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Surface Water Management Plan for Remediation Area 1, Phase II

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Fernald, Ohio
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PARSONS

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Surface Water Management Plan
for
Remediation Area 1, Phase II

2049

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LIST OF ACRONYMS AND ABBREVIATIONS

A1PI	Area 1, Phase I
A1PII	Area 1, Phase II
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
HDPE	High Density Polyethylene
NPDES	National Pollutant Discharge Elimination System
ODNR	Ohio Department of Natural Resources
OSDF	On-Site Disposal Facility
STP	Sewage Treatment Plant
SWMP	Surface Water Management Plan
SWPPP	Stormwater Pollution Prevention Plan

EXECUTIVE SUMMARY

This Surface Water Management Plan (SWMP) addresses surface water management of the Area 1, Phase II (A1PII) project area during remediation activities. This SWMP addresses control/management of erosion and sedimentation, stormwater runon and runoff, accumulations of perched water and stormwater in the Sewage Treatment Plant (STP) and STP influent/effluent pipeline excavations, and other surface water issues for A1PII.

The A1PII project consists of demolition of below grade structures, removal of subsurface utility lines, and excavation at the Sewage Treatment Plant (STP); demolition of concrete pads, and excavation of lead contaminated soils at the former Trap Range Area; surface stripping around the STP excavation area (see Construction Drawings for location); and miscellaneous activities including removal of agricultural drain tiles, and removal of sediments from existing sediment basins used during the Area 1, Phase I (A1PI) remedial activities. The remediation of A1PII involves removal of approximately 50,000 bank cubic yards of impacted material.

Three sediment basins will be used in the A1PII project to manage surface water and collect sediments during remediation. Sediment Basin 1 will be a new basin constructed to accommodate runoff from the STP and Trap Range excavation areas. A minimum of 27 cubic yards per acre watershed area of sediment storage will be provided in this basin. Stormwater collected in the basins will discharge through a principal spillway structure and outlet channel into an existing drainageway which conveys runoff from the southern portion of the plant to Paddys Run. Sediment Basin 2 is an existing basin presently used by the On-Site Disposal Facility (OSDF). This basin, along with associated drainage ditches, will be used for activities in the northeastern portion of the project area. Sediment Basin 3 is an existing basin which was used during A1PI remediation activities. Sediment Basin 3, along with associated drainage ditches, will be used for activities in the northwestern portion of the project area. There are small, isolated activities, consisting of sediment removal from two existing A1PI basins, and removal of an existing gravel staging area, where surface runoff cannot be directed to sediment basins. Perimeter silt fence will be used for sediment control for these areas.

The overall operation of the surface water management system was planned and designed to minimize erosion and provide means to collect and control runoff from remediation areas. Upon completion of remediation activities, the deep excavation area at the STP will be backfilled to the approximate original contour. Areas that receive surficial stripping will not be backfilled. All areas disturbed will be regraded to provide positive drainage and will be revegetated.

SECTION 1

INTRODUCTION AND AREA 1, PHASE II 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 mission of the facility was to provide high-purity uranium metal products to support United States defense programs. Production operations were discontinued in 1989. Subsequently, the United States Department of Energy (DOE) decided to decontaminate and dismantle the facility and began environmental remediation of the site.

To facilitate management of the environmental remediation activities, the site was divided into seven sitewide remediation areas. Several of these areas will be remediated in phases. Area 1 is subdivided into two major phases (Phase I and Phase II). Remediation of A1PI was completed in March 1997.

The A1PII project area encompasses approximately 153 acres and is located in the southeastern part of the FEMP. It is bordered on the east and south by the FEMP boundary; on the west by the South Access Road, an unnamed stream and former production area.; and on the north by A1PI, and the OSDF. The terrain in the project area is rolling pasture. The STP and Phase I of the North Entrance Road are either partially or completely located in this area. A former trap shooting range is also located in the area. The remediation activities within the A1PII project will include: demolition of below grade structures, removal of subsurface utility lines, and excavation at the STP; demolition of concrete pads, and excavation of lead contaminated soils at the former Trap Range Area; surface stripping around the STP excavation area (see Figure 1-1, and Construction Drawings for locations); and miscellaneous activities including removal of agricultural drain tiles, and removal of sediments from existing sediment basins used during the A1PI remedial activities.

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 A1PII.

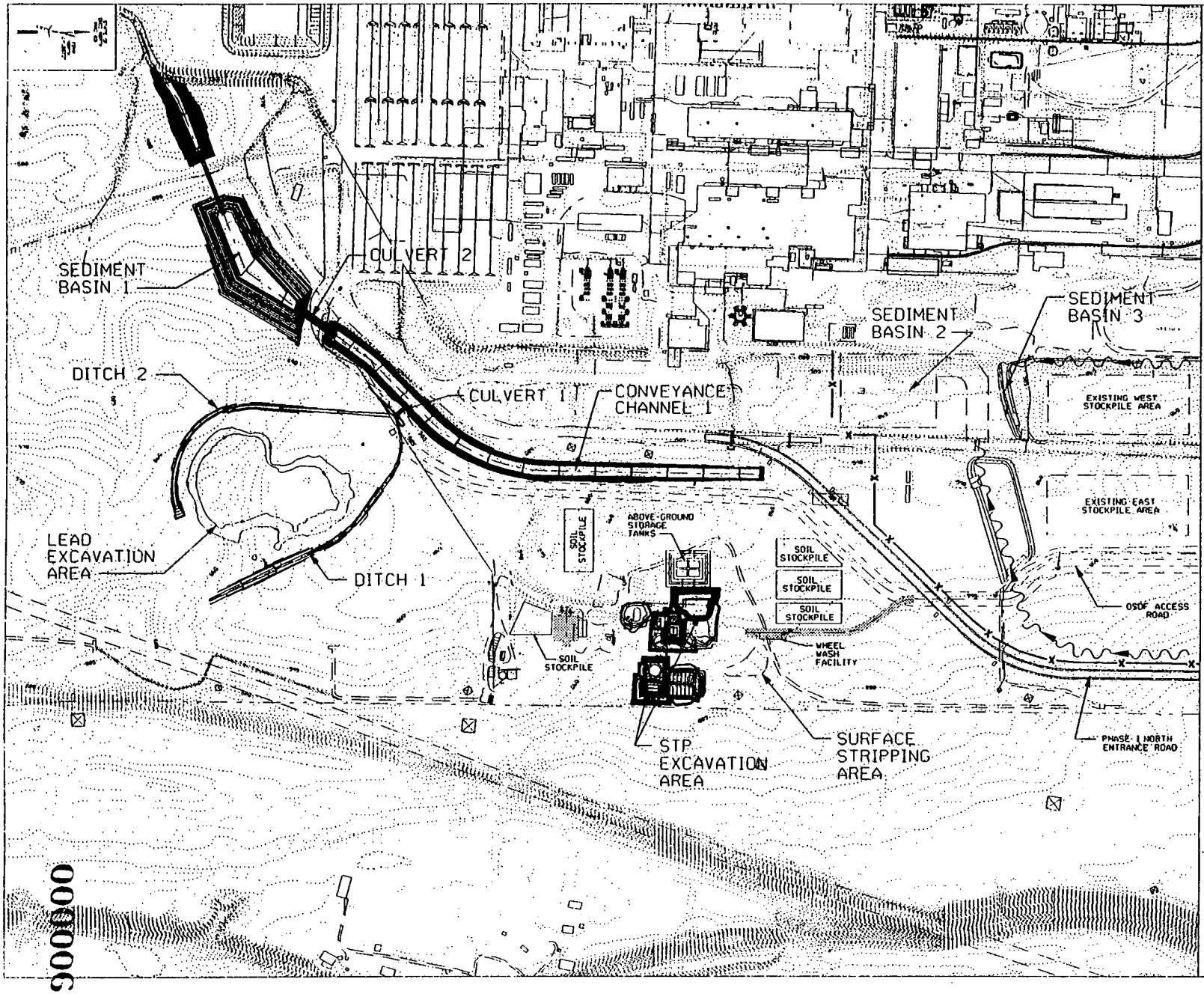

FIGURE 1-1

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Stormwater and 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. 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 A1PII project,

Description of the A1PII proposed surface water management system.

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.

SECTION 2

SURFACE WATER MANAGEMENT SYSTEM

2.1 Overall Approach

The principal objectives of surface water management in the A1PII project area 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. The project area covers approximately 153 acres. The topography is gentle to rolling pasture land. Existing drainage consists of mainly sheet flow that is uncontrolled before reaching existing conveyance channels. Drainage flows through the A1PII area in a south and westerly direction and eventually empties into Paddys Run via a storm sewer outfall ditch.

Runon from upgradient areas will be prevented, where possible, from flowing into the remediation area. This will minimize the possibility of erosion and limit the amount of potentially contaminated water.

Existing drainage patterns and facilities will be used for stormwater management, wherever possible, by implementing improvements to convey design flows. Incorporating erosion control measures and revegetation will 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. Sediment basins will be used to provide detention time for sediments to settle out. Where runoff cannot be directed to sediment basin, silt fence will be used to filter-out sediments.

Water collected in the STP excavation area may be contaminated. Therefore, all water collected within the STP excavation will be stored in surface storage tanks, or retained within the open excavation area. Water samples will be collected and analyzed to determine the appropriate disposition.

2.2 Surface Water

Precipitation not collected in excavation areas will be classified as surface water. Surface water which flows through the A1PII area will be collected and transported to sediment basins where practicable. Diversions (berms, ditches) will be used to divert surface water around the excavation where possible.

Surface water runoff from the STP and Trap Range excavation areas will be conveyed to a new sediment basin designated as Sediment Basin 1. Runoff from activities in the northern portion of the A1PII project area will utilize two existing sediment basins (designated as Sediment Basins 2 & 3) to control sediment. Sediment Basin 2 is approximately 2 acres in size, and is currently being used as the sediment basin for OSDF construction activities. Sediment Basin 3 is located just north of Sediment Basin 2, and is approximately one-half acre in

size. This basin was used previously during the A1PI remediation activities. There is an isolated area south of Sediment Basin 2 which will require soil stripping. Due to the relatively small size (approximately 1.5 acres) and flat topography, runoff from these areas will be directed to perimeter silt fencing.

2.3 Specific System Components

Specific components of the surface water management system are described below. See the construction drawings and technical specifications for detailed design information concerning stormwater controls. See Appendix A for design calculations. A drainage area map is presented in Appendix B.

2.3.1 Diversion Ditches and Related Devices

Runon from upgradient areas will be collected and diverted, where possible, around the remediation areas.

2.3.2 Excavation Sumps

The STP area of excavation will be graded to drain to field located collection points 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 above-grade storage tanks for analysis. Multiple sumps/pumps may be used for dewatering of the excavation area. They may be moved as the excavation progresses or as necessary to collect water from specific areas, based on the contaminates or construction requirements.

2.3.3 Above-Ground Storage Tanks

A series of above-ground, bladder-type, storage tanks with a total storage volume of 100,000 gallons, will be located adjacent to the STP excavation area. The tanks will be set within a compacted clay diked area. The diked area is sized to store the entire tank storage volume (100,000 gallons) in addition to the volume of direct precipitation resulting from a 10-year, 24-hour event. The bottom of the diked area will be sloped to a sump. Rainwater collected in the sump will be pumped to one of the storage tanks.

2.3.4 Transfer Line

Water removed from the STP excavation area, which analysis determines is acceptable for Advanced Water Treatment Facility (AWWT) Phase I treatment, will be transferred via two sections of new HDPE piping, and the use of a section of existing 12-inch effluent line. This line will originate at the temporary storage tanks and run westward to an existing manhole within the production area (See Construction Drawings). Once in the storm sewer system, water is directed to the Stormwater Retention Basin for storage until subsequent transfer to the AWWT.

2.3.5 Equipment Decontamination Facility

An Equipment Decontamination Facility will be constructed north of the STP excavation area. It will be used to remove mud and debris from the wheels and undercarriage of haul vehicles. Water from the collection sump will be pumped to one of the above ground storage tanks and treated as excavation sump water. See Section 2.3.2

2.3.6 Sediment Basin 1

The proposed (during excavation conditions) watershed is approximately 74 acres in size. Runoff will be collected and conveyed to the new sediment basin (see Construction Drawings and calculations) via Conveyance Channel 1. The sediment basin will be located adjacent to the South Access Road, and will cover approximately 2.0 acres of surface area.

The sediment basin will be designed in accordance with the Ohio Department of Natural Resources' (ODNR) *"Rainwater and Land Development Manual"* as a minimum. The required storage capacity for the sediment basin and sediment trap are given as follows:

Sediment Basin

Watershed Area = 74.0 Acres
Total Storage Required = 3.1 Acre-Feet
Sediment Storage Required =1.2 Acre-Feet

The OSDF originally planned a sediment basin in the same location to accommodate the development of the OSDF Borrow Area. A preliminary borrow area grading plan and sediment basin design have been submitted as part of the OSDF Drawings to the Ohio Environmental Protection Agency. Since the A1PII project is scheduled to be completed just prior to beginning development of the OSDF Borrow Area, the goal is to prevent duplication in the construction of two sediment basins. The A1PII will provide a sediment basin which

will accommodate the A1PII remediation activities, while providing OSDF with a sediment basin that can be modified to accommodate future activities..

Since the OSDF borrow area grading plan and geometry of the sediment basin are interrelated, the OSDF sediment basin geometry will be used as much as possible. A review of the OSDF Borrow Area sediment basin design reveals that the basin was designed according to *"Water Management and Sediment Control for Urbanizing Area"* (USDA-SCS, 1987). This basin is an excavated basin with 100 percent drawdown (i.e., dry basin) and has a combination principal/emergency outlet control spillway structure.

Sediment basin requirements specified in the ODNR "*Rainwater and Land Development Manual*" will be used for A1PII remediation activities. With the basin geometry defined, an outlet control structure will be designed for the A1PII remediation work which will meet total volume and sediment storage requirements. In anticipation of modifications that may be needed for future OSDF use, a second riser/barrel outlet structure will be installed during basin construction. When A1PII activities are completed, the outlet control structures can be modified as needed by the OSDF project.

2.3.7 Sediment Basin 2

The northeast portion of the project area is currently draining into the existing OSDF sediment basin (Sediment Basin 2) and ditch system. During remediation activities (i.e., removal of OSDF East Impacted Stockpile) runoff will continue to drain into this ditch/basin system. This basin/ditch system will be removed after A1PII activities are completed and the area certified.

2.3.8 Sediment Basin 3

The northwest portion of the project area is currently draining into an existing sediment basin used for A1PI remediation activities. During remediation activities under A1PII, which includes removal of the OSDF West Impacted Stockpile, runoff will continue to flow into this sediment basin.

2.3.9 Conveyance Channel

A conveyance channel will be constructed west of the STP excavation area to intercept and convey runoff from the A1PII project area south of the North Entrance Road to Sediment Basin 1. The conveyance channel will be grassed-lined using an erosion control blanket and will be designed to accommodate a 10-year, 24 hour precipitation event with a maximum velocity in the channel of 3 feet per second. The conveyance channel will remain after A1PII remediation has been completed in anticipation of future modification and use by the OSDF. Diversion Ditch 1 will be constructed downgradient around the Trap Range area to collect and convey runoff to Sediment Basin 1. Diversion Ditch 2 will be constructed upgradient of the Trap Range area to minimize surface water run-on.

2.3.10 Culverts

At the STP Access Road, a series of culverts will be installed to carry flow from the conveyance channel to Sediment Basin 1. The culverts will pass underneath an existing 24" diameter groundwater line and will be located such that the future road construction under Phase II of the North Entrance Road rerouting will not disturb the culverts.

There are several locations where temporary access is required which will need small culverts to maintain positive drainage.

SECTION 3

STORMWATER MANAGEMENT

The goal of FEMP stormwater management on a sitewide basis is to prevent a significant increase in the peak runoff during remediation and restoration activities. Stormwater management as described in this SWMP addresses the peak runoff that discharges from the site during construction/remediation activities.
The A1PII project site is currently vegetated and consists of sheet flow and shallow concentrated flow in the upper watershed areas, leading to concentrated flows in the existing stormwater conveyance ditch, located east of the production area. All runoff from the A1PII project area 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, where possible, and collect and convey runoff from the site for storm events up to the 10-year, 24-hour storm. Since the majority of runoff from the site will be diverted to sediment basins, the peak runoff from the site to Paddys Run should not increase significantly.

As part of the remediation, the STP excavation area will be restored to the approximate original topography. Areas where surficial stripping occurs will not be backfilled. Instead, surface stripped areas will be graded to provide positive drainage. Initial land use after remediation will be undeveloped with a vegetated cover. Based on an undeveloped land use scenario, the total amount of runoff from the A1PII project site after remediation can be expected to be similar to the current conditions. Stormwater management for future land use of the A1PII project area is beyond the scope of this plan.

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 Contractor 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, and
removal of sediment prior to discharge.

Erosion and sediment control measures incorporated into the A1PII project incorporate applicable State, Federal, DOE, and FEMP requirements. The FEMP standards for erosion and sediment control follow the 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.

Runoff from the STP and Trap Range excavation areas will be directed to a new sediment basin (Sediment Basin 1) located adjacent to the South Access Road. Runoff from activities in the northeast portion of the project area will be directed to the existing OSDF sediment basin (Sediment Basin 2) and ditch system. Runoff from activities in the northwest portion of the project area will be directed to the existing A1PI sediment basin (Sediment Basin 3) and ditch system. Sediment control for isolated stripping activities south of Sediment Basin 2 and for the sediment removal activities for the A1PI basins will consist of perimeter silt fence.

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 the sediment basin. 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 manufacturer's recommendations. The locations presented on the construction drawings for the project areas are considered the minimum necessary during construction. Intermediate silt fencing may be used by the Contractor to control and slow down flows in active excavation areas. The Contractor will install breaks and overlaps in the silt fencing to allow vehicle access to the construction areas.

Inspection and maintenance 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 will be stabilized by applying a crusting agent within 7 days. Temporary measures will help to stabilize exposed soil and limit erosion. As construction progresses, areas containing the crusting agent will be left in place until final seeding or until construction resumes.

4.2.3 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.

4.2.4 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.

4.2.5 Dumped Rock

The outlet channel from the Sediment Basin 1 will be lined with dumped rock to protect against erosion from excessive velocities. The slopes around the inlet and outlet of the culverts at the STP Access Road will be lined with dumped rock. Additionally, a dumped rock apron will be installed at the inlet and outlet of these culverts to prevent scouring.

4.3 Design Criteria and Standards

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

4.3.1 Sediment Basin 1

Minimum total volume - determines invert elevation of principal riser and is based on 67 cubic yards per watershed acre in accordance with ODNR *"Rainwater and Land Development"*.

Maximum sediment cleanout elevation - determines maximum cleanout elevation and is based on 27 cubic yards per watershed acre in accordance with ODNR *"Rainwater and Land Development"*.

A basin designed to store less than 15 acre-feet at elevation where water would overflow embankment.

Principal spillway structures - 2 riser/barrel structures consisting of a 48-inch riser with a 36-inch spool piece, which enlarges to a 48-inch barrel. The 10-year, 24-hour storm event is routed through outlet structures to evaluate performance under worst case conditions for A1PII. Spillway hydraulics evaluated by examining head losses through system (i.e., entrance, bend, enlargement, friction, and velocity). A tailwater condition was assumed using a 16-foot bottom width, 3H:1V side slopes, 0.8 percent channel slope, and a uniform flow depth of 2.85 feet (250 cfs).

(Note that the second principal spillway structure was added to provide additional capacity if OSDF elects to add to the drainage area beyond that for the A1PII basin. No analysis was performed for any additional areas and will be the responsibility of others).

A defined emergency spillway will not be constructed for Sediment Basin 1 due to the close proximity of the existing South Access Road. Instead, emergency overflow (should an overflow situation ever arise), will flow in a northwest direction over the South Access Road.

4.3.2 Culverts

Culvert 1 is a series of three pipes which convey drainage from the Trap Range underneath the gravel road leading to the STP. This culvert will be designed for the 10-year, 24-hour storm event.

Culvert 2 is a series of 5 pipes used to convey flow from Conveyance Channel 1 into Sediment Basin 1. In anticipation of future use by the OSDF, Culvert 2 is designed to carry 250 cfs (10-year peak flow = 99 cfs) with an assumed tailwater elevation (height above outlet invert) at 575.0. Culvert 2 is located to pass approximately 2 feet below existing 24-inch diameter groundwater line. Additionally, Culvert 2 is also located so that Phase II of the North Entrance Road can be constructed without disturbing the pipes.

4.3.3 Conveyance Channel

Channel designed to convey 10-year, 24 hour peak runoff from A1PII at a velocity which allows erosion control mat lining without using check dams (i.e., less than 3 fps).

4.3.4 Silt Fence

Silt fence criteria is as specified in ODNR *Rainwater and Land Development*.

SECTION 5

IMPLEMENTATION

Because of the large expanse of area that will be impacted by remediation, 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 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. The Contractor will be required to periodically remove sediments from silt fences, drainage ditches, and sediment basins to maintain desired performance. Sediment removed from silt fences, drainage ditches, and sediment basins will be managed as impacted material and disposed of in the OSDF.

Any area left exposed for more than 45 consecutive days without any immediate plans for future work will be stabilized using a crusting agent (see construction drawings for proposed stormwater and sediment controls). Areas will also be stabilized to the extent practical prior to winter shutdown.

