NEW BRITAIN – HARTFORD BUSWAY

STATE PROJECT NO. 171-305

DRAINAGE REPORT

FINAL DESIGN

July 2010

AMTRAK ACCESS ROAD/
Track Drainage

Contract Project No. 093-H052/063-H157

PREPARED FOR:

STATE OF CONNECTICUT

DEPARTMENT OF TRANSPORTATION

PREPARED BY:

GM2 ASSOCIATES, INC.

PREPARED FOR:

MICHAEL BAKER ENGINEERING, INC.

Foreword

The drainage design analysis documented in the following pages was prepared by GM2 Associates, Inc., acting as a subconsultant to Michael Baker Corporation, for the State of Connecticut Department of Transportation. All computations documented herein were performed based on best available information as supplied by the Access Road Design Engineer. The results of this analysis relate only to this specific project (171-305), and not intended for use on unrelated projects without independent verification.

We attest that this report was:

Prepared by:

Eric W. Buckley (GM2)

Reviewed by:

Manish K Gupta PhD, PE (GM2)

INTRODUCTION

As a result of transportation planning studies for the Hartford West Corridor, A Bus Rapid Transit (BRT) system has been proposed and is currently in the design phase. This Busway will run along active and inactive railroad rights-of-way from New Britain, through Newington and West Hartford with its terminus in Hartford. In order to support the Busway adjacent to the active track segments, it was necessary to relocate 4.5 miles of the access road servicing these tracks. This drainage report is a portion of the design services required for the relocation of the access road running from Amtrak Baseline station 1623+00 to 1858+50.

As the project design progressed, Amtrak had further requested that a separate system be constructed to service the area between the tracks and the Busway barrier wall to the west. This system services areas between Amtrak Baseline 1623+00 to near 1901+50. The term "track drainage" has been used herein to distinguish between the access road drainage and the track drainage systems.

This design report is prepared to accompany the project plan sets submitted by others. Specific system elevations and applicable pipe sizes used in the attached design computations were taken directly from the project plans.

DRAINAGE DESIGN OVERVIEW

Access Road Drainage

The access road is generally aligned with the railway bed and is essentially the same grade as the tracks (flat with grades mostly less than 1%). Where cuts were required to construct the base of the roadway, a swale was engineered into the cross section in order to address runoff both from the roadway and the tracks. This swale is designed to be below the track ballast in order to receive the rainfall that infiltrates through the highly porous ballast rock down to the sub-ballast. In areas where there was limited required grading or fill of the construction of the roadway, the runoff is designed to sheet flow down the roadway embankment slope following its existing patterns.

The objective of this drainage design was to utilize independent outlet points (as practical), eliminating the need to discharge flow into private and municipal drainage systems.

Track Drainage

The area between the tracks and the Busway is generally aligned horizontally with the rail bed and essentially follows the same vertical profile of the tracks. Outlet points were selected using the same objectives and the Access Road drainage design. This was to maintain system independence as much as practical. Busway drainage flow lines were utilized as outlet points where required and will be pointed out as appropriate.

Computational Approach

Drainage areas contributing flows to the engineered track drainage swale and the system servicing the Amtrak Access Road were developed using the roadway cross sections and field verified due to an absence of any proposed contours developed for the plans. Developing areas from cross sections was completed by determining the distance between successive high points for each cross section (average spacing between sections 50') and employing the average end area method to determine the contributing area between successive sections.

The calculations were completed using the following approved design models:

The FEMA produced Quick-2 version 2.0 was utilized for all channel design computations for the Access Road drainage swale. This is a single sections open channel hydraulic model based on Manning's equation for flow velocity.

The FHWA produced Hydraulic Toolbox version 1.0 (developed by Aquaveo), was utilized for all channel design computations for the track drainage swale. This is a single sections open channel hydraulic model based on Manning's equation for flow velocity[1].

HY8, also produced by the FHWA version 7.2 (developed by Aquaveo), was utilized for all culvert design.

Hydraflow Storm Sewers (2008) was used for all subsurface drainage which incorporated either a junction or inlet to a subsurface run.

Global Design Parameters (used unless otherwise noted)

Due to the highly pervious and uniform character of the project site with the majority of the drainage areas consisting of stone ballast material, global parameters for hydrology were implemented that would increase conservatism in the runoff rate computations. Specifically, a time of concentration of 10 minutes was used without taking into account the travel time for runoff from the hydraulically most remote point of each drainage area. This would allow for the greatest rainfall rate to be used in the rational method of runoff computation. Additionally, a runoff coefficient of 0.3 was selected globally following the recommendation for railroad yard areas (Drainage Manual – Table 6-4).

It has been proposed that the engineered drainage swales be lined with modified riprap, and as such, a roughness coefficient of 0.06 was used for all swale computations. This roughness coefficient takes into account a future condition with vegetation established within the swale. Where computed flow velocities approach 8 feet-per-second, stability computations were performed to verify the adequacy of the proposed rock size.

Amtrak design requirements are more stringent than roadway design applications due to the economic burden of closing a line due to flooding; detour routes are usually not available. As such, the drainage system has been designed for a 100-year event. The rainfall intensity for a 100-year event at a 10-minute time of concentration is 6.5 $^{in}/_{hr}$. The overall approach to the design of this access road drainage was systematic in that for each portion or individual drainage system was wholly designed from hydrology to hydraulics and outlet/channel protection. This report is set up in a similar fashion, documenting design of each system in increasing station order. The design computations for each system are provided in the following numbered sections.

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[1] The reason for using two separate single section channel models is due to the availability of each of the models at the time of design. The Access Road drainage swale was designed prior to the track drainage swale. When the Track Drainage swale was engineered, the Hydraulic Toolbox was available (build date January, 2010). Each of these swales are separate, and there is no switch of model usage for an individual swale.

TRACK DRAINAGE OUTLET 1 – SWALE CONVEYING FLOWS BETWEEN STATIONS 701+50 AND 765+50

A swale has been designed to run the length of this area. The low point of the swale is at station 711+50 (near the Busway Site 4 culvert crossing). In order to avoid the costly construction of jacking a pipe under the tracks to outlet downstream of the Site 4 Crossing, it is proposed to install a drop manhole above the existing "site 4" culvert crossing and outlet directly to this existing structure. Upstream from the junction, the existing box culvert will be filled and flows originally maintained by the masonry box culvert will have been diverted to adjacent proposed twin 6.5' diameter pipe culverts as designed and documented in the associated Site 4 Hydraulic Report.

Another design aspect of this system is near station 755+50. Due to the proximity of the proposed Busway barrier to the tracks, it was necessary to elevate the swale for a portion of the flow line. For drainage purposes, a 6" diameter PVC pipe is proposed to maintain the flow line upstream of this elevated swale to downstream of the elevated swale. It is not intended that this pipe carry the entire design runoff rate, rather to prevent ponding at a point along the normal swale. The designations for the separate swale segments are as follows: the elevated swale segment will be referred to as "elevated swale" and the remainder of the swale will be referred to as normal swale.

At 712+00, computations were performed on the swale to verify that the swale has capacity for the length of the system

Station 755+50

Steps in computing the hydraulics for the proposed 6" pipe and elevated swale:

1. Determine contributing area to the inlet of the pipe, and area comprising the elevated swale.
    a. Sum of these areas equal the total drainage area for the receiving reach of the normal swale.
2. Develop a tailwater rating curve for the receiving reach of the normal swale to be used as a starting water surface elevation of the HY-8 analysis, and as an intermediate check of the capacity of the normal swale.
3. Compute culvert hydraulics on the proposed 6" pipe to determine the pipe capacity and the overtopping flows to be conveyed by the elevated swale.
4. Separate the product of the area (A) and curve number (C) from the weir flow discharge and add this CxA parameter to the CxA of the contributing area of the elevated swale.
5. Compute channel hydraulics of the most downstream portion of the elevated swale using the total CxA as computed in 4. Check freeboard of the computed design water surface elevation to the track elevation – attempt to maintain 1' of freeboard.

