 61.0
11010 62.0
11020 63.0
11030 64. 0
11040 65. 0
11050 66. 0
11100 67. 0
11110 68. 0
11120 69. 0
11130 70. 0
11140 71. 0
11150 72. 0
11200 73. 0
11210 74. 0
11220 75. 0
11230 76. 0
11240 77. 0
11250 78. 0
11300 79. 0
11310 80. 0
11320 81. 0
11330 82. 0
11340 83. 0
11350 84. 0
11400 85. 0
11410 86. 0
11420 87. 0
11430 88. 0
11440 89. 0
11450 90. 0
11500 91. 0

```
11510  92.          0                                                                                                  X.
11520  93.         0.                                                                                                  X.
11530  94.         0.                                                                                                  X.
11540  95.        0 .                                                                                                  X.
11550  96.        0 .                                                                                                  X.
11600  97.        0 .                                                                                                  X.
11610  98.       0  .                                                                                                  X.
11620  99.       0  .                                                                                                  X.
11630 100.       0  .                                                                                                  X.
11640 101. . . .0. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .L.
11650 102.       0  .                                                                                                  L.
11700 103.      0   .                                                                                                  L.
11710 104.      0   .                                                                                                  L.
11720 105.      0   .                                                                                                  L.
11730 106.      0   .                                                                                                  L.
11740 107.      0   .                                                                                                  .
11750 108.      0   .                                                                                                  .
11800 109.     0    .                                                                                                  .
11810 110.     0    .                                                                                                  .
11820 111. . .0. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .L.
11830 112.     0    .                                                                                                  .
11840 113.     0    .                                                                                                  .
11850 114.     0    .                                                                                                  .
11900 115.     0    .                                                                                                  .
11910 116.     0    .                                                                                                  .
11920 117.     0    .                                                                                                  .
11930 118.     0    .                                                                                                  .
11940 119.    0     .                                                                                                  .
11950 120.    0     .                                                                                                  .
12000 121. . 0 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
12010 122.    0     .                                                                                                  .
12020 123.    0     .                                                                                                  .
12030 124.    0     .                                                                                                  .
12040 125.    0     .                                                                                                  .
12050 126.    0     .                                                                                                  .
12100 127.    0     .                                                                                                  .
12110 128.    0     .                                                                                                  .
12120 129.    0     .                                                                                                  .
12130 130.    0     .                                                                                                  .
12140 131. . 0 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
12150 132.    0     .                                                                                                  .
12200 133.   0      .                                                                                                  .
12210 134.   0      .                                                                                                  .
12220 135.   0      .                                                                                                  .
12230 136.   0      .                                                                                                  .
12240 137.   0      .                                                                                                  .
12250 138.   0      .                                                                                                  .
12300 139.   0      .                                                                                                  .
12310 140.   0      .                                                                                                  .
12320 141. .0. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
12330 142.   0      .                                                                                                  .
12340 143.   0      .                                                                                                  .
12350 144.   0      .                                                                                                  .
20000 145.   0      .                                                                                                  .
20010 146.   0      .                                                                                                  .
20020 147.   0      .                                                                                                  .
20030 148.  0       .                                                                                                  .
20040 149.  0       .                                                                                                  .
20050 150.0         .                                                                                                  .
20100 151.0. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
20110 152.0         .                                                                                                  .
20120 153.0         .                                                                                                  .
20130 1540          .                                                                                                  .
20140 1550          .                                                                                                  .
20150 1560          .                                                                                                  .
20200 1570          .                                                                                                  .
20210 1580          .                                                                                                  .
20220 1590          .                                                                                                  .
20230 1600          .                                                                                                  .
20240 1610 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
20250 1620          .                                                                                                  .
20300 1630          .                                                                                                  .
20310 1640          .                                                                                                  .
20320 1650          .                                                                                                  .
```

20330 1660
20340 1670
20350 1680
20400 1690
20410 1700
20420 1710
20430 1720
20440 1730
20450 1740
20500 1750
20510 1760
20520 1770
20530 1780
20540 1790
20550 1800
20600 1810
20610 1820
20620 1830
20630 1840
20640 1850
20650 1860
20700 1870
20710 1880
20720 1890
20730 1900
20740 1910
20750 1920
20800 1930
20810 1940
20820 1950
20830 1960
20840 1970
20850 1980
20900 1990
20910 2000
20920 2010
20930 2020
20940 2030
20950 2040
21000 2050
21010 2060
21020 2070
21030 2080
21040 2090
21050 2100
21100 2110
21110 2120
21120 2130
21130 2140
21140 2150
21150 2160
21200 2170
21210 2180
21220 2190
21230 2200
21240 2210
21250 2220
21300 2230
21310 2240
21320 2250
21330 2260
21340 2270
21350 2280
21400 2290
21410 2300
21420 2310
21430 2320
21440 2330
21450 2340
21500 2350
21510 2360
21520 2370
21530 2380
21540 2390

