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Surface Water Management Plan
for
Waste Units Remediation Project
Southern Waste Units
Subcontract No. FSC607

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August 1997
Revision 1

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FDF Project No. 20400

PARSONS

25 Merchant Street
Cincinnati, Ohio 45246

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LIST OF ACRONYMS AND ABBREVIATIONS

AFP	Active Flyash Pile
AWWT	Advanced Wastewater Treatment (Facility)
cfs	cubic feet per second
DOE	United States Department of Energy
FEMP	Fernald Environmental Management Project
FDF	Fluor Daniel Fernald, Inc.
FRL	Final Remediation Level
GMA	Great Miami Aquifer
gpm	gallons per minute
HDPE	High Density Polyethylene
IFP	Inactive Flyash Pile
NPDES	National Pollutant Discharge Elimination System
ODNR	Ohio Department of Natural Resources
OSDF	On-Site Disposal Facility
SF	South Field
SWMP	Surface Water Management Plan
SWPPP	Stormwater Pollution Prevention Plan
SWRB	Stormwater Retention Basin
SWUs	Southern Waste Units
WAC	Waste Acceptance Criteria
WURP	Waste Units Remediation Project

EXECUTIVE SUMMARY

This Surface Water Management Plan (SWMP) addresses surface water management of the Southern Waste Units (SWUs) during remediation. This SWMP addresses erosion and sedimentation, stormwater runoff, and other surface water issues at the SWUs.

The SWUs consist of the South Field (SF), the Inactive Flyash Pile (IFP), and the Active Flyash Pile (AFP) areas. The remediation of the SWUs involve the removal of approximately 340,000 bank cubic yards of impacted material consisting of soil, debris (fill), and flyash. The SWUs remediation project will be performed in two phases- 1) Site Preparation, and 2) Excavation. The site preparation phase of the SWUs Project is scheduled to begin in the summer of 1997. The excavation phase of the SWUs Project is scheduled to begin in 1998. The excavation phase is scheduled to require two construction seasons.

Three retention basins (Nos. 1, 2, and 3) will be constructed in the SWUs area to manage surface water during remediation. The retention basins will be lined with one ft. of compacted clay overlain by a geomembrane liner. The non-impacted soil stockpiles and selected collection ditches will be lined with a geomembrane liner. Both sediment and stormwater storage capacity will be provided in the retention basins. A minimum of 27 cubic yards/watershed acre of storage capacity in each basin will be provided for sediment storage. Stormwater storage capacity has been provided above the sediment level to store the runoff from a 25-year, 24-hour storm for basins 1 and 2 and to store the runoff from a 10-year, 24-hour storm for basin 3. Stormwater collected in the basins will discharge through riser pipes and gravity flow to lift stations located adjacent to each of the retention basins. From the lift stations, collected runoff will be pumped through a common double-walled pipe to the Stormwater Retention Basin (SWRB), and subsequently conveyed to the Advanced Wastewater Treatment (AWWT) facility for treatment prior to discharge to the Great Miami River.

The overall operation of the surface water management system was planned and designed to minimize the generation of contaminated runoff and to collect potentially contaminated surface water prior to discharge. Run-on control ditches will be constructed prior to remediation to prevent water from upgradient areas from flowing across the construction area. These run-on control ditches will remain after remediation to prevent potential recontamination. Runoff from disturbed areas will drain to collection ditches which will route the runoff to the retention basins. These basins provide temporary storage while allowing for additional sediment removal prior to runoff being conveyed to the SWRB and AWWT. Excavation of the SWU with the highest known contamination (IFP) was prioritized; it will be excavated first. Within the IFP and other areas, excavation will be performed to minimize potential cross-contamination.

Upon completion of remediation/excavation activities the site will be graded to drain and graded to approximate original (1952) topographical conditions, where possible.

SECTION 1

INTRODUCTION AND SWU DESCRIPTION

1.1 Introduction

The Fernald Environmental Management Project (FEMP) is a 1,050-acre facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The FEMP contains low-level radioactive, solid, and hazardous wastes. The Operable Unit 2 Waste Units Remediation Project (WURP) consists of the following waste units:

- Active Flyash Pile (AFP)
- Inactive Flyash Pile (IFP)
- South Field (SF)
- Lime Sludge Ponds (LSPs)
- Solid Waste Landfill (SWL).

The SF, IFP, and the AFP are collectively known as the Southern Waste Units (SWUs). The LSPs and SWL have been separated from the SWUs due primarily to remedial action schedule; it was determined that since the IFP contributes a greater source of contamination to the Great Miami Aquifer (GMA), the SWUs remediation was of high priority. Therefore, the LSPs and SWL will be addressed separately from the SWUs.

This SWMP addresses surface water management during remediation of the SWUs. The SWUs project will involve excavation and removal of approximately 340,000 bank cubic yards of impacted material from the SWUs. Impacted material consists of all material placed in the area by previous United States Department of Energy (DOE) operations and includes soil, debris (fill), and flyash. Most of the impacted material will be placed in the OSDF. In addition, approximately 3,400 cubic yards of material will be transported to the Above-WAC Queue Area pending shipment to an off-site permitted commercial disposal facility. Approximately 100 cubic yards of lead-contaminated soil will be excavated and shipped offsite for treatment and disposal.

1.2 Purpose

The FEMP is operating under a National Pollutant Discharge Elimination System (NPDES) Permit which requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP). This SWPPP became effective May 1, 1996. Section 6 of the SWPPP addresses discharges related to construction activities. The measures outlined in the SWMP and details shown on the construction

drawings and specifications will be implemented to effectively manage stormwater and limit the amount of erosion and the release of sediment that will occur during the remediation of the SWUs.

Stormwater, erosion and sediment control measures are also required to minimize release of radiological contaminants. This SWMP has been prepared as a guide to minimize construction-related impacts on water quality from erosion and sedimentation, and minimize the spread of contamination during remediation of the SWUs. During remediation, Fluor Daniel Fernald, Inc. (FDF) will perform required NPDES monitoring at the permitted stormwater outfalls and comply with all applicable Federal, State, DOE, and FEMP requirements.

1.3 Scope

This SWMP provides the following information:

- Background discussion of the scope of the SWUs project,
- Description of the SWUs proposed surface water management system for the Southern Waste Units Remediation Project,
- Description of proposed general and area-specific erosion and sediment control measures,
- Description of the type and frequency of maintenance activities required to support the control measures.

The SWMP addresses stormwater management, erosion prevention, sediment control, hydrologic and hydraulic loading, physical site characteristics that impact the selection and implementation of control measures, and references to established design criteria. Supporting engineering data and calculations are attached as Appendix A.

1.4 Construction Drawings and Specifications

The construction within the SWU will be accomplished in 2 phases; The site preparation phase and the excavation phase. Construction drawings and specifications from both phases are incorporated herein by reference. They will be a part of the subcontract bid documents for that phase of remediation of the SWUs. The site preparation phase construction will address the stormwater and erosion control measures herein discussed (including the retention basins and ditches), the support area, wheel wash area, transfer line and all other items required to remove impacted material from the SWU. The excavation phase construction will address the removal of impacted material from the SWU and the subsequent disposition of that material.

SECTION 2

SURFACE WATER MANAGEMENT SYSTEM

2.1 Overall Approach

The principal objectives of surface water management in the SWUs are to prevent or minimize stormwater runon to the work areas and to control water and runoff which has come into contact with contamination and/or impacted material. Runon from upgradient areas will be prevented (via diversion ditches and berms) from flowing into the construction area; this will minimize the generation of contaminated stormwater and sediment. Runon control ditches will be designed to handle the 10-year, 24-hour storm event except for ditch 2 and ditch 6 which will be designed to handle the 25-year, 24-hour storm event. Surface water in the SWUs project will be treated as potentially contaminated and will be collected in ditches and conveyed to three retention basins. Water from the retention basins will then be pumped to the SWRB and subsequently to the AWWT facility for treatment. The design for basins 1 and 2 used in stormwater controls are based on a 25-year, 24-hour storm event and a 10-year, 24-hour storm event for basin 3. Water that enters the excavations during construction will be collected in excavation sumps and handled as described in this plan.

The SWUs consist of the IFP, SF, and the AFP areas and cover approximately 15.8 acres within a total watershed area of 26.0 acres. The SWUs have steep outslopes to the west, south, and southwest. The IFP and SF outslopes are heavily vegetated with trees and brush. Existing drainage consists of sheet flow and shallow concentrated flow that is generally uncontrolled before reaching Paddys Run. A portion of the IFP is situated adjacent to Paddys Run. A rock embankment was constructed under Removal Action 29 along a section of the eastern bank of Paddys Run to protect the IFP from stream erosion.

Because of the proximity of the SWUs to Paddys Run and the nature of the remediation activities, a surface water management system will be used during remediation. Some components of the surface water control system will remain in operation through restoration of the SWUs area. The surface water management system will include diversion ditches and berms to prevent runon from entering the remediation areas, and excavation sumps, collection ditches, retention basins, lift stations, and transfer lines to control runoff. Existing drainage patterns and facilities will be utilized for stormwater management, wherever possible, by implementing improvements to convey design flows and incorporating erosion control materials and revegetation to limit erosion along drainage paths. Where necessary, new ditches or diversion berms will be constructed to redirect existing drainage paths away from the construction area.

See Figure 2-1 for the overall operation of the surface water management system.

2.2 Specific System Components

Specific components of the surface water management system are shown in Figure 2-1 and are described below. See the construction drawings and technical specifications for detailed design information concerning stormwater controls. See Appendix A for design calculations. Drainage area maps are presented in Appendix B.

2.2.1 Diversion Ditches and Related Devices

Runon from upgradient areas will be collected and diverted around the excavation area. Runon will be handled by diversion ditches and other components generally located north of the SWUs.

A ditch (designated as D-12 on the construction drawings) north of the existing road (that runs along the northern edge of the IFP and SF) will be constructed to intercept runon and convey this water westward to a new pipe under the road and into an existing catch basin. This catch basin is located at the northwest corner of the IFP, and has an 18-inch corrugated polyethylene pipe which conveys this runon to an existing drainage way, approximately 300 feet north of the existing National Pollution Discharge Elimination System (NPDES) Discharge Point No. *4004 at Paddys Run. An earthen berm will be constructed around the existing catch basin to collect potential runon water from the south side of the road and prevent potentially contaminated runoff from entering the system. The existing 18-inch pipe will be extended to discharge at the existing NPDES Discharge Point No. *4004. Impacted runoff will be diverted away from NPDES Discharge Point No. *4004 and into the retention basins.

An earthen berm will be constructed across a low area (topographically) north of the AFP to ensure that runon water will not enter the AFP remediation area.

The runon control components of the surface water management system will remain in place after restoration to prevent runon from uncertified areas upgradient from potentially contaminating the restored areas of the SWUs.

2.2.2 Excavation Sumps

As remediation is performed, active areas of excavation will be graded to drain to collection points located within the excavation area to the extent practical. Temporary excavation sumps will be excavated at these collection points to temporarily hold the stormwater. Water will be pumped out of the sumps and into retention basins on an as-needed basis to keep the excavation area functional. Multiple sumps/pumps may be used for dewatering of the excavation area and will be moved as the excavation of the work face progresses.

2.2.3 Collection Ditches and Related Devices

Collection ditches will be constructed around the perimeter of the remediation/construction areas to collect and convey stormwater runoff to the SWUs retention basins. Where possible, the channel slopes will follow the existing topography to minimize excavation. The ditches will be trapezoidal (flat bottom) or triangular in shape depending on anticipated flow rates and site constraints. All ditches will be lined to prevent channel erosion with either erosion control blanket or dumped rock, depending on the design flow velocities, see Summary of Ditch Performance, Sheet B34, Appendix A. Collection ditches excavated into the sand and gravels of the GMA will be lined with a geomembrane liner.

2.2.4 Retention Basins

The SWUs project area is divided into three major drainage areas (P1, P2, and P3 as shown in Appendix B) based on existing topography (drainage areas). Three retention basins (one per drainage area) will be constructed to retain potentially contaminated stormwater runoff. Non-impacted soil removed during basin construction will be placed in non-impacted soil stockpile areas (stockpile #1 and stockpile #2 as indicated on the construction drawings). Material in the non-impacted soil stockpile areas will be used to reclaim the retention basins during the restoration phase of the project.

Each retention basin will have a lift station which will pump runoff to the SWRB. The lift station will consist of a manhole, pump, and related piping/wiring/etc., and will be located adjacent to each basin. A high density, polyethylene (HDPE) riser/intake structure will be constructed inside the basin to feed the lift station. The riser will be designed with three hooded orifices sized to prevent starvation of the pump. The top of the riser will have a cap-type perforated lid. Construction details for the lift station and riser/intake structure are shown on the construction drawings.

Overflow outlets will be provided for all three basins. The overflow outlets will consist of open, trapezoidal channels with invert elevations above the top of the riser pipe and below the top elevation of the basin embankment. The overflow outlets for basins 1 and 2 will not discharge unless the 25-year, 24-hour storm is exceeded. The overflow outlet for basin 3 will not discharge unless the 10-year, 24-hour storm is exceeded. However, all three basins are located in the 100-year floodplain (see Evaluation of the Potential Peak Stages in Paddys Run During Storm Events at Cross Sections Close to the Proposed Retention Basin No. 1, and additional cross sections, Appendix C & Appendix D). Under certain circumstances, the SWRB will bypass the AWWT and discharge directly to the Great Miami River (in accordance with the OU5 ROD, Sections 9.1.4 and 9.1.5: Treatment of Discharges). During these periods of stormwater bypass, the outlet pumps from the Area 2, Phase I retention basins will continue to pump until the SWRB reaches its capacity below the freeboard level. When the SWRB reaches its

capacity, the outlet pumps from the Area 2 Phase I retention basins will be turned off and the water will be stored in these basins, which will be designed for 25-year or 10-year storm. After a sufficient amount of water from the SWRB has been bypassed and the water level is below the freeboard level, the outlet pumps at the Area 2, Phase I retention basins will resume operations and pump the water to the SWRB.

After remediation and SWU restoration is completed, all three retention basins will be removed and backfilled. The compacted clay subgrade and geomembrane liner will be removed and hauled to the OSDF and the basins backfilled with material from the non-impacted soil stockpile.

The retention basins and respective drainage areas are described as follows:

2.2.4.1 Retention Basin 1

The proposed (developed conditions) P1 watershed is approximately 15.2 acres in size and contains the IFP and a portion of the SF and non-impacted soil stockpile area. Runoff will be collected and conveyed to Retention Basin 1 (see Construction Drawings and calculations) via collection ditches D1, D2 (D2A & D2B), D3, and D4. Retention Basin 1 will be located south of the IFP and SF and will cover approximately 1.5 acres of surface area. This basin is designed to retain the runoff volume from a 25-year, 24-hour storm event without discharge to the environment. A lift station with a 400 gallons per minute (gpm) pump system will be installed to pump collected runoff to the SWRB. Anticipated dewatering time for a 25-year, 24-hour storm event is approximately 72 hours. A 20-foot wide, open trapezoidal channel will be constructed to provide positive drainage for overflow occurring from storm events in excess of the 25-year, 24-hour storm or during sufficiently large sequential rain events.

Basin 1 will be constructed almost entirely by excavation with only a minimal amount of fill used for berms. Because Basin 1 is located within the GMA, the bottom and side slopes of the basin will be lined with one ft. of compacted clay and a geomembrane liner.

2.2.4.2 Retention Basin 2

The proposed (developed conditions) P2 watershed is approximately 6.0 acres in size and contains the SF and the remainder of the non-impacted soil stockpile area. Runoff will be collected and conveyed to Basin 2 through collection ditches D5, D6, D7, and D8 (D8A & D8B). Basin 2 will be located south of the SF and will cover approximately 0.5 acre of surface area. This basin is designed to retain the runoff volume from a 25-year, 24-hour storm event without discharge to the environment. A lift station with a 100 gpm pump system will be provided to pump collected runoff to the SWRB. Anticipated dewatering time for a 25-year, 24-hour storm event is approximately 72 hours. A 15-foot wide, open trapezoidal channel will be constructed to provide positive drainage for overflow occurring from storm events in excess of the 25-year, 24-hour storm.

Basin 2 will be constructed by excavation. Because this basin is located within the GMA, the bottom and side slopes of the basin will be lined with one ft. of compacted clay and a geomembrane liner.

2.2.4.3 Retention Basin 3

The proposed (developed conditions) P3 watershed is approximately 4.8 acres in size and contains the AFP. Runoff will be collected and conveyed to Basin 3 through collection ditches D9, D10 (D10A & D10B) and D11. Basin 3 will be located south of the AFP and will cover approximately 0.4 acre of surface area. This basin is designed to retain the runoff volume from a 10-year, 24-hour storm event without discharge to the environment. A lift station with a 100 gpm pump system will be provided to pump collected runoff to the SWRB. Anticipated dewatering time for a 10-year, 24-hour storm event is approximately 72 hours. A 15-foot wide, open trapezoidal channel will be constructed to provide positive drainage for overflow occurring from storm events in excess of the 10-year, 24-hour storm.

Basin 3 will be constructed by excavation. Because this basin is located within the GMA, the bottom and side slopes of the basin will be lined with one ft. of compacted clay and a geomembrane liner.

2.2.5 Transfer Line

A double-walled, HDPE pipe will be installed to convey runoff collected in the retention basins to the SWRB. The main transfer line begins at the lift station at Basin 1 and proceeds in an eastward direction where the lift stations for Basins 2 and 3 discharge into the transfer line. From Basin 3 the transfer line runs northward, east of the AFP, until reaching the termination point at the SWRB diversion box (see construction drawings). Cleanouts will be provided at strategic low points along the run of pipe. Air relief valves will be provided at strategic high points.

2.2.6 SWRB and AWWT

The SWRB will receive all water pumped from the SWUs retention basins. Under normal conditions, the SWRB is pumped to the AWWT facility for treatment and discharge, consistent with the NPDES and OU-5 ROD requirements.

2.2.7 Wheel Wash Facility

A wheel wash facility will be constructed at the SWUs north of the IFP. It will be used to remove mud and debris from the wheels and undercarriage of haul vehicles prior to using the haul road. Water from the wheel wash facility will gravity flow via underground pipe through an oil-water separator to the west seepage control lift station and be pumped to the AWWT.

2.3 OVERALL SYSTEM OPERATION

A major goal of the surface water management system is to prevent potentially contaminated surface water from being discharged to the environment prior to treatment. Initial management will be provided by constructing diversion ditches and berms at strategic locations to prevent surface water runon from entering the area of the SWUs that will be remediated. Runoff from the area of the SWUs that will be remediated will be managed through a series of excavation sumps and collection ditches, which collect and convey runoff from the remediation areas to three earthen retention basins.

The retention basins will provide temporary storage for runoff. The basins also provide pre-treatment of the water by providing detention time for sediments to settle out. Lift stations are provided to transfer runoff stored in the basins to the SWRB through a double-walled, HDPE transfer line. At the SWRB the potentially contaminated runoff is stored until it can be treated at the AWWT. During high flow conditions when the SWRB is at full capacity, the pumps at the retention basin lift stations will be shut off until adequate drawdown at the SWRB.

At the AWWT facility the water will be treated as required prior to being released to the Great Miami River.

SECTION 3

STORMWATER MANAGEMENT

Stormwater management as described in this Surface Water Management Plan addresses the peak runoff that discharges (and will discharge) from the site during existing, construction/remediation, and restoration conditions. The goal of stormwater management is to prevent a significant increase in the peak runoff during remediation and restoration activities.

The SWUs project site is currently vegetated and consists of sheet flow and shallow concentrated flow in the upper watershed areas, leading to concentrated flows in drainage ways around the site. All stormwater from the SWUs project site presently flows into Paddys Run. Prior to the start of remediation a surface water management system will be implemented to prevent runon to the site, and collect and convey runoff from the site for storm events up to the 25-year, 24-hour storm for Retention Basins 1 & 2, and ditches 2 & 6. Retention Basin 3 and the remaining ditches will collect and convey runoff from the site for storm events up to the 10-year, 24-hour storm. Since runoff from the site will be pumped to the SWRB, the peak runoff from the site to Paddys Run will be reduced during remediation/excavation.

After remediation the site will be restored to the approximate original topography. Land use after remediation will be undeveloped with a vegetated cover. Based on an undeveloped land use scenario, the peak and total amount of runoff from the SWUs after remediation can be expected to be similar to the conditions that existed in 1952.

SECTION 4

EROSION AND SEDIMENT CONTROL MEASURES

4.1 Overall Concept

Soil conservation practices, combining vegetative and structural measures, have been incorporated in construction documents to mitigate soil erosion damage, off-site sediment migration, and water pollution from erosion. Many of these measures will be long-term in nature and will become part of the completed construction project (i.e., grading, and permanent seeding). Other measures will be temporary and will be removed by the excavation subcontractor at the completion of excavation and restoration. The selection of erosion and sediment control measures was based on several general principles including the following:

- minimization of erosion through project design,
- incorporation of temporary and permanent erosion control measures,
- removal of sediment prior to discharge.

Erosion and sediment control measures incorporated into the SWUs project incorporate applicable State, Federal, DOE, and FEMP requirements. The FEMP standards for erosion and sediment control follow the Ohio Department of Natural Resources (ODNR) and United States Soil Conservation Service standards for construction and materials. Vegetative stabilization, silt fencing, and ditch protection will be implemented in accordance with Ohio Department of Transportation Construction and Material Specifications and the Location and Design Manual, Volume Two, Drainage. A generalized description of proposed erosion and sediment control measures is presented in this section. Construction details for erosion and sediment control measures are included in the construction drawings and specifications.

4.2 Specific Components

There are two types of erosion and sediment control components: temporary and long-term measures. Temporary measures include silt fencing, crusting agents, stabilization measures (vegetation, matting, dumped rock), and sediment storage capacity within retention basins. Long-term measures include design features such as grading, vegetation, and dumped rock. Both temporary and long-term measures are discussed below.

4.2.1 Silt Fencing

Silt fencing will be used to intercept sheet flow, retain sediments, and disperse flow prior to runoff reaching the collection ditches. Prior to clearing, grading, and excavation activities, silt fencing will be installed along downgradient perimeters to prevent migration of sediment eroded from exposed areas. Silt fencing will consist of a woven filter fabric attached to wooden posts. Silt fencing will be constructed so that the toe of the filter fabric is securely buried to prevent water from undercutting the fence. Silt fencing will be installed in accordance with details presented on the drawings and in accordance with manufacturers recommendations. The locations presented on the construction drawings for the project areas are considered the minimum necessary during construction. Intermediate silt fencing may be used by the subcontractor to control and slow down flows in active excavation areas. The subcontractor shall install breaks and overlaps in the silt fencing to allow vehicle access to the construction areas.

Inspection of silt fence shall occur at regular intervals as outlined in Section 6.

4.2.2 Temporary Stabilization

As a result of phased construction, portions of the project areas may be left in intermediate/incomplete conditions. Intermediate areas may include rough graded areas awaiting final grading. Intermediate areas where activities will not resume for a period of 45 consecutive days or greater shall be stabilized (e.g., seeded with a quick germinating seed mixture, covered with a layer of straw mulch, or application of a crusting agent) within 7 days. Temporary measures will help to stabilize exposed soil and limit erosion. As construction progresses, areas containing temporary vegetation, straw mulch, or the crusting agent will be left in place until final seeding or until construction resumes.

4.2.3 Retention Basins

Although the primary purpose of the retention basins is to collect and hold runoff for treatment, the basins also provide an additional measure of sediment control. Runoff is detained in the retention basins until pumped to the SWRB. Because the rate of pumping to the SWRB is less than 1 cubic feet per second (cfs) (one cfs is 448.8 gallons per minute), which is small compared to discharges from standard outlet structures (usually several cfs), the retention basins provide a large detention storage time for sediments to settle out.

To account for the sediment removal capability of the retention basins, the basins have been designed with sediment storage capacities in excess of the 27 cubic yards per watershed acre as recommended in the ODNR's "Rainwater and Land Development Manual". For storm routing purposes, the sediment storage volume was assumed as dead storage (i.e., at full sediment capacity) and was not included in the basin

volume computations. The designed versus required sediment storage capacity for each basin is given below:

Retention Basin 1

Watershed Area = 15.2 Acres
Sediment Storage Required = 0.25 Acre-Feet
Sediment Storage as Designed = 0.38 Acre-Feet

Retention Basin 2

Watershed Area = 6.0 Acres
Sediment Storage Required = 0.10 Acre-Feet
Sediment Storage as Designed = 0.11 Acre-Feet

Retention Basin 3

Watershed Area = 4.8 Acres
Sediment Storage Required = 0.08 Acre-Feet
Sediment Storage as Designed = 0.10 Acre-Feet

4.2.4 Grading and Design Features

Grading design features incorporated into the construction drawings to control erosion include runon controls, limiting steep slopes, routing runoff to surface water collection ditches, limiting discharge and flow velocities in the collection ditches to the extent practical, and lining collection ditches with erosion control blankets or dumped rock as required to maintain non-erosive velocities.

4.2.5 Vegetation

Subsequent to final remediation of the project areas, a revegetation program will be implemented to establish a permanent variety of vegetation. The vegetation layer (turf type grass) will reduce erosion, enhance evapotranspiration of water, and improve the quality of water leaving the area. The project area will be seeded in stages as remediation is completed. In addition to seeding with a permanent variety of grass seed, mulch and erosion control blankets will be placed to prevent erosion during turf establishment. Mulch will be placed on graded slopes, and erosion control blankets will also be used in all grass ditches. As an aid to turf establishment, seeded areas will be fertilized with a starter fertilizer as described in the technical specifications.

4.2.6 Dumped Rock

Where added erosion protection is necessary for protection from excessive velocities, diversion ditches will be lined with dumped rock. Also, the existing drainageway north of the AFP, and where the unnamed tributary discharges into Paddys Run just west of the IFP, will be lined with dumped rock. Dumped rock will be placed in these locations to prevent further erosion as shown on the construction drawings.

4.3 Design Criteria and Standards

The criteria used to design the various components of the surface water management plan are described below.

- Retention basins 1 and 2 are designed to retain the runoff from a 25-year, 24-hour storm event (minimum) without discharge to the environment. Retention Basin 3 is designed to retain the runoff from a 10-year, 24-hour storm event (minimum) without discharge to the environment.

- Retention basins are designed with a sediment storage capacity which exceeds 27 cubic yards per watershed acre.

- Pump rates at the lift stations are designed to convey accumulated water from the design storm event in approximately 72 hours.

- Runon and diversion and collection ditches (drainage ditches) and culverts are designed based on a 10-year, 24-hour storm frequency, except ditches 2 and 6 which are designed based on a 25-year, 24-hour storm frequency, see Summary of Ditch Performance, Sheet B34, Appendix A.

Various standards and good engineering practices were used in the technical portion of the design. See calculations in Appendix A for a listing and discussion of the standards and practices used.

SECTION 5

IMPLEMENTATION

Because of the large expanse of area that will be impacted by remediation, relatively steep slopes, and close proximity to Paddys Run, intensive erosion control measures will be required to minimize erosion and maximize the capture of sediment. In conjunction with stormwater management measures, silt fencing will be installed along perimeter downslope areas (along contours) and drainage ditches, where necessary, prior to the beginning of excavation activities.

Once excavation of impacted material and contaminated soil begins, erosion and sediment control measures will be integrated with stormwater management measures. Runoff from the active working face will either be gravity drained to collection ditches and basins, or collected in excavation sumps and pumped to collection ditches or directly to the retention basins. Initiation of the surface water management system will commence during site preparation and remain in operation until the final phase of Area 2, Phase 1 soil remediation is complete. Runoff from all areas will be routed to the retention basins until the areas are certified below FRLs and all upslope soils are stabilized with vegetation etc. The subcontractors will be required to periodically remove sediments from silt fences, drainage ditches, and basins to maintain desired performance. Sediment removed from silt fences, drainage ditches, and basins will be managed as impacted material and disposed of in the OSDF.

Areas in which work will not occur for 45 days will be stabilized within 7 days (see Technical Specification Section 02270. Vegetation Standards, specifically percent grass coverage, are discussed in Technical Specification Section 02900). Areas will also be stabilized to the extent practical prior to winter shutdown.

5.1 General Construction Practices

In general, it is advantageous to disturb only as much area as necessary to accommodate construction needs. Limiting the extent of grading and excavation will minimize disturbed areas subject to erosion at any given time. However, disturbed areas may be expanded to separate work areas and provide more room to work for safety reasons. The construction phasing ultimately incorporated into the work plan is dependent on several factors including the following:

- subcontractor's management strategies,
- construction conditions,
- seasonal and weather conditions.

The following construction practices will be followed as a general rule.

- All erosion and sediment control measures are to be installed prior to or as the first step in excavation.

- Disturbed/exposed areas will be excavated as quickly as practical. Disturbed areas which will remain unworked for 45 consecutive days or greater will be stabilized with a temporary vegetative cover or other measures, such as mulching, within 7 days.

- All erosion and sediment control measures shall be maintained and/or modified as approved by FDF in accordance with regulatory criteria during construction to comply with this plan.

- Potential cross-contamination from vehicle traffic will be prevented by stabilization of entry/exit routes, wheel washing, and monitoring vehicles exiting the work zone.

5.2 Construction Sequencing

The following sections discuss the general erosion control sequencing plan (during site preparation) and the excavation sequencing plan.

5.2.1 General Erosion Control Sequencing Plan (During Site Preparation)

Step 1. Establish site boundaries and access controls.

Step 2. Install silt fence and diversion ditches in locations indicated on the construction drawings.

Step 3. Strip the top 12 inches of soil (if not certified below FRLs by FDF) from areas designated for retention basin construction and stockpile the material within the boundaries of the impacted material stockpile within the SF to be field located as noted on the construction drawings.

Step 4. Complete excavation of retention basins to lines and grades shown on the plans. Prior to excavation (to the extent practical), FDF will determine whether material to be excavated is below FRLs. During excavation FDF may perform additional monitoring with real-time instruments. Soil suspected to be impacted (not below FRLs) will be placed in Impacted Material Stockpile shown on the construction drawings. Other soil

Step 5. Install risers, barrels, lift stations, and transfer lines for the retention basins as shown on the construction drawings.

Step 6. Install compacted clay subgrade and geomembrane liner in the retention basins.

Step 7. Divert flow into the retention basins by constructing collection ditches.

Step 8. Construct wheel wash pad and associated devices.

5.2.2 Excavation Sequencing Plan for Impacted Material Excavation

Step 1. Establish site boundaries and access controls.

Step 2. Establish erosion, siltation, and surface water controls in locations indicated on the plans and as shown in the details. Confirm that all erosion and sediment controls are in place and all runoff from potentially contaminated and disturbed areas flows to the retention basins.

Step 3. Clear remaining trees and vegetation. Stumps will be ground in place and excavated with surface soil removal.

Step 4. Excavate impacted material to the limits indicated on the construction drawings.

Step 5 Excavate construction sumps near working face to collect runoff.

Step 6 As excavation progresses, relocate sumps as required.

Step 7. Where the GMA is exposed, cover with a geomembrane liner as shown on the construction drawings.

Step 8. When excavation is completed in a discrete area, certification samples will be collected (by FDF).

Step 9. Upon certification that soils remaining in the remediation area meet FRLs, restoration grading shall be performed.

Step 10. Install stabilization blankets and apply seed and mulch to all disturbed areas.

Step 11. Upon verification that the excavation meets FRLs and has an established stand of vegetation, accumulated sediments, compacted clay subgrade, and the geomembrane liner shall be removed from the retention basins.

Step 12. Install temporary erosion and sedimentation controls for decommissioning of retention basins.

Step 13. Upon certifying that retention basins 1, 2, and 3 meets FRLs, basins are to be backfilled, seeded, and mulched following removal of associated barrels, risers, lift stations, and transfer line.

Step 14. Remove temporary erosion and sedimentation controls following completion of final grading activities and after the excavation areas have an established stand of vegetation. Seed and mulch any areas disturbed by this activity.

SECTION 6

SEDIMENT CONTROL MAINTENANCE AND MONITORING

6.1 Monitoring and Inspection

The erosion and sediment controls identified in this SWMP will be monitored by a qualified representative of the subcontractor and FDF every 7 calendar days or within 24 hours of a precipitation event of 0.5 inches or greater during the construction phase of the project. Inspections will include areas under excavation, unstabilized exposed areas, erosion control measures, and locations where vehicles enter/exit the project area. Where portions of the project area have been completed and permanent erosion control measures have been implemented, inspection will be conducted at least once every month until the entire project area is completely stabilized. All inspections will be conducted and documented in accordance with the SWPPP.

Disturbed areas and areas used for storage of materials that are exposed to the elements will be inspected for evidence of, or for the potential of, pollutants entering local drainage systems. Locations where vehicles exit the project area will be inspected for evidence of off-site tracking of contaminated soil or impacted material.

If the inspections indicate that control measures are not adequate or effective, modifications to the control measure will be implemented immediately by FDF. A report summarizing the scope of the inspection, name of the inspector, inspection date, observations relating to the implementation of this plan, and corrective action measures (if any) will be made and retained in the FDF project files to demonstrate compliance. The reports will either identify any areas of noncompliance with this plan, or contain a certification that control measures are effective and in compliance with this plan.

6.2 Maintenance

Erosion and sediment controls will be maintained in good operating condition until the project area has been completely stabilized and the soils remaining in the project area are certified to meet FRLs. Specific maintenance procedures will address silt fencing, drainage ditches, retention basins, and the wheel wash pad.

Silt Fencing

As sediment collects along the silt fences, the fences will be cleaned to maintain desired removal performance and prevent structural failure of the fence. Sediment will be removed by the subcontractor and managed as impacted material and placed in the impacted material stockpile for subsequent placement into the OSDF. The perimeter silt fencing will remain in place until excavation activities in the area are completed and vegetative cover or other erosion control measures are adequately established.

Drainage Ditches

The subcontractor will be required to periodically remove sediment from the drainage ditches to maintain conveyance. Sediment removed from ditches will be managed as impacted material and placed in the impacted material stockpile for subsequent placement into the OSDF.

Retention Basins

The subcontractor will be required to periodically remove sediment from the retention basins to maintain desired sediment storage capacity. Sediment removed from basins will be managed as impacted material and placed in the impacted material stockpile for subsequent placement into the OSDF.

Wheel Wash Pad

Sediments will be removed from the trench and oil/water separator as required. The sediments removed from the Wheel Wash Pad will be managed as impacted material and placed in the OSDF.

APPENDIX A

CALCULATIONS

PARSONS
ERA PROJECT

DESIGN CALCULATIONS INDEX

Discipline CIVIL Project Order No. 165 OU No. 2

CALCULATION NO.	SUBJECT	COMPUTER GENERATED (Y/N)	ORIGINATING AUTHOR	CHECKED BY	REV. NO./ DATE
15-01	STORMWATER MANAGEMENT	BOTH	T. BROWN	B. PARTON	0/ 5/22/97
15-01	STORMWATER MANAGEMENT	BOTH	T. BROWN	B. PARTON	1/ 8/15/97

APPROVED [signature] DATE 8/26/97
Technical Lead

10/96

ENG023

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- Basis Sheet . . . . . 2-4 of 12
- Computer Calculation Summary Sheet . . . . . 5-7 of 12
- Results . . . . . 8 of 12
- Computer 9-12

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  - Channel FlowWorksheet A7
  - Runoff Curve Number Data A8
  - Runoff Curve Number Summary A9
  - Tabular Inflow Hydrograph A10-A15
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Attachment D
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Attachment F
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Appendix B, Surface Water Management Plan, Drainage Area Maps

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 8/15/97

Sheet 1 of 12

Proj. Order No. 165 Calculation No. 15-01

Project Title SOUTHERN WASTE UNITS

Calculation Subject STORMWATER MANAGEMENT Date Verified/Checked Frank Parker 8/26/97

STATUS: PRELIMINARY ____ FINAL X SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

1) Determine size of three retention basins required to collect and retain runoff from the 25 yr-24 hr precipitation event (Basins 1 & 2) and the 10 yr-24 hr precipitation event (Basin 3).

2) Determine size of collection ditches and culverts required to convey a 10-yr storm event to the retention basins. Due to the close proximity to Paddys Run, Ditch 2 & Ditch 6 will also be evaluated for the 25-yr storm event.

SUMMARY OF CONCLUSIONS

1) The basins, as shown on Dwg. 92X-5900-G-00282 are of sufficient size to collect runoff from the 10 yr-24 hr (Basin 3), or 25 yr-24 hr (Basins 1 & 2) storm event as required.
2) Ditches and culverts shown on Dwg. 92X-5900-G-00282, Dwg. 92X-5900-G-00283, and 92X-5900-G-00453 are of sufficient size to convey the 10-yr or 25-yr storm event, as required, to the basins.

Originator's Signature and Date: 8-26-97

CHECKING METHOD

1. Review ____
2. Alternate Calculation ____

Checker's Signature and Date: Franklin Parker 8/26/97

Lead Discipline Engineer's Signature and Date: Frank Parker 8/26/97

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. 1
Sheet 2 of 12

Proj. Order No. 165 Calculation No. 15-01

Project Title Southern Waste Units

Calculation Subject Stormwater Management Date Verified/Checked 8/26/97

Prepared By: T. Brown TB Checked/Verified By: Frank Pardi

Date 8/15/97

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

Data Sources

1. PARSONS DWGs. (used to create drainage area maps)
2. Haestad Methods. 1989. Quick TR-55™ *Urban Hydrology for Small Watersheds*
3. Haestad Methods. 1989. Pond-2™ *Detention Pond Analysis*
4. Haestad Methods. 1995. Flow Master™ v 5.13
5. U.S. Weather Bureau. *Rainfall Frequency Atlas of the United States*
6. Soil Conservation Service. *Soil Survey of Hamilton County, Ohio*. August 1982
7. ODOT. *Location and Design Manual, Vol. 2, Drainage Design*
8. FHWA. *Hydraulic Design of Highway Culverts*. HDS No. 5. 1985
9. Brater, E.F., & King, H.W., *"Handbook of Hydraulics"*, 6th ed., 1976, McGraw-Hill

CODES

Applicable sections of the Ohio Department of Natural Resources *Rainwater and Land Development Manual*

ASSUMPTIONS

1. Retention basins: The retention basins will be in place and operational prior to excavation. Therefore, the contributing watershed areas prior to, and during excavation were examined to identify the worst-case for storm volumes.

ENGINEERING CALCULATIONS
BASIS SHEET
SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS (continued)

2. Ditches and Culverts: Both existing and proposed conditions were evaluated, with the one producing the highest flow rates used in design.
3. The Rainfall Intensity-Frequency-Duration Curve for the Fernald area has the shortest duration equal to 10 minutes. The time of concentrations (t_c) computed for drainage areas P1, P2, and P3 were less than 10 minutes. Since the drainage areas for ditches are smaller than basin drainage areas (and subsequent t_c's for ditches less than those for basins), calculations for t_c for ditch and culvert drainage areas were not performed (except for Ditch-12, and Culvert-4). Instead, the smallest duration (10 min.) from the Rainfall Intensity-Frequency-Duration Curve were used to calculate rainfall intensities. For Ditch-12 and Culvert-4, t_c's were calculated using SCS methodologies due to the relatively large, flat drainage areas.
4. Ditches were designed based on uniform flow.
5. The existing ditches and 24" dia. culvert at the proposed wheel wash area were designed under Calculation No. 15-02, for PO158 (Haulroad Upgrade Project), and is included for information as an attachment to this calculation.
6. The existing catch basin and 18" corrugated HDPE storm drain located west of the Inactive Flyash Pile was designed under Calculation No. 15-01, for PO139 (Design of Seepage Collection & Removal of Sediment), and is included for information as an attachment to this calculation.
7. The Contingency Stockpile Area (Stockpile #2), located north-northwest of ditch-12, may or may not be utilized, depending on the amount of excess soil. Therefore, ditches 8A, 8B, and Basin 2 were designed assuming that this stockpile area would be utilized.
8. Dumped Rock Fill will be used in ditches that do not have a geomembrane liner where velocities are greater than 4.0 fps for erosion control blanket lining. ODOT Type "C" dumped rock fill will be used due to the small geometrical shape of the ditches.

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS (continued)

9. Ditches 2B, 3-7, and 9 will have a geomembrane liner. Where velocity checks are used, flow depths will be determined using a broad-crested weir analysis.

PARSONS ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 165 Job Number: 7663-0165-11112-141

Computer Code: QTR-55 Version: 5.46

Code Verification Status: REV 0, Nov 1992

Description of Program: Developes runoff hydrographs per SCS TR-55, Determines peak flows per Modified Rational Method

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To determine volume of runoff produced by 10-yr, 24-hr storm event, Retention Basins will be sized to accommodate these volumes.

To determine peak flows for design of ditches and culverts.

Run Performed By: T. Brown

Date/Time of Run: various, see computer printouts

Computer Time of Run: n/a

Input Filename: See attached list on Sheets 8-11

Output Filename: See attached list on Sheets 8-11

Files Saved to Diskname: p:\engdata\c&sdata\po165\swu\swcalc Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TDB Date: 8-26-97

Checked By: Frank Parker Date: 8-26-97

Approved By: Date:

PARSONS
ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 165 Job Number: 7663-0165-11112-141

Computer Code: Flow Master Version: 5.13

Code Verification Status: Rev 0, Feb. 1997

Description of Program: Computes solutions to uniform flow open channel hydraulic problems

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: Used to evaluate and select drainage channel geometry and acceptable lining material.

Run Performed By: T. Brown

Date/Time of Run: various, see computer print-outs

Computer Time of Run: n/a

Input Filename: See attached list on Sheets 8-11

Output Filename: See attached list on Sheets 8-11

Files Saved to Diskname: p:engdata\c&sdata\po165\swu\swcalc Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TB Date: 8-26-97

Checked By: [signature] Date: 8-26-97

Approved By: Date:

PARSONS
ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 165 Job Number: 7663-0165-11112-141

Computer Code: POND -2 Version: 5.17

Code Verification Status: REV 0, NOV 1992

Description of Program: Computes solution for routing inflow hydrograph generated by OTR-55 and generates an outflow hydrograph using level-pool routing techniques

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: Used to size retention basins to ensure no discharge for 10-year, 24-hour storm event.

Run Performed By: T. Brown

Date/Time of Run: various, see computer print-outs

Computer Time of Run: n/a

Input Filename: See attached list on Sheets 8-11

Output Filename: See attached list on Sheets 8-11

Files Saved to Diskname: p:\engdata\c&sdata\po165\swu\swcalc Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TJB Date: 8-26-97

Checked By: Frank Parker Date: 8-26-97

Approved By: Date:

REV	BY	DATE	CK	DATE	TITLE: STORMWATER MANAGEMENT	
1	TJB	8-26-97		8-26-97		
						OU - 2
					AUTHOR: T. Brown SHEET 8 of 12	PO165

RESULTS:

The results from the routing of the 25-year, 24-hour storm event through retention basins 1 & 2 are as follows:

RETENTION BASIN 1

Q_{25} =	88 CFS
Initial Storage (Assumed full of sediment) =	0.36 Ac-Ft
Overflow Elev. =	538.5
Water Surface Elev. (WSE_{25}) =	537.87
Q_{25} Discharge =	0 CFS

RETENTION BASIN 2

Q_{25} =	34 CFS
Initial Storage (Assumed full of sediment) =	0.11 Ac-Ft
Overflow Elev. =	537.0
Water Surface Elev. (WSE_{25}) =	536.63
Q_{25} Discharge =	0 CFS

The results from the routing of the 10-year, 24-hour storm event through retention basin 3 are as follows:

RETENTION BASIN 3

Q_{10} =	21 CFS
Initial Storage (Assumed full of sediment) =	0.10 Ac-Ft
Overflow Elev. =	540.0
Water Surface Elev. (WSE_{10}) =	539.89
Q_{10} Discharge =	0 CFS

The retention basins do not discharge during the design storm events and are acceptable.

The diversion ditches and culverts were designed to accommodate a 10-year storm event.
The results for diversion ditches and culverts are included within the body of the calculations.

SHT 9-12

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c4p.mod
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cvrsht.txt
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SHT 11-12

3

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ATTACHMENT A, RETENTION BASINS

Methodology

This calculation is performed by examining the existing and proposed conditions to identify the "worst case" for storm volumes.

The existing drainage area for each basin is computed using the existing topography. The proposed drainage area for each basin is computed on the final grading plan. Time of concentrations are determined using sheet flow, shallow concentrated flow, and channel flow as required by the drainage characteristics of each drainage area. See Drainage Area Map in Appendix B of the Surface Water Management Plan. A weighted curve number is developed for each drainage area based on soil types and conditions within the drainage area. The proposed inflow hydrographs are then developed using SCS Technical Release No. 55 (TR-55) and the computer program Quick TR-55. Retention Basins No. 1 & 2 will use the 25 yr - 24 hr storm as the design storm event. Retention Basin No. 3 will use the 10 yr - 24 hr storm as the design storm event. The drainage areas for each basin under existing and proposed conditions are as follows:

	EXISTING	PROPOSED
Basin 1	14.33 AC	15.23 AC
Basin 2	7.04 AC	6.1 AC
Basin 3	4.78 AC	4.78 AC

By inspection, The worst-case volume condition for basin 1 and basin 3 will occur during proposed conditions due to the size of the drainage areas and the use of higher curve numbers for disturbed conditions. However, for basin 2 it is not apparent which condition will generate the largest storm runoff volume. Therefore, runoff hydrographs will be generated for each condition and routed through the storage volume estimate routine of the Pond-2 computer program. The condition which produces the largest estimated storage volume will be used as the worst-case and will be routed through the basin.

Stage-storage information is developed from the grading plans for each basin. This information is entered into the Pond-2 computer program. Since the basins retain the design storm instead of regulating outflow, an outflow rating table is not required. Also, the pumping rate at the lifts stations (400 gallons per minute at basin 1, and 100 gpm at basins 2 & 3) was not considered when routing the design storm event.

The inflow hydrographs are then routed through the basins using level-pool reservoir routing techniques found in the Pond-2 computer program. Maximum water surface elevations due to storage of the entire storm volume are evaluated to ensure that adequate volume is provided to contain the design storm events.

Variables used in development of the inflow hydrographs are taken from TR-55. Variable definitions, values used, and reference location within TR-55 are defined.

Time of Concentration

Time of concentration is comprised of travel times from sheet flow, shallow concentrated flow, and channel flow components. Each component is described as follows:

Sheet Flow (Equation 3-3)

$$T_t = \frac{0.007\,(n \times L)^{0.8}}{(P_2)^{0.5}\, s^{0.4}}$$

where:

T_t = Travel time (hrs)
n = Manning's roughness coefficient. Use following values from Table 3-1, Page 3-3 for n:

n = 0.011 for bare soil conditions,
n = 0.13 for range conditons (vegetated)

P_2 = 2 yr - 24 hr rainfall (in.). The 2 yr - 24 hr rainfall is used in the SCS equation for sheet flow for any storm frequency. For the Fernald Area use 3.0 inches (Reference 5)
L = Flow Length (ft)
s = Land slope (ft/ft)

Shallow Concentrated Flow (Page 3-1)

$$T_t = L / 3600 \times V$$

where:

T_t = Travel time (hrs)
L = Flow Length (ft)
3600 is conversion factor from seconds to hours
V = Average velocity (ft/s) taken from Figure 3-1

Channel Flow (Page 3-3)

$$T_t = L / 3600 \times V$$

T_t = Travel time (hrs)
L = Flow Length (ft)
3600 is conversion factor from seconds to hours
V = Average channel velocity taken from equation 3-4

Runoff Curve Number

A weighted curve number is derived for watershed areas based on the soil type, hydrologic soil group, cover type, and treatment. The soil types in the area and the hydrologic soil groupings are based on soil surveys of the area (Reference 6, see Attachment E). The cover types and treatment (i.e., proposed-bare soil conditions, or existing-wooded conditons) are based on the expected conditions to be encountered during the project. Curve numbers are assigned based on the Curve Number Tables 2-2a, 2-2b, and 2-2c.

SHT A4

RETENTION BASIN 1

Quick TR-55 Ver.5.46 S/N:
Executed: 10:05:30 08-19-1997 c:\po165tk\P1.TCT

RETENTION BASIN - 1

Tc COMPUTATIONS FOR: P1

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		BARE	
Manning's roughness coeff., n		0.0110	
Flow length, L (total < or = 300)	ft	280.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0210	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.05	= 0.05

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	240.0	
Watercourse slope, s	ft/ft	0.1120	
Avg.V = Csf * $(s)^{0.5}$	ft/s	5.3996	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	10.00	
Wetted perimeter, Pw	ft	12.47	
Hydraulic radius, r = a/Pw	ft	0.802	
Channel slope, s	ft/ft	0.0080	
Manning's roughness coeff., n		0.0400	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.8758	
Flow length, L	ft	305	
T = L / (3600*V)	hrs	0.03	= 0.03

::

TOTAL TIME (hrs) 0.09

USE 0.1 hrs

SHT A6

Quick TR-55 Ver.5.46 S/N:
Executed: 10:05:30 08-19-1997 c:\po165tk\P1.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN - 1

Subarea descr.	Tc or Tt	Time (hrs)
P1	Tc	0.09

USE 0.1 hrs

P1 WATERSHED, CHANNEL FLOW
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	P1 WATERSHED, CHANNEL FLOW
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Depth	1.00	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	8.00	ft

Results		
Discharge	28.68	cfs
Flow Area	10.00	ft^2
Wetted Perimeter	12.47	ft
Top Width	12.00	ft
Critical Depth	0.69	ft
Critical Slope	0.028706	ft/ft
Velocity	2.87	ft/s
Velocity Head	0.13	ft
Specific Energy	1.13	ft
Froude Number	0.55	
Flow is subcritical.		

Notes:

THIS ANALYSIS WAS TO DETERMINE THE FLOW AREA, WETTED PERIMETER, AND HYDRAULIC RADIUS OF D-3 FLOWING 1 FT. DEEP.

RESULTS USED TO DETERMINE TRAVEL TIME FOR CHANNEL FLOW COMPONENT OF TIME OF CONCENTRATION OF P1 DRAINAGE AREA.

SHT A8

Quick TR-55 Ver.5.46 S/N:
Executed: 10:15:12 08-19-1997

RETENTION BASIN 1
59% HoA, 20% HeF, 10% MaB,
10% Gn, 1% Gravel Road

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN
HoA, (C): FALLOW, BARE SOIL	8.97	91
MaB, (C): FALLOW, BARE SOIL	1.52	91
HeF, (B): FALLOW, BARE SOIL	3.04	86
Gn, (B): FALLOW, BARE SOIL	1.55	86
Gravel Road	0.15	91
COMPOSITE AREA --->	15.23	89.5 ~~(89)~~

::

(90)

000043

SHTA9

Quick TR-55 Ver.5.46 S/N:
Executed: 10:15:12 08-19-1997

RETENTION BASIN 1
59% HoA, 20% HeF, 10% MaB,
10% Gn, 1% Gravel Road

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
	15.23	~~89~~ USE 90

SEE PREVIOUS SHEET

SHT A10

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
P1	15.23	90.0	0.10	0.00	4.80	3.68	.05	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 15.23 acres or 0.02380 sq.mi
Peak discharge = 88 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P1	0.10	0.00	**	**	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P1	88	12.1
Composite Watershed	88	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P1	2	3	5	29	57	88	55	19	13
Total (cfs)	2	3	5	29	57	88	55	19	13

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P1	11	9	8	7	6	5	4	4	4
Total (cfs)	11	9	8	7	6	5	4	4	4

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P1	3	3	3	3	2	2	2	2	2
Total (cfs)	3	3	3	3	2	2	2	2	2

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P1	2	1	1	1	0
Total (cfs)	2	1	1	1	0

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	2	14.8	3
11.1	2	14.9	3
11.2	3	15.0	3
11.3	3	15.1	3
11.4	4	15.2	3
11.5	4	15.3	2
11.6	5	15.4	2
11.7	13	15.5	2
11.8	21	15.6	2
11.9	29	15.7	2
12.0	57	15.8	2
12.1	88	15.9	2
12.2	55	16.0	2
12.3	19	16.1	2
12.4	13	16.2	2
12.5	11	16.3	2
12.6	9	16.4	2
12.7	8	16.5	2
12.8	7	16.6	2
12.9	6	16.7	2
13.0	6	16.8	2
13.1	5	16.9	2
13.2	5	17.0	2
13.3	4	17.1	2
13.4	4	17.2	2
13.5	4	17.3	2
13.6	4	17.4	2
13.7	4	17.5	2
13.8	4	17.6	2
13.9	3	17.7	2
14.0	3	17.8	2
14.1	3	17.9	2
14.2	3	18.0	2
14.3	3	18.1	2
14.4	3	18.2	2
14.5	3	18.3	2

SMA14

14.6	3	18.4	2
14.7	3	18.5	2

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:17:37
Watershed file: --> C:\PO165TK\P1 .MOP
Hydrograph file: --> C:\PO165TK\P1-25.HYD

RETENTION BASIN 1
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	1	22.4	1
18.7	1	22.5	1
18.8	1	22.6	1
18.9	1	22.7	1
19.0	1	22.8	1
19.1	1	22.9	1
19.2	1	23.0	1
19.3	1	23.1	1
19.4	1	23.2	1
19.5	1	23.3	1
19.6	1	23.4	1
19.7	1	23.5	1
19.8	1	23.6	1
19.9	1	23.7	1
20.0	1	23.8	1
20.1	1	23.9	1
20.2	1	24.0	1
20.3	1	24.1	0
20.4	1	24.2	0
20.5	1	24.3	0
20.6	1	24.4	0
20.7	1	24.5	0
20.8	1	24.6	0
20.9	1	24.7	0
21.0	1	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0
21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

SHT A16

POND-2 Version: 5.17
S/N:

RETENTION BASIN NO. 1

CALCULATED 08-19-1997 10:23:58
DISK FILE: c:\po165tk\SW1 .VOL

Planimeter scale: 1 inch = 40 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
531.40	0.00	0.00	0.00	0.00	0.00
532.00	5.27	0.19	0.19	0.04	0.04
533.00	16.74	0.61	1.15	0.38	0.42
534.00	23.83	0.88	2.22	0.74	1.16
535.00	25.38	0.93	2.71	0.90	2.07
536.00	26.97	0.99	2.88	0.96	3.03
537.00	28.60	1.05	3.06	1.02	4.05
538.00	31.45	1.16	3.31	1.10	5.15
539.00	35.20	1.29	3.67	1.22	6.38
540.00	36.27	1.33	3.94	1.31	7.69

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

532.90	-----	0.56	1.09	0.33	0.36
538.50	-----	1.22	3.57	0.59	5.75

* Incremental volume computed by the Conic Method for Reservoir Volumes.

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34


```
*************************
*                       *
*   RETENTION BASIN 1   *
* 25 YR - 24 HR STORM   *
* PROPOSED CONDITIONS   *
*                       *
*                       *
*************************
```

Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Rating Table file: c:\po165tk\SW1 .PND

----INITIAL CONDITIONS----
Elevation = 532.90 ft — MAX. SEDIMENT CLEANOUT ELEV.
Outflow = 0.00 cfs
Storage = 0.36 ac-ft — MAX. SEDIMENT STORAGE VOLUME

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
531.40	0.0	0.000
532.00	0.0	0.040
532.90	0.0	0.360
533.00	0.0	0.420
534.00	0.0	1.160
535.00	0.0	2.070
536.00	0.0	3.030
537.00	0.0	4.050
538.00	0.0	5.150
538.50	0.0	5.750
539.00	0.0	6.380
540.00	0.0	7.690

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
9.7	9.7
87.1	87.1
101.6	101.6
280.7	280.7
500.9	500.9
733.3	733.3
980.1	980.1
1246.3	1246.3
1391.5	1391.5
1544.0	1544.0
1861.0	1861.0

Time increment (t) = 0.100 hrs.