5.1 General Construction Practices

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

Contractor's management strategies,
construction conditions,
seasonal and weather conditions.

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

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

Disturbed/exposed areas will be excavated as quickly as practical. Disturbed areas which will remain unworked for 45 consecutive days or greater will be stabilized with a crusting agent within 7 days.

All erosion and sediment control measures shall be maintained and/or modified or supplemented as approved by FDF in accordance with the ODNR reference during construction to comply with this plan.

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

5.2 Construction Sequencing

The following sections discuss the general erosion control sequencing.

5.2.1 General Erosion Control Sequencing (Prior to Impacted Material Excavation)

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 6 inches of soil (if not certified below Final Remediation Levels (FRLs) by FDF) from areas designated for Sediment Basin 1 construction as noted on the construction drawings.

Step 4. Complete excavation of sediment basin to lines and grades shown on the plans.

Step 5. Install risers, barrels, as shown on the Construction Drawings.

Step 6. Divert flow into Sediment Basin 1 by constructing the conveyance channel and diversion ditches.

Step 7. Construct wheel wash pad and associated devices.

5.2.2 Impacted Material Excavation Sequencing

Step 1. Establish site boundaries and access controls.

Step 2. Confirm that surface water controls are 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 disturbed areas flows to the sediment basins or through silt fence.

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

Step 6. Upon certification that soils remaining in the remediation area meet FRLs, perform restoration grading where required, install stabilization blankets and apply seed and mulch to all disturbed areas.

Step 7. Upon verification that the excavation meets FRLs and has an established stand of vegetation, remove accumulated sediments from the sediment basins and silt fences.

Step 8. Install temporary erosion and sedimentation controls for removal of sediments from sediment basins.

Step 9. Upon certifying that the sediment basin meets FRLs, remove the associated barrel, riser, and spillway backfilled, seeded, and mulched.

Step 10. 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

EROSION AND SEDIMENT CONTROLS/ INSPECTION AND MAINTENANCE

6.1 Inspection

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

Disturbed areas and areas used for storage of materials that are exposed to the elements will be inspected for evidence of, or for the potential of, pollutants entering local drainage systems. Locations where vehicles exit the 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 the Contractor. A report summarizing the scope of the inspection, name of the inspector, inspection date, observations relating to the implementation of this plan, and 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

The Contractor will maintain erosion and sediment controls 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, conveyance ditch, sediment basins, and the wheel wash pad.

6.2.1 Silt Fence

The Contractor will remove the sediment that collects along the silt fences to maintain the desired removal performance and prevent structural failure of the fence. Sediment removed will be managed as impacted material and placed in the OSDF. The perimeter silt fencing will remain in place until excavation activities in the area are completed and vegetative cover or other erosion control measures are adequately established.

6.2.2 Conveyance Channel

The Contractor will be required to periodically remove sediment from the conveyance channel and other ditches to maintain flow. Sediment removed will be managed as impacted material and placed in the OSDF.

6.2.3 Sediment Basins

The contractor will be required to periodically remove sediment from the sediment basins to maintain desired sediment storage capacity. Cleanout elevations are indicated on the construction drawings. Sediment removed will be managed as impacted material and placed in the OSDF.

6.2.4 Equipment Decontamination Facility

The Contractor will remove the sediments from the collection sump as required. The sediments removed from the Equipment Decontamination Facility will be managed as impacted material and placed in the OSDF.

APPENDIX A

CALCULATIONS

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PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS TITLE AND SUMMARY SHEET

2049

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Date 10/20/97
Sheet 1 of 7

Proj. Order No. PO175 Calculation No. 15-01

Project Title Area I, Phase II Remediation

Calculation Subject Sediment Basin Date Verified/Checked

STATUS: PRELIMINARY X FINAL SUPERSEDED VOID

STATEMENT OF PROBLEM

Design drainage structures (i.e., sediment basin, conveyance channel, and associated drainage culverts) to accommodate Area I, Phase II (AIPII) remediation activities.

SUMMARY OF CONCLUSIONS	Originator's Signature and Date
Drainage structures are of adequate size to accommodate AIPII remediation activities.	10/20/97

CHECKING METHOD		Checker's Signature and Date
1. Review	✓	11-17-97
2. Alternate Calculation		Lead Discipline Engineer's Signature and Date

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

05/93 ENG080

PARSONS
ERA PROJECT

ENGINEERING CALCULATIONS BASIS SHEET

Revision No. B
Sheet 2 of 7

Proj. Order No. PO175 Calculation No. 15-01

Project Title Area I, Phase II

Calculation Subject Sediment Basin Date Verified/Checked

Prepared By: T. Brown TB Checked/Verified By: [illegible] 11/17/97

Date 10/20/97

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. FHWA. *Hydraulic Design of Highway Culverts*. HDS No. 5. 1985
8. Haan, C.T., Barfield, B.J., Hayes, J.C., *"Design Hydrology and Sedimentology for Small Catchments"*, 2nd ed., 1994, Academic Press
9. Brater, E.F., & King, H.W., *"Handbook of Hydraulics"*, 6th ed., 1976, McGraw-Hill
10. ODOT, *Location and Design Manual, Vol 2, Drainage Design*
11. Soil Conservation Service, State of Ohio, *Engineering Standard, Pond - 378*, 1986

CODES

Applicable sections of the Ohio Department of Natural Resources *Rainwater and Land Development Manual*, 1996

ASSUMPTIONS

1. Conveyance Channel was designed based on uniform flow.

Sm 3 of 1 ~~1093~~

PARSONS
EFIA PROJECT

COMPUTER CALCULATION SUMMARY SHEET 2049

OU: 2 PO: 175 Job Number: 7663-0175-11115-151

Computer Code: OTR-55 Version: 5.46

Code Verification Status: REV 0, Nov 1992

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

Source of Data: Refer to Data Sources, Sheet 2

Purpose/Description of Calculation: To develop runoff hydrographs for 10-yr, 24-hr. storm event. Sediment Basin 1, Ditch 1, Conveyance Channels 1A & 1B, and Culverts 1 & 2 will be sized for this storm. Ditch 2 will be designed for the 10-year frequency storm using the Modified Rational Method.

Run Performed By: T. Brown

Date/Time of Run: 9/97

Computer Time of Run: n/a

Input Filename: See attached list on Sheet 7

Output Filename: See attached list on Sheet 7

Files Saved to Diskname: p:\engdata\c&sdata\po175\basincal Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TB Date: 10/20/97

Checked By: [signature] Date: 11/17/97

Approved By: Date:

SHT 4 of 7

PARSONS ERA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

OU: 2 PO: 175 Job Number: 7663-0175-11115-151

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 Sediment Basin 1.

Run Performed By: T. Brown

Date/Time of Run: 9/97

Computer Time of Run: n/a

Input Filename: See attached list on Sheet 7

Output Filename: See attached list on Sheet 7

Files Saved to Diskname: p:\engdata\c&sdata\po175\basincal Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TB Date: 10/30/97

Checked By: [signature] Date: 11/17/97

Approved By: Date:

12/92 ENG095

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SHT 5 of 7

PARSONS
EFA PROJECT

COMPUTER CALCULATION SUMMARY SHEET

2049

OU: 2 PO: 175 Job Number: 7663-0175-11115-151

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 conveyance channel and diversion ditch geometry and acceptable lining material.

Run Performed By: T. Brown

Date/Time of Run: 9/97

Computer Time of Run: n/a

Input Filename: See attached list on Sheet 7

Output Filename: See attached list on Sheet 7

Files Saved to Diskname: p:engdata\c&sdata\po175\basincal Disk Location: network directory, backup with discipline files

Results: Refer to calculation

Performed By: T. Brown TB Date: 10/20/97

Checked By: [signature] Date: 11/17/97

Approved By: Date:

12/92 ENG095

PARSONS
ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE Sediment Basin		
							OU2
B	TJB	10/97	WLC by TJB	11/12/97	AUTHOR T. Brown	SHEET 6 OF 7	PO 175

SEDIMENT BASIN

Basin Requirements

Watershed Size: 73.85 acres

Total storage volume required: 67 cubic yards / acre X 73.85 acres = 4,947.95 cubic yards
4,947.95 cubic yards X 27 cubic feet / cubic yards = 133,594.65 cubic feet
133,594.65 cubic feet / 43,560 square feet / acre = 3.07 acre-feet

Sediment cleanout elevation: 27 cubic yards / acre X 73.85 acres = 1,993.95 cubic yards
1,993.95 cubic yards X 27 cubic feet / cubic yard = 53,836.65 cubic feet
53,836.65 cubic feet / 43,560 square feet / acre = 1.24 acre-feet

Sediment Basin Geometry

	Elev.	Total Volume (ac-ft)
	567.00	0.00
	568.00	0.10
	569.00	0.52
	570.00	1.18
(Sediment Cleanout Elev)	570.25	1.37
	571.00	1.99
	572.00	2.94
(Invert Principal Riser)	572.40	3.36
	573.00	4.04
	574.00	5.28
	575.00	6.67
	576.00	8.22
	577.00	9.93
	578.00	11.81
	579.00	13.87

Total Storage Volume @ Invert Principal Riser = 3.36 ac-ft > 3.07 ac-ft (req'd.) ∴ O.K.

Sediment Volume @ Sediment cleanout elevation = 1.37 ac-ft > 1.24 ac-ft (req'd) ∴ O.K.

Print File List
10/30/97 3:44PM
C:\PO175\BASINCAL

SHT 7 of 7

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2049

Total Files: 60
Total Bytes: 783,955

c1-10.hyd
c1-25.hyd
c2-10.hyd
c2-25.hyd
calca.rpt
calcb.rpt
ch1a-10.hyd
ch1a-25.hyd
ch1b-10.hyd
ch1b-25.hyd
chan 1a.mop
chan 1a.rcn
chan 1a.tct
chan 1b.mop
chan 1b.rcn
chan 1b.tcm
chan 1b.tct
culv 1.mop
culv 1.rcn
culv 1.tct
culv 2.mop
culv 2.rcn
culv 2.tcm
culv 2.tct
d1-10.hyd
d1-25.hyd
d1p.mod
d2.mod
ditch 1.mop
ditch 1.rcn
ditch 1.tct
ditch 2.mod
eng023
eng025
eng080
eng095
eng095.1
eng095.2
eng095.3
eng098
estimate.est
outlet.xls
outlet1.xls
project1.bak
project1.fm2
sb1-10.hyd
sb1-100.hyd
sb1-25.hyd
sb1.mop
sb1.msr
sb1.pnd
sb1.rcn
sb1.tcm
sb1.tct
sb1.vol
sb1o-10.hyd
sb1o-25.hyd
swu10.idf
swu25.idf

ATTACHMENT A, SEDIMENT BASIN

Introduction

The Area 1, Phase II project area is divided into two major drainage Areas (A & B as shown in Appendix B) based on existing topography and site features (i.e. Phase I of North Entrance Road). One sediment basin will be constructed to accommodate drainage from drainage area B. The existing OSDF sediment basin and accompanying ditch system will be utilized for activities in drainage area A.

After remediation and Area 1, Phase II restoration is completed, the sediment basin constructed for Drainage Area B will remain after remediation to serve as the sediment basin for the OSDF activities. The sediment basin will be designed to match the current OSDF design to the extent practical to minimize change.

The proposed (during excavation conditions) watershed is approximately 74 acres in size. Runoff will be collected and conveyed to the new sediment basin (see Construction Drawings and calculations) via conveyance ditch No. 1. The sediment basin will be located adjacent to the South Access Road, and will cover approximately 2.0 acres of surface area.

The sediment basin will be designed in accordance with the ODNR's "Rainwater and Land Development Manual" as a minimum. The required storage capacity for the sediment basin and sediment trap are given as follows:

Sediment Basin

Watershed Area = 74.0 Acres
Total Storage Required = 3.1 Acre-Feet
Sediment Storage Required = 1.2 Acre-Feet

The OSDF originally planned a sediment basin in the same location to accommodate the development of the OSDF Borrow Area. A preliminary borrow area grading plan and sediment basin design have been submitted as part of the OSDF Permit Drawings to the Ohio Environment Protection Agency (OEPA), Division of Solid and Infectious Waste Management. Since the AIPII project is scheduled to be completed just prior to beginning development of the OSDF Borrow Area, the goal is to prevent duplication in the construction of two sediment basins. The AIPII will provide a sediment basin which will accommodate the AIPII remediation activities, while providing OSDF with a basin sediment basin that can be modified to accommodate future activities..

Since the OSDF borrow area grading plan and geometry of the sediment basin are interrelated, the OSDF sediment basin geometry will be used as much as possible. A review of the OSDF Borrow Area sediment basin design reveals that the basin was designed according to *"Water Management and Sediment Control for Urbanizing Area"* (USDA-SCS, 1987). This basin is an excavated basin with 100% drawdown (i.e., dry basin) and has a combination principal/emergency outlet control spillway structure.

Sediment basin requirements specified in the Ohio Department of Natural Resources (ODNR) "*Rainwater and Land Development Manual*" will be used for AIPII remediation activities. With the basin geometry defined, an outlet control structure will be designed for the AIPII remediation work which will meet total volume and sediment storage requirements. In anticipation of modifications that may be needed for future OSDF use, a second riser/barrel outlet structure will be installed during basin construction. When AIPII activities are completed, the outlet control structures can be modified as needed by the OSDF project.

The 10 yr - 24 hr storm event will be routed through the basin/outlet control structure assuming that the required sediment volume is full. The water surface elevation obtained from the 10 yr-24 hr storm event will be used in the design of collection ditches and culverts. The proposed 10 yr - 24 hr inflow hydrograph is developed using *"Technical Release No. 55"* and the computer program Quick TR-55 (Reference 2). The Pond-2 computer program (Reference 3) will be used to route the inflow hydrograph through the sediment basin utililizing level pool routing techniques.

After Area 1, Phase II activities are completed, the outlet control structure will be replaced and the basin modified as required by the OSDF.

Methodology

The calculations are performed by evaluating the remediation activities within the project area and identifying the "worst case" conditions. Due to the may factors involved with construction sequencing on remediation projects, it is assumed that approximately 10 acres within Subarea 1 will be disturbed. For subarea 2, it was assumed that 50% of the watershed area would be disturbed at one time.

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.

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 (Reference 2). The weighted curve number is derived as follows.

$$CN = \Sigma (CN_i \times Area_i) / \text{Total Area}$$

where:

CN	= Weighted curve number for drainage subarea,
CN_i	= Weighted curve number for drainage subarea (i),
$Area_i$	= Area of subarea (i),
Total Area	= Total drainage area

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 (Reference 2) for n:

n = 0.011 for bare soil conditions,
n = 0.13 for range conditions (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 (ft/s) taken from equation $V = (1.486 r^{2/3} s^{1/2}) / n$ and $r = a / p$
r = Hydraulic radius (ft)
a = Cross sectional area of flow (ft^2)
p = Wetted perimeter (ft)
s = Land slope (ft/ft)
n = Manning's roughness coefficient.

Basin Storage Volume

The minimum required volume for total basin storage is calculated based on 67 cubic yards (cy) of storage per acre watershed area (Ohio Department of Natural Resources *"Rainwater and Land Development Manual"*, 1996). Due to the requirement for sediment cleanout to occur when the basin volume has been reduced to 40 cy of total storage per acre of watershed area, a maximum sediment storage volume is computed at 27 cy of storage per acre of watershed area (67 cy - 40 cy = 27 cy).

Normally with the required volumes known, the basin can be located and the geometry designed to accommodate the required volumes. However, as explained previously, the basin geometry is already defined. Therefore, the required volumes and basin geometry can be used together to determine the sediment cleanout elevation and invert elevation for the principal spillway. The following equation is used by the Pond-2 computer program (Reference 3) to calculate volumes:

Incremental Volume =
$1/3 \times (EL_2 - EL_1) \times (Area_1 + Area_2 + (Area_1 \times Area_2)^{1/2})$

where:

EL_1, EL_2	= Lower and upper elevations of the increment
$Area_1$, $Area_2$	= Areas computed for EL_1, EL_2 respectively
Volume	= Incremental volume between EL_1 and EL_2

Total volume is the sum of the incremental volumes.

Principal Spillway

The principal spillway structure is comprised of a dewatering riser, principal riser, and an outlet barrell pipe. The structure is designed to dewater the basin while providing capacity to pass the 10 yr-24 hr storm event.

The dewatering riser structure is a capped 8 in. diameter corrugated metal pipe (CMP) which is perforated with 1 in. diameter holes. The top of the dewatering riser is set to the stage-storage elevation which corresponds to the sediment cleanout elevation. The principal riser will be an open CMP with a trash rack/anti-vortex top. The dewatering and principal riser structures will flow into a CMP barrell outlet.

In order to route the design inflow hydrograph through the basin, a stage-storage-discharge curve must be developed. The following assumptions are made in developing stage-storage-discharge curve:

1) Since the sediment storage cleanout elevation extends to the top of the dewatering riser, it is assumed that the basin is full of sediment (i.e. sediment volume at maximum elevation and ready for cleanout) and water will not flow through the perforations.

2) Sediment storage volume will not be available for storm storage.

Flow through the principal spillway structure will be controlled by either weir flow or orifice flow at the principal riser, or pipe flow at the barrel outlet pipe. In order to develop a relationship between water elevation and discharge, the hydraulics of both the principal riser and barrel outlet pipe will be evaluated by examining head losses through the system (i.e., entrance, bend, enlargement, friction, and velocity), with the lowest discharge value being used. The following equations will be used to evaluate the flow through the principal riser and barrel outlet pipe.

(Note that the second principal spillway structure was added to provide additional capacity if OSDF elects to add to the drainage area beyond that for the Area I, Phase II basin. No analysis was performed for any additional areas and will be the responsibility of others).

Weir Flow

$$Q = CLH^{3/2} \text{ (pg 5-9, Reference 9)}$$

where Q = discharge (cfs)
C = weir coefficient for sharp crested weir = 3.22 + 0.44 H/P (pg 5-9, Reference 9)
L = length of weir (ft)
H = head over weir (ft)
P = height of weir

Orifice Flow

$$Q = Ca(2gh)^{1/2} \text{ (pg 4-10, Reference 9)}$$

where Q = discharge (cfs)
C = orifice coefficient, use 0.6 for all heads
a = orifice opening (ft^2)
g = gravitational constant = 32.2 ft/s^2
h = head over orifice (ft)

Pipe Flow

Pipe flow is evaluated for the principal spillway pipe system using Bernoulli's Equation and the Continuity Equation as follows:

$p_1/\omega + z_1 + V_1^2 / 2g = p_2/\omega + z_2 + V_2^2 / 2g + \Sigma h_{l1\rightarrow 2}$ and $Q = V_1A_1 = V_2A_2$ (pg 6-3 Reference 9)

where p = pressure (psf)
ω = unit weight of water (pcf)
z = water surface elevation above some datum (ft)
V = velocity (fps)
$\Sigma h_{l1\rightarrow 2}$ = sum of head losses from inlet to outlet. See calculation sheet for head losses evaluated in system
Q = discharge (cfs)
A = flow area of pipe (ft^2)

Emergency Spillway

A defined emergency spillway will not be constructed for Sediment Basin 1 due to the close proximity of the existing South Access Road. Instead, emergency overflow (should an overflow situation ever arise), will flow in a northwest direction over the South Access Road. The design flow for an emergency spillway was taken from the ODNR *"Rainwater and Land Development"* Manual, 1996, and is given as follows:

$$Q_{design} = 4 \text{ cfs / acre drainage area}$$

For Sediment Basin 1, Q_{design} = 4 cfs / 74 acres = 296 cfs

A profile along the centerline of the South Access Road was examined to provide the overflow geometry. With the design flow and profile known, the flow depth is determined using the FlowMaster computer program (Reference 4), which is based on the uniform flow theory using Manning's equation. In order to evaluate performance during an overflow condition, it was assumed that the two principal spillway outlet structures are plugged.

Basin Outlet Channel

The basin outlet channel is designed in accordance with criteria outlined in Attachment B. Since this channel will be used later by the OSDF, an anticpated design flow of 250 cfs was used to evaluate performance of the outlet channel.

Anti-Flotation Device

To prevent flotation of the principal spillway outlet structures, a concrete base is used. See calculation.

Antiseep Collars

Antiseep collars will be located along the pipe at equal spacings. The number of collars is determined as follows:

$$N = 0.075\ L / V \qquad \text{(Reference 11)}$$

where N = number of collars
L = Length of pipe within saturation zone (ft.)
V = Collar projection (ft.)

Calculations are included on the following pages.

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SEDIMENT BASIN 1

SHT A8

Quick TR-55 Ver.5.46 S/N:
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SEDIMENT BASIN 1

Tc COMPUTATIONS FOR: SUBAREA 1

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	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0233	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.34	= 0.34

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	1214.0	
Watercourse slope, s	ft/ft	0.0186	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.2005	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.15	= 0.15

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	25.78	
Wetted perimeter, Pw	ft	37.25	
Hydraulic radius, r = a/Pw	ft	0.692	
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	2.6068	
Flow length, L	ft	1277	
T = L / (3600*V)	hrs	0.14	= 0.14

::

TOTAL TIME (hrs) 0.63

SHT A9

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SUBAREA 1; Tc
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	SUBAREA 1; Tc
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	34.00	ft
Discharge	67.00	cfs

Results		
Depth	0.73	ft
Flow Area	25.78	ft^2
Wetted Perimeter	37.25	ft
Top Width	36.91	ft
Critical Depth	0.49	ft
Critical Slope	0.030115	ft/ft
Velocity	2.60	ft/s
Velocity Head	0.10	ft
Specific Energy	0.83	ft
Froude Number	0.55	
Flow is subcritical.		