For this analysis, 1.0 cfs of runoff for the 100-year event was computed at the inlet of the proposed pipe from the 0.54 acres contributing. Using the tailwater rating curve computed for station 743+00, the capacity of the pipe at the design flow rate 0.35-cfs with 0.64-cfs overtopping and continuing down the elevated swale. At the end of the elevated swale, the total runoff computed – with the overtopping of the 6" pipe – is 1.61-cfs. From this analysis, freeboard to the tracks was computed. At station 743+50 (end of elevated swale), the computed water surface elevation (CWSEL) is 73.53', the track elevation is 74.14',

resulting in a freeboard of 0.6 feet. At station 743+00 (receiving section of normal swale), the CWSEL is 71.43', the track elevation is 74.02', resulting in a freeboard of 2.6 feet.

Station 712+00

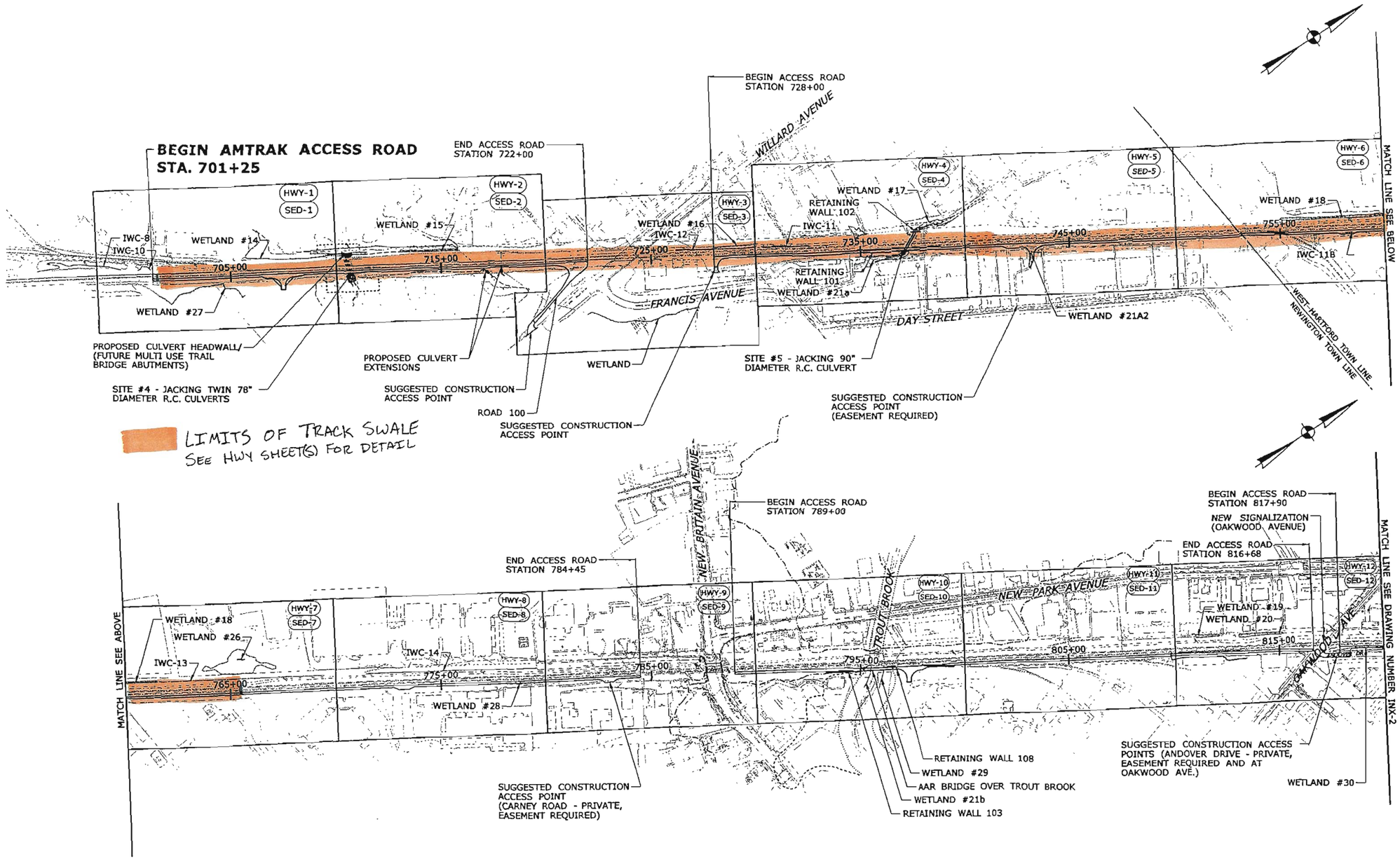
Swale capacity near the end of the swale – immediately before the outlet point.

CWSEL is 65.8', the track elevation is 66.9' resulting in 1.1 feet of freeboard. The hydraulic characteristics here were computed from 5.65 cfs-as generated from 2.9 acres contributing.

Outlet at 711+50

A CL type catch basin is proposed to intercept runoff from the swale at the low point of the profile and discharge to a drop manhole above the existing "site 4" culvert crossing, outletting directly to this existing structure. Upstream from the junction, the existing box culvert will be filled and flows originally maintained by the masonry box culvert will have been diverted to adjacent proposed twin 6.5' diameter pipe culverts as designed and documented in the associated site 4 Hydraulic report. The calculated depth of flow over the catch basin at the design discharge rate is approximately 0.5 feet, providing plenty of freeboard to the tracks (as determined from the swale check at station 712+00). From this information it can be surmised that the controlling feature of the maximum water surface elevation is the swale flow, not the depth over the catch basin.

All computations and program output are attached with this section.



NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

INDEX PLAN

SCALE: 1"=250'

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

FINAL PLANS FOR REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted: 9/2/2009

DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW.MSH.093.H052.INX-01.dgn

MICHAEL BAKER ENGINEERING, INC.

APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-01
SHEET NO. 7

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Drainage

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: swale at 743+00

Notes: Development of tailwater rating curve for HY-8 analysis of PVC pipe at station 755+50

Parameters

Channel Type: Custom Cross Section

Flow: 2.1000 (cfs)

Depth: 0.9351 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0024 (ft/ft)

Area of Flow: 2.6837 (ft^2)

Wetted Perimeter: 5.1817 (ft)

Average Velocity: 0.7825 (ft/s)

Top Width: 4.7402 (ft)

Froude Number: 0.1833

Critical Depth: 0.3950 (ft)

Critical Velocity: 2.9705 (ft/s)

Critical Slope: 0.0887 (ft/ft)

Critical Top Width: 2.5798 (ft)

Calculated Max Shear Stress: 0.1400 (lb/ft^2)