Marshall Ash Landfill
Appendix 1 p. 7 of 13

```
21550 2400
21600 2410
21610 2420
21620 2430
21630 2440
21640 2450
21650 2460
21700 2470
21710 2480
21720 2490
21730 2500
21740 2510
21750 2520
21800 2530
21810 2540
21820 2550
21830 2560
21840 2570
21850 2580
21900 2590
21910 2600
21920 2610
21930 2620
21940 2630
21950 2640
22000 2650
22010 2660
22020 2670
22030 2680
22040 2690
22050 2700
22100 2710
22110 2720
22120 2730
22130 2740
22140 2750
22150 2760
22200 2770
22210 2780
22220 2790
22230 2800
22240 2810
22250 2820
22300 2830
22310 2840
22320 2850
22330 2860
22340 2870
22350 2880
30000 2890
30010 2900
30020 2910
30030 2920
30040 2930
30050 2940
30100 2950
30110 2960
30120 2970
30130 2980
30140 2990
30150 3000
1

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
 18 KK    *    DISC1   *
          *            *
          **************
```

Route Flow Thru Culvert C20

Marshall Ash Landfill
Appendix 1 p. 8 of 13

HYDROGRAPH ROUTING DATA

```
20 RS        STORAGE ROUTING
                  NSTPS          1  NUMBER OF SUBREACHES
                   ITYP       ELEV  TYPE OF INITIAL CONDITION
                 RSVRIC     790.00  INITIAL CONDITION
                      X        .00 WORKING R AND D COEFFICIENT

21 SA           AREA          .0       .1       1.0       5.8      11.1      16.4

22 SE        ELEVATION     790.00   792.00   794.00   796.00   798.00   800.00

23 SQ        DISCHARGE         0.      30.      50.      70.      90.     110.     130.     150.

24 SE        ELEVATION     788.50   791.10   791.80   792.70   794.40   795.90   797.70   799.80
```

***

COMPUTED STORAGE-ELEVATION DATA

```
      STORAGE       .00      .03      .86     6.95    23.57    50.90
    ELEVATION    790.00   792.00   794.00   796.00   798.00   800.00
```

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

```
      STORAGE       .00      .00      .01      .02      .03      .13      .86     1.37     6.39     6.95
      OUTFLOW       .00    17.31    30.00    50.00    54.44    70.00    85.29    90.00   110.00   111.11
    ELEVATION    788.50   790.00   791.10   791.80   792.00   792.70   794.00   794.40   795.90   796.00

      STORAGE     20.38    23.57    47.68    50.90
      OUTFLOW    130.00   132.86   150.00   151.90
    ELEVATION    797.70   798.00   799.80   800.00
```

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 0. TO 70.
THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