000041

SHT A10

Quick TR-55 Ver.5.46 S/N:
Executed: 11:27:49 10-27-1997 c:\po175\basincal\SB1.TCT

SEDIMENT BASIN 1

Tc COMPUTATIONS FOR: SUBAREA 2

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	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0392	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.28	= 0.28

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	487.0	
Watercourse slope, s	ft/ft	0.0068	
$Avg.V = Csf * (s)^{0.5}$	ft/s	1.3305	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.10	= 0.10

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	7.26	
Wetted perimeter, Pw	ft	11.37	
Hydraulic radius, r = a/Pw	ft	0.639	
Channel slope, s	ft/ft	0.0100	
Manning's roughness coeff., n		0.0400	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.7621	
Flow length, L	ft	570	
T = L / (3600*V)	hrs	0.06	= 0.06

::

TOTAL TIME (hrs) 0.44

SHT A11

~~1093~~

2049

SUBAREA 2, Tc
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	SUBAREA 2, Tc
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.040	
Channel Slope	0.010000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	9.00	cfs

Results		
Depth	0.84	ft
Flow Area	3.76	ft²
Wetted Perimeter	7.28	ft
Top Width	7.01	ft
Critical Depth	0.63	ft
Critical Slope	0.032533	ft/ft
Velocity	2.39	ft/s
Velocity Head	0.09	ft
Specific Energy	0.92	ft
Froude Number	0.58	
Flow is subcritical.		

000043

SHT A12

Quick TR-55 Ver.5.46 S/N:
Executed: 13:02:28 10-22-1997 c:\po175\basincal\SB1.TCT

SEDIMENT BASIN 1

Tc COMPUTATIONS FOR: SUBAREA 3

SHEET FLOW (Applicable to Tc only)

		1	2		
Segment ID		1	2		
Surface description		Fallow	Bare		
Manning's roughness coeff., n		0.0500	0.0110		
Flow length, L (total < or = 300)	ft	160.0	140.0		
Two-yr 24-hr rainfall, P2	in	3.000	3.000		
Land slope, s	ft/ft	0.0063	0.0236		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.16	+ 0.03	=	0.19

SHALLOW CONCENTRATED FLOW

Segment ID		3		
Surface (paved or unpaved)?		Unpaved		
Flow length, L	ft	83.0		
Watercourse slope, s	ft/ft	0.0210		
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.3381		
where: Unpaved Csf = 16.1345				
Paved Csf = 20.3282				
T = L / (3600*V)	hrs	0.01	=	0.01

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) 0.20

SHT A13

Quick TR-55 Ver.5.46 S/N:
Executed: 15:08:03 11-17-1997 c:\po175\basincal\SB1.TCT

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2049

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

SEDIMENT BASIN 1

Subarea descr.	Tc or Tt	Time (hrs)
SUBAREA 1	Tc	0.63
SUBAREA 2	Tc	0.44
SUBAREA 3	Tc	0.20

SHT A14

SUBAREAS 1 & 2; Tt
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	SUBAREAS 1 & 2; Tt
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	34.00	ft
Discharge	100.00	cfs

Results		
Depth	0.92	ft
Flow Area	33.08	ft^2
Wetted Perimeter	38.13	ft
Top Width	37.69	ft
Critical Depth	0.64	ft
Critical Slope	0.027717	ft/ft
Velocity	3.02	ft/s
Velocity Head	0.14	ft
Specific Energy	1.06	ft
Froude Number	0.57	
Flow is subcritical.		

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000044

SHT A15

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2049

Quick TR-55 Ver.5.46 S/N:
Executed: 10:27:24 10-22-1997

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using Length/Velocity)

SEDIMENT BASIN 1
TRAVEL TIME

USE SAME VELOCITY AS Tc CHANNEL FLOW

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

SHT A16

Quick TR-55 Ver.5.46 S/N:
Executed: 10:27:24 10-22-1997

SEDIMENT BASIN 1
TRAVEL TIME

USE SAME VELOCITY AS Tc CHANNEL FLOW

Tc or Tt DATA
::

Subarea: DESCRIPTION	LENGTH (feet)	VELOCITY (ft/sec)	TIME minutes		hours
SUBAREA 1 OUTLET TO BASIN	280	3.03	1.5	=	0.03
			minutes		hours
		TOTAL Tt --->	1.5	=	0.03

::::::::::::::::::::::::::::::::::::

Subarea: DESCRIPTION	LENGTH (feet)	VELOCITY (ft/sec)	TIME minutes		hours
SUBAREA 2 OUTLET TO BASIN	280	3.03	1.5	=	0.03
			minutes		hours
		TOTAL Tt --->	1.5	=	0.03

::::::::::::::::::::::::::::::::::::

SHT A17

Quick TR-55 Ver.5.46 S/N:
Executed: 11:10:49 10-22-1997

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2049

SEDIMENT BASIN 1

RUNOFF CURVE NUMBER DATA

::

Composite Area: SUBAREA 1

SURFACE DESCRIPTION	AREA (acres)	CN	
FdA; Pasture; (35.4%)(HSG-C)	14.41	79	
FdA; Bare; (24.6%)(HSG-C)	10.00	91	
XfB2; Pasture; (33.7%)(HSG-B)	13.70	69	
FdA; GRAVEL; (6.3%)(HSG-C)	2.57	89	
COMPOSITE AREA --->	40.68	79.2	(79)

::

Composite Area: SUBAREA 2

SURFACE DESCRIPTION	AREA (acres)	CN	
XfB2; Bare; (30.0%)(HSG-B)	7.46	86	
XfB2; Pasture; (30.0%)(HSG-B)	7.46	58	
FdA; Bare; (20.0%)(HSG-C)	4.97	91	
FdA; Pasture; (20.0%)(HSG-C)	4.97	79	
COMPOSITE AREA --->	24.86	77.2	(77)

::

Composite Area: SUBAREA 3

SURFACE DESCRIPTION	AREA (acres)	CN
XfB2; Pasture; (25%)(HSG-B)	2.08	58
FdA; Bare; (38.9%)(HSG-C)	3.23	91

SHT A18

Quick TR-55 Ver.5.46 S/N:
Executed: 11:10:49 10-22-1997

Impoundment; (24.1%)	2.00	98	
Gravel Rd; (12.0%)	1.00	89	
COMPOSITE AREA --->	8.31	84.2	(84)

::

SHT A19

Quick TR-55 Ver.5.46 S/N:
Executed: 11:10:49 10-22-1997

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2049

SEDIMENT BASIN 1

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
SUBAREA 1	40.68	79
SUBAREA 2	24.86	77
SUBAREA 3	8.31	84

SHTA20

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 10 years

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

Executed: 11-17-1997 15:18:14
Watershed file: --> C:\PO175\BASINCAL\SB1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\SB1-10.HYD

SEDIMENT BASIN 1

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

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
SUBAREA 1	40.68	79.0	0.50	0.10	4.10	2.04	I.13	.13
SUBAREA 2	24.86	77.0	0.40	0.10	4.10	1.89	I.15	.15
SUBAREA 3	8.31	84.0	0.20	0.00	4.10	2.46	I.09	.10

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

Total area = 73.85 acres or 0.11539 sq.mi
Peak discharge = 104 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
SUBAREA 1	0.63	0.03	0.50	0.10	Yes	--
SUBAREA 2	0.44	0.03	0.40	0.10	Yes	--
SUBAREA 3	0.20	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: 10 years

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

2049

Executed: 11-17-1997 15:18:14
Watershed file: --> C:\PO175\BASINCAL\SB1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\SB1-10.HYD

SEDIMENT BASIN 1

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

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
SUBAREA 1	62	12.5
SUBAREA 2	38	12.4
SUBAREA 3	26	12.2
Composite Watershed	104	12.4

Return Frequency: 10 years

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

Executed: 11-17-1997 15:18:14
Watershed file: --> C:\PO175\BASINCAL\SB1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\SB1-10.HYD

SEDIMENT BASIN 1

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
SUBAREA 1	2	2	3	6	9	16	28	46	58
SUBAREA 2	1	1	2	4	6	12	23	33	38
SUBAREA 3	1	1	2	7	13	24	26	15	8
Total (cfs)	4	4	7	17	28	52	77	94	104

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
SUBAREA 1	62	56	45	36	22	15	11	9	8
SUBAREA 2	35	28	21	16	10	7	5	5	4
SUBAREA 3	5	4	3	3	2	2	2	2	1
Total (cfs)	102	88	69	55	34	24	18	16	13

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

Executed: 11-17-1997 15:18:14
Watershed file: --> C:\PO175\BASINCAL\SB1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\SB1-10.HYD

SEDIMENT BASIN 1

Composite Hydrograph Summary (cfs)

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
SUBAREA 1	7	6	5	5	4	4	3	3	3
SUBAREA 2	4	3	3	3	2	2	2	2	2
SUBAREA 3	1	1	1	1	1	1	1	1	1
Total (cfs)	12	10	9	9	7	7	6	6	6

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
SUBAREA 1	3	2	2	2	0
SUBAREA 2	2	1	1	1	0
SUBAREA 3	1	1	0	0	0
Total (cfs)	6	4	3	3	0

SHT A24

Return Frequency: 10 years

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

Executed: 11-17-1997 15:18:14
Watershed file: --> C:\PO175\BASINCAL\SB1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\SB1-10.HYD

SEDIMENT BASIN 1

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	4	14.8	9
11.1	4	14.9	9
11.2	4	15.0	9
11.3	4	15.1	9
11.4	5	15.2	8
11.5	6	15.3	8
11.6	7	15.4	7
11.7	10	15.5	7
11.8	14	15.6	7
11.9	17	15.7	7
12.0	28	15.8	7
12.1	52	15.9	7
12.2	77	16.0	7
12.3	94	16.1	7
12.4	104	16.2	7
12.5	102	16.3	6
12.6	88	16.4	6
12.7	69	16.5	6
12.8	55	16.6	6
12.9	44	16.7	6
13.0	34	16.8	6
13.1	29	16.9	6
13.2	24	17.0	6
13.3	21	17.1	6
13.4	18	17.2	6
13.5	17	17.3	6
13.6	16	17.4	6
13.7	14	17.5	6
13.8	13	17.6	6
13.9	12	17.7	6
14.0	12	17.8	6
14.1	11	17.9	6
14.2	11	18.0	6
14.3	10	18.1	6
14.4	10	18.2	6
14.5	9	18.3	5

SAT A25

14.6	9	18.4	5
14.7	9	18.5	5

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SHT A26

Return Frequency: 10 years

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

Executed: 11-17-1997 15:18:14
Watershed file: --> C:\PO175\BASINCAL\SB1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\SB1-10.HYD

SEDIMENT BASIN 1

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	5	22.4	3
18.7	5	22.5	3
18.8	4	22.6	3
18.9	4	22.7	2
19.0	4	22.8	2
19.1	4	22.9	2
19.2	4	23.0	2
19.3	4	23.1	2
19.4	4	23.2	2
19.5	4	23.3	2
19.6	3	23.4	2
19.7	3	23.5	2
19.8	3	23.6	2
19.9	3	23.7	2
20.0	3	23.8	2
20.1	3	23.9	2
20.2	3	24.0	2
20.3	3	24.1	1
20.4	3	24.2	1
20.5	3	24.3	1
20.6	3	24.4	1
20.7	3	24.5	1
20.8	3	24.6	1
20.9	3	24.7	1
21.0	3	24.8	1
21.1	3	24.9	1
21.2	3	25.0	1
21.3	3	25.1	1
21.4	3	25.2	1
21.5	3	25.3	1
21.6	3	25.4	0
21.7	3	25.5	0
21.8	3	25.6	0
21.9	3	25.7	0
22.0	3	25.8	0
22.1	3	25.9	0
22.2	3		
22.3	3		

SHT A27 ~~1098~~

POND-2 Version: 5.17
S/N:

2049

SEDIMENT BASIN 1

CALCULATED 10-22-1997 13:09:14
DISK FILE: C:\PO175\BASINCAL\SB1 .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)
567.00	0.00	0.00	0.00	0.00	0.00
568.00	124.35	0.29	0.29	0.10	0.10
569.00	253.13	0.58	1.27	0.42	0.52
570.00	324.61	0.75	1.98	0.66	1.18
571.00	383.72	0.88	2.44	0.81	1.99
572.00	444.84	1.02	2.85	0.95	2.94
573.00	508.09	1.17	3.28	1.09	4.04
574.00	573.31	1.32	3.72	1.24	5.28
575.00	640.69	1.47	4.18	1.39	6.67
576.00	710.12	1.63	4.65	1.55	8.22
577.00	781.57	1.79	5.13	1.71	9.93
578.00	857.25	1.97	5.64	1.88	11.81
579.00	936.75	2.15	6.18	2.06	13.87

Elevations With Areas Interpolated From
The Closest Two Planimeter Readings

570.25	-----	0.78	2.28	0.19	1.37
572.40	-----	1.08	3.15	0.42	3.36

IA = (sq.rt(Area1) + ((Ei-E1)/(E2-E1))*(sq.rt(Area2)-sq.rt(Area1)))^2

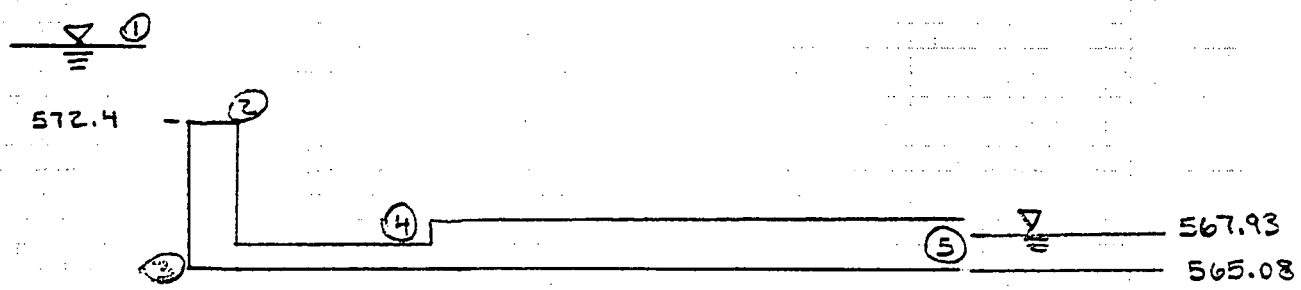
where: E1, E2 = Closest two elevations with planimeter data
Ei = Elevation at which to interpolate area
Area1,Area2 = Areas computed for E1, E2, respectively
IA = Interpolated area for Ei

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

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

~~000057~~



THE FOLLOWING EQUATIONS TAKEN FROM REFERENCES?

$$\frac{P_1}{\omega} + z_1 + \frac{V_1^2}{2g} = \frac{P_5}{\omega} + z_5 + \frac{V_5^2}{2g} + h_{L_{1\to5}} \qquad \text{(EQN 6-1)}$$

IF $Q_1 = Q_5 = V_1A_1 = V_5A_5$, THEN FOR 3'Φ PIPE, $Q_{3'0} = Q_{4'0} = V_3A_3 = V_4A_4$

$$V_3 = \frac{V_4A_4}{A_3} = V_4\frac{\frac{\pi(D_4)^2}{4}}{\frac{\pi(D_3)^2}{4}} = V_4\left(\frac{D_4}{D_3}\right)^2$$

THEN NEGLECTING FRICTION LOSS FROM 2 → 3

$h_{L_{1\to5}}$ = WHERE

h_{L2} = ENTRANCE LOSS = $K_e V^2/2g$ and K_e = USE $K_e = 1.0$ (Pg 6-21)

h_L = CONTRACTION LOSS = $K_c V^2/2g$ and $K_c = 0.13$ for $V = 8$ fps, (TABLE 6-10)

h_{L3} = BEND LOSS = $K_b \frac{V^2}{2g}$ and K_b = USE $K_b = 0.5$ (Pg 6-25)

h_{L4} = ENLARGEMENT LOSS = $K_{EN}\frac{V^2}{2g}$ and K_{EN} = ASSUME $V = 8$ fps, $d_2/d_1 = 4/3 = 1.33$, $K_{EN} \cong 0.18$ (TABLE 6-7)

$h_{L3\to4}$ = FRICTION LOSS = $f\frac{l}{d}\frac{V^2}{2g}$, from pg 6-12, ε for CMP = 0.18, THEN $\varepsilon/D = 0.18/3 = 0.06$

ASSUMING TURBULENT FLOW, $R = \frac{dV}{\nu}$

d - dia. = 3 ft

V = VELOCITY, ASSUME V = 8 fps

ν = KINEMATIC VISCOSITY = 0.00001059 @ 70°F (TABLE 1-2) (ft^2/s)

$$R = \frac{3\text{ ft} \times 8\text{ ft/s}}{0.00001059\text{ ft}^2/\text{s}} = 2.27\times10^6$$

THEN f = COMPLETE TURBULENCE, USE f = 0.09 (FIGURE 6-4)

$h_{L\,4\to5}$ = FRICTION LOSS FROM ④ → ⑤ = $f\frac{l}{d}\frac{V^2}{2g}$

$\epsilon/d = 0.18/4 = 0.045$

$R = \frac{dV}{\nu}$, ASSUMING $V = 6$ fps, $R = \frac{4\times6}{0.00001059} = 2.27\times10^6$

FROM FIG 6-4, $f \cong 0.07$

NOW $\cancel{\frac{P_1}{\omega}}^{ATM} + Z_1 + \cancel{\frac{V_1^2}{2g}}^{0} = \cancel{\frac{P_5}{\omega}}^{ATM} + Z_5 + \frac{V_5^2}{2g} + h_{L\,1\to5}$

$$Z_1 = 567.93 + \frac{V_5^2}{2g} + K_e\frac{V^2}{2g} + K_c\frac{V^2}{2g} + K_b\frac{V^2}{2g} + K_{ev}\frac{V^2}{2g} + f\frac{l}{d}\frac{V^2}{2g} + f\frac{l}{d}\frac{V^2}{2g}$$

$$= 567.93 + \frac{V^2}{2g} + 1.0\frac{V^2}{2g} + 0.13\frac{V^2(4/3)^4}{2g} + \frac{0.5V^2(4/3)^4}{2g} + 0.18\frac{V^2}{2g} + 0.09\left(\frac{15}{3}\right)\frac{V^2(4/3)^4}{2g}$$

$$+ 0.07\left(\frac{225}{4}\right)\frac{V^2}{2g}$$

$$= 567.93 + \frac{V^2}{2g} + \frac{V^2}{2g}\left(1.0 + 0.41 + 1.58 + 0.18 + 1.42 + 3.94\right)$$

$$Z_1 = 567.93 + \frac{V^2}{64.4} + 8.53\frac{V^2}{64.4}$$

$$Z_1 = 567.93 + 9.53\frac{V^2}{64.4}$$

NOW LET $Z_1 = 573.00$ TO 579.00

$Z_1 = 573.00 - 567.93 = 9.53\,V^2/64.4 \Rightarrow V = 5.85$ fps
$Q = 5.85 \times 12.57\ ft^2 = 73.53$ cfs

$Z_1 = 574.00 - 567.93 = 9.53\,V^2/64.4 \Rightarrow V = 6.41$ fps
$Q = 6.41 \times 12.57\ ft^2 = 80.57$ cfs

$Z_1 = 575.00 - 567.93 = 9.53\,V^2/64.4 \Rightarrow V = 6.91$ fps
$Q = 6.91 \times 12.57\ ft^2 = 86.86$ cfs

PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE	Project
						AIPII
						PO No.
B	TJB	10/20/97	WLC RVDB	11/17/97	AUTHOR T BROWN SHEET A30 OF	75

$z_1 = 576.00 - 567.93 = 9.53 \; V^2/64.4 \Rightarrow V = 7.39 \text{ fps}$

$Q = 7.39 \text{ fps} \times 12.57 \text{ ft}^2 = 92.89 \text{ cfs}$

$z_1 = 577.00 - 567.93 = 9.53 \; V^2/64.4 \Rightarrow V = 7.83 \text{ fps}$

$Q = 7.83 \text{ fps} \times 12.57 \text{ ft}^2 = 98.42 \text{ cfs}$

$z_1 = 578.00 - 567.93 = 9.53 \; V^2/64.4 \Rightarrow V = 8.25 \text{ fps}$

$Q = 8.25 \text{ fps} \times 12.57 \text{ ft}^2 = 103.7 \text{ CFS}$

$z_1 = 579.00 - 567.93 = 9.53 \; V^2/64.4 \Rightarrow V = 8.65 \text{ fps}$

$Q = 8.65 \text{ fps} \times 12.57 \text{ ft}^2 = 108.73 \text{ CFS}$

000062

SAC-A31
2049 ~~1093~~

			WEIR		ORIFICE		PIPE		
		SIZE (FT)=	4.0000	SIZE(FT)=	4.0000	SIZE(FT)=	4.0000		
		INVERT=	572.4000	INVERT=	572.4000	INVERT IN=	567.0000		
		L=	12.5600	AREA=	12.5600	INVERT OU	565.0800		
		P=WEIR HT	5.4000	C=	0.6000	LENGTH=	240.0000		
		C=	3.22+0.44(h/P)			AREA=	12.5600		
						TW ELEV	567.9300		
ELEV	h	C	Q	h	Q	h	Q	TOTAL	TOTAL X 2
567.0000	0.0000	N/A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
568.0000	0.0000	N/A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
569.0000	0.0000	N/A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
570.0000	0.0000	N/A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
571.0000	0.0000	N/A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
572.0000	0.0000	N/A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
573.0000	0.6000	3.2689	19.0817	0.6000	46.8446	5.0700	73.5300	19.0817	38.1634
574.0000	1.6000	3.3504	85.1653	1.6000	76.4969	6.0700	80.5700	76.4969	152.9938
575.0000	2.6000	3.4319	180.7083	2.6000	97.5148	7.0700	86.8600	86.8600	173.7200
576.0000	3.6000	3.5133	301.4135	3.6000	114.7453	8.0700	92.8900	92.8900	185.7800
577.0000	4.6000	3.5948	445.4540	4.6000	129.7068	9.0700	98.4200	98.4200	196.8400
578.0000	5.6000	3.6763	611.9024	5.6000	143.1126	10.0700	103.7000	103.7000	207.4000
579.0000	6.6000	3.7578	800.2702	6.6000	155.3659	11.0700	108.7300	108.7300	217.4600

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SHT A32


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**********************
*                    *
*  SEDIMENT BASIN 1  *
*                    *
*                    *
*                    *
*                    *
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Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Rating Table file: C:\PO175\BASINCAL\SB1 .PND

----INITIAL CONDITIONS----
Elevation = 570.25 ft
Outflow = 0.00 cfs
Storage = 1.38 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
567.00	0.0	0.000
568.00	0.0	0.100
569.00	0.0	0.520
570.00	0.0	1.180
571.00	0.0	1.990
572.00	0.0	2.940
573.00	38.2	4.040
574.00	153.0	5.280
575.00	173.7	6.670
576.00	185.8	8.220
577.00	196.8	9.930
578.00	207.4	11.810
579.00	217.5	13.870

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
24.2	24.2
125.8	125.8
285.6	285.6
481.6	481.6
711.5	711.5
977.7	1015.8
1277.8	1430.8
1614.1	1787.9
1989.2	2175.0
2403.1	2599.9
2858.0	3065.4
3356.5	3574.0

Time increment (t) = 0.100 hrs.