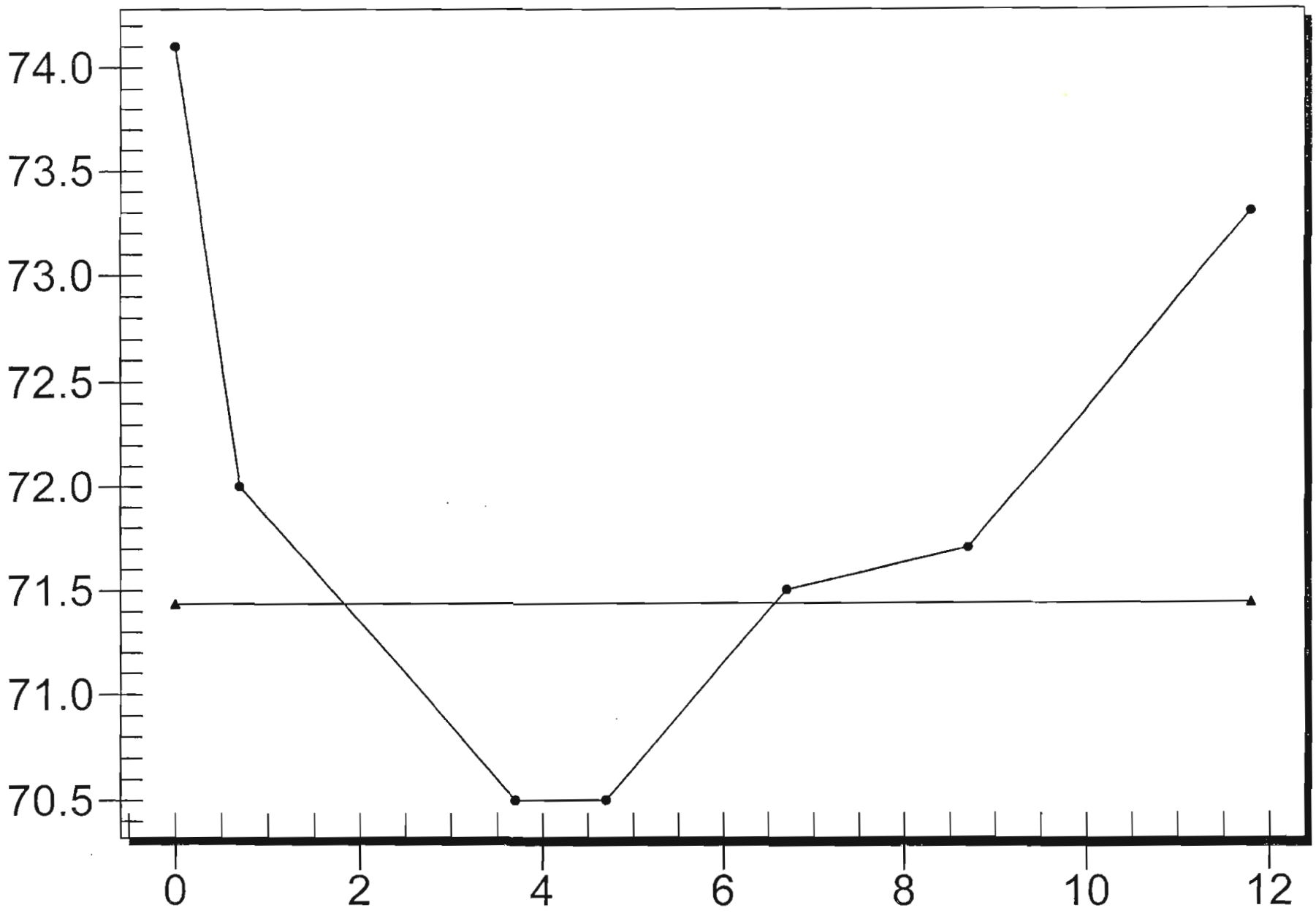
Calculated Avg Shear Stress: 0.0776 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
0.00	74.10	0.0600
0.70	72.00	0.0600
3.70	70.50	0.0600
4.70	70.50	0.0600
6.70	71.50	0.0600
8.70	71.70	0.0600
11.80	73.30	—

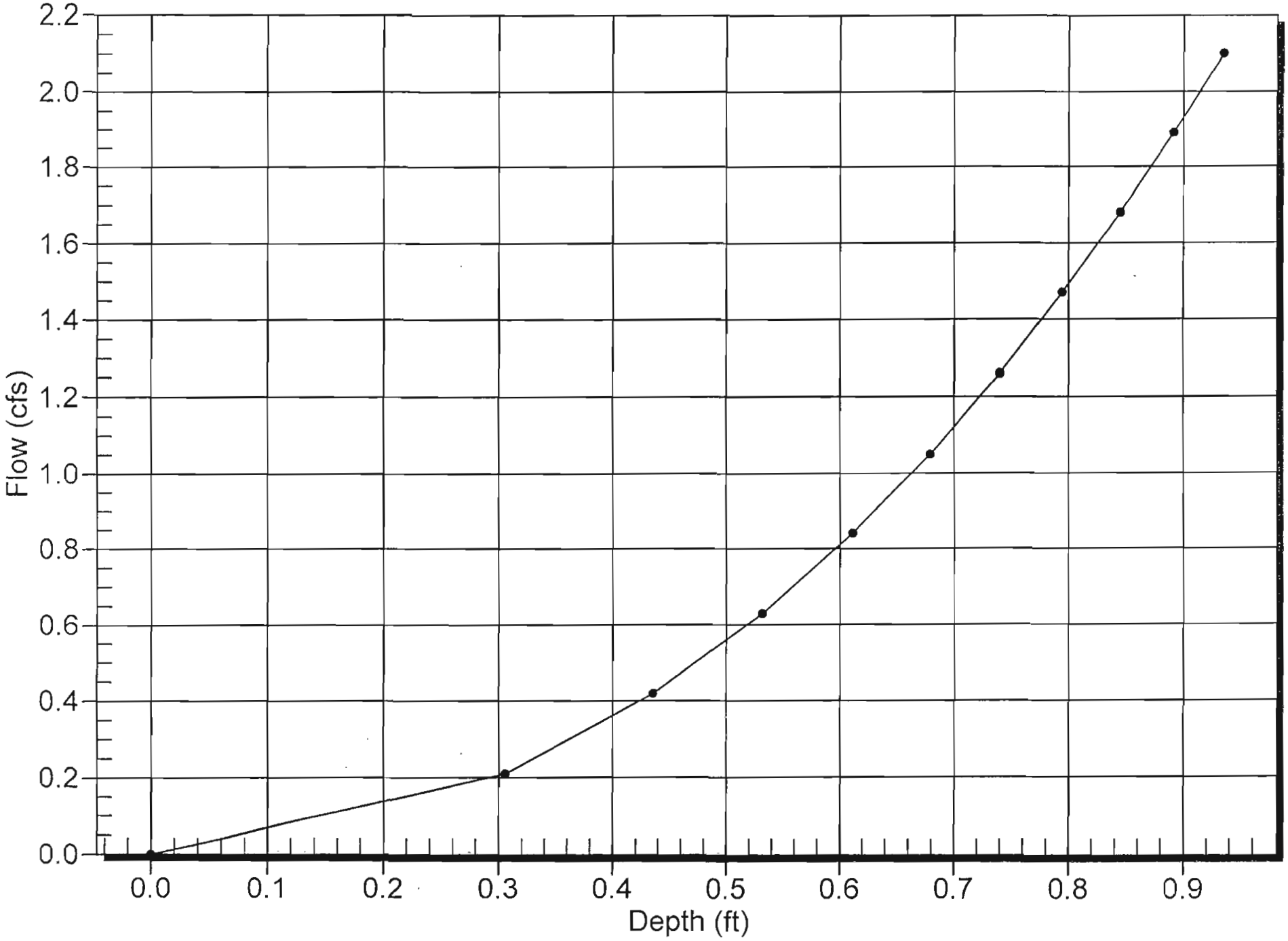
Cross Section

Station 743+00



Flow vs. Depth

Station 743+00



HY-8 Culvert Analysis Report
Proposed Pipe at 755+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
73.21	0.00	0.00	0.00	1
73.59	0.21	0.21	0.00	1
74.23	0.42	0.35	0.06	59
74.25	0.63	0.35	0.27	5
74.26	0.84	0.35	0.48	4
74.27	1.00	0.35	0.64	3
74.29	1.26	0.35	0.90	3
74.30	1.47	0.35	1.11	3
74.31	1.68	0.35	1.32	3
74.32	1.89	0.35	1.52	2
74.32	2.10	0.35	1.73	2
74.22	0.35	0.35	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: Pipe at 755+50