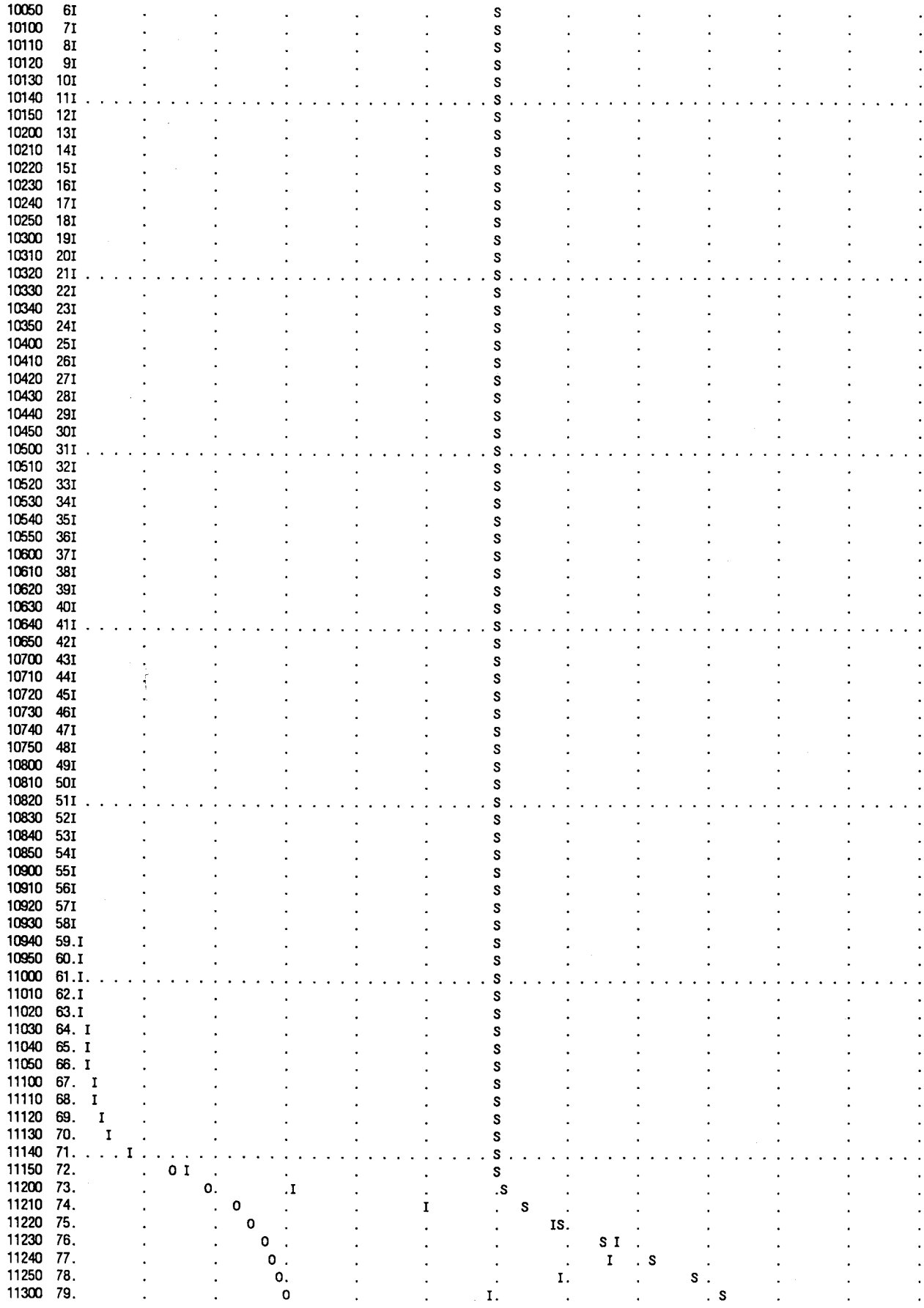
*** *** *** *** ***

HYDROGRAPH AT STATION DISC1

```
 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     49.83-HR
+  (CFS)       (HR)
                          (CFS)
+    123.     13.67                  94.         29.         14.         14.
                       (INCHES)    2.921       3.619       3.626       3.626
                        (AC-FT)      47.         58.         58.         58.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR     49.83-HR
+  (AC-FT)      (HR)
      15.     13.67                   7.          2.          1.          1.

 PEAK STAGE     TIME                          MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR     49.83-HR
+  (FEET)       (HR)
   797.08     13.67                794.95      790.60      789.51      789.51
```