SHT A18

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	2.00	-----	87.1	87.1	0.00	532.90
11.100	2.00	4.0	91.1	91.1	0.00	532.93
11.200	3.00	5.0	96.1	96.1	0.00	532.96
11.300	3.00	6.0	102.1	102.1	0.00	533.00
11.400	4.00	7.0	109.1	109.1	0.00	533.04
11.500	4.00	8.0	117.1	117.1	0.00	533.09
11.600	5.00	9.0	126.1	126.1	0.00	533.14
11.700	13.00	18.0	144.1	144.1	0.00	533.24
11.800	21.00	34.0	178.1	178.1	0.00	533.43
11.900	29.00	50.0	228.1	228.1	0.00	533.71
12.000	57.00	86.0	314.1	314.1	0.00	534.15
12.100	88.00	145.0	459.1	459.1	0.00	534.81
12.200	55.00	143.0	602.1	602.1	0.00	535.44
12.300	19.00	74.0	676.1	676.1	0.00	535.75
12.400	13.00	32.0	708.1	708.1	0.00	535.89
12.500	11.00	24.0	732.1	732.1	0.00	536.00
12.600	9.00	20.0	752.1	752.1	0.00	536.08
12.700	8.00	17.0	769.1	769.1	0.00	536.15
12.800	7.00	15.0	784.1	784.1	0.00	536.21
12.900	6.00	13.0	797.1	797.1	0.00	536.26
13.000	6.00	12.0	809.1	809.1	0.00	536.31
13.100	6.00	12.0	821.1	821.1	0.00	536.36
13.200	5.00	11.0	832.1	832.1	0.00	536.40
13.300	4.00	9.0	841.1	841.1	0.00	536.44
13.400	4.00	8.0	849.1	849.1	0.00	536.47
13.500	4.00	8.0	857.1	857.1	0.00	536.50
13.600	4.00	8.0	865.1	865.1	0.00	536.53
13.700	4.00	8.0	873.1	873.1	0.00	536.57
13.800	4.00	8.0	881.1	881.1	0.00	536.60
13.900	4.00	8.0	889.1	889.1	0.00	536.63
14.000	3.00	7.0	896.1	896.1	0.00	536.66
14.100	3.00	6.0	902.1	902.1	0.00	536.68
14.200	3.00	6.0	908.1	908.1	0.00	536.71
14.300	3.00	6.0	914.1	914.1	0.00	536.73
14.400	3.00	6.0	920.1	920.1	0.00	536.76
14.500	3.00	6.0	926.1	926.1	0.00	536.78
14.600	3.00	6.0	932.1	932.1	0.00	536.81
14.700	3.00	6.0	938.1	938.1	0.00	536.83
14.800	3.00	6.0	944.1	944.1	0.00	536.85
14.900	3.00	6.0	950.1	950.1	0.00	536.88
15.000	3.00	6.0	956.1	956.1	0.00	536.90
15.100	3.00	6.0	962.1	962.1	0.00	536.93
15.200	3.00	6.0	968.1	968.1	0.00	536.95
15.300	2.00	5.0	973.1	973.1	0.00	536.97
15.400	2.00	4.0	977.1	977.1	0.00	536.99

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	2.00	4.0	981.1	981.1	0.00	537.00
15.600	2.00	4.0	985.1	985.1	0.00	537.02
15.700	2.00	4.0	989.1	989.1	0.00	537.03
15.800	2.00	4.0	993.1	993.1	0.00	537.05
15.900	2.00	4.0	997.1	997.1	0.00	537.06
16.000	2.00	4.0	1001.1	1001.1	0.00	537.08
16.100	2.00	4.0	1005.1	1005.1	0.00	537.09
16.200	2.00	4.0	1009.1	1009.1	0.00	537.11
16.300	2.00	4.0	1013.1	1013.1	0.00	537.12
16.400	2.00	4.0	1017.1	1017.1	0.00	537.14
16.500	2.00	4.0	1021.1	1021.1	0.00	537.15
16.600	2.00	4.0	1025.1	1025.1	0.00	537.17
16.700	2.00	4.0	1029.1	1029.1	0.00	537.18
16.800	2.00	4.0	1033.1	1033.1	0.00	537.20
16.900	2.00	4.0	1037.1	1037.1	0.00	537.21
17.000	2.00	4.0	1041.1	1041.1	0.00	537.23
17.100	2.00	4.0	1045.1	1045.1	0.00	537.24
17.200	2.00	4.0	1049.1	1049.1	0.00	537.26
17.300	2.00	4.0	1053.1	1053.1	0.00	537.27
17.400	2.00	4.0	1057.1	1057.1	0.00	537.29
17.500	2.00	4.0	1061.1	1061.1	0.00	537.30
17.600	2.00	4.0	1065.1	1065.1	0.00	537.32
17.700	2.00	4.0	1069.1	1069.1	0.00	537.33
17.800	2.00	4.0	1073.1	1073.1	0.00	537.35
17.900	2.00	4.0	1077.1	1077.1	0.00	537.36
18.000	2.00	4.0	1081.1	1081.1	0.00	537.38
18.100	2.00	4.0	1085.1	1085.1	0.00	537.39
18.200	2.00	4.0	1089.1	1089.1	0.00	537.41
18.300	2.00	4.0	1093.1	1093.1	0.00	537.42
18.400	2.00	4.0	1097.1	1097.1	0.00	537.44
18.500	2.00	4.0	1101.1	1101.1	0.00	537.45
18.600	1.00	3.0	1104.1	1104.1	0.00	537.47
18.700	1.00	2.0	1106.1	1106.1	0.00	537.47
18.800	1.00	2.0	1108.1	1108.1	0.00	537.48
18.900	1.00	2.0	1110.1	1110.1	0.00	537.49
19.000	1.00	2.0	1112.1	1112.1	0.00	537.50
19.100	1.00	2.0	1114.1	1114.1	0.00	537.50
19.200	1.00	2.0	1116.1	1116.1	0.00	537.51
19.300	1.00	2.0	1118.1	1118.1	0.00	537.52
19.400	1.00	2.0	1120.1	1120.1	0.00	537.53
19.500	1.00	2.0	1122.1	1122.1	0.00	537.53
19.600	1.00	2.0	1124.1	1124.1	0.00	537.54
19.700	1.00	2.0	1126.1	1126.1	0.00	537.55
19.800	1.00	2.0	1128.1	1128.1	0.00	537.56
19.900	1.00	2.0	1130.1	1130.1	0.00	537.56
20.000	1.00	2.0	1132.1	1132.1	0.00	537.57

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	1.00	2.0	1134.1	1134.1	0.00	537.58
20.200	1.00	2.0	1136.1	1136.1	0.00	537.59
20.300	1.00	2.0	1138.1	1138.1	0.00	537.59
20.400	1.00	2.0	1140.1	1140.1	0.00	537.60
20.500	1.00	2.0	1142.1	1142.1	0.00	537.61
20.600	1.00	2.0	1144.1	1144.1	0.00	537.62
20.700	1.00	2.0	1146.1	1146.1	0.00	537.62
20.800	1.00	2.0	1148.1	1148.1	0.00	537.63
20.900	1.00	2.0	1150.1	1150.1	0.00	537.64
21.000	1.00	2.0	1152.1	1152.1	0.00	537.65
21.100	1.00	2.0	1154.1	1154.1	0.00	537.65
21.200	1.00	2.0	1156.1	1156.1	0.00	537.66
21.300	1.00	2.0	1158.1	1158.1	0.00	537.67
21.400	1.00	2.0	1160.1	1160.1	0.00	537.68
21.500	1.00	2.0	1162.1	1162.1	0.00	537.68
21.600	1.00	2.0	1164.1	1164.1	0.00	537.69
21.700	1.00	2.0	1166.1	1166.1	0.00	537.70
21.800	1.00	2.0	1168.1	1168.1	0.00	537.71
21.900	1.00	2.0	1170.1	1170.1	0.00	537.71
22.000	1.00	2.0	1172.1	1172.1	0.00	537.72
22.100	1.00	2.0	1174.1	1174.1	0.00	537.73
22.200	1.00	2.0	1176.1	1176.1	0.00	537.74
22.300	1.00	2.0	1178.1	1178.1	0.00	537.74
22.400	1.00	2.0	1180.1	1180.1	0.00	537.75
22.500	1.00	2.0	1182.1	1182.1	0.00	537.76
22.600	1.00	2.0	1184.1	1184.1	0.00	537.77
22.700	1.00	2.0	1186.1	1186.1	0.00	537.77
22.800	1.00	2.0	1188.1	1188.1	0.00	537.78
22.900	1.00	2.0	1190.1	1190.1	0.00	537.79
23.000	1.00	2.0	1192.1	1192.1	0.00	537.80
23.100	1.00	2.0	1194.1	1194.1	0.00	537.80
23.200	1.00	2.0	1196.1	1196.1	0.00	537.81
23.300	1.00	2.0	1198.1	1198.1	0.00	537.82
23.400	1.00	2.0	1200.1	1200.1	0.00	537.83
23.500	1.00	2.0	1202.1	1202.1	0.00	537.83
23.600	1.00	2.0	1204.1	1204.1	0.00	537.84
23.700	1.00	2.0	1206.1	1206.1	0.00	537.85
23.800	1.00	2.0	1208.1	1208.1	0.00	537.86
23.900	1.00	2.0	1210.1	1210.1	0.00	537.86
24.000	0.00	1.0	1211.1	1211.1	0.00	537.87
24.100	0.00	0.0	1211.1	1211.1	0.00	537.87
24.200	0.00	0.0	1211.1	1211.1	0.00	537.87
24.300	0.00	0.0	1211.1	1211.1	0.00	537.87
24.400	0.00	0.0	1211.1	1211.1	0.00	537.87
24.500	0.00	0.0	1211.1	1211.1	0.00	537.87
24.600	0.00	0.0	1211.1	1211.1	0.00	537.87

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 10:26:34

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	1211.1	1211.1	0.00	537.87
24.800	0.00	0.0	1211.1	1211.1	0.00	537.87
24.900	0.00	0.0	1211.1	1211.1	0.00	537.87
25.000	0.00	0.0	1211.1	1211.1	0.00	537.87
25.100	0.00	0.0	1211.1	1211.1	0.00	537.87
25.200	0.00	0.0	1211.1	1211.1	0.00	537.87
25.300	0.00	0.0	1211.1	1211.1	0.00	537.87
25.400	0.00	0.0	1211.1	1211.1	0.00	537.87
25.500	0.00	0.0	1211.1	1211.1	0.00	537.87
25.600	0.00	0.0	1211.1	1211.1	0.00	537.87
25.700	0.00	0.0	1211.1	1211.1	0.00	537.87
25.800	0.00	0.0	1211.1	1211.1	0.00	537.87
25.900	0.00	0.0	1211.1	1211.1	0.00	537.87

SHTA22

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

Starting Pond W.S. Elevation = 532.90 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 88.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 537.87 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.36 ac-ft
Peak Storage From Storm = 4.64 ac-ft

Total Storage in Pond = 5.00 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

PEAK ELEV 537.87 < OVERFLOW ELEV 538.5

∴ BASIN IS ACCEPTABLE

SHT A13 of 1

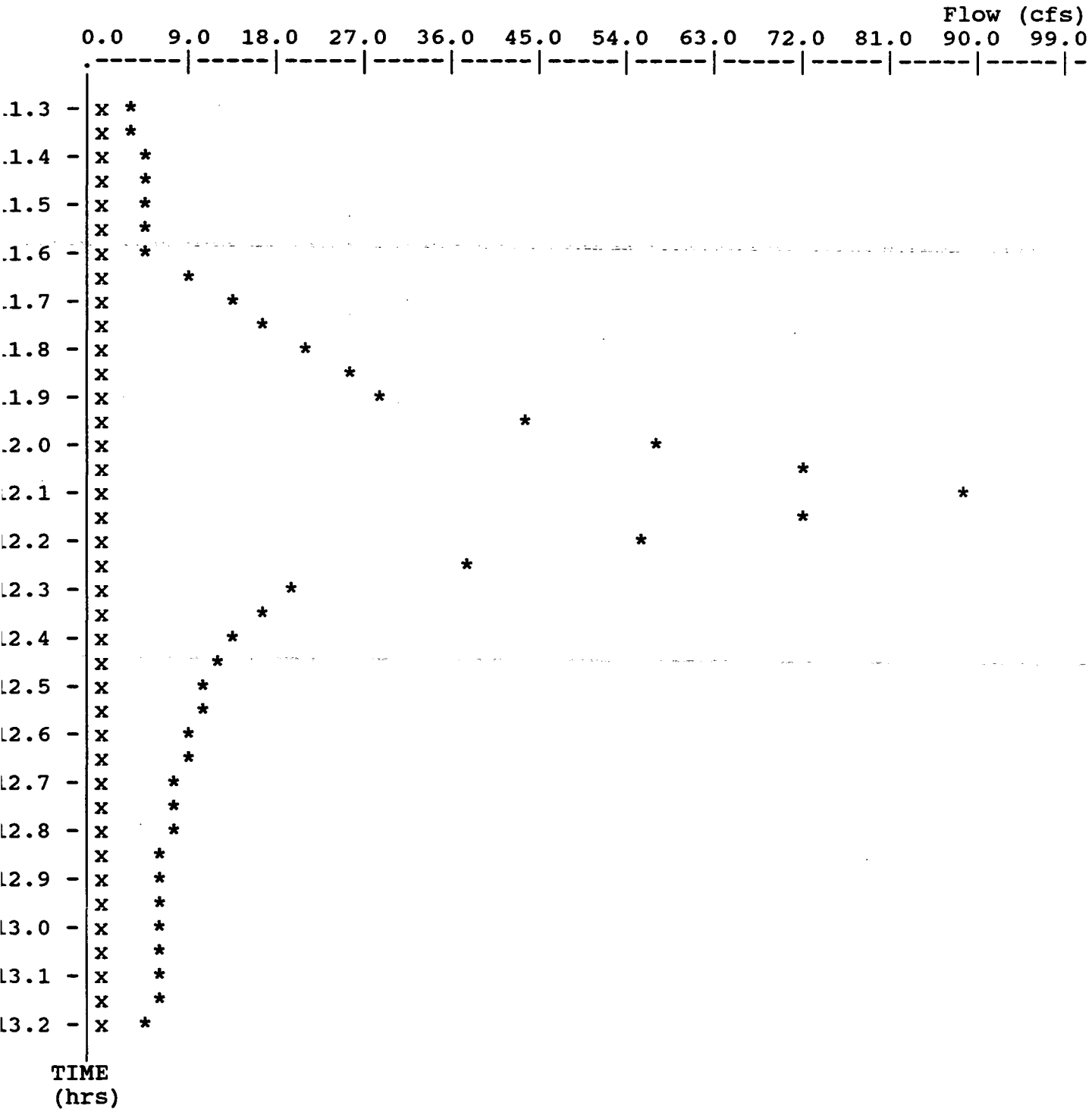
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.17 S/N:

Pond File: c:\po165tk\SW1 .PND
Inflow Hydrograph: c:\po165tk\P1-25 .HYD
Outflow Hydrograph: c:\po165tk\SW1 .HYD

EXECUTED: 08-19-1997
10:26:34

Peak Inflow = 88.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 537.87 ft



SHTA24

```
*  File:  c:\po165tk\P1-25    .HYD   Qmax =    88.0 cfs
x  File:  c:\po165tk\SW1      .HYD   Qmax =     0.0 cfs
```

000064

RETENTION BASIN 2

SHT A26

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:15 08-19-1997 c:\po165tk\P2E.TCT

RETENTION BASIN 2
EXISTING CONDITIONS

Tc COMPUTATIONS FOR: P2

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description	RANGE		
Manning's roughness coeff., n		0.1300	
Flow length, L (total < or = 300)	ft	266.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0450	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.24	= 0.24

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	160.0	
Watercourse slope, s	ft/ft	0.0970	
$Avg.V = Csf * (s)^{0.5}$	ft/s	5.0251	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	1.48	← FROM DITCH 8B CALC.
Wetted perimeter, Pw	ft	3.85	←
Hydraulic radius, r = a/Pw	ft	0.384	
Channel slope, s	ft/ft	0.1000	
Manning's roughness coeff., n		0.0600	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	4.1518	
Flow length, L	ft	280	
T = L / (3600*V)	hrs	0.02	= 0.02

::

TOTAL TIME (hrs) 0.27

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:15 08-19-1997 c:\po165tk\P2E.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN 2
EXISTING CONDITIONS

Subarea descr.	Tc or Tt	Time (hrs)
P2	Tc	0.27

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:45 08-19-1997

RETENTION BASIN 2, EXISTING CONDITIONS
HoA 51.0%, Gn 36.9%, HeF 6.4%,
GRAVEL ROAD 3.0%,
MaC2 2.7%

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
HoA (C): BRUSH, FAIR	2.43	70	
HoA (C): FALLOW, BARE SOIL	1.16	91	
Gn (B): BRUSH, FAIR	1.00	56	
Gn (B): FALLOW, BARE SOIL	1.60	86	
HeF, (B): BRUSH, FAIR	0.45	56	
MaC2, (C): BRUSH, FAIR	0.19	70	
GRAVEL ROAD	0.21	91	
COMPOSITE AREA --->	7.04	74.8	(75)

::

SHT A29

Quick TR-55 Ver.5.46 S/N:
Executed: 10:33:45 08-19-1997

RETENTION BASIN 2, EXISTING CONDITIONS
HoA 51.0%, Gn 36.9%, HeF 6.4%,
GRAVEL ROAD 3.0%,
MaC2 2.7%

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
	7.04	75

SHT A30

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/use
P2	7.04	75.0	0.30	0.00	4.80	2.29	I.14 .14

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 7.04 acres or 0.01100 sq.mi
Peak discharge = 17 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P2	0.27	0.00	0.30	0.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P2	17	12.3
Composite Watershed	17	12.3

SHTA32

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P2	0	1	1	2	5	10	16	17	12
Total (cfs)	0	1	1	2	5	10	16	17	12

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P2	7	5	4	3	2	2	2	1	1
Total (cfs)	7	5	4	3	2	2	2	1	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P2	1	1	1	1	1	1	1	1	1
Total (cfs)	1	1	1	1	1	1	1	1	1

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P2	1	0	0	0	0
Total (cfs)	1	0	0	0	0

SHT A33

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	1
11.1	0	14.9	1
11.2	1	15.0	1
11.3	1	15.1	1
11.4	1	15.2	1
11.5	1	15.3	1
11.6	1	15.4	1
11.7	1	15.5	1
11.8	2	15.6	1
11.9	2	15.7	1
12.0	5	15.8	1
12.1	10	15.9	1
12.2	16	16.0	1
12.3	17	16.1	1
12.4	12	16.2	1
12.5	7	16.3	1
12.6	5	16.4	1
12.7	4	16.5	1
12.8	3	16.6	1
12.9	2	16.7	1
13.0	2	16.8	1
13.1	2	16.9	1
13.2	2	17.0	1
13.3	2	17.1	1
13.4	2	17.2	1
13.5	2	17.3	1
13.6	1	17.4	1
13.7	1	17.5	1
13.8	1	17.6	1
13.9	1	17.7	1
14.0	1	17.8	1
14.1	1	17.9	1
14.2	1	18.0	1
14.3	1	18.1	1
14.4	1	18.2	1
14.5	1	18.3	1

SHT A34

14.6	1	18.4	1
14.7	1	18.5	1

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:40:24
Watershed file: --> C:\PO165TK\P2EX .MOP
Hydrograph file: --> C:\PO165TK\P2E-25.HYD

RETENTION BASIN 2
EXISTING CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	0	22.4	0
18.7	0	22.5	0
18.8	0	22.6	0
18.9	0	22.7	0
19.0	0	22.8	0
19.1	0	22.9	0
19.2	0	23.0	0
19.3	0	23.1	0
19.4	0	23.2	0
19.5	0	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

Quick TR-55 Ver.5.46   S/N:
Executed: 10:45:26   08-19-1997   c:\po165tk\P2.TCT

RETENTION BASIN 2
PROPOSED CONDITIONS

Tc COMPUTATIONS FOR: P2

SHEET FLOW (Applicable to Tc only)

Segment ID		1		
Surface description		BARE		
Manning's roughness coeff., n		0.0110		
Flow length, L (total < or = 300)	ft	250.0		
Two-yr 24-hr rainfall, P2	in	3.000		
Land slope, s	ft/ft	0.0280		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.04	=	0.04

SHALLOW CONCENTRATED FLOW

Segment ID		2		3			
Surface (paved or unpaved)?		Unpaved		Unpaved			
Flow length, L	ft	210.0		220.0			
Watercourse slope, s	ft/ft	0.1190		0.0100			
$Avg.V = Csf * (s)^{0.5}$	ft/s	5.5658		1.6135			
where: Unpaved Csf = 16.1345							
Paved Csf = 20.3282							
T = L / (3600*V)	hrs	0.01	+	0.04	=	0.05	

CHANNEL FLOW

Segment ID		N/A		
Cross Sectional Flow Area, a	sq.ft	0.00		
Wetted perimeter, Pw	ft	0.00		
Hydraulic radius, r = a/Pw	ft	0.000		
Channel slope, s	ft/ft	0.0000		
Manning's roughness coeff., n		0.0000		
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000		
Flow length, L	ft	0		
T = L / (3600*V)	hrs	0.00	=	0.00

:::

TOTAL TIME (hrs)   0.09

use 0.1 hrs

SHTA37 1121

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:26 08-19-1997 c:\po165tk\P2.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN 2
PROPOSED CONDITIONS

Subarea descr.	Tc or Tt	Time (hrs)
P2	Tc	0.09

USE 0.1 hrs

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:54 08-19-1997

RETENTION BASIN 2, PROPOSED CONDITIONS
HoA 49.5%, Gn 38.1%, HeF 6.6%,
GRAVEL ROAD 3.5%,
MaC2 2.3%

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
HoA (C): FALLOW, BARE SOIL	3.00	91	
Gn (B): FALLOW, BARE SOIL	2.31	86	
HeF, (B): FALLOW, BARE SOIL	0.40	86	
MaC2, (C): FALLOW, BARE SOIL	0.14	91	
GRAVEL ROAD	0.21	91	
COMPOSITE AREA --->	6.06	88.8	(89)

::

Quick TR-55 Ver.5.46 S/N:
Executed: 10:45:54 08-19-1997

RETENTION BASIN 2, PROPOSED CONDITIONS
HoA 49.5%, Gn 38.1%, HeF 6.6%,
GRAVEL ROAD 3.5%,
MaC2 2.3%

RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
	6.06	89

SHT A40

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/us
P2	6.06	89.0	0.10	0.00	4.80	3.58	I.05 .1

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 6.06 acres or 0.00947 sq.mi
Peak discharge = 34 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P2	0.10	0.00	**	**	No	Computed Ia/p < .

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P2	34	12.1
Composite Watershed	34	12.1

SHT A42

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12. hr
P2	1	1	2	11	22	34	21	7	5
Total (cfs)	1	1	2	11	22	34	21	7	5

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13. hr
P2	4	4	3	3	2	2	2	2	1
Total (cfs)	4	4	3	3	2	2	2	2	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17. hr
P2	1	1	1	1	1	1	1	1	1
Total (cfs)	1	1	1	1	1	1	1	1	1

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P2	1	1	0	0	0
Total (cfs)	1	1	0	0	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	1	14.8	1
11.1	1	14.9	1
11.2	1	15.0	1
11.3	1	15.1	1
11.4	1	15.2	1
11.5	2	15.3	1
11.6	2	15.4	1
11.7	5	15.5	1
11.8	8	15.6	1
11.9	11	15.7	1
12.0	22	15.8	1
12.1	34	15.9	1
12.2	21	16.0	1
12.3	7	16.1	1
12.4	5	16.2	1
12.5	4	16.3	1
12.6	4	16.4	1
12.7	3	16.5	1
12.8	3	16.6	1
12.9	2	16.7	1
13.0	2	16.8	1
13.1	2	16.9	1
13.2	2	17.0	1
13.3	2	17.1	1
13.4	2	17.2	1
13.5	2	17.3	1
13.6	2	17.4	1
13.7	1	17.5	1
13.8	1	17.6	1
13.9	1	17.7	1
14.0	1	17.8	1
14.1	1	17.9	1
14.2	1	18.0	1
14.3	1	18.1	1
14.4	1	18.2	1
14.5	1	18.3	1

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14.6	1	18.4	1
14.7	1	18.5	1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 10:56:59
Watershed file: --> C:\PO165TK\P2 .MOP
Hydrograph file: --> C:\PO165TK\P2-25.HYD

RETENTION BASIN 2
PROPOSED CONDITIONS

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	1	22.4	0
18.7	1	22.5	0
18.8	1	22.6	0
18.9	1	22.7	0
19.0	1	22.8	0
19.1	1	22.9	0
19.2	1	23.0	0
19.3	1	23.1	0
19.4	1	23.2	0
19.5	1	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

SHT A46

POND-2 Version: 5.17 S/N:

>>>>> OUTFLOW HYDROGRAPH ESTIMATOR <<<<<

Inflow Hydrograph: c:\po165tk\P2E-25 .HYD
Qpeak = 17.0 cfs

Estimated Outflow: c:\po165tk\ESTIMATE.EST
Qpeak = 0.0 cfs

Approximate Storage Volume
(computed from t= 11.00 to 25.90 hrs)

1.3 acre-ft

POND-2 Version: 5.17 S/N:

>>>>> OUTFLOW HYDROGRAPH ESTIMATOR <<<<<

Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Qpeak = 34.0 cfs

Estimated Outflow: c:\po165tk\ESTIMATE.EST
Qpeak = 0.0 cfs

Approximate Storage Volume
(computed from t= 11.00 to 25.90 hrs)

1.7 acre-ft

NOTE: VOLUME ESTIMATE FOR EXISTING CONDITIONS = 1.3 AC.-FT (PREVIOUS SHEET)

VOLUME ESTIMATE FOR PROPOSED CONDITIONS = 1.7 AC-FT

USE PROPOSED CONDITIONS
FOR ROUTING

SHT A48

POND-2 Version: 5.17
S/N:

RETENTION BASIN 2
W/3:1 SIDE SLOPES

CALCULATED 08-19-1997 11:11:30
DISK FILE: c:\po165tk\SW2-T1 .VOL

Planimeter scale: 1 inch = 10 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
528.70	0.00	0.00	0.00	0.00	0.00
529.00	25.38	0.06	0.06	0.01	0.01
530.00	42.26	0.10	0.23	0.08	0.08
531.00	62.78	0.14	0.36	0.12	0.20
532.00	83.00	0.19	0.50	0.17	0.37
533.00	104.32	0.24	0.64	0.21	0.58
534.00	127.21	0.29	0.80	0.27	0.85
535.00	154.79	0.36	0.97	0.32	1.17
536.00	185.99	0.43	1.17	0.39	1.56
537.00	215.38	0.49	1.38	0.46	2.02

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

530.30	-----	0.11	0.31	0.03	0.11

* Incremental volume computed by the Conic Method for Reservoir Volumes.

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44


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**********************
*                    *
*   STORM BASIN NO. 2 *
*   W/3:1 SIDE SLOPES *
*                    *
*                    *
*                    *
**********************
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Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Rating Table file: c:\po165tk\SW2-T1 .PND

----INITIAL CONDITIONS----
Elevation = 530.30 ft —— MAX. SEDIMENT CLEANOUT ELEV
Outflow = 0.00 cfs
Storage = 0.11 ac-ft —— MAX. SEDIMENT STORAGE VOLUME

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + O (cfs)
528.70	0.0	0.000	0.0	0.0
529.00	0.0	0.010	2.4	2.4
530.00	0.0	0.080	19.4	19.4
530.30	0.0	0.110	26.6	26.6
531.00	0.0	0.200	48.4	48.4
532.00	0.0	0.370	89.5	89.5
533.00	0.0	0.580	140.4	140.4
534.00	0.0	0.850	205.7	205.7
535.00	0.0	1.170	283.1	283.1
536.00	0.0	1.560	377.5	377.5
537.00	0.0	2.020	488.8	488.8

Time increment (t) = 0.100 hrs.

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	1.00	-----	26.6	26.6	0.00	530.30
11.100	1.00	2.0	28.6	28.6	0.00	530.36
11.200	1.00	2.0	30.6	30.6	0.00	530.43
11.300	1.00	2.0	32.6	32.6	0.00	530.49
11.400	1.00	2.0	34.6	34.6	0.00	530.56
11.500	2.00	3.0	37.6	37.6	0.00	530.65
11.600	2.00	4.0	41.6	41.6	0.00	530.78
11.700	5.00	7.0	48.6	48.6	0.00	531.01
11.800	8.00	13.0	61.6	61.6	0.00	531.32
11.900	11.00	19.0	80.6	80.6	0.00	531.78
12.000	22.00	33.0	113.6	113.6	0.00	532.47
12.100	34.00	56.0	169.6	169.6	0.00	533.45
12.200	21.00	55.0	224.6	224.6	0.00	534.24
12.300	7.00	28.0	252.6	252.6	0.00	534.61
12.400	5.00	12.0	264.6	264.6	0.00	534.76
12.500	4.00	9.0	273.6	273.6	0.00	534.88
12.600	4.00	8.0	281.6	281.6	0.00	534.98
12.700	3.00	7.0	288.6	288.6	0.00	535.06
12.800	3.00	6.0	294.6	294.6	0.00	535.12
12.900	2.00	5.0	299.6	299.6	0.00	535.17
13.000	2.00	4.0	303.6	303.6	0.00	535.22
13.100	2.00	4.0	307.6	307.6	0.00	535.26
13.200	2.00	4.0	311.6	311.6	0.00	535.30
13.300	2.00	4.0	315.6	315.6	0.00	535.34
13.400	2.00	4.0	319.6	319.6	0.00	535.39
13.500	2.00	4.0	323.6	323.6	0.00	535.43
13.600	2.00	4.0	327.6	327.6	0.00	535.47
13.700	2.00	4.0	331.6	331.6	0.00	535.51
13.800	1.00	3.0	334.6	334.6	0.00	535.55
13.900	1.00	2.0	336.6	336.6	0.00	535.57
14.000	1.00	2.0	338.6	338.6	0.00	535.59
14.100	1.00	2.0	340.6	340.6	0.00	535.61
14.200	1.00	2.0	342.6	342.6	0.00	535.63
14.300	1.00	2.0	344.6	344.6	0.00	535.65
14.400	1.00	2.0	346.6	346.6	0.00	535.67
14.500	1.00	2.0	348.6	348.6	0.00	535.69
14.600	1.00	2.0	350.6	350.6	0.00	535.71
14.700	1.00	2.0	352.6	352.6	0.00	535.74
14.800	1.00	2.0	354.6	354.6	0.00	535.76
14.900	1.00	2.0	356.6	356.6	0.00	535.78
15.000	1.00	2.0	358.6	358.6	0.00	535.80
15.100	1.00	2.0	360.6	360.6	0.00	535.82
15.200	1.00	2.0	362.6	362.6	0.00	535.84
15.300	1.00	2.0	364.6	364.6	0.00	535.86
15.400	1.00	2.0	366.6	366.6	0.00	535.88

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	1.00	2.0	368.6	368.6	0.00	535.91
15.600	1.00	2.0	370.6	370.6	0.00	535.93
15.700	1.00	2.0	372.6	372.6	0.00	535.95
15.800	1.00	2.0	374.6	374.6	0.00	535.97
15.900	1.00	2.0	376.6	376.6	0.00	535.99
16.000	1.00	2.0	378.6	378.6	0.00	536.01
16.100	1.00	2.0	380.6	380.6	0.00	536.03
16.200	1.00	2.0	382.6	382.6	0.00	536.05
16.300	1.00	2.0	384.6	384.6	0.00	536.06
16.400	1.00	2.0	386.6	386.6	0.00	536.08
16.500	1.00	2.0	388.6	388.6	0.00	536.10
16.600	1.00	2.0	390.6	390.6	0.00	536.12
16.700	1.00	2.0	392.6	392.6	0.00	536.14
16.800	1.00	2.0	394.6	394.6	0.00	536.15
16.900	1.00	2.0	396.6	396.6	0.00	536.17
17.000	1.00	2.0	398.6	398.6	0.00	536.19
17.100	1.00	2.0	400.6	400.6	0.00	536.21
17.200	1.00	2.0	402.6	402.6	0.00	536.23
17.300	1.00	2.0	404.6	404.6	0.00	536.24
17.400	1.00	2.0	406.6	406.6	0.00	536.26
17.500	1.00	2.0	408.6	408.6	0.00	536.28
17.600	1.00	2.0	410.6	410.6	0.00	536.30
17.700	1.00	2.0	412.6	412.6	0.00	536.32
17.800	1.00	2.0	414.6	414.6	0.00	536.33
17.900	1.00	2.0	416.6	416.6	0.00	536.35
18.000	1.00	2.0	418.6	418.6	0.00	536.37
18.100	1.00	2.0	420.6	420.6	0.00	536.39
18.200	1.00	2.0	422.6	422.6	0.00	536.41
18.300	1.00	2.0	424.6	424.6	0.00	536.42
18.400	1.00	2.0	426.6	426.6	0.00	536.44
18.500	1.00	2.0	428.6	428.6	0.00	536.46
18.600	1.00	2.0	430.6	430.6	0.00	536.48
18.700	1.00	2.0	432.6	432.6	0.00	536.49
18.800	1.00	2.0	434.6	434.6	0.00	536.51
18.900	1.00	2.0	436.6	436.6	0.00	536.53
19.000	1.00	2.0	438.6	438.6	0.00	536.55
19.100	1.00	2.0	440.6	440.6	0.00	536.57
19.200	1.00	2.0	442.6	442.6	0.00	536.58
19.300	1.00	2.0	444.6	444.6	0.00	536.60
19.400	1.00	2.0	446.6	446.6	0.00	536.62
19.500	0.00	1.0	447.6	447.6	0.00	536.63
19.600	0.00	0.0	447.6	447.6	0.00	536.63
19.700	0.00	0.0	447.6	447.6	0.00	536.63
19.800	0.00	0.0	447.6	447.6	0.00	536.63
19.900	0.00	0.0	447.6	447.6	0.00	536.63
20.000	0.00	0.0	447.6	447.6	0.00	536.63

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EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	0.00	0.0	447.6	447.6	0.00	536.63
20.200	0.00	0.0	447.6	447.6	0.00	536.63
20.300	0.00	0.0	447.6	447.6	0.00	536.63
20.400	0.00	0.0	447.6	447.6	0.00	536.63
20.500	0.00	0.0	447.6	447.6	0.00	536.63
20.600	0.00	0.0	447.6	447.6	0.00	536.63
20.700	0.00	0.0	447.6	447.6	0.00	536.63
20.800	0.00	0.0	447.6	447.6	0.00	536.63
20.900	0.00	0.0	447.6	447.6	0.00	536.63
21.000	0.00	0.0	447.6	447.6	0.00	536.63
21.100	0.00	0.0	447.6	447.6	0.00	536.63
21.200	0.00	0.0	447.6	447.6	0.00	536.63
21.300	0.00	0.0	447.6	447.6	0.00	536.63
21.400	0.00	0.0	447.6	447.6	0.00	536.63
21.500	0.00	0.0	447.6	447.6	0.00	536.63
21.600	0.00	0.0	447.6	447.6	0.00	536.63
21.700	0.00	0.0	447.6	447.6	0.00	536.63
21.800	0.00	0.0	447.6	447.6	0.00	536.63
21.900	0.00	0.0	447.6	447.6	0.00	536.63
22.000	0.00	0.0	447.6	447.6	0.00	536.63
22.100	0.00	0.0	447.6	447.6	0.00	536.63
22.200	0.00	0.0	447.6	447.6	0.00	536.63
22.300	0.00	0.0	447.6	447.6	0.00	536.63
22.400	0.00	0.0	447.6	447.6	0.00	536.63
22.500	0.00	0.0	447.6	447.6	0.00	536.63
22.600	0.00	0.0	447.6	447.6	0.00	536.63
22.700	0.00	0.0	447.6	447.6	0.00	536.63
22.800	0.00	0.0	447.6	447.6	0.00	536.63
22.900	0.00	0.0	447.6	447.6	0.00	536.63
23.000	0.00	0.0	447.6	447.6	0.00	536.63
23.100	0.00	0.0	447.6	447.6	0.00	536.63
23.200	0.00	0.0	447.6	447.6	0.00	536.63
23.300	0.00	0.0	447.6	447.6	0.00	536.63
23.400	0.00	0.0	447.6	447.6	0.00	536.63
23.500	0.00	0.0	447.6	447.6	0.00	536.63
23.600	0.00	0.0	447.6	447.6	0.00	536.63
23.700	0.00	0.0	447.6	447.6	0.00	536.63
23.800	0.00	0.0	447.6	447.6	0.00	536.63
23.900	0.00	0.0	447.6	447.6	0.00	536.63
24.000	0.00	0.0	447.6	447.6	0.00	536.63
24.100	0.00	0.0	447.6	447.6	0.00	536.63
24.200	0.00	0.0	447.6	447.6	0.00	536.63
24.300	0.00	0.0	447.6	447.6	0.00	536.63
24.400	0.00	0.0	447.6	447.6	0.00	536.63
24.500	0.00	0.0	447.6	447.6	0.00	536.63
24.600	0.00	0.0	447.6	447.6	0.00	536.63

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 11:12:44

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	447.6	447.6	0.00	536.63
24.800	0.00	0.0	447.6	447.6	0.00	536.63
24.900	0.00	0.0	447.6	447.6	0.00	536.63
25.000	0.00	0.0	447.6	447.6	0.00	536.63
25.100	0.00	0.0	447.6	447.6	0.00	536.63
25.200	0.00	0.0	447.6	447.6	0.00	536.63
25.300	0.00	0.0	447.6	447.6	0.00	536.63
25.400	0.00	0.0	447.6	447.6	0.00	536.63
25.500	0.00	0.0	447.6	447.6	0.00	536.63
25.600	0.00	0.0	447.6	447.6	0.00	536.63
25.700	0.00	0.0	447.6	447.6	0.00	536.63
25.800	0.00	0.0	447.6	447.6	0.00	536.63
25.900	0.00	0.0	447.6	447.6	0.00	536.63

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

Starting Pond W.S. Elevation = 530.30 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 34.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 536.63 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.11 ac-ft
Peak Storage From Storm = 1.74 ac-ft

Total Storage in Pond = 1.85 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

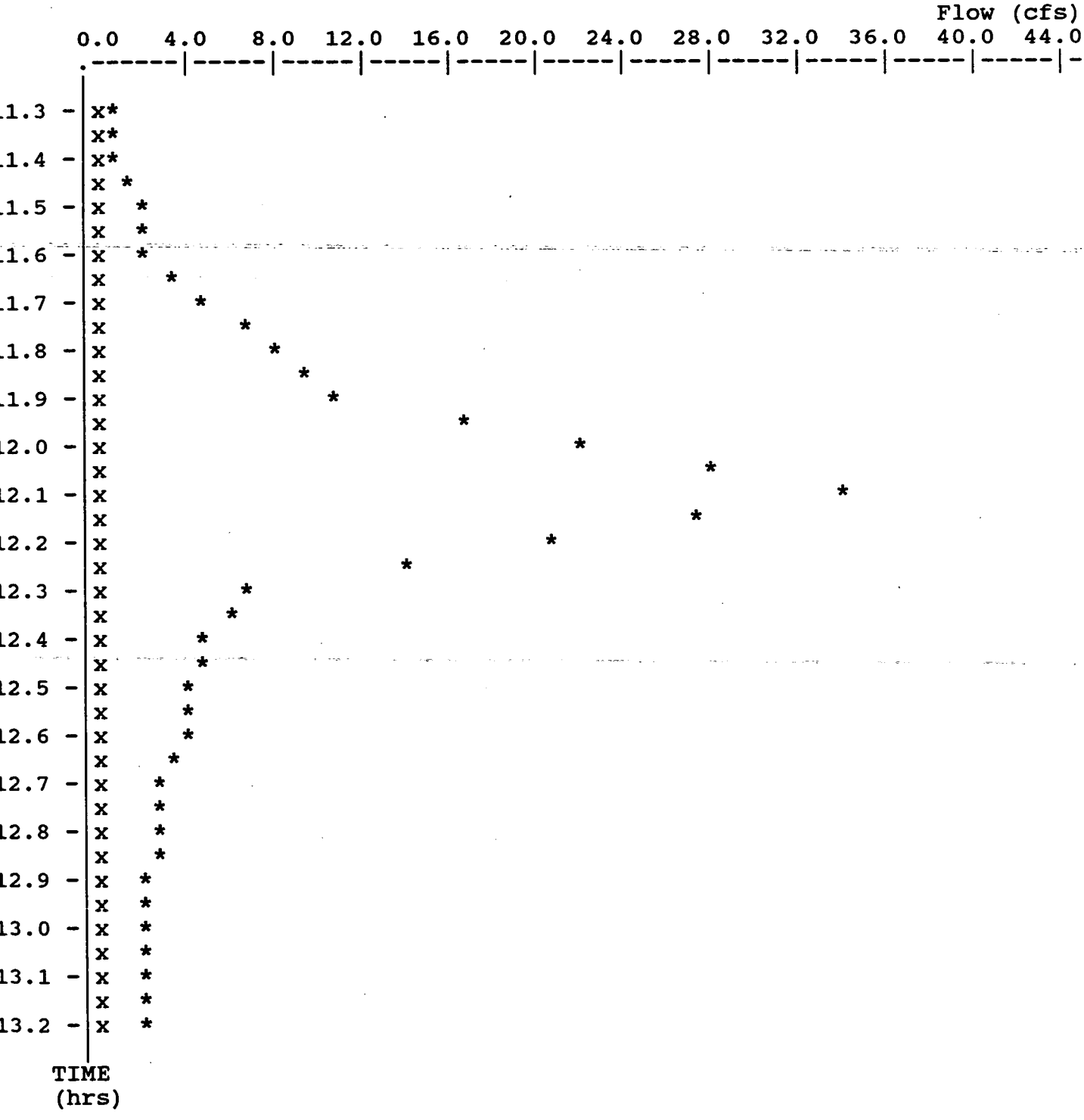
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.17 S/N: Page 7

Pond File: c:\po165tk\SW2-T1 .PND
Inflow Hydrograph: c:\po165tk\P2-25 .HYD
Outflow Hydrograph: c:\po165tk\SW2-T1 .HYD

EXECUTED: 08-19-1997
11:12:44

Peak Inflow = 34.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 536.63 ft



```
* File:  c:\po165tk\P2-25    .HYD   Qmax =    34.0 cfs
x File:  c:\po165tk\SW2-T1   .HYD   Qmax =     0.0 cfs
```

SNTA56

RETENTION BASIN 3

SHT A58

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:38 08-19-1997 c:\po165tk\P3.TCT

RETENTION BASIN 3

Tc COMPUTATIONS FOR: P3

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		BARE SOIL	
Manning's roughness coeff., n		0.0110	
Flow length, L (total < or = 300)	ft	222.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0810	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.02	= 0.02

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	145.0	
Watercourse slope, s	ft/ft	0.0760	
$Avg.V = Csf * (s)^{0.5}$	ft/s	4.4480	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID		N/A	
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.03

USE 0.1 hrs

000098

SHT A59

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:38 08-19-1997 c:\po165tk\P3.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

RETENTION BASIN 3

Subarea descr.	Tc or Tt	Time (hrs)
P3	Tc	0.03

USE 0.1 hrs

SHT A60

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:53 08-19-1997

RETENTION BASIN 3
HoA 35%, MoE2 30%, Gn 15%, HeF 11.6%
GRAVEL SURFACE = 8.4%%
ASSUMED ANY VEG AREA AS BARE

RUNOFF CURVE NUMBER DATA

::

Composite Area: P3

SURFACE DESCRIPTION	AREA (acres)	CN	
HoA, (C): FALLOW, BARE SOIL	1.67	91	
MoE2, (B): FALLOW, BARE SOIL	1.43	86	
Gn, (B): FALLOW, BARE SOIL	0.72	86	
HeF, (B): FALLOW, BARE SOIL	0.56	86	
GRAVEL ROAD	0.40	91	
COMPOSITE AREA --->	4.78	88.2	(88)

::

Quick TR-55 Ver.5.46 S/N:
Executed: 11:20:53 08-19-1997

RETENTION BASIN 3
HoA 35%, MoE2 30%, Gn 15%, HeF 11.6%
GRAVEL SURFACE = 8.4%%
ASSUMED ANY VEG AREA AS BARE

RUNOFF CURVE NUMBER SUMMARY
::

Subarea Description	Area (acres)	CN (weighted)
P3	4.78	88

SHT A52

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/use
P3	4.78	88.0	0.10	0.00	4.10	2.82	I.07 .1(

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 4.78 acres or 0.00747 sq.mi
Peak discharge = 21 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
P3	0.10	0.00	**	**	No	Computed Ia/p < .:

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
P3	21	12.1
Composite Watershed	21	12.1

SHT A64

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
P3	1	1	1	7	14	21	13	5	3
Total (cfs)	1	1	1	7	14	21	13	5	3

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
P3	3	2	2	2	1	1	1	1	1
Total (cfs)	3	2	2	2	1	1	1	1	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
P3	1	1	1	1	1	0	0	0	0
Total (cfs)	1	1	1	1	1	0	0	0	0

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
P3	0	0	0	0	0
Total (cfs)	0	0	0	0	0

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	1	14.8	1
11.1	1	14.9	1
11.2	1	15.0	1
11.3	1	15.1	1
11.4	1	15.2	1
11.5	1	15.3	1
11.6	1	15.4	1
11.7	3	15.5	1
11.8	5	15.6	1
11.9	7	15.7	1
12.0	14	15.8	0
12.1	21	15.9	0
12.2	13	16.0	0
12.3	5	16.1	0
12.4	3	16.2	0
12.5	3	16.3	0
12.6	2	16.4	0
12.7	2	16.5	0
12.8	2	16.6	0
12.9	1	16.7	0
13.0	1	16.8	0
13.1	1	16.9	0
13.2	1	17.0	0
13.3	1	17.1	0
13.4	1	17.2	0
13.5	1	17.3	0
13.6	1	17.4	0
13.7	1	17.5	0
13.8	1	17.6	0
13.9	1	17.7	0
14.0	1	17.8	0
14.1	1	17.9	0
14.2	1	18.0	0
14.3	1	18.1	0
14.4	1	18.2	0
14.5	1	18.3	0

SHT A66

14.6	1	18.4	0
14.7	1	18.5	0

Return Frequency: 10 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 08-19-1997 11:22:38
Watershed file: --> C:\PO165TK\P3 .MOP
Hydrograph file: --> C:\PO165TK\P3-10.HYD

RETENTION BASIN 3

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	0	22.4	0
18.7	0	22.5	0
18.8	0	22.6	0
18.9	0	22.7	0
19.0	0	22.8	0
19.1	0	22.9	0
19.2	0	23.0	0
19.3	0	23.1	0
19.4	0	23.2	0
19.5	0	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

SWT-A68

POND-2 Version: 5.17
S/N:

RETENTION BASIN 3
W/3:1 SIDE SLOPES
1' DEEPER

CALCULATED 08-19-1997 13:16:51
DISK FILE: c:\po165tk\SW3-T1 .VOL

Planimeter scale: 1 inch = 10 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
532.50	0.00	0.00	0.00	0.00	0.00
533.00	26.52	0.06	0.06	0.01	0.01
534.00	36.29	0.08	0.22	0.07	0.08
535.00	47.04	0.11	0.29	0.10	0.18
536.00	58.73	0.13	0.36	0.12	0.30
537.00	71.40	0.16	0.45	0.15	0.45
538.00	85.08	0.20	0.54	0.18	0.63
539.00	99.71	0.23	0.64	0.21	0.84
540.00	117.39	0.27	0.75	0.25	1.09
541.00	131.90	0.30	0.86	0.29	1.37

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

540.10	-----	0.27	0.81	0.03	1.11
540.20	-----	0.28	0.82	0.05	1.14
540.30	-----	0.28	0.82	0.08	1.17
540.40	-----	0.28	0.83	0.11	1.20
540.50	-----	0.29	0.83	0.14	1.23
540.60	-----	0.29	0.84	0.17	1.26
540.70	-----	0.29	0.84	0.20	1.28
540.80	-----	0.30	0.85	0.23	1.31
540.90	-----	0.30	0.85	0.26	1.34

* Incremental volume computed by the Conic Method for Reservoir Volumes.

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51


```
*****************************
*                           *
* STORM WATER BASIN NO. 3   *
*                           *
*                           *
*                           *
*                           *
*****************************
```

Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Rating Table file: c:\po165tk\SW3-T1 .PND

----INITIAL CONDITIONS----
Elevation = 534.20 ft — MAX. SEDIMENT CLEANOUT ELEV.
Outflow = 0.00 cfs
Storage = 0.10 ac-ft — MAX. SEDIMENT STORAGE

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + O (cfs)
532.50	0.0	0.000	0.0	0.0
533.00	0.0	0.010	2.4	2.4
534.00	0.0	0.080	19.4	19.4
535.00	0.0	0.180	43.6	43.6
536.00	0.0	0.300	72.6	72.6
537.00	0.0	0.450	108.9	108.9
538.00	0.0	0.630	152.5	152.5
539.00	0.0	0.840	203.3	203.3
540.00	0.0	1.090	263.8	263.8
540.10	3.2	1.110	268.6	271.8
540.20	6.5	1.140	275.9	282.4
540.30	9.7	1.170	283.1	292.8
540.40	13.0	1.200	290.4	303.4
540.50	16.2	1.230	297.7	313.9
540.60	22.1	1.260	304.9	327.0
540.70	29.6	1.280	309.8	339.4
540.80	37.8	1.310	317.0	354.8
540.90	46.8	1.340	324.3	371.1
541.00	56.5	1.370	331.5	388.0

Time increment (t) = 0.100 hrs.

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	1.00	-----	24.2	24.2	0.00	534.20
11.100	1.00	2.0	26.2	26.2	0.00	534.28
11.200	1.00	2.0	28.2	28.2	0.00	534.37
11.300	1.00	2.0	30.2	30.2	0.00	534.45
11.400	1.00	2.0	32.2	32.2	0.00	534.53
11.500	1.00	2.0	34.2	34.2	0.00	534.61
11.600	1.00	2.0	36.2	36.2	0.00	534.70
11.700	3.00	4.0	40.2	40.2	0.00	534.86
11.800	5.00	8.0	48.2	48.2	0.00	535.16
11.900	7.00	12.0	60.2	60.2	0.00	535.57
12.000	14.00	21.0	81.2	81.2	0.00	536.24
12.100	21.00	35.0	116.2	116.2	0.00	537.17
12.200	13.00	34.0	150.2	150.2	0.00	537.95
12.300	5.00	18.0	168.2	168.2	0.00	538.31
12.400	3.00	8.0	176.2	176.2	0.00	538.47
12.500	3.00	6.0	182.2	182.2	0.00	538.59
12.600	2.00	5.0	187.2	187.2	0.00	538.68
12.700	2.00	4.0	191.2	191.2	0.00	538.76
12.800	2.00	4.0	195.2	195.2	0.00	538.84
12.900	2.00	4.0	199.2	199.2	0.00	538.92
13.000	1.00	3.0	202.2	202.2	0.00	538.98
13.100	1.00	2.0	204.2	204.2	0.00	539.02
13.200	1.00	2.0	206.2	206.2	0.00	539.05
13.300	1.00	2.0	208.2	208.2	0.00	539.08
13.400	1.00	2.0	210.2	210.2	0.00	539.11
13.500	1.00	2.0	212.2	212.2	0.00	539.15
13.600	1.00	2.0	214.2	214.2	0.00	539.18
13.700	1.00	2.0	216.2	216.2	0.00	539.21
13.800	1.00	2.0	218.2	218.2	0.00	539.25
13.900	1.00	2.0	220.2	220.2	0.00	539.28
14.000	1.00	2.0	222.2	222.2	0.00	539.31
14.100	1.00	2.0	224.2	224.2	0.00	539.35
14.200	1.00	2.0	226.2	226.2	0.00	539.38
14.300	1.00	2.0	228.2	228.2	0.00	539.41
14.400	1.00	2.0	230.2	230.2	0.00	539.44
14.500	1.00	2.0	232.2	232.2	0.00	539.48
14.600	1.00	2.0	234.2	234.2	0.00	539.51
14.700	1.00	2.0	236.2	236.2	0.00	539.54
14.800	1.00	2.0	238.2	238.2	0.00	539.58
14.900	1.00	2.0	240.2	240.2	0.00	539.61
15.000	1.00	2.0	242.2	242.2	0.00	539.64
15.100	1.00	2.0	244.2	244.2	0.00	539.68
15.200	1.00	2.0	246.2	246.2	0.00	539.71
15.300	1.00	2.0	248.2	248.2	0.00	539.74
15.400	1.00	2.0	250.2	250.2	0.00	539.78

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	1.00	2.0	252.2	252.2	0.00	539.81
15.600	1.00	2.0	254.2	254.2	0.00	539.84
15.700	1.00	2.0	256.2	256.2	0.00	539.87
15.800	0.00	1.0	257.2	257.2	0.00	539.89
15.900	0.00	0.0	257.2	257.2	0.00	539.89
16.000	0.00	0.0	257.2	257.2	0.00	539.89
16.100	0.00	0.0	257.2	257.2	0.00	539.89
16.200	0.00	0.0	257.2	257.2	0.00	539.89
16.300	0.00	0.0	257.2	257.2	0.00	539.89
16.400	0.00	0.0	257.2	257.2	0.00	539.89
16.500	0.00	0.0	257.2	257.2	0.00	539.89
16.600	0.00	0.0	257.2	257.2	0.00	539.89
16.700	0.00	0.0	257.2	257.2	0.00	539.89
16.800	0.00	0.0	257.2	257.2	0.00	539.89
16.900	0.00	0.0	257.2	257.2	0.00	539.89
17.000	0.00	0.0	257.2	257.2	0.00	539.89
17.100	0.00	0.0	257.2	257.2	0.00	539.89
17.200	0.00	0.0	257.2	257.2	0.00	539.89
17.300	0.00	0.0	257.2	257.2	0.00	539.89
17.400	0.00	0.0	257.2	257.2	0.00	539.89
17.500	0.00	0.0	257.2	257.2	0.00	539.89
17.600	0.00	0.0	257.2	257.2	0.00	539.89
17.700	0.00	0.0	257.2	257.2	0.00	539.89
17.800	0.00	0.0	257.2	257.2	0.00	539.89
17.900	0.00	0.0	257.2	257.2	0.00	539.89
18.000	0.00	0.0	257.2	257.2	0.00	539.89
18.100	0.00	0.0	257.2	257.2	0.00	539.89
18.200	0.00	0.0	257.2	257.2	0.00	539.89
18.300	0.00	0.0	257.2	257.2	0.00	539.89
18.400	0.00	0.0	257.2	257.2	0.00	539.89
18.500	0.00	0.0	257.2	257.2	0.00	539.89
18.600	0.00	0.0	257.2	257.2	0.00	539.89
18.700	0.00	0.0	257.2	257.2	0.00	539.89
18.800	0.00	0.0	257.2	257.2	0.00	539.89
18.900	0.00	0.0	257.2	257.2	0.00	539.89
19.000	0.00	0.0	257.2	257.2	0.00	539.89
19.100	0.00	0.0	257.2	257.2	0.00	539.89
19.200	0.00	0.0	257.2	257.2	0.00	539.89
19.300	0.00	0.0	257.2	257.2	0.00	539.89
19.400	0.00	0.0	257.2	257.2	0.00	539.89
19.500	0.00	0.0	257.2	257.2	0.00	539.89
19.600	0.00	0.0	257.2	257.2	0.00	539.89
19.700	0.00	0.0	257.2	257.2	0.00	539.89
19.800	0.00	0.0	257.2	257.2	0.00	539.89
19.900	0.00	0.0	257.2	257.2	0.00	539.89
20.000	0.00	0.0	257.2	257.2	0.00	539.89

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	0.00	0.0	257.2	257.2	0.00	539.89
20.200	0.00	0.0	257.2	257.2	0.00	539.89
20.300	0.00	0.0	257.2	257.2	0.00	539.89
20.400	0.00	0.0	257.2	257.2	0.00	539.89
20.500	0.00	0.0	257.2	257.2	0.00	539.89
20.600	0.00	0.0	257.2	257.2	0.00	539.89
20.700	0.00	0.0	257.2	257.2	0.00	539.89
20.800	0.00	0.0	257.2	257.2	0.00	539.89
20.900	0.00	0.0	257.2	257.2	0.00	539.89
21.000	0.00	0.0	257.2	257.2	0.00	539.89
21.100	0.00	0.0	257.2	257.2	0.00	539.89
21.200	0.00	0.0	257.2	257.2	0.00	539.89
21.300	0.00	0.0	257.2	257.2	0.00	539.89
21.400	0.00	0.0	257.2	257.2	0.00	539.89
21.500	0.00	0.0	257.2	257.2	0.00	539.89
21.600	0.00	0.0	257.2	257.2	0.00	539.89
21.700	0.00	0.0	257.2	257.2	0.00	539.89
21.800	0.00	0.0	257.2	257.2	0.00	539.89
21.900	0.00	0.0	257.2	257.2	0.00	539.89
22.000	0.00	0.0	257.2	257.2	0.00	539.89
22.100	0.00	0.0	257.2	257.2	0.00	539.89
22.200	0.00	0.0	257.2	257.2	0.00	539.89
22.300	0.00	0.0	257.2	257.2	0.00	539.89
22.400	0.00	0.0	257.2	257.2	0.00	539.89
22.500	0.00	0.0	257.2	257.2	0.00	539.89
22.600	0.00	0.0	257.2	257.2	0.00	539.89
22.700	0.00	0.0	257.2	257.2	0.00	539.89
22.800	0.00	0.0	257.2	257.2	0.00	539.89
22.900	0.00	0.0	257.2	257.2	0.00	539.89
23.000	0.00	0.0	257.2	257.2	0.00	539.89
23.100	0.00	0.0	257.2	257.2	0.00	539.89
23.200	0.00	0.0	257.2	257.2	0.00	539.89
23.300	0.00	0.0	257.2	257.2	0.00	539.89
23.400	0.00	0.0	257.2	257.2	0.00	539.89
23.500	0.00	0.0	257.2	257.2	0.00	539.89
23.600	0.00	0.0	257.2	257.2	0.00	539.89
23.700	0.00	0.0	257.2	257.2	0.00	539.89
23.800	0.00	0.0	257.2	257.2	0.00	539.89
23.900	0.00	0.0	257.2	257.2	0.00	539.89
24.000	0.00	0.0	257.2	257.2	0.00	539.89
24.100	0.00	0.0	257.2	257.2	0.00	539.89
24.200	0.00	0.0	257.2	257.2	0.00	539.89
24.300	0.00	0.0	257.2	257.2	0.00	539.89
24.400	0.00	0.0	257.2	257.2	0.00	539.89
24.500	0.00	0.0	257.2	257.2	0.00	539.89
24.600	0.00	0.0	257.2	257.2	0.00	539.89

POND-2 Version: 5.17 S/N:
EXECUTED: 08-19-1997 13:19:51

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	0.00	0.0	257.2	257.2	0.00	539.89
24.800	0.00	0.0	257.2	257.2	0.00	539.89
24.900	0.00	0.0	257.2	257.2	0.00	539.89
25.000	0.00	0.0	257.2	257.2	0.00	539.89
25.100	0.00	0.0	257.2	257.2	0.00	539.89
25.200	0.00	0.0	257.2	257.2	0.00	539.89
25.300	0.00	0.0	257.2	257.2	0.00	539.89
25.400	0.00	0.0	257.2	257.2	0.00	539.89
25.500	0.00	0.0	257.2	257.2	0.00	539.89
25.600	0.00	0.0	257.2	257.2	0.00	539.89
25.700	0.00	0.0	257.2	257.2	0.00	539.89
25.800	0.00	0.0	257.2	257.2	0.00	539.89
25.900	0.00	0.0	257.2	257.2	0.00	539.89

SHT A74

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

Starting Pond W.S. Elevation = 534.20 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 21.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 539.89 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0.10 ac-ft
Peak Storage From Storm = 0.96 ac-ft

Total Storage in Pond = 1.06 ac-ft

Warning: Inflow hydrograph truncated on left side.