Rating Curve Plot for Crossing: Pipe at 755+50

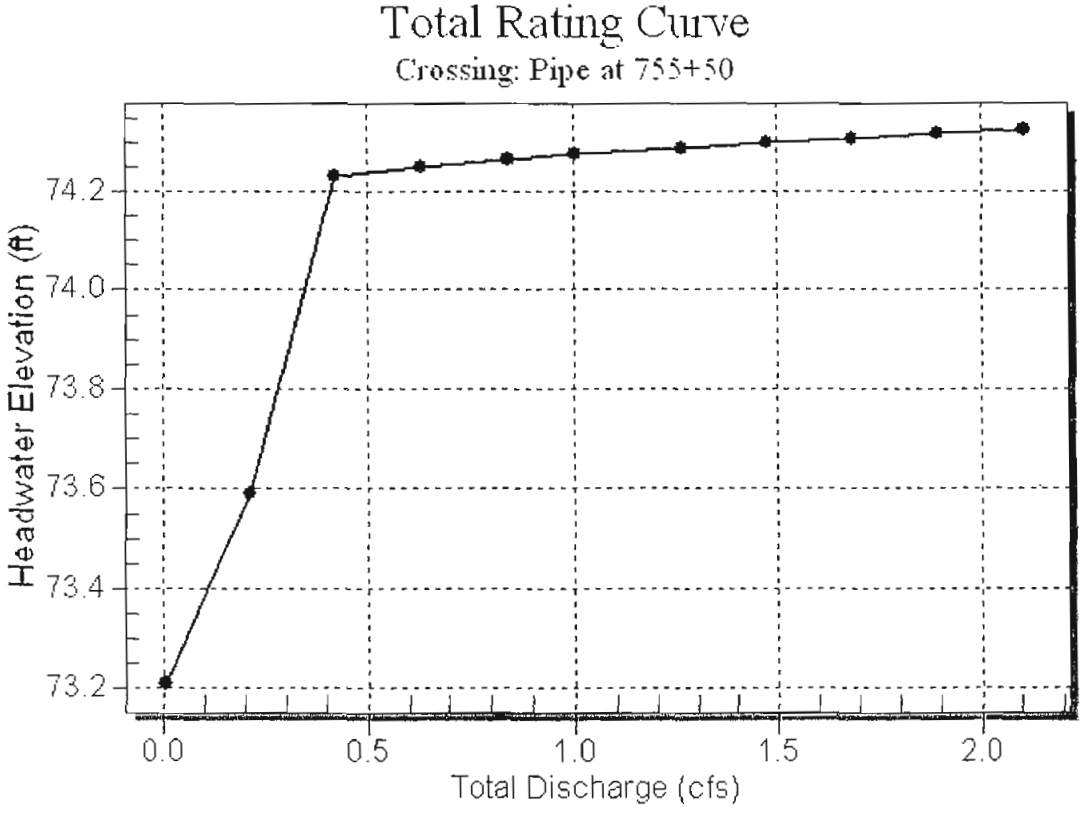


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	73.21	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.21	0.21	73.59	0.337	0.379	3-M2t	0.303	0.229	0.276	0.306	1.889	0.000
0.42	0.35	74.23	0.466	0.968	7-M2t	0.500	0.302	0.406	0.436	2.072	0.000
0.63	0.35	74.25	0.466	1.442	4-FFf	0.500	0.302	0.500	0.532	1.801	0.000
0.84	0.35	74.26	0.466	1.521	4-FFf	0.500	0.302	0.500	0.611	1.801	0.000
1.00	0.35	74.27	0.466	1.589	4-FFf	0.500	0.302	0.500	0.679	1.801	0.000
1.26	0.35	74.29	0.466	1.650	4-FFf	0.500	0.302	0.500	0.740	1.801	0.000
1.47	0.35	74.30	0.466	1.705	4-FFf	0.500	0.302	0.500	0.795	1.801	0.000
1.68	0.35	74.31	0.466	1.755	4-FFf	0.500	0.302	0.500	0.845	1.801	0.000
1.89	0.35	74.32	0.466	1.801	4-FFf	0.500	0.302	0.500	0.891	1.801	0.000
2.10	0.35	74.32	0.465	1.820	4-FFf	0.500	0.301	0.500	0.935	1.795	0.000

* theoretical depth is impractical. Depth reported is corrected.

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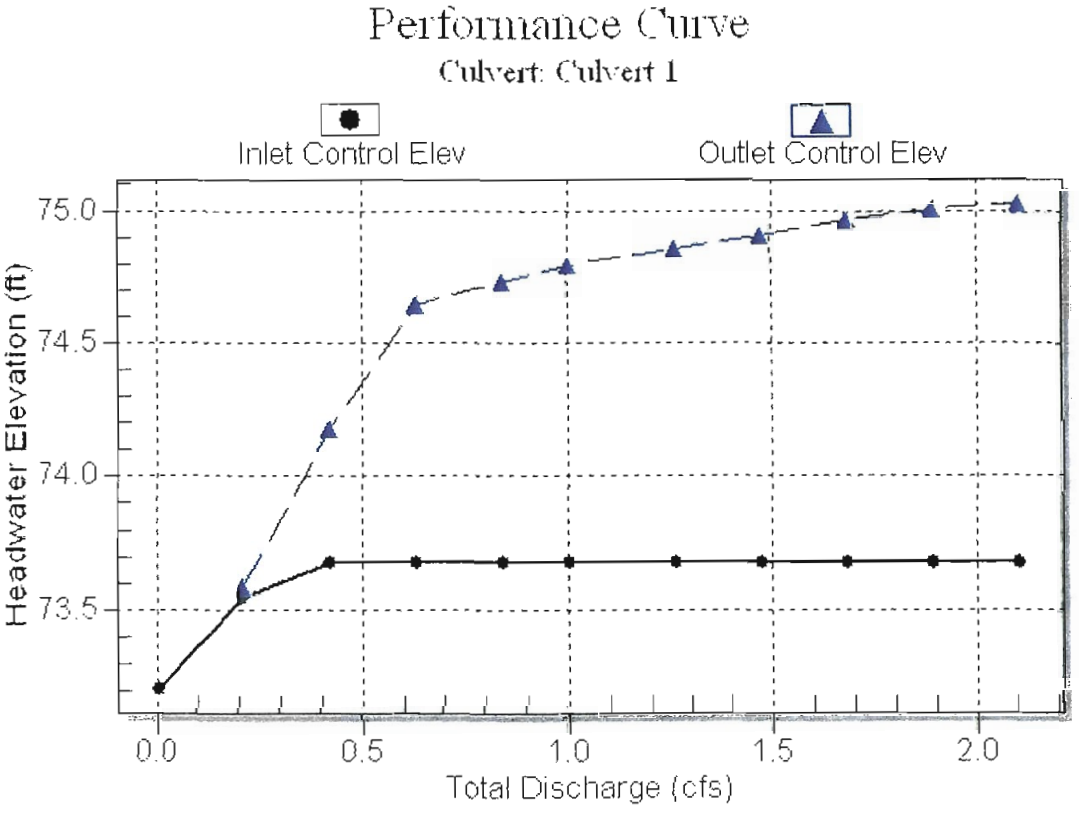
Inlet Elevation (invert): 73.21 ft, Outlet Elevation (invert): 70.53 ft