POND-2 Version: 5.17 S/N:
EXECUTED: 10-27-1997 11:35:26

Return Freq: 10 years

Pond File: C:\PO175\BASINCAL\SB1 .PND
Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Outflow Hydrograph: C:\PO175\BASINCAL\SB10-10 .HYD

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INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
11.000	4.00
11.100	4.00
11.200	4.00
11.300	4.00
11.400	5.00
11.500	6.00
11.600	7.00
11.700	10.00
11.800	14.00
11.900	17.00
12.000	28.00
12.100	52.00
12.200	77.00
12.300	94.00
12.400	104.00
12.500	102.00
12.600	88.00
12.700	69.00
12.800	55.00
12.900	44.00
13.000	34.00
13.100	29.00
13.200	24.00
13.300	21.00
13.400	18.00
13.500	17.00
13.600	16.00
13.700	14.00
13.800	13.00
13.900	12.00
14.000	12.00
14.100	11.00
14.200	11.00
14.300	10.00
14.400	10.00
14.500	9.00
14.600	9.00
14.700	9.00
14.800	9.00
14.900	9.00
15.000	9.00
15.100	9.00
15.200	8.00
15.300	8.00
15.400	7.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	334.6	334.6	0.00	570.25
8.0	342.6	342.6	0.00	570.29
8.0	350.6	350.6	0.00	570.33
8.0	358.6	358.6	0.00	570.37
9.0	367.6	367.6	0.00	570.42
11.0	378.6	378.6	0.00	570.47
13.0	391.6	391.6	0.00	570.54
17.0	408.6	408.6	0.00	570.63
24.0	432.6	432.6	0.00	570.75
31.0	463.6	463.6	0.00	570.91
45.0	508.6	508.6	0.00	571.12
80.0	588.6	588.6	0.00	571.47
129.0	716.0	717.6	0.76	572.02
171.0	843.0	887.0	22.01	572.58
198.0	950.8	1041.0	45.13	573.06
206.0	1002.4	1156.8	77.16	573.34
190.0	1018.4	1192.4	87.04	573.43
157.0	1010.7	1175.4	82.31	573.38
124.0	992.6	1134.7	71.07	573.29
99.0	973.3	1091.6	59.13	573.18
78.0	955.4	1051.3	47.99	573.09
63.0	940.7	1018.4	38.86	573.01
53.0	922.9	993.7	35.38	572.93
45.0	903.6	967.9	32.15	572.84
39.0	884.6	942.6	28.98	572.76
35.0	867.4	919.6	26.10	572.68
33.0	853.1	900.4	23.69	572.62
30.0	840.0	883.1	21.51	572.56
27.0	828.0	867.0	19.50	572.51
25.0	817.5	853.0	17.75	572.47
24.0	808.9	841.5	16.31	572.43
23.0	801.7	831.9	15.10	572.40
22.0	795.6	823.7	14.07	572.37
21.0	790.2	816.6	13.18	572.35
20.0	785.5	810.2	12.38	572.32
19.0	781.1	804.5	11.66	572.31
18.0	777.2	799.1	10.99	572.29
18.0	774.2	795.2	10.49	572.27
18.0	771.9	792.2	10.12	572.27
18.0	770.3	789.9	9.84	572.26
18.0	769.0	788.3	9.63	572.25
18.0	768.1	787.0	9.47	572.25
17.0	766.6	785.1	9.23	572.24
16.0	764.8	782.6	8.92	572.23
15.0	762.7	779.8	8.56	572.22

SNT A34

POND-2 Version: 5.17 S/N:
EXECUTED: 10-27-1997 11:35:26

Return Freq: 10 years

Pond File: C:\PO175\BASINCAL\SB1 .PND
Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Outflow Hydrograph: C:\PO175\BASINCAL\SB10-10 .HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
15.500	7.00
15.600	7.00
15.700	7.00
15.800	7.00
15.900	7.00
16.000	7.00
16.100	7.00
16.200	7.00
16.300	6.00
16.400	6.00
16.500	6.00
16.600	6.00
16.700	6.00
16.800	6.00
16.900	6.00
17.000	6.00
17.100	6.00
17.200	6.00
17.300	6.00
17.400	6.00
17.500	6.00
17.600	6.00
17.700	6.00
17.800	6.00
17.900	6.00
18.000	6.00
18.100	6.00
18.200	6.00
18.300	5.00
18.400	5.00
18.500	5.00
18.600	5.00
18.700	5.00
18.800	4.00
18.900	4.00
19.000	4.00
19.100	4.00
19.200	4.00
19.300	4.00
19.400	4.00
19.500	4.00
19.600	3.00
19.700	3.00
19.800	3.00
19.900	3.00
20.000	3.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
14.0	760.3	776.7	8.17	572.21
14.0	758.6	774.3	7.88	572.21
14.0	757.2	772.6	7.66	572.20
14.0	756.3	771.2	7.49	572.20
14.0	755.5	770.3	7.37	572.19
14.0	755.0	769.5	7.28	572.19
14.0	754.5	769.0	7.21	572.19
14.0	754.2	768.5	7.16	572.19
13.0	753.3	767.2	6.99	572.18
12.0	751.8	765.3	6.74	572.18
12.0	750.7	763.8	6.56	572.17
12.0	749.8	762.7	6.42	572.17
12.0	749.2	761.8	6.31	572.17
12.0	748.7	761.2	6.23	572.16
12.0	748.4	760.7	6.18	572.16
12.0	748.1	760.4	6.13	572.16
12.0	747.9	760.1	6.10	572.16
12.0	747.8	759.9	6.07	572.16
12.0	747.7	759.8	6.06	572.16
12.0	747.6	759.7	6.04	572.16
12.0	747.5	759.6	6.03	572.16
12.0	747.5	759.5	6.02	572.16
12.0	747.4	759.5	6.02	572.16
12.0	747.4	759.4	6.01	572.16
12.0	747.4	759.4	6.01	572.16
12.0	747.4	759.4	6.01	572.16
12.0	747.4	759.4	6.01	572.16
12.0	747.4	759.4	6.00	572.16
11.0	746.6	758.4	5.88	572.15
10.0	745.3	756.6	5.66	572.15
10.0	744.3	755.3	5.49	572.14
10.0	743.6	754.3	5.37	572.14
10.0	743.0	753.6	5.28	572.14
9.0	741.8	752.0	5.08	572.13
8.0	740.2	749.8	4.81	572.13
8.0	739.0	748.2	4.61	572.12
8.0	738.1	747.0	4.46	572.12
8.0	737.4	746.1	4.34	572.11
8.0	736.9	745.4	4.26	572.11
8.0	736.5	744.9	4.19	572.11
8.0	736.2	744.5	4.14	572.11
7.0	735.3	743.2	3.98	572.10
6.0	733.8	741.3	3.74	572.10
6.0	732.7	739.8	3.55	572.09
6.0	731.9	738.7	3.41	572.09
6.0	731.3	737.9	3.31	572.09

POND-2 Version: 5.17 S/N:
EXECUTED: 10-27-1997 11:35:26

Return Freq: 10 years

2049

Pond File: C:\PO175\BASINCAL\SB1 .PND
Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Outflow Hydrograph: C:\PO175\BASINCAL\SB10-10 .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	3.00	6.0	730.8	737.3	3.23	572.08
20.200	3.00	6.0	730.4	736.8	3.17	572.08
20.300	3.00	6.0	730.2	736.4	3.13	572.08
20.400	3.00	6.0	730.0	736.2	3.10	572.08
20.500	3.00	6.0	729.8	736.0	3.07	572.08
20.600	3.00	6.0	729.7	735.8	3.05	572.08
20.700	3.00	6.0	729.7	735.7	3.04	572.08
20.800	3.00	6.0	729.6	735.7	3.03	572.08
20.900	3.00	6.0	729.5	735.6	3.02	572.08
21.000	3.00	6.0	729.5	735.5	3.02	572.08
21.100	3.00	6.0	729.5	735.5	3.01	572.08
21.200	3.00	6.0	729.5	735.5	3.01	572.08
21.300	3.00	6.0	729.5	735.5	3.01	572.08
21.400	3.00	6.0	729.4	735.5	3.01	572.08
21.500	3.00	6.0	729.4	735.4	3.00	572.08
21.600	3.00	6.0	729.4	735.4	3.00	572.08
21.700	3.00	6.0	729.4	735.4	3.00	572.08
21.800	3.00	6.0	729.4	735.4	3.00	572.08
21.900	3.00	6.0	729.4	735.4	3.00	572.08
22.000	3.00	6.0	729.4	735.4	3.00	572.08
22.100	3.00	6.0	729.4	735.4	3.00	572.08
22.200	3.00	6.0	729.4	735.4	3.00	572.08
22.300	3.00	6.0	729.4	735.4	3.00	572.08
22.400	3.00	6.0	729.4	735.4	3.00	572.08
22.500	3.00	6.0	729.4	735.4	3.00	572.08
22.600	3.00	6.0	729.4	735.4	3.00	572.08
22.700	2.00	5.0	728.7	734.4	2.87	572.08
22.800	2.00	4.0	727.3	732.7	2.66	572.07
22.900	2.00	4.0	726.4	731.3	2.49	572.07
23.000	2.00	4.0	725.6	730.4	2.37	572.06
23.100	2.00	4.0	725.1	729.6	2.28	572.06
23.200	2.00	4.0	724.7	729.1	2.21	572.06
23.300	2.00	4.0	724.4	728.7	2.15	572.06
23.400	2.00	4.0	724.1	728.4	2.12	572.06
23.500	2.00	4.0	724.0	728.1	2.09	572.05
23.600	2.00	4.0	723.8	728.0	2.07	572.05
23.700	2.00	4.0	723.7	727.8	2.05	572.05
23.800	2.00	4.0	723.7	727.7	2.04	572.05
23.900	2.00	4.0	723.6	727.7	2.03	572.05
24.000	2.00	4.0	723.6	727.6	2.02	572.05
24.100	1.00	3.0	722.8	726.6	1.89	572.05
24.200	1.00	2.0	721.4	724.8	1.67	572.04
24.300	1.00	2.0	720.4	723.4	1.50	572.04
24.400	1.00	2.0	719.7	722.4	1.37	572.04
24.500	1.00	2.0	719.1	721.7	1.28	572.03
24.600	1.00	2.0	718.7	721.1	1.21	572.03

SHT A36

POND-2 Version: 5.17 S/N:
EXECUTED: 10-27-1997 11:35:26

Return Freq: 10 years

Pond File: C:\PO175\BASINCAL\SB1 .PND
Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Outflow Hydrograph: C:\PO175\BASINCAL\SB1O-10 .HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
24.700	1.00
24.800	1.00
24.900	1.00
25.000	1.00
25.100	1.00
25.200	1.00
25.300	1.00
25.400	0.00
25.500	0.00
25.600	0.00
25.700	0.00
25.800	0.00
25.900	0.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
2.0	718.4	720.7	1.16	572.03
2.0	718.2	720.4	1.12	572.03
2.0	718.0	720.2	1.09	572.03
2.0	717.9	720.0	1.07	572.03
2.0	717.8	719.9	1.05	572.03
2.0	717.7	719.8	1.04	572.03
2.0	717.6	719.7	1.03	572.03
1.0	716.8	718.6	0.90	572.02
0.0	715.5	716.8	0.67	572.02
0.0	714.5	715.5	0.50	572.01
0.0	713.7	714.5	0.38	572.01
0.0	713.2	713.7	0.28	572.01
0.0	712.7	713.2	0.21	572.01

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

Pond File: C:\PO175\BASINCAL\SB1 .PND
Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Outflow Hydrograph: C:\PO175\BASINCAL\SB10-10 .HYD

Starting Pond W.S. Elevation = 570.25 ft

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

Peak Inflow = 104.00 cfs
Peak Outflow = 87.04 cfs
Peak Elevation = 573.43 ft

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

Initial Storage = 1.38 ac-ft
Peak Storage From Storm = 3.19 ac-ft

Total Storage in Pond = 4.57 ac-ft

Warning: Inflow hydrograph truncated on left side.

SHT A38

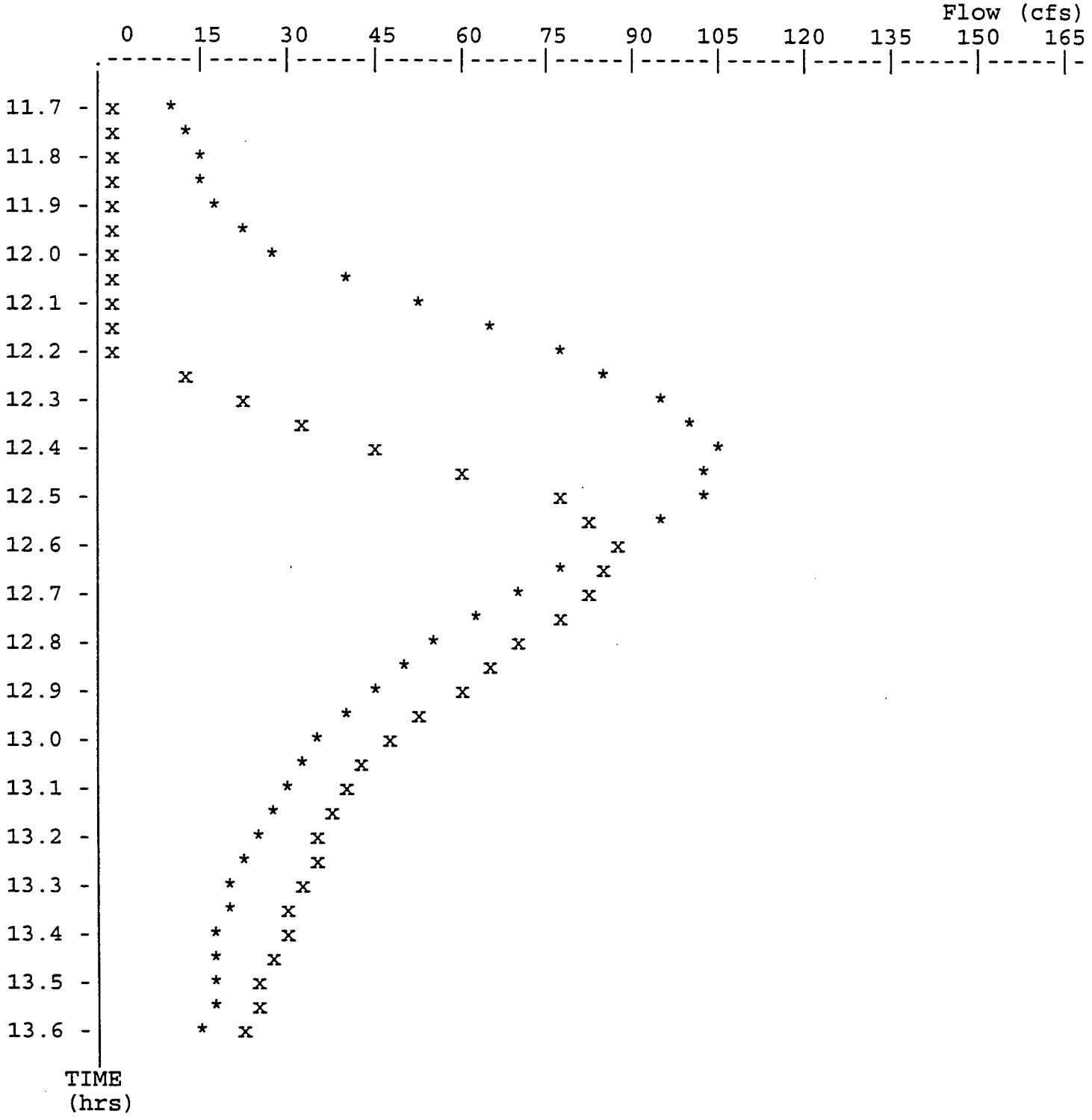
POND-2 Version: 5.17 S/N:

Return Freq: 10 years

Pond File: C:\PO175\BASINCAL\SB1 .PND
Inflow Hydrograph: C:\PO175\BASINCAL\SB1-10 .HYD
Outflow Hydrograph: C:\PO175\BASINCAL\SB10-10 .HYD

EXECUTED: 10-27-1997
11:35:26

Peak Inflow = 104.00 cfs
Peak Outflow = 87.04 cfs
Peak Elevation = 573.43 ft



* File: C:\PO175\BASINCAL\SB1-10 .HYD Qmax = 104.0 cfs
x File: C:\PO175\BASINCAL\SB10-10 .HYD Qmax = 87.0 cfs

SHT A39 ~~1002~~

2049

EMERGENCY SPILLWAY
Worksheet for Irregular Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	EMERGENCY SPILLWAY
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.005000 ft/ft

Elevation range: 579.00 ft to 581.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	581.00	0.00	1,188.11	0.022
300.97	580.00			
432.11	579.00			
676.69	579.00			
940.65	580.00			
1,188.11	581.00			

Discharge 300.00 cfs

Results		
Wtd. Mannings Coefficient	0.022	
Water Surface Elevation	579.41	ft
Flow Area	132.45	ft^2
Wetted Perimeter	405.57	ft
Top Width	405.57	ft
Height	0.41	ft
Critical Depth	579.33	ft
Critical Slope	0.010895	ft/ft
Velocity	2.26	ft/s
Velocity Head	0.08	ft
Specific Energy	579.49	ft
Froude Number	0.70	

Flow is subcritical.