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

PEAK ELEV = 539.89 < OVERFLOW OUTLET ELEV 540.0

∴ BASIN IS ACCEPTABLE

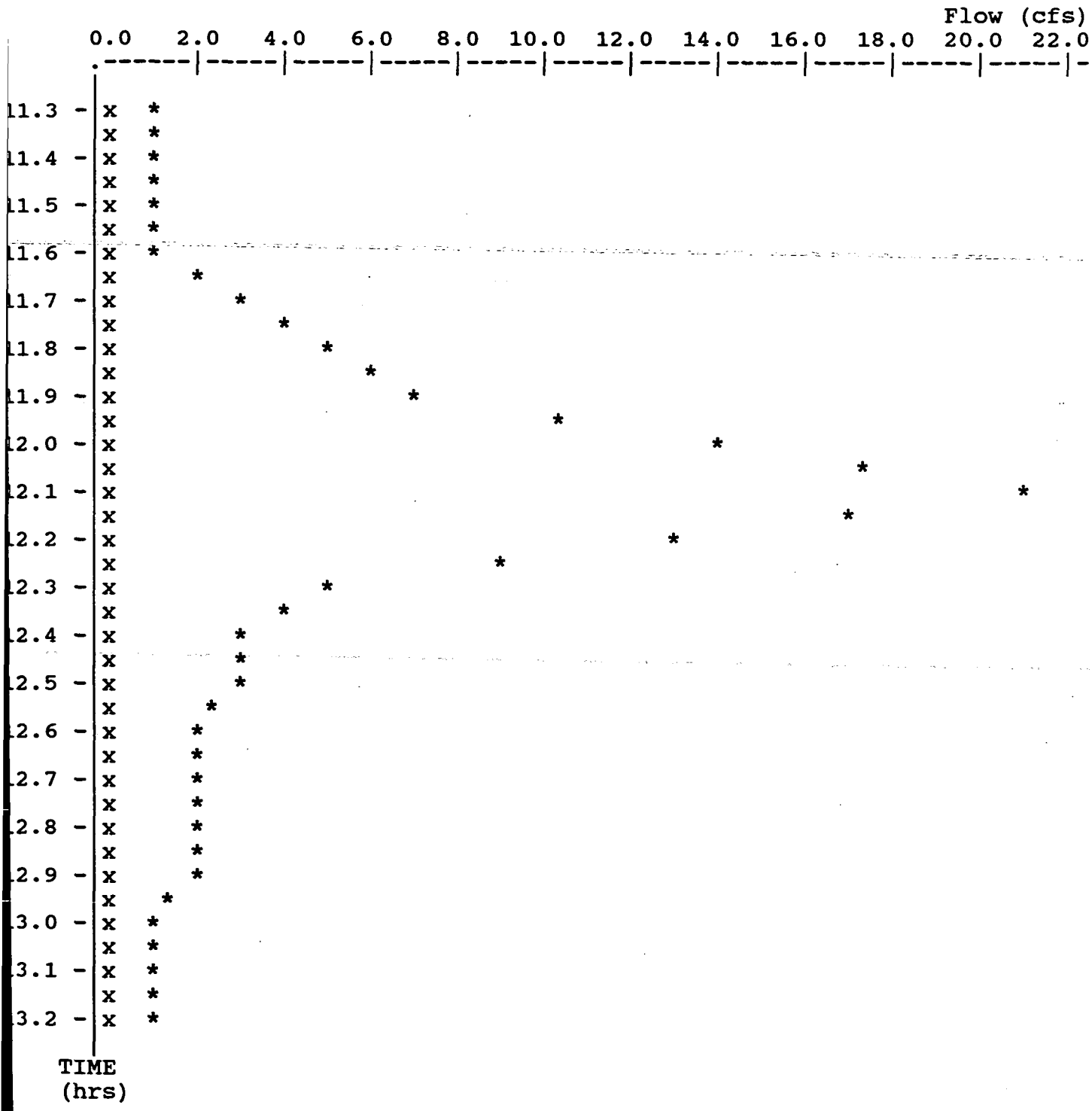
>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.17 S/N:

Pond File: c:\po165tk\SW3-T1 .PND
Inflow Hydrograph: c:\po165tk\P3-10 .HYD
Outflow Hydrograph: c:\po165tk\SW3-T1 .HYD

EXECUTED: 08-19-1997
13:19:51

Peak Inflow = 21.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 539.89 ft



SHT A76

```
*  File:   c:\po165tk\P3-10    .HYD    Qmax =     21.0 cfs
x  File:   c:\po165tk\SW3-T1   .HYD    Qmax =      0.0 cfs
```

ATTACHMENT B, DITCHES

Methodology

This calculation is performed using the "worst case" scenario for peak flows. Each ditch was evaluated under existing conditions (after construction of ditches and basins, but before remediation activities begin), and proposed conditions (after remediation activities have been completed).

The Modified Rational Method (Reference 2) was used to determine peak flows for the 10 year and 25 year (Ditches 2 & 6 only) frequency storm events. After drainage areas (existing and proposed) were calculated for each ditch, a weighted runoff coefficient (C) was determined based on land use area and type. A rainfall intensity was selected based on the shortest duration (duration = 10 min for all ditches except ditch 12) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

Ditch 12 has a large, relatively flat drainage area (see last assumption on this page). SCS procedures were used to find the time of concentration (duration) for the ditch 12 drainage area. The rainfall intensity was selected based on the time of concentration (duration) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

With the peak flows known for both existing and proposed conditions, the highest peak flow was selected for design. Ditches were designed based on the uniform flow theory using Manning's equation. In most cases ditch slopes varied. In one instance the bottom width varied. In order to evaluate ditch design and performance of ditch lining, the worst case flow conditions for velocity and flow depth were considered for the three types of ditch lining (i.e. erosion control blanket, dumped rock fill, or exposed geomembrane liner). The Flow Master computer program was used to evaluate the effects of the varying components on the performance of the ditch (Reference 4).

Ditch sections 2A and 2B, and ditch sections 2C and 2D are all the same ditch. Ditch sections 2A and 2B will be constructed to accommodate existing conditions. The section of ditch labeled 2A has channel slopes of approximately 10% and will be lined with riprap (dumped rock fill). The section of ditch labeled 2B has flat channel slopes (approx. 0.8%), and will be lined with erosion control blanket.

Ditch section 2C under proposed condtiions is the same section as 2A under existing conditions. Since ditch section 2C under proposed conditions has less flow than section 2A under existing condtiions, section 2C will not be modified.

Ditch section 2D will replace ditch section 2B during grading activities. This ditch section will have a flat channel slope (approx 0.7%) with a varying left-side slope.

Ditch 12 will be designed assuming that an existing culvert located east of the drainage area (see Proposed Conditions, Sheet 2 of 2 drainage area map) becomes

clogged and forces additional water into the normal drainage area for Ditch 12. Ditches 13 & 14 and the existing 24" culvert at the wheel wash area were originally designed under Calculation No. 15-02, PO158 (Haul Road Upgrade Project). These ditches were relocated eastward to accommodate construction of the Wheel Wash Facility. The total drainage area or land use did not change. Therefore, the design geometry proposed for these ditches under PO158 will be used on this project. New calculations are not provided.

Two types of ditch lining were evaluated for most ditches; vegetated using erosion control blankets, and dumped rock fill. Ditches 2B, 3-7, and 9 will have an exposed geomembrane liner. Roughness coefficients for the erosion control blanket and dumped rock fill were selected from Reference 7, and are as follows:

Erosion Control Blankets $n = 0.04$
Riprap $n = 0.06$

Maximum flow velocity for using erosion control blankets as a lining material was established at 4.0 feet per second (Reference 7).

Roughness coefficient for the exposed geomembrane liner was derived from values typically used for polyethylene pipe:

Geomembrane liner $n = 0.009$

Calculations are included on the following pages.

TABLE 1
DRAINAGE AREA AND PEAK FLOW SUMMARY

DITCH	EXISTING CONDITIONS		PROPOSED CONDITIONS	
	DRAINAGE AREA (AC)	FLOW (CFS)	DRAINAGE AREA (AC)	FLOW (CFS)
10 YEAR STORM FREQUENCY				
DITCH - 1	1.57	3.88	0.54	2.18
DITCH - 2A	3.45	8.18	N/A	N/A
DITCH - 2B	3.45	8.18	N/A	N/A
DITCH - 2C	N/A	N/A	1.82	6.09
DITCH - 2D	N/A	N/A	3.54	12.65
DITCH - 3	8.40	19.31	6.63	25.33
DITCH - 4	0.69	2.67	0.69	2.67
DITCH - 5	0.62	2.37	0.62	2.37
DITCH - 6	0.47	1.79	0.47	1.79
DITCH - 7	1.76	5.90	2.04	7.87
DITCH - 8A	1.80	5.88	1.45	5.56
DITCH - 8B	3.21	9.21	1.82	7.02
DITCH - 9	3.31	11.50	3.42	13.22
DITCH - 10 (A & B)	0.41	1.34	0.27	0.88
DITCH - 11	1.17	4.28	0.85	3.24
DITCH - 12	7.52	8.91	7.52	8.91
DITCH - 13	DESIGNED UNDER PO158, HAUL ROAD UPGRADE			
DITCH - 14	DESIGNED UNDER PO158, HAUL ROAD UPGRADE			
DITCH - 15	0.20	1.0	0.2	1.0
25 YEAR STORM FREQUENCY				
DITCH - 2A	3.45	10.06	N/A	N/A
DITCH - 2B	3.45	10.06	N/A	N/A
DITCH - 2C	N/A	N/A	1.82	7.49
DITCH - 2D	N/A	N/A	3.54	15.56
DITCH - 6	0.47	2.20	0.47	2.20

SHT B4

Quick TR-55 Ver.5.46 S/N:
Executed: 15:18:48 10-27-1996

DITCH-1
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	1.46						
GRAVEL RD	0.900	0.11						
			10.00	0.454	0.454	5.450	1.57	3.88

SHT BE 1 2 1

Quick TR-55 Ver.5.46 S/N:
Executed: 14:50:44 10-27-1996

DITCH-1
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, S>4:1	0.700	0.43						
GRAVEL RD	0.900	0.11						
			10.00	0.741	0.741	5.450	0.54	2.18

SHT B6

Quick TR-55 Ver.5.46 S/N:
Executed: 06:37:27 02-04-1997

DITCH-2A
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	5.450	3.45	8.18

000122

Quick TR-55 Ver.5.46 S/N:
Executed: 14:09:34 07-21-1997

DITCH-2A
DRAINAGE AREA P1
EXISTING CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	6.700	3.45	10.06

SHT B8

Quick TR-55 Ver. 5.46 S/N:
Executed: 06:38:22 02-04-1997

DITCH-2B
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	5.450	3.45	8.1

SHT B9

Quick TR-55 Ver.5.46 S/N:
Executed: 14:10:15 07-21-1997

1121

DITCH-2B
DRAINAGE AREA P1
EXISTING CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	3.34						
GRAVEL ROAD	0.900	0.11						
			10.00	0.435	0.435	6.700	3.45	10.06

000123

SHT B10

Quick TR-55 Ver. 5.46 S/N:
Executed: 06:43:08 02-04-1997

DITCH-2C
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, >4:1	0.700	0.82						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.614	0.614	5.450	1.82	6.0

000126

SHT BU 121

Quick TR-55 Ver.5.46 S/N:
Executed: 14:11:45 07-21-1997

DITCH-2C
DRAINAGE AREA P1
PROPOSED CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.82						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.614	0.614	6.700	1.82	7.49

000127

SHT B12

Quick TR-55 Ver.5.46 S/N:
Executed: 06:43:50 02-04-1997

DITCH-2D
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, >4:1	0.700	2.54						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.656	0.656	5.450	3.54	12.6

000128

Quick TR-55 Ver.5.46 S/N:
Executed: 16:54:32 08-19-1997

SHT B13
1121

DITCH-2D
DRAINAGE AREA P1
PROPOSED CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE, >4:1	0.700	2.54						
WOODED, FAIR	0.500	0.89						
GRAVEL ROAD	0.900	0.11						
			10.00	0.656	0.656	6.700	3.54	15.56

SHT B14

Quick TR-55 Ver.5.46 S/N:
Executed: 15:56:04 10-27-1996

DITCH-3
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. S>4:1	0.420	8.37						
GRAVEL ROAD	0.900	0.03						
			10.00	0.422	0.422	5.450	8.40	19.3

SHT B15

Quick TR-55 Ver.5.46 S/N:
Executed: 15:00:44 01-22-1997

1121

DITCH-3
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	6.60						
GRAVEL ROAD	0.900	0.03						
			10.00	0.701	0.701	5.450	6.63	25.33

SHT B16

Quick TR-55 Ver.5.46 S/N:
Executed: 15:07:33 04-26-1997

DITCH-4
DRAINAGE AREA P1
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1 GRAVEL ROAD	0.700	0.66						
	0.900	0.03						
			10.00	0.709	0.709	5.450	0.69	2.67

SHT B17

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 15:06:30 04-26-1997

DITCH-4
DRAINAGE AREA P1
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.66						
GRAVEL ROAD	0.900	0.03						
			10.00	0.709	0.709	5.450	0.69	2.67

SHT B18

Quick TR-55 Ver.5.46 S/N:
Executed: 14:15:21 04-28-1997

DITCH-5
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.62						
			10.00	0.700	0.700	5.450	0.62	2.37

Quick TR-55 Ver.5.46 S/N:
Executed: 14:16:50 04-28-1997

DITCH-5
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.62						
			10.00	0.700	0.700	5.450	0.62	2.37

SHT B20

Quick TR-55 Ver.5.46 S/N:
Executed: 14:18:30 04-28-1997

DITCH-6
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	5.450	0.47	1.79

SHT B21

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 14:19:02 04-28-1997

DITCH-6
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	5.450	0.47	1.79

B22

Quick TR-55 Ver.5.46 S/N:
Executed: 17:07:06 08-19-1997

DITCH-6
DRAINAGE AREA P2
EXISTING CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	6.700	0.47	2.20

000138

B23

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 17:07:40 08-19-1997

DITCH-6
DRAINAGE AREA P2
PROPOSED CONDITIONS, 25 YR STORM

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.47						
			10.00	0.700	0.700	6.700	0.47	2.20

SHT B24

Quick TR-55 Ver.5.46 S/N:
Executed: 16:06:06 04-29-1997

DITCH-7
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG. FAIR	0.420	0.59						
BARE,>4:1	0.700	1.09						
GRAVEL RD	0.900	0.08						
			10.00	0.615	0.615	5.450	1.76	5.90

0001.3

SHT B25

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 07:34:14 04-29-1997

DITCH-7
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	1.96						
GRAVEL RD	0.900	0.08						
			10.00	0.708	0.708	5.450	2.04	7.87

SHT B26

Quick TR-55 Ver.5.46 S/N:
Executed: 10:46:30 04-30-1997

DITCH-8A
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
`C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.10						
VEG, FAIR	0.420	0.67						
GRAVEL RD	0.900	0.03						
			10.00	0.599	0.599	5.450	1.80	5.88

SHT B27

Quick TR-55 Ver.5.46 S/N:
Executed: 14:47:00 04-29-1997

1121

DITCH-8A
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.42						
GRAVEL RD	0.900	0.03						
			10.00	0.704	0.704	5.450	1.45	5.56

SHT B28

Quick TR-55 Ver.5.46 S/N:
Executed: 10:46:56 04-30-1997

DITCH-8B
DRAINAGE AREA P2
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.10						
VEG, FAIR	0.420	2.04						
GRAVEL RD	0.900	0.07						
			10.00	0.526	0.526	5.450	3.21	9.21

SHT B29
1121

Quick TR-55 Ver.5.46 S/N:
Executed: 14:48:13 04-29-1997

DITCH-8B
DRAINAGE AREA P2
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE	0.700	1.75						
GRAVEL RD	0.900	0.07						
			10.00	0.708	0.708	5.450	1.82	7.02

SHT B30

Quick TR-55 Ver.5.46 S/N:
Executed: 16:47:01 01-20-1997

DITCH-9
DRAINAGE AREA P3
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	2.63						
BARE	0.700	0.40						
GRAVEL RD	0.900	0.28						
			10.00	0.637	0.637	5.450	3.31	11.50

0001

SHT B31

Quick TR-55 Ver.5.46 S/N:
Executed: 16:47:37 01-20-1997

1121

DITCH-9
DRAINAGE AREA P3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	2.89						
GRAVEL RD	0.900	0.28						
VEG, POOR	0.600	0.25						
			10.00	0.709	0.709	5.450	3.42	13.22

000147

SHT B32

Quick TR-55 Ver.5.46 S/N:
Executed: 09:27:01 11-24-1996

DITCH-10 (10A AND 10B)
DRAINAGE AREA P3
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.41						
			10.00	0.600	0.600	5.450	0.41	1.34

SHT B33

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 09:27:45 11-24-1996

DITCH-10 (10A AND 10B)
DRAINAGE AREA P3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.27						
			10.00	0.600	0.600	5.450	0.27	0.88

000143

SHT 834

Quick TR-55 Ver.5.46 S/N:
Executed: 16:49:52 01-20-1997

DITCH-11
DRAINAGE AREA P3
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.89						
GRAVEL	0.900	0.28						
			10.00	0.672	0.672	5.450	1.17	4.28

SHT B35

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 16:49:22 01-20-1997

DITCH-11
DRAINAGE AREA P3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.57						
GRAVEL	0.900	0.28						
			10.00	0.699	0.699	5.450	0.85	3.24

SHT B36

Quick TR-55 Ver.5.46 S/N:
Executed: 14:03:23 02-04-1997

DITCH-12
EXISTING/PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
WOODS	0.300	6.32						
VEG, FAIR	0.420	1.00						
GRAVEL ROAD	0.900	0.20						
			20.40	0.332	0.332	3.570	7.52	8.91

000152

SHT B37

Quick TR-55 Ver.5.46 S/N:
Executed: 14:02:25 02-04-1997 c:\po165d\D12P.TCT

1121

DITCH 12

Tc COMPUTATIONS FOR: DITCH 12

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		WOODS, LT	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	122.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0500	

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.30 = 0.30

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 0.0000

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.00 = 0.00

CHANNEL FLOW

Segment ID		2	
Cross Sectional Flow Area, a	sq.ft	7.50	
Wetted perimeter, Pw	ft	8.71	
Hydraulic radius, r = a/Pw	ft	0.861	
Channel slope, s	ft/ft	0.0130	
Manning's roughness coeff., n		0.0400	

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 3.8441

Flow length, L ft 485

T = L / (3600*V) hrs 0.04 = 0.04

::

TOTAL TIME (hrs) 0.34

SHT B38

Quick TR-55 Ver.5.46 S/N:
Executed: 14:02:25 02-04-1997 c:\po165d\D12P.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

DITCH 12

Subarea descr.	Tc or Tt	Time (hrs)
DITCH 12	Tc	0.34

SHT B39

1121

TIME OF CONCENTRATION, DITCH 12
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	TIME OF CONC., DITCH 12
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.013000	ft/ft
Depth	1.50	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft

Results		
Discharge	28.76	cfs
Flow Area	7.50	ft^2
Wetted Perimeter	8.71	ft
Top Width	8.00	ft
Critical Depth	1.25	ft
Critical Slope	0.027917	ft/ft
Velocity	3.83	ft/s
Velocity Head	0.23	ft
Specific Energy	1.73	ft
Froude Number	0.70	
Flow is subcritical.		

SHT B40

DITCHES 13 & 14 DESIGNED UNDER PO158, HAUL ROAD UPGRADE PROJECT

Quick TR-55 Ver.5.46 S/N:
Executed: 09:39:59 06-10-1997

DITCH 15
EXISTING AND PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
GRAVEL	0.900	0.20						
			10.00	0.900	0.900	5.450	0.20	0.98

TABLE 2

SUMMARY OF DITCH PERFORMANCE

DITCH	Q (CFS)	SLOPE		VELOCITY		FLOW DEPTH		COMMENTS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
10 YR STORM EVENT								
DITCH - 1	3.88	0.5	2.6	1.6	3.0	0.8	1.1	EROSION CONTROL BLANKET
DITCH - 2A	8.18	10.0	10.0	4.5	4.5	1.0	1.0	DUMPED ROCK FILL
DITCH - 2B	8.18	0.8	0.8	7.2	7.2	0.8	0.8	GEOMEMBRANE LINER
DITCH - 2C	6.09 CFS < 8.18 CFS UNDER EXISTING CONDITIONS, USE SAME AS D-2B							
DITCH - 2D	12.65	0.7	0.7	1.3	2.3	0.6	1.4	EROSION CONTROL BLANKET
DITCH - 3	25.33	0.7	0.7	7.0	8.1	0.4	0.6	GEOMEMBRANE LINER
DITCH - 4	2.67	0.9	0.9	4.9	4.9	0.2	0.2	GEOMEMBRANE LINER
DITCH - 5	2.37	1.5	1.5	5.7	5.7	0.2	0.2	GEOMEMBRANE LINER
DITCH - 6	1.79	1.4	1.4	5.1	5.1	0.2	0.2	GEOMEMBRANE LINER
DITCH - 7	7.87	1.1	2.9	7.5	10.4	0.3	• D_n = 0.4 • D_w = 1.6	GEOMEMBRANE LINER
DITCH - 8A	5.88	0.8	0.8	2.2	2.2	1.2	1.2	EROSION CONTROL BLANKET
DITCH - 8B	9.21	10.0	10.0	4.6	4.6	1.0	1.0	DUMPED ROCK FILL
DITCH - 9	13.22	1.1	6.7	7.8	14.1	0.2	• D_n = 0.4 • D_w = 1.7	GEOMEMBRANE LINER
DITCH - 10A	1.34	4.3	4.3	2.8	2.8	0.5	0.5	EROSION CONTROL BLANKET
DITCH - 10B	1.34	20.0	20.0	3.7	3.7	0.4	0.4	DUMPED ROCK FILL
DITCH - 11	4.28	2.6	4.0	3.1	3.6	0.8	• D_n = 0.8 • D_w = 1.7	EROSION CONTROL BLANKET
DITCH - 12	8.91	0.8	1.4	2.4	2.9	0.8	1.0	EROSION CONTROL BLANKET
DITCHES - 13 & 14	DITCH DESIGNED UNDER PO158, HAUL ROAD UPGRADE							EROSION CONTROL BLANKET
DITCH - 15	1.0	2.5	3.0	2.1	2.3	0.5	0.5	EROSION CONTROL BLANKET
25 YR STORM								
DITCH - 2A	10.1	10.0	10.0	4.7	4.7	1.0	1.0	DUMPED ROCK FILL
DITCH - 2B	10.1	0.8	0.8	7.6	7.6	0.8	0.8	GEOMEMBRANE LINER
DITCH - 2C	7.49 CFS < 10.1 CFS UNDER EXISTING CONDITIONS, USE SAME AS D-2B							
DITCH - 2D	12.65	0.7	0.7	1.3	2.3	0.6	1.4	EROSION CONTROL BLANKET
DITCH - 6	2.20	1.4	1.4	5.4	5.4	0.2	0.2	GEOMEMBRANE LINER

• D_n = Normal flow depth • D_w = Flow depth upstream of velocity check

000158

SH B42

SHT B43
1121

DITCH-1 (D1)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-1 (D1)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.005000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	3.88	cfs

Results		
Depth	1.09	ft
Flow Area	2.38	ft^2
Wetted Perimeter	4.88	ft
Top Width	4.37	ft
Critical Depth	0.75	ft
Critical Slope	0.037554	ft/ft
Velocity	1.63	ft/s
Velocity Head	0.04	ft
Specific Energy	1.13	ft
Froude Number	0.39	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 on slopes from 0.5% to 3.6% (See Rating Table).

Use Erosion Control Blanket for channel lining

SHT B44

DITCH-1 (D1)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-1 (D1)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	3.88 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020
Channel Slope	0.005000	0.026000	0.021000 ft/ft

Rating Table

Channel Slope (ft/ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.005000	0.040	1.09	1.63
0.005000	0.060	1.27	1.20
0.026000	0.040	0.80	3.02
0.026000	0.060	0.93	2.23

DITCH 2A, EXISTING CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2A, EXISTING CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	8.18	cfs

Results		
Depth	0.82	ft
Flow Area	1.36	ft^2
Wetted Perimeter	3.68	ft
Top Width	3.29	ft
Critical Depth	1.01	ft
Critical Slope	0.033997	ft/ft
Velocity	6.03	ft/s
Velocity Head	0.57	ft
Specific Energy	1.39	ft
Froude Number	1.66	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04, Not acceptable

Use Riprap for channel lining on steep section

SHT 846

DITCH 2A, EXISTING CONDITIONS
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2A, EXISTING CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	8.18 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.82	6.03
0.060	0.96	4.45

SHT B47 1 of 1

DITCH 2A-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2A-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	10.10	cfs

Results		
Depth	1.04	ft
Flow Area	2.15	ft²
Wetted Perimeter	4.64	ft
Top Width	4.15	ft
Critical Depth	1.10	ft
Critical Slope	0.074376	ft/ft
Velocity	4.69	ft/s
Velocity Head	0.34	ft
Specific Energy	1.38	ft
Froude Number	1.15	
Flow is supercritical.		

SHT B48

DITCH 2B, EXISTING CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2B, EXISTING CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	8.18	cfs

Results		
Depth	0.76	ft
Flow Area	1.14	ft^2
Wetted Perimeter	3.38	ft
Top Width	3.02	ft
Critical Depth	1.01	ft
Critical Slope	0.001721	ft/ft
Velocity	7.16	ft/s
Velocity Head	0.80	ft
Specific Energy	1.55	ft
Froude Number	2.05	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 8.2 fps: OK

DITCH 2B-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2B-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	10.10	cfs

Results		
Depth	0.82	ft
Flow Area	1.34	ft^2
Wetted Perimeter	3.66	ft
Top Width	3.27	ft
Critical Depth	1.10	ft
Critical Slope	0.001673	ft/ft
Velocity	7.55	ft/s
Velocity Head	0.89	ft
Specific Energy	1.70	ft
Froude Number	2.08	
Flow is supercritical.		

SHT B50

DITCH 2C, PROPOSED CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	8.18	cfs

Results		
Depth	0.82	ft
Flow Area	1.36	ft^2
Wetted Perimeter	3.68	ft
Top Width	3.29	ft
Critical Depth	1.01	ft
Critical Slope	0.033997	ft/ft
Velocity	6.03	ft/s
Velocity Head	0.57	ft
Specific Energy	1.39	ft
Froude Number	1.66	
Flow is supercritical.		

Notes:

This is same ditch with same discharge as ditch 2A under existing conditions.

SHT B5 1121

DITCH 2C, PROPOSED CONDITIONS
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	8.18 cfs

Input Data

	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.82	6.03
0.060	0.96	4.45

SHT B52

DITCH 2C-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	7.49	cfs

Results		
Depth	0.80	ft
Flow Area	1.27	ft^2
Wetted Perimeter	3.56	ft
Top Width	3.19	ft
Critical Depth	0.97	ft
Critical Slope	0.034401	ft/ft
Velocity	5.90	ft/s
Velocity Head	0.54	ft
Specific Energy	1.34	ft
Froude Number	1.65	
Flow is supercritical.		

SHT B53

1121

DITCH 2C-25
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2C-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	7.49 cfs

Input Data

	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.80	5.90
0.060	0.93	4.36

SHT B54

DITCH 2D, PROPOSED CONDITIONS
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D, PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	12.70	cfs

Results		
Depth	1.35	ft
Flow Area	5.51	ft^2
Wetted Perimeter	8.62	ft
Top Width	8.13	ft
Critical Depth	1.02	ft
Critical Slope	0.031514	ft/ft
Velocity	2.31	ft/s
Velocity Head	0.08	ft
Specific Energy	1.44	ft
Froude Number	0.49	
Flow is subcritical.		

Notes:

DITCH 2D WITH VARYING LEFT SIDE SLOPE.

TWO CRITERIA FOR ACCEPTANCE:
1.COMPARE LEFT SIDE SLOPE WITH FLOW DEPTH TO ENSURE FREEBOARD,
2. COMPARE VELOCITY TO ENSURE THAT
V < 4.0 FPS FOR EROSION CONTROL BLANKET.

OK FOR BOTH

0001.0

SHT B 55

1121

DITCH 2D, PROPOSED CONDITIONS
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D, PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.040
Channel Slope	0.007000 ft/ft
Right Side Slope	2.000000 H : V
Discharge	12.70 cfs

Input Data	Minimum	Maximum	Increment
Left Side Slope	4.000000	60.000000	2.000000 H : V

Rating Table

Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
4.000000	1.35	2.31
6.000000	1.21	2.17
8.000000	1.11	2.06
10.000000	1.04	1.97
12.000000	0.98	1.90
14.000000	0.93	1.84
16.000000	0.89	1.79
18.000000	0.85	1.75
20.000000	0.82	1.71
22.000000	0.80	1.67
24.000000	0.77	1.64
26.000000	0.75	1.61
28.000000	0.73	1.58
30.000000	0.71	1.56
32.000000	0.70	1.53
34.000000	0.68	1.51
36.000000	0.67	1.49
38.000000	0.66	1.47
40.000000	0.64	1.46
42.000000	0.63	1.44
44.000000	0.62	1.42
46.000000	0.61	1.41
48.000000	0.60	1.39

SHT B 56

DITCH 2D, PROPOSED CONDITIONS
Rating Table for Triangular Channel

Rating Table		
Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
50.000000	0.59	1.38
52.000000	0.59	1.37
54.000000	0.58	1.36
56.000000	0.57	1.34
58.000000	0.56	1.33
60.000000	0.56	1.32

SHT 657

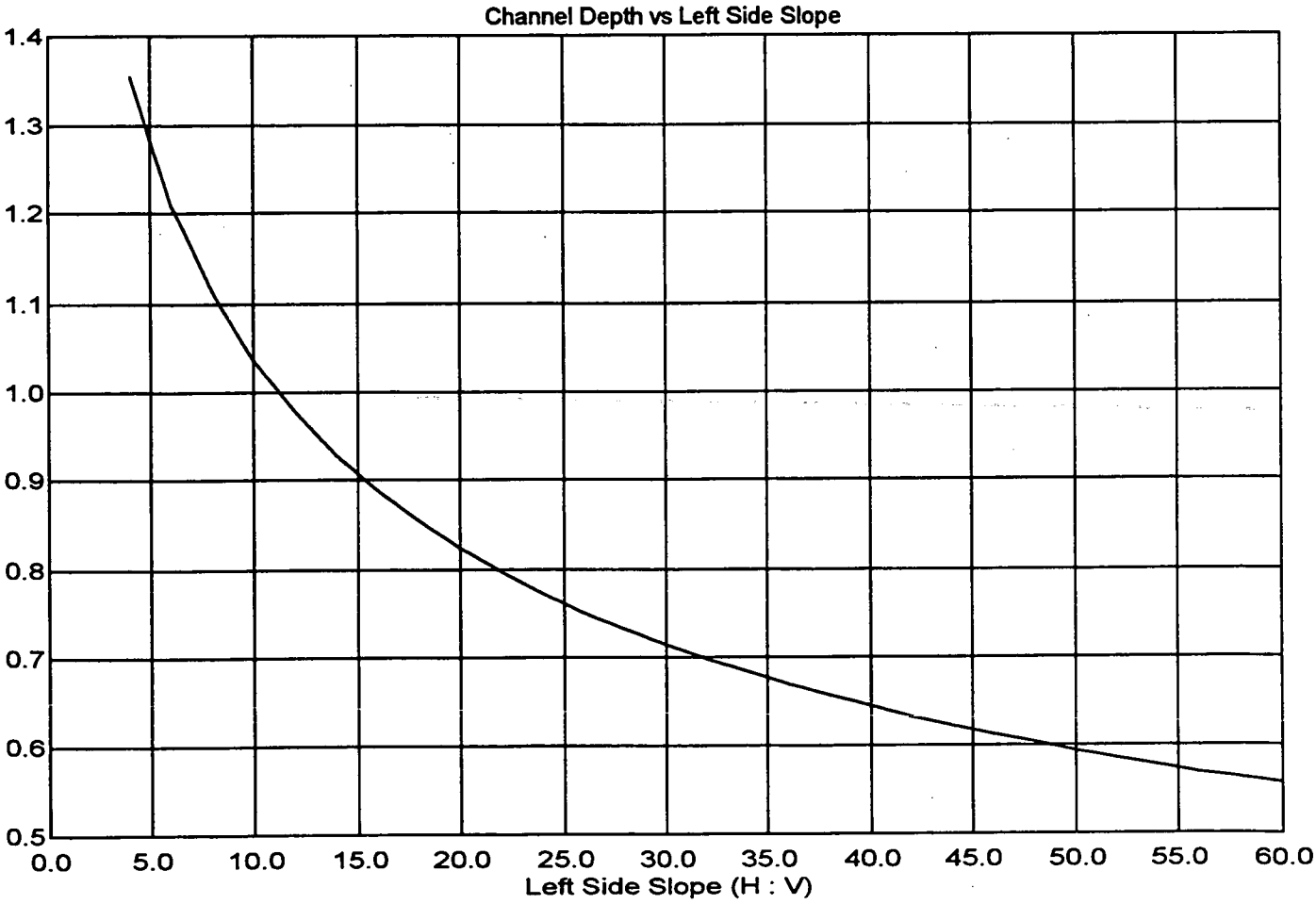
1121

DITCH 2D, PROPOSED CONDITIONS
Plotted Curves for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D, PROPOSED CONDITIONS
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000 ft/ft	
Right Side Slope	2.000000 H : V	
Discharge	12.70	cfs

Input Data			
	Minimum	Maximum	Increment
Left Side Slope	4.000000	60.000000	2.000000 H : V



SHT B58

DITCH 2D-25
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000	ft/ft
Left Side Slope	4.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	12.65	cfs

Results		
Depth	1.35	ft
Flow Area	5.49	ft^2
Wetted Perimeter	8.60	ft
Top Width	8.12	ft
Critical Depth	1.02	ft
Critical Slope	0.031530	ft/ft
Velocity	2.30	ft/s
Velocity Head	0.08	ft
Specific Energy	1.44	ft
Froude Number	0.49	
Flow is subcritical.		

Notes:

DITCH 2D-25 WITH VARYING LEFT SIDE SLOPES

TWO CRITERIA FOR ACCEPTANCE:
1. COMPARE LEFT SIDE SLOPE WITH FLOW DEPTH TO ENSURE FREEBOARD,
2. COMPARE VELOCITY TO ENSURE THAT V < 4,0 FPS FOR EROSION CONTROL BLANKET

OK FOR BOTH

000174

SHT B59 1121

DITCH 2D-25
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 2D-25
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Channel Slope	0.007000	ft/ft
Right Side Slope	2.000000	H : V
Discharge	12.65	cfs

Input Data			
	Minimum	Maximum	Increment
Left Side Slope	4.000000	60.000000	2.000000 H : V

Rating Table

Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
4.000000	1.35	2.30
6.000000	1.21	2.16
8.000000	1.11	2.06
10.000000	1.03	1.97
12.000000	0.98	1.90
14.000000	0.93	1.84
16.000000	0.89	1.79
18.000000	0.85	1.74
20.000000	0.82	1.70
22.000000	0.79	1.67
24.000000	0.77	1.64
26.000000	0.75	1.61
28.000000	0.73	1.58
30.000000	0.71	1.55
32.000000	0.70	1.53
34.000000	0.68	1.51
36.000000	0.67	1.49
38.000000	0.66	1.47
40.000000	0.64	1.45
42.000000	0.63	1.44
44.000000	0.62	1.42
46.000000	0.61	1.41
48.000000	0.60	1.39

SHT 860

DITCH 2D-25
Rating Table for Triangular Channel

Rating Table		
Left Side Slope (H : V)	Depth (ft)	Velocity (ft/s)
50.000000	0.59	1.38
52.000000	0.59	1.37
54.000000	0.58	1.35
56.000000	0.57	1.34
58.000000	0.56	1.33
60.000000	0.56	1.32

SHT B61

DITCH-3 (D3)
Worksheet for Trapezoidal Channel

1121

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-3 (D3)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.006700	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	4.00	ft
Discharge	25.33	cfs

Results		
Depth	0.60	ft
Flow Area	3.12	ft^2
Wetted Perimeter	6.68	ft
Top Width	6.40	ft
Critical Depth	0.92	ft
Critical Slope	0.001432	ft/ft
Velocity	8.13	ft/s
Velocity Head	1.03	ft
Specific Energy	1.63	ft
Froude Number	2.05	
Flow is supercritical.		

Notes:

NOTE: 4' WIDE DITCH SECTION DOES NOT GET TOTAL "Q"

GEOMEMBRANE LINER

V = 8.1 fps: OK

SHT B62

DITCH-3 (D3)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-3 (D3)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Channel Slope	0.006700	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	25.33	cfs

Input Data			
	Minimum	Maximum	Increment
Bottom Width	4.00	8.00	4.00 ft

Rating Table		
Bottom Width (ft)	Depth (ft)	Velocity (ft/s)
4.00	0.60	8.13
8.00	0.41	6.96

SHT B63

1121

DITCH-4 (D4)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-4 (D4)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.008600	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.67	cfs

Results		
Depth	0.22	ft
Flow Area	0.54	ft^2
Wetted Perimeter	2.99	ft
Top Width	2.89	ft
Critical Depth	0.34	ft
Critical Slope	0.001943	ft/ft
Velocity	4.91	ft/s
Velocity Head	0.37	ft
Specific Energy	0.60	ft
Froude Number	2.00	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 4.91 fps: OK

SHT B64

DITCH-5 (D5)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-5 (D5)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	*0.009*	
Channel Slope	0.015000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.37	cfs

Results		
Depth	0.18	ft
Flow Area	0.42	ft^2
Wetted Perimeter	2.79	ft
Top Width	2.71	ft
Critical Depth	0.32	ft
Critical Slope	0.001977	ft/ft
Velocity	5.69	ft/s
Velocity Head	0.50	ft
Specific Energy	0.68	ft
Froude Number	2.56	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 5.7 fps: OK

000180

SHT B65
1121

DITCH-6 (D6)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-6 (D6)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.014000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	1.79	cfs

Results		
Depth	0.15	ft
Flow Area	0.35	ft^2
Wetted Perimeter	2.69	ft
Top Width	2.61	ft
Critical Depth	0.27	ft
Critical Slope	0.002064	ft/ft
Velocity	5.06	ft/s
Velocity Head	0.40	ft
Specific Energy	0.55	ft
Froude Number	2.42	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 5.1 fps: OK

SHT 866

DITCH 6-25
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 6-25
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.014000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	2.20	cfs

Results		
Depth	0.17	ft
Flow Area	0.41	ft^2
Wetted Perimeter	2.77	ft
Top Width	2.69	ft
Critical Depth	0.30	ft
Critical Slope	0.002000	ft/ft
Velocity	5.42	ft/s
Velocity Head	0.46	ft
Specific Energy	0.63	ft
Froude Number	2.46	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

V = 5.4 fps: OK

00015

SHT 867

1121

DITCH-7 (D7)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-7 (D7)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.011000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	7.87	cfs

Results		
Depth	0.38	ft
Flow Area	1.05	ft^2
Wetted Perimeter	3.70	ft
Top Width	3.52	ft
Critical Depth	0.63	ft
Critical Slope	0.001671	ft/ft
Velocity	7.48	ft/s
Velocity Head	0.87	ft
Specific Energy	1.25	ft
Froude Number	2.41	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

Vmin = 7.5 fps @ S = 1.1% - OK
Vmax = 10.4 fps @ S = 2.9% - USE VELOCITY CHECK

SHT B68

DITCH-7 (D7)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-7 (D7)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	2.00	ft
Discharge	7.87	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.011000	0.028600	0.017600 ft/ft

Rating Table		
Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.011000	0.38	7.48
0.028600	0.29	10.43

NORMAL DEPTH

FOR FLOW DEPTH UPSTREAM OF VELOCITY CHECK, USE BROAD-CRESTED WEIR

$Q = CLH^{3/2}$ where $C = 2.61$ (REFERENCE 9 for $h = 0.4$)

$L = 6'$

$$H = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{7.87}{2.61 \times 6}\right)^{2/3} = 0.63 \text{ ft}$$

FLOW DEPTH = 1.0 ft (velocity check h) + 0.63 ft = **1.63 ft**

SHT E69
1121

DITCH-8A (D8A)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-8A (D8A)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000001	H : V
Right Side Slope	2.000000	H : V
Discharge	5.88	cfs

Results		
Depth	1.17	ft
Flow Area	2.73	ft^2
Wetted Perimeter	5.22	ft
Top Width	4.67	ft
Critical Depth	0.88	ft
Critical Slope	0.035527	ft/ft
Velocity	2.16	ft/s
Velocity Head	0.07	ft
Specific Energy	1.24	ft
Froude Number	0.50	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for slope = 0.8% - OK

Use Erosion Control Blanket for channel lining

SHT B70

DITCH-8B (D8B)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-8B (D8B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.100000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	9.21	cfs

Results		
Depth	0.86	ft
Flow Area	1.48	ft^2
Wetted Perimeter	3.85	ft
Top Width	3.44	ft
Critical Depth	1.06	ft
Critical Slope	0.033465	ft/ft
Velocity	6.22	ft/s
Velocity Head	0.60	ft
Specific Energy	1.46	ft
Froude Number	1.67	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04, Not acceptable

Use Riprap for channel lining

SHT B71

1121

DITCH 8B (D8B)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-8B (D8B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.100000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	9.21 cfs

Input Data

	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.86	6.22
0.060	1.00	4.59

SHT B72

DITCH-9 (D9)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-9 (D9)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.009	
Channel Slope	0.011000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	4.00	ft
Discharge	13.22	cfs

Results		
Depth	0.36	ft
Flow Area	1.69	ft^2
Wetted Perimeter	5.61	ft
Top Width	5.44	ft
Critical Depth	0.62	ft
Critical Slope	0.001573	ft/ft
Velocity	7.80	ft/s
Velocity Head	0.95	ft
Specific Energy	1.30	ft
Froude Number	2.46	
Flow is supercritical.		

Notes:

GEOMEMBRANE LINER

Vmin = 7.8 fps @ S = 1.1% - OK

Vmax = 14.1fps @ S = 6.7% - USE VELOCITY CHECK

000188

SHT B73

1121

DITCH-9 (D9)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-9 (D9)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.009	
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	4.00	ft
Discharge	13.22	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.011000	0.066700	0.055700 ft/ft

Rating Table

Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.011000	0.36	7.80
0.066700	0.21	14.08

NORMAL DEPTH

FOR FLOW DEPTH UPSTREAM OF VELOCITY CHECK, USE BROAD-CRESTED WEIR

$Q = CLH^{3/2}$ WHERE $C = 2.61$ (REFERENCE 9, TABLE 5-3)

$L = 8$ ft

$$H = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{13.22}{2.61 \times 8}\right)^{2/3} = 0.74 \text{ ft}$$

FLOW DEPTH = 1.0 ft (velocity check ht) + 0.74 ft = **1.74 ft**

SHT B.74

DITCH-10A (D10A)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10A (D10A)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.043000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.34	cfs

Results		
Depth	0.49	ft
Flow Area	0.48	ft^2
Wetted Perimeter	2.19	ft
Top Width	1.96	ft
Critical Depth	0.49	ft
Critical Slope	0.043270	ft/ft
Velocity	2.80	ft/s
Velocity Head	0.12	ft
Specific Energy	0.61	ft
Froude Number	1.00	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 on 4.3% slope, OK

Use Erosion Control Blanket for channel lining

SHT 875

1121

DITCH-10A (D10A)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10A (D10A)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.043000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	1.34 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.49	2.80
0.060	0.57	2.06

SHT B76

DITCH-10B (D10B)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10B (D10B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.200000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.34	cfs

Results		
Depth	0.43	ft
Flow Area	0.36	ft²
Wetted Perimeter	1.91	ft
Top Width	1.71	ft
Critical Depth	0.49	ft
Critical Slope	0.097364	ft/ft
Velocity	3.67	ft/s
Velocity Head	0.21	ft
Specific Energy	0.64	ft
Froude Number	1.40	
Flow is supercritical.		

Notes:

Velocity > 4.0 fps for n = 0.04 on steeper slopes,
(See Rating Table), Not acceptable

Use Riprap for channel lining

SHT B77

1121

DITCH-10B (D10B)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-10B (D10B)
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Channel Slope	0.200000 ft/ft
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	1.34 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020

Rating Table

Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.040	0.37	4.98
0.060	0.43	3.67

SHT B78

DITCH-11 (D11)
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-11
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.026000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	4.28	cfs

Results		
Depth	0.83	ft
Flow Area	1.38	ft^2
Wetted Perimeter	3.72	ft
Top Width	3.33	ft
Critical Depth	0.78	ft
Critical Slope	0.037065	ft/ft
Velocity	3.10	ft/s
Velocity Head	0.15	ft
Specific Energy	0.98	ft
Froude Number	0.85	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 on slopes from 2.6% to 4.0% (See Rating Table) OK

Use Erosion Control Blanket for channel lining

SHT B79

1121

DITCH-11 (D11)
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH-11
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

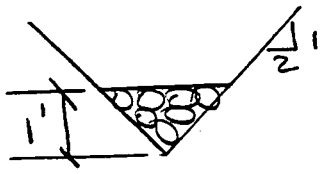
Constant Data	
Left Side Slope	2.000000 H : V
Right Side Slope	2.000000 H : V
Discharge	4.28 cfs

Input Data	Minimum	Maximum	Increment
Mannings Coefficient	0.040	0.060	0.020
Channel Slope	0.026000	0.040000	0.014000 ft/ft

Rating Table

Channel Slope (ft/ft)	Mannings Coefficient	Depth (ft)	Velocity (ft/s)
0.026000	0.040	0.83	3.10
0.026000	0.060	0.97	2.28
0.040000	0.040	0.77	3.64
0.040000	0.060	0.89	2.69

NORMAL DEPTH



FOR FLOW DEPTH UPSTREAM OF CHECK DAM, USE BROAD-CRESTED WEIR

$Q = CLH^{3/2}$ WHERE $C = 2.61$ (REFERENCE 9, TABLE 5-3)

$L = 4$ ft

$$H = \left(\frac{Q}{CL}\right)^{2/3} = \left(\frac{4.28\text{ cfs}}{2.61 \times 4}\right)^{2/3} = 0.55\text{ ft}$$

FLOW DEPTH = 1.0 ft (CHECK DAM) + 0.55 ft = 1.55 ft

SHT B 80

DITCH 12 (REVISED)
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 12 (REVISED)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.008000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	8.90	cfs

Results		
Depth	0.96	ft
Flow Area	3.77	ft^2
Wetted Perimeter	6.30	ft
Top Width	5.85	ft
Critical Depth	0.68	ft
Critical Slope	0.032473	ft/ft
Velocity	2.36	ft/s
Velocity Head	0.09	ft
Specific Energy	1.05	ft
Froude Number	0.52	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04 OK

Use Erosion Control Blanket for channel lining.

SHT B81

1121

DITCH 12 (REVISED)
Rating Table for Trapezoidal Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH 12 (REVISED)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	2.00	ft
Discharge	8.90	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.008000	0.014000	0.006000 ft/ft

Rating Table		
Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.008000	0.96	2.36
0.014000	0.84	2.90

SHT B82

DITCH - 15
Worksheet for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH - 15
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.025000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	1.00	cfs

Results		
Depth	0.49	ft
Flow Area	0.47	ft^2
Wetted Perimeter	2.17	ft
Top Width	1.94	ft
Critical Depth	0.43	ft
Critical Slope	0.044992	ft/ft
Velocity	2.12	ft/s
Velocity Head	0.07	ft
Specific Energy	0.56	ft
Froude Number	0.76	
Flow is subcritical.		

Notes:

Velocity < 4.0 fps for n = 0.04: OK

Use Erosion Control Blanket for Channel Lining

SAT B83

DITCH - 15
Rating Table for Triangular Channel

Project Description	
Project File	c:\po165d\swu.fm2
Worksheet	DITCH - 15
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data		
Mannings Coefficient	0.040	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Discharge	1.00	cfs

Input Data	Minimum	Maximum	Increment
Channel Slope	0.025000	0.030000	0.005000 ft/ft

Rating Table		
Channel Slope (ft/ft)	Depth (ft)	Velocity (ft/s)
0.025000	0.49	2.12
0.030000	0.47	2.27

ATTACHMENT C, CULVERTS

Methodology

This calculation is performed using the "worst case" scenario for peak flows. Each culvert was evaluated under existing conditions (after construction of ditches and basins, but before remediation activities begin), and proposed conditions (after remediation activities have been completed).

The Modified Rational Method (Reference 2) was used to determine peak flows for the 10 year frequency storm event. After drainage areas (existing and proposed) were calculated for each culvert, a weighted runoff coefficient (C) was determined based on land use area and type. A rainfall intensity was selected based on the shortest duration (duration = 10 min for all culverts except culvert 4) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

Culvert 4 has a large, relatively flat drainage area. SCS procedures were used to find the time of concentration (duration) for the culvert 4 drainage area. The rainfall intensity was selected based on the time of concentration (duration) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 7).

Calculations are included on the following pages.

SHT C2

Quick TR-55 Ver.5.46 S/N:
Executed: 15:17:59 01-20-1997

CULVERT 1

EXISTING/PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	0.60						
GRAVEL	0.900	0.90						
			10.00	0.820	0.820	5.450	1.50	6.7

000201

PROJECT: Southern Waste Units
Culvert - 1

STATION: _____

SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____

REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

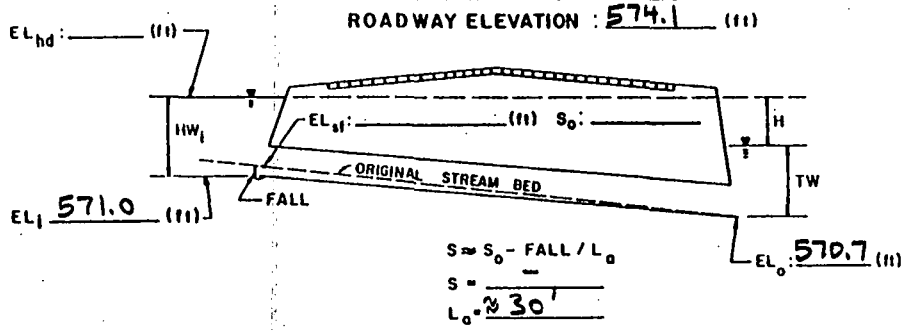
SEE ADD'L. SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	6.7	*

ROADWAY ELEVATION: 574.1 (ft)



$S \approx S_o - FALL / L_a$

S = —

L_a = ≈ 30'

CULVERT DESCRIPTION:

MATERIAL - SHAPE - SIZE - ENTRANCE

CULVERT DESCRIPTION	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ CMP	6.7	6.7	1.8	2.25	-	573.3	0.5	1.0	1.1	1.1	0.9	2.2	574.0	574.0	-	OUTLET CONTROL TOO HIGH
TRY 18" Φ CMP	6.7	6.7	1.13	1.70	-	572.7	0.5	0.95	1.2	1.2	0.9	0.85	572.8	572.8	—	OUTLET CONTROL OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

* ASSUME OUTLET DRAINAGEWAY FLOWING 0.5' DEEP

PROJECTING ENDS ∴ Ke = 0.9

CULVERT BARREL SELECTED:

SIZE: 18" Φ

SHAPE: ROUND

MATERIAL: CMP n 0.024

ENTRANCE: PROJECTING

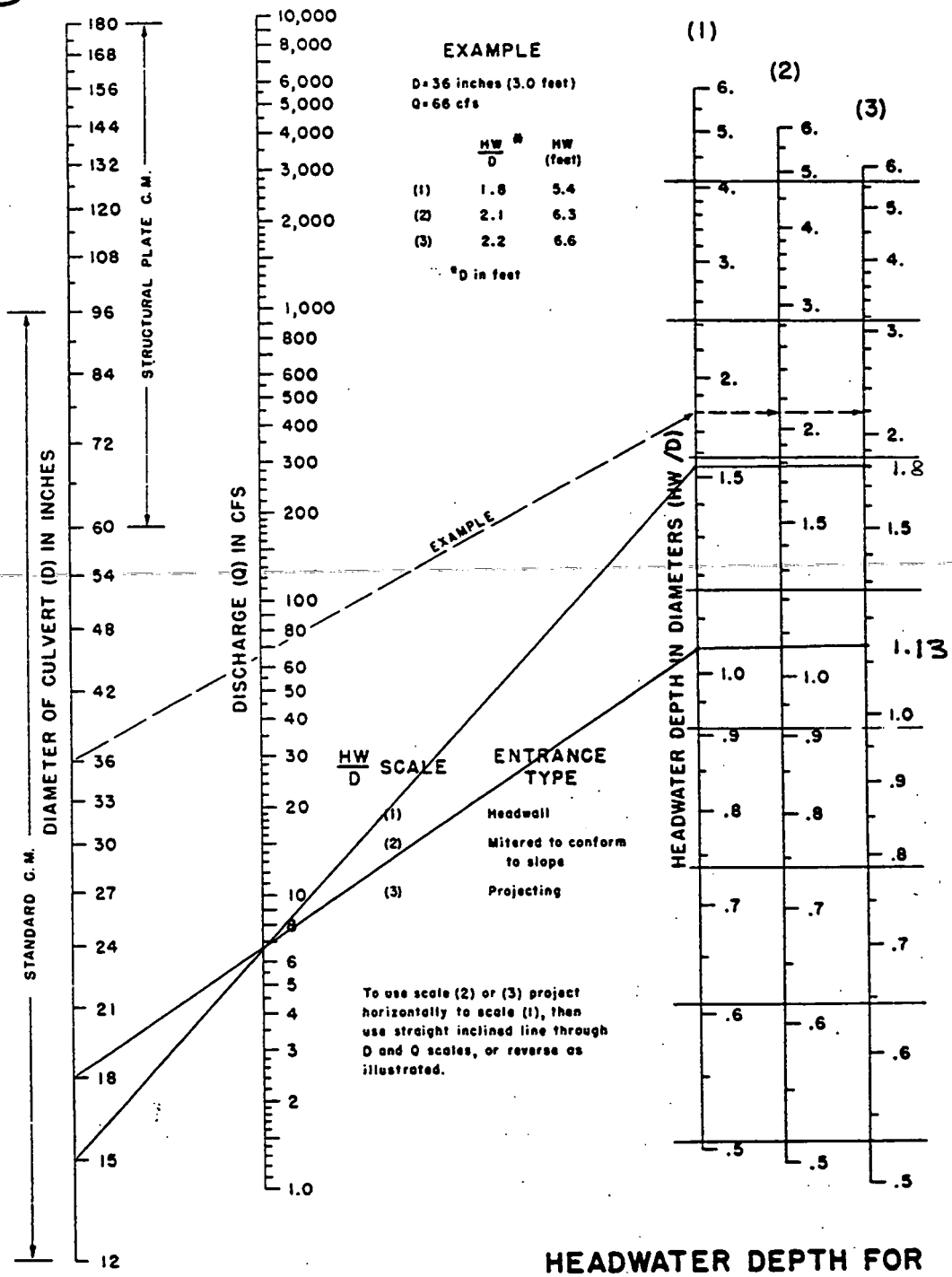
240

SHT C3 1 121

000202

SHT C4

CHART 2

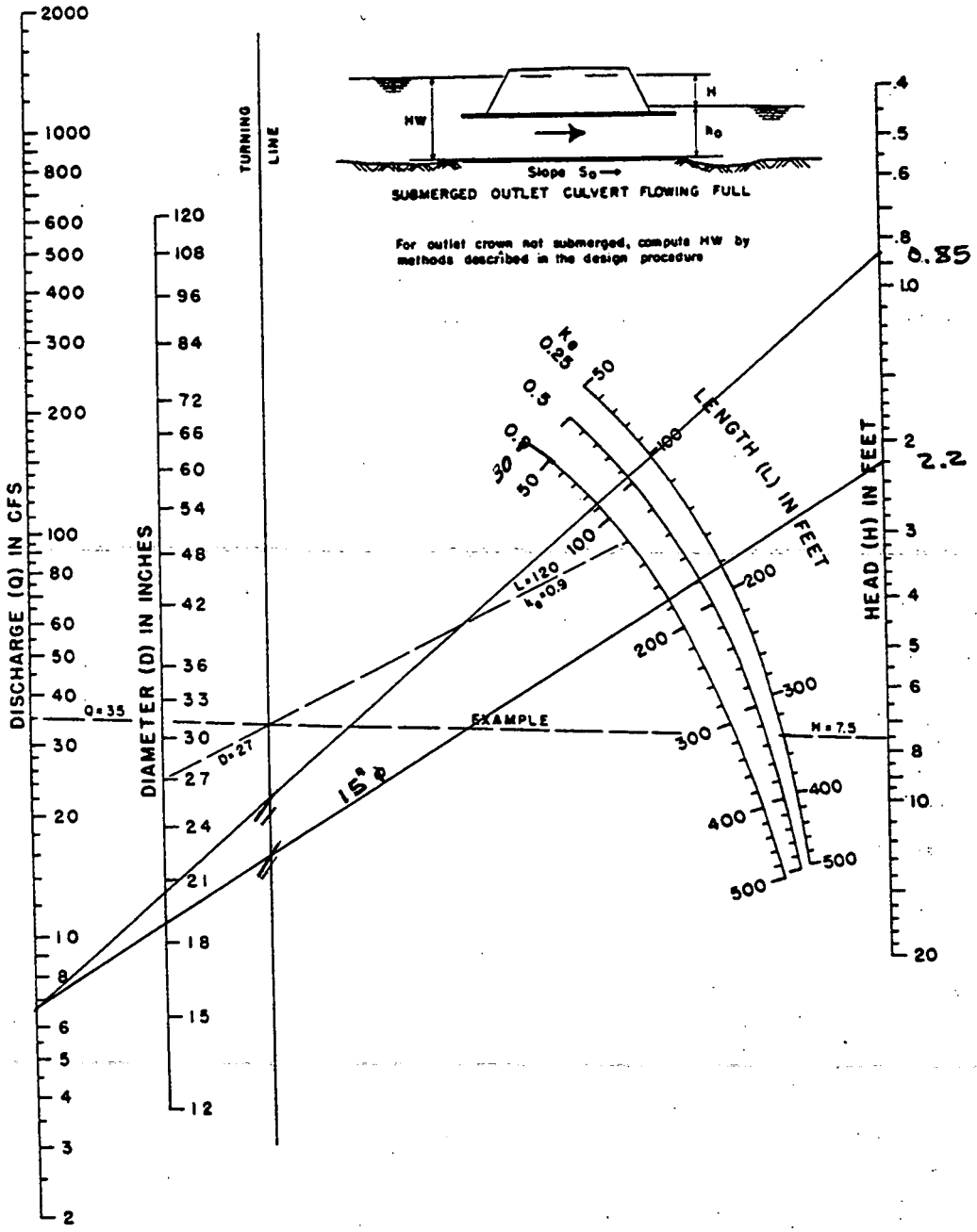


HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000103

CHART 6

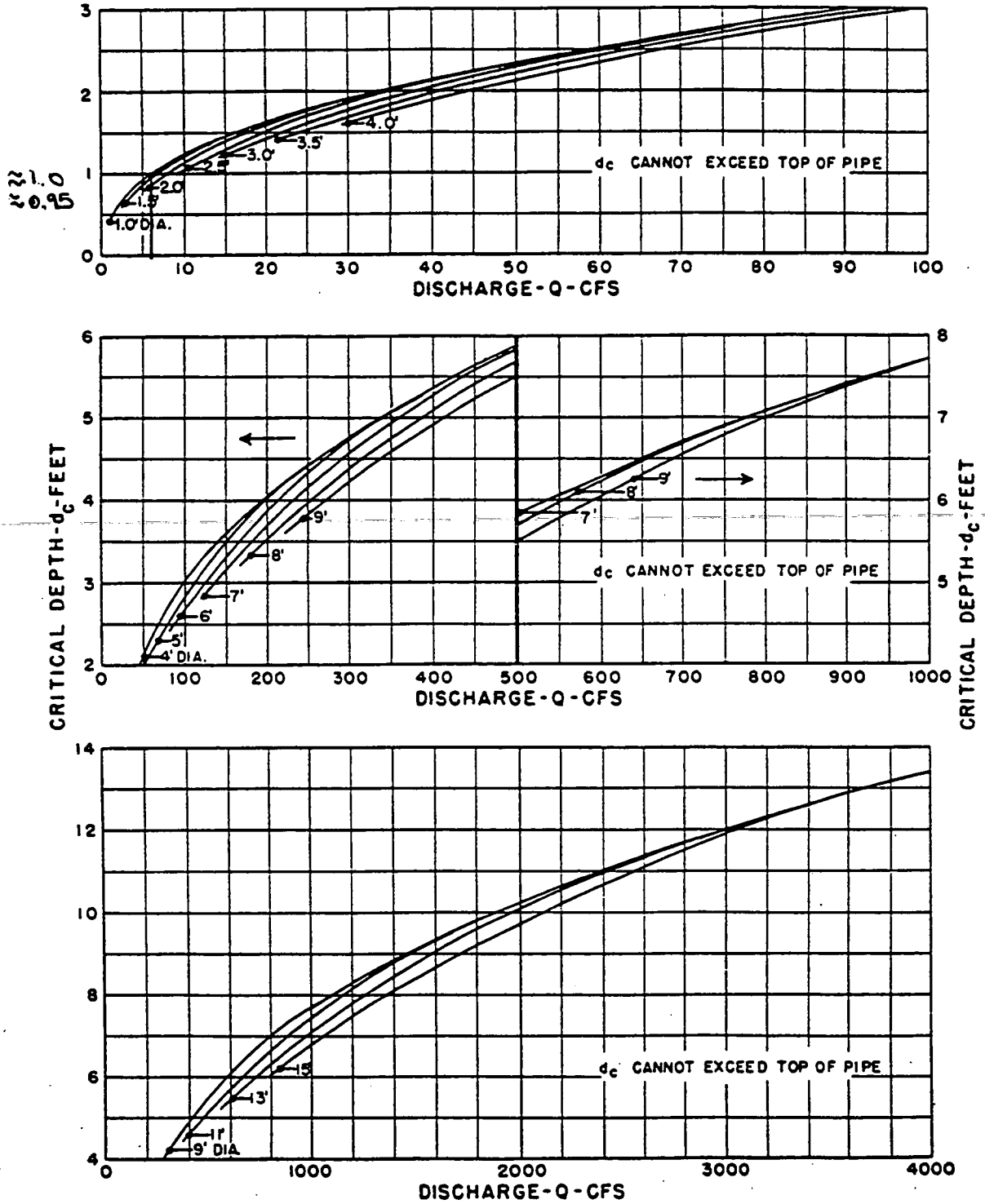


HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

SHT C6

CHART 4



BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

00020.3

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

SHT C8

Quick TR-55 Ver.5.46 S/N:
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CULVERT 2
USE SAME AS D11
EXISTING CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.89						
GRAVEL	0.900	0.28						
			10.00	0.672	0.672	5.450	1.17	4.2