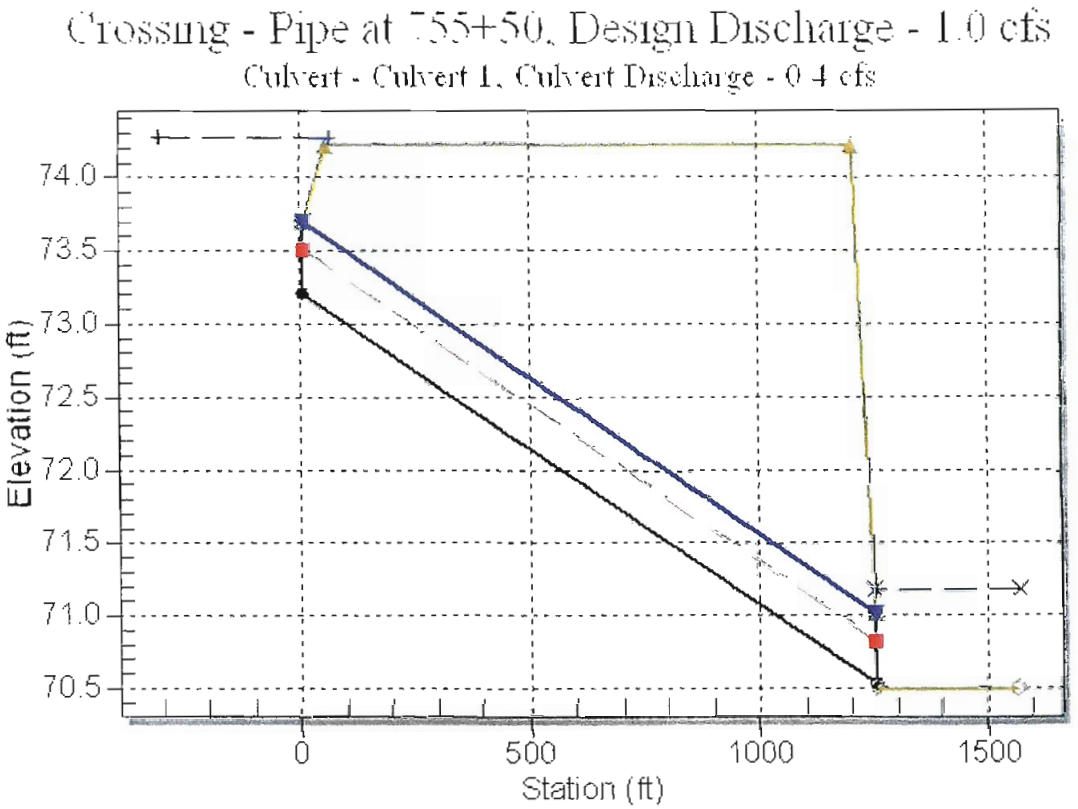
Culvert Length: 1250.00 ft, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 73.21 ft

Outlet Station: 1250.00 ft

Outlet Elevation: 70.53 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 0.50 ft

Barrel Material: PVC

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Pipe at 755+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	70.50	0.00
0.21	70.81	0.31
0.42	70.94	0.44
0.63	71.03	0.53
0.84	71.11	0.61
1.00	71.18	0.68
1.26	71.24	0.74
1.47	71.30	0.80
1.68	71.34	0.84
1.89	71.39	0.89
2.10	71.44	0.94

Tailwater Channel Data - Pipe at 755+50

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Pipe at 755+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 74.22 ft

Roadway Surface: Gravel

Roadway Top Width: 1150.00 ft

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Drainage

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 743+50

Notes: Elevated swale capacity check to track elevation

Parameters

Channel Type: Custom Cross Section

Flow: 1.6100 (cfs)

Depth: 0.7332 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0024 (ft/ft)

Area of Flow: 2.2221 (ft^2)

Wetted Perimeter: 4.8154 (ft)

Average Velocity: 0.7245 (ft/s)

Top Width: 4.4616 (ft)

Froude Number: 0.1809

Critical Depth: 0.2799 (ft)

Critical Velocity: 2.6803 (ft/s)

Critical Slope: 0.0924 (ft/ft)

Critical Top Width: 2.6924 (ft)

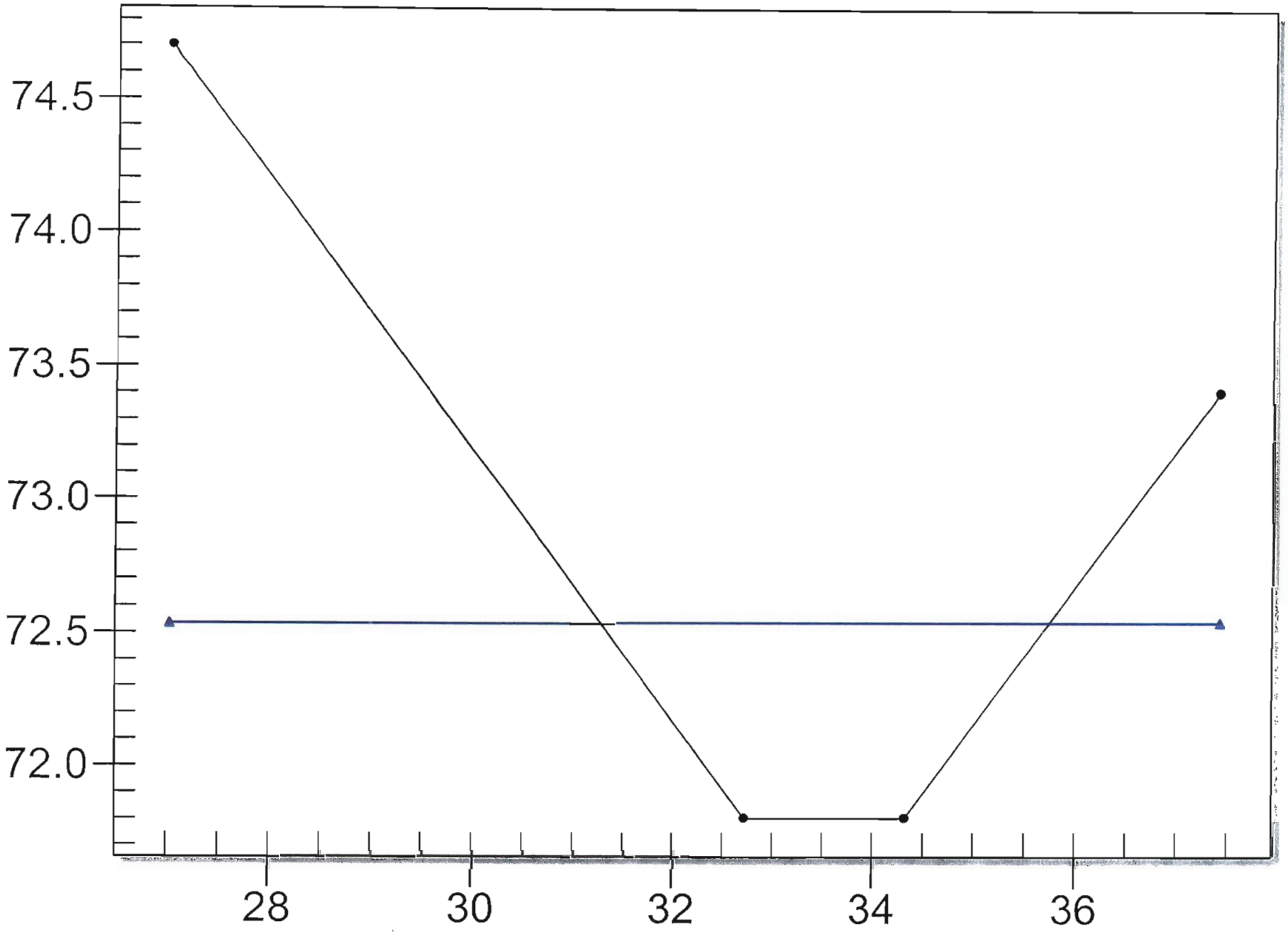
Calculated Max Shear Stress: 0.1098 (lb/ft^2)