CUMULATIVE AREA = .30 SQ MI

```
1                                                    STATION    DISC1

                      (I) INFLOW,   (O) OUTFLOW
        0.      40.      80.     120.     160.     200.     240.     280.     320.       0.       0.       0.       0.
                                                                          (S) STORAGE
        0.       0.       0.       0.       0.       0.       0.       4.       8.      12.      16.       0.       0.
DAHRMN PER
 10000  1I---O-----.---------.---------.---------.---------.---------S---------.---------.---------.---------.---------.---------.
 10010  2I        .         .         .         .         .         S         .         .         .         .         .         .
 10020  3I        .         .         .         .         .         S         .         .         .         .         .         .
 10030  4I        .         .         .         .         .         S         .         .         .         .         .         .
 10040  5I        .         .         .         .         .         S         .         .         .         .         .         .
```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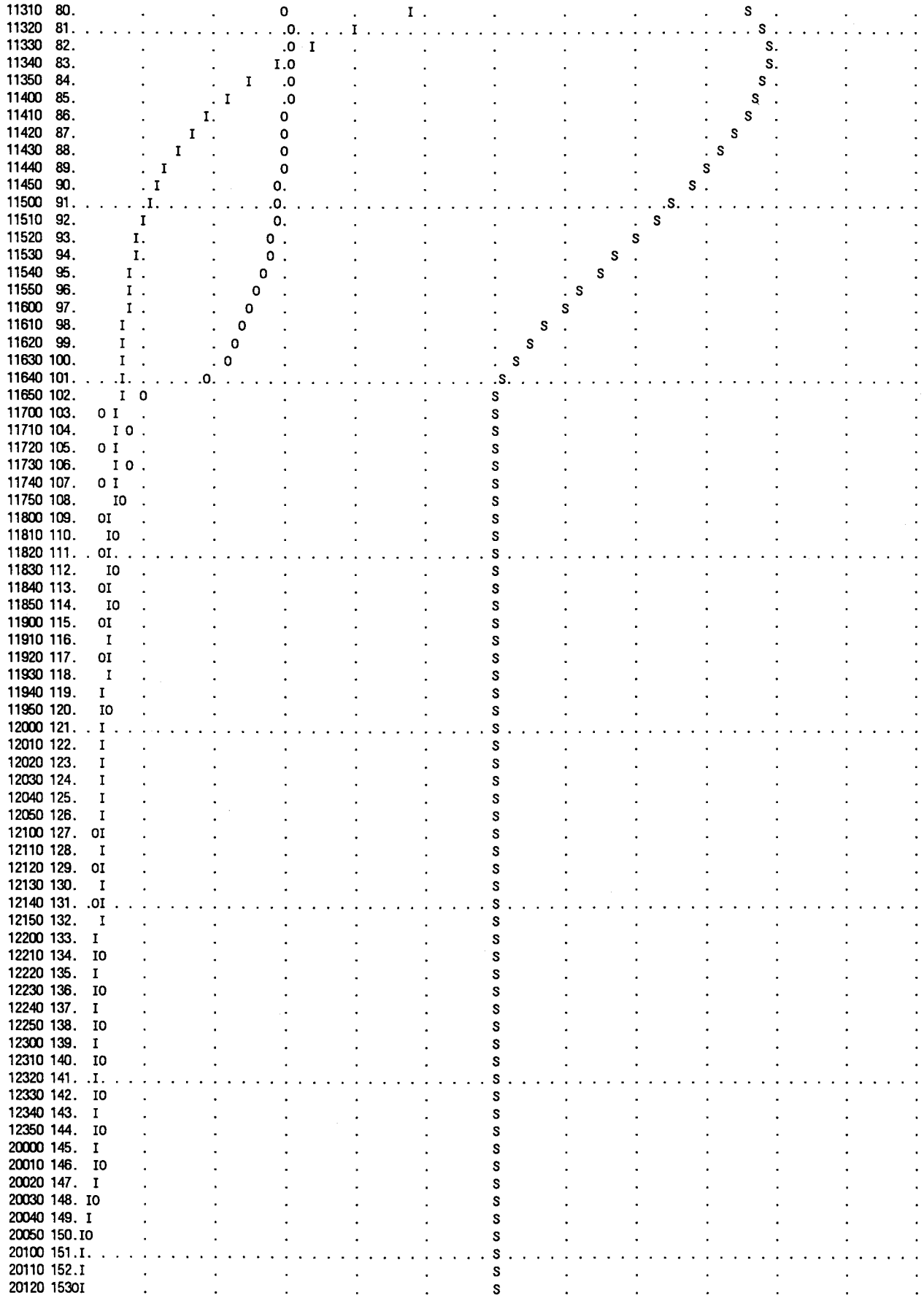
10240 17I
10250 18I
10300 19I
10310 20I
10320 21I
10330 22I
10340 23I
10350 24I
10400 25I
10410 26I
10420 27I
10430 28I
10440 29I
10450 30I
10500 31I
10510 32I
10520 33I
10530 34I
10540 35I
10550 36I
10600 37I
10610 38I
10620 39I
10630 40I
10640 41I
10650 42I
10700 43I
10710 44I
10720 45I
10730 46I
10740 47I
10750 48I
10800 49I
10810 50I
10820 51I
10830 52I
10840 53I
10850 54I
10900 55I
10910 56I
10920 57I
10930 58I
10940 59.I
10950 60.I
11000 61.I
11010 62.I
11020 63.I
11030 64. I
11040 65. I
11050 66. I
11100 67. I
11110 68. I
11120 69. I
11130 70. I
11140 71. I
11150 72. O I
11200 73. O. I
11210 74. O I S
11220 75. O IS.
11230 76. O S I
11240 77. O I S
11250 78. O. I. S
11300 79. O I. S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11320 81.
11330 82.
11340 83.
11350 84.
11400 85.
11410 86.
11420 87.
11430 88.
11440 89.
11450 90.
11500 91.
11510 92.
11520 93.
11530 94.
11540 95.
11550 96.
11600 97.
11610 98.
11620 99.
11630 100.
11640 101.
11650 102.
11700 103.
11710 104.
11720 105.
11730 106.
11740 107.
11750 108.
11800 109.
11810 110.
11820 111.
11830 112.
11840 113.
11850 114.
11900 115.
11910 116.
11920 117.
11930 118.
11940 119.
11950 120.
12000 121.
12010 122.
12020 123.
12030 124.
12040 125.
12050 126.
12100 127.
12110 128.
12120 129.
12130 130.
12140 131.
12150 132.
12200 133.
12210 134.
12220 135.
12230 136.
12240 137.
12250 138.
12300 139.
12310 140.
12320 141.
12330 142.
12340 143.
12350 144.
20000 145.
20010 146.
20020 147.
20030 148.
20040 149.
20050 150.
20100 151.
20110 152.
20120 153