SHT C9

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 16:48:20 01-20-1997

CULVERT 2
USE SAME AS D11
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
VEG, POOR	0.600	0.57						
GRAVEL	0.900	0.28						
			10.00	0.699	0.699	5.450	0.85	3.24

PROJECT: SOUTHERN WASTE UNITS
CULVERT-2

STATION: _____
SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

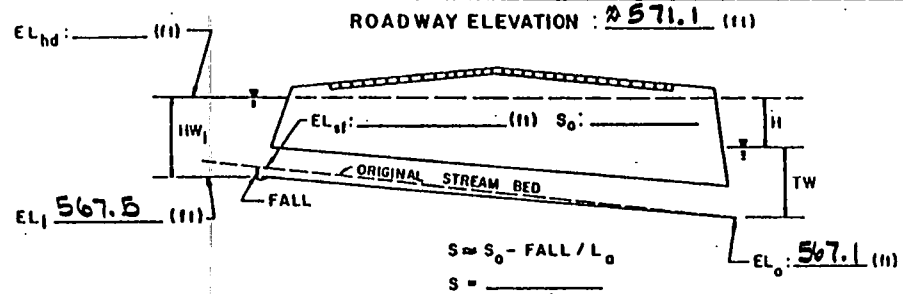
SEE ADD'L SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	4.3	*

ROADWAY ELEVATION: ≈ 571.1 (ft)



$S \approx S_o - FALL / L_o$
$S =$ _____
$L_o \approx 40'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ CMP	4.3	4.3	1.12	1.4	–	568.9	0.8	0.8	1.03	1.03	0.9	0.9	569.0	569.0	—	OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

* ASSUME OUTLET FLOWING FULL, FROM D-11 CALC, DEPTH FOR n = 0.04 DITCH = 0.77' ⇒ USE TW = 0.8'

PROJECTING ENDS ∴ $K_e = 0.9$

CULVERT BARREL SELECTED:

SIZE: 15" Φ
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

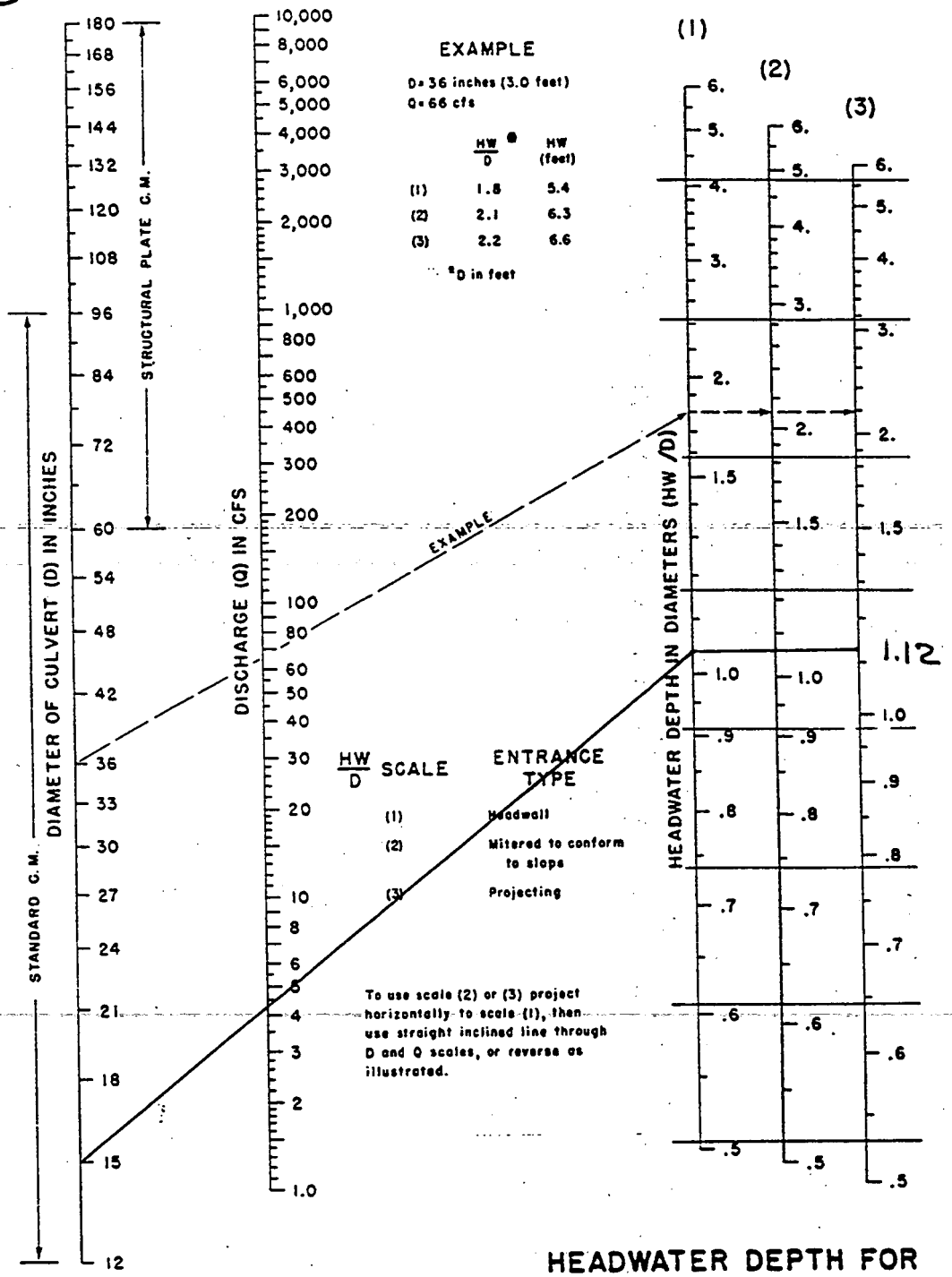
240

000209

SHT C10

SHT C11
1121

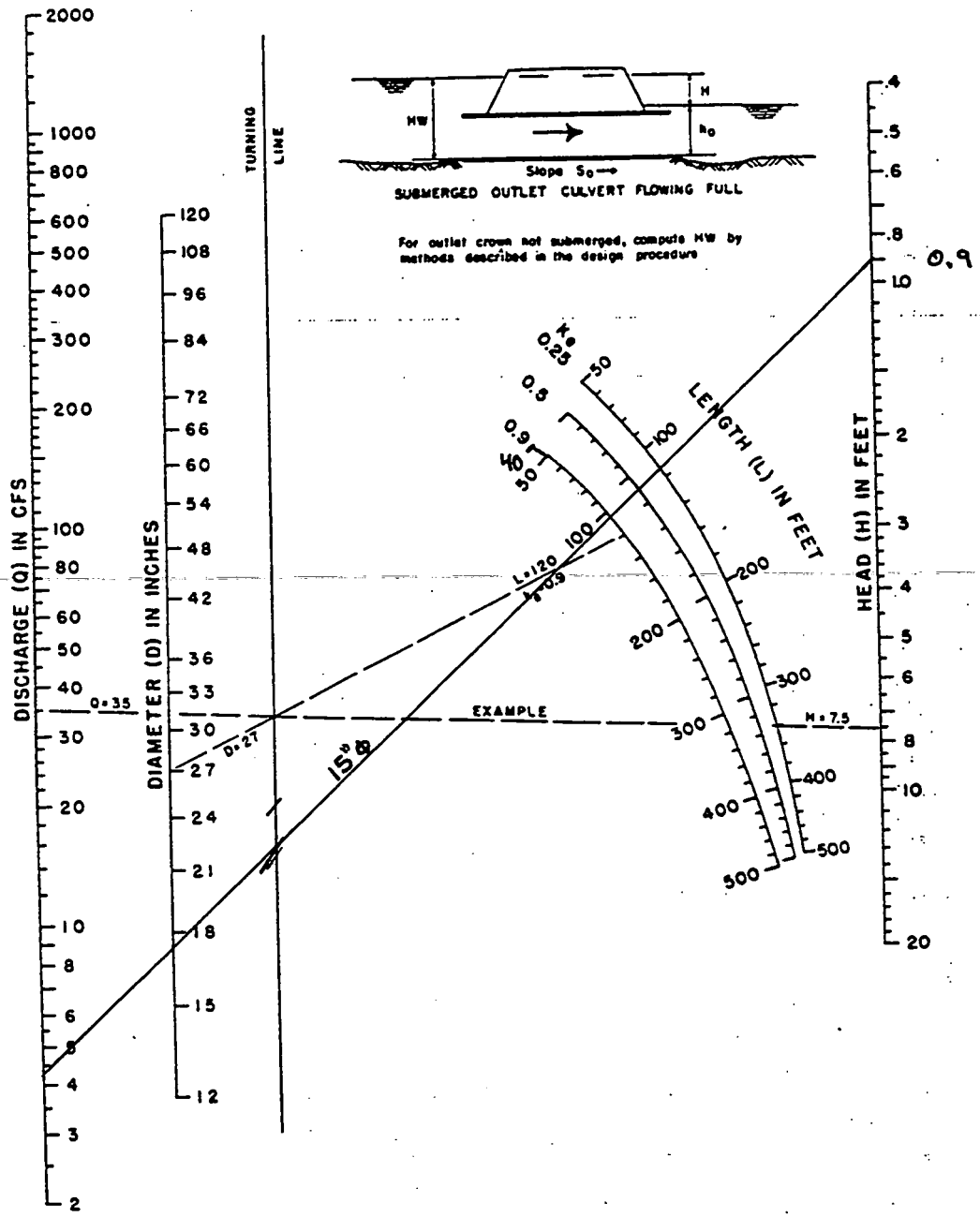
CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 6



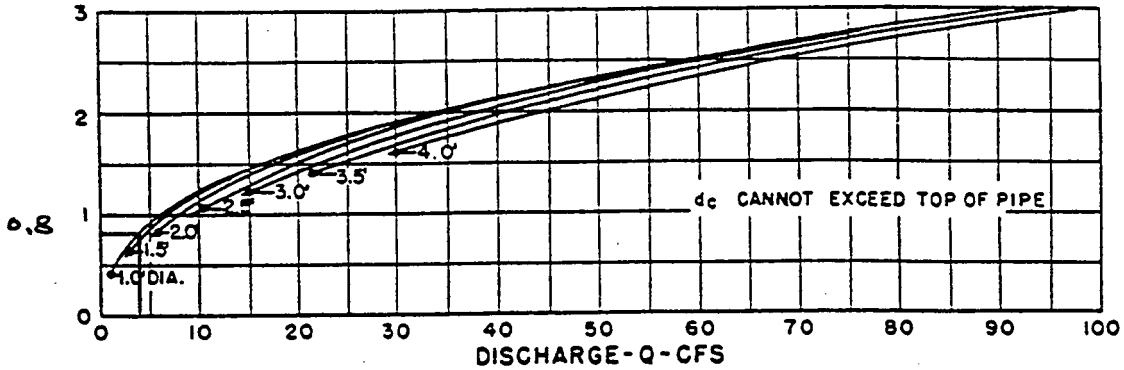
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

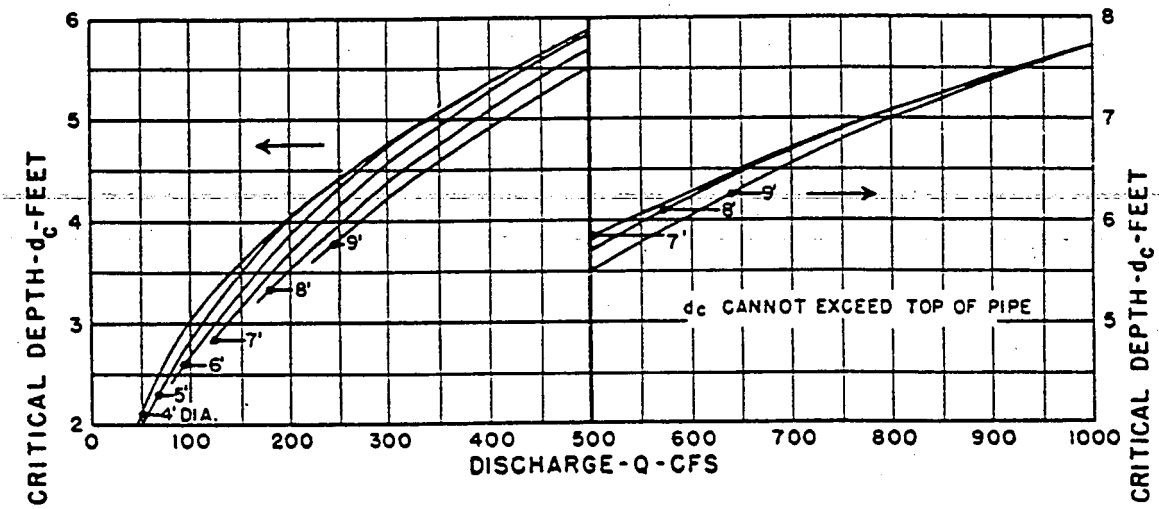
BUREAU OF PUBLIC ROADS JAN. 1963

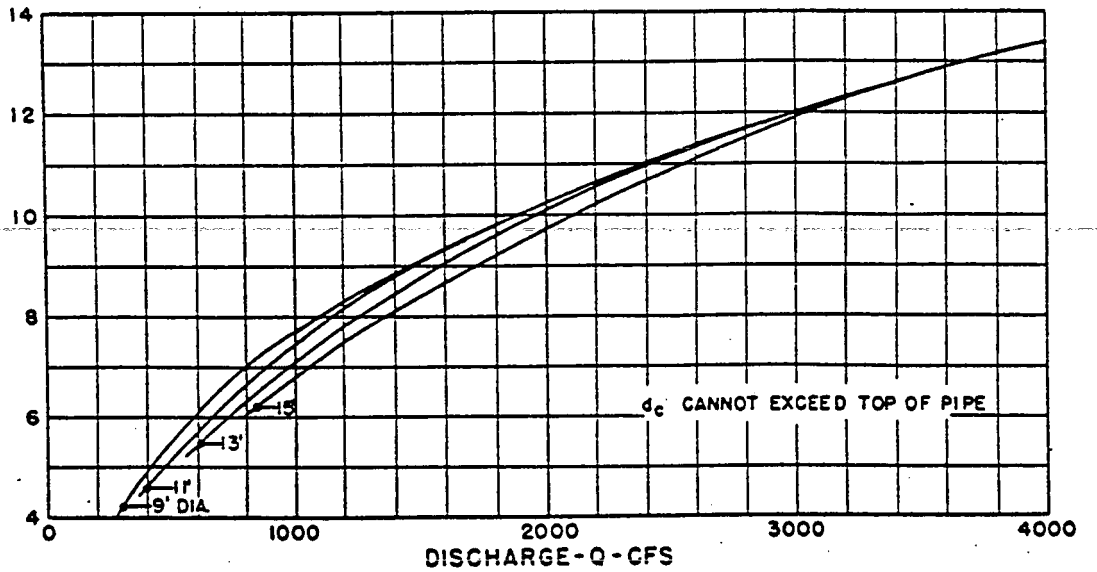
SHT C13

1121

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000212

SHT C14

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000213

SHT C15

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 14:39:46 04-28-1997

DITCH-5 & 6 COMBINED
CULVERT 3
PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	1.09						
			10.00	0.700	0.700	5.450	1.09	4.16

000214

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 3

STATION: N/A
SHEET — OF —

CULVERT DESIGN FORM

DESIGNER / DATE: ____ / ____
REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

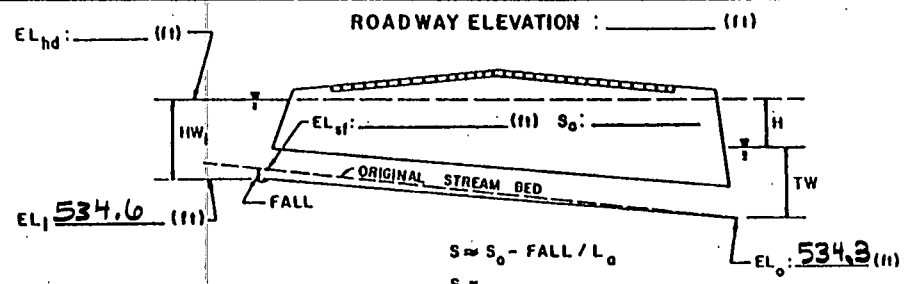
SEE ADD'L. SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	4.2	*

ROADWAY ELEVATION: ____ (ft)



$S \approx S_o - FALL / L_a$
$S =$ ____
$L_a \approx$ 45'

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ CMP	4.2	4.2	1.1	1.38	—	536.0	0.8	0.8	1.03	1.03	0.9	0.82	536.15	536.15	—	OUTLET CONTROL

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})_i$ FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION: * ASSUME D-7 FLOWING FULL. FROM D-7 CALC, DEPTH = 0.8 FT

PROJECTING, $K_e = 0.9$

CULVERT BARREL SELECTED:

SIZE: 15"
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

240

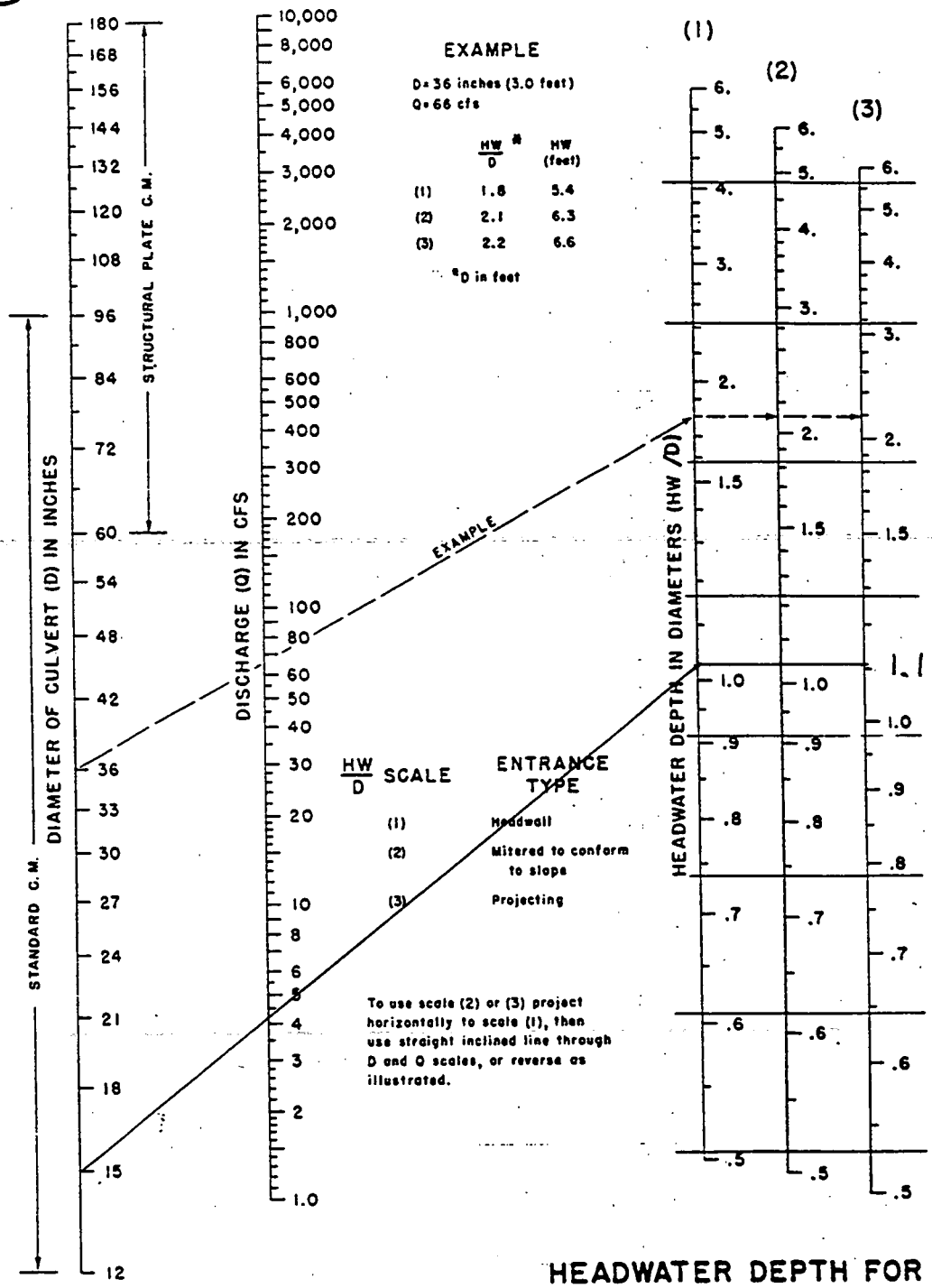
0001

Sht C16

SHT C17

1121

CHART 2



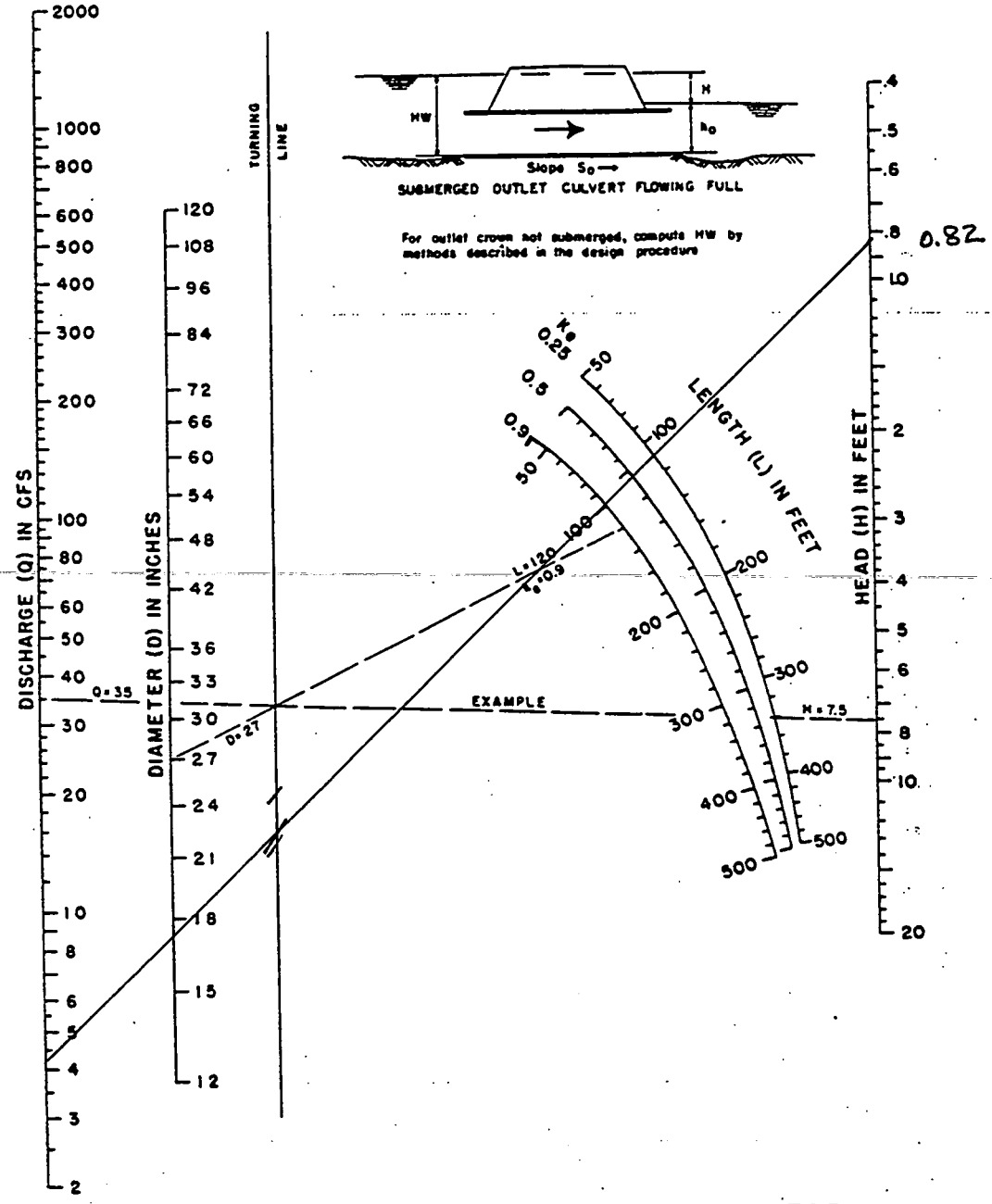
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000216

SHT C18

CHART 6



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

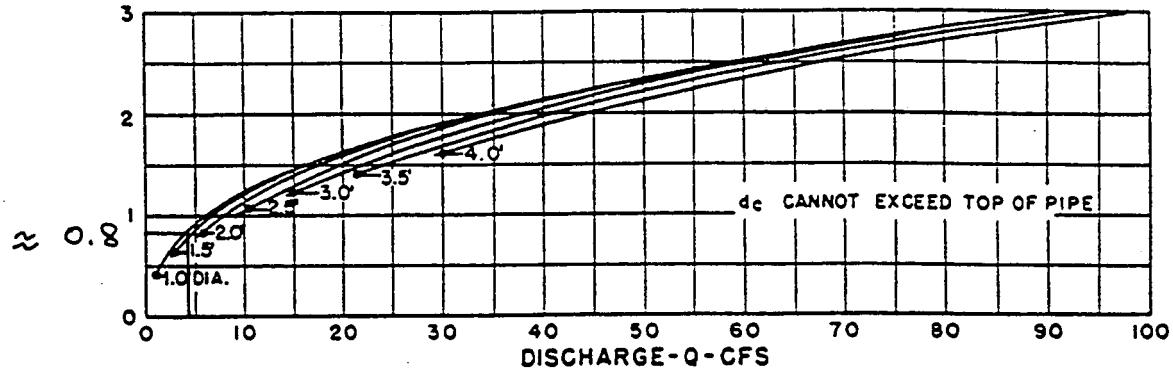
BUREAU OF PUBLIC ROADS JAN. 1963

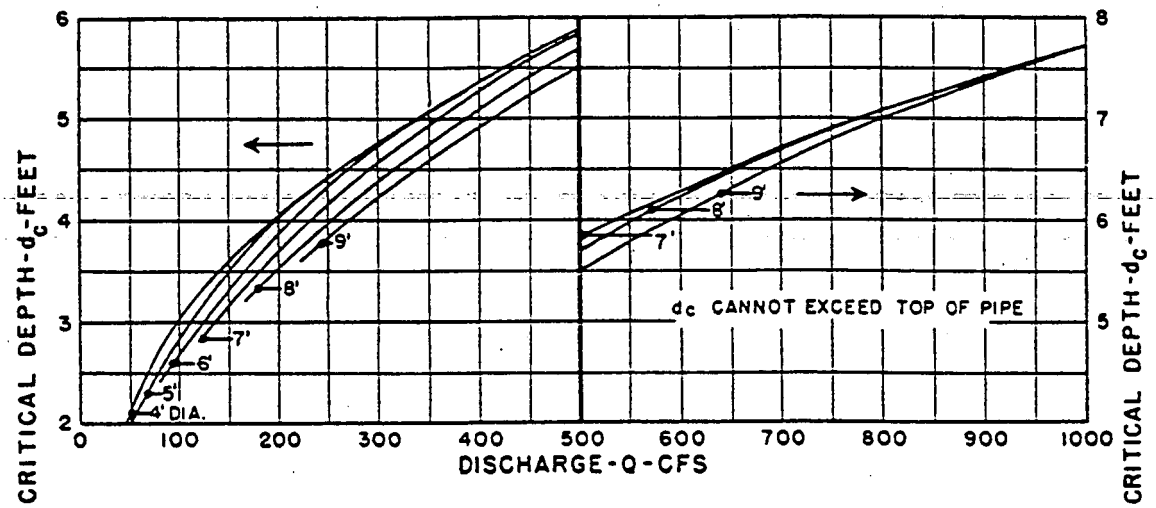
000217

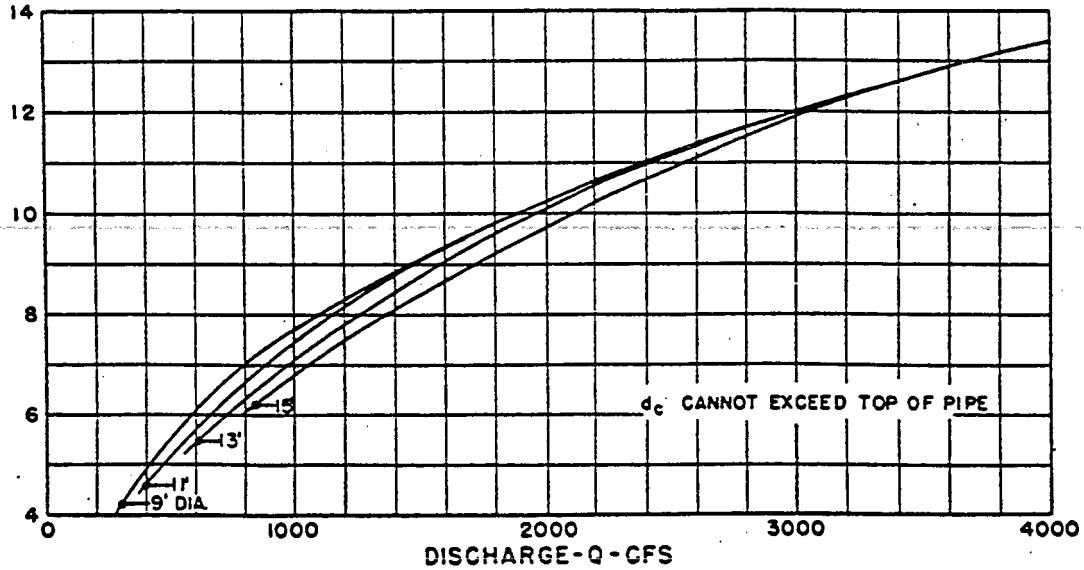
SHT C19

1121

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000218

SHT C20

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g}\right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

00021

SHT cd 121

Quick TR-55 Ver.5.46 S/N:
Executed: 13:44:02 02-04-1997

CULVERT 4

PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
WOODS	0.300	8.10						
VEG, FAIR	0.420	2.01						
GRAVEL RD	0.900	0.20						
BARE,(WDCHP)	0.700	0.50						
			39.00	0.352	0.352	2.750	10.81	10.46

SHT C22

Quick TR-55 Ver.5.46 S/N:
Executed: 13:42:27 02-04-1997 c:\po165d\C4.TCT

CULVERT 4

Tc COMPUTATIONS FOR: CULVERT 4

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		WOODS, LT	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0500	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.62	= 0.62

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	345.0	
Watercourse slope, s	ft/ft	0.0290	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.7476	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.03	= 0.03

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.65

000221

SHT C23
1121

Quick TR-55 Ver.5.46 S/N:
Executed: 13:42:27 02-04-1997 c:\po165d\C4.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

CULVERT 4

Subarea descr.	Tc or Tt	Time (hrs)
CULVERT 4	Tc	0.65

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 4

STATION: _____

SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____

REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

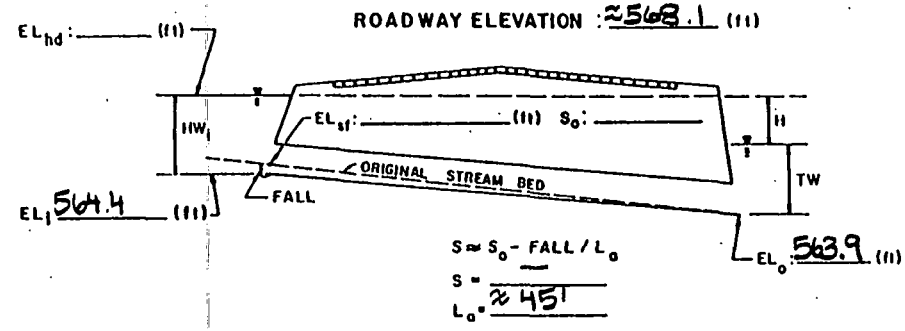
SEE ADD'L SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: — ☐ STREAM SLOPE: —
- ☐ CHANNEL SHAPE: —
- ☐ ROUTING: — ☐ OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	10.5	2'

ROADWAY ELEVATION: ≈568.1 (ft)



$S \approx S_o - FALL / L_o$

$S =$ —

$L_o =$ ≈ 45'

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS — INLET CONTROL: HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL: TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 18" ϕ	10.5	10.5	1.8	2.7	—	567.1	2	1.3	1.4	2	0.9	2.4	568.3	568.3	—	
TRY 24" ϕ	10.5	10.5	0.95	1.9	—	566.3	2	1.2	1.6	2	0.9	0.7	566.6	566.6	—	
TRY 21" ϕ	10.5	10.5	1.2	2.1	—	566.5	2	1.25	1.5	2	0.9	1.2	567.1	567.1	—	

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
i. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 21" ϕ

SHAPE: CIRCULAR

MATERIAL: CMP n 0.024

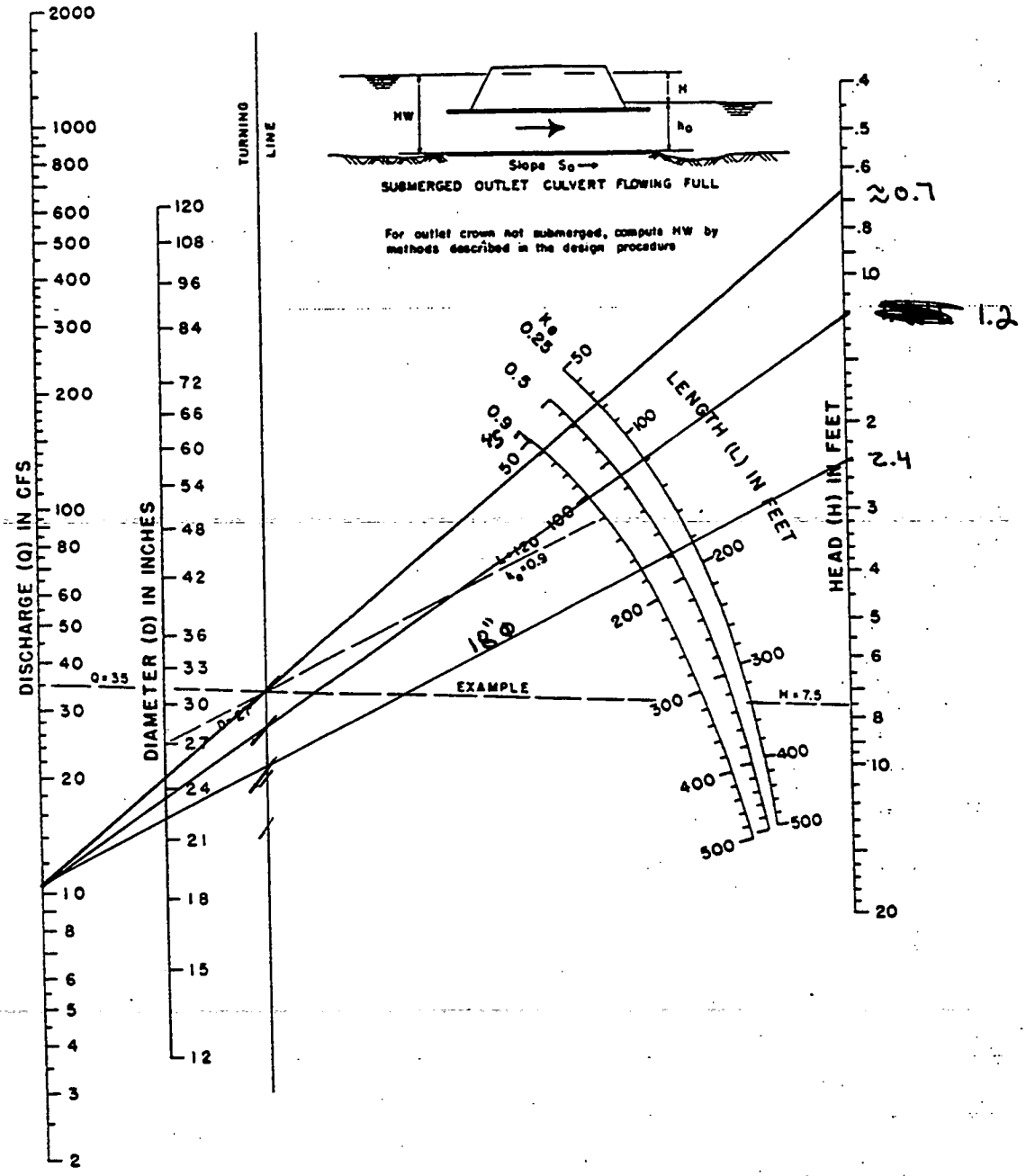
ENTRANCE: PROJECTING

SHT C24

000223

SHT C25
1121

CHART 6



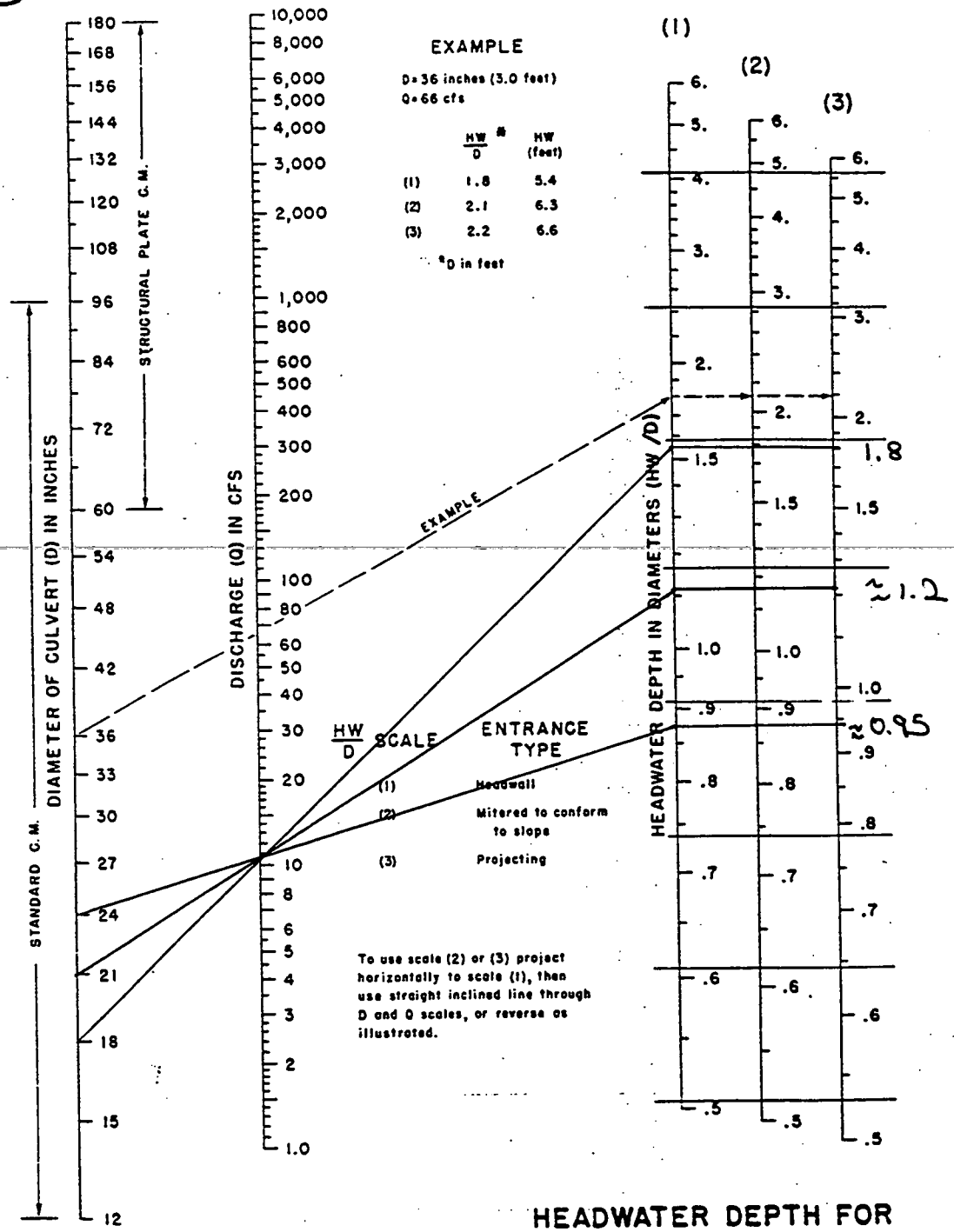
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

000224

SHT C26

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

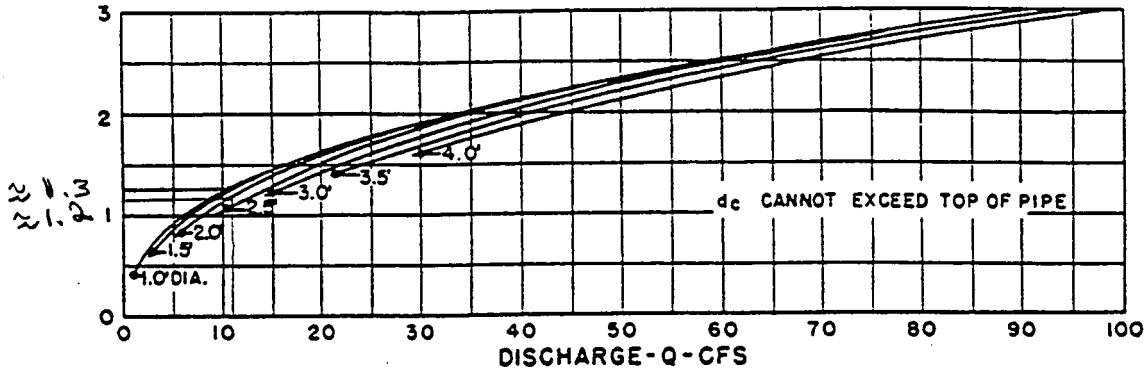
BUREAU OF PUBLIC ROADS JAN. 1963

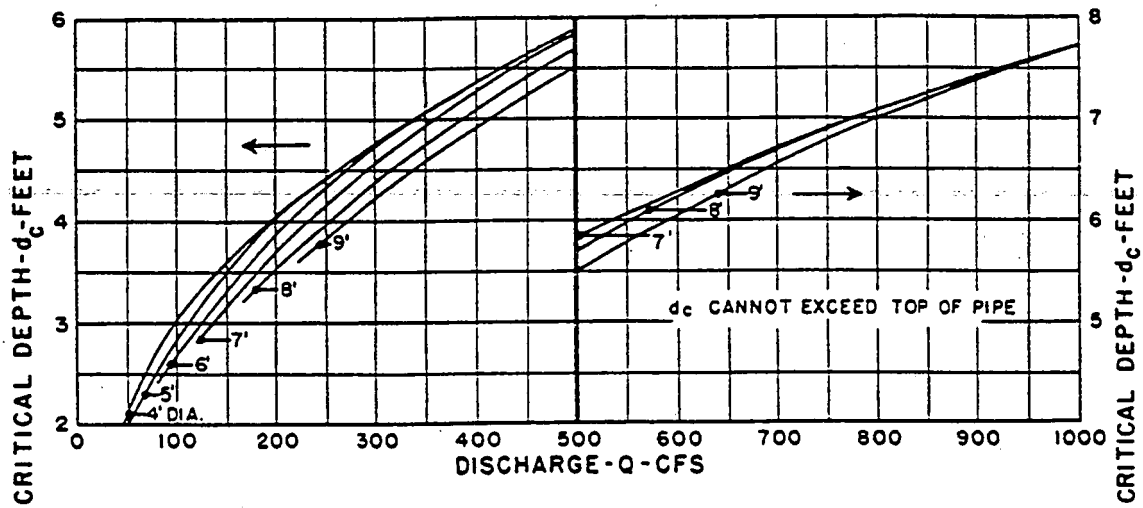
000225

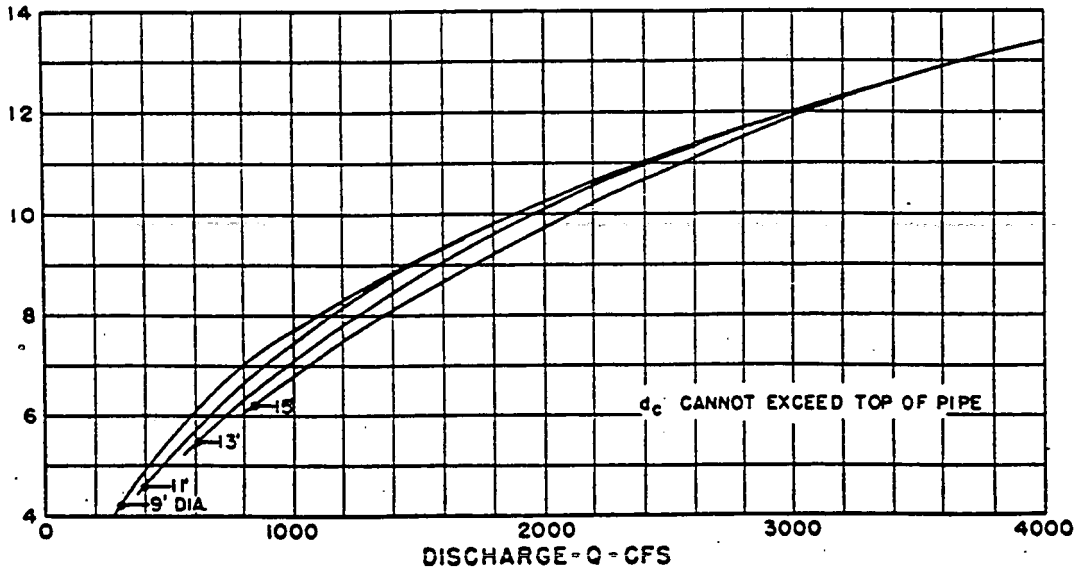
SHT C27

= 1121

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000226

SHT C28

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000227

SHT C29 1121

Quick TR-55 Ver.5.46 S/N:
Executed: 07:08:08 01-15-1997

CULVERT 5

PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
PAVEMENT	0.900	0.50						
			10.00	0.900	0.900	5.450	0.50	2.45

PROJECT: SOUTHERN WASTE UNIT
CULVERT - 5

STATION: _____
SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

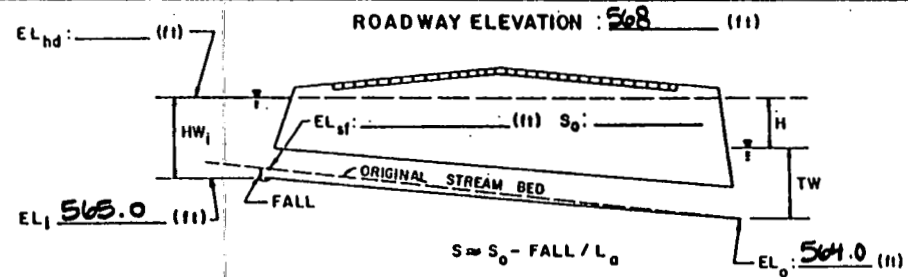
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	2.5	2



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" Φ	2.5	2.5	0.78	0.98	—	565.98	2	0.6	0.93	2	0.9	0.55	566.6	566.6	—	OUTLET CONTROL
TRY 18" Φ	2.5	2.5	0.59	0.89	—	565.89	2	≈0.6	1.05	2	0.9	≈ 0	566.0	566.0	—	OUTLET CONTROL

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW /D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

PROJECTING ENDS

CULVERT BARREL SELECTED:

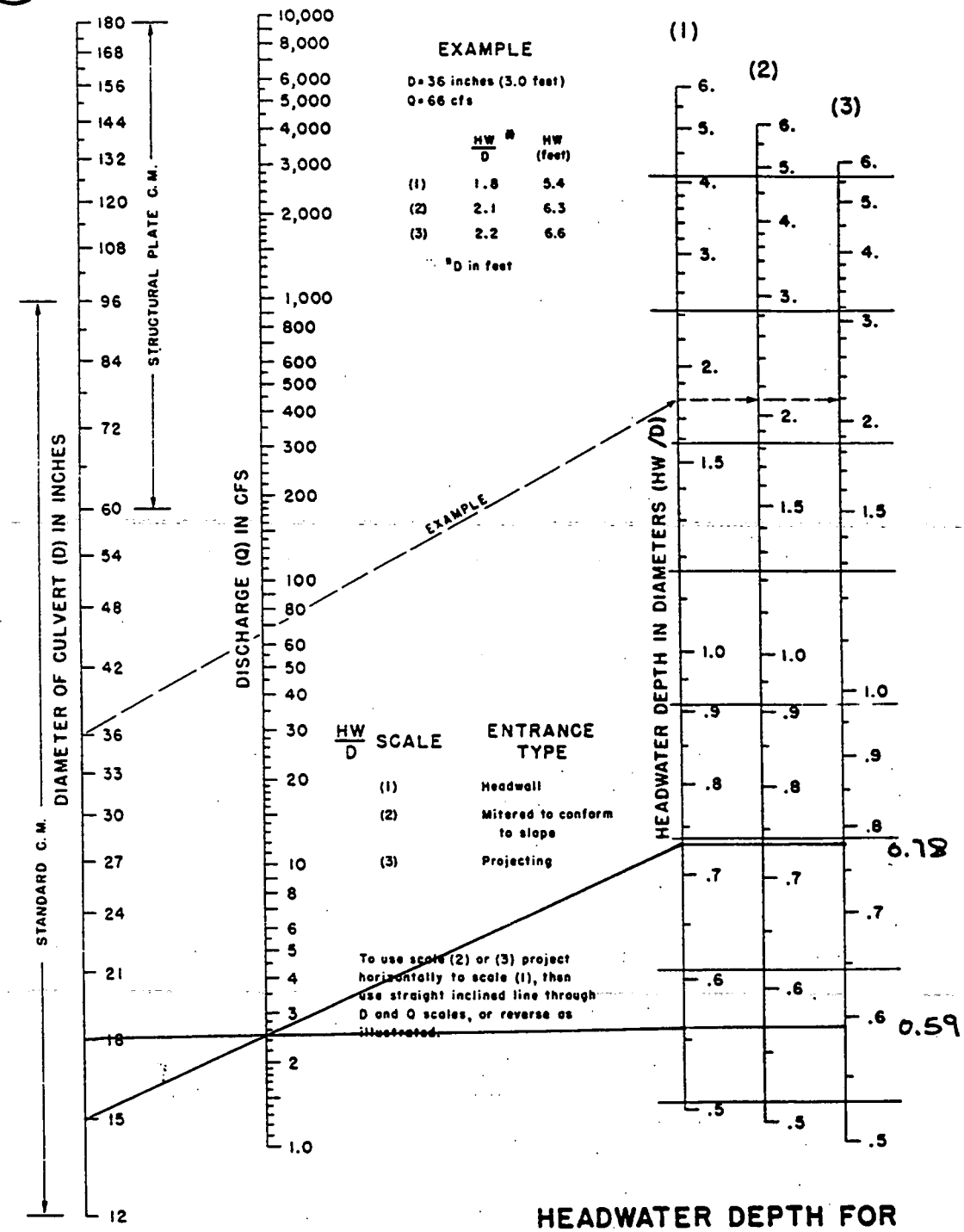
SIZE: 15" Φ
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

SHT C30

SHT C31

1121

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

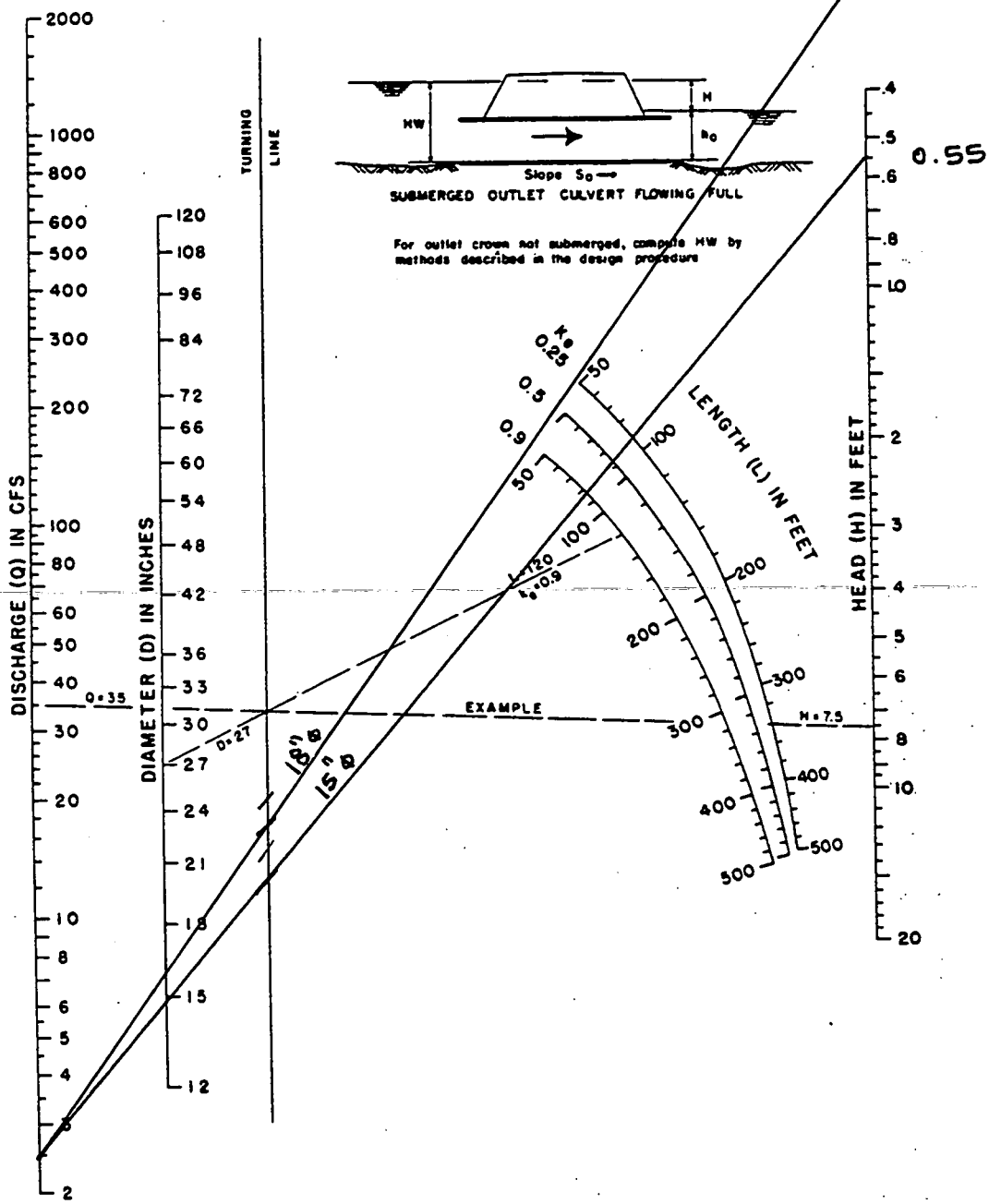
BUREAU OF PUBLIC ROADS JAN. 1963

000230

SHT C32

CHART 6

INSIGNIFICANT



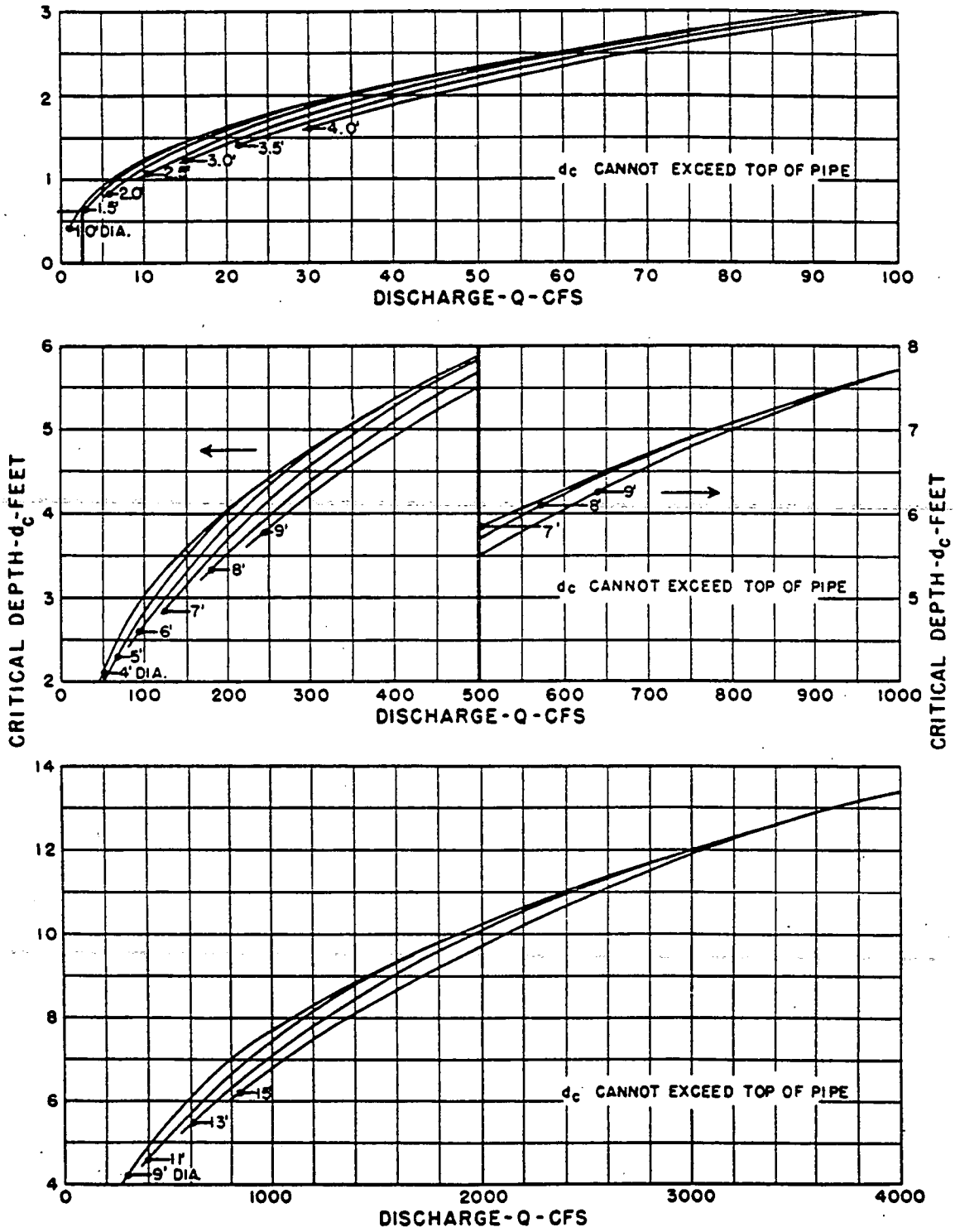
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

000231

SHT C33
1121

CHART 4



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000232

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

SHT C35

Quick TR-55 Ver.5.46 S/N:
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1121

CULVERT-6
EXISTING AND PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
BARE,>4:1	0.700	1.00						
			10.00	0.700	0.700	5.450	1.00	3.81

000234

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 6 (CONTINGENCY CULVERT)

STATION: —
SHEET — OF —

CULVERT DESIGN FORM

DESIGNER / DATE: — / —
REVIEWER / DATE: — / —

HYDROLOGICAL DATA

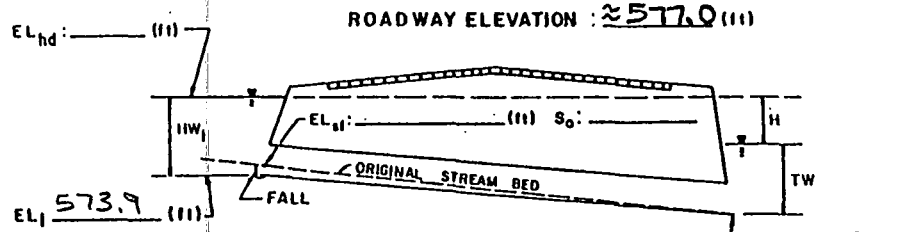
SEE ADD'L SHTS.