000071

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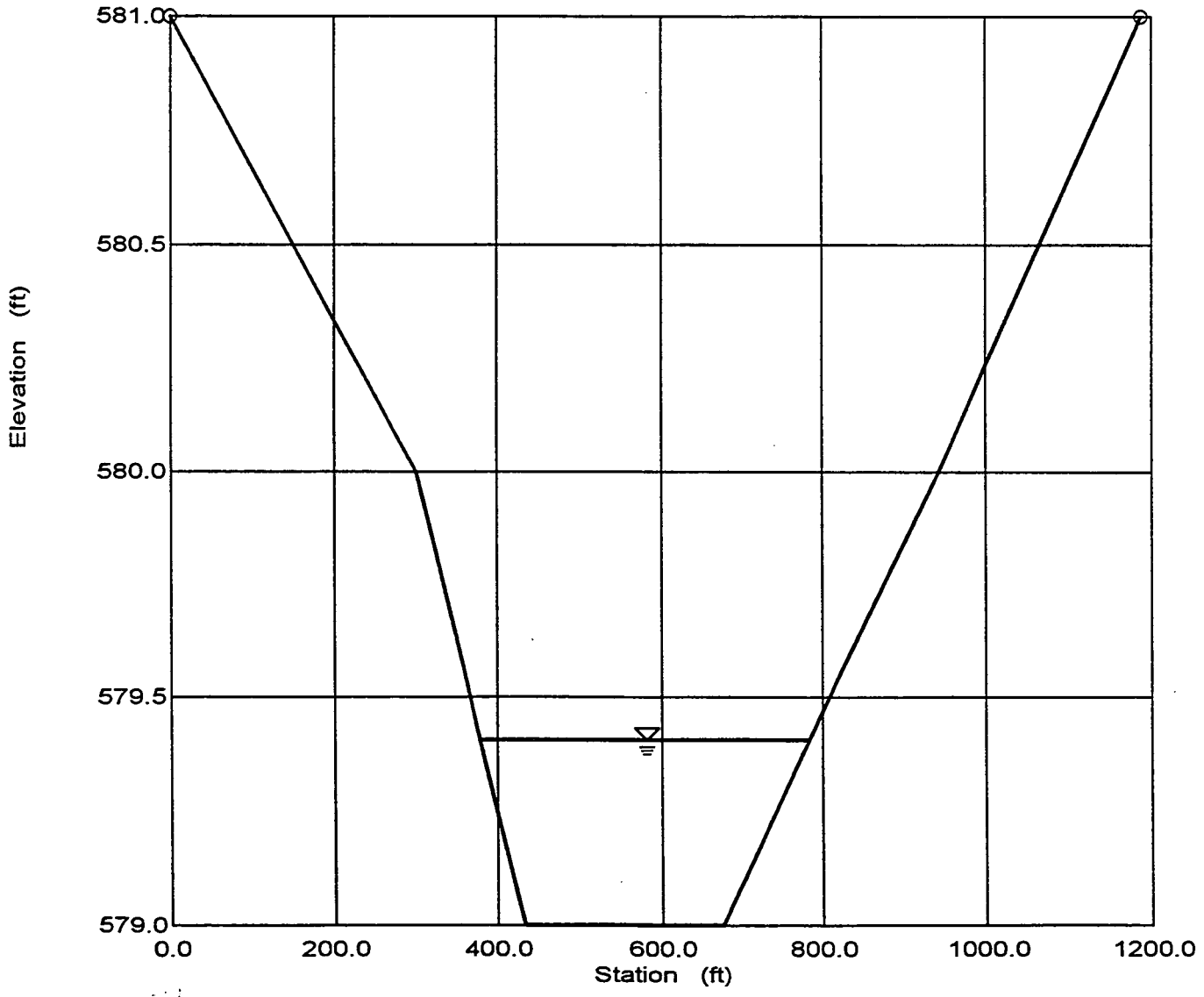
SHT A40

EMERGENCY SPILLWAY
Cross Section for Irregular Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	EMERGENCY SPILLWAY
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.022	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	579.41	ft
Discharge	300.00	cfs



000072

SKT A41 ~~1093~~

2049

BASIN OUTLET CHANNEL
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\dcalc2\project1.fm2
Worksheet	BASIN OUTLET CHANNEL
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.060	
Channel Slope	0.008000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	16.00	ft
Discharge	250.00	cfs

Results		
Depth	2.85	ft
Flow Area	69.84	ft^2
Wetted Perimeter	34.00	ft
Top Width	33.08	ft
Critical Depth	1.75	ft
Critical Slope	0.048196	ft/ft
Velocity	3.58	ft/s
Velocity Head	0.20	ft
Specific Energy	3.05	ft
Froude Number	0.43	
Flow is subcritical.		

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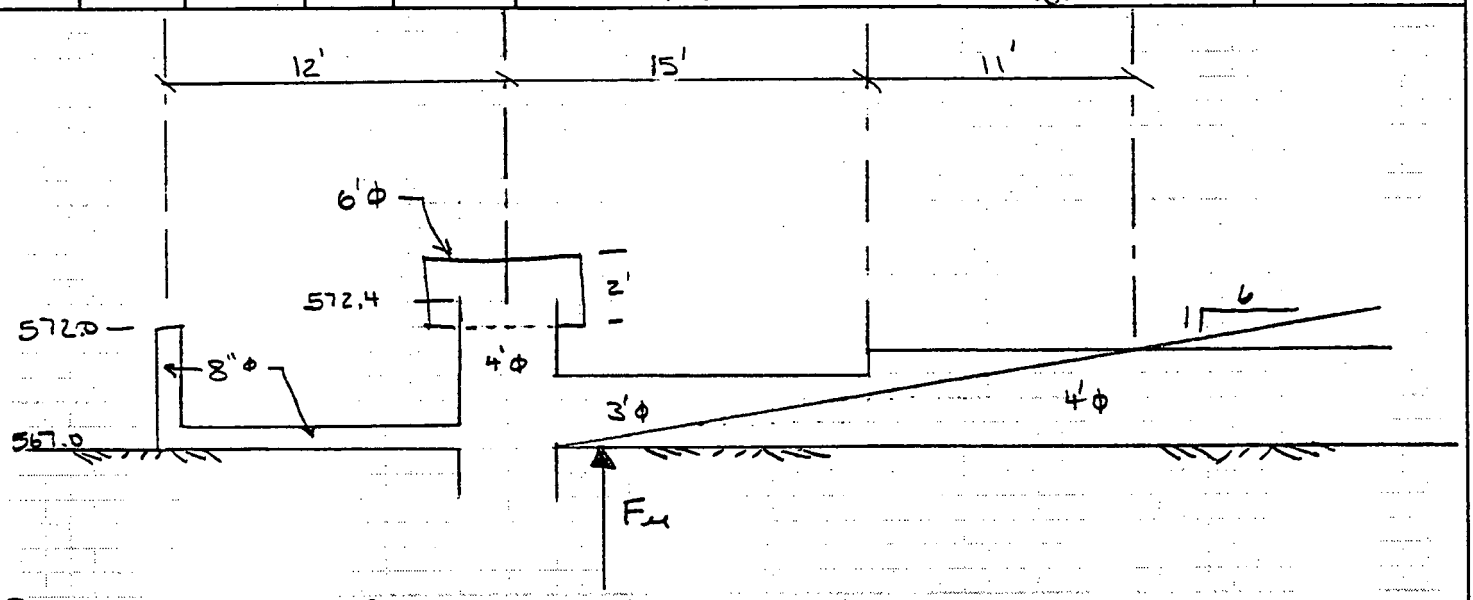
PARSONS ERA PROJECT

CALCULATION SHEET

REV	BY	DATE	CK	DATE	TITLE ANTI-FLOTATION DEVICE	Project
B	TJB	10/2/97				PO No.
					AUTHOR T BROWN SHEET A42 OF	



① DETERMINE BUOYANT FORCE

$F_u = Vol \times W_w$ WHERE $W_w = 62.4\ lb/ft^3$

$$VOL = 5' + 10' \times \pi\frac{(0.67)^2}{4} + 5.4' + 11' \times \pi\frac{(4)^2}{4} + 13' \times \frac{\pi(3)^2}{4} + 2' \times \frac{\pi(6)^4}{4} =$$

$$= 5.3\ ft^3 + 206.1\ ft^3 + 91.9\ ft^3 + 56.6\ ft^3 = 359.9 \Rightarrow 360\ ft^3$$

$$F_u = 360\ ft^3 \times 62.4\ lb/ft^3 = 22{,}464\ lbs$$

② DETERMINE VOL CONC. REQ'D TO COUNTER BUOYANT FORCE
ASSUME WT OF CMP & GRAVEL = 0
USE SF = 1.1

$$VOL.\ CONC = 1.1\frac{F_u}{(W_c - W_w)}$$

WHERE W_c = WT CONCRETE = $150\ lb/ft^3$
$(W_c - W_w)$ = ASSUMES GROUND UNDERNEATH RISER IS SATURATED

$$VOL\ CONC. = 1.1 \times \frac{22464\ lbs}{(150\ lb/ft^3 - 62.4\ lb/ft^3)} = 282.08 \Rightarrow USE\ 282\ ft^3$$

TRY $11 \times 11 \times 2'-4'' = 281.93$ ∴ OK

000074

PARSONS
ERA PROJECT

CALCULATION SHEET

2049 ~~1093~~

REV	BY	DATE	CK	DATE	TITLE ANTISEEP COLLARS	Project
						PO No.
B	TJB	10/20/97			AUTHOR T BROWN SHEET A43 OF	

① DETERMINE NUMBER OF ANTISEEP COLLARS REQ'D.

$$N = 0.075\ L/V$$

WHERE N = NUMBER OF COLLARS
L = LENGTH OF PIPE IN SATURATION ZONE
V = COLLAR PROJECTION (FT)

② PIPE LENGTH ≈ 220 FT BURIED, ASSUME 220 ft SATURATED

③ TRY $V = 2'-9'' = 2.75'$

$$N = 0.075 \times 220\ ft / 2.75 = 6$$

USE MINIMUM OF 6 COLLARS

000075

04/96

NA/ENG025

~~000075~~

ATTACHMENT B, CONVEYANCE CHANNEL/DIVERSION DITCHES

Methodology

These calculations are performed using the "worst case" scenario for peak flows. The conveyance channels 1A and 1B were evaluated under the same watershed conditions as the sediment basin. The conveyance channels and ditch 1 were designed using the10 yr - 24 hr storm event. The inflow hydrograph is developed using *"Technical Release No. 55"*, and the computer program Quick TR-55 (Reference 2). Input variables used in TR-55 are described in Attachment A, Basins.

Due to the small drainage area associated with Ditch 2, the Modified Rational Method (Reference 2) was used to determine the peak flow for the 10 year frequency storm event. After drainage area was calculated, 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) using the Rainfall Intensity-Frequency-Duration Curve for the Fernald area (Reference 10).

The conveyance channels and ditches were designed based on the uniform flow theory using Manning's equation. In order to evaluate channel/ditch design and performance of the channel lining, the worst case flow conditions for velocity and flow depth were considered for the two types of ditch lining. The Flow Master computer program was used to evaluate the effects of the varying components on the performance of the channel/ditch (Reference 4).

Two type of ditch lining were evaluated; vegetated using erosion control blankets, and dumped rock fill (riprap). Roughness coefficients for these lining types were selected from Reference 10, and are as follows:

Erosion Control Blankets n = 0.04
Riprap n = 0.06

Maximum flow velocity for using erosion control blankets without velocity checks was established at 3.0 fps. The maximum velocity for the use of erosion control blankets as a lining material was established at 4.0 feet per second (Reference 10).

Calculations are included on the following pages.

SHT B2

CONVEYANCE CHANNEL 1A

Quick TR-55 Ver.5.46 S/N:
Executed: 14:20:22 10-22-1997 c:\po175\basincal\CHAN 1A.TCT

CONVEYANCE CHANNEL 1A

2049

Tc COMPUTATIONS FOR: SUBAREA A

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	300.0		
Two-yr 24-hr rainfall, P2	in	3.000		
Land slope, s	ft/ft	0.0233		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.34	=	0.34

SHALLOW CONCENTRATED FLOW

Segment ID		2		
Surface (paved or unpaved)?		Unpaved		
Flow length, L	ft	1214.0		
Watercourse slope, s	ft/ft	0.0186		
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.2005		
where: Unpaved Csf = 16.1345				
Paved Csf = 20.3282				
T = L / (3600*V)	hrs	0.15	=	0.15

CHANNEL FLOW

Segment ID		3		
Cross Sectional Flow Area, a	sq.ft	33.08		
Wetted perimeter, Pw	ft	38.13		
Hydraulic radius, r = a/Pw	ft	0.868		
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	3.0307		
Flow length, L	ft	1277		
T = L / (3600*V)	hrs	0.12	=	0.12

::

TOTAL TIME (hrs) 0.61

SHT B4

Quick TR-55 Ver.5.46 S/N:
Executed: 14:20:22 10-22-1997 c:\po175\basincal\CHAN 1A.TCT

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

CONVEYANCE CHANNEL 1A

Subarea descr.	Tc or Tt	Time (hrs)
SUBAREA A	Tc	0.61

SHT B5 ~~T003~~

SUBAREA 1; Tc
Worksheet for Trapezoidal Channel

2049

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	SUBAREA 1; Tc
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	34.00	ft
Discharge	100.00	cfs (CONSERVATIVE)

Results		
Depth	0.92	ft
Flow Area	33.08	ft^2
Wetted Perimeter	38.13	ft
Top Width	37.69	ft
Critical Depth	0.64	ft
Critical Slope	0.027717	ft/ft
Velocity	3.02	ft/s
Velocity Head	0.14	ft
Specific Energy	1.06	ft
Froude Number	0.57	
Flow is subcritical.		

000080

SHT 36

Quick TR-55 Ver.5.46 S/N:
Executed: 14:25:16 10-22-1997

CONVEYANCE CHANNEL 1A

RUNOFF CURVE NUMBER DATA

::

Composite Area: SUBAREA A

SURFACE DESCRIPTION	AREA (acres)	CN	
FdA; Pasture; (35.4%)(HSG-C)	14.41	79	
FdA; Bare; (24.6%)(HSG-C)	10.00	91	
XfB2; Pasture; (33.7%)(HSG-B)	13.70	69	
FdA; GRAVEL; (6.3%)(HSG-C)	2.57	89	
COMPOSITE AREA --->	40.68	79.2	(79)

::

E ~~1003~~

SHB7

Quick TR-55 Ver.5.46 S/N:
Executed: 14:25:16 10-22-1997

2049

CONVEYANCE CHANNEL 1A

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
SUBAREA A	40.68	79

SHT 88

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 10 years

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

Executed: 10-22-1997 14:26:13
Watershed file: --> C:\PO175\BASINCAL\CHAN 1A .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1A-10.HYD

CONVEYANCE CHANNEL 1A

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

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
SUBAREA A	40.68	79.0	0.50	0.00	4.10	2.04	I.13	.13

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

Total area = 40.68 acres or 0.06356 sq.mi
Peak discharge = 67 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
SUBAREA A	0.61	0.00	0.50	0.00	Yes	--

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

Return Frequency: 10 years

2049

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

Executed: 10-22-1997 14:26:13
Watershed file: --> C:\PO175\BASINCAL\CHAN 1A .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1A-10.HYD

CONVEYANCE CHANNEL 1A

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

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
SUBAREA A	67	12.4
Composite Watershed	67	12.4

Return Frequency: 10 years

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

Executed: 10-22-1997 14:26:13
Watershed file: --> C:\PO175\BASINCAL\CHAN 1A .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1A-10.HYD

CONVEYANCE CHANNEL 1A

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
SUBAREA A	2	3	4	6	11	20	37	58	67
Total (cfs)	2	3	4	6	11	20	37	58	67

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
SUBAREA A	64	52	39	30	19	13	10	8	7
Total (cfs)	64	52	39	30	19	13	10	8	7

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
SUBAREA A	6	6	5	4	4	4	3	3	3
Total (cfs)	6	6	5	4	4	4	3	3	3

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
SUBAREA A	3	2	2	2	0
Total (cfs)	3	2	2	2	0

Return Frequency: 10 years

2049

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

Executed: 10-22-1997 14:26:13
Watershed file: --> C:\PO175\BASINCAL\CHAN 1A .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1A-10.HYD

CONVEYANCE CHANNEL 1A

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	2	14.8	4
11.1	2	14.9	4
11.2	3	15.0	4
11.3	3	15.1	4
11.4	3	15.2	4
11.5	4	15.3	4
11.6	4	15.4	4
11.7	5	15.5	4
11.8	5	15.6	4
11.9	6	15.7	4
12.0	11	15.8	4
12.1	20	15.9	4
12.2	37	16.0	4
12.3	58	16.1	4
12.4	67	16.2	4
12.5	64	16.3	3
12.6	52	16.4	3
12.7	39	16.5	3
12.8	30	16.6	3
12.9	24	16.7	3
13.0	19	16.8	3
13.1	16	16.9	3
13.2	13	17.0	3
13.3	11	17.1	3
13.4	10	17.2	3
13.5	9	17.3	3
13.6	8	17.4	3
13.7	7	17.5	3
13.8	7	17.6	3
13.9	6	17.7	3
14.0	6	17.8	3
14.1	6	17.9	3
14.2	6	18.0	3
14.3	6	18.1	3
14.4	6	18.2	3
14.5	5	18.3	3

SHT B12

14.6	5	18.4	3
14.7	5	18.5	3

Return Frequency: 10 years

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

-- 2049

Executed: 10-22-1997 14:26:13
Watershed file: --> C:\PO175\BASINCAL\CHAN 1A .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1A-10.HYD

CONVEYANCE CHANNEL 1A

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	2	22.4	2
18.7	2	22.5	2
18.8	2	22.6	2
18.9	2	22.7	2
19.0	2	22.8	2
19.1	2	22.9	2
19.2	2	23.0	2
19.3	2	23.1	1
19.4	2	23.2	1
19.5	2	23.3	1
19.6	2	23.4	1
19.7	2	23.5	1
19.8	2	23.6	1
19.9	2	23.7	1
20.0	2	23.8	1
20.1	2	23.9	1
20.2	2	24.0	1
20.3	2	24.1	1
20.4	2	24.2	1
20.5	2	24.3	1
20.6	2	24.4	1
20.7	2	24.5	1
20.8	2	24.6	1
20.9	2	24.7	1
21.0	2	24.8	1
21.1	2	24.9	1
21.2	2	25.0	1
21.3	2	25.1	0
21.4	2	25.2	0
21.5	2	25.3	0
21.6	2	25.4	0
21.7	2	25.5	0
21.8	2	25.6	0
21.9	2	25.7	0
22.0	2	25.8	0
22.1	2	25.9	0
22.2	2		
22.3	2		

SHT B14

CONVEYANCE CHANNEL 1A
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	CONVEYANCE CHANNEL 1A
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	34.00	ft
Discharge	67.00	cfs

Results		
Depth	0.73	ft
Flow Area	25.78	ft^2
Wetted Perimeter	37.25	ft
Top Width	36.91	ft
Critical Depth	0.49	ft
Critical Slope	0.030115	ft/ft
Velocity	2.60	ft/s
Velocity Head	0.10	ft
Specific Energy	0.83	ft
Froude Number	0.55	
Flow is subcritical.		

000089

SHT B15. 1093

2049

CONVEYANCE CHANNEL 1B

SHT B16

Quick TR-55 Ver.5.46 S/N:
Executed: 11:44:58 10-27-1997 c:\po175\basincal\CHAN 1B.TCT

CONVEYANCE CHANNEL 1B

Tc COMPUTATIONS FOR: SUBAREA 1

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	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0233	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.34	= 0.34

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	1214.0	
Watercourse slope, s	ft/ft	0.0186	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.2005	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.15	= 0.15

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	33.08	
Wetted perimeter, Pw	ft	38.13	
Hydraulic radius, r = a/Pw	ft	0.868	
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	3.0307	
Flow length, L	ft	1277	
T = L / (3600*V)	hrs	0.12	= 0.12

::

TOTAL TIME (hrs) 0.61

SHT B17 ~~109~~

Quick TR-55 Ver.5.46 S/N:
Executed: 11:44:58 10-27-1997 c:\po175\basincal\CHAN 1B.TCT 2049

CONVEYANCE CHANNEL 1B

Tc COMPUTATIONS FOR: SUBAREA 2

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	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0392	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.28	= 0.28

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	487.0	
Watercourse slope, s	ft/ft	0.0068	
$Avg.V = Csf * (s)^{0.5}$	ft/s	1.3305	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.10	= 0.10

CHANNEL FLOW

Segment ID		3	4	
Cross Sectional Flow Area, a	sq.ft	7.26	33.08	
Wetted perimeter, Pw	ft	11.37	38.13	
Hydraulic radius, r = a/Pw	ft	0.639	0.868	
Channel slope, s	ft/ft	0.0100	0.0080	
Manning's roughness coeff., n		0.0400	0.0400	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.7621	3.0307	
Flow length, L	ft	570	280	
T = L / (3600*V)	hrs	0.06 +	0.03	= 0.08

::

TOTAL TIME (hrs) 0.46

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000092

SHT B18

Quick TR-55 Ver.5.46 S/N:
Executed: 11:44:58 10-27-1997 c:\po175\basincal\CHAN 1B.TCT

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

CONVEYANCE CHANNEL 1B

Subarea descr.	Tc or Tt	Time (hrs)
SUBAREA 1	Tc	0.61
SUBAREA 2	Tc	0.46

SHT 819 ~~1093~~

Quick TR-55 Ver.5.46 S/N:
Executed: 14:37:54 10-22-1997

2049

CONVEYANCE CHANNEL 1B

Tc or Tt DATA
::

Subarea: DESCRIPTION	LENGTH (feet)	VELOCITY (ft/sec)	TIME minutes		TIME hours
CONVEYANCE CHANNEL 1A OUTLET	280	3.03	1.5	=	0.03
			minutes		hours
		TOTAL Tt --->	1.5	=	0.03

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SHT B20

Quick TR-55 Ver.5.46 S/N:
Executed: 14:41:04 10-22-1997

CONVEYANCE CHANNEL 1B

RUNOFF CURVE NUMBER DATA

::

Composite Area: SUBAREA 1

SURFACE DESCRIPTION	AREA (acres)	CN	
FdA; Pasture; (35.4%)(HSG-C)	14.41	79	
FdA; Bare; (24.6%)(HSG-C)	10.00	91	
XfB2; Pasture; (33.7%)(HSG-B)	13.70	69	
FdA; GRAVEL; (6.3%)(HSG-C)	2.57	89	
COMPOSITE AREA --->	40.68	79.2	(79)

::

Composite Area: SUBAREA 2

SURFACE DESCRIPTION	AREA (acres)	CN	
XfB2; Bare; (30.0%)(HSG-B)	7.46	86	
XfB2; Pasture; (30.0%)(HSG-B)	7.46	58	
FdA; Bare; (20.0%)(HSG-C)	4.97	91	
FdA; Pasture; (20.0%)(HSG-C)	4.97	79	
COMPOSITE AREA --->	24.86	77.2	(77)

::

Quick TR-55 Ver.5.46 S/N:
Executed: 14:41:04 10-22-1997

CONVEYANCE CHANNEL 1B

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
SUBAREA 1	40.68	79
SUBAREA 2	24.86	77