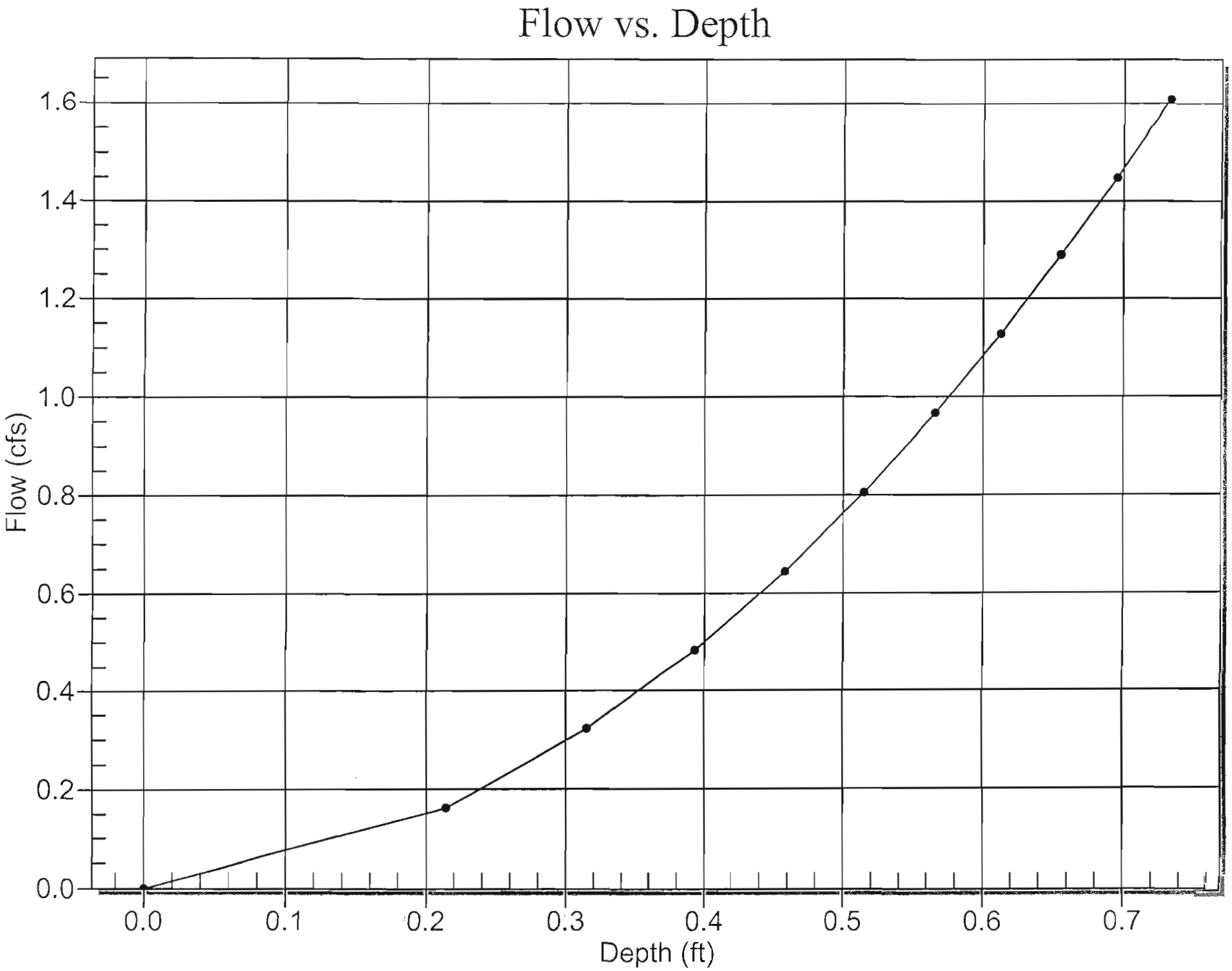
Calculated Avg Shear Stress: 0.0691 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
27.00	74.70	0.0600
32.70	71.80	0.0600
34.30	71.80	0.0600
37.40	73.40	-----

Cross Section




Flow vs. Depth
Flow (cfs)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Depth (ft)

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Draiange

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 712+00

Notes: Check Swale for capacity

Parameters

Channel Type: Custom Cross Section

Flow: 5.6500 (cfs)

Depth: 2.2919 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0002 (ft/ft)

Area of Flow: 14.2394 (ft^2)

Wetted Perimeter: 11.8095 (ft)

Average Velocity: 0.3968 (ft/s)

Top Width: 10.1005 (ft)

Froude Number: 0.0589

Critical Depth: 0.6542 (ft)

Critical Velocity: 3.6552 (ft/s)

Critical Slope: 0.0780 (ft/ft)

Critical Top Width: 3.7258 (ft)

Calculated Max Shear Stress: 0.0286 (lb/ft^2)

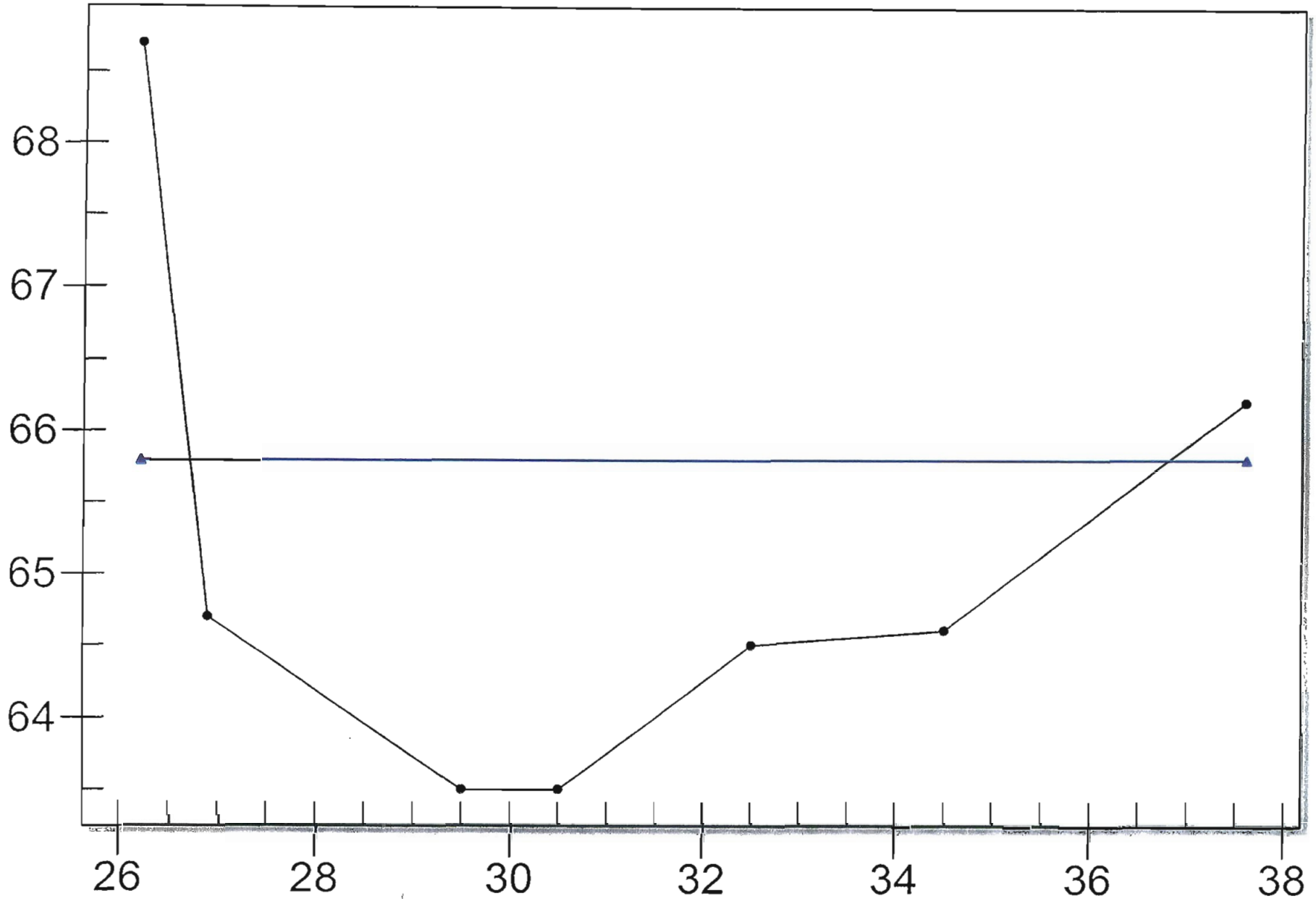
Calculated Avg Shear Stress: 0.0150 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
26.20	68.70	0.0600
26.90	64.70	0.0600
29.50	63.50	0.0600
30.50	63.50	0.0600
32.50	64.50	0.0600
34.50	64.60	0.0600
37.60	66.20	----