- [x] METHOD: RATIONAL
- [ ] DRAINAGE AREA: — [ ] STREAM SLOPE: —
- [ ] CHANNEL SHAPE: —
- [ ] ROUTING: — [ ] OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	3.81	*

ROADWAY ELEVATION: ≈577.0 (ft)



$S \approx S_o - FALL / L_o$
$S =$
$L_o = \approx 55'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 15" ϕ	3.8	3.8	1.0	1.25	—	575.2	1.2	0.7	1.0	1.2	0.9	0.9	576.4	576.4	—	OUTLET CONTROL OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})_i$ FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION: * ASSUME TW AT FLOW DEPTH FOR DITCH 8A, FROM CALC FOR 8A, TW = 1.2 FT

CULVERT BARREL SELECTED:

SIZE: 15"
SHAPE: ROUND
MATERIAL: CMP n=0.024
ENTRANCE: PROJECTING

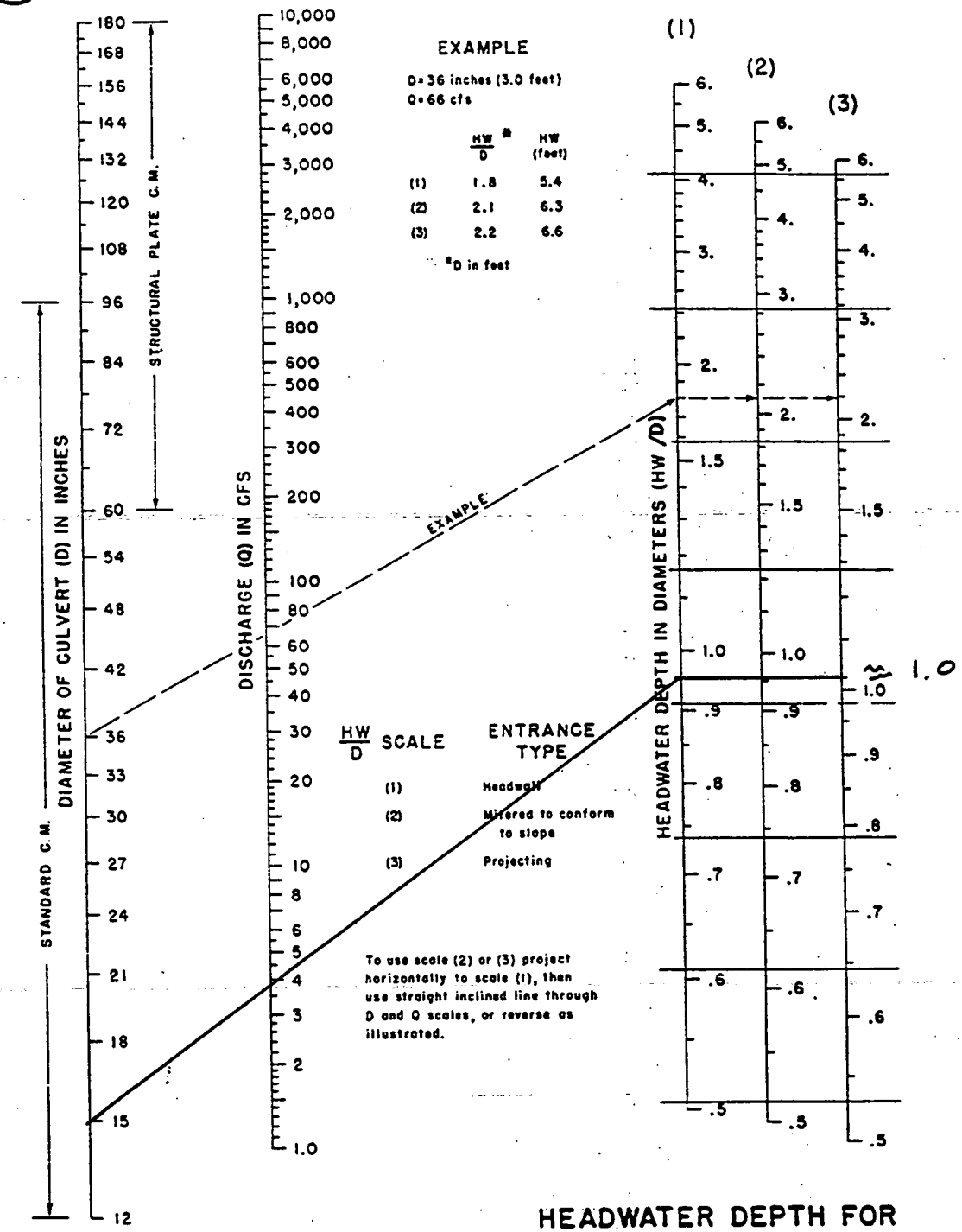
SHT C36

240

000235

SHT C37
1121

CHART 2



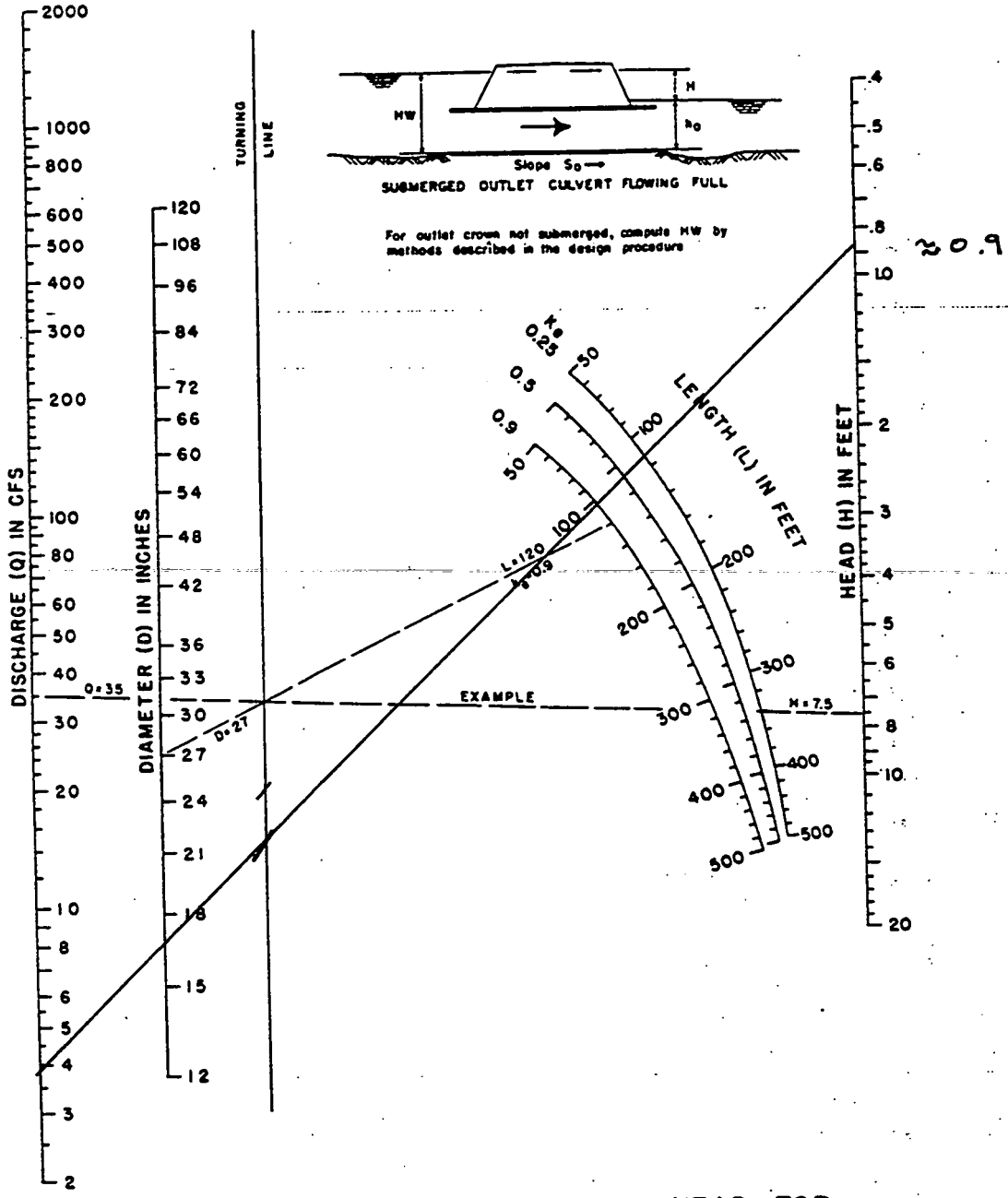
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

000236

SHT C38

CHART 6

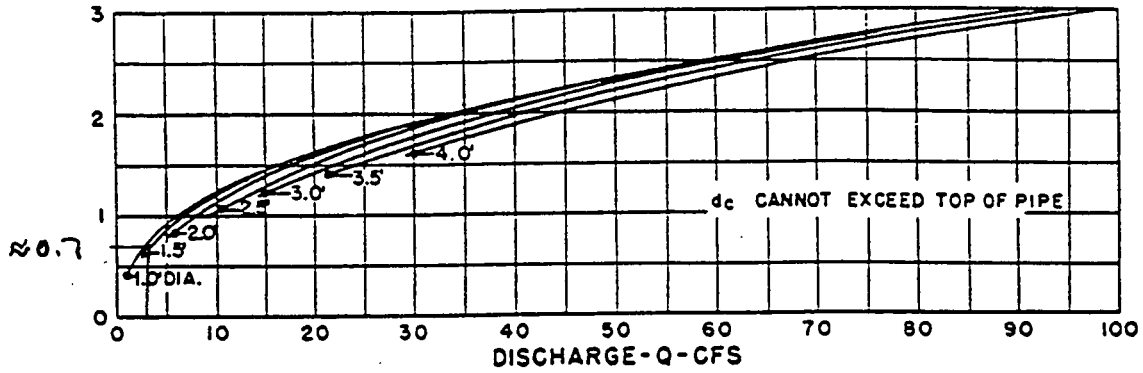


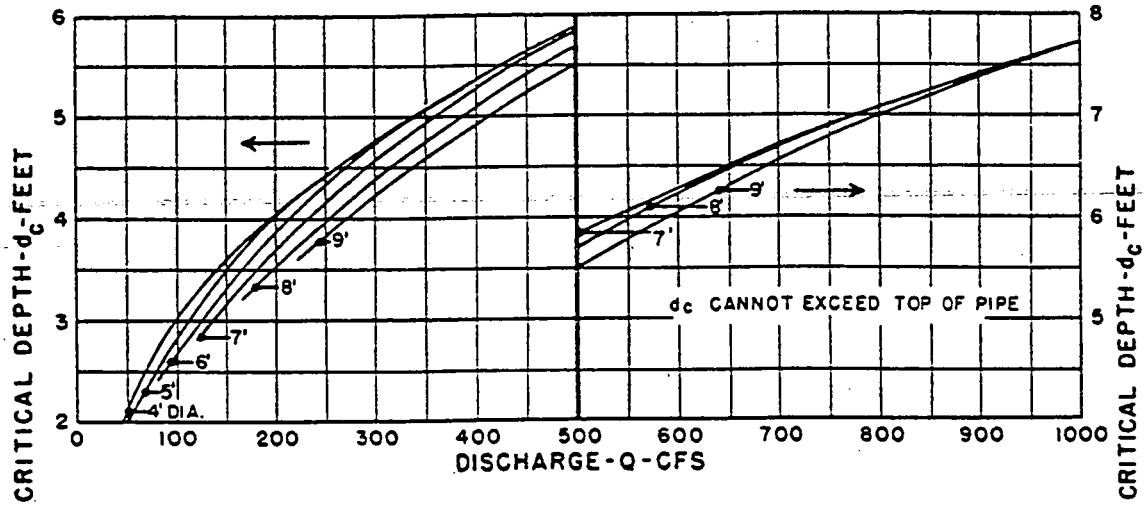
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

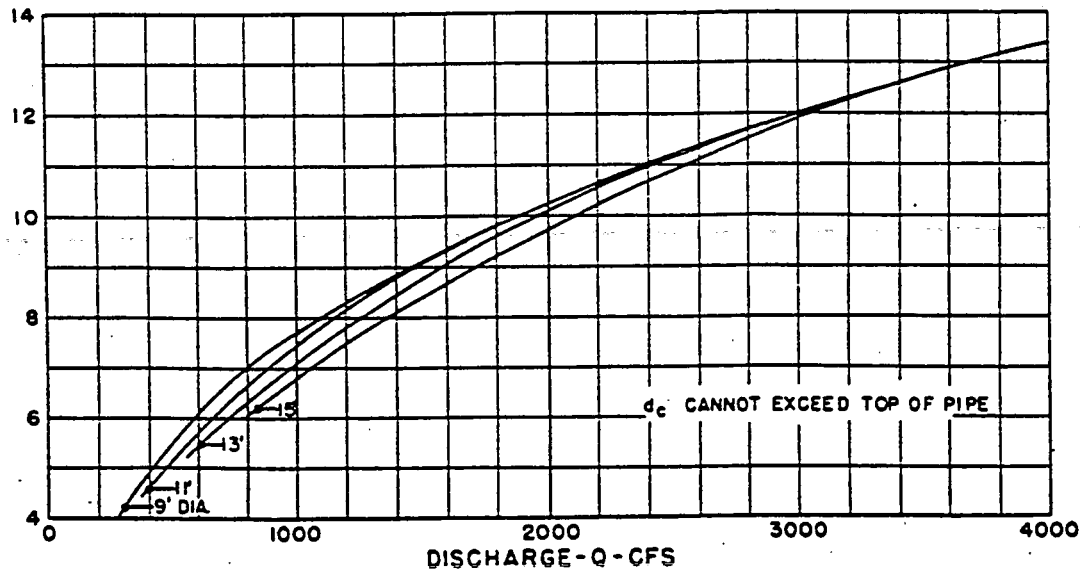
BUREAU OF PUBLIC ROADS JAN. 1963

000237

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

SHTC40

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000213

SHT C41

1121

Quick TR-55 Ver.5.46 S/N:
Executed: 16:53:28 06-07-1997

CULVERT-7
EXISTING AND PROPOSED CONDITIONS

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
'C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
GRAVEL	0.900	0.20						
			10.00	0.900	0.900	5.450	0.20	0.98

PROJECT: SOUTHERN WASTE UNITS
CULVERT - 7

STATION: _____
SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____
REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

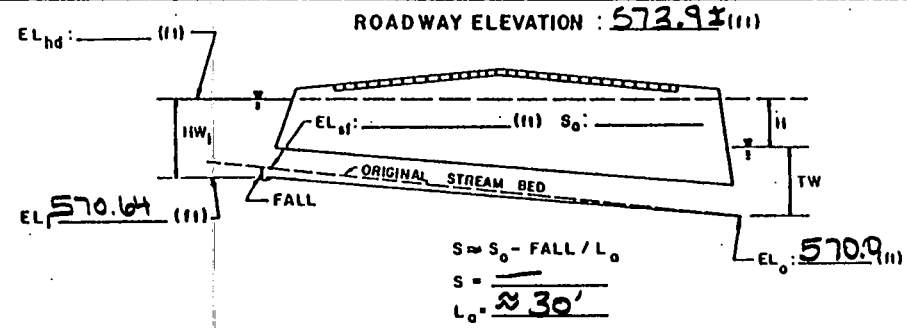
SEE ADD'L SHTS.

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: — ☐ STREAM SLOPE: —
- ☐ CHANNEL SHAPE: —
- ☐ ROUTING: — ☐ OTHER: —

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	0.98	*

ROADWAY ELEVATION: 573.9* (ft)



CULVERT DESCRIPTION:

MATERIAL - SHAPE - SIZE - ENTRANCE

CULVERT DESCRIPTION	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW i/D (2)	HW i	FALL (3)	EL hi (4)	OUTLET CONTROL TW (5)	d c	(d c + D)/2	h o (6)	h e	H (7)	EL ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
TRY 12" ϕ CMP	1.0	1.0	0.64	0.64	—	571.3	1	0.4	0.7	1	0.9	≈0	571.0	571.3	—	INLET CONTROL OK

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

* ASSUME TW = 1.0 ft

CULVERT BARREL SELECTED:

SIZE: 12"
SHAPE: ROUND
MATERIAL: CMP n 0.024
ENTRANCE: PROJECTING

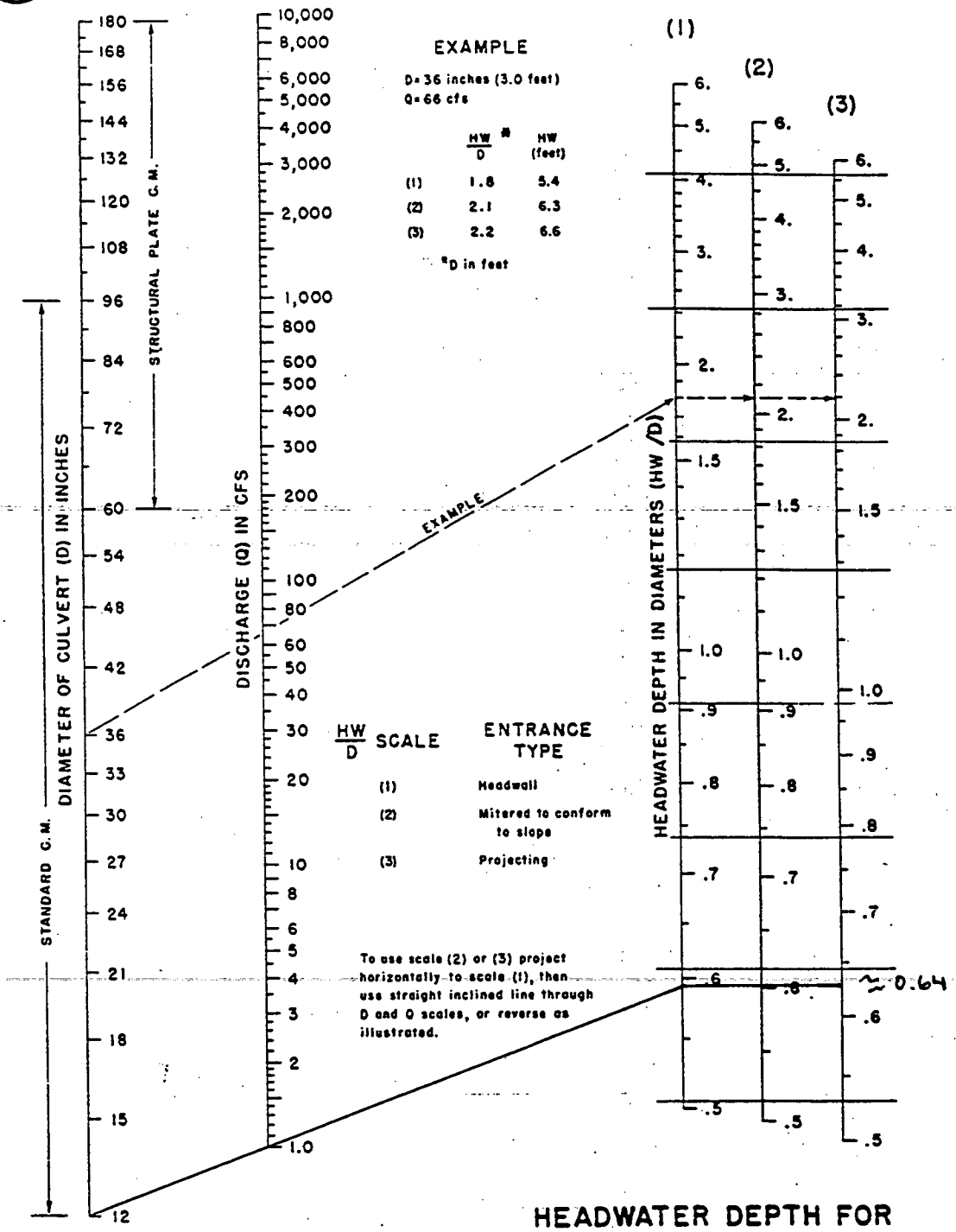
000271

54T C42

SHT C43

1121

CHART 2



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

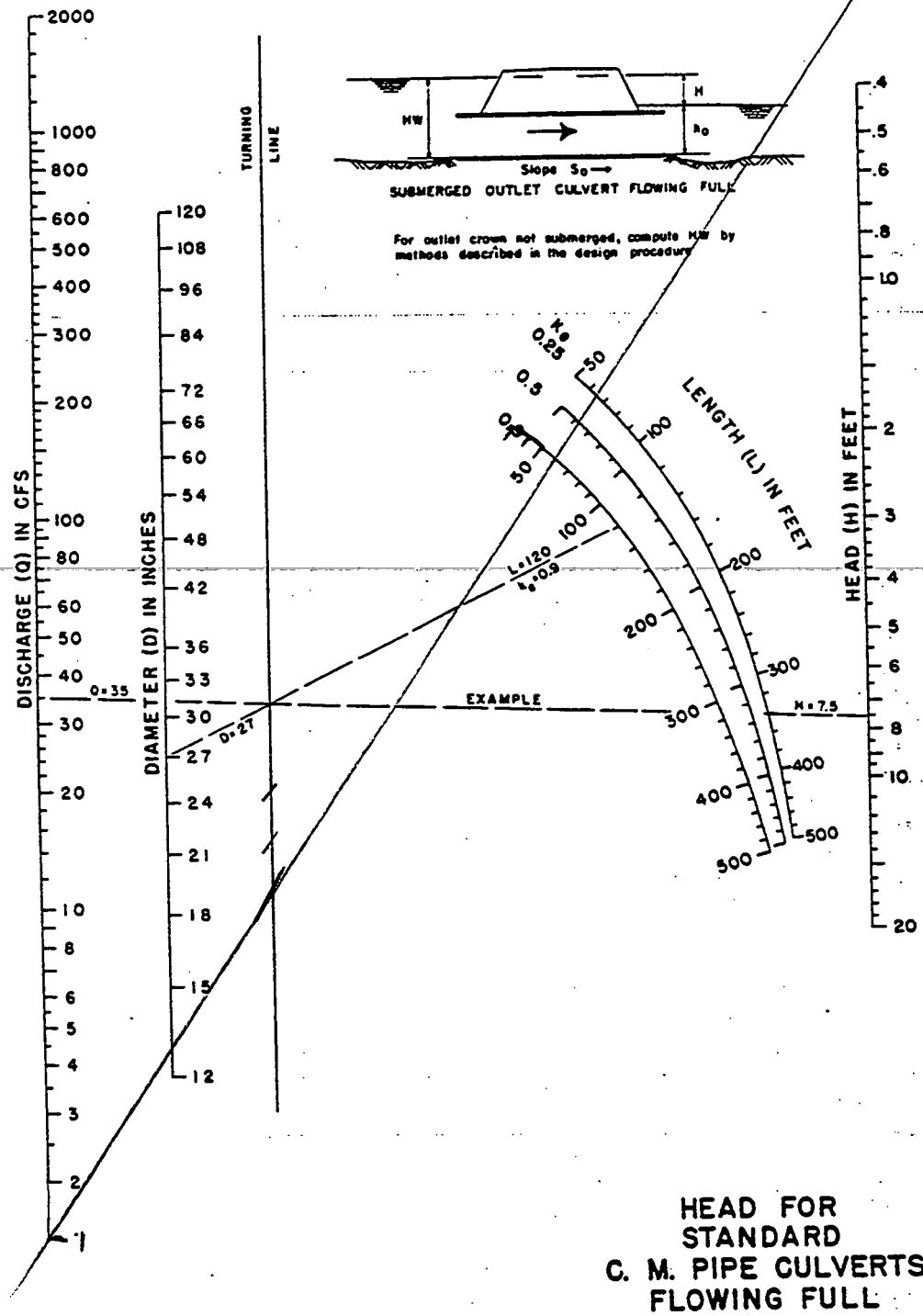
BUREAU OF PUBLIC ROADS JAN. 1963

000242

SHT C44

CHART 6

INSIGNIFICANT



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

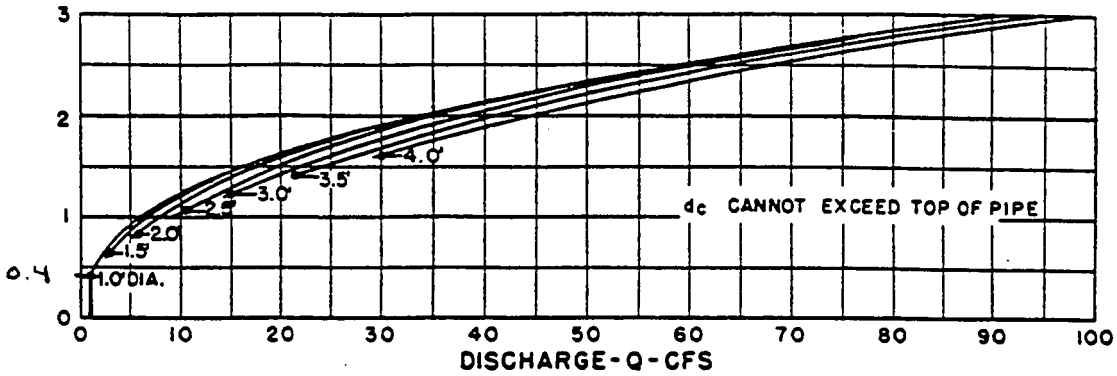
BUREAU OF PUBLIC ROADS JAN. 1963

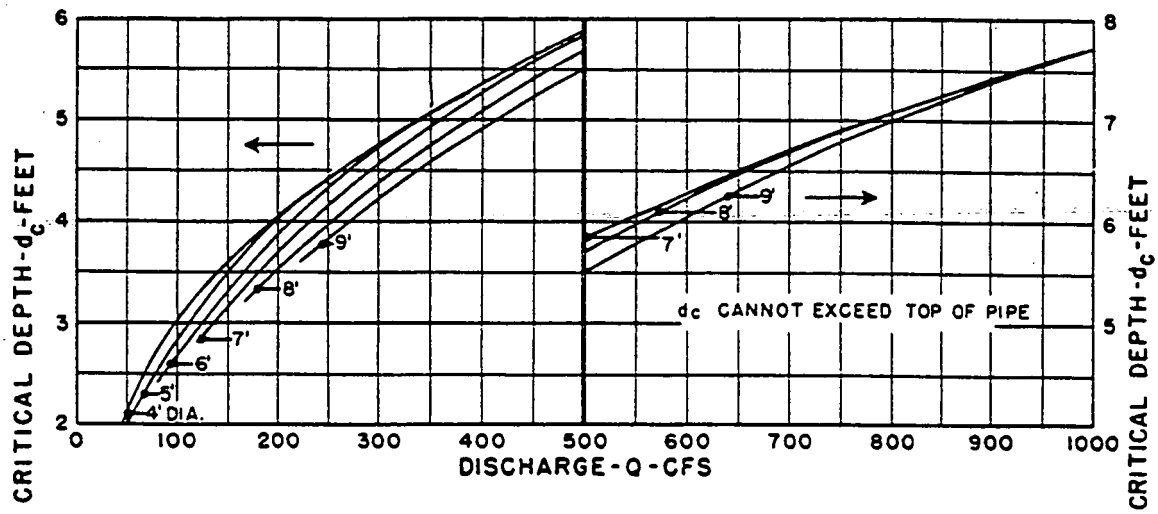
000243

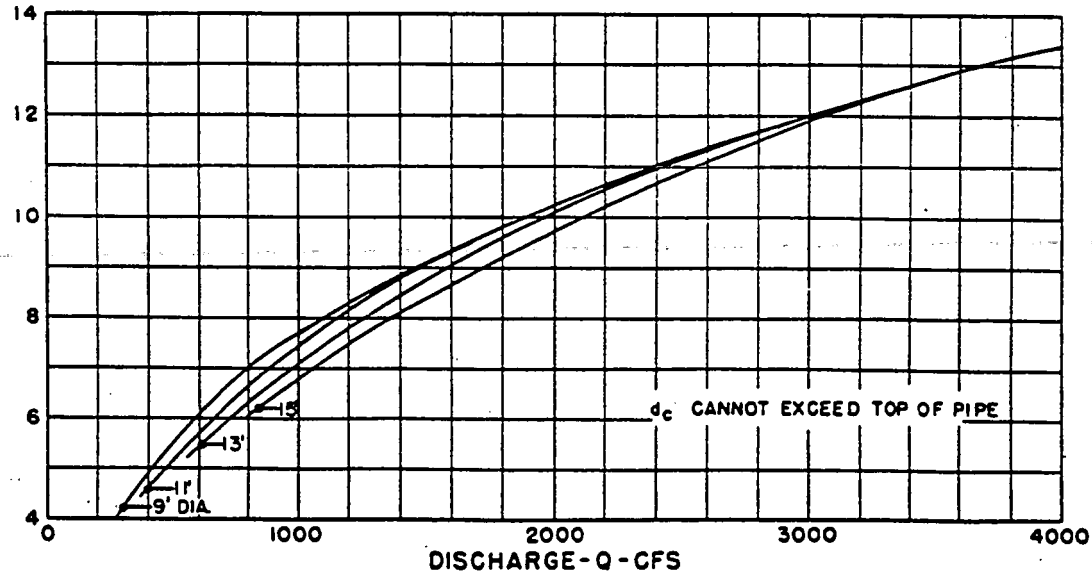
SHT C45

- 1121

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000244

SHT C46

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

000245

ATTACHMENT D

1) Soils Map (Reference 6)
2) Rainfall Intensity-Duration-Frequency Curve (Reference 7)

SHT P1 121

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

000247

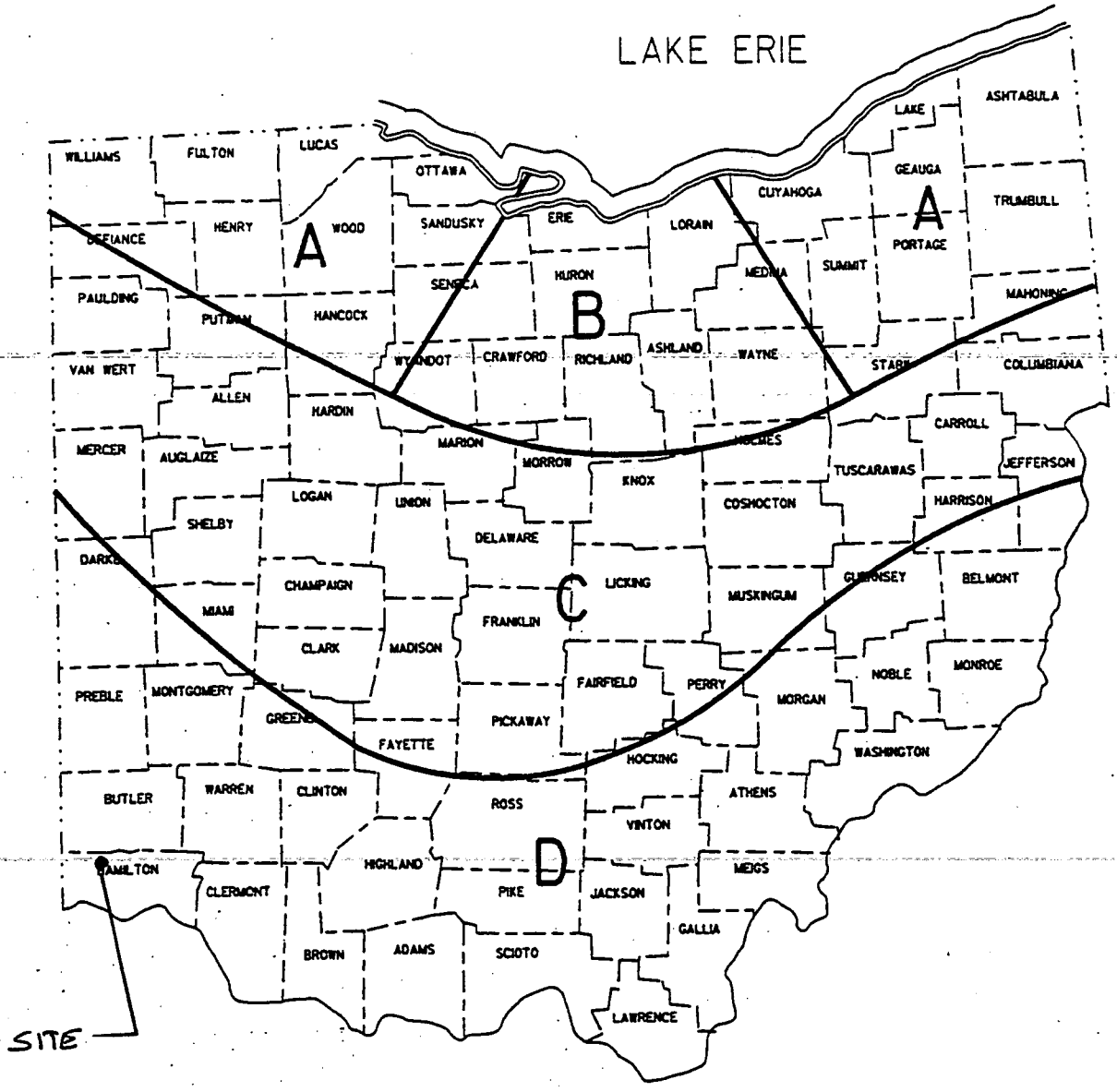
SHT D2

1121

RAINFALL INTENSITY ZONE MAP

1101-3

REFERENCE SECTION
1101.24

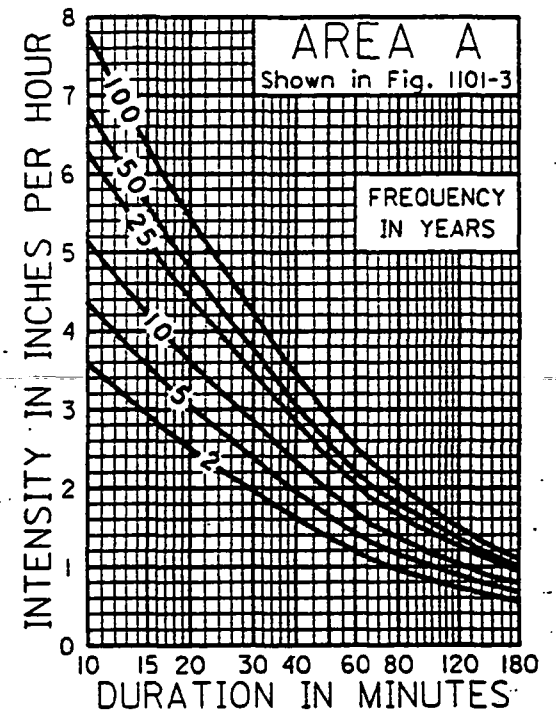


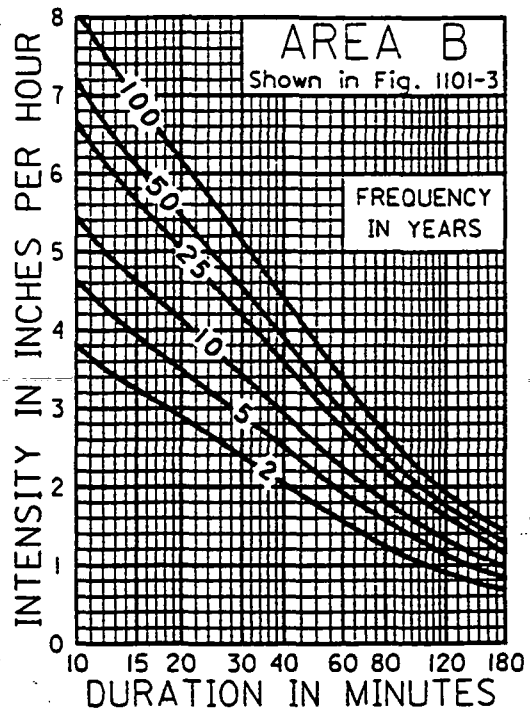
000248

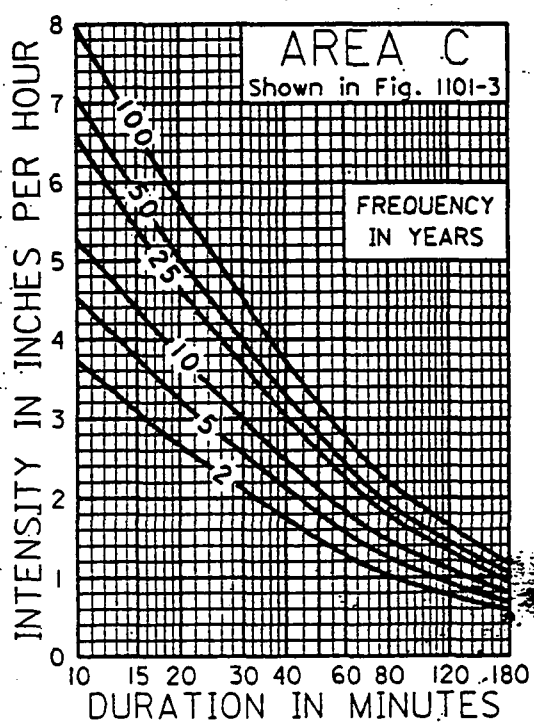
SHT D3

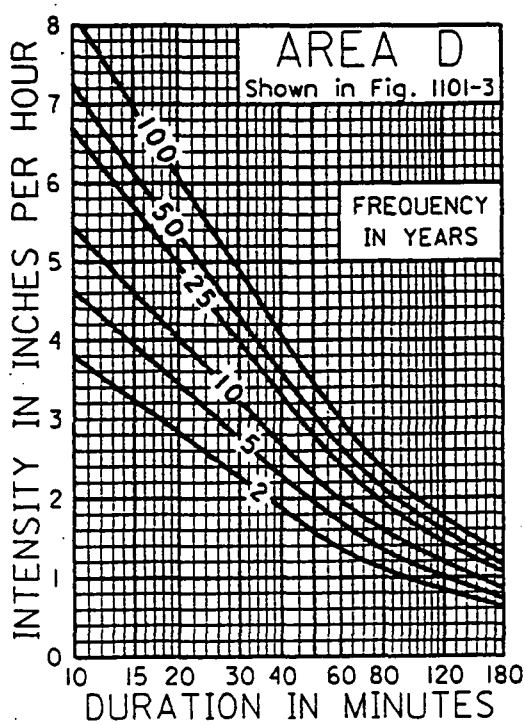
RAINFALL INTENSITY-FREQUENCY-DURATION CURVES	1101-2
	REFERENCE SECTION 1101.24

RAINFALL INTENSITY-FREQUENCY-DURATION CURVES









USE D CURVE

ATTACHMENT E

Calculation 15-02

PO158

Haulroad Drainage

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 7/23/96
Sheet 1 of 2

Proj. Order No. 158 Calculation No. 15-02

Project Title HAUL ROAD CONSTRUCTION

Calculation Subject DRAINAGE Date Verified/Checked 5/21/96

STATUS: PRELIMINARY ____ FINAL X SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

DITCH & CULVERT DESIGN CALCULATIONS FOR THE HAUL ROAD.
HAUL ROAD MAXIMUM DITCH VELOCITY IS 2 FT/SEC.

SUMMARY OF CONCLUSIONS	Originator's Signature and Date
DITCHES ARE DESIGNED AND PLOTTED IN THE PROFILE AND CROSS SECTIONS	AJ Shannon 5/21/96 REV 7/8/96

CHECKING METHOD	Checker's Signature and Date
1. Review X 2. Alternate Calculation ____	AM Christo 5/21/96 REV 7/8/96
	Lead Discipline Engineer's Signature and Date John Gilleslup 7/23/96

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. 0
Sheet 2 of 2

Proj. Order No. 158 Calculation No. 15-02

Project Title HAUL ROAD CONSTRUCTION

Calculation Subject DRAINAGE Date Verified/Checked 5/21/96

Prepared By: [illegible] Checked/Verified By: [illegible]

Date 5/21/96 REV 7/8/96

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

- ASSUMPTIONS - STATED IN CALCULATIONS
- CODES - ODOT LOCATION & DESIGN MANUAL
- SOURCES - PLAN DRAWINGS

De Leuw, Cather
Engineers and Planners

Subject: Haul Road
Job No. 660620
Sheet No. 1 of 3
Made by: AJS Date: 7/3/96
Checked by: Amc Date: 7/8/96

Revised Conduit Design

Assumptions/Criteria

- Use Inlet Control: Allowable HW = D ($\frac{HW}{D} = 1$)
  Use ODOT L&D Manual, Fig 1100-245 (Attachment B)
- Use Corrugated Metal Pipe
- Design based on 25-year peak discharge, Rational Method
- 2 fps maximum ditch velocity ahead of Sta 121+00
- 3 fps maximum ditch velocity below Sta 121+00

Sta 101+20

A = 12.39 Acres

Overland flow width ≈ 800 ft

Ground slope = 0.01 = 1.0%

T_o = 33 min (Attachment D)

$$T_D = \frac{(106+50 - 101+20)}{3 \text{ fps}} = 176.67 \text{ sec} = 2.9 \text{ say } 3 \text{ min}$$

T_c = 36 min

i_{25} = 3.6 in/hr

$Q_{25} = 0.3(3.6)(12.39)$

$= 13.4$ cfs

Required Pipe Size is 24" (Attachment B)

Sta 109+30

A = 10.44 Acres

Overland flow width ≈ 800 ft

Ground slope = 1.0%

$T_o = 33$ min

$$T_D = \frac{109+30 - 106+50}{3 \text{ fps}} = 93.3 \text{ sec} = 1.56 \text{ say } 2 \text{ min}$$

$T_c = T_o + T_D = 35$ min

$i_{25} = 3.65$ in/hr

$Q_{25} = 0.3(3.65)(10.44)$

$= 11.4$ cfs

Req'd Pipe Size is 24" (Attachment B)

Sta 119+12

A = 9.15 Acres (East Side from Sta 116+50 to the K-65 Trench @ 126+50)

Overland flow width = 350 ft, Ground slope ≈ 0.8%

$T_o = 26$ min

$$T_D = \frac{(126+50 - 119+12)}{3 \text{ fps}} \times \frac{1}{60} = 4.1 \text{ min}$$

$T_c = 30$ min

$i_{25} = 4$ inches/hr

De Leuw, Cather
Engineers and Planners

Subject: Haul Road
Job No. 660620
Sheet No. 3 of 3
Made by: AJS Date: 7/3/96
Checked by: [illegible] Date: 7/8/96

Sta 119+12 (cont)

$Q_{25} = 0.3(4.0)(9.15)$

$= 10.98$ cfs say 11 cfs

Required pipe size is 24" (Attachment B)

---

ipe Slopes

Assumptions/Restrictions

- Maximum velocity of 3 fps for stations below 121+00
- Velocity based on full flow using Mannings Equation

$$S_{MAX.\ ALLOWABLE} = \left[\frac{V\,n}{1.49(A/P)^{2/3}}\right]^2 \quad \text{where}$$

$V = 3$ fps

$A = \pi r^2 = 3.141$ ft^2

$P = 2\pi r = 6.283$ ft

} All Pipes are 24" dia.

$n = 0.024$ (Attachment C)

$$S_{MAX.\ ALLOWABLE} = \left[\frac{(3\text{ fps})(0.024)}{1.49\,(0.500)^{2/3}}\right]^2$$

$S_{MAX.} = 0.0059$

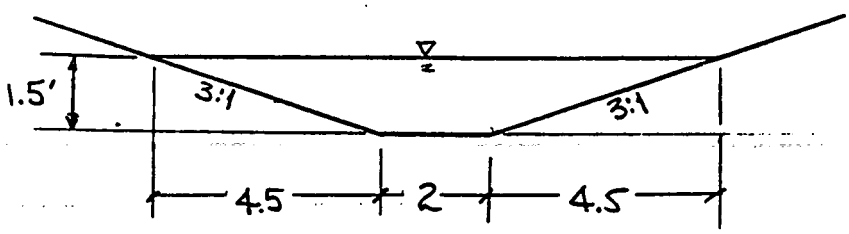
De Leuw, Cather
Engineers and Planners

Subject: Haul Road
Job No. 660620
Sheet No. 1 of 5
Made by: AJS
Date: 5/17/96
Checked by: AMC
Date: 5/22/96
Reiteration of Previous Calcs by DCB

Ditch Design

Assumptions/Restrictions

- Max velocity of 2 fps for Stations greater than 121+00
- Max velocity of 3 fps for Stations less than 121+00
- Trapezoidal Ditch Section; 2 foot bottom, 3:1 slopes
- Design Flow depth 1.5 ft. maximum



$A = 9.75\ ft^2$

$P = 11.49\ ft$

$R = A/P = 0.849\ ft$

Since capacity is not an issue on the Haul Rd due to small discharges, the main objective will be to control the velocity by means of restricting the allowable ditch slope.

De Leuw, Cather
Engineers and Planners

Subject: Haul Road **Job No.** 660620
Sheet No. 2 of 5
Made by: AJS **Date:** 5/17/96
Checked by: AMC **Date:** 5/22/96

Reiteration of Previous Calc's by DCB

V = 3 fps (Sta 121+00 forward) n = 0.04 for sod lining
(ODOT L&D Manual, Table 1102-2 Attachment F)

$$S = \left[\frac{Vn}{1.49 R^{2/3}}\right]^2$$

$$= \left[\frac{(3\text{fps})(0.04)}{(1.49)(0.849)^{2/3}}\right]^2$$

$$= 0.008$$

$$= 0.80\% \text{ maximum}$$

V = 2 fps (Sta 121+00 back)

$$S = \left[\frac{(2\text{fps})(0.04)}{(1.49)(0.849)^{2/3}}\right]^2$$

$$= 0.0036$$

$$= 0.36\% \text{ maximum}$$

$$S = \left[\frac{(2\text{fps})(0.06)}{(1.49)(0.849)^{2/3}}\right]$$

$$= 0.008$$

$$= 0.80\% \text{ max}$$

Sta 121+00 to Sta 128+35

ΔElev = 573.05 − 569.10 = 3.95 ft

S = 3.95 ft / 735 ft = 0.0054

$$n = \frac{1.49}{V} R^{2/3} S^{1/2} = \frac{1.49}{2}(0.849)^{2/3}(0.0054)^{1/2} = 0.049$$

Use RCP, n = 0.06

000257

AJS 5/14/96
Sheet 3 of 5
ck'd 5/22/96

Haul Road Ditch Checks (Steps)

- Restrict velocity to 2 fps maximum
- Minimize Use of Rock Channel Protection
  (try to limit to 'step' area)

Sta 130+07 to Sta 141+00
Ditch Length = 1093 ft
Drainage Area = 2.03 acres (from previous calcs)

From plans, the overland flow width to the high end of the ditch is 50 feet (±), and the ground slope is approximately 2% (0.02)

T_o = 10 min (L&D Manual, Figure 1101-1, Attachment D)

Based on a ditch velocity of 2 fps

T_D = 1093 ft / 2 ft/sec = 546.5 sec = 9 min

$T_c = T_o + T_D$ = 19 min

From Fig 1101-2, i_{25} = 5 inches/hr (Attachment E)

$Q_{25} = 0.3(5)(2.03) = 3.04$ cfs

Assume a flow depth of 1.5 feet, trapezoidal cross section with a bottom width of 2 feet and 3:1 side slopes, and sod lining ($n = 0.04$).

Then the flow area is

$$A = \tfrac{1}{2}\left[2 + 2 + 2(3)(1.5)\right](1.5) = 9.75\ ft^2$$

The wetted perimeter is

$$P = 2 + 2\left[(1.5)^2 + (4.5)^2\right]^{1/2} = 11.49\ ft$$

And the hydraulic radius is

$$R = A/P = 9.75/11.49 = 0.849\ ft$$

The ditch flow capacity is

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

For $S = 0.008$, $Q = 29.12$ cfs $\gg$ Max. discharge $= 3$ cfs

For $S = 0.006$, $Q = 25.22$ cfs $\gg 3$ cfs

Let $S = 0.006$ and find normal depth for $Q = 3$ cfs (peak flow in the ditch 'step' area).

Let $d = 0.5$ ft

$A = \frac{1}{2}[2 + (2 + 2(3)(0.5))](0.5) = 1.75 \text{ ft}^2$

$P = 2 + 2[(0.5)^2 + (1.5)^2]^{1/2} = 5.16$ ft

$R = A/P = 0.339$ ft

$Q = \frac{1.49}{0.04}(1.75)(0.339)^{2/3}(0.006)^{1/2} = 2.45$ cfs

Let $d = 0.6$ ft

$A = \frac{1}{2}[2 + (2 + 2(3)(0.6))](0.6) = 2.28 \text{ ft}^2$

$P = 2 + 2[(0.6)^2 + (1.8)^2]^{1/2} = 5.79$ ft

$R = A/P = 0.393$ ft

$Q = \frac{1.49}{0.04}(2.28)(0.393)^{2/3}(0.006)^{1/2} = 3.53$ cfs OKAY

$V = Q/A = 3.53/2.28 = 1.55$ f.p.s. OKAY

∴ In step area, use 0.60% ditch grade and 2-foot drops lined with Rock Channel Protection locally. Remainder of ditch to be lined with sod. Step interval is 200 ft.

1100 Drainage Design Procedures

1101 Estimating Design Discharge

1101.1 General

In order to properly design highway drainage facilities, it is essential that a reasonable estimate be made of the design and check discharges. Some of the more important factors affecting runoff are duration, intensity and frequency of rainfall, and the size, imperviousness, slope and shape of the drainage area. Also a proper evaluation should be made of probable changes in land use throughout the drainage area.

1101.2 Procedures

1101.21 Statistical Methods

The statistical methods developed by the U.S. Geological Survey and published in USGS Water Resources Investigations Reports 89-4126 and 86-4197 are recommended for estimating runoff from larger drainage areas. A description and limitations of these methods are described in Section 1003.

1101.22 Rational Method

The Rational method is considered to be more reliable for estimating runoff from small drainage areas, usually less than 6 acres; and for areas that contribute sheet flow only to the roadway ditch or pavement. The design discharge "Q" is obtained from the equation Q = CiA where:

C = Coefficient of runoff

i = Average rainfall intensity, in inches per hour, for a given storm frequency and for a duration equal to the time of concentration

A = Drainage area, in acres

The time of concentration is the time required for runoff to flow from the most remote point of the drainage area to the point of concentration. The point of concentration could be a culvert inlet or the checkpoint in a roadway ditch used to determine the need for protection. Time of concentration is ordinarily designated by T and is the summation of the time of overland flow "t_o" and the time of ditch flow "t_d".

Overland flow is that flow not carried in a discernible channel, and the time of such flow may be obtained from Figure 1101-1 or a similar overland flow chart.

1101.23 Coefficient Of Runoff

The recommended value for the coefficient of runoff for various contributing surfaces are shown in Table 1101-1. Where two values are shown, the higher value ordinarily applies to the steeper slopes.