SHT B22

Return Frequency: 10 years

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

Executed: 10-27-1997 11:47:53
Watershed file: --> C:\PO175\BASINCAL\CHAN 1B .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1B-10.HYD

CONVEYANCE CHANNEL 1B

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

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
SUBAREA 1	40.68	79.0	0.50	0.10	4.10	2.04	I.13	.13
SUBAREA 2	24.86	77.0	0.40	0.00	4.10	1.89	I.15	.15

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

Total area = 65.54 acres or 0.10241 sq.mi
Peak discharge = 99 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
SUBAREA 1	0.61	0.03	0.50	0.10	Yes	--
SUBAREA 2	0.44	0.00	0.40	0.00	Yes	--

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

Return Frequency: 10 years

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

2049

Executed: 10-27-1997 11:47:53
Watershed file: --> C:\PO175\BASINCAL\CHAN 1B .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1B-10.HYD

CONVEYANCE CHANNEL 1B

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

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
SUBAREA 1	62	12.5
SUBAREA 2	41	12.3
Composite Watershed	99	12.4

SHT B24

Return Frequency: 10 years

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

Executed: 10-27-1997 11:47:53
Watershed file: --> C:\PO175\BASINCAL\CHAN 1B .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1B-10.HYD

CONVEYANCE CHANNEL 1B

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
SUBAREA 1	2	2	3	6	9	16	28	46	58
SUBAREA 2	1	1	2	4	8	17	31	41	41
Total (cfs)	3	3	5	10	17	33	59	87	99

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
SUBAREA 1	62	56	45	36	22	15	11	9	8
SUBAREA 2	31	22	16	12	8	6	5	4	4
Total (cfs)	93	78	61	48	30	21	16	13	12

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
SUBAREA 1	7	6	5	5	4	4	3	3	3
SUBAREA 2	4	3	3	3	2	2	2	2	2
Total (cfs)	11	9	8	8	6	6	5	5	5

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
SUBAREA 1	3	2	2	2	0
SUBAREA 2	2	1	1	1	0

Total (cfs)	5	3	3	3	0

SHT B25

~~1093~~

2049

000100

~~000103~~

SHT B26

Return Frequency: 10 years

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

Executed: 10-27-1997 11:47:53
Watershed file: --> C:\PO175\BASINCAL\CHAN 1B .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1B-10.HYD

CONVEYANCE CHANNEL 1B

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	3	14.8	8
11.1	3	14.9	8
11.2	3	15.0	8
11.3	3	15.1	8
11.4	4	15.2	7
11.5	4	15.3	7
11.6	5	15.4	6
11.7	7	15.5	6
11.8	8	15.6	6
11.9	10	15.7	6
12.0	17	15.8	6
12.1	33	15.9	6
12.2	59	16.0	6
12.3	87	16.1	6
12.4	99	16.2	6
12.5	93	16.3	5
12.6	78	16.4	5
12.7	61	16.5	5
12.8	48	16.6	5
12.9	39	16.7	5
13.0	30	16.8	5
13.1	25	16.9	5
13.2	21	17.0	5
13.3	18	17.1	5
13.4	16	17.2	5
13.5	15	17.3	5
13.6	13	17.4	5
13.7	12	17.5	5
13.8	12	17.6	5
13.9	11	17.7	5
14.0	11	17.8	5
14.1	10	17.9	5
14.2	10	18.0	5
14.3	9	18.1	5
14.4	9	18.2	5
14.5	8	18.3	4

SHT B2 1

14.6	8	18.4	4
14.7	8	18.5	4

~~1093~~

2049

5H B28

Return Frequency: 10 years

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

Executed: 10-27-1997 11:47:53
Watershed file: --> C:\PO175\BASINCAL\CHAN 1B .MOP
Hydrograph file: --> C:\PO175\BASINCAL\CH1B-10.HYD

CONVEYANCE CHANNEL 1B

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	4	22.4	3
18.7	4	22.5	3
18.8	3	22.6	3
18.9	3	22.7	2
19.0	3	22.8	2
19.1	3	22.9	2
19.2	3	23.0	2
19.3	3	23.1	2
19.4	3	23.2	2
19.5	3	23.3	2
19.6	3	23.4	2
19.7	3	23.5	2
19.8	3	23.6	2
19.9	3	23.7	2
20.0	3	23.8	2
20.1	3	23.9	2
20.2	3	24.0	2
20.3	3	24.1	1
20.4	3	24.2	1
20.5	3	24.3	1
20.6	3	24.4	1
20.7	3	24.5	1
20.8	3	24.6	1
20.9	3	24.7	1
21.0	3	24.8	1
21.1	3	24.9	1
21.2	3	25.0	1
21.3	3	25.1	1
21.4	3	25.2	1
21.5	3	25.3	1
21.6	3	25.4	0
21.7	3	25.5	0
21.8	3	25.6	0
21.9	3	25.7	0
22.0	3	25.8	0
22.1	3	25.9	0
22.2	3		
22.3	3		

SHT B29

~~1008~~

2049

CONVEYANCE CHANNEL 1B
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	CONVEYANCE CHANNEL 1B
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	34.00	ft
Discharge	99.00	cfs

Results		
Depth	0.92	ft
Flow Area	32.88	ft^2
Wetted Perimeter	38.10	ft
Top Width	37.67	ft
Critical Depth	0.63	ft
Critical Slope	0.027774	ft/ft
Velocity	3.01	ft/s
Velocity Head	0.14	ft
Specific Energy	1.06	ft
Froude Number	0.57	
Flow is subcritical.		

000104

~~000102~~

SHT B30

DITCH 1

SHT B31

~~1008~~

Quick TR-55 Ver.5.46 S/N:
Executed: 10:30:42 10-30-1997 c:\po175\basincal\DITCH 1.TCT

DITCH 1

2049

Tc COMPUTATIONS FOR: SUBAREA 1

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	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0392	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.28	= 0.28

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	487.0	
Watercourse slope, s	ft/ft	0.0068	
$Avg.V = Csf * (s)^{0.5}$	ft/s	1.3305	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.10	= 0.10

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	7.26	
Wetted perimeter, Pw	ft	11.37	
Hydraulic radius, r = a/Pw	ft	0.639	
Channel slope, s	ft/ft	0.0100	
Manning's roughness coeff., n		0.0400	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.7621	
Flow length, L	ft	570	
T = L / (3600*V)	hrs	0.06	= 0.06

::

TOTAL TIME (hrs) 0.44

000106

~~000104~~

SHT B32

Quick TR-55 Ver.5.46 S/N:
Executed: 10:30:42 10-30-1997 c:\po175\basincal\DITCH 1.TCT

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

DITCH 1

Subarea descr.	Tc or Tt	Time (hrs)
SUBAREA 1	Tc	0.44

SHT B33

~~1008~~

Quick TR-55 Ver.5.46 S/N:
Executed: 10:58:46 10-30-1997

2049

DITCH 1

RUNOFF CURVE NUMBER DATA

::

Composite Area: SUBAREA 1

SURFACE DESCRIPTION	AREA (acres)	CN	
XfB2; Bare; (42.0%)(HSG-B)	2.51	86	
Gravel; (16.0%)	1.00	89	
COMPOSITE AREA --->	6.02	50.6	(51)

::

000108

~~000108~~

SHT B 34

Quick TR-55 Ver.5.46 S/N:
Executed: 10:58:46 10-30-1997

DITCH 1

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
SUBAREA 1	6.02	51

Return Frequency: 10 years

2049

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

Executed: 10-30-1997 10:59:02
Watershed file: --> C:\PO175\BASINCAL\DITCH 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\D1-10.HYD

DITCH 1

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

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
SUBAREA 1	6.02	75.0	0.40	0.00	4.10	1.74	I.16	.16

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

Total area = 6.02 acres or 0.00941 sq.mi
Peak discharge = 9 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
SUBAREA 1	0.44	0.00	0.40	0.00	Yes	--

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

SHT 15 56

Return Frequency: 10 years

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

Executed: 10-30-1997 10:59:02
Watershed file: --> C:\P0175\BASINCAL\DITCH 1 .MOP
Hydrograph file: --> C:\P0175\BASINCAL\D1-10.HYD

DITCH 1

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

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
SUBAREA 1	9	12.3
Composite Watershed	9	12.3

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

2049

Executed: 10-30-1997 10:59:02
Watershed file: --> C:\PO175\BASINCAL\DITCH 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\D1-10.HYD

DITCH 1

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
SUBAREA 1	0	0	0	1	2	4	7	9	9
Total (cfs)	0	0	0	1	2	4	7	9	9

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
SUBAREA 1	7	5	4	3	2	1	1	1	1
Total (cfs)	7	5	4	3	2	1	1	1	1

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

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

SHT B38

Return Frequency: 10 years

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

Executed: 10-30-1997 10:59:02
Watershed file: --> C:\PO175\BASINCAL\DITCH 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\D1-10.HYD

DITCH 1

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	1
11.1	0	14.9	1
11.2	0	15.0	1
11.3	0	15.1	1
11.4	0	15.2	1
11.5	0	15.3	1
11.6	0	15.4	1
11.7	0	15.5	1
11.8	1	15.6	1
11.9	1	15.7	1
12.0	2	15.8	0
12.1	4	15.9	0
12.2	7	16.0	0
12.3	9	16.1	0
12.4	9	16.2	0
12.5	7	16.3	0
12.6	5	16.4	0
12.7	4	16.5	0
12.8	3	16.6	0
12.9	2	16.7	0
13.0	2	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 B39

14.6	1	18.4	0
14.7	1	18.5	0

~~1095~~

2049

SHT B40

Return Frequency: 10 years

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

Executed: 10-30-1997 10:59:02
Watershed file: --> C:\PO175\BASINCAL\DITCH 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\D1-10.HYD

DITCH 1

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		

SHT B4L

~~1003~~

2049

DITCH 1
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	DITCH 1
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	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	9.00	cfs

Results		
Depth	0.88	ft
Flow Area	4.09	ft^2
Wetted Perimeter	7.57	ft
Top Width	7.28	ft
Critical Depth	0.63	ft
Critical Slope	0.032532	ft/ft
Velocity	2.20	ft/s
Velocity Head	0.08	ft
Specific Energy	0.96	ft
Froude Number	0.52	
Flow is subcritical.		

Notes:

Velocity < 3.0 fps
Use Erosion Control Blanket Lining w/o Rock Velocity Checks

000116

SHT B42

DITCH 2

000117

Quick TR-55 Ver.5.46 S/N:
Executed: 13:59:59 10-30-1997

B43 ~~109~~

DITCH-2

2049

* * * * * * 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	1.87						
GRAVEL RD	0.900	0.20						
			10.00	0.719	0.719	5.450	2.07	8.12

000118

~~000118~~

SHT B44

DITCH 2
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\po175\basincal\project1.fm2
Worksheet	DITCH 2
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	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	2.00	ft
Discharge	8.10	cfs

Results		
Depth	0.84	ft
Flow Area	3.78	ft^2
Wetted Perimeter	7.30	ft
Top Width	7.03	ft
Critical Depth	0.59	ft
Critical Slope	0.033008	ft/ft
Velocity	2.14	ft/s
Velocity Head	0.07	ft
Specific Energy	0.91	ft
Froude Number	0.52	
Flow is subcritical.		

Notes:

Velocity < 3.0 fps
Use Erosion Control Blanket Lining w/o Rock Velocity Checks.

000119

ATTACHMENT C, CULVERTS

Methodology

The culverts were designed using the "worst case" land use conditions for a 10 yr - 24 hr storm event. The inflow hydrograph is developed using *"Technical Release No. 55"*, and the computer program Quick TR-55 (Reference 2). Input variables used in TR-55 are described in Attachment A, Basins.

Culvert 1 is located approximately 280 ft upstream from culvert 2 and is used to convey drainage from sediment basin subarea 2 into conveyance channel 1B.

Culvert 2 consists of a series of 5 corrugated polyethylene pipes which convey drainage from conveyance channel 1B into sediment basin 1. At the direction of FDF, Culvert 2 has been located below an existing 24" diameter groundwater line to prevent disturbance of the line. Culvert 2 has also been designed so that the Phase II construction of the North Access Road can be accomplished without modifying the culverts.

Calculations are included on the following pages.

SNT C2

CULVERT 1

SHT C3

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2049

Quick TR-55 Ver.5.46 S/N:
Executed: 12:22:45 10-27-1997 c:\po175\basincal\CULV 1.TCT

CULVERT 1

Tc COMPUTATIONS FOR: SUBAREA ~~1~~ 2 (SHOWN AS SUBAREA 2 ON DRAINAGE MAP)

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	300.0	
Two-yr 24-hr rainfall, P2	in	3.000	
Land slope, s	ft/ft	0.0392	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.28	= 0.28

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	487.0	
Watercourse slope, s	ft/ft	0.0068	
$Avg.V = Csf * (s)^{0.5}$	ft/s	1.3305	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.10	= 0.10

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	7.26	
Wetted perimeter, Pw	ft	11.37	
Hydraulic radius, r = a/Pw	ft	0.639	
Channel slope, s	ft/ft	0.0100	
Manning's roughness coeff., n		0.0400	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	2.7621	
Flow length, L	ft	570	
T = L / (3600*V)	hrs	0.06	= 0.06

::

TOTAL TIME (hrs) 0.44

000122

~~000122~~

SHT CH

Quick TR-55 Ver.5.46 S/N:
Executed: 12:22:45 10-27-1997 c:\po175\basincal\CULV 1.TCT

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

CULVERT 1

Subarea descr.	Tc or Tt	Time (hrs)
SUBAREA ~~1~~ 2	Tc	0.44
~~SUBAREA 2~~	~~?~~	~~0.00~~

SHT C5

~~1098~~

2049

Quick TR-55 Ver.5.46 S/N:
Executed: 15:22:29 10-22-1997

CULVERT 1

RUNOFF CURVE NUMBER DATA

::

Composite Area: SUBAREA 12

SURFACE DESCRIPTION	AREA (acres)	CN	
XfB2; Bare; (30.0%)(HSG-B)	7.46	86	
XfB2; Pasture; (30.0%)(HSG-B)	7.46	58	
FdA; Bare; (20.0%)(HSG-C)	4.97	91	
FdA; Pasture; (20.0%)(HSG-C)	4.97	79	
COMPOSITE AREA --->	24.86	77.2	(77)

::

SHT C6

Quick TR-55 Ver.5.46 S/N:
Executed: 15:22:29 10-22-1997

CULVERT 1

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
SUBAREA 12	24.86	77

SHT C7 ~~1093~~

Quick TR-55 Version: 5.46 S/N:

Return Frequency: 10 years

2049

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

Executed: 10-27-1997 12:23:02
Watershed file: --> C:\PO175\BASINCAL\CULV 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\C1-10.HYD

CULVERT 1

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

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
SUBAREA ~~1~~2	24.86	77.0	0.40	0.00	4.10	1.89	I.15	.15

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

Total area = 24.86 acres or 0.03884 sq.mi
Peak discharge = 41 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
SUBAREA ~~1~~2	0.44	0.00	0.40	0.00	Yes	--

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

SHT C8

Return Frequency: 10 years

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

Executed: 10-27-1997 12:23:02
Watershed file: --> C:\PO175\BASINCAL\CULV 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\C1-10.HYD

CULVERT 1

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

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
SUBAREA ~~1~~ 2	41	12.3
Composite Watershed	41	12.3

Return Frequency: 10 years

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

2049

Executed: 10-27-1997 12:23:02
Watershed file: --> C:\PO175\BASINCAL\CULV 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\C1-10.HYD

CULVERT 1

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
SUBAREA 12	1	1	2	4	8	17	31	41	41
Total (cfs)	1	1	2	4	8	17	31	41	41

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
SUBAREA 12	31	22	16	12	8	6	5	4	4
Total (cfs)	31	22	16	12	8	6	5	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
SUBAREA 12	4	3	3	3	2	2	2	2	2
Total (cfs)	4	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
SUBAREA 12	2	1	1	1	0
Total (cfs)	2	1	1	1	0

SHT C10

Return Frequency: 10 years

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

Executed: 10-27-1997 12:23:02
Watershed file: --> C:\PO175\BASINCAL\CULV 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\C1-10.HYD

CULVERT 1

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	1	14.8	3
11.1	1	14.9	3
11.2	1	15.0	3
11.3	1	15.1	3
11.4	1	15.2	3
11.5	2	15.3	2
11.6	2	15.4	2
11.7	3	15.5	2
11.8	3	15.6	2
11.9	4	15.7	2
12.0	8	15.8	2
12.1	17	15.9	2
12.2	31	16.0	2
12.3	41	16.1	2
12.4	41	16.2	2
12.5	31	16.3	2
12.6	22	16.4	2
12.7	16	16.5	2
12.8	12	16.6	2
12.9	10	16.7	2
13.0	8	16.8	2
13.1	7	16.9	2
13.2	6	17.0	2
13.3	5	17.1	2
13.4	5	17.2	2
13.5	5	17.3	2
13.6	4	17.4	2
13.7	4	17.5	2
13.8	4	17.6	2
13.9	4	17.7	2
14.0	4	17.8	2
14.1	4	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

SHT C11

14.6	3	18.4	2
14.7	3	18.5	2

~~1093~~

2049

SHT C12

Return Frequency: 10 years

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

Executed: 10-27-1997 12:23:02
Watershed file: --> C:\PO175\BASINCAL\CULV 1 .MOP
Hydrograph file: --> C:\PO175\BASINCAL\C1-10.HYD

CULVERT 1

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		

PROJECT:	STATION:	CULVERT DESIGN FORM
	SHEET ____ OF ____	DESIGNER / DATE: ____ / ____
		REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

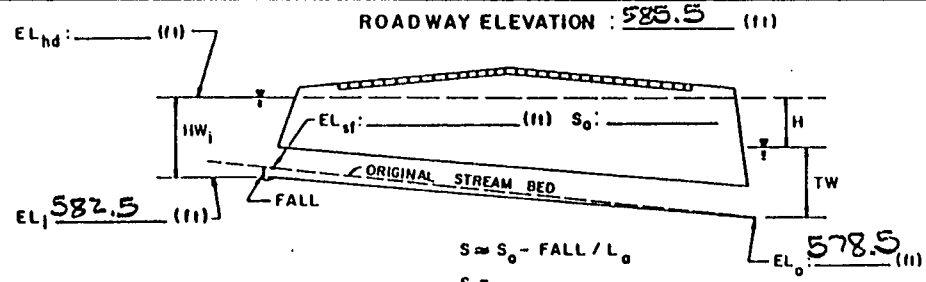
SEE ADD'L SHTS.