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20130 154IO . . . . . S . . . . . .
20140 155I  . . . . . S . . . . . .
20150 156I  . . . . . S . . . . . .
20200 157I  . . . . . S . . . . . .
20210 158I  . . . . . S . . . . . .
20220 159I  . . . . . S . . . . . .
20230 160I  . . . . . S . . . . . .
20240 161I  . . . . . S . . . . . .
20250 162I  . . . . . S . . . . . .
20300 163I  . . . . . S . . . . . .
20310 164I  . . . . . S . . . . . .
20320 165I  . . . . . S . . . . . .
20330 166I  . . . . . S . . . . . .
20340 167I  . . . . . S . . . . . .
20350 168I  . . . . . S . . . . . .
20400 169I  . . . . . S . . . . . .
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20420 171I  . . . . . S . . . . . .
20430 172I  . . . . . S . . . . . .
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20620 183I  . . . . . S . . . . . .
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20640 185I  . . . . . S . . . . . .
20650 186I  . . . . . S . . . . . .
20700 187I  . . . . . S . . . . . .
20710 188I  . . . . . S . . . . . .
20720 189I  . . . . . S . . . . . .
20730 190I  . . . . . S . . . . . .
20740 191I  . . . . . S . . . . . .
20750 192I  . . . . . S . . . . . .
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20940 203I  . . . . . S . . . . . .
20950 204I  . . . . . S . . . . . .
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21020 207I  . . . . . S . . . . . .
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21050 210I  . . . . . S . . . . . .
21100 211I  . . . . . S . . . . . .
21110 212I  . . . . . S . . . . . .
21120 213I  . . . . . S . . . . . .
21130 214I  . . . . . S . . . . . .
21140 215I  . . . . . S . . . . . .
21150 216I  . . . . . S . . . . . .
21200 217I  . . . . . S . . . . . .
21210 218I  . . . . . S . . . . . .
21220 219I  . . . . . S . . . . . .
21230 220I  . . . . . S . . . . . .
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21300 223I  . . . . . S . . . . . .
21310 224I  . . . . . S . . . . . .
21320 225I  . . . . . S . . . . . .
21330 226I  . . . . . S . . . . . .
21340 227I  . . . . . S . . . . . .
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21350 228I S
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21410 230I S
21420 231I S
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22320 285I S
22330 286I S
22340 287I S
22350 288I S
30000 289I S
30010 290I S
30020 291I S
30030 292I S
30040 293I S
30050 294I S
30100 295I S
30110 296I S
30120 297I S
30130 298I S
30140 299I S
30150 300I S

1

Marshall Ash Landfill
Appendix I p. 13 of 13

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	C20	307.	12.50	94.	29.	14.	.30		
+	ROUTED TO	DISC1	123.	13.67	94.	29.	14.	.30		
+									797.08	13.67

*** NORMAL END OF HEC-1 ***

ATTACHMENT B

DRAWINGS