Table 1101-1

Types of Surface	Coefficient of Runoff "C"
Pavement & Paved Shoulders	0.9
Berms and slopes 4:1 or flatter	0.5
Berms and slopes steeper than 4:1	0.7
Contributing Areas:	
Residential (single family)	0.4-0.6
Residential (multi-unit)	0.5-0.7
Woods	0.3
Cultivated	0.3-0.6

The total width contributing flow to a given point usually consists of surfaces having a variable land cover and thereby require a weighted coefficient of runoff "C". The weighted coefficient is obtained by averaging the coefficients for the different types of contributing surfaces, as noted in the following example:

Contributing Width "W"	Land Use	"C"	"CW"
20 Ft.	Paved Area	0.9	18
40 Ft.	Earth Berms & Slopes	0.7	28
140 Ft.	Residential Area	0.6	84
200 Ft.			130

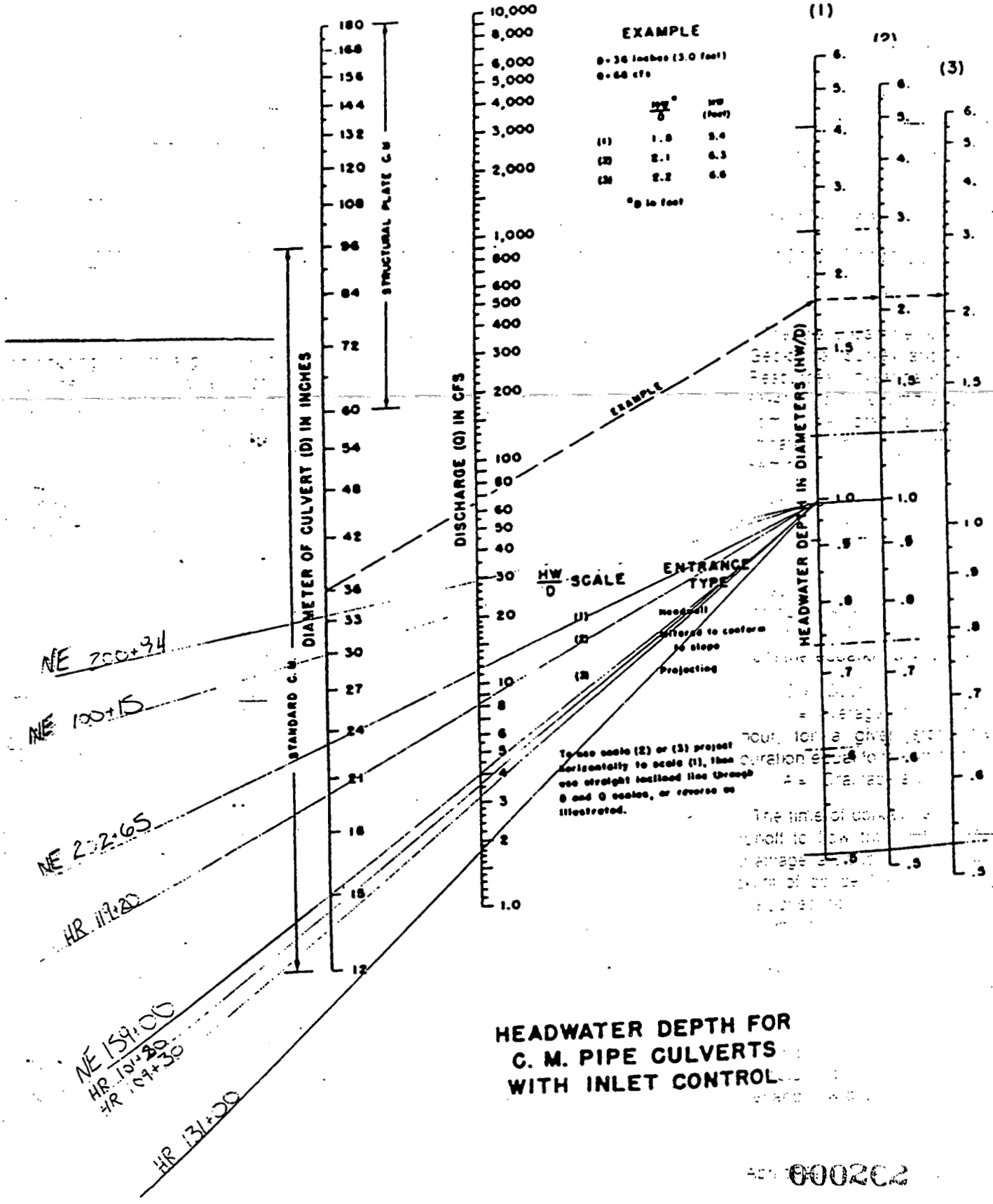
$$\text{Weighted "C"} = \frac{130}{200} = 0.65$$

1101.24 Rainfall Intensity

The average rainfall intensity "i" in inches per hour may be obtained from the Intensity-Frequency-Duration curves shown on Figure 1101-2. Each set of curves applies to a specific geographic area, A, B, C or D as shown on the Rainfall Intensity Zone Map, Figure 1101-3. The geographic areas were established from an analysis of rainfall records obtained from Weather Bureau stations in Ohio. Some political subdivisions may have developed curves for their specific area similar to Figure 1101-2. Such curves may be based on a much longer period of record,

Attachment B

Fig. 1100-245



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

000202

TABLE 10.3 TYPICAL VALUES OF THE ROUGHNESS COEFFICIENT n

Lined Canals	n
Cement plaster	0.011
Untreated gunite	0.016
Wood, planed	0.012
Wood, unplaned	0.013
Concrete, troweled	0.012
Concrete, wood forms, unfinished	0.015
Rubble in cement	0.020
Asphalt, smooth	0.013
Asphalt, rough	0.016
Corrugated metal	0.024
Unlined Canals	
Earth, straight and uniform	0.023
Earth, winding and weedy banks	0.035
Cut in rock, straight and uniform	0.030
Cut in rock, jagged and irregular	0.045
Natural Channels	
Gravel beds, straight	0.025
Gravel beds plus large boulders	0.040
Earth, straight, with some grass	0.026
Earth, winding, no vegetation	0.030
Earth, winding, weedy banks	0.050
Earth, very weedy and overgrown	0.080

Manning Equation—Traditional System of Units

It can be shown that, in converting from SI to the traditional system one must apply a factor equal to 1.49 if the same value of n is used in systems. Thus in the traditional system the discharge equation using n is given as

$$Q = \frac{1.49}{n} A R_h^{2/3} S_0^{1/2}$$

EXAMPLE 10.16 If the channel of Example 10.15 has a slope what is the discharge in the channel and what is the numerical valu ning's n for this channel?

Solution From Example 10.15, we have an f value of 0.130, and th mate value of R_h is 4.3 ft. In Example 10.14 it was shown that

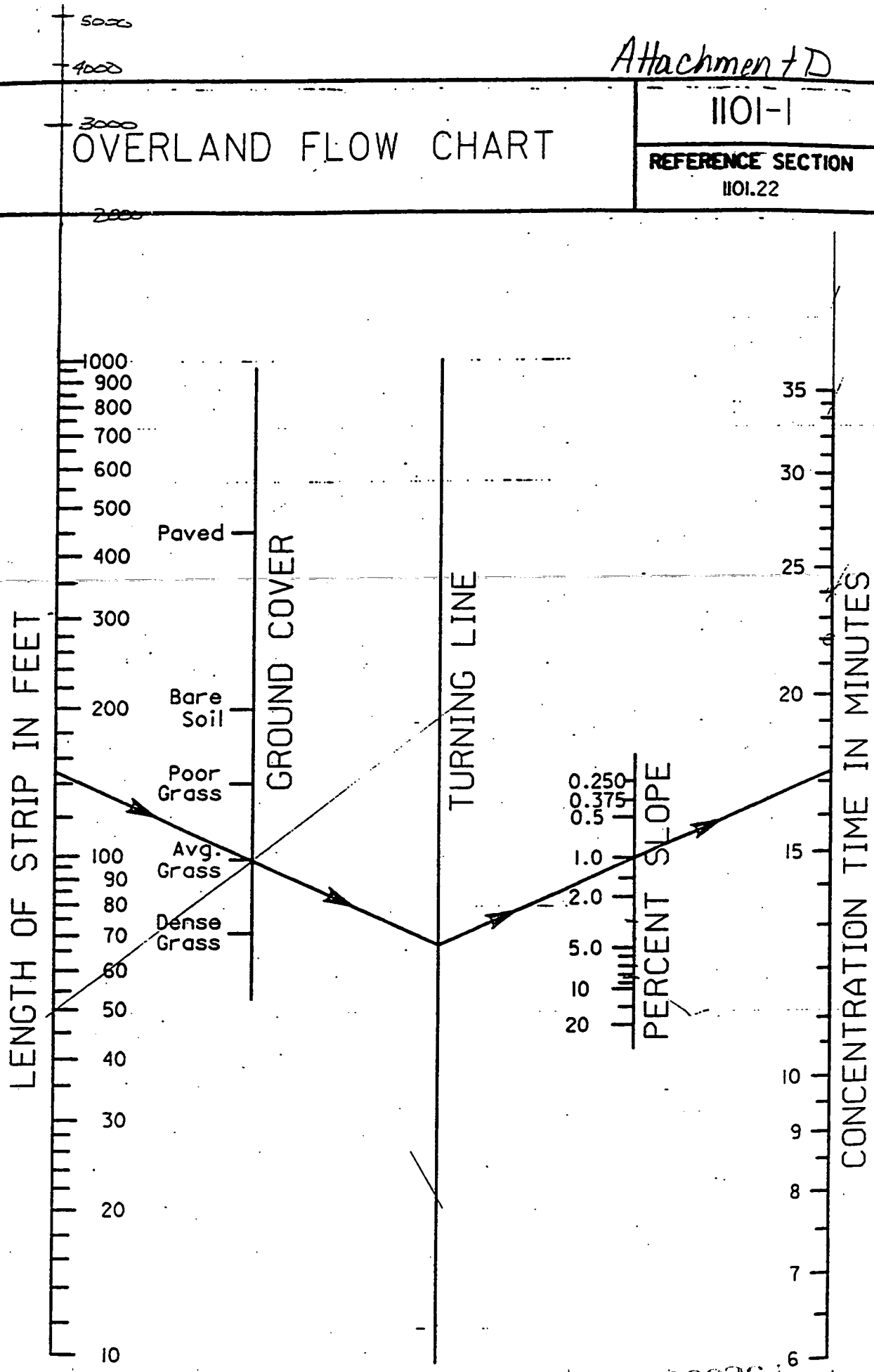
$$V = \sqrt{\frac{8g}{f}}\sqrt{R_h S_0}$$

Attachment D

OVERLAND FLOW CHART

1101-1

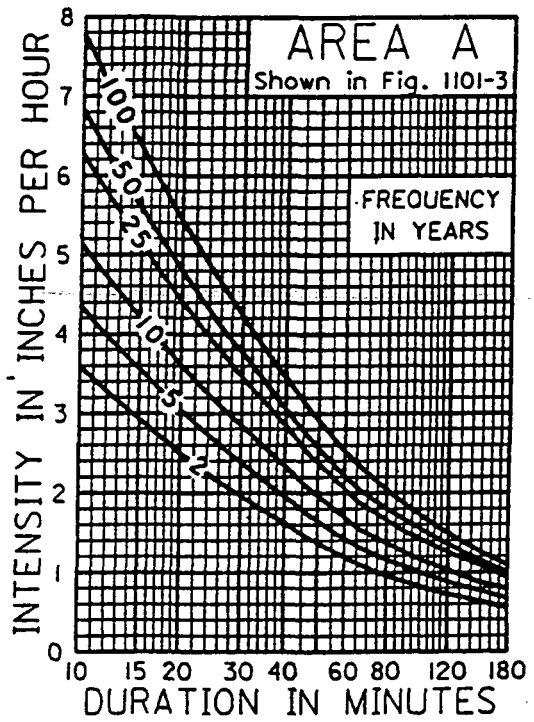
REFERENCE SECTION
1101.22

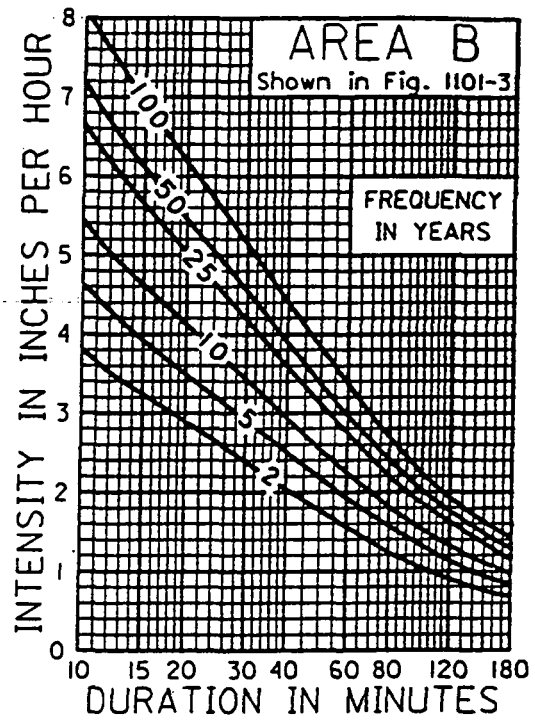


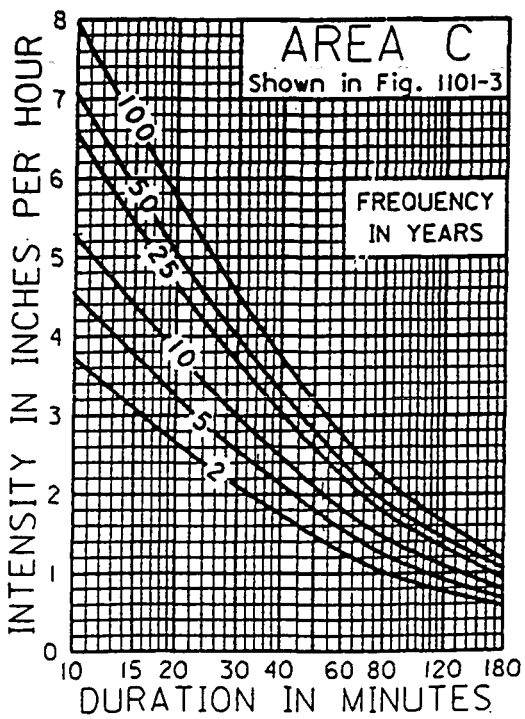
Attachment E

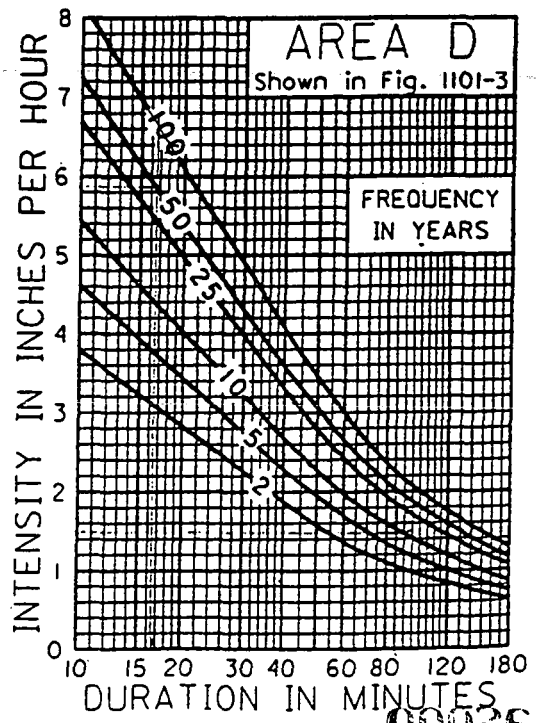
RAINFALL INTENSITY-FREQUENCY-DURATION CURVES	1101-2
	REFERENCE SECTION 1101.24

RAINFALL INTENSITY-FREQUENCY-DURATION CURVES









Attachment F

1102.3 Ditch Design Criteria - Design Traffic Exceeding 2000 ADT

1102.31 Design Frequency

It is recommended that a 10-year frequency storm be used to determine the depth of flow, and a 5-year frequency be used to determine the velocity of flow and the depth of ditch lining where needed. Where a flexible ditch lining is required for calculated velocities exceeding the allowable for seed, the minimum width of the lining shall be 7-1/2 feet. The depth of flow shall be limited to an elevation 12 inches below the edge of pavement for the design discharge. Other ditches, including toe of slope, should not be overtopped by the design discharge.

1102.32 Velocity

The velocity for the five-year frequency storm should not exceed the values shown in Table 1102-1 for the various soil types and flexible linings.

Table 1102-1

ALLOWABLE DITCH VELOCITIES
(Ft. Per. Sec.)

Soil Type	Seed Lining (659)	Sod Lining (660)	Jute or Excelsior Matting (667) or (668)
Sand	1.5	3.5	3.0
Firm Loam	2.0	4.0	4.0
Clay	2.5	5.0	4.0
Gravel	3.5	6.0	5.0
Weathering Shale	4.5	6.0	5.0

If the calculated velocity exceeds that shown in the table, a concrete lining should be considered only as a last resort. Also Type B, C or D Rock Channel Protection may be used to line the ditch if the nearest point of the lining is outside the design clear zone or located behind guardrail. Item 838 Seeding and Erosion Control with Matting may be used in lieu of rock, where average flow velocity is less than 10 feet per second and the ditch slope is less than 10%. Type B or C rock should be considered for lining ditches on steep grades that carry flow from the end of a cut section down to the valley floor.

1102.33 Roughness

Suggested values for Manning's Roughness Coefficient "n" for the various types of open water carriers covered in Section 1102.2 are listed in Table1102-2.

Table 1102-2

Type of Lining	Roughness Coefficient
Bare Earth	.02
Seeded	.03
Sod	.04
Jute Mat	.04
Excelsior Mat	.04
Item 838 Matting	.04
Concrete	.015
Bituminous	.018
Grouted Riprap	.02
Rock Channel Protection	.06 for ditches .04 for large channels

1102.34 Catch Basin Types

The Standard CB-4, 5 and 8 Catch Basins are suitable for the standard roadside designs covered in the Roadway Design Manual. The tilt built into the basin top provides a self-cleaning feature when the basins are used on continuous grades and the wide bar spacing minimizes clogging possibilities, thereby resulting in an efficient design. The bases of the 4, 5 and 8 Catch Basins can be expanded to accommodate larger diameter conduits by specifying 4A, 5A or 8A Basins, detailed on Standard Drawing CB-458A. The bar spacing can be decreased, when desirable for safety reasons, by specifying Grate E for the CB-4 and Grate B for CB-5. The following catch basin types are generally recommended based on the size and shape of the ditch.

A. Standard CB-4 for depressed medians wider than 40 feet.

B. Standard CB-5 for 40 foot radius roadside or median ditches (Use grate B where pedestrian traffic may be expected).

C. Standard CB-8 for 20 foot radius roadside or depressed medians 40 feet or less in width.

D. Standard CB-2-2-A catch basins may be used in trapezoidal toe ditches where the basin is located outside the design clear zone or behind guardrail and the protruding feature of the basin is

ATTACHMENT F

Calculation 15-01

PO139

Design of Seepage Collection & Removal of Sediment

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

Date 20 Feb 95
Sheet 1 of 6

Proj. Order No. 139 Calculation No. 15-01

Project Title Seepage Design and Sediment Removal

Calculation Subject Storm Drainage Date Verified/Checked

STATUS: PRELIMINARY ____ FINAL X SUPERSEDED ____ VOID ____

STATEMENT OF PROBLEM

Determine the peak runoff for the 25-year, 24-hour storm event for the proposed diversion pipe and size the pipe using corrugated HDPE. (Per FERMCO CRU-2 direction)

SUMMARY OF CONCLUSIONS

The peak discharge is 9 cfs and the pipe is 18 inch diameter.

Originator's Signature and Date

Kenneth F. Gerard 2/28/95

CHECKING METHOD

1. Review X
2. Alternate Calculation ____

Checker's Signature and Date

CR TOMONGIN 3/17/95

Lead Discipline Engineer's Signature and Date

Ed Kuk 3/17/95

Rev. No.	Sheet No.	Description	Reviser's Signature/Date	Checker's Signature/Date	Approved by Signature/Date

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. 0
Sheet 2 of 6

Proj. Order No. 139 Calculation No. 15-01

Project Title Seepage Design and Sediment Removal

Calculation Subject Storm Drainage Date Verified/Checked 3/17/95

Prepared By: K. Gerard Checked/Verified By: CR TOMONGIN

Date 2/20/95

SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS

Data Sources

1. PARSONS DWG. (used as DA Map)
2. Haestad Methods, 1989. *Quick TR-55™ Urban Hydrology for Small Watersheds*
3. SCS Ohio 24-Hour Rainfall (inches)
4. SCS, August 1982. *Soil Survey of Hamilton County, Ohio*
5. Advanced Drainage Systems, Inc. (ADS), 1988. N-12 Pipe product literature
6. ODOT, *Location and Design Manual, Volume Two, Drainage Design*
7. Brater, Ernest F. & Horace Williams King, 1976. *Handbook of Hydraulics*, Sixth Ed. New York: McGraw-Hill Book Company
8. Heald, C.C., Ed., 1992. *Cameron Hydraulic Data Book*, 17 ed. Woodcliff Lake, N.J.: Ingersoll-Rand

Codes

1. DOE Order 6430.1A / RM-FMPC-0001

Assumptions

1. Use SCS TR-55 to determine peak discharge. (Haestad Methods Quick TR-55).
2. Use SCS storm events for Hamilton County, Ohio. (Ref 3)
3. Pipe will be used for a short term, low-traffic area. Per FERMCO CRU-2 directive to use HDPE pipe material, use corrugated polyethylene pipe using ADS N-12 pipe data. Mannings n for ADS N-12 is o.010 - 0.012. Use 0.011 to account for the bends.

PARSONS ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

CRU: 2 PO: 139 Job Number: 7663-0139-11112-120

Computer Code: FlowMaster Version: 3.41

Code Verification Status: REV 0, Dec 1992

Description of Program: Computes solutions to open channel hydraulics problems

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To determine Tc values and to size proposed storm drain

Run Performed By: K. Gerard

Date/Time of Run: 2/20/95 - 2/28/95

Computer Time of Run: n/a

Input Filename: WESTPIPE.H&H & PRODITCH.H&H

Output Filename: same as input

Files Saved to Diskname: a:\po139\SD Disk Location: with calc set w/ backup with discipline files

Results: Refer to the calculations.

Performed By: K. Gerard Date: 2/28/95

Checked By: CR TOMONGIN Date: 3/17/95

Approved By: E. Kabir Date: 3/17/95

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	
0	KG	2/20/95	CRT	3/17/95	Design of Seepage Collection & Sediment Removal	
					Storm Drain	CRU- 2
					AUTHOR: K. Gerard SHEET 6 OF	PO - 139

RESULTS

The results of the peak discharge calculations are as follows:

2-yr	3 cfs
10-yr	7 cfs
25-yr	9 cfs

The table below summarizes the results of the pipe design calculations for a pipe slope at 0.6%:

	Dia.	$V_{2\text{-}Yr}$ fps	$V_{25\text{-}Yr}$ fps	Q_{FULL} cfs	Q_{MAX} cfs
ADS	15"	4.84	--	5.91	*
ADS	18"	4.81	6.18	9.62	10.34
ADS	24"	4.69	6.36	20.71	22.28

* not calculated

CONCLUSIONS AND RECOMMENDATIONS

The velocity is sufficient at the 2-year storm to provide self cleaning of sediment. An 18" HDPE (ADS N-12) pipe is large enough for the 25-year storm and is recommended.

ODOT Table 1107-1 indicates that 6.5 l.f. of 6" stone, Type C is required. This is based on a V = 6.2 fps for the $Q_{25\text{-}Yr}$ condition.

An ODOT No. 2-2-A catch basin was evaluated and found acceptable when modified for an East Jordan Iron Works, (EJIW), 6610 grate.

ENGINEERING CALCULATIONS
BASIS SHEET
SUMMARY OF DATA SOURCES - CODES - ASSUMPTIONS (continued)

4. Land use is mixed. Use weighted Runoff Curve Number. See D.A. Map (in the back of the calculations) and calculations for land use, acreage, and coverage conditions used. All ground coverage conditions were assumed to be in good condition.

5. From Reference 4, the soils in the vicinity of the site and their HSG are as follows:

Gn	Genesee Loam, HSG B (This is most likely in the Paddy's Run Flood Plain and not in the DA)
HeF	Hennepin Silt Loam, 35 to 60 % slopes, HSG B (This is most likely in the steep slope areas adjacent to Paddy's Run and not in the DA)
HoA	Henshaw Silt Loam, 0 to 2 % slopes, HSG C
MaB	Markland Silty Clay Loam, 2 to 6 % slopes, HSG C
MaC2	Markland Silty Clay Loam, 6 to 12 % slopes, HSG C

A copy of the soil survey map is in the back of the calculations. Given the information from the soil survey map, HSG C is used for all land uses for the peak discharge calculations.

6. For computing Tc segment DE, the same open channel assumed to exist between the proposed pipe and the gravel road was assumed to exist where the runoff goes under the gravel road (existing culvert is assumed to exist and is operational).

7. For computing Tc segment DE, the proposed open channel between the proposed pipe and the gravel road is assumed to be a 2 ft. flat bottom trapezoidal ditch with 4:1 side slopes, rip rap lined.

8. Other assumptions are as specified in the calculations.

PARSONS ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

CRU: 2 PO: 139 Job Number: 7663-0139-11112-120

Computer Code: OTR-55 Version: 5.46

Code Verification Status: REV 0, Nov 1992

Description of Program: Computes peak discharge per SCS TR-55 Method

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To determine peak discharge to size proposed storm drain

Run Performed By: K. Gerard

Date/Time of Run: 2/20/95

Computer Time of Run: n/a

Input Filename: WESTPIPE.***, *** = RCN, TCT, GPD

Output Filename: same as input

Files Saved to Diskname: a:\po139\SD Disk Location: with calc set w/ backup with discipline files

Results: Peak discharge for 25-year, 24-hour storm is 9 cfs.

Performed By: K. Gerard Date: 2/28/95

Checked By: CR TOMONGIN Date: 3/7/95

Approved By: Ed Kahn Date: 3/17/95

ATTACHMENT A

SUPPORTING CALCULATIONS

Quick TR-55 Ver.5.46 S/N:
Executed: 09:17:20 02-20-1995

PO-139 RA #31
Design of Seepage Collection
and
Sediment Removal

RUNOFF CURVE NUMBER DATA

::

Composite Area: West Pipe

SURFACE DESCRIPTION	AREA (acres)	CN
Open Space/good/HSG C	3.13	74
Woods/good/HSG C	8.48	70
Gravel/HSG C	0.29	89
COMPOSITE AREA --->	11.90	71.5

72

::

SEE D.A. MAP

A-1

Triangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: Tc Calc

Comment: Tc Segment B-C

Solve For Discharge

Given Input Data:

Left Side Slope..	2.00:1 (H:V)
Right Side Slope.	2.00:1 (H:V)
Manning's n.....	0.040
Channel Slope....	0.0250 ft/ft
Depth.....	0.50 ft

Computed Results:

Discharge.....	1.08 cfs
Velocity.....	2.16 fps
Flow Area.....	0.50 sf
Flow Top Width...	2.00 ft
Wetted Perimeter.	2.24 ft
Critical Depth...	0.45 ft
Critical Slope...	0.0446 ft/ft
Froude Number....	0.76 (flow is Subcritical)

ASSUME Tc SEGMENT HAS THE INPUT DATA GIVEN

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A-2

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: Tc Calc

Comment: Tc Segment D-E

Solve For Discharge

Given Input Data:

Bottom Width.....	2.00 ft
Left Side Slope..	4.00:1 (H:V)
Right Side Slope.	4.00:1 (H:V)
Manning's n.....	0.035
Channel Slope....	0.0250 ft/ft
Depth.....	0.60 ft

Computed Results:

Discharge.....	9.30 cfs ≈ PEAK DISCHARGE, OK
Velocity.....	3.52 fps
Flow Area.....	2.64 sf
Flow Top Width...	6.80 ft
Wetted Perimeter.	6.95 ft
Critical Depth...	0.60 ft
Critical Slope...	0.0252 ft/ft
Froude Number....	1.00 (flow is Critical)

ASSUME Tc SEGMENT HAS THE INPUT DATA GIVEN,

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```
Quick TR-55 Ver.5.46   S/N:
Executed: 09:07:52   02-20-1995    a:\po139\sd\WESTPIPE.TCT

                         PO-139    RA #31
           Design of Seepage Collection and Sediment Removal


                  Tc COMPUTATIONS FOR: West Pipe

SHEET FLOW (Applicable to Tc only)
    Segment ID                                      AB
    Surface description                         woods
    Manning's roughness coeff., n                   0.4000
    Flow length, L (total < or = 300)       ft      210.0
    Two-yr 24-hr rainfall, P2               in      3.000
    Land slope, s                           ft/ft   0.0025
                        0.8
          .007 * (n*L)
    T =  -------------                      hrs     1.54                 =  1.54
              0.5    0.4
            P2    *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                      CD
    Surface (paved or unpaved)?                     Unpaved
    Flow length, L                          ft      270.0
    Watercourse slope, s                    ft/ft   0.0075

                           0.5
    Avg.V =  Csf *  (s)                     ft/s    1.3973
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                        hrs     0.05                 =  0.05


CHANNEL FLOW
    Segment ID                                      BC          DE
    Cross Sectional Flow Area, a            sq.ft   0.50        2.64
    Wetted perimeter, Pw                    ft      2.24        6.95
    Hydraulic radius, r = a/Pw              ft      0.223       0.380
    Channel slope, s                        ft/ft   0.0250      0.0250
    Manning's roughness coeff., n                   0.0400      0.0350

                      2/3    1/2
          1.49   *  r    *  s
    V =  -------------------                ft/s    2.1673      3.5305
                    n

    Flow length, L                          ft      260         125

    T = L / (3600*V)                        hrs     0.03   +    0.01     =  0.04
:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                                  TOTAL TIME (hrs)         1.63
```

Quick TR-55 Version: 5.46 S/N:

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

PO-139 RA #31
Design of Seepage Collection and Sediment Removal

CALCULATED
DISK FILE: a:\po139\sd\WESTPIPE.GPD

Drainage Area	(acres)	11.9	--->	0.0186 sq.mi.
Runoff Curve Number	(CN)	72		
Time of Concentration,Tc	(hrs)	1.63		
Rainfall Distribution	(Type)	II		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	2	10	25
Rainfall, P, 24-hr (in)	3.0	4.1	4.8
Initial Abstraction, Ia (in)	0.778	0.778	0.778
Ia/p Ratio	0.259	0.190	0.162
Unit Discharge, * qu (csm/in)	222	239	246
Runoff, Q (in)	0.81	1.53	2.05
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	3	7	9

Summary of Computations for qu

Ia/p	#1	0.100	0.100	0.100
C0	#1	2.553	2.553	2.553
C1	#1	-0.615	-0.615	-0.615
C2	#1	-0.164	-0.164	-0.164
qu (csm)	#1	260.210	260.210	260.210
Ia/p	#2	0.300	0.300	0.300
C0	#2	2.465	2.465	2.465
C1	#2	-0.623	-0.623	-0.623
C2	#2	-0.117	-0.117	-0.117
qu (csm)	#2	212.799	212.799	212.799
* qu (csm)		222	239	246

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$
$$qp\ (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond\ \&\ Swamp\ Adj.)$$

A-5

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Description: Proposed Pipe at West Pump Station

Solve For Actual Depth

Given Constant Data;

Slope.....	0.0060	
Mannings n.....	0.011	ADS N-12 *
Q_2=Discharge.....	3.00	

Variable Input Data	Minimum	Maximum	Increment By
Diameter	1.25 15"	2.00 24"	0.25

* ADS Recommends a "n" value of 0.010 — 0.012.

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VARIABLE				COMPUTED	COMPUTED	COMPUTED
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs Q2-YR	Depth ft	Velocity fps	Capacity Full cfs
1.25	0.0060	0.011	3.00	0.63	4.84	5.91
1.50	0.0060	0.011	3.00	0.58	4.81	9.62
~~1.75~~	~~0.0060~~	~~0.011~~	~~3.00~~	~~0.54~~	~~4.75~~	~~14.51~~ N/A
2.00	0.0060	0.011	3.00	0.51	4.69	20.71

Open Channel Flow Module, Version 3.41 (c)
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Description: Proposed Pipe at West Pump Station

Solve For Actual Depth

Given Constant Data;

Slope..... 0.0060
Mannings n..... 0.011 * ADS N-12
Q_{25}=Discharge..... 9.00 cfs

Variable Input Data	Minimum	Maximum	Increment By
Diameter	1.25	2.00	0.25
	15"	24"	

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VARIABLE				COMPUTED	COMPUTED	COMPUTED	
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs	Depth ft	Velocity fps	Capacity Full cfs	
Unable to compute this instance. (1.25' Ø Too small)							
1.50	0.0060	0.011	9.00	1.15	6.18	9.62	
~~1.75~~	~~0.0060~~	~~0.011~~	~~9.00~~	~~1.00~~	~~6.35~~	~~14.51~~	N/A
2.00	0.0060	0.011	9.00	0.92	6.36	20.71	

Open Channel Flow Module, Version 3.41 (c)
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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Description: Proposed Pipe at West Pump Station

Solve For Full Flow Capacity

Given Constant Data;

Slope.....	0.0060
Mannings n.....	0.011
Discharge.....	5.91

ADS N-12

Variable Input Data	Minimum	Maximum	Increment By
Diameter	1.25	2.00	0.25
	15"	24"	

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VARIABLE			COMPUTED	COMPUTED	COMPUTED	COMPUTED	
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs	Depth ft	Velocity fps	Capacity Full cfs	
1.25	0.0060	0.011	5.91	1.25	4.82	5.91	
1.50	0.0060	0.011	9.62	1.50	5.44	9.62	
~~1.75~~	~~0.0060~~	~~0.011~~	~~14.51~~	~~1.75~~	~~6.03~~	~~14.51~~	N/A
2.00	0.0060	0.011	20.71	2.00	6.59	20.71	

Open Channel Flow Module, Version 3.41 (c)
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Comment: Proposed Pipe at West Pump Station

Solve For Actual Discharge @ 0.94D

Given Input Data:

	Diameter.....	1.50 ft	18"
	Slope.....	0.0060 ft/ft	
	Manning's n.....	0.011	ADS N-12
0.94D =	Depth.....	1.41 ft	

Computed Results:

QmAx =	Discharge.....	10.34 cfs
V@QmAx =	Velocity.....	6.00 fps
	Flow Area.....	1.72 sf
	Critical Depth....	1.24 ft
	Critical Slope....	0.0069 ft/ft
	Percent Full.....	94.00 %
	Full Capacity.....	9.62 cfs
	QMAX @.94D.....	10.34 cfs
	Froude Number.....	0.68 (flow is Subcritical)

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Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: West Diversion Pipe

Comment: Proposed Pipe at West Pump Station

Solve For Actual Discharge @ 0.94 D

Given Input Data:

D =	Diameter.....	2.00 ft	24"
	Slope.....	0.0060 ft/ft	
	Manning's n.....	0.011	ADS-N-12
0.94D =	Depth.....	1.88 ft	

Computed Results:

QMAX =	Discharge.....	22.28 cfs
VMAX =	Velocity.....	7.27 fps
	Flow Area.....	3.06 sf
	Critical Depth....	1.68 ft
	Critical Slope....	0.0066 ft/ft
	Percent Full.....	94.00 %
	Full Capacity.....	20.71 cfs
	QMAX @.94D.....	22.28 cfs
	Froude Number.....	0.71 (flow is Subcritical)

Open Channel Flow Module, Version 3.41 (c) 1991
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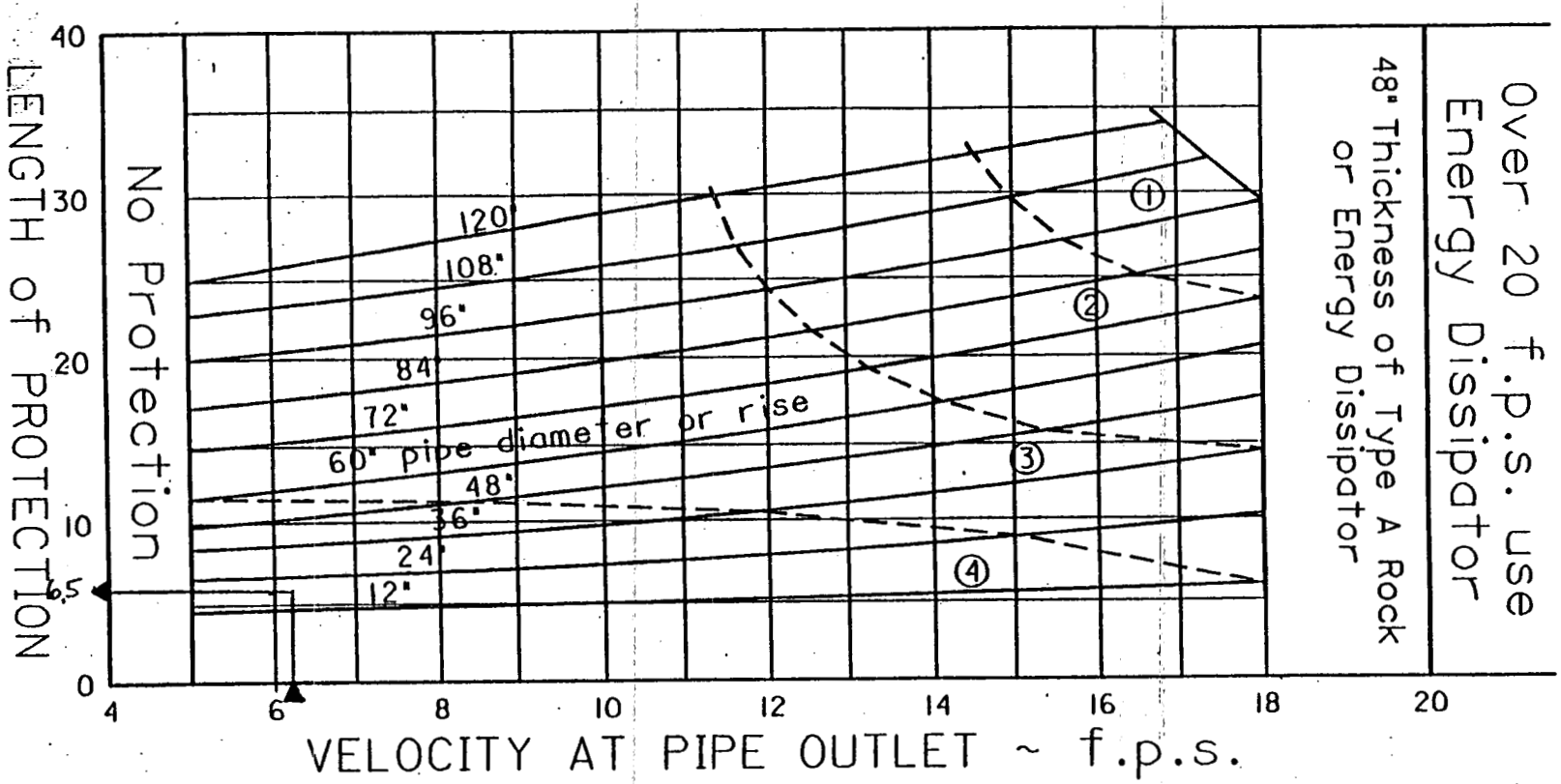
ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1107-1

REFERENCE SECTION 1107.2



$Q_{25} = 4$ cfs

$V_{25} = 6.2$ fps

NOTES

Rock size (6", 12", 18") indicates the square opening on which 85% of the material, by weight, will be retained.

The width of protection shall be the width of the headwall, with 4' being the minimum.

(Where a stream bed will withstand the calculated velocity without erosion, no rock channel protection will be required.)

LEGEND	ROCK TYPE
① 48" of 18" rock	A
② 36" of 18" rock	A
③ 30" of 12" rock	B
④ 18" of 6" rock	C

A-4

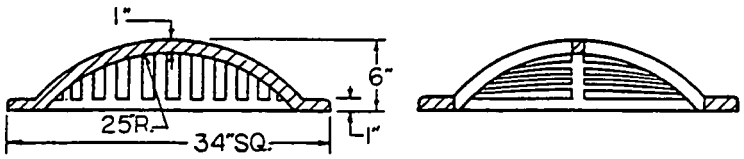
PARSONS ERA PROJECT

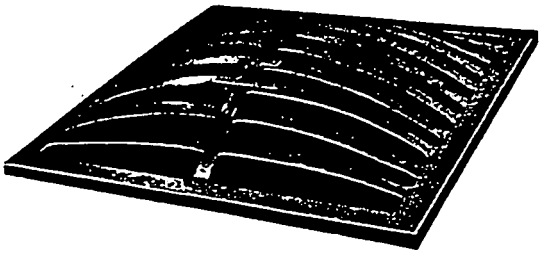
CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE
	KG	2/24/95	CRT	3/17/95	SEEPAGE CONTROL & SEDIMENT REMOVAL STORM DRAIN
					CRU 2
					AUTHOR K. Gerard SHEET OF PO 139

Heavy Duty
6610

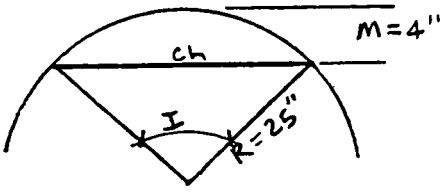
190 pounds total weight
Approximately 600 square inches of opening





104 *Always Specify EJIW Number*

***East Jordan Iron Works**, East Jordan, Michigan USA, 1-800-874-4100*



$M = R(1 - \cos I/2)$

$4'' = 25''(1 - \cos I/2)$

$\cos I/2 = 1 - 0.16$

$I/2 = 32.8598°$

$Ch = 2R \sin I/2$

$= 2(25)(\sin 32.8598)$

$Ch = 27.13''$

ASSUME Ch IS THE PERIMETER DIMENSION / SIDE

ON LONG SLOT SIDES, MINUS 1" FOR STEEL, $2(26.13) = 52.26''$

ON SHORT OPENING SIDE, 10 - 1" BARS OR 17.13"/SIDE $2(17.13) = 34.26$

OPENING LENGTH @ PERIMETER $= 86.52''$

OR $7.2'$

USE 7.2' FOR WEIR LENGTH, Lg, FOR WEIR CALCULATIONS.

$Q_w = 3.087 L H^{3/2}$ REF 7., pg 5-24

FOR ORIFICE FLOW CONDITIONS

$Q_o = C a (2gh)^{1/2}$ REF 7, pg 4-3

$C = 0.66$ (ASSUMED. SEE TABLE 4-5, REF 7 FOR 10:1 RECTANGLE @ h = 1FT.)

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/23/95
CRU-2 KG

FIND: Head, H, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume weir flow conditions using EJIW 6610 grate

Given:

Q25 =	9	cfs	Q = 3.087*L*H^(3/2)
Lw =	4	lf	Q = Qw + Qg
h =	0.42	ft	Qw = weir flow
Lg =	7.2	lf	Qg = grate flow

H, ft	Q, cfs	Qw	Hg, ft	Qg
0.42	3.36	3.36	0.00	0.00
0.50	3.36	3.36	0.00	0.00
0.58	3.74	3.36	0.08	0.38
0.67	4.53	3.36	0.17	1.17
0.75	5.44	3.36	0.25	2.08
0.83	6.52	3.36	0.33	3.16
0.92	7.90	3.36	0.42	4.54
1.00	9.25	3.36	0.50	5.89
1.16	12.30	3.36	0.66	8.94
1.25	14.19	3.36	0.75	10.83
1.33	15.97	3.36	0.83	12.61

Note:

1. There are 2-2' wide openings which are the Lw for "weir flow" condition. Weir height = h.
2. Maximum "Weir flow" is assumed when H = h. When H > 0.50', then its "grate flow" which is also calculated by weir flow equation. Hgrate = H-0.50'. The grate is 1" thick and its top elev. is 6" above the weir elev.
3. Lg is the inside perimeter of the inlet.
4. An efficiency factor of 0.75 is used for the grate condition to compensate for grating and trash accumilation.
5. Lg based on East Jordon Iron Works, (EJIW), 6610 grate.
6. Hg is measured from the base of grate.

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/23/95
CRU-2 KG

FIND: Head, H, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume weir flow conditions using EJIW 6610 grate

Given:

7	Q25 =	9	cfs	Q = 3.087*L*H^(3/2)
	Lw =	3.33	lf	Q = Qw + Qg
9	h =	0.42	ft	Qw = weir flow
	Lg =	7.2	lf	Qg = grate flow

	A	B	C	D	E
	H, ft	Q, cfs	Qw	Hg, ft	Qg
13	0.42	+C13+E13	3.087*$A:$B$8*($A:$B$9^1.5)	+A13-$A:$B$9	0.75*3.087*$A:$B$10*(D13)^1.5
	0.50	+C14+E14	3.087*$A:$B$8*($A:$B$9^1.5)	+A14-$A:$B$9	0.75*3.087*$A:$B$10*(D14)^1.5
15	0.58	+C15+E15	3.087*$A:$B$8*($A:$B$9^1.5)	+A15-$A:$B$9	0.75*3.087*$A:$B$10*(D15)^1.5
	0.67	+C16+E16	3.087*$A:$B$8*($A:$B$9^1.5)	+A16-$A:$B$9	0.75*3.087*$A:$B$10*(D16)^1.5
17	0.75	+C17+E17	3.087*$A:$B$8*($A:$B$9^1.5)	+A17-$A:$B$9	0.75*3.087*$A:$B$10*(D17)^1.5
	0.83	+C18+E18	3.087*$A:$B$8*($A:$B$9^1.5)	+A18-$A:$B$9	0.75*3.087*$A:$B$10*(D18)^1.5
19	0.92	+C19+E19	3.087*$A:$B$8*($A:$B$9^1.5)	+A19-$A:$B$9	0.75*3.087*$A:$B$10*(D19)^1.5
	1.00	+C20+E20	3.087*$A:$B$8*($A:$B$9^1.5)	+A20-$A:$B$9	0.75*3.087*$A:$B$10*(D20)^1.5
21	1.16	+C21+E21	3.087*$A:$B$8*($A:$B$9^1.5)	+A21-$A:$B$9	0.75*3.087*$A:$B$10*(D21)^1.5
	1.25	+C22+E22	3.087*$A:$B$8*($A:$B$9^1.5)	+A22-$A:$B$9	0.75*3.087*$A:$B$10*(D22)^1.5
23	1.33	+C23+E23	3.087*$A:$B$8*($A:$B$9^1.5)	+A23-$A:$B$9	0.75*3.087*$A:$B$10*(D23)^1.5

Note:

1. There are 2-2' wide openings which are the Lw for "weir flow" condition. Weir height = h.
2. Maximum "Weir flow" is assumed when H = h. When H > 0.50', then its "grate flow" which is also calculated by weir flow equation. Hgrate = H-0.50'. The grate is 1" thick and its top elev. is 6" above the weir elev.
3. Lg is the inside perimeter of the inlet.
4. An efficiency factor of 0.75 is used for the grate condition to compensate for grating and trash accumilation.
5. Lg based on East Jordon Iron Works, (EJIW), 6610 grate.
6. Hg is measured from the base of grate.

\PO139\SS\139SD.WK3 A:

(This sheet is B in the LOTUS 1-2-3 file. Used to display formulas from A:)

A-17

000231

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/24/95
CRU-2 KG

FIND: Head, h, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume orifice flow conditions using EJIW 6610 grate

Given:

area, a =	600	sq in	Qo =	C*a*(2*g*h) ^ (1/2)
	4.17	sq ft	H =	Head – from bottom of weir
C =	0.66		hg =	Head – above base of grate
g =	32.2	ft/s ^ 2	Q =	Q – Total Flow
Qw =	3.36	cfs (from side weirs. See weir calc)		

H, ft	Q, cfs	Qw, cfs	hg ft	a, sq ft	Qo cfs
0.42	3.36	3.36	0	0.00	0.00
0.50	3.36	3.36	0.00	0.00	0.00
0.58	4.11	3.36	0.08	0.67	0.75
0.67	5.68	3.36	0.17	1.42	2.32
0.75	7.50	3.36	0.25	2.08	4.14
0.83	9.64	3.36	0.33	2.75	6.28
0.92	12.37	3.36	0.42	3.50	9.01
1	15.06	3.36	0.50	4.17	11.70

Note:

1. Assumes that there is no increase in weir flow under orifice flow conditions.
2. Assume an efficiency factor of 0.75 used for the grate condition to compensate for trash accumulation.
3. Assumes that the full 600 sq ft opening value is available when the water surface elevation is equal to the top elevation of the grate. The area, a, is proportional to the hg; a = (hg/0.5')*4.17 sq ft up to O.5'. Initially, there will be weir flow which will transition to orifice. The "worst case" would be when hg is measured from the top of the grate and not the base.
4. EJIW – East Jordon Iron Works
5. The grate is 1" thick and its top elev. is 6" above the weir elev.

.\PO139\SS\139SD.WK3 C:

PO 139 SEEPAGE CONTROL & SEDIMENT REMOVAL 2/24/95
CRU-2 KG

FIND: Head, h, for bypass pipe inlet using ODOT STD. No. 2-2-A
Assume orifice flow conditions using EJIW 6610 grate

Given:

47	area, a =	600	sq in	Qo =	C*a*(2*g*h) ^ (1/2)
		4.17	sq ft	H =	Head – from bottom of weir
49	C =	0.66		hg =	Head – above base of grate
	g =	32.2	ft/s^2	Q =	Q – Total Flow
51	Qw =	3.36	cfs (from side weirs. See weir calc)		

	A H, ft	B Q, cfs	C Qw, cfs	D hg ft	E a, sq ft	F Qo cfs
56	0.42	+C56+F56	+$C:$B$51	0	(D56/0.5)*$C:$B$48	0.75*$C:$B$49*E56*(2*$C:$B$10*D56)^0.5
	0.50	+C57+F57	+$C:$B$51	+A57-0.5	(D57/0.5)*$C:$B$48	0.75*$C:$B$49*E57*(2*$C:$B$10*D57)^0.5
58	0.58	+C58+F58	+$C:$B$51	+A58-0.42	(D58/0.5)*$C:$B$48	0.75*$C:$B$49*E58*(2*$C:$B$10*D58)^0.5
	0.67	+C59+F59	+$C:$B$51	+A59-0.42	(D59/0.5)*$C:$B$48	0.75*$C:$B$49*E59*(2*$C:$B$10*D59)^0.5
60	0.75	+C60+F60	+$C:$B$51	+A60-0.42	(D60/0.5)*$C:$B$48	0.75*$C:$B$49*E60*(2*$C:$B$10*D60)^0.5
	0.83	+C61+F61	+$C:$B$51	+A61-0.42	(D61/0.5)*$C:$B$48	0.75*$C:$B$49*E61*(2*$C:$B$10*D61)^0.5
62	0.92	+C62+F62	+$C:$B$51	+A62-0.42	(D62/0.5)*$C:$B$48	0.75*$C:$B$49*E62*(2*$C:$B$10*D62)^0.5
	1	+C63+F63	+$C:$B$51	+A63-0.42	+$C:$B$48	0.75*$C:$B$49*E63*(2*$C:$B$10*D63)^0.5

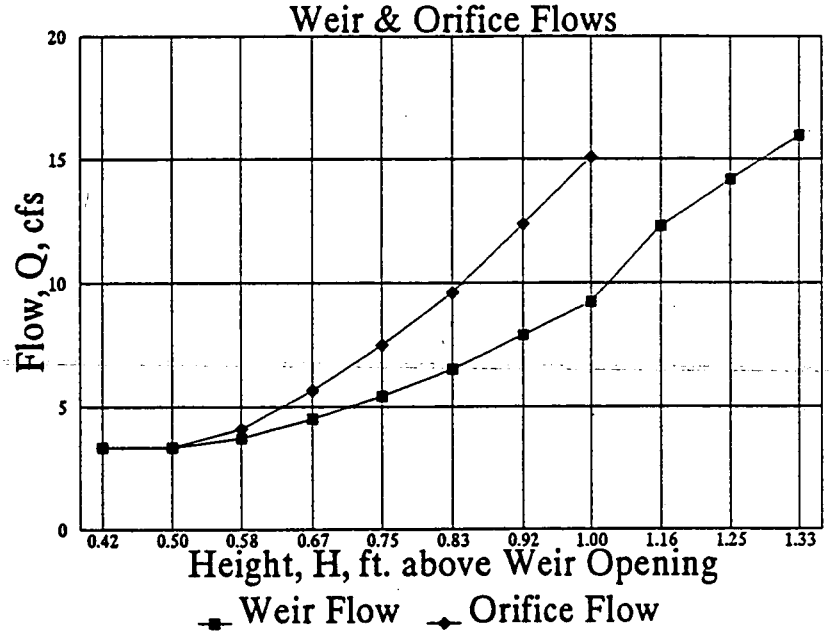
Note:

1. Assumes that there is no increase in weir flow under orifice flow conditions.
2. Assume an efficiency factor of 0.75 used for the grate condition to compensate for trash accumulation.
3. Assumes that the full 600 sq ft opening value is available when the water surface elevation is equal to the top elevation of the grate. The area, a, is proportional to the hg; a = (hg/0.5')*4.17 sq ft up to 0.5'. Initially, there will be weir flow which will transition to orifice. The "worst case" would be when hg is measured from the top of the grate and not the base.
4. EJIW – East Jordon Iron Works
5. The grate is 1" thick and its top elev. is 6" above the weir elev.

\PO139\SS\139SD.WK3 C:

(This sheet is D in the LOTUS 1-2-3 file. Used to display formulas from C:)

Grate Flow Conditions



PARSONS ERA PROJECT CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE DESIGN OF SEEPAGE COLLECTION AND SEDIMENT REMOVAL STORM DRAIN	CRU 2
0	KG	2/28/95	CRT	2/28/95		
					AUTHOR K. Gerard SHEET OF	PO 139

CALCULATE THE EQUIVALENT LENGTH OF PIPE FOR 22½° BENDS

$L = KD/f$ (pg 3-120)

D = ID, ft
K = Resistance Coefficient, use 0.10. (pg 3-113) (30°)
f = Friction Factor

FIND: f

ASSUME N-12 HDPE HAS SIMILAR FRICTION PROPERTIES AS COPPER, BRASS, LEAD, TIN OR GLASS PIPE

HAZEN-WILLIAMS - C = 130 (pg 3-8)
ABSOLUTE ROUGHNESS ε = 0.000005' (pg 3-5)

$\varepsilon/D = 0.000005'/1.5' = 0.0000033$

$R = \frac{VD}{\nu}$ (pg 3-6)

V = velocity, fps
D = ID, ft.
ν = Kinematic viscosity, ft²/sec.

Assume ν of fluid is similar to fresh water at 60°F, or 1.13 centistokes. (pg 4-45) (pg 4-27)

(1.13 centistokes)(0.0000107639) = 0.0000121 ft²/sec

For full flow conditions. (Q_F = 9.62 cfs) V = 5.44 fps

$R = (5.44\ fps)(1.5\ ft)/0.0000121\ ft^2/s$

R = 674,882
6.75×10^5

Using Moody diagram, f = 0.0125

L = (0.10)(1.5')/(0.0125) = 12' each bend or 36' for 3 bends.

L_{TOTAL} = 212' + 36' = 248' USE 250' FOR CALCULATIONS.

NOTE: ALL PAGE No. REFERENCES TAKEN FROM CAMERON HYDRAULIC DATA

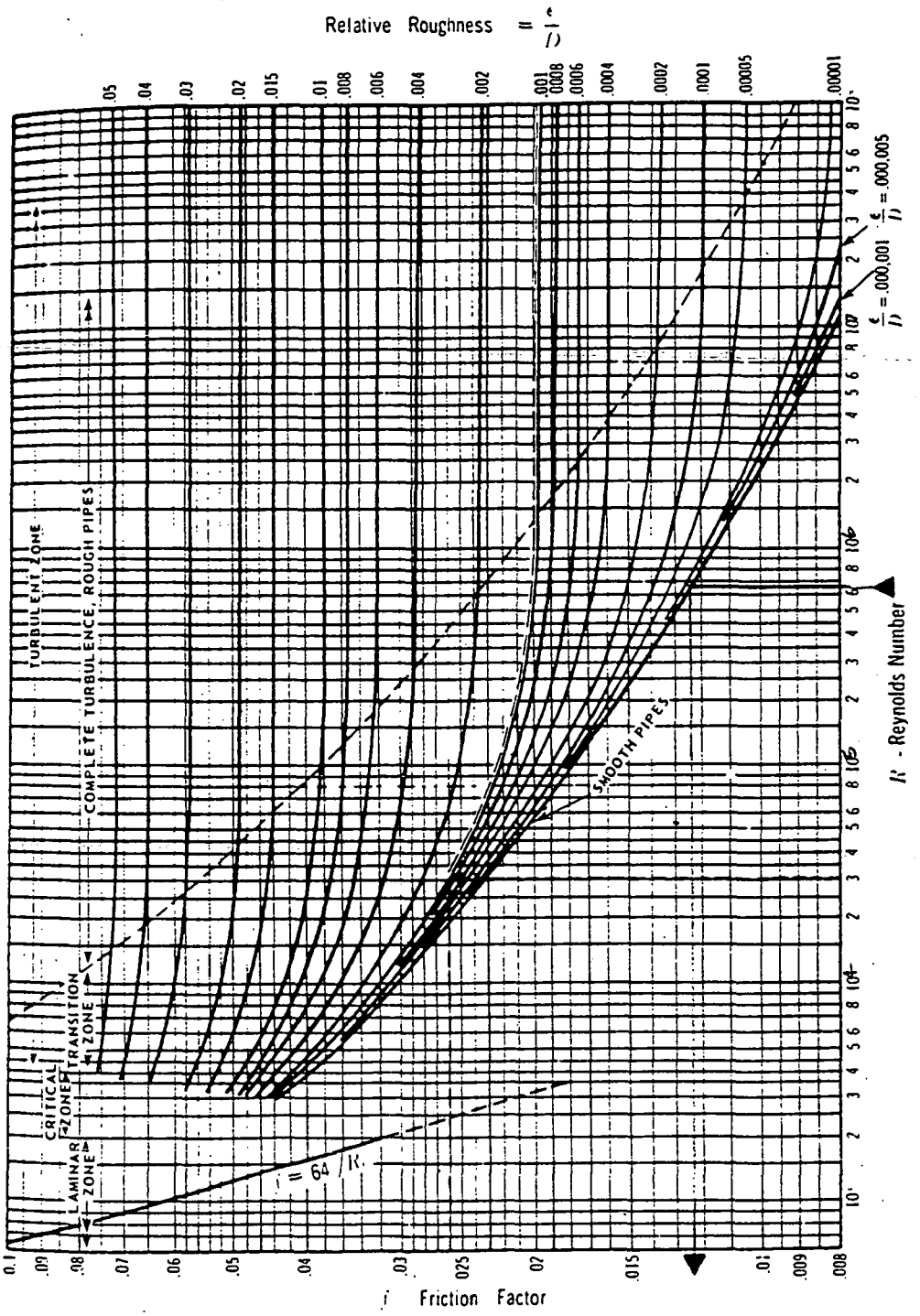
PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE DESIGN OF SEEPAGE COLLECTION AND SEDIMENT REMOVAL STORM DRAIN	CRU 2
0	KG	2/28/95	CRT	2/17/95		
					AUTHOR K. Gerard SHEET OF	PO 139

Friction Factors for Commercial Pipe

(for Darcy-Weisbach formula, page 3-3)



Moody diagram. (V. L. Streeter, "Fluid Mechanics," 5th ed. Copyright 1971 by McGraw-Hill Book Company, New York)

Note: Chart shows relation of relative roughnesss—ε/D where ε is absolute roughness in feet and D is diameter in feet.

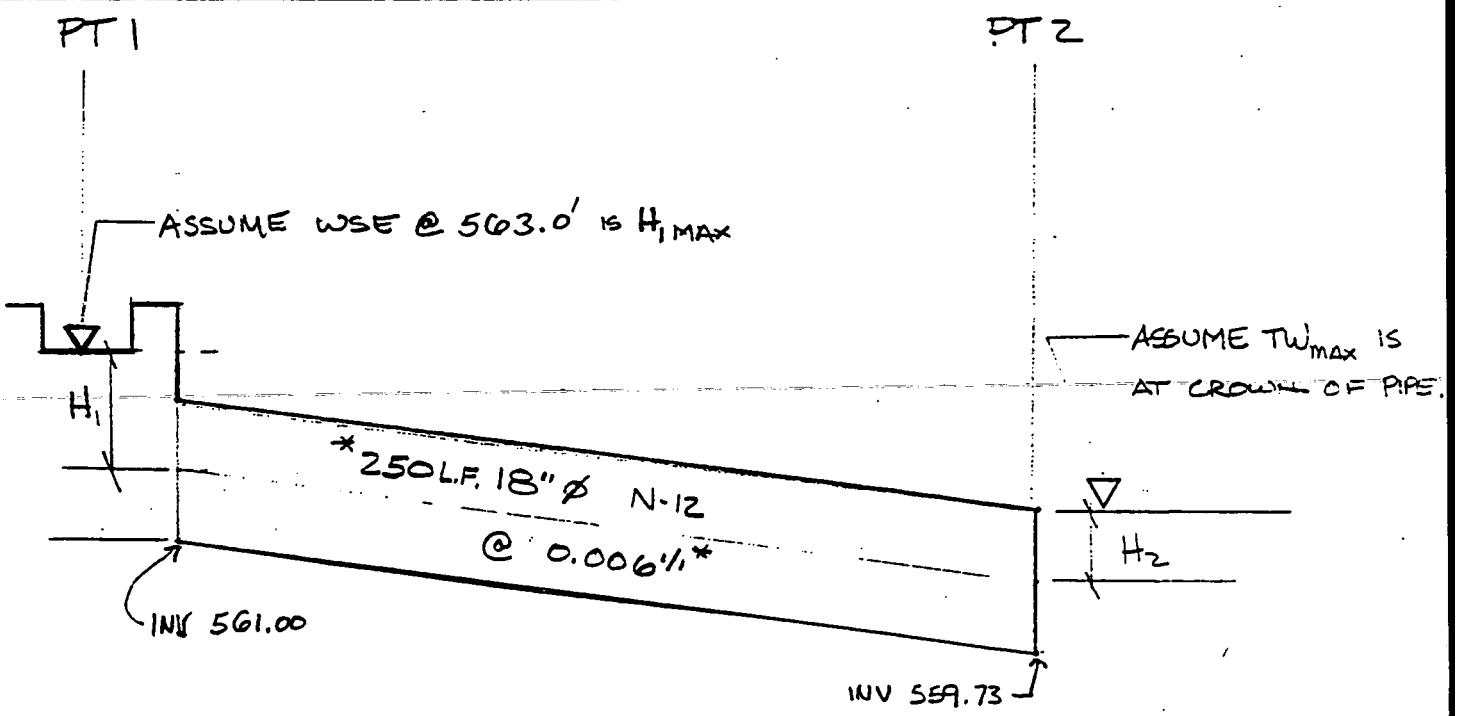
(REF. No. 8)
pg 3-11

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	DESIGN OF SEEPAGE COLLECTION AND SEDIMENT REMOVAL STORM DRAIN	CRU 2
0	KG	2/28/95	CRT	3/17/95			
					AUTHOR K. Gerard	SHEET OF	PO 139

CHECK PIPE UNDER PRESSURE FLOW CONDITIONS



* 212' actual + 36' for bends. Invert elevations and S shown based on actual.

$$H_{1_{max}} = 1.25' \times 62.4\ lbs/CF \times 1SF/144\ in^2 = 0.54\ psi$$

$$Q_F = 9.62\ cfs \times 7.48\ gal/cf \times 60s/min = 4317\ gpm \quad \text{use } 4320\ gpm$$

$$H_2 = 0.75' \times 62.4\ lb/cf \times 1SF/144\ in^2 = 0.27\ psi$$

SEE FLOWMASTER CALCULATIONS FOR HAZEN-WILLIAMS EQUATION.

Pressure Pipe Analysis & Design
Circular Pipe

Worksheet Name: West Diversion Pipe

Comment: Using 1/16 Bends

Solve For Pressure @ 1

Given Input Data:

Elevation @ 1.....	561.75	ft
Elevation @ 2.....	560.48	ft
Pressure @ 2.....	0.27	psi
Q_{FULL} = Discharge.....	4320.00	gpm (9.62 cfs)
Diameter.....	18.00	in
Length.....	250.00	ft
Hazen-Williams C..	130.00	

Computed Results:

Pressure @ 1.....	0.29	psi < 0.54 psi ∴ OK
Velocity.....	5.45	fps
Headloss.....	1.32	ft
Energy Grade @ 1..	562.89	ft
Energy Grade @ 2..	561.56	ft
Friction Slope....	5.289	ft/1000 ft

SEE SKETCH / CALC

Open Channel Flow Module, Version 3.41 (c) 1991
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

A-24

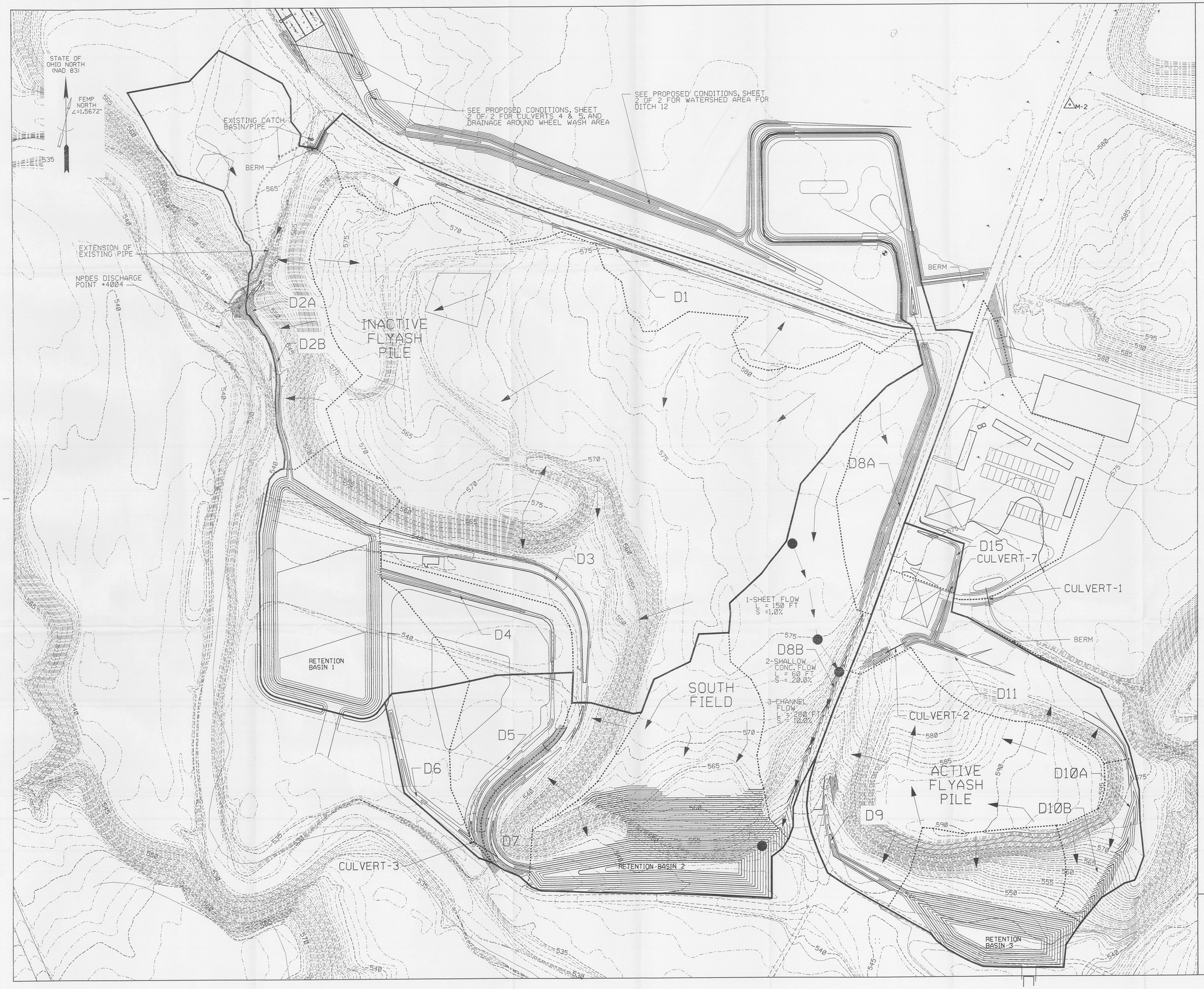
ATTACHMENT B

SUPPORTING FIGURES

R. 1 E. R. 2 E.
1 380 000 FEET
485 000 FEET
R. 1 E. R. 2 E.
US RESERVATION
(ATOMIC ENERGY COMMISSION)
DRAINAGE AREA
(Joins sheet 3)
T. 2 N.
Paddy Run
1 Mile
MnC2
EcD
EcC2
RwB2
HoA
McA
MaB
Gn
RdA
XfB2
FdA
DaB
Rn
HeF
FeA
RpA
EcE
SwC2
SwB2
EcE
PfC
XfA
Pn
MaC2
McB
EpA
EpB2
EpC2
FoA
MoE2
I
I2
6
7

APPENDIX B

DRAINAGE AREA MAPS


STATE OF OHIO NORTH (NAD 83)
FEMP NORTH ∠=1.5672°
SEE PROPOSED CONDITIONS, SHEET 2 OF 2 FOR CULVERTS 4 & 5, AND DRAINAGE AROUND WHEEL WASH AREA
SEE PROPOSED CONDITIONS, SHEET 2 OF 2 FOR WATERSHED AREA FOR DITCH 12
EXISTING CATCH BASIN/PIPE
BERM
EXTENSION OF EXISTING PIPE
NPDES DISCHARGE POINT #4004
D2A
D2B
INACTIVE FLYASH PILE
D1
D3
D4
D5
D6
D7
D8A
D8B
D9
D10A
D10B
D11
D15
CULVERT-1
CULVERT-2
CULVERT-3
CULVERT-7
RETENTION BASIN 1
RETENTION BASIN 2
RETENTION BASIN 3
SOUTH FIELD
ACTIVE FLYASH PILE
1-SHEET FLOW L = 150 FT S =1.0%
2-SHALLOW CONC. FLOW L = 60 FT S = 20.0%
3-CHANNEL FLOW L = 280 FT S = 10.0%
M-2
LEGEND
RETENTION BASIN DRAINAGE AREA
DITCH/CULVERT DRAINAGE AREA
DIRECTION OF FLOW
EXISTING CONDITIONS
50 0 50 100
SCALE: 1" = 50'

1. CONTINGENCY STOCKPILE AREA (STOCK PILE #2) IS PROVIDED FOR ADDITIONAL SOIL STORAGE SHOULD PRIMARY STOCKPILE AREA BECOME TOO SMALL. DITCHES 8A, 8B, AND BASIN 2 ARE DESIGNED TO ACCOMMODATE THE CONTINGENCY STOCKPILE AREA IF USED.

LEGEND

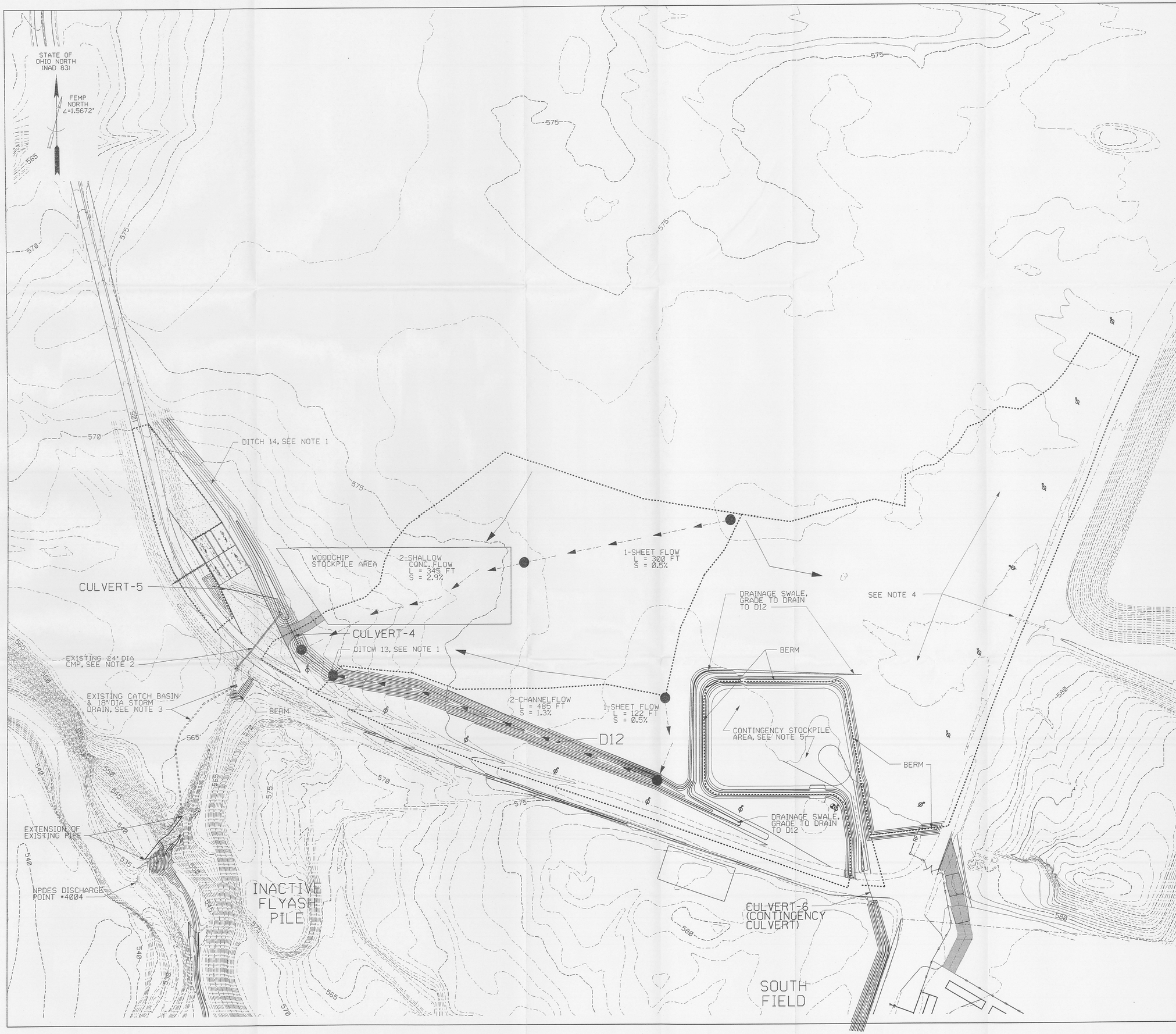
RETENTION BASIN DRAINAGE AREA — P1

DITCH/CULVERT DRAINAGE AREA

DIRECTION OF FLOW

PROPOSED CONDITIONS
SHEET 1 OF 2

50 0 50 100
SCALE: 1" = 50'



NOTES:

1. EXISTING DITCHES IN THIS AREA WERE ORIGINALLY DESIGNED UNDER THE HAULROAD UPGRADE PROJECT, (P0158), CALCULATION NO. 15-02. DITCHES 13 & 14 WILL BE THE SAME SIZE AS THE EXISTING DITCHES AND WILL BE USED TO ROUTE RUNOFF AROUND NEW WORK.
2. EXISTING 24" DIA CMP WAS DESIGNED UNDER THE HAULROAD UPGRADE PROJECT (P0158), CALCULATION NO. 15-02.
3. EXISTING 18" DIA STORM DRAIN AND CATCH BASIN WERE DESIGNED UNDER THE SEEPAGE COLLECTION AND SEDIMENT REMOVAL PROJECT, (P0139), CALCULATION NO. 15-01.
4. DITCH-12 AND CULVERT-4 WERE DESIGNED ASSUMING THAT THE EXISTING CULVERT SHOWN WAS PLUGGED. IT WAS FURTHER ASSUMED THAT THE RUNOFF FROM THE ADDITIONAL DRAINAGE AREA SHOWN WOULD FLOW SOUTH TO DITCH-12 AND CULVERT-4.
5. CONTINGENCY STOCKPILE AREA (STOCKPILE #2) IS PROVIDED FOR ADDITIONAL SOIL STORAGE SHOULD PRIMARY STOCKPILE AREA BECOME TOO SMALL. DITCHES 8A, 8B, AND BASIN 2 ARE DESIGNED TO ACCOMMODATE THE CONTINGENCY STOCKPILE AREA IF USED.

LEGEND

DITCH/CULVERT DRAINAGE AREA

DIRECTION OF FLOW

EXISTING POWER POLE

PROPOSED CONDITIONS
SHEET 2 OF 2

50 0 50 100
SCALE: 1" = 50'

APPENDIX C

Evaluation of the Potential Peak Stages in Paddys Run During Storm Events at Cross Sections Close to the Proposed Retention Basin No. 1

EVALUATION OF THE POTENTIAL PEAK STAGES IN PADDYS RUN DURING STORM EVENTS AT CROSS SECTIONS CLOSE TO THE PROPOSED RETENTION BASIN NO. 1

Fernald Environmental Management Project
Fernald, Ohio

Prepared By

BROWN & ROOT ENVIRONMENTAL
661 Andersen Drive
Pittsburgh, PA 15220

July, 1997

EVALUATION OF THE POTENTIAL PEAK STAGES IN PADDYS RUN DURING STORM EVENTS AT CROSS SECTIONS CLOSE TO THE PROPOSED RETENTION BASIN NO. 1

July, 1997

Objective

As proposed in the Area 2 Phase I Site Preparation Plan, a Surface Water Management Plan was prepared to address management of surface water at the Southern Waste Units (SWUs) during site preparation and excavation activities at the FEMP. According to this plan, the Retention Basin No. 1 will be constructed south of the Inactive Flyash Pile to control and collect potentially impacted storm water runoff from the Area 2, Phase I Remediation Area. The top bank elevations of the Retention Basin No.1 is proposed to be 540 feet. The objective of this task is to perform a hydraulic analysis to calculate the water surface elevations at the cross-sections A'-A', B'-B' and C'-C' along Paddys Run near the Retention Basin No.1, and to determine whether the water from Paddys Run will overflow into the proposed basin bank under 24-hour duration storms with the return periods of 1-year, 5-year, 10-year and 25-year, respectively. Locations of cross sections A'-A', B'-B' and C'-C' are shown in Figure 1.

Conceptual Model

The Paddys Run is an intermittent stream which drains a mid-size catchment (approximately 15 square miles) which includes most of the Fernald Environmental Management Project (FEMP) site. The Paddys Run drainage basin consists of land surface drained by streams and channels discharging to Paddys Run. The basin can be divided into subbasins so that the runoff from any particular area can be analyzed separately. The runoff from each of the subbasin can then be added together to yield the total hydrograph for the basin. The basin and subbasin boundaries were derived using topographic maps created by the U.S. Geological Survey (USGS) and supplemented with site topographic maps. Figure 2 shows all the subbasins in the simulation. The details of the boundaries of the basin and subbasins are presented in the Surface Water Flow and Infiltration Model (SWF&IM) Report (DOE 1993) developed for the FEMP and Operable Unit 5 RI/FS. The SWF&IM is a combination of the FEMP site-specific hydrological input parameters and several hydraulic and transport models used to simulate the various physical and chemical processes involved in the transport of contaminants from surface soil into surface water and subsequently into groundwater. The hydrologic/ hydraulic portion of the SWF&IM incorporated the U.S. Army

Corps of Engineers HEC-1 model to calculate runoff hydrographs and Manning's equation to calculate the Stage in Paddys Run. The methods are described in further detail in the following paragraphs.

Technical Approach

HEC-1 model was used to simulate surface runoff into Paddys Run. The HEC-1 model was developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. The HEC-1 generates runoff hydrographs from many different subbasins and then combines and routes the hydrographs through the watershed. The entire Paddys Run drainage basin was modeled by linking the various subbasins together within the HEC-1 model. In the HEC-1 model, a runoff hydrograph is calculated for each subbasin. The hydrographs are then added together at locations called stations in the HEC-1 model. The combined runoff hydrographs can then be routed through a channel reaches, and combined with hydrographs from other subbasins.

The HEC-1 model provides hydrographs in terms of discharge rate versus time at each cross-section location. The rating curve (discharge versus depth relationship) is developed at each cross section based on the Mannings equation (Henderson, 1966). Mannings equation assumes that the channel flow is steady and uniform. The rating curve for each cross section is then used to obtain the peak river stage based on the cross-section-specific peak discharge in the hydrographs from HEC-1 model. It should be noted that this modeling approach was developed for the SWF&IM model whose primary purposed was contaminant fate and transport. The river stage is a relatively insensitive parameter in the contaminant model. The method used to develop the rating curve is relatively simplistic and reasonable conservative. If more accuracy is required more detailed analysis could be performed.

In the SWF&IM, cross sections D-D and E-E were called stations. Hydrographs at these two stations are computed based on hydrographs generated from upstream subbasins and then combined and routed to these stations. Cross section D-D is located at upstream of cross section C'-C' and cross section E-E is located at downstream of cross section A'-A' (see Figure 1). (Note: Cross sections in the SWF&IM were named A-A through K-K, three new sections A'-A', B'-B' and C'-C' are intermediate sections between the original D-D and E-E sections used to study this particular area of interest) The peak river stages at cross sections D-D and E-E are calculated by using the rating curve presented in the SWF&IM and the peak discharge output from the HEC-1 model. As mentioned earlier, the rating curves were developed using the Mannings equation, cross section of Paddys run and Manning roughness coefficients based on field reconnaissance. The peak river stages at cross sections A'-A', B'-B' and C'-C' are then linearly interpolated from the peak stages at cross sections D-D and E-E based on the distance between these cross sections.

000308

The procedures used to obtain the peak stages in Paddys Run at cross sections A'-A', B'-B' and C'-C' are summarized as follows:

(1) Obtaining the peak discharges at cross sections D-D and E-E from the output of HEC-1 runs,

(2) Calculating the peak stages at cross sections D-D and E-E by using the rating curves, and

(3) Interpolating the peak stages at cross sections A'-A', B'-B' and C'-C' from the peak stages at cross sections D-D and E-E.

Input Data

The HEC-1 model requires input to represent the rainfall event and to describe the surface hydrological properties of the drainage area. Four 24-hour storm events with return periods of 1-year, 5-year, 10-year and 25-year, respectively, were chosen to evaluate the peak discharge and stage at the cross sections near the Retention Basin No. 1. The volume of precipitation contained in a storm event is often reported in depth. The storms have total precipitation depths of 2.5 inches, 3.6 inches, 4.1 inches and 4.8 inches for the 1-year, 5-year, 10-year and 25-year return periods, respectively. The method used to produce the storm hyetograph (the variation of rainfall intensity with time) used in the HEC-1 requires the rainfall amounts (depth) for storm of various durations up to the entire length of the storm being modeled. The depth-duration data required by the HEC-1 model is listed in Table 1. The rainfall depth listed in Table 1 were obtained from the rainfall frequency atlas of the United States (Hershfield 1961).

Most of the parameters used to describe the drainage basin were taken from topographic maps of the Paddys Run watershed. Some information, such as Paddys Run cross section data, used for channel routing, were obtained from topographic maps developed from field surveys. Parameters such as channel roughness, slope, catchment lengths and areas, and stream channel dimensions are required to define the water movement over the basin surface. The detailed description of the input data can be found in SWF&IM. Appendix A and Appendix B list all data used to characterize overland flow and channel flow elements, respectively. The Soil Conservation Service (SCS) curve number method was utilized to calculate precipitation losses. The curve number associated with each of the different soil types, land uses, and vegetation are then weighted and averaged to represent each subbasin for input into the HEC-1 model. Appendix C provides the weighting procedure used to determine the SCS curve number for the subbasins. The final curve number(s) used for each subbasin is also presented in this Appendix.

The area upstream of Section D-D is covered by eleven subbasins in this simulation. Storm water from the former production area of the FEMP and the waste pit area is assumed to be collected in the Storm Water Retention Basin

and pumped to the Great Miami River. therefore. the discharge from former production area and waste pit area does not affect the peak discharge at section A'-A'. B'-B' and C'-C'.

The rating curve (depth-discharge relationship) was developed for the cross sections D-D and E-E. The Mannings roughness coefficient and slope for each cross section used in a rating curve calculation are listed in Appendix B. Figures 3 and 4 show the geometry of cross sections D-D and E-E, respectively. The resulting rating curves for cross sections D-D and E-E are presented in Figures 5 and 6, respectively.

The HEC-1 model input files for 1-year, 5-year, 10-year, and 25-year return period storms are presented in Appendix E

Calibration

A comparison between the model simulated and field measured river stages was performed in response to the EPA comments on SWF&IM in 1994. Appendix D includes the detailed description of the performance of this calibration. As described in Appendix D, the curve number used for the HEC-1 model of the representative storm event are based on an Antecedent Moisture Condition-II (AMC-II) which represents an average moisture content in the surface soils prior to the storm rainfall event. AMC-I represents a dryer than average moisture content in the surface soil and AMC-III represents a wetter than average soil condition. The AMC-II curve number are primarily used for design purposes (SCS, Technical Release 55, June 1986).

In order to better evaluate the performance of the runoff model, actual rainfall data from FEMP from two storm event (the April 28-29 1989 event and another one on April 3-4 1989) and SCS curve number that represent actual soil conditions during an abnormally wet season were input into the HEC-1 model. The rainfall in the spring of 1989 was above average (DOE 1993, Groundwater Modeling Report Summary of Model Development) indicating that the ground surface could have been saturated prior to the storm event which would cause a larger amount of runoff. The SCS National Engineering Handbook, Section 4, Hydrology (NEH-4 [SCS 1985]) recommends that if more than 1.1 inches of precipitation falls during the five days before the storm event being modeled that a AMC-III should be used. Approximately 1.3 inches of rain fell in the five days prior to the storm event on April 28-29, 1989. Since this was in the range of AMC-III recommended in NEH-4, an AMC-III was used to simulate this storm. An AMC-III was also used for the simulation of the April 3-4 storm since this storm occurred four days after a storm event on March 31, 1989 which caused the Storm Water Retention Basin to overflow. The site precipitation data was not readily available for the March 31 storm, but it is valid to assume that such a event would create AMC-III soil conditions for the April 3-4 event. The area weighted SCS curve number is 64 for AMC-II condition and 81 for AMC-III condition used in HEC-1 model.

Table 2 presents the comparison of the modeled and measured rise in the flow depth of Paddys Run. The measured rise in water surface elevation was measured at two locations along Paddys Run in April 1989: Stilling Well 9 (near cross section location C-C) and Stilling Well 14 (near cross section location E-E). The location of cross section C-C is indicated in Figure 2. As stated in Appendix D, the conclusion of the comparison for the response to comments in1994 was that the surface water model can predict the water surface elevation with acceptable accuracy.

Simulation Results

The output from the HEC-1 model includes runoff hydrographs, peak discharge, and the total volume of runoff from each subbasin and cross section location in the model. The peak discharges at cross sections D-D and E-E under different storm events from the HEC-1 model were used to calculate the peak river stages based on the rating curves at these cross sections. The peak discharges and river stages at cross sections D-D and E-E are shown in Figures 5 and 6. The peak river stages at cross sections D-D and E-E were then used to interpolate the peak river stages at cross sections A'-A', B'-B' and C'-C'. Figure 7 shows the interpolated peak river stages at cross sections A'-A', B'-B' and C'-C'. Also, the peak river stages at these cross sections are tabulated in Table 3. The top elevation of the proposed bank for Retention Basin No. 1 at cross sections A'-A', B'-B' and C'-C' is about 540 feet. The river stages in Table 3 indicates that the Paddys Run does not overflow the proposed basin bank at these cross sections even under the 25-year return period, 24-hour storm event.

References

Henderson, F.M., 1966," Open Channel Flow," McMillian Publishing Co., Inc., New York pp. 96

Hershfield, D.M., 1961, " Rainfall Frequency Atlas of the United States," Technical Paper No. 40, Department of Commerce, Washington, DC.

U.S. Army Corps of Engineers, 1990, " HEC-1 Flood Hydrograph Package User's Manual," CPD-1A, Version 4.0.

U.S. Department of Energy, Fernald Office, 1993, "Surface Water Flow and Infiltration Model Summary Report."

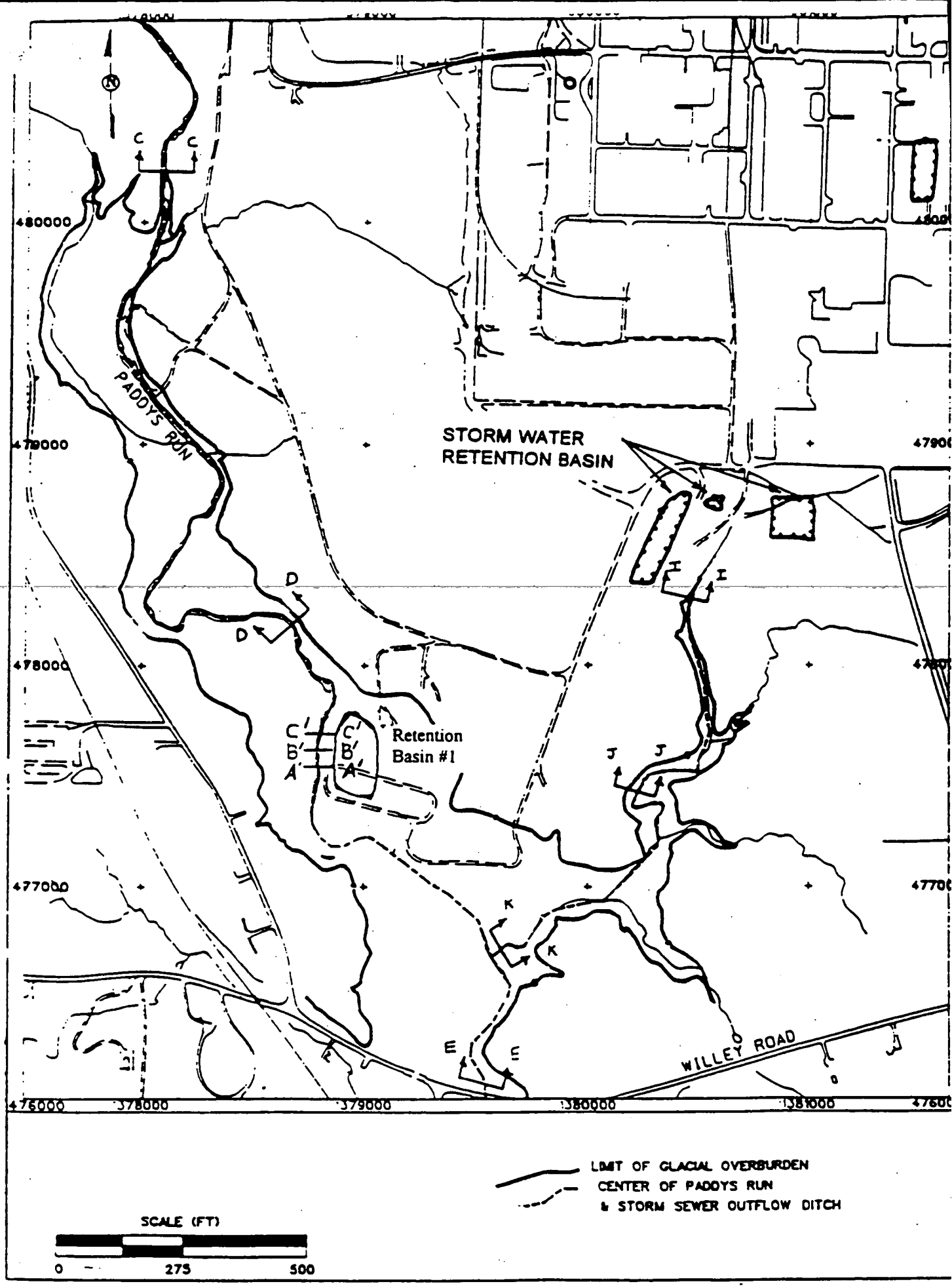


Figure 1 Location of Cross Sections

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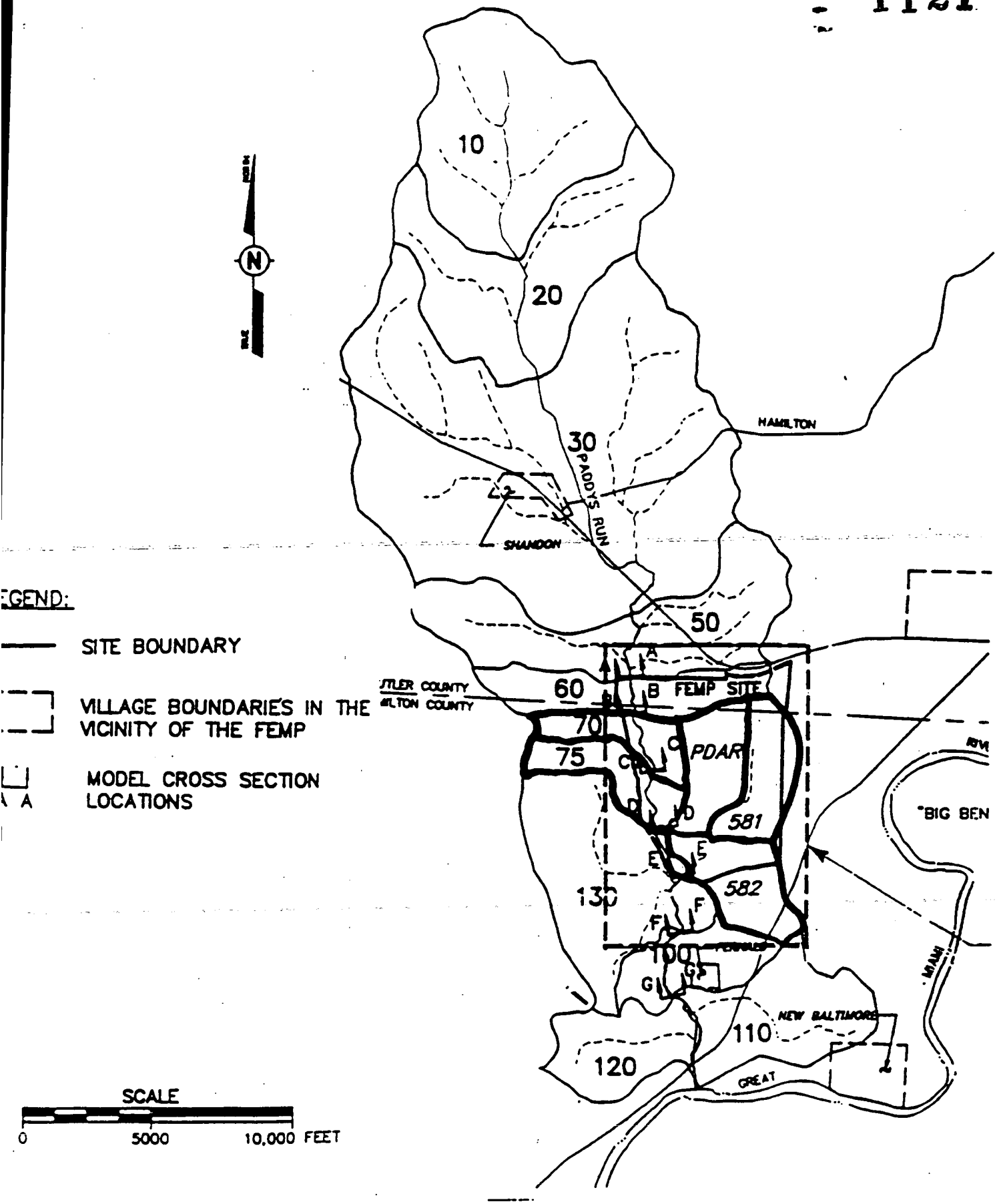

Figure 2 Paddys Run Subbasins

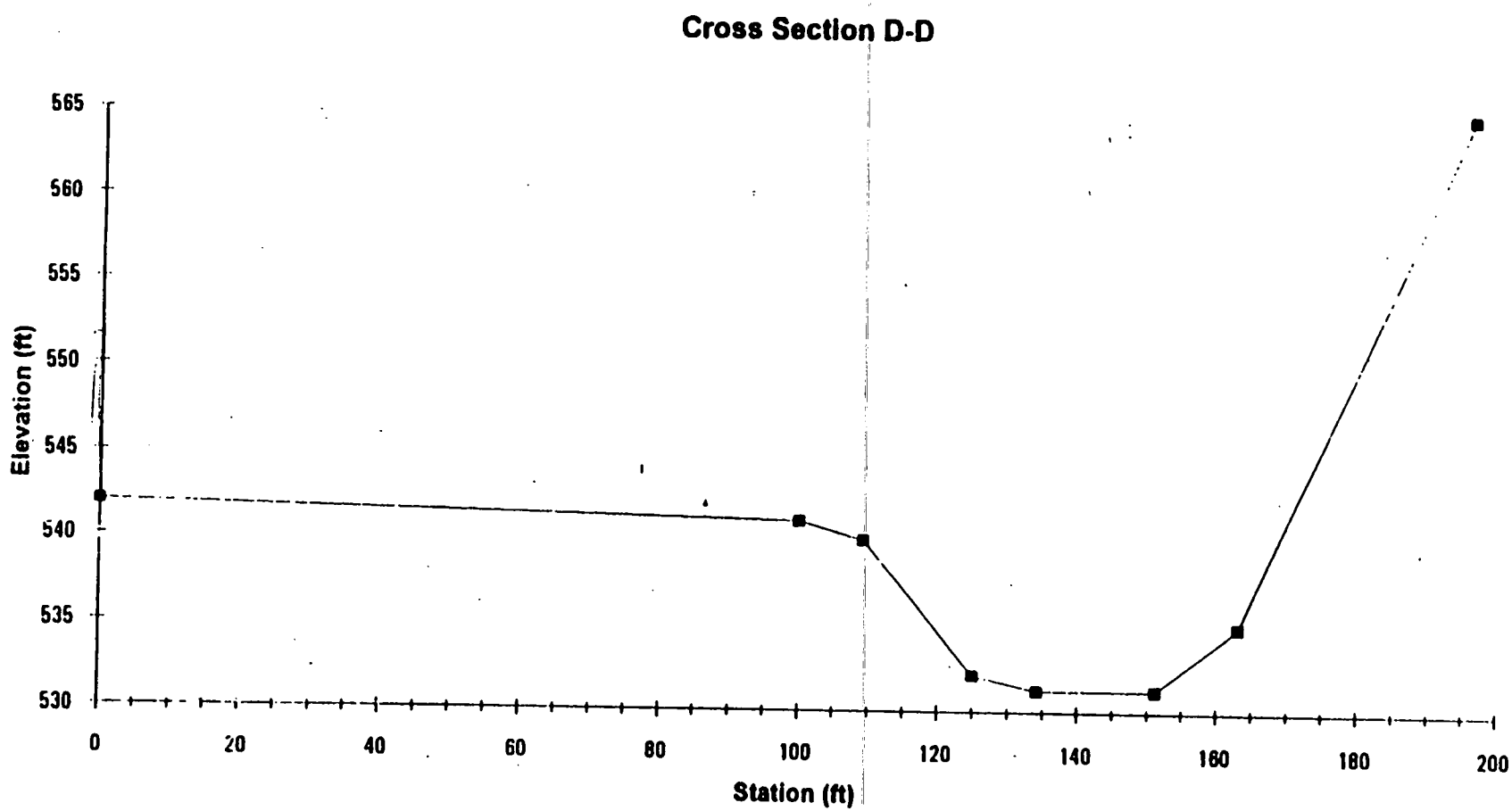

Figure 3 Cross Section D-D

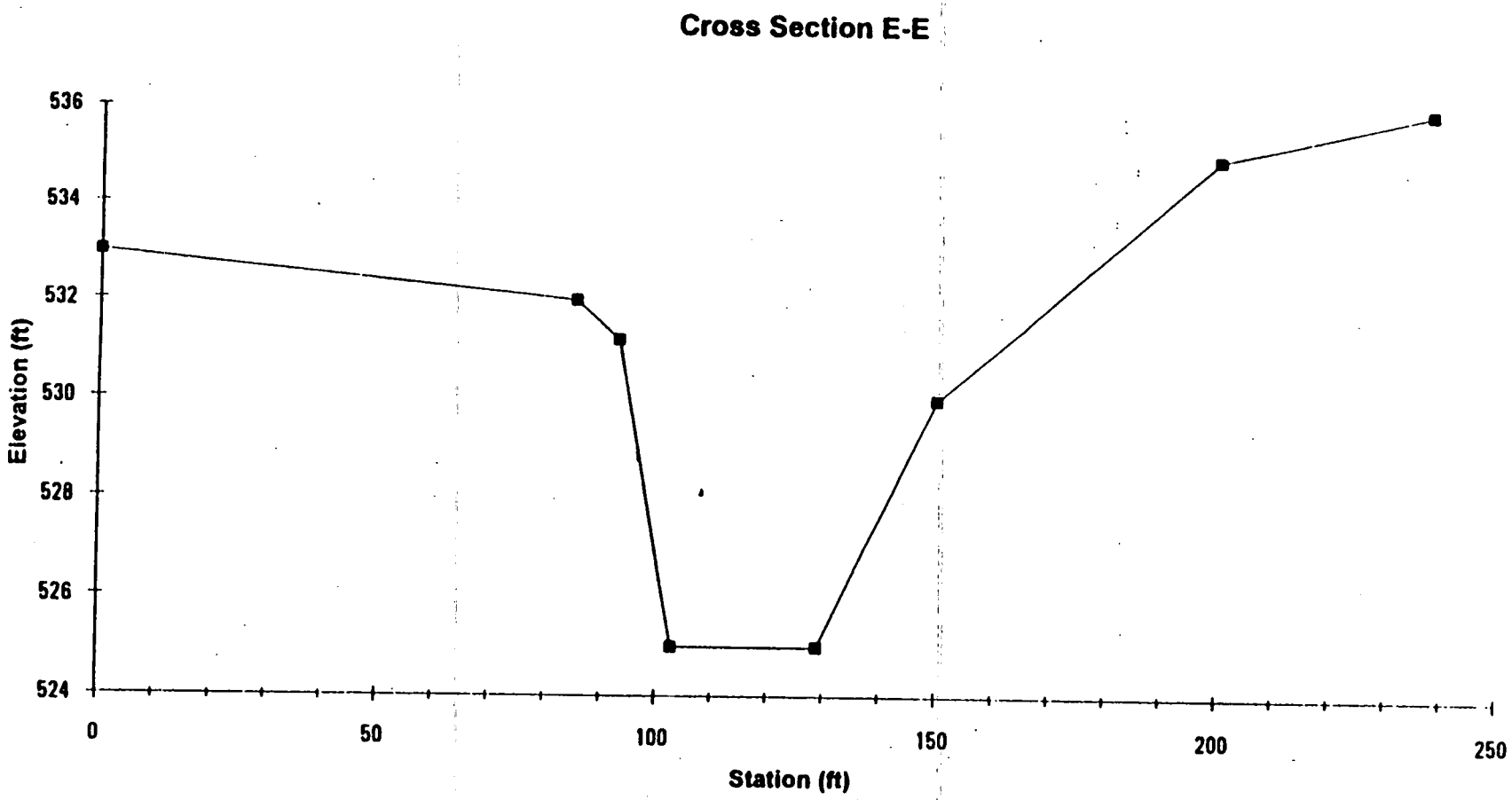

Figure 4 Cross Section E-E

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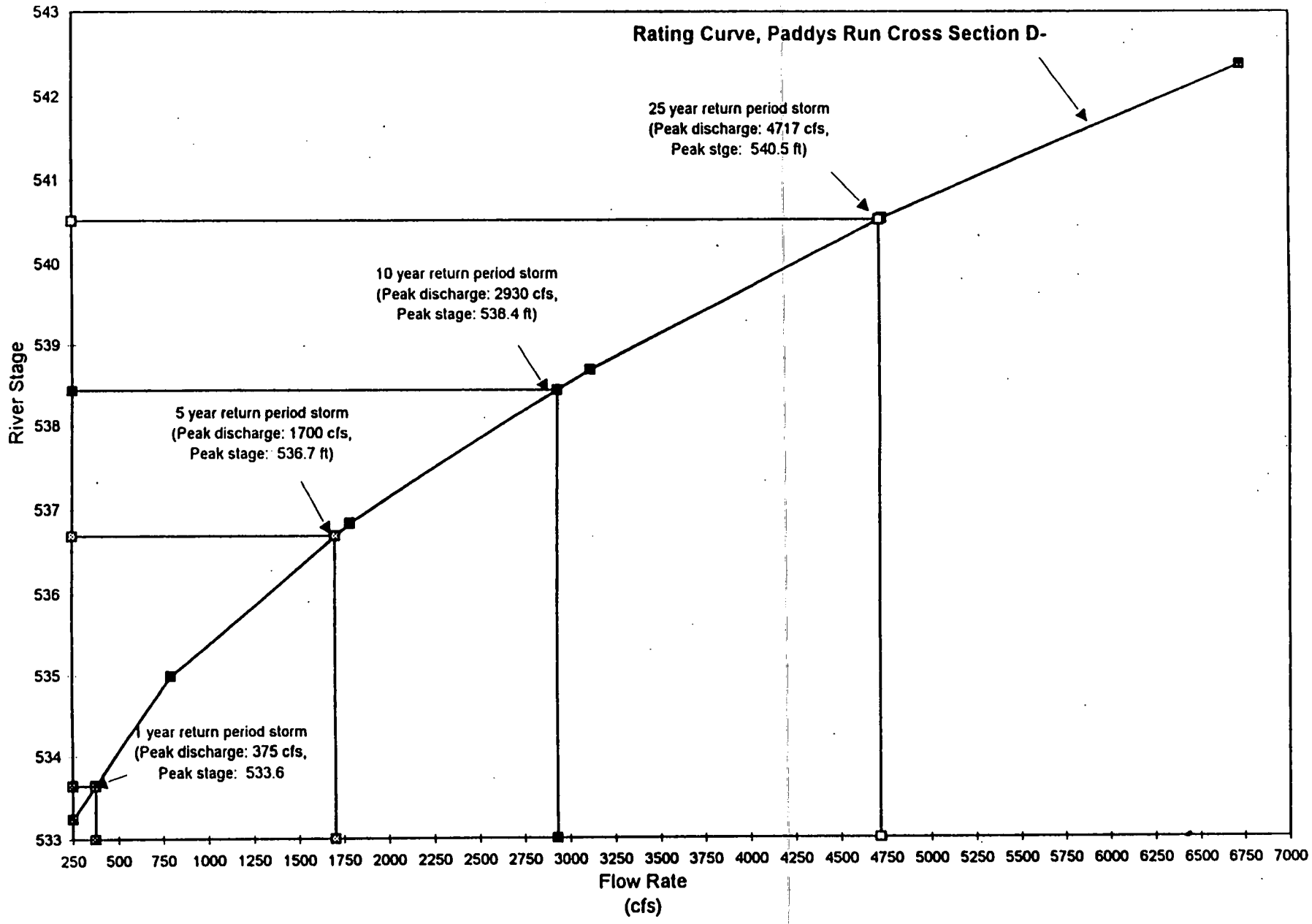

Figure 5 Rating Curve, Peak Discharge and Stage at Cross Section D-D

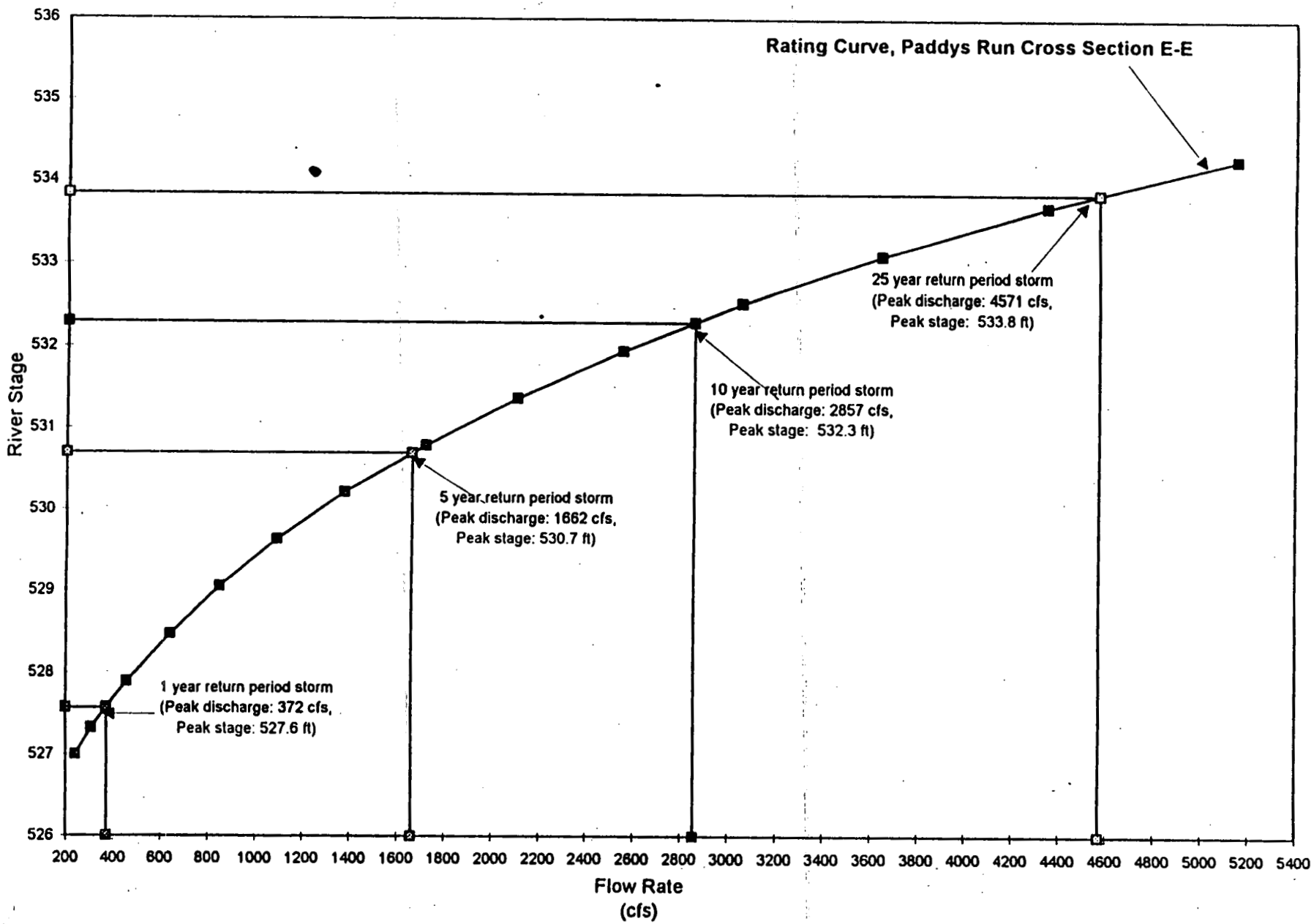

Figure 6 Rating Curve, Peak Discharge and Stage at Cross Section E-E

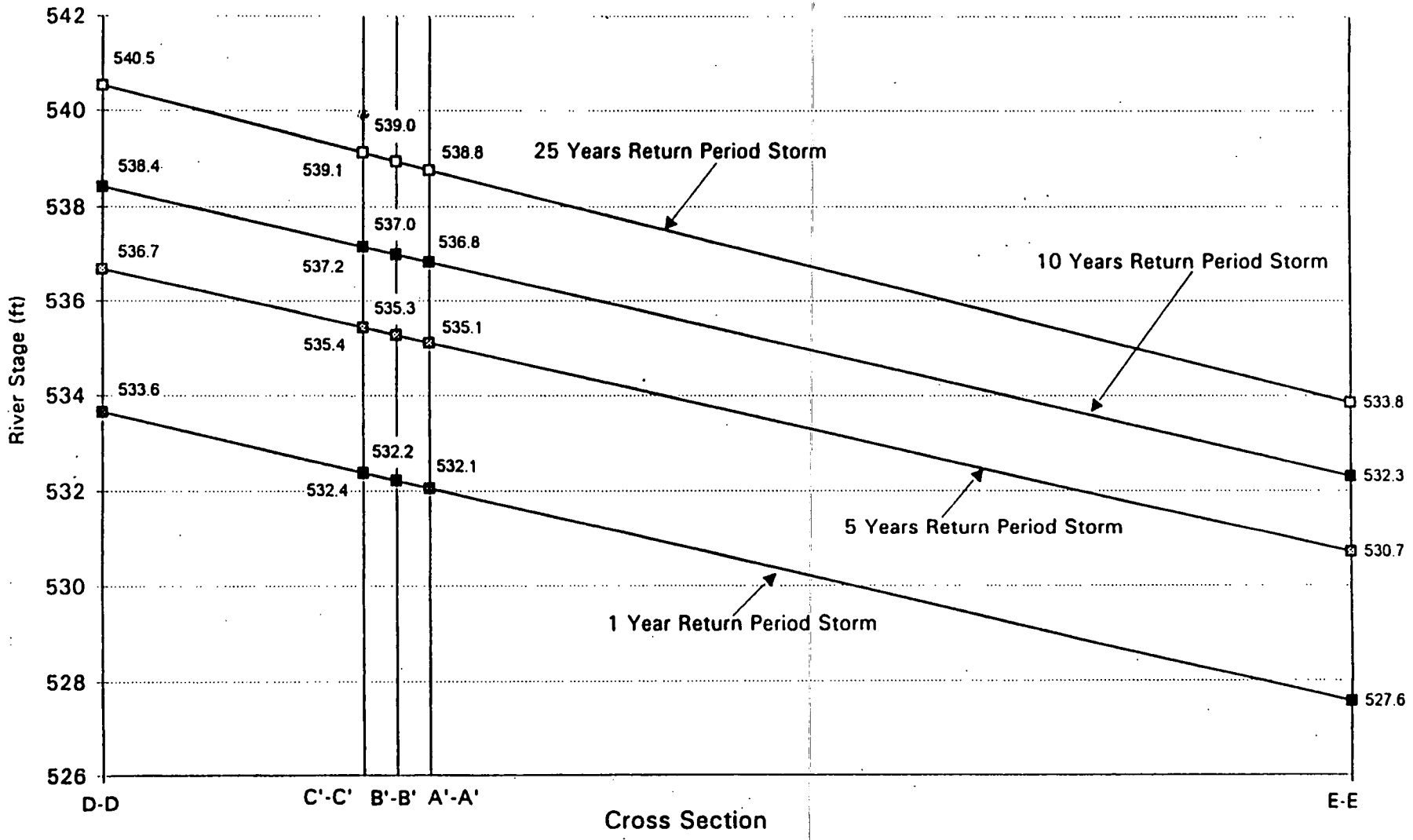

Figure 7 Interpolated Peak Stages at Cross Section A'-A', B'-B' and C'-C'

000315

Table 1 Depth-Duration Data for 24-Hour Storm*

Duration	Depth (in)			
	1-Year Return Period Storm	5-Years Return Period Storm	10-Years Return Period Storm	25-Years Return Period Storm
5 minutes	0.330	0.500	0.540	0.625
15 minutes	0.625	1.000	1.125	1.250
60 minutes	1.100	1.500	1.900	2.220
2 hours	1.400	1.900	2.200	2.700
3 hours	1.480	2.100	2.400	3.000
6 hours	1.800	2.400	2.900	3.500
12 hours	2.100	3.000	3.360	4.100
24 hours	2.500	3.600	4.100	4.800

* Hershfield, D.M., 1961, Rainfall Frequency Atlas of the United States. Technical Paper No.40. Department of Commerce, Washington, D.C.

Table 2

COMPARISON OF MODELED AND MEASURED INCREASE OF PADDYS RUN FLOW DEPTHS

Date of Storm Event	Precipitation Amount IN.[a]	Cross Section C-C		Cross Section E-E	
		Measured Rise in Stream Depth (Stilling Well 9)[b] FT.	Modeled Rise in Stream Depth (STA70)[c] FT.	Measured Rise in Stream Depth (Stilling Well 14)[b] FT.	Modeled Rise in Stream Depth (STAEE)[c] FT.
April 3-4, 1989	1.92	4.06	3.99	5.51	5.35
April 28-29,1989	1.96	2.39	3.13	4.98	4.17

(a) Precipitation amounts from raingauge at the FEMP, except portion of April 28-29 storm which is supplemented with data from the Greater Cincinnati Airport due to missing data from the FEMP raingauge.

(b) Stream depth rise taken from data presented in Groundwater Report, Feed Materials Production Center, U.S. DOE December, 1990.

(c) Stream depth calculated from Paddys Run flow rate predicted with HEC-1 and Mannings equation.

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Table 3 Peak River Stages at Cross Section A'-A', B'-B' and C'-C'

24-Hour Storm	River Stage (ft) at Cross Sections		
	A'-A'	B'-B'	C'-C'
1 Year Return Period	532.1	532.2	532.4
5 Years Return Period	535.1	535.3	535.4
10 Years Return Period	536.8	537.0	537.2
25 Years Return Period	538.8	539.0	539.1

Appendix A

HEC-1 INPUT DATA

SUBBASIN CHARACTERISTICS (OVERLAND FLOW PLANE DATA)

Subbasin	Overland Flow Length[a] (FT)	Overland Flow Slope[a] (ft/ft)	Resistance Factor[b] N	% Subbasin Area[a]	Drain Area[a] (Sq. mile)	SCS Curve Number[c]
10	150	0.07	0.4	100	1.869	65.4
20	200	0.075	0.4	100	1.589	63.7
30	200	0.08	0.4	100	5.188	63
50	200	0.04	0.4	100	1.288	66
60	200	0.08	0.4	100	0.599	59.8
70	150	0.013	0.4	75	0.313	61
	200	0.013	0.15	25		88.8
75	150	0.013	0.4	75	0.408	61
	200	0.013	0.15	25		88
PDAR	150	0.01	0.15	100	0.294	86.2
580	100	0.01	0.25	100	0.036	71.9
581	200	0.025	0.25	100	0.456	69.4
582	200	0.025	0.30	100	0.487	66.5
100	180	0.1	0.4	30	0.51	62.1
110	200	0.2	0.4	50	0.832	61.9
120	150	0.03	0.3	50		69
	100	0.28	0.4	100	0.561	69.4
130	200	0.033	0.4	100	1.385	68.2

HEC-1 INPUT DATA

SUBBASIN CHARACTERISTICS (OVERLAND FLOW PLANE DATA)

SUBBASINS DIVIDED FOR CONTAMINATED CALCULATIONS

Subbasin	Overland Flow Length[d] (FT)	Overland Flow Slope[e] (ft/ft)	Resistance Factor[e] N	% Subbasin Area[a]	Drain Area[a] (Sq. mile)	SCS Curve Number[f]
60	200	0.08	0.4	100	0.282	59.9
560	200	0.10	0.4	100	0.317 0.599	62.9
70	200	0.01	0.4	100	0.121	62.4
570	200	0.017	0.25	100	0.120	76.7
WPA	200	0.024	0.15	100	0.072 0.313	76.8
75	150	0.15	0.40	100	0.288	67.6
575	200	0.013	0.15	25	0.120 0.408	69.8

[a]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437.5/7.5, 1981, DMA 4062 ISW-Series V852.

[b]Table 3.5, HEC-1 User's Manual.

[c]See Table 3-4 for SCS curve number calculation procedure.

[d]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437.5/7.5, 1981, DMA 4062 ISW-Series V852.

[e]Table 3.5, HEC-1 User's Manual.

[f]See Table 3-4 for SCS curve number calculation procedure.

Appendix B

HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

Element	Length[a] (ft)	Slope[a]	Manning[b] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
Sub 10								
Subcollector Channel	500	0.07	0.045	0.08	TRAP	0	1	
Collector channel	3200	0.05	0.045	0.47	TRAP	0	1	
Main channel	5200	0.015	0.045		TRAP	0	1	No
Sub 20								
Collector channel	4500	0.085	0.045	0.132	TRAP		1	
Main channel	4800	0.015	0.045		TRAP	0	1	Yes
Sub 30								
Subcollector channel	3600	0.05	0.045	0.18	TRAP	0	1	
Collector channel	6000	0.007	0.045	1.297	TRAP	0	1	
Main channel	10800	0.003	0.045		TRAP	20	1	Yes
Sub 50								
Collector channel	5000	0.02	0.045	0.322	TRAP	0	1	
Main channel	2800	0.002	0.035		Irregular	--	1	Yes
Rout 60								
Main channel	1600	0.004	0.035		Irregular		1	Yes
Sub 60								
Collector channel	4500	0.04	0.02	0.15	TRAP	5	1	
Main channel	1600	0.004	0.035		Irregular		1	No
Rout 0								
Main channel	2986	0.004	0.025		Irregular			Yes
Sub 70								
Main channel	4000	0.013	0.045		TRAP	5	1	No

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HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Element	Length[a] (ft)	Slope[a]	Manning[b] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
Rout 1								
Main channel	3093	0.003	0.025		Irregular			Yes
Sub 75								
Main channel	4000	0.013	0.045		TRAP	5	1	No
Rout 2								
Main channel	2773	0.002	0.025		Irregular			Yes
PDAR								
Main channel	2600	0.005	0.015	–	CIRC	2	–	No
580								
Collector channel	500	0.100	0.04	0.020	TRAP	0	1	No
Main channel	600	0.010	0.035	–	TRAP	5	1	No
581								
Collector channel	1000	0.020	0.04	0.080	TRAP	0	1	No
Main channel	3300	0.012	0.030	–	TRAP	5	1	No
Rout 80								
Main channel	1300	0.009	0.035	–	Irregular	–	–	Yes

000327

HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Element	Length[a] (ft)	Slope[a]	Manning[b] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
582								
Colector channel	3600	0.022	0.045	0.033	TRAP	5	1	No
Main channel	3800	0.015	0.025	–	TRAP	26	2.27	No
Rout 25								
Main channel	2613	0.002	0.025		TRAP	52.8	4.55	Yes
Sub 100								
Collector channel	4000	0.01	0.045	0.412	TRAP	5	1	
Main channel	2773	0.0003	0.025		TRAP	27.2	26.32	Yes
Rout 3								
Main channel	3626	0.0025	0.025		TRAP	63.6	7.3	Yes
Sub 110								
Collector channel	500	0.04	0.045	0.21	TRAP	0	1	
Main channel	10,000	0.009	0.025		TRAP	20	3.33	No
Sub 120								
Collector channel	500	0.2	0.045	0.15	TRAP	0	1	
Main channel	8000	0.021	0.045		TRAP	20	3.33	No
Sub 130								
Collector channel	5000	0.018	0.045	0.588	TRAP	5	1	
Main channel	1800	0.02	0.025		TRAP	52.8	4.55	No

HEC-1 INPUT DATA

CHANNEL CHARACTERISTICS

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Element	Length[c] (ft)	Slope[b]	Manning[d] n	Area[a] (sq. mile)	Shape	Width (ft)	Side Slope (ft/ft)	Route Upstream Flow
Sub 60								
Main Channel	4500	0.04	0.03	–	TRAP	0	1	No
Sub 560								
Main channel	4800	0.01	0.04	–	TRAP	0	1	No
Sub 70								
Main channel	4600	0.013	0.045	–	TRAP	0	1	No
Sub 570								
Main channel	1800	0.017	0.030	–	TRAP	0	1	No
WPA								
Main channel	1800	0.024	0.030	–	TRAP	0	1	No
Sub 75								
Main channel	4000	0.013	0.045	–	TRAP	5	1	No
Sub 575								
Main channel	650	0.067	0.045	–	TRAP	5	1	No

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[a]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437 5/7 5, 1981, DMA 4062 ISW-Series V852.

[b]Table 4.2, Henderson F.M., 1966, Open Channel Flow, MacMillan Publishing Co., Inc.

[c]Estimated from USGS topographic map, Shandon, Ohio, N3915_W8437 5/7.5, 1981, DMA 4062 ISW-Series V852.

[d]Table 4.2, Henderson F.M., 1966, Open Channel Flow, MacMillan Publishing Co., Inc.

Appendix C

SCS CURVE NUMBER WEIGHTING

Subbasin	Land Cover[a]	Hydraulic Condition	Hydrologic Soil Group[b]	Weighted SCS Number[c]	Average SCS Number
10	Woods 30%	Good	0.5C + 0.5B	0.5 x 71 + 0.5 x 55	
	Meadow 60%	Good	0.4C + 0.6B	0.4 x 71 + 0.6 x 58	65.4
	Hard surface 10%	–	0.5 C + 0.5B	0.5 x 84 + 0.5 x 90	
20	Woods 15%	Good	0.7C + 0.3B	0.7 x 70 + 0.3 x 55	
	Meadow 80%	Good	0.3C + 0.7B	0.3 x 71 + 0.7 x 58	63.7
	Hard surface 5%	–	0.5C + 0.5B	0.5 x 84 + 0.5 x 90	
30	Woods 10%	Fair	0.4C + 0.6B	0.4 x 73 + 0.6 x 60	
	Meadow 85%	Good	0.25C + 0.75B	0.25 x 71 + 0.75 x 58	63
	Hard surface 5%	–	0.5C + 0.5B	0.5 x 84 + 0.5 x 90	
50	Woods 20%	Fair	0.4C + 0.6B	0.4 x 73 + 0.6 x 60	
	Meadow 70%	Good	0.4C + 0.6B	0.4 x 71 + 0.6 x 58	66
	Hard Surface 10%	–	0.4C + 0.6B	0.4 x 84 + 0.6 x 90	
60	Woods 35%	Good	0.1C + 0.9B	0.1 x 70 + 0.9 x 55	
	Meadow 60%	Good	0.1C + 0.9B	0.1 x 71 + 0.9 x 58	59.8
	Hard surface 5%	–	0.1C + 0.9B	0.1 x 84 + 0.9 x 90	
70	Woods 10%	Fair	0.2C + 0.8B	0.2 x 73 + 0.8 x 60	61
	Meadow 65%	Good	0.2C + 0.8B	0.2 x 71 + 0.8 x 58	
	Hard surface 25%	–	0.2C + 0.8B	0.2 x 84 + 0.8 x 90	88.8
75	Woods 10%	Fair	0.2C + 0.8B	0.2 x 73 + 0.8 x 60	61
	Meadow 65%	Good	0.2C + 0.8B	0.2 x 71 + 0.8 x 58	
	Hard surface 25%	–	0.2C + 0.8B	0.2 x 84 + 0.8 x 90	88.8
80	Woods 10%	Fair	0.5C + 0.5B	0.5 x 73 + 0.5 x 60	65
	Meadow 65%	Good	0.5C + 0.5B	0.5 x 71 + 0.5 x 58	
	Hard surface 25%	–	0.5C + 0.5B	0.5 x 84 + 0.5 x 90	87

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SCS CURVE NUMBER WEIGHTING

Subbasin	Land Cover[a]	Hydraulic Condition	Hydrologic Soil Group[b]	Weighted SCS Number[c]	Average SCS Number
580	Woods 45%	Good	0.0B + 1.0C	0.0 x 55 + 1.0 x 71	
	Meadow 50%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	71.95
	Hard Surface 5%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
PDAR	Woods 0%	Good	0.0B + 1.0C	0.0 x 55 + 1.0 x 71	
	Meadow 20%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	86.20
	Hard Surface 80%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
581	Woods 0%	Good	0.5B + 0.5C	0.5 x 55 + 0.5 x 71	
	Meadow 85%	Good	0.4B + 0.6C	0.4 x 58 + 0.6 x 71	69.43
	Hard Surface 15%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
582	Woods 15%	Good	0.5B + 0.5C	0.5 x 55 + 0.5 x 71	
	Meadow 75%	Good	0.5B + 0.5C	0.5 x 58 + 0.5 x 71	66.53
	Hard Surface 10%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
100	Woods 5%	Fair	0.2C + 0.8B	0.2 x 73 + 0.8 x 60	
	Meadow 90%	Good	0.2C + 0.8B	0.2 x 71 + 0.8 x 58	62.1
	Hard surface 5%	--	0.2C + 0.8B	0.2 x 84 + 0.8 x 90	
110	Woods 15%	Fair	0.1C + 0.9B	0.1 x 73 + 0.9 x 60	
	Meadow 75%	Good	0.1C + 0.9B	0.1 x 71 + 0.9 x 58	61.9
	Hard surface 10%	--	0.1C + 0.9B	0.1 x 84 + 0.9 x 90	
120	Woods 85%	Good	0.9C + 0.1B	0.9 x 70 + 0.1 x 55	
	Meadow 10%	Good	0.9C + 0.1B	0.9 x 71 + 0.1 x 58	69.4
	Hard surface 5%	--	0.9C + 0.1B	0.9 x 84 + 0.1 x 90	
130	Woods 10%	Fair	0.7C + 0.3B	0.7 x 73 + 0.3 x 60	
	Meadow 85%	Good	0.7C + 0.3B	0.7 x 71 + 0.3 x 58	68.2
	Hard surface 5%	--	0.7C + 0.3B	0.7 x 84 + 0.3 x 90	

SCS CURVE NUMBER WEIGHTING

SUBBASINS DIVIDED FOR CONTAMINANT CALCULATIONS

Subbasin	Land Cover[a]	Hydraulic Condition	Hydrologic Soil Group[b]	Weighted SCS Number[c]	Average SCS Number
60	Woods 30%	Good	0.9B + 0.1C	0.9 x 55 + 0.1 x 71	
	Meadow 65%	Good	0.9B + 0.1C	0.9 x 58 + 0.1 x 71	59.88
	Hard surface 5%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
560	Woods 25%	Good	0.7B + 0.3C	0.7 x 55 + 0.3 x 71	
	Meadow 70%	Good	0.7B + 0.3C	0.3 x 58 + 0.3 x 71	62.63
	Hard surface 5%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
70	Woods 20%	Good	0.2B + 0.8C	0.2 x 55 + 0.8 x 71	
	Meadow 75%	Good	0.9B + 0.1C	0.9 x 58 + 0.1 x 71	62.39
	Hard surface 5%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	
WPA	Woods 5%	Good	1.0B + 0.0C	1.0 x 55 + 0.0 x 71	
	Meadow 60%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	76.85
	Hard Surface 35%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
570	Woods 5%	Good	0.0B + 1.0C	0.0 x 55 + 1.0 x 71	
	Meadow 65%	Good	0.0B + 1.0C	0.0 x 58 + 1.0 x 71	76.70
	Hard surface 30%	--	0.0B + 1.0C	0.0 x 84 + 1.0 x 90	
75	Woods 25%	Good	0.4B + 0.6C	0.4 x 55 + 0.6 x 71	
	Meadow 65%	Good	0.4B + 0.6C	0.4 x 58 + 0.6 x 71	
	Hard surface 10%	--	0.5B + 0.5C	0.5 x 84 + 0.5 x 90	67.62
575	Woods 50%	Good	0.3B + 0.7C	0.3 x 55 + 0.7 x 71	
	Meadow 35%	Good	0.3B + 0.7C	0.3 x 58 + 0.7 x 71	
	Hard surface 15%	--	0.3B + 0.7C	0.3 x 84 + 0.7 x 90	69.82

[a]Estimated from USGS Topographic Map, Shandon, Ohio, N3915-W8437. 5/7.5, 1981, DMA 4062 I SW-Series V852.

[b]0.4C and 0.6B means 40% is hydrologic soil group C and 60% is hydrologic soil group B. Percentages of each group were determined from soil survey maps: Soil Survey of Butler Co., Ohio, USDA 1980; Soil Survey of Hamilton Co., Ohio, USDA, 1982.

SCS CURVE NUMBER WEIGHTING

[c]SCS curve number obtained from G. O. Schwab, R. K. Frevert, T. W. Edminster, and K. K. Barnes, 1981, ***Soil and Water Conservation Engineering***, John Wiley and Sons, Inc., pp. 74.

[d]Estimated from USGS Topographic Map, Shandon, Ohio, N3915-W8437.5/7.5, 1981, DMA 4062 I SW-Series V852.

[e]0.4C and 0.6B means 40% is hydrologic soil group C and 60% is hydrologic soil group B. Percentages of each group were determined from soil survey maps: Soil Survey of Butler Co., Ohio, USDA 1980; Soil Survey of Hamilton Co., Ohio, USDA, 1982.

[f]SCS curve number obtained from G. O. Schwab, R. K. Frevert, T. W. Edminster, and K. K. Barnes, 1981, ***Soil and Water Conservation Engineering***, John Wiley and Sons, Inc., pp. 74.

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Appendix D

sufficiently homogenous to only require one SCS curve number per subbasin.

For every subbasin, the last column in Table 3-2 labeled "Average SCS Number" represents a weighted average of the SCS curve numbers for each land use type. That is, a weighted curve number was calculated for each land use type (woods, meadow, or hard surface) based on the hydrologic soil group. This calculation is presented in the next to last column (labeled " Weighted SCS Number") of Table 3-2. The overall curve number for the subbasin was then calculated by averaging the curve numbers for each land use type weighted by the percent of the subbasin covered by each land use as indicated in the second column (labeled "Land Cover"). The results of this second weighted average (the overall curve numbers input into the HEC-1 model) are then presented in the last column of Table 3-2.

Action: The revised Surface Water Flow and Infiltration Model Summary Report submitted will contain additional text to clarify the contents of Table 3-2.

2. <u>Section 3.4.5. Page 3-39, Paragraph 4</u>

Comment: The report concludes that the model compares favorably to measured increases in the river stage of Paddys Run and the elevation of the groundwater in response to an observed precipitation event. The report also presents a reasonable explanation for the error associated with the increase in the groundwater levels. While these statements are qualitatively correct, the quantitative comparison indicated a potential for significant error. For example, the modeled river stage of Paddys Run rose only one-half the height of what was observed. Assuming that U.S. DOE's explanation of why the modeled groundwater elevation rose only 1.65 feet is correct, the modeled rise in the river stage of Paddys Run should have been much greater than what was reported. U.S. DOE should explain why the river stage did not increase as much as it should have. In addition, U.S. DOE should collect more field data to further verify the model.

Response: This comment raises two issues with the performance of the surface water model. The first is concerned with the predicted amount of infiltration and the response of the groundwater table to the representative storm event. The second is the comparison of the predicted rise in water surface elevation and the measured rise in water surface elevation in Paddys Run. As was discussed in the response to the first general comment, the infiltration model is very conservative in its estimation of

the annual percent of contaminated runoff which infiltrates into the GMA, so that the distribution of the infiltration determined from the representative storm event is more important than the actual volume of infiltration from that storm event. The infiltration distribution is then applied to the annual infiltration and in turn the contaminant loading. In addition, the differences in the initial conditions of the modeled event and the measured event make a true quantitative comparison difficult although qualitatively the general aquifer response was similar.

It is difficult to quantitatively compare the output from the model for the representative storm to actual field data because of the differences in the initial conditions of the ground surface and the streambeds, the duration of the storm event and the variation of intensity of the rainfall with time (hyetograph), and differences in the shape of the stream cross sections where the stage measurements and calculations were made. The Surface Water Flow and Infiltration Model Summary Report qualitatively compares the results from the model of the representative storm event to a rainfall event occurring in April of 1989 (note the report incorrectly indicates that the date of the rainfall event; it should have been reported as April 28-29). The curve numbers used for the HEC-1 model of the representative storm event are based on an Antecedent Moisture Condition-II (AMC-II) which represents an average moisture content in the surface soils prior to the storm rainfall event. AMC-I condition represents a dryer than average initial soil condition and AMC-III represents a wetter than average soil condition. The AMC-II curve numbers are primarily used for design (SCS, Technical Release 55, June 1986). The SCS curve numbers presented for use in the Superfund Exposure Assessment Manual (EPA, 1988) do not specifically indicate what AMC they are for, but they do match the curve numbers given for the same land use and soil type for AMC-II conditions in the SCS's Technical Release 55 (SCS 1986). Since AMC-II is most commonly used in design and because of the curve number presented in the Superfund Exposure Assessment Manual, AMC-II Curve numbers were also used in the HEC-1 model of the representative storm event. In order to better evaluate the performance of the runoff model, actual rainfall data from the FEMP from two storm events (the April 28-29 event and another one on April 3-4 1989) and SCS curve numbers that represent actual soil conditions during an abnormally wet season were input into the HEC-1 model. The input and results for these modeled conditions are discussed below.

The rainfall in the spring of 1989 was above average (DOE, 1993 Groundwater Modeling Report Summary of Model Development) indicating that the ground surface could have been saturated prior

to the storm event which would cause a larger amount of runoff (and deeper depth in Paddys Run) than if the ground surface is unsaturated. If the ground surface is saturated prior to the storm event, a greater percentage of the rainfall will become runoff (than if the ground is unsaturated) since the ground surface does not have unsaturated pore spaces available to capture the rainfall. Storm water runoff is the only major source of flow in Paddys Run since flow from groundwater would only represent a small portion of the total flow during a fairly large storm event. The total amount of precipitation as measured at the Greater Cincinnati Airport by the National Weather Service (NWS) was 5.19 inches during April 1989. The average monthly rainfall of April for the years 1958 through 1992 also at the Greater Cincinnati Airport is 3.53 inches. The rain gauge information at the FEMP reported 6.09 inches of rainfall in the month of April 1989 before it stopped recording during the rainfall event on April 28. If the site rainfall data is supplemented with rainfall data from the Greater Cincinnati Airport to replace the missing data, a total of 7.48 inches of rain would have fallen on the FEMP in April 1989.

Storm events occurring on April 3-4 and 28-29, 1989 were simulated with the surface water model. Hourly precipitation data from the FEMP supplemented with data from the Greater Cincinnati Airport was input into the HEC-1 model with the curve number modified to represent an AMC-III initial moisture condition. The FEMP precipitation data was supplemented with data from the Greater Cincinnati Airport to replace several missing data points from the FEMP rain gauge. This data was used because it was the best information available for the missing data points in question. The SCS National Engineering Handbook, Section 4, Hydrology (NEH-4 [SCS 1985]) recommends that if more than 1.1 inches of precipitation falls during the five days before the storm event being modeled that a AMC-III should be used. Approximately, 1.3 inches of rain fell in the five days prior to the storm event on April 28-29, 1989. Since this was in the range for AMC-III recommended in NEH-4 an AMC-III was used to simulate this storm. An AMC-III was also used for the simulation of the April 3-4 storm since this storm occurred four days after a storm event on March 31, 1989 which caused the Storm Water Retention Basin to overflow. The site precipitation data was not readily available for the March 31 storm, but it is valid to assume that such a event would create AMC-III soil conditions for the April 3-4 event.

A comparison of the modeled and measured rise in flow depth of Paddys run is presented in the attached Table 1. The measured rise in water surface elevation was measured at two location along

Paddys Run in April of 1989; stilling well 9 (near cross section location C-C) and stilling well 14 (near cross section location E-E). The measured and modeled rises in stream elevation for the April 3-4 storm were within three percent of each other at both measuring locations on Paddys Run. The modeled rise in stream depth for the April 28-29 storm did not match as well although the differences between the modeled and the measured elevation rises are less than 10 inches. The second storm event may not match as well because the site rainfall data for this event had to be supplemented with rainfall data from the Greater Cincinnati Airport approximately 17 miles to the south. Based on the simulated actual storm events, it is determined that the surface water model is predicting the water surface elevations with acceptable accuracy so that additional field data is not required to verify the model.

Changing parameters in the HEC-1 model of the representative storm event to match the changes in the simulation of actual storm events discussed above (curve numbers based on AMC-III) is not necessary for the following reasons. An average Antecedent Moisture Condition (AMC-II) is usually used for designs and match values given in U.S. EPA documents. As was discussed in the response to the general comment, the representative storm event runoff is used to estimate the annual runoff. Using an AMC-II (average moisture condition) for the representative storm event would provide more realistic results to base the annual calculations on. An AMC-III initial moisture content will tend to increase the overall discharge from the basin, however, the amount of contaminant released in the dissolved phase is directly proportional to the amount of runoff from a subbasin so that the concentration should not change. The predicted mass of contaminant loaded to the GMA could increase for the simulated representative storm event. The single representative storm event will not have a significant effect on the annual loading to the GMA since the representative storm event only accounts for 6% of the annual runoff. The annual runoff is based on average moisture conditions since it is used to represent all of the different storms that occur during the year. In addition, the surface water model already is conservatively overestimating the annual loadings to the GMA. Modeled simulations performed for the Draft Remedial Investigation Report for Operable Unit 5 submitted for internal review at the U.S. Department of Energy (U.S. DOE) illustrated the conservativeness of the predicted loadings to the GMA. The surface water model was set up to predict the total amount of uranium-238 released to the GMA through the streambeds of Paddys Run and the SSOD. The predicted amount ranged from 6200 kg to 12300 kg. Out of the total estimated mass of 4800 kg of uranium within the plume of significant concentration in the GMA, 1860 kgs are

located along the SSOD and Paddys Run south of the SSOD in the GMA. The 1860 kg of uranium is believed to originate primarily from the surface water loading.

Action: Actual storm rainfall was put into the HEC-1 model to compare the modeled rise in stream depth to the measured rise in stream depth. As was discussed in the Response to this comment, the model compared well with the measured data so that the collection of additional field data is not necessary. The comparison between the model output and measured data will be included in the revised Surface Water Flow and Infiltration Model Summary Report.

3. <u>Section 3.4.5, Page 3-41, Paragraph 1.</u>

Comment: U.S. DOE attempted to validate the model by conducting two types of volume calculations. The results of the two methods differed significantly but U.S. DOE stated that because the results of the two methods are within one order of magnitude, the results are therefore reasonable. An order of magnitude estimation of surface water infiltration does not appear to be accurate. Because the amount of water infiltrating into the GMA will affect the mass of contaminants entering the GMA and ultimately the concentration of contaminants in the GMA, U.S. DOE should provide additional documentation on the accuracy of its infiltration estimate.

Response: The response to the general comment discusses the relative importance of the predicted infiltration volume resulting from the representative storm event. Because of the conservative assumptions used in the method of predicting the contaminant loading (96 percent of the annual dissolved contaminant released is predicted to reach the GMA) the distribution of the infiltration amount along Paddys Run and the SSOD is more important than the actual infiltration volume.

The Surface Water Flow and Infiltration Model (SWF&IM) Summary Report in actuality only attempted to estimate the volume of infiltration with the VS2DT model. The other method discussed in the report (described as the verification infiltration volume calculation in the SWF&IM report) which simply involved the calculation of the unsaturated pore space beneath the streambed was only intended to be used as a general reference to check the range of the infiltration volume predicted with VS2DT. It was understood that the calculation of the unsaturated pore space beneath the streambed would yield results that are lower than actual infiltration volumes because it did not account for lateral movement of water in the unsaturated zone away from the streambed and it did not account for

TABLE 1

COMPARISON OF MODELED AND MEASURED INCREASE OF PADDYS RUN FLOW DEPTHS

Date of Storm Event	Precipitation Amount IN.[a]	Cross Section C-C		Cross Section E-E	
		Measured Rise in Stream Depth (Stilling Well 9)[b] FT.	Modeled Rise in Stream Depth (STA70)[c] FT.	Measured Rise in Stream Depth (Stilling Well 14)[b] FT.	Modeled Rise in Stream Depth (STAEE)[c] FT.
April 3-4, 1989	1.92	4.06	3.99	5.51	5.35
April 28-29,1989	1.96	2.39	3.13	4.98	4.17

(a) Precipitation amounts from raingauge at the FEMP, except portion of April 28-29 storm which is supplemented with data from the Greater Cincinnati Airport due to missing data from the FEMP raingauge.

(b) Stream depth rise taken from data presented in Groundwater Report, Feed Materials Production Center, U.S. DOE December, 1990.

(c) Stream depth calculated from Paddys Run flow rate predicted with HEC-1 and Mannings equation.

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Appendix E

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ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          1-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.333   0.625   1.100   1.400   1.480   1.800     2.1     2.5
LS           65.4
UK   150.    0.07     0.4     100
RK    500    0.07   0.045    0.06    TRAP       0       1
RK   3200    0.05   0.045    0.47    TRAP       0       1      NO
RK  5200.   0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS           63.7
UK    200   0.075     0.4     100
RK   4500   0.065   0.045   0.132    TRAP       0       1
RK  4800.   0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS             63
UK    200    0.08     0.4     100
RK   3600    0.05   0.045    0.18    TRAP       0       1
RK   6000   0.007   0.045   1.297    TRAP       0       1
RK  10800   0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO             0                1      21
KF    YES(f12.4)
BA 1.288
LS             66
UK    200    0.04     0.4     100
RD   5000    0.02   0.045   0.322    TRAP       0       1
RD                                                           YES
RC 0.045   0.035   0.045    2800   0.002
RX   129     140   141.1   144.1   168.1     190   194.1   196.2
RY566.08  563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO             0                1      21
RD                                                           YES
RC 0.045   0.035   0.045  1599.8   0.004
RX    77      83      86    86.5   120.1     123     126   130.1
RY562.16  559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO             0                1      21
BA 0.282
LS           59.9
UK    200    0.08     0.4     100
RD   4500    0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS           62.6
UK    200    0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUTO
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0               1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0               1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 7OCT,SUB70 AND UPSTREAM FLOW
KO     1       0               1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0               1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0               1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
```

```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                 1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035            TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                 1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030            TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                 1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                 1      21
RD                                                              YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                 1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025            TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                 1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                 1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                 1      21
RD   2613   0.002   0.025            TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                 1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025            TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                 1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS           62.1                    62.11
UK    180     0.1     0.4      30
UK    250   0.018     0.3      70
RD   4000    0.01   0.045   0.412    TRAP       5       1
RD   2773  0.0003   0.025            TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD   3626  0.0025   0.025            TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS           61.9                      69
UK    200     0.2     0.4      50
UK    150    0.03     0.3      50
RD    500    0.04   0.045    0.21    TRAP       0       1
RD  10000   0.009   0.025            TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS           69.4
UK    100    0.28     0.4     100
RD    500     0.2   0.045    0.15    TRAP       0       1
RD   8000   0.021   0.045            TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
```

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ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          5-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.500   1.000   1.500   1.900   2.100   2.400     3.0     3.6
LS          65.4
UK  150.    0.07     0.4     100
RK   500    0.07   0.045    0.06    TRAP       0       1
RK  3200    0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.   0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS          63.7
UK   200   0.075     0.4     100
RK  4500   0.065   0.045   0.132    TRAP       0       1
RK 4800.   0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS            63
UK   200    0.08     0.4     100
RK  3600    0.05   0.045    0.18    TRAP       0       1
RK  6000   0.007   0.045   1.297    TRAP       0       1
RK 10800   0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO            0                1      21
KF   YES(f12.4)
BA 1.288
LS            66
UK   200    0.04     0.4     100
RD  5000    0.02   0.045   0.322    TRAP       0       1
RD                                                          YES
RC 0.045   0.035   0.045    2800   0.002
RX   129     140   141.1   144.1   168.1     190   194.1   196.2
RY566.08  563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO            0                1      21
RD                                                          YES
RC 0.045   0.035   0.045  1599.8   0.004
RX    77      83      86    86.5   120.1     123     126   130.1
RY562.16  559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO            0                1      21
BA 0.282
LS          59.9
UK   200    0.08     0.4     100
RD  4500    0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS          62.6
UK   200    0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT0
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0               1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0               1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 7OCT,SUB70 AND UPSTREAM FLOW
KO     1       0               1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0               1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0               1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
```

```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                 1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035           TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                 1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030           TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                 1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                 1      21
RD                                                              YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                 1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025           TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                 1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                 1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                 1      21
RD   2613   0.002   0.025           TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                 1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025           TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                 1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS           62.1                    62.11
UK    180     0.1     0.4      30
UK    250   0.018     0.3      70
RD   4000    0.01   0.045   0.412    TRAP       5       1
RD   2773  0.0003   0.025           TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD   3626  0.0025   0.025           TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS           61.9                      69
UK    200     0.2     0.4      50
UK    150    0.03     0.3      50
RD    500    0.04   0.045    0.21    TRAP       0       1
RD  10000   0.009   0.025           TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS           69.4
UK    100    0.28     0.4     100
RD    500     0.2   0.045    0.15    TRAP       0       1
RD   8000   0.021   0.045           TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
```

```
ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          10-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                   0.540   1.125   1.900   2.200   2.400   2.900    3.36     4.1
LS           65.4
UK  150.     0.07     0.4     100
RK   500     0.07   0.045    0.06    TRAP       0       1
RK  3200     0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.    0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS           63.7
UK   200    0.075     0.4     100
RK  4500    0.065   0.045   0.132    TRAP       0       1
RK 4800.    0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS             63
UK   200     0.08     0.4     100
RK  3600     0.05   0.045    0.18    TRAP       0       1
RK  6000    0.007   0.045   1.297    TRAP       0       1
RK 10800    0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO             0                1      21
KF   YES(f12.4)
BA 1.288
LS             66
UK   200     0.04     0.4     100
RD  5000     0.02   0.045   0.322    TRAP       0       1
RD                                                            YES
RC 0.045    0.035   0.045    2800   0.002
RX   129      140   141.1   144.1   168.1     190   194.1   196.2
RY566.08   563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO             0                1      21
RD                                                            YES
RC 0.045    0.035   0.045  1599.8   0.004
RX    77       83      86    86.5   120.1     123     126   130.1
RY562.16   559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO             0                1      21
BA 0.282
LS           59.9
UK   200     0.08     0.4     100
RD  4500     0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS           62.6
UK   200     0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP      0       1      NO
•
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0                1      21
HC     3
•
KK ROUT0
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0                1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
•
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0                1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
•
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0                1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
•
KK  ST70
KM COMBINE RUNOFF FROM 7OCT,SUB70 AND UPSTREAM FLOW
KO     1       0                1      21
HC     3
•
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0                1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
•
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0                1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
•
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0                1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
•
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0                1      21
HC     3
•
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0                1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
```

```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                 1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035           TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                 1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030           TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                 1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                 1      21
RD                                                              YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                 1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025           TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                 1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                 1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                 1      21
RD   2613   0.002   0.025           TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                 1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025           TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                 1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0                1      21
BA 0.510
LS          62.1                    62.11
UK   180     0.1     0.4      30
UK   250   0.018     0.3      70
RD  4000    0.01   0.045   0.412    TRAP       5       1
RD  2773  0.0003   0.025            TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD  3626  0.0025   0.025            TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS          61.9                      69
UK   200     0.2     0.4      50
UK   150    0.03     0.3      50
RD   500    0.04   0.045    0.21    TRAP       0       1
RD 10000   0.009   0.025            TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS          69.4
UK   100    0.28     0.4     100
RD   500     0.2   0.045    0.15    TRAP       0       1
RD  8000   0.021   0.045            TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0                1      21
HC      3
ZZ
```

```
ID          Paddy's Run Simulation (06-26-1997/wyu)

ID          25-year return period storm.
*DIAGRAM

IT     10 01JAN97    1200     300
IO      3       0
*
KK SUB10
KM  RUNOFF FROM SUBBASIN 10
KO      1
BA 1.869
PH                  0.625   1.250   2.220   2.700   3.000   3.500    4.10     4.8
LS           65.4
UK  150.     0.07     0.4     100
RK   500     0.07   0.045    0.06    TRAP       0       1
RK  3200     0.05   0.045    0.47    TRAP       0       1      NO
RK 5200.    0.015   0.045            TRAP       0       1
*
KK SUB20

KM RUNOFF FROM SUBBASIN 20
BA 1.589
LS           63.7
UK   200    0.075     0.4     100
RK  4500    0.065   0.045   0.132    TRAP       0       1
RK 4800.    0.015   0.045            TRAP               1     YES
*
KK SUB30
KM RUNOFF FROM SUBBASIN 30 40 AND 41
BA 5.188
LS             63
UK   200     0.08     0.4     100
RK  3600     0.05   0.045    0.18    TRAP       0       1
RK  6000    0.007   0.045   1.297    TRAP       0       1
RK 10800    0.003   0.045            TRAP      20       1     YES
*
KK SUB50
KO             0                1      21
KF   YES(f12.4)
BA 1.288
LS             66
UK   200     0.04     0.4     100
RD  5000     0.02   0.045   0.322    TRAP       0       1
RD                                                            YES
RC 0.045    0.035   0.045    2800   0.002
RX   129      140   141.1   144.1   168.1     190   194.1   196.2
RY566.08   563.07     560  559.03  559.03  561.17  562.12  564.07
*
KKROUT60
KM ROUTE FROM CROSS SECTION A-A TO B-B
KO             0                1      21
RD                                                            YES
RC 0.045    0.035   0.045  1599.8   0.004
RX    77       83      86    86.5   120.1     123     126   130.1
RY562.16   559.17     555  551.98  551.98  554.16     555     560
*
KK SUB60
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC B-B
KO             0                1      21
BA 0.282
LS           59.9
UK   200     0.08     0.4     100
RD  4500     0.04    0.03            TRAP       0       1      NO
*
KK SB560
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC B-B
KM ENCOMPASSES NPDES OUTFALL STRM 4
KO      1       0                1      21
BA 0.317
LS           62.6
UK   200     0.10     0.4     100
```

```
RD  4800    0.01    0.04            TRAP       0       1      NO
*
KK  ST60
KM COMBINE RUNOFF FROM SUB60,SB560, AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT0
KM ROUTE FROM CROSS SECTION B-B TO C-C
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2986   0.004
RX  11.3    53.7      85    95.9   119.8   168.8   179.7   194.6
RY   551     551     550     540     540     545     550     555
*
KK SUB70
KM SUBBASIN FLOW FROM WEST SIDE OF PADDYS RUN TO X-SEC C-C
KO             0               1      21
BA 0.121
LS          62.4
UK   200   0.010     0.4     100
RD  4600   0.013   0.045            TRAP       0       1
*
KK SB570
KM SUBBASIN FLOW FROM EAST SIDE OF PADDYS RUN TO X-SEC C-C
KM ENCOMPASSES NPDES OUTFALL STRM 3
KO     1       0               1      21
BA 0.120
LS          76.7
UK   200   0.017    0.25     100
RD  1800   0.017   0.030            TRAP       0       1
*
KK  ST70
KM COMBINE RUNOFF FROM 70CT,SUB70 AND UPSTREAM FLOW
KO     1       0               1      21
HC     3
*
KK ROUT1
KM ROUTE FROM CROSS SECTION C-C TO D-D
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    3093   0.003
RX   100   109.2    125.   134.2   151.1     163   195.9     200
RY541.07    540.   532.1   531.3   531.3     535     565   566.4
*
KK SUB75
KM SUBBASIN FLOW FROM THE WEST SIDE OF PADDYS RUN TO X-SEC D-D
KO             0               1      21
BA 0.288
LS          67.6
UK   150    0.15    0.40     100
RD  4000   0.013   0.045            TRAP       5       1
*
KK SB575
KM SUBBASIN FLOW FROM THE EAST SIDE OF PADDYS RUN
KM AREA ENCOMPASSES NPDES OUTFALL STRM 2
KO     1       0               1      21
BA 0.120
LS          69.8
UK   100   0.030    0.40     100
RD   650   0.067   0.045            TRAP       0       1
*
KK  ST75
KM COMBINE RUNOFF FROM TB75 AND UPSTREAM
KO     1       0               1      21
HC     3
*
KK ROUT2
KM  ROUTE FROM CROSS SECTION D-D TO E-E
KO     1       0               1      21
RD                                                              YES
RC 0.045   0.025   0.045    2773   0.002
```

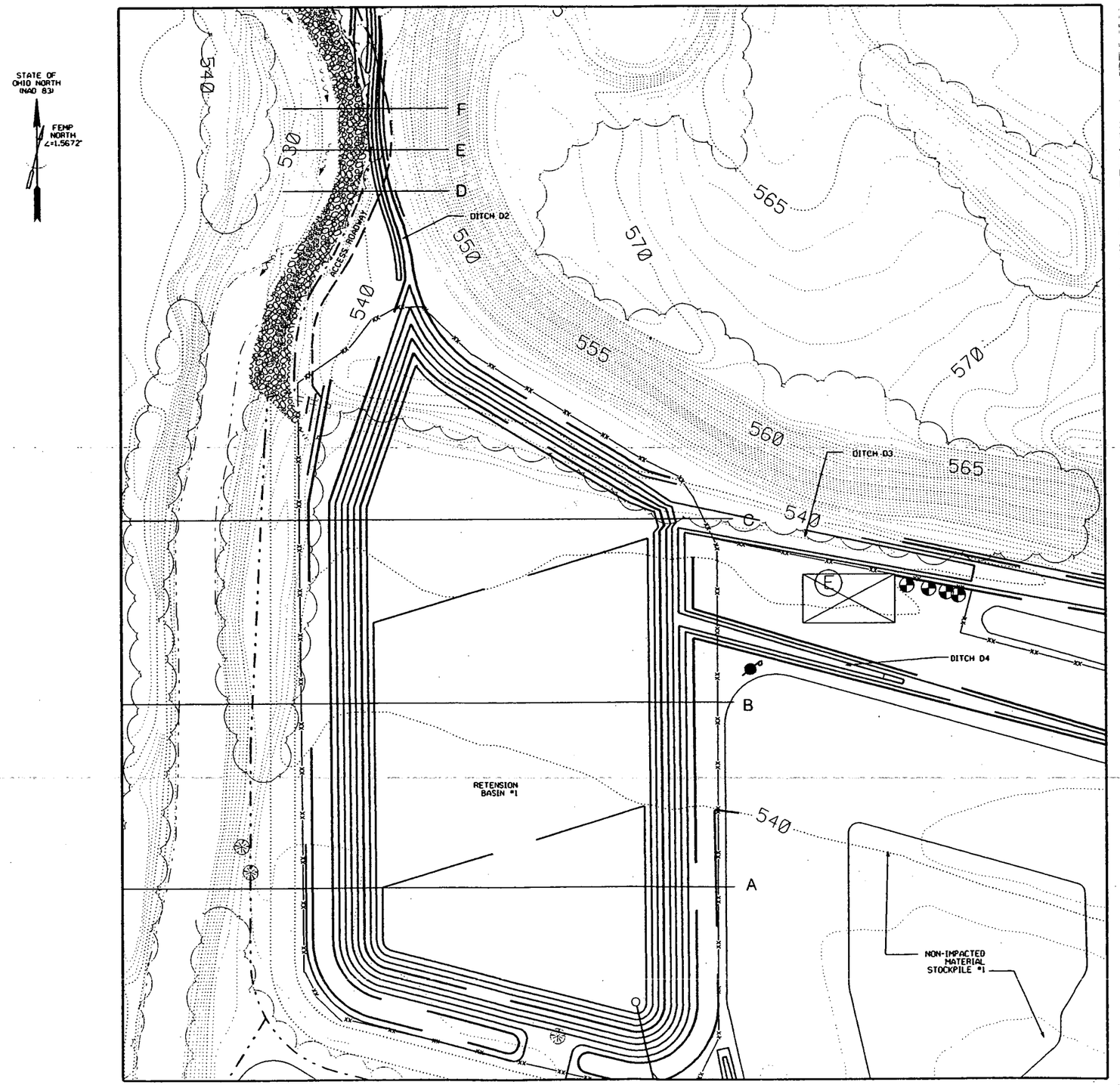
```
RX      0    82.3      93   102.9     129     150     200   237.8
RY    533     532   531.2     525     525     530     535     536
*
KK SB580
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH FROM THE RETENTION BASIN TO
KM CROSS SECTION J-J
KO      1       0                 1      21
BA 0.036
LS           71.9
UK    100   0.010    0.25     100
RD    500   0.100    0.04   0.020    TRAP       0       1
RD    600   0.010   0.035           TRAP       5       1
*
KK SB581
KM RUNOFF TO THE STORM SEWER OUTFALL DITCH ABOVE THE RETENTION BASIN
KO      1       0                 1      21
BA 0.456
LS           69.4
UK    200   0.025    0.25     100
RD   1000   0.020    0.04   0.080    TRAP       0       1
RD   3300   0.012   0.030           TRAP       5       1
*
KK  STJJ
KM COMBINE RUNOFF FROM PRODUCTION AREA AND SB581
KO      1       0                 1      21
HC      2
*
KK ROT80
KM  ROUTE FROM RET. BASIN TO OUTFALL OF SSOD XSEC J-J TO K-K
KO      1       0                 1      21
RD                                                              YES
RC 0.035   0.035   0.035    1300   0.009
RX  360.    370.    372.    378.    380.    390.    395.    420.
RY 544.4   539.4   539.4   539.4   539.4   539.4   539.4   544.4
*
KK SB582
KM RUNOFF FROM SB582 (LOWER STORM SEWER OUTFALL DITCH)
KO      1       0                 1      21
BA 0.487
LS           66.5
UK    200   0.025     0.3     100
RD   3600   0.022   0.045    0.33    TRAP       5       1
RD   3800   0.015   0.025           TRAP      26    2.27
*
KK  ST80
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND SB582
KM THIS POINT COORISPONDS TO NPDES OUTFALL STRM 1
KO      1       0                 1      21
HC      2
*
KK  STEE
KM COMBINE RUNOFF FROM STORM SEWER OUTFALL DITCH AND PADDY'S RUN
KO      1       0                 1      21
HC      2
*
KKROUT25
KM ROUTE FROM CROSS SECTION E-E TO F-F
KO              0                 1      21
RD   2613   0.002   0.025           TRAP    52.8    4.55     YES
*
KKSUB130
KM RUNOFF FROM SUBBASIN 130
KO              0                 1      21
BA 1.385
LS           68.2
UK    200   0.033     0.4     100
RD   5000   0.016   0.045   0.588    TRAP       5       1
RD   1800    0.02   0.025           TRAP    52.8    4.55
*
KK ST130
KM  COMBINE RUNOFF FROM FROM SUB130 TO PADDY'S RUN.
KO      1       0                 1      21
```

```
HC      2
*
KKSUB100
KM RUNOFF FROM SUB100 AND ROUTE FROM CROSS SECTION F-F TO G-G
KO              0              1      21
BA 0.510
LS          62.1                  62.11
UK   180     0.1     0.4      30
UK   250   0.018     0.3      70
RD  4000    0.01   0.045   0.412    TRAP       5       1
RD  2773  0.0003   0.025           TRAP    27.2   26.32     YES
*
KK ROUT3
KM ROUTE FROM CROSS SECTION G-G TO H-H
RD  3626  0.0025   0.025           TRAP    63.6    7.30     YES
*
KKSUB110
KMRUNOFF FROM SUB110
BA 0.823
LS          61.9                     69
UK   200     0.2     0.4      50
UK   150    0.03     0.3      50
RD   500    0.04   0.045    0.21    TRAP       0       1
RD 10000   0.009   0.025           TRAP      20    3.33
*
KKSUB120
KM RUNOFF FROM SUB120
BA 0.561
LS          69.4
UK   100    0.28     0.4     100
RD   500     0.2   0.045    0.15    TRAP       0       1
RD  8000   0.021   0.045           TRAP      20    3.33
*
KK ST120
KM COMBINE RUNOFF FROM SUB110 AND SUB220 TO PADDY'S RUN
KO              0              1      21
HC      3
ZZ
```

APPENDIX D

Additional Sketches of Paddys Run

skg04548.m po165@ws316. Wed Aug 27 12:30:52 CDT 1997



NOTES

1121

FOR INFORMATION ONLY

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERNCO	DATE
		INITIALS AND DATE		

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

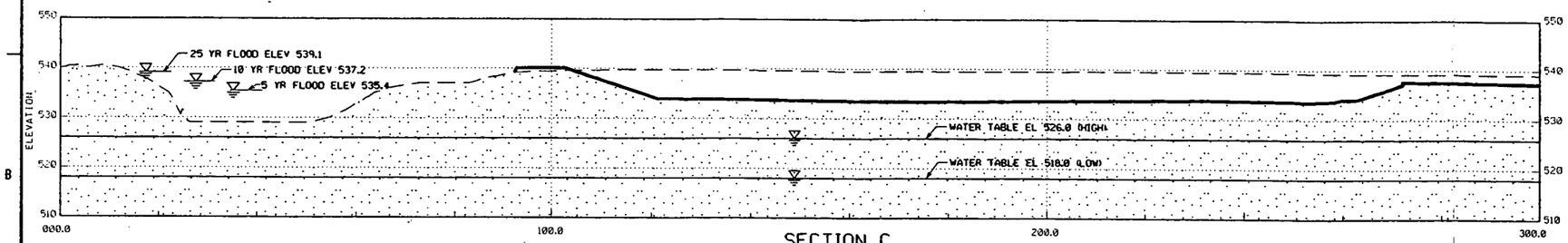
PROJECT NAME
WASTE UNITS REMEDIATION
SOUTHERN WASTE UNITS

DRAWING TITLE
SKETCH #1

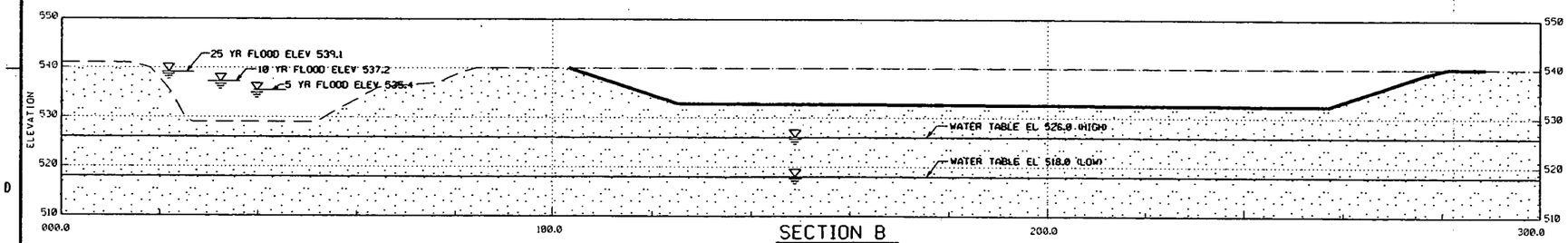
DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
PLANT/BLDG NO.		FLOOR		SCALE 1"=20'	CLASS
SUBMITTED FOR APPROVAL		FERNCO CRU APPROVAL			

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	A-E DOE PROJECT NO.	FEMP PROJECT NO.	DRAWING INDEX CODE NO.	SHEET NO.	REV. NO.
		00-90701	SK-G-04548		A

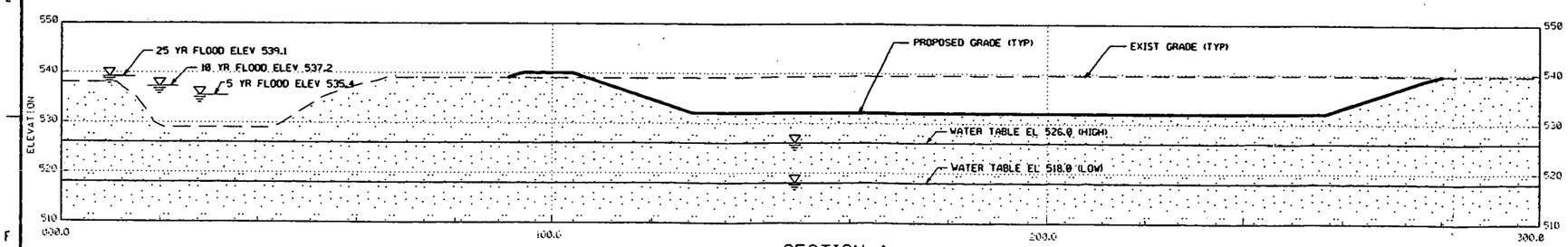
skg04548.m po165@ws316. Wed Aug 27 15:50:21 CDT 1997



SECTION C
SCALE: HOR 1"=10'
VER 1"=10'



SECTION B
SCALE: HOR 1"=10'
VER 1"=10'



SECTION A
SCALE: HOR 1"=10'
VER 1"=10'

GRAPHIC SCALE: 1"=10' VERTICAL

GRAPHIC SCALE: 1"=10' HORIZONTAL

PREPARED UNDER PARSONS PROJECT ORDER NUMBER

NOTES

1. THE 5 YEAR, 10 YEAR, AND 25 YEAR FLOOD ELEVATIONS ARE FROM FDF HYDROLOGICAL MODEL CROSS - SECTION C'-C'.

1121

LEGEND:

- EXISTING GROUND
- EXCAVATION GRADE LINE
- WATER TABLE (AVERAGE)
- GREAT MIAMI AQUIFER

THE 5 YEAR, 10 YEAR, AND 25 YEAR FLOOD ELEVATIONS WERE PROVIDED BY FDF.

FOR INFORMATION ONLY

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERNCO	DATE
		INITIALS AND DATE		

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
WASTE UNITS REMEDIATION
SOUTHERN WASTE UNITS

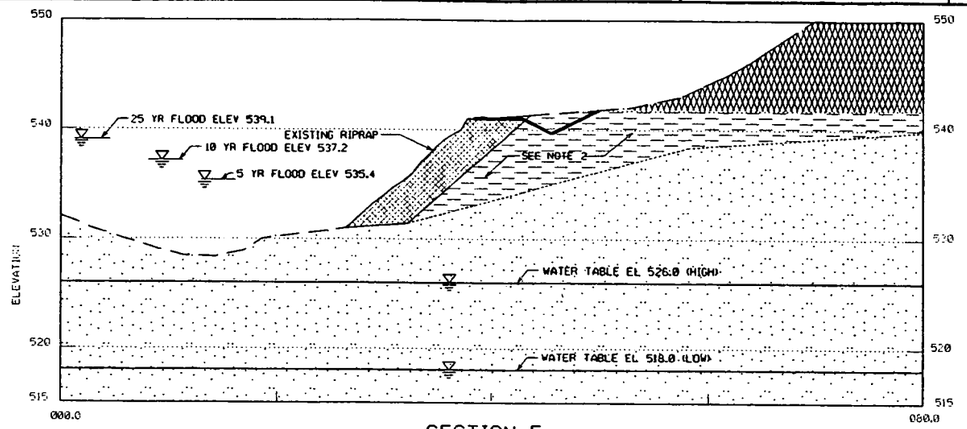
DRAWING TITLE
SKETCH #2

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
PLANT/BLDG. NO.		FLOOR		SCALE 1"=10'	CLASS
SUBMITTED FOR APPROVAL		FERNCO CRU APPROVAL			
A-E	DATE		DATE		

DOE PROJECT NO.	FEMP PROJECT NO.	DRAWING PROJ. CODE NO.	SHEET NO.	REV. NO.
	00-90701	SK-G-04548		A

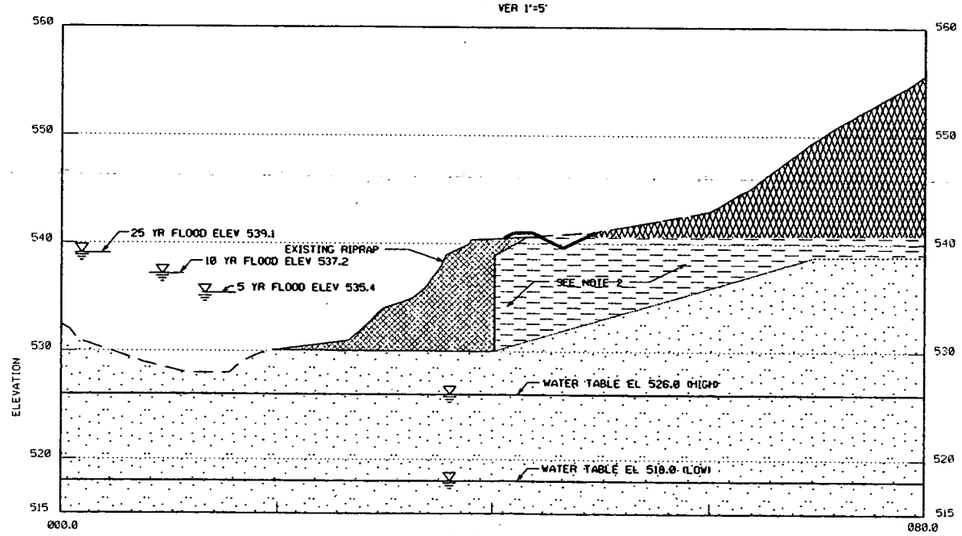
000362

skg04548.m po165@ws316. Wed Aug 27 15:43:55 CDT 1997



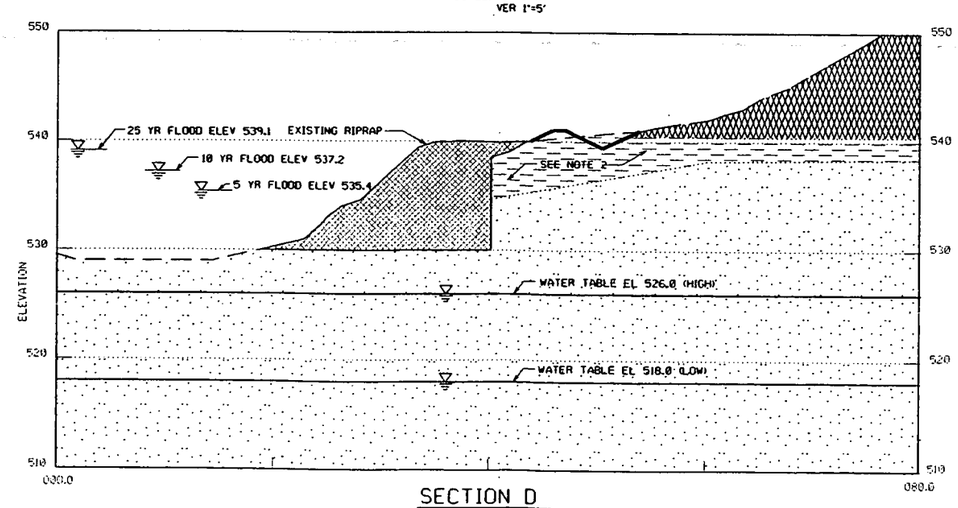
SECTION F

SCALE: HOR 1"=5'
VER 1"=5'



SECTION E

SCALE: HOR 1"=5'
VER 1"=5'



SECTION D

SCALE: HOR 1"=5'
VER 1"=5'

NOTES

1. THE 5 YEAR, 10 YEAR, AND 25 YEAR FLOOD ELEVATIONS ARE FROM FDF HYDROLOGICAL MODEL CROSS - SECTION C'-C'.
2. GEOLOGY ADJACENT TO RIPRAP BASED ON FIELD OBSERVATIONS AND INTERPOLATION FROM SUBSURFACE INVESTIGATIONS.

1121

LEGEND:

- EXISTING GROUND
- EXCAVATION GRADE LINE
- WATER TABLE
- SAND/GRAVEL
- GLACIAL OVERBURDEN/TILL
- GREAT MIAMI AQUIFER
- RIPRAP
- ASH

GRAPHIC SCALE: 1"=5'
VERTICAL

GRAPHIC SCALE: 1"=5'
HORIZONTAL

FOR INFORMATION ONLY

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERNCO	DATE
		INITIALS AND DATE		

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
WASTE UNITS REMEDIATION
SOUTHERN WASTE UNITS

DRAWING TITLE
SKETCH #3

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
PLANT/BLDG. NO.		FLOOR		SCALE 1"=5'	CLASS
SUBMITTED FOR APPROVAL		FERNCO CRU APPROVAL			
A-E	DATE		DATE		

DOE PROJECT NO.	TEMP PROJECT NO.	DRAWING SERV. CODE NO.	SHEET NO.	REV. NO.
	00-90701	SK-G-04548		A

PREPARED UNDER PARSONS PROJECT ORDER NUMBER