- [x] METHOD: SCS
- [ ] DRAINAGE AREA: ____ [ ] STREAM SLOPE: ____
- [ ] CHANNEL SHAPE: ____
- [ ] ROUTING: ____ [ ] OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10	37	*

ROADWAY ELEVATION: 585.5 (ft)



$S \approx S_o$ - FALL / L_o

S = ____

L_o = ≈ 50 ft

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 43" x 27"	41	41	1.6	3.6	—		1.0	1.6	1.9	1.9	0.9	2.2	4.1	—	—	
TRY 3-29" x 18"	41	13.7	1.4	2.1	—	584.6	1.0	1.0	1.3	1.3	0.9	1.6	581.4	584.6	—	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) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(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 1 ft TW

CULVERT BARREL SELECTED:

SIZE: ____

SHAPE: ____

MATERIAL: ____ n ____

ENTRANCE: ____

240

0001132

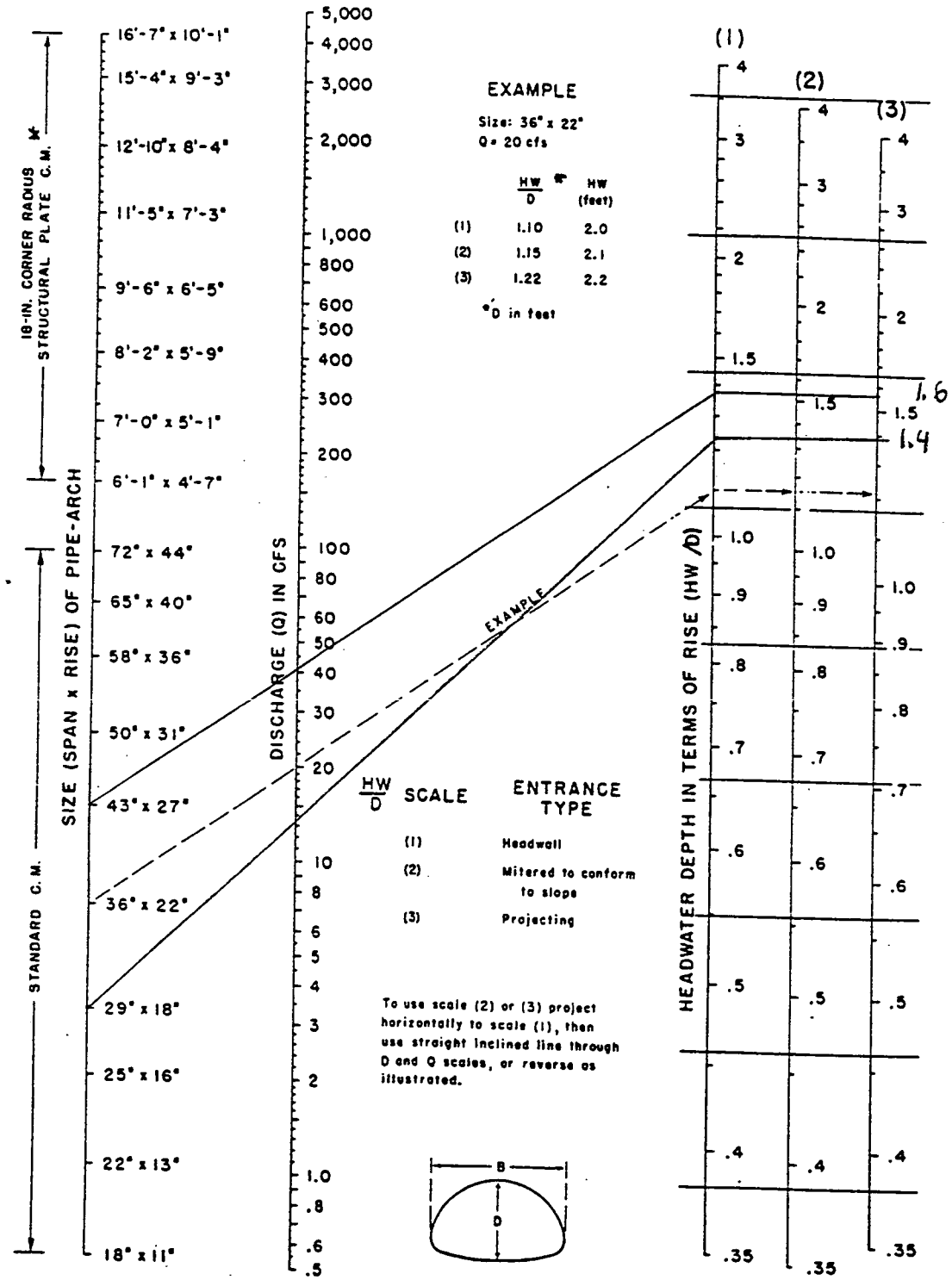
SHT C13

2049

1093

SHT C14

CHART 34



*ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

BUREAU OF PUBLIC ROADS JAN. 1963

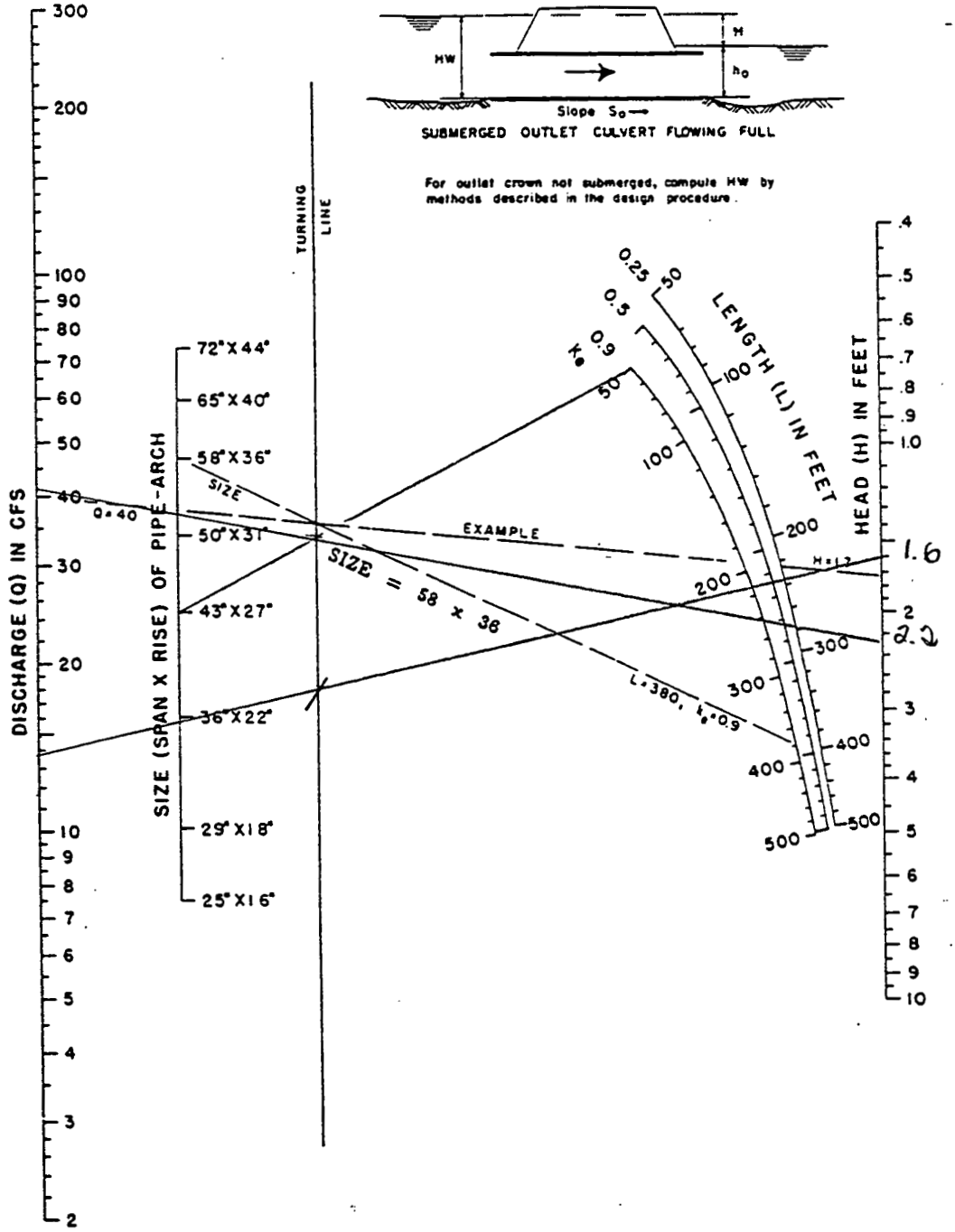
HEADWATER DEPTH FOR C. M. PIPE-ARCH CULVERTS WITH INLET CONTROL

000133

SHT C15

CHART 39 ~~1093~~

2049



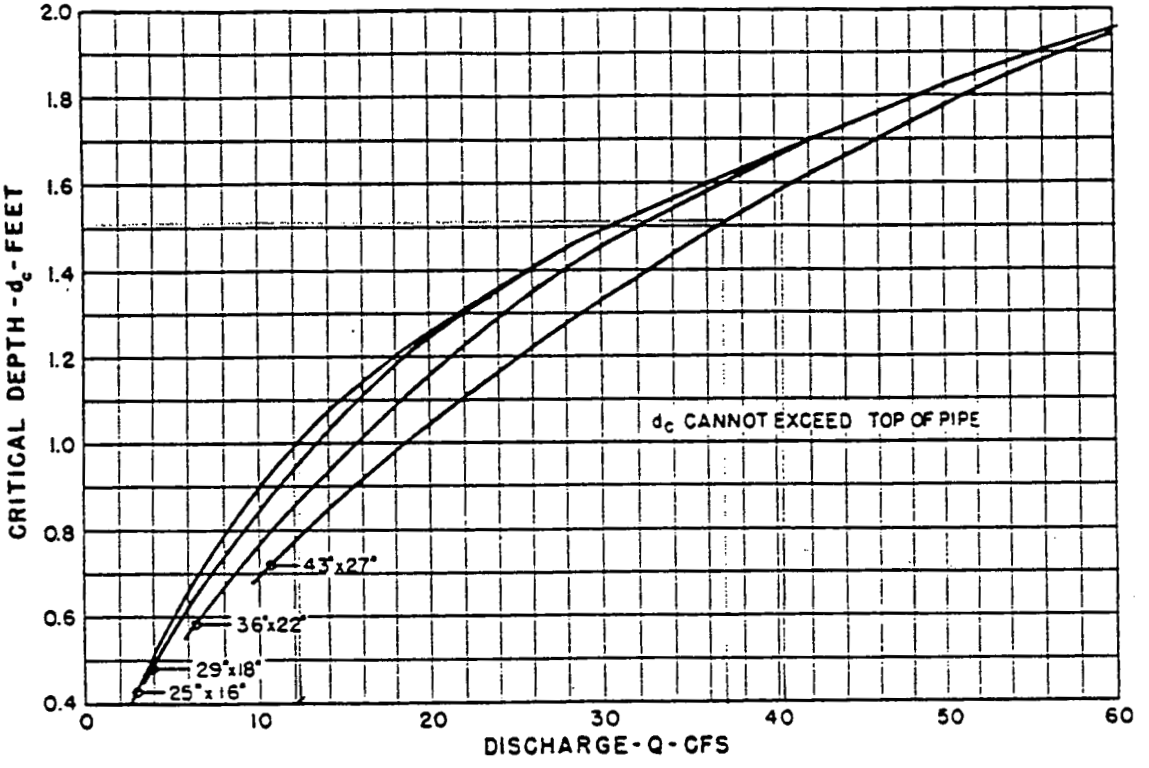
HEAD FOR
STANDARD C. M. PIPE-ARCH CULVERTS
FLOWING FULL
n=0.024

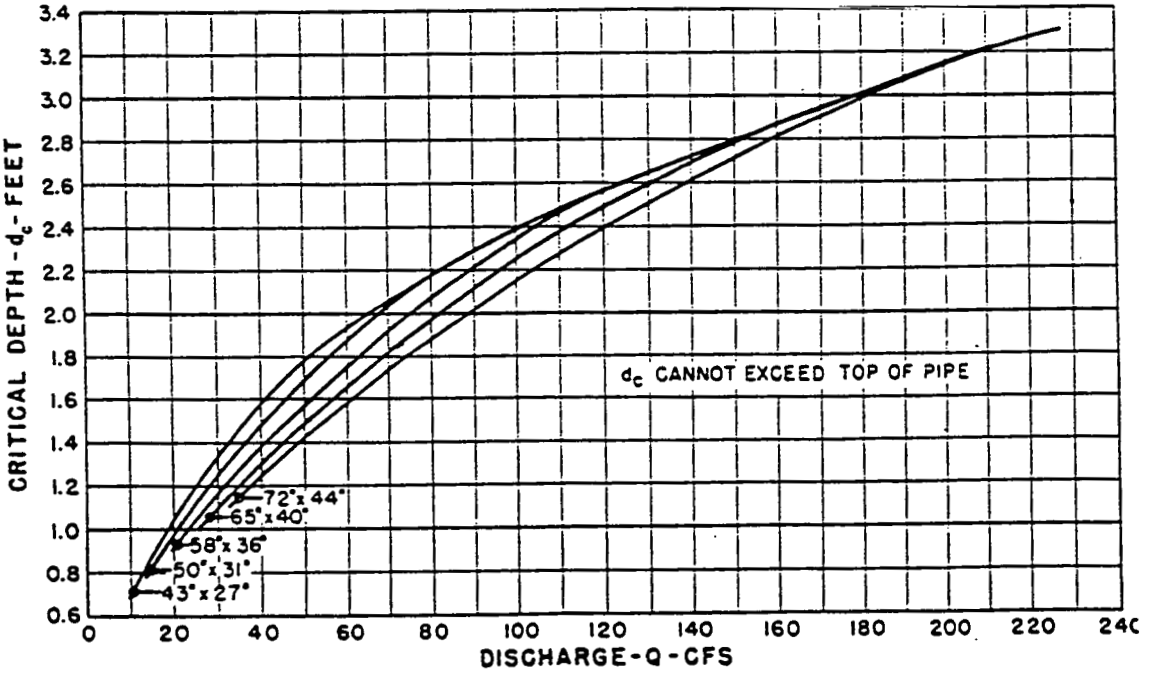
BUREAU OF PUBLIC ROADS JAN. 1963

000134

SAT C16

CHART 37





BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
STANDARD C.M. PIPE-ARCH

000135

[redacted]

SHT C17

~~1093~~

2049

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

000136

Culvert 2

Use design flow for Conveyance Channel 1B, Q_{10} = 99 cfs

Check anticipated flow for later use by OSDF, use Q = 250 cfs

PROJECT: AIPII CULVERT 2	STATION: ____ SHEET ____ OF ____	CULVERT DESIGN FORM DESIGNER / DATE: ____ / ____ REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

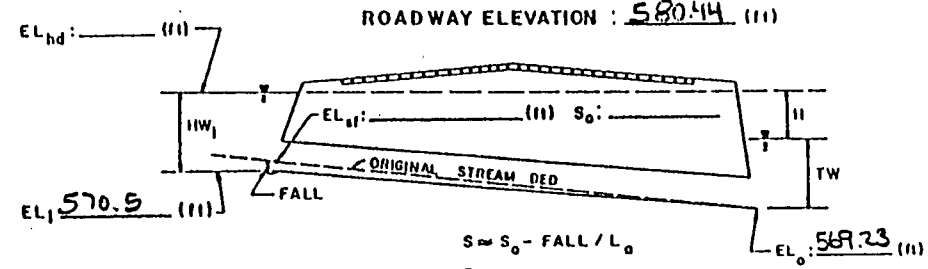
SEE ADD'L. SHTS.

- ☐ METHOD: ____
- ☐ DRAINAGE AREA: ____ ☐ STREAM SLOPE: ____
- ☐ CHANNEL SHAPE: ____
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
10 YR	99	4.2
— TRY	250	5.8

ROADWAY ELEVATION: 580.44 (ft)



$S \approx S_o - FALL / L_o$

$S =$ ____

$L_o =$ 160

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 5-36" ϕ w/n=0.012	99	19.6	0.7	2.1	—	572.6	4.2	1.5	2.3	4.2	0.7	—	573.48	573.43	—	OK.
TRY 5-36" ϕ w/n 0.012 @ 250cfs	250	50	1.3	3.9	-	574.4	5.8	2.4	2.7	5.8	0.7	2.2	577.22	577.23		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) $H = \left[1 + k_e + (29 n^2 L)/R^{1.33}\right] V^2/2g$

(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:

$TW_{10YR} = 573.42 - 569.23 = 4.19 \geq 4.2$

FOR 250CFS, USE TW = 575 - 569.23 = 5.8

CULVERT BARREL SELECTED:

SIZE: ____

SHAPE: ____

MATERIAL: ____ n ____

ENTRANCE: ____

240

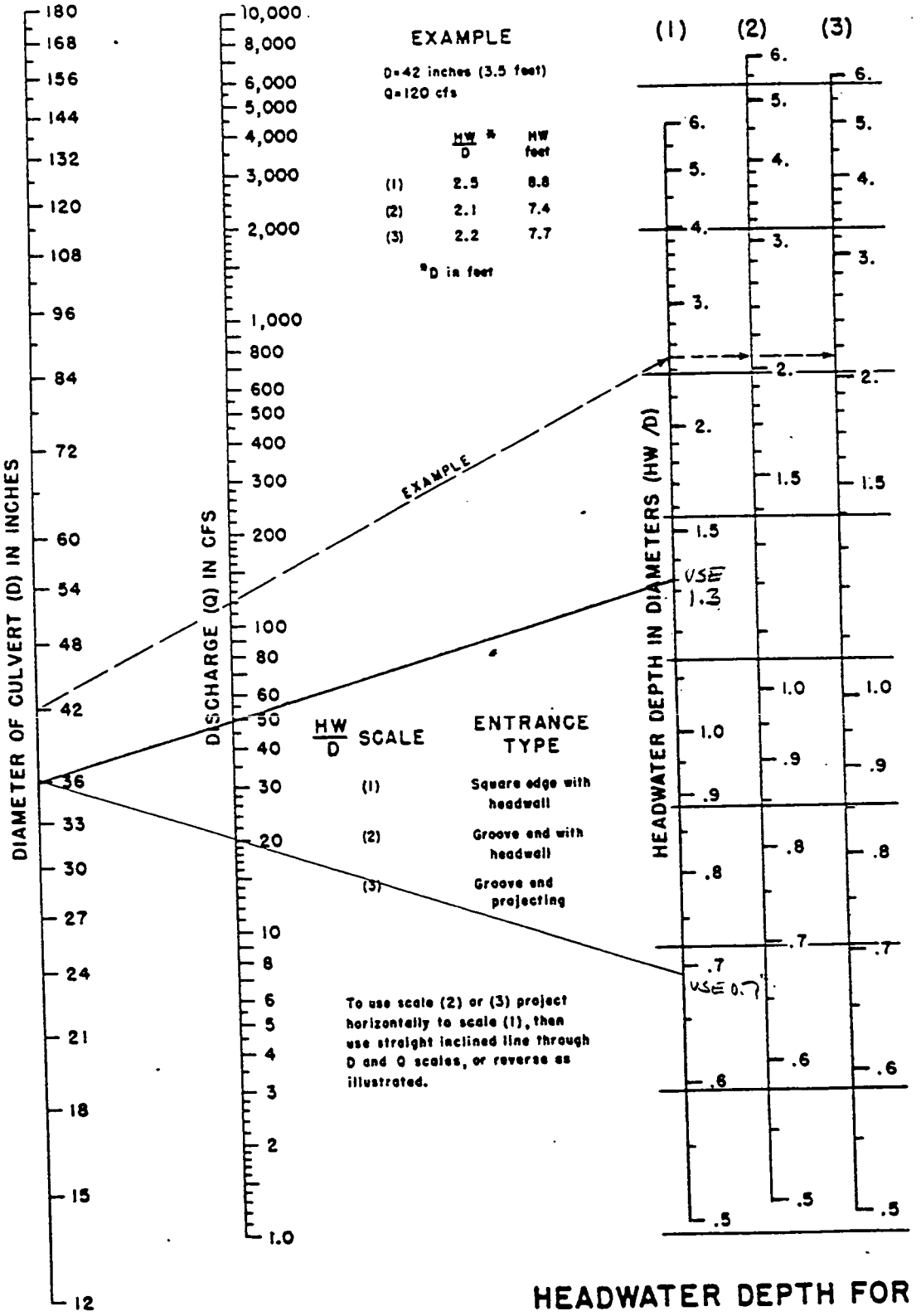
000138

2049

SHEET 1 of 1

SHT C20

CHART 1



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 283
REVISED MAY 1964

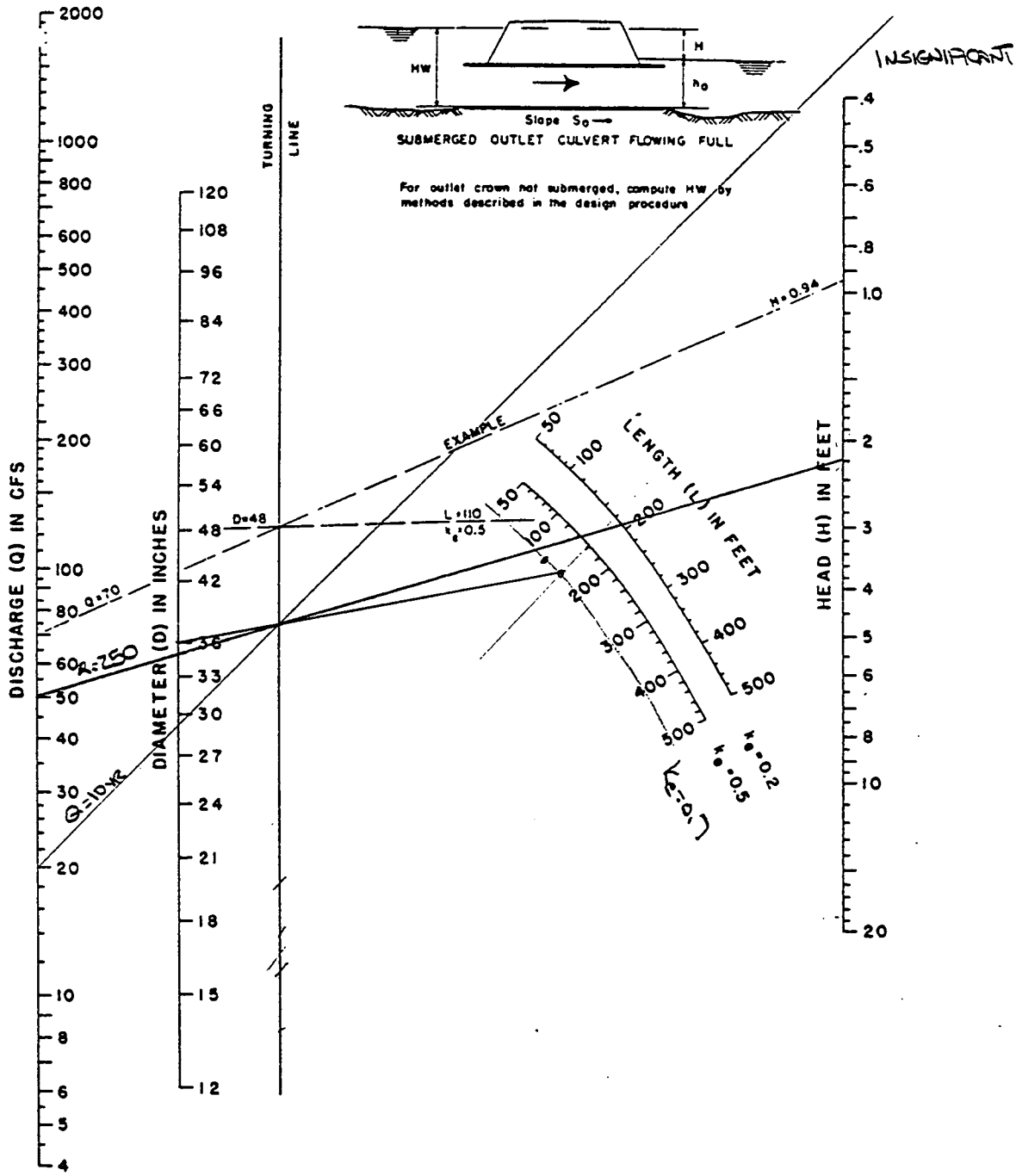
BUREAU OF PUBLIC ROADS JAN. 1963

000139

[redacted]