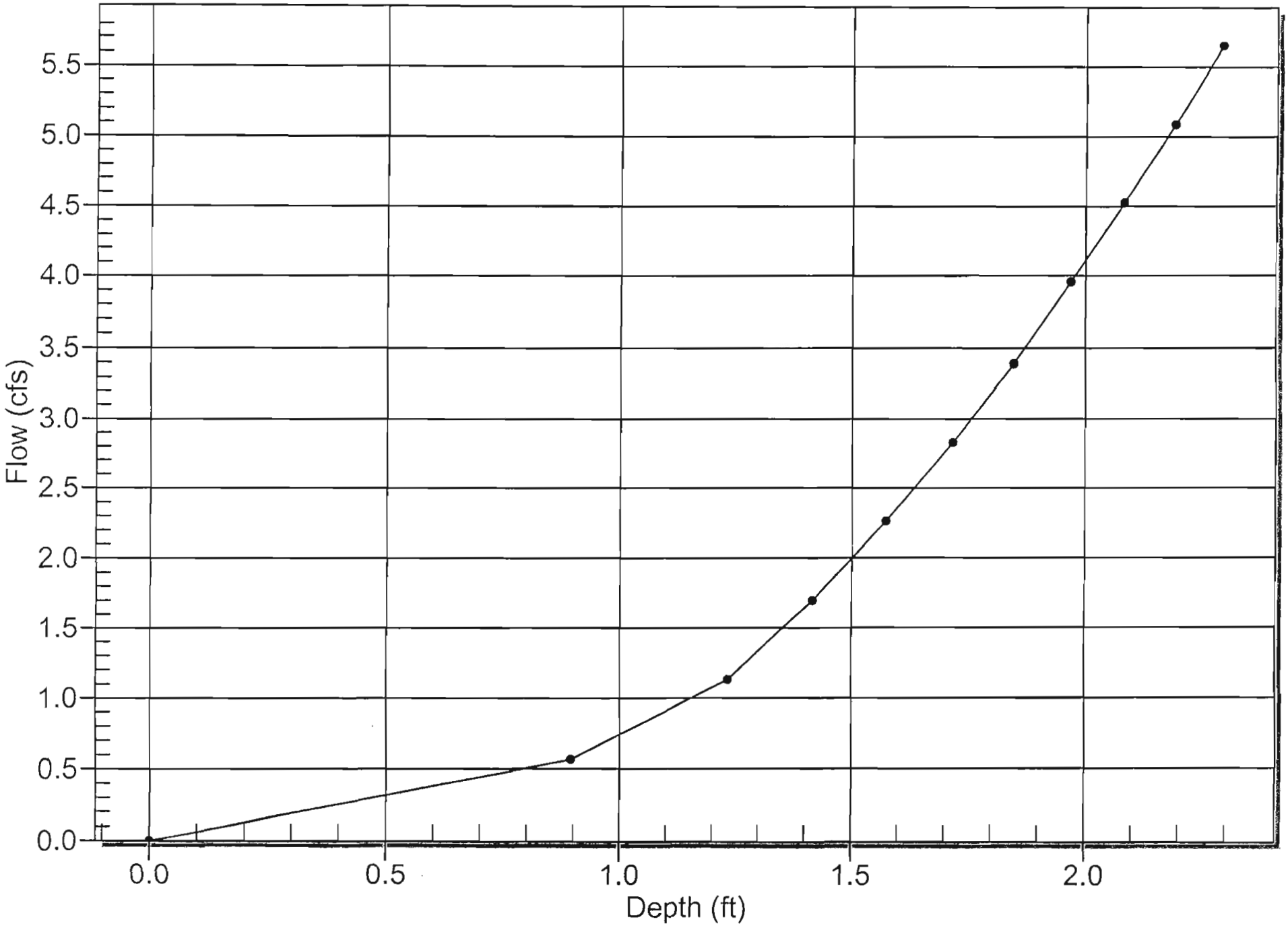
Cross Section

Station 712+00



Flow vs. Depth

Station 712+00



GM2 Associates

Engineers • Inspectors • Surveyors

Job Track Drainage Computed By _____ Date _____

Description _____ Checked By _____ Date _____

AREA 1 from Stations 701+50 → 711+50 ← 765+50 Sheet 1 of _____

Drainage Area 1 Contributing from 701+50 to 765+50
Low point @ 711+50 - Area Outlet
Intermediate Design Points 755+50 - pipe
712+00 - Check Swale

Pipe @ 755+50 inlet receiving channel 743+00
Q 1.0 CFS 2.1 CFS for TW RATING CURVE

Size Pipe try 6"

flow line 73.21' 70.53
Slope = 0.2%

Channel over pipe - Sta 743+50
Channel slope 0.0024
Discharge 0.64 CFS from overtopping
$CA_{OVER} = 0.098 + CA_{SWALE} = 0.15$

Sta	EL	
27.0	74.7	Depth 0.73'
32.7	71.8	Elev 72.53' 1.6 Freeboard
34.3	71.8	
37.4	73.4	1.61 CFS Track el 74.14

RESULTS SEE Channel analysis output for Tailwater
HY8 analysis output
Channel analysis output for overtopping flow Sta 743+50

Channel Geometry

Sta	EL
0	74.1
0.7	72.0
3.7	70.5
4.7	70.5
6.7	71.5
8.7	71.7
11.8	73.3

Check Swale @ 712+00 Design flow @ 712+00 2.9 ac $C_{0.3}$ $I_{6.5}$ = 5.65 CFS

Channel geometry

Sta	EL
26.2	68.7
26.9	64.7
29.5	63.5
30.5	63.5
32.5	64.5
34.5	64.6
37.6	66.2

depth 2.29 → WSEL 65.8'
Track EL 66.9' ⇒ 1.1' freeboard.

GM2 Associates

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Job _____ Computed By _____ Date _____

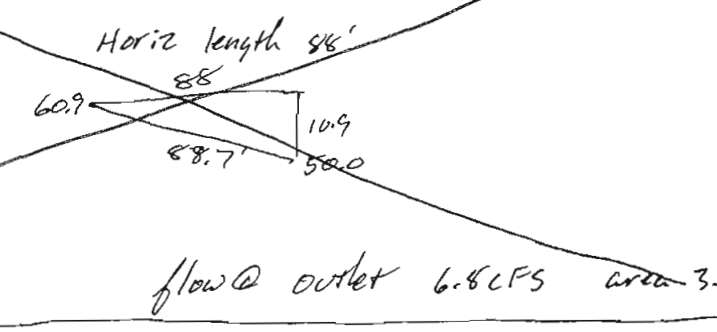
Description _____ Checked By _____ Date _____

Area 1 Cont.. Sheet 2 of _____

Drainage Area 1 Cont

outlet to basin @ 711+50 pipe flow to Abutment/Headwall of Site 4

pipe EL in 60.9 out 50.0



Pipe 88.7' slope 12% flow @ outlet 6.8 CFS area 3.49 ac

depth of flow @/over basin 0.5' plenty freeboard

depth @ CLCB Hand check

weir $d = \left(\frac{Q_i C_{FS}}{C_o P}\right)^{2/3}$

$= \left(\frac{6.8 \cdot 1.25}{3.0 \cdot 7.33}\right)^{2/3}$

$= 0.53'$ ✓

$Q = 6.8$ CFS
$C_{FS} = 1.25$
$C_{weir} = 3.0$
$P = 7.33$
$C_{orif} = 0.67$
Area = 3.13

orifice $d = \left(\frac{Q C_{FS}}{C_o A}\right)^2 / 2g$

$= \left(\frac{6.8 \cdot 1.25}{0.67 \cdot 3.13}\right)^2 / 2 \cdot 32.2$

$= 0.25$

AMTRAK ACCESS ROAD SYSTEM 1 – MANAGING AREAS BETWEEN 737+50 AND 765+00

Station 758+50

To maintain a vehicle turnoff for the access road, a 12" cross culvert approximately 100-feet in length was designed to maintain the flow line. The contributing area to this culvert is 0.83 acres as determined from the design cross sections (field verified). The resulting flow rate using parameters as discussed in the global design parameters section of this report is calculated to be 1.62-cfs for the 100-yr event. Using normal depth of the swale at the outlet of the culvert, the headwater depth above the culvert inlet is 0.85 feet, maintaining that the 12" culvert proposed at this location is adequate for the 100-year design event. All computations are included within this report section.

Station 756+00

A 12" culvert is proposed to carry the flow line under an active railroad siding. This culvert is approximately 100-feet in length. The contributing area to this culvert includes both the area contributing to station 758+50 as well as the open channel area from the previous outlet to the inlet of this pipe for a total of 1.08 acres as determined from the design cross sections (field verified). The resulting flow rate is calculated to be 2.1-cfs for the 100-year event. Using normal depth of the swale at the outlet of the culvert, the headwater depth above the culvert was 1.3 feet or elevation 72.2 – giving over two feet of freeboard to the roadway surface.

Station 743+50

Near station 743+50, there is a vehicular access drive to the roadway, creating a need to bury the flow line in a culvert crossing. This conduit length is approximately 225 feet long and was designed to convey drainage from 3.04 acres. This drainage basin includes area from station 758+50 and 756+00 as well as the open channel area from the previous outlet to the inlet of this pipe. The drainage area size produces a 100-year flow of 5.9-cfs. With a design flow line slope of 0.24%, an 18" crossing was required to convey the 100-year event. The resulting headwater was 70.73 feet in elevation, giving 0.26 feet of freeboard from the roadway elevation.

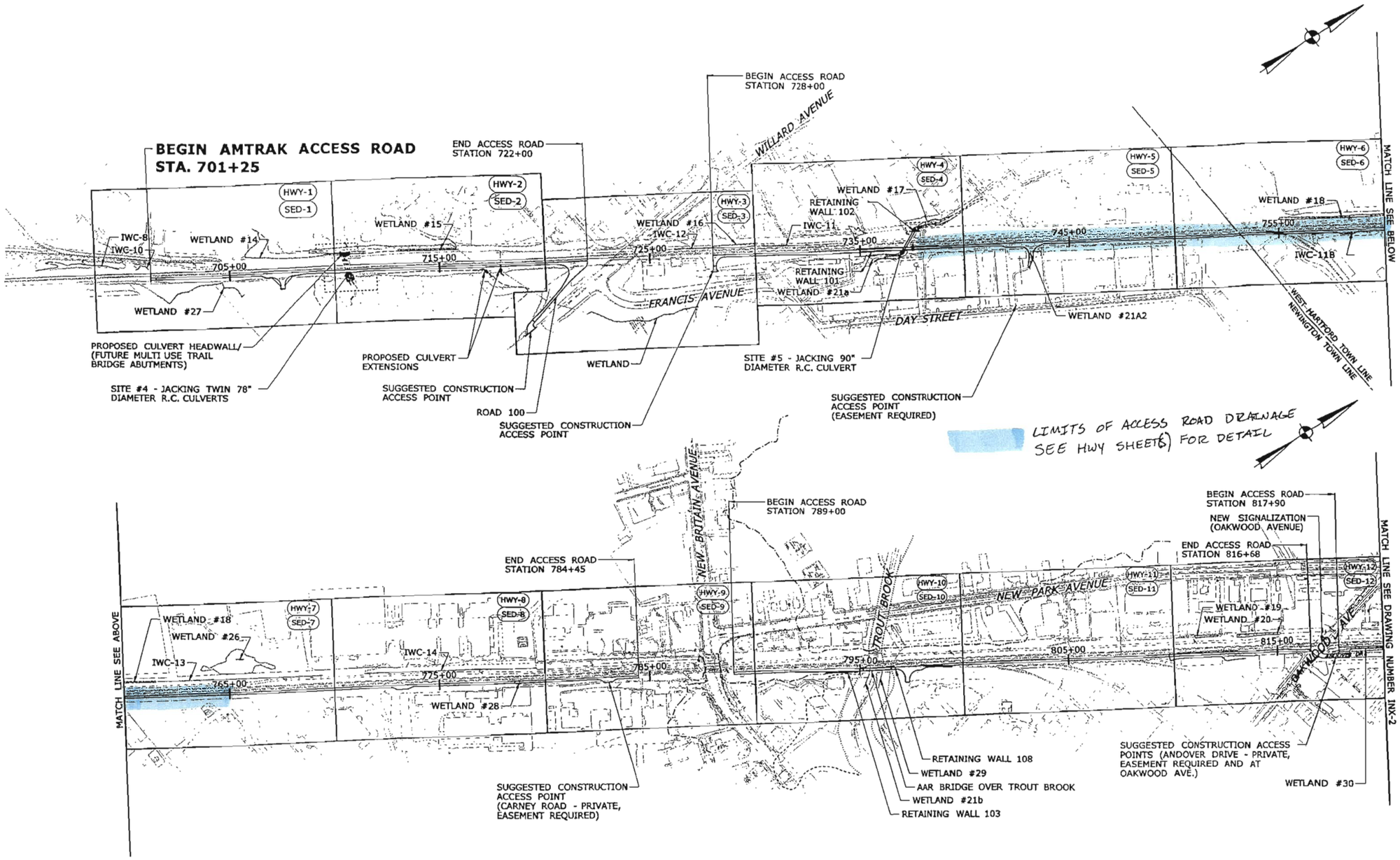
Station 739+00

Immediately following station 739+00, there is a major change to the flow line. This section was selected to determine if the swale has the capacity for the design flow rate at this point. At station 739+00, the contributing drainage area is 3.92 acres, which, using the global design parameters, produces a 100-year flow discharge of 7.6-cfs. The stream slope of 0.24%, along with the engineered swale geometry provides a flow depth of 1.57 feet with a water surface elevation of 69.51 feet. This leaves 0.5 feet of freeboard from the roadway surface.

Station 737+50

This section represents the system 1 outlet to a unnamed tributary to Piper Brook. The overall stream slope for this reach of swale is 6.7%. At this outlet, the total drainage area for system 1 is 4.27 acres, with a computed design flow rate of 8.3-cfs. Using the channel geometry and global design parameters as previously stated, the resulting depth of flow in the channel is 0.8 feet with a flow velocity of 3.9 feet per second.

All computations have been included with this section of the report.



NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

INDEX PLAN

SCALE: 1"=250'

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

FINAL PLANS FOR REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted: 9/2/2009

DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ..\HW_MSH_093_H052_INX-01.dgn

MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD
DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-01
SHEET NO. 7

GM2 Associates
Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 1 Design From Sta 765+00 to 737+50 Sheet 1 of 4

Station 758+50

Global Assumptions 10 min t_c

Runoff Coefficient 0.3

Rainfall intensity 6.5 in/hr

I_{100} @ 10 min t_c

4.8 in/hr

I_{10} @ 10 min t_c

check Swale @ sta 759+00

① Area Contributing 31903.75 Ft^2 ⇒ 0.73 ac

$(0.73\,ac)(0.5)(6.5\,in/hr) = 1.4$ CFS Q_{100}

$(0.73ac)(0.3)(4.8) = 1.0$ CFS Q_{10}

② Hydraulic parameters

Stream Slope 0.32%

Roughness 0.06

IRREGULAR channel

Sta	EL
6