SHT C21 ~~1098~~

CHART 5 2049



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

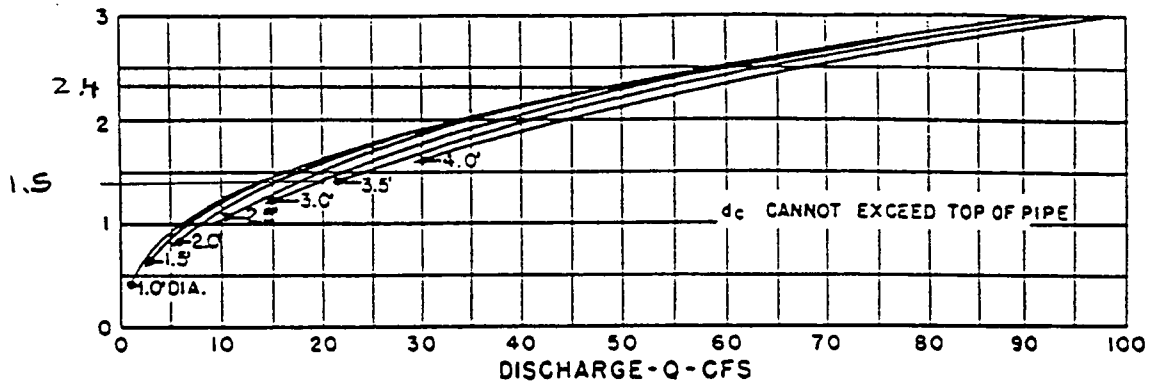
BUREAU OF PUBLIC ROADS JAN. 1963

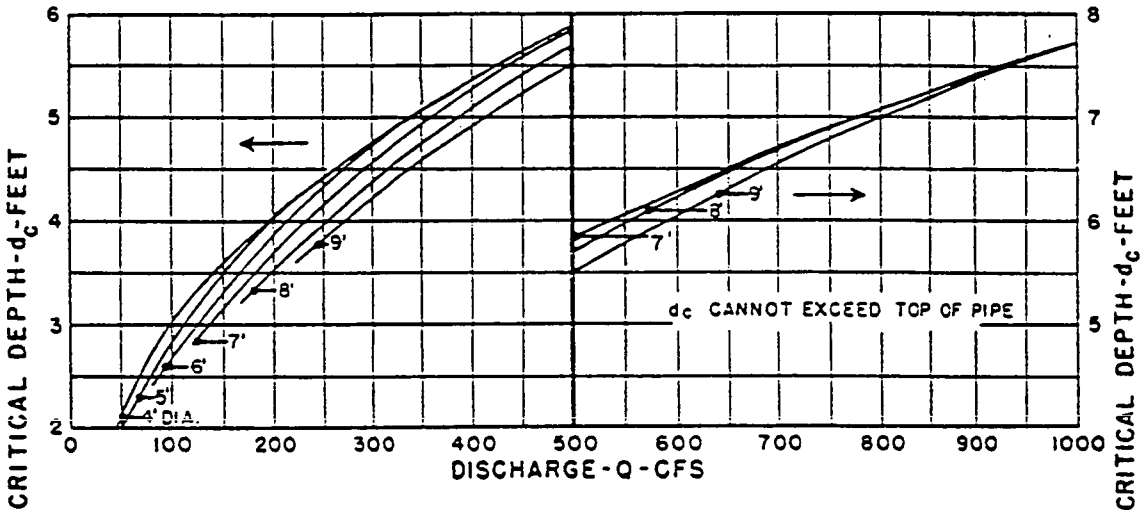
000140

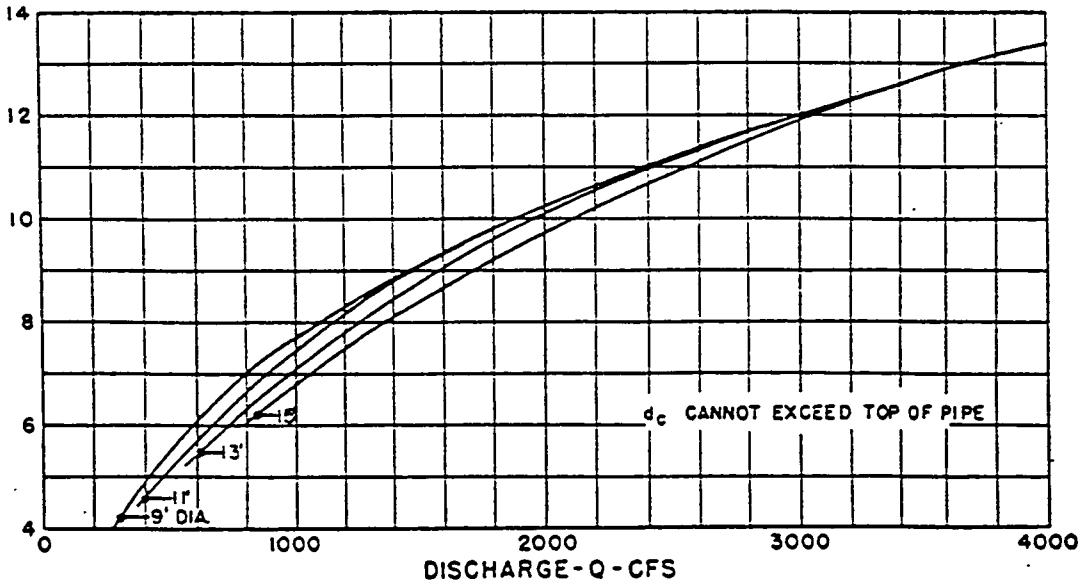
~~000148~~

SHT C22

CHART 4







BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

000141

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

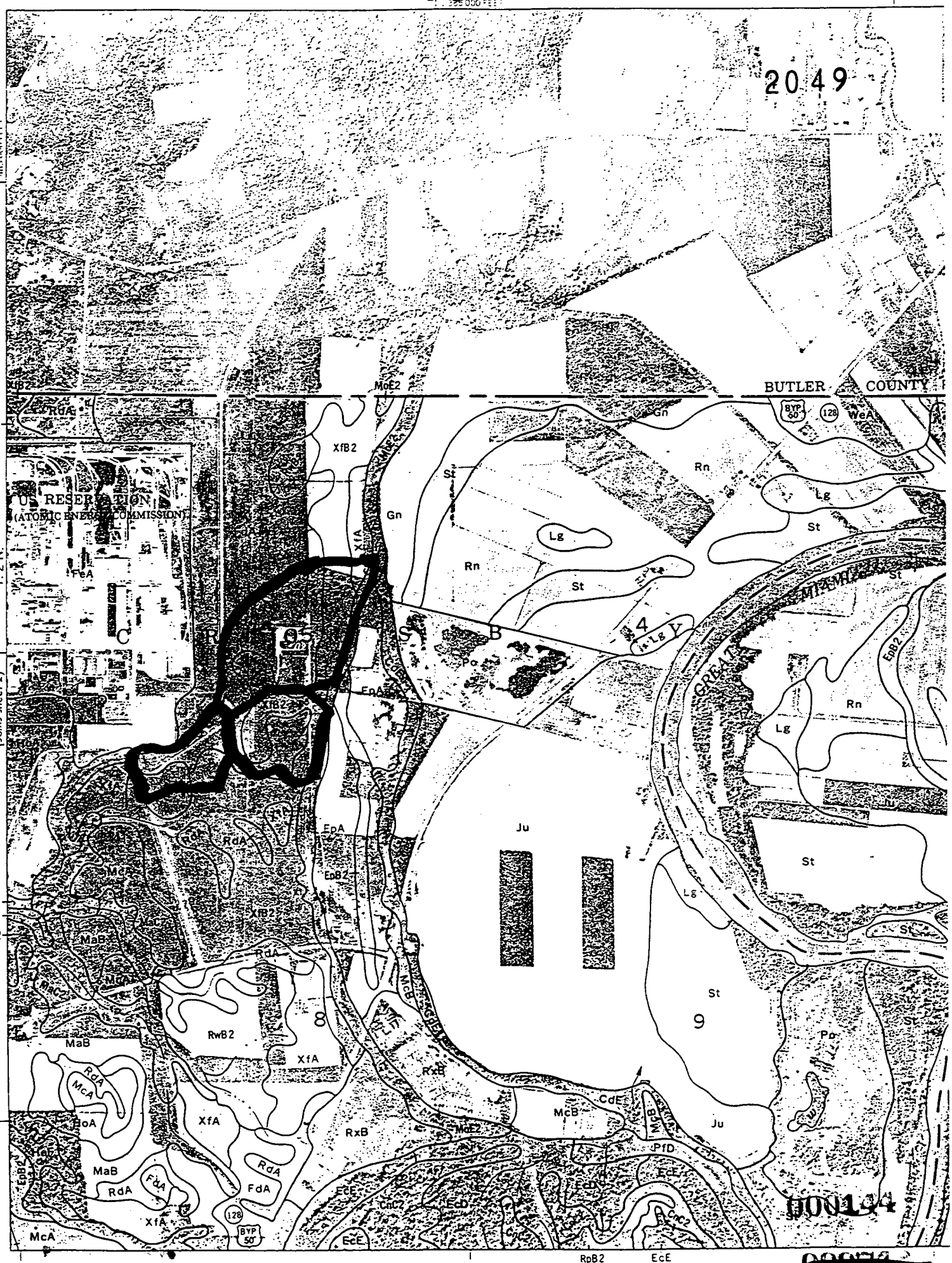
$$H_e = k_e \left(\frac{V^2}{2g}\right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

ATTACHMENT D

1) Soils Map (Reference 6)
2) Rainfall Intensity-Duration-Frequency Curve (Reference 7)



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.

TABLE 18.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
ArA, ArB2, ArC2---Ava	C	None--------	---	---	2.0-4.0	Perched	Mar-Jun	>60	---	High-----	Moderate	High.
AsB*, AsC*:												
Ava----------	C	None--------	---	---	2.0-4.0	Perched	Mar-Jun	>60	---	High-----	Moderate	High.
Urban land.												
AvA----------Avonburg	D	None--------	---	---	1.0-3.0	Perched	Jan-Apr	>60	---	High-----	High-----	High.
AwA*:												
Avonburg---------	D	None--------	---	---	1.0-3.0	Perched	Jan-Apr	>60	---	High-----	High-----	High.
Urban land.												
BoD, BoE, BoF-----Bonnell	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
CcC2, CdD, CdE, CdF----------Casco	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
CnB2, CnC2--------Cincinnati	C	None--------	---	---	>4.0	Perched	Jan-Apr	>60	---	High-----	Moderate	High.
DaB----------Dana	B	None--------	---	---	3.0-6.0	Perched	Mar-Apr	>60	---	High-----	Moderate	Moderate.
EcB2, EcC2, EcD, EcE, EdF---------Eden	C	None--------	---	---	>6.0	---	---	20-40	Soft	High-----	Moderate	Low.
EeB*, EeC*, EeD*:												
Eden----------	C	None--------	---	---	>6.0	---	---	20-40	Soft	High-----	Moderate	Low.
Urban land.												
EpA, EpB2, EpC2---Eldean	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
ErA*, ErB*:												
Eldean----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Urban land.												
FdA----------Fincastle	C	None--------	---	---	1.0-3.0	Apparent	Jan-Apr	>60	---	High-----	High-----	Moderate.

See footnotes at end of table.

000145

SAT D2

Soil Survey

TABLE 18.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
XfA, XfB2--------- Xenia	B	None--------	---	---	2.0-6.0	Apparent	Mar-Apr	>60	---	High-----	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.
** The plus sign preceding the range in depth to the water table means that the range in this soil is from .5 foot above the surface to 2.0 feet below.

2049
SHT D3 1000
000146

SHT D4

RAINFALL INTENSITY ZONE MAP

1101-3

REFERENCE SECTION
1101.24

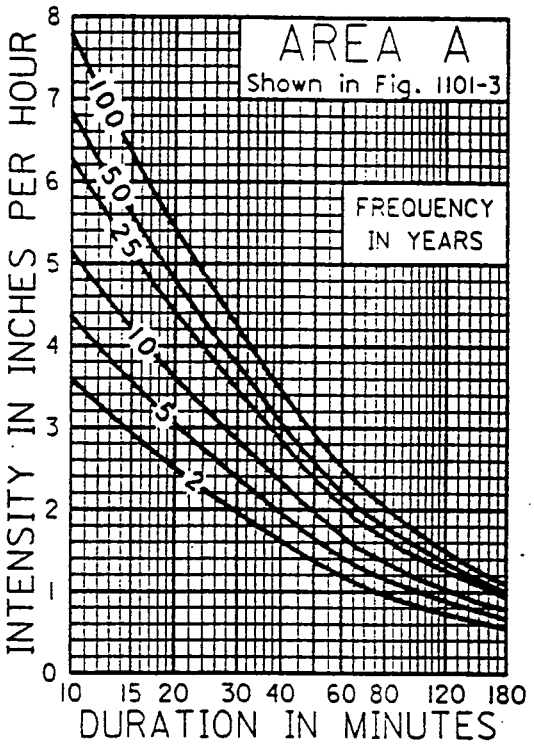
000147

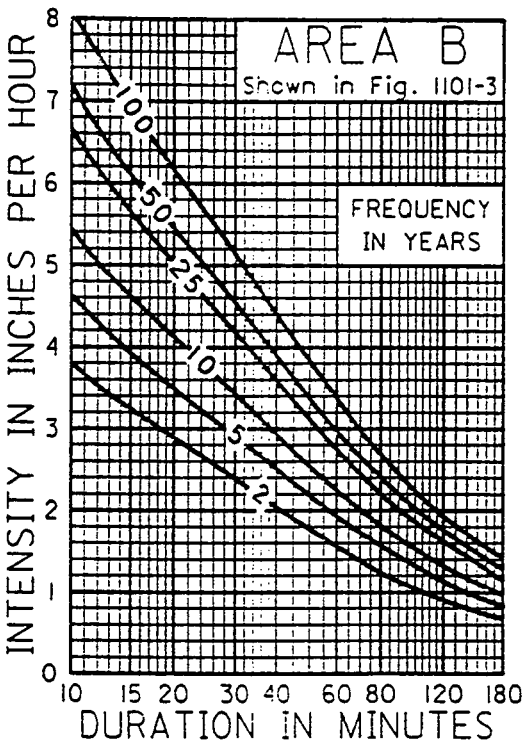
SHT D 5 ~~1008~~

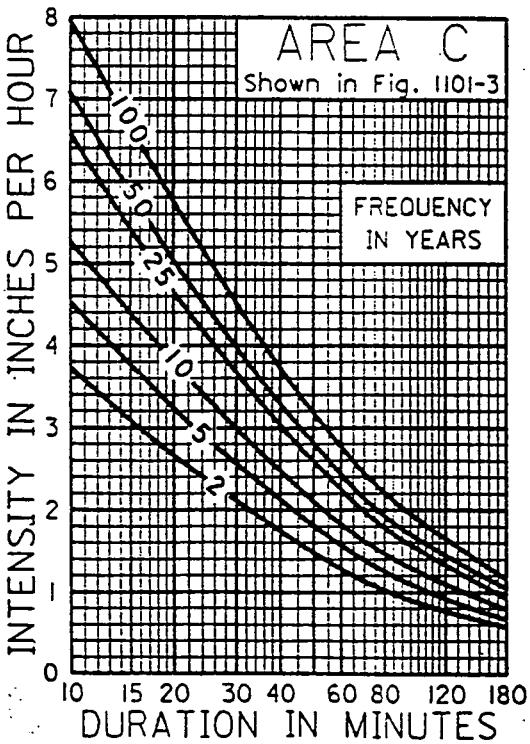
RAINFALL INTENSITY-FREQUENCY-DURATION CURVES	1101-2
	REFERENCE SECTION 1101.24

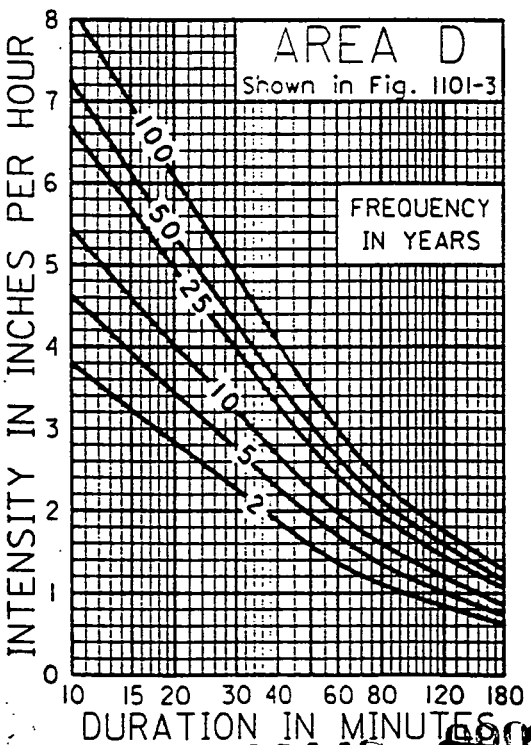
2049

RAINFALL INTENSITY-FREQUENCY-DURATION CURVES





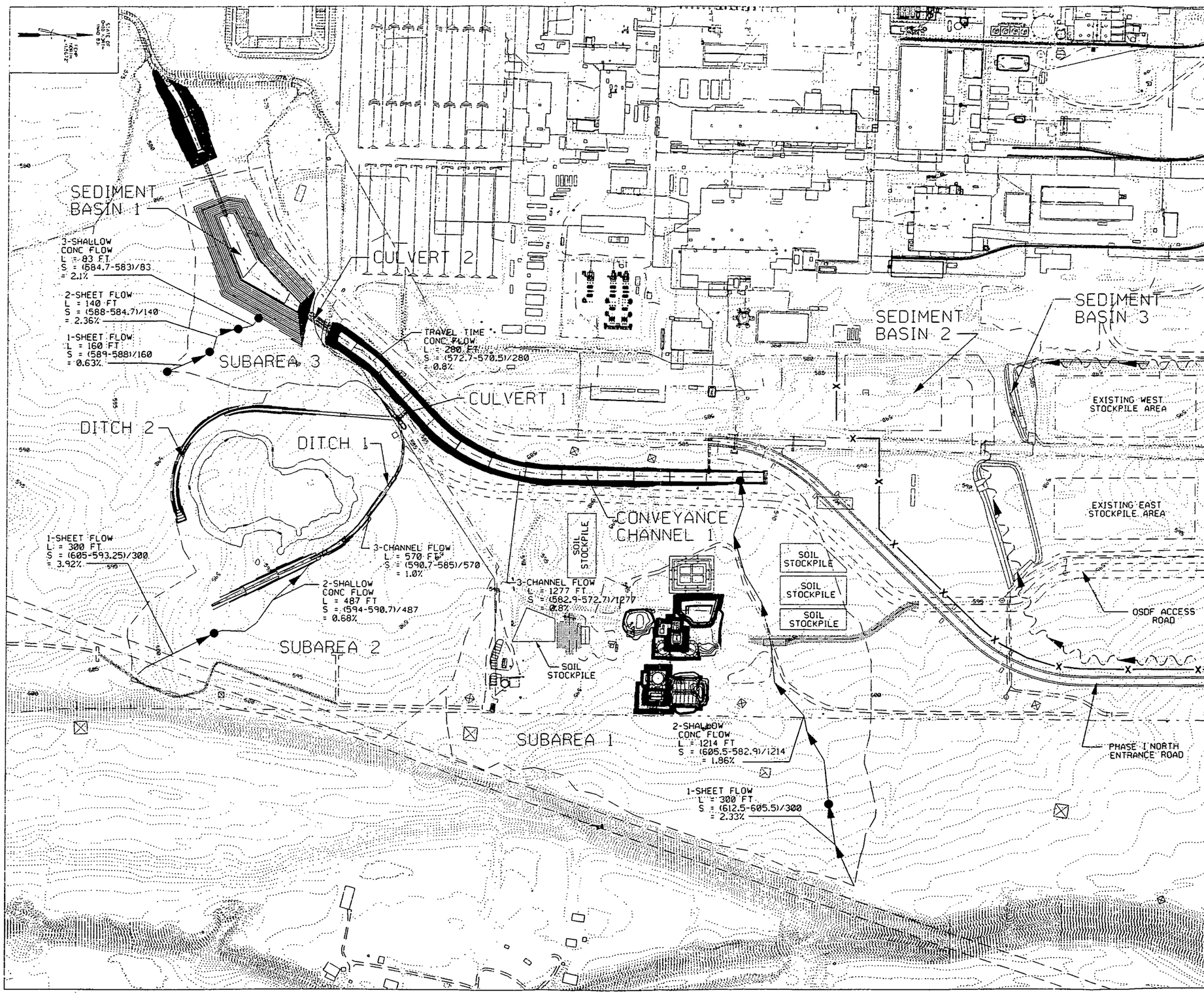




APPENDIX B

DRAINAGE AREA MAP

skg04533.m po175@ws316. Tue Nov 18 08:01:40 CST 1997



DRAINAGE AREA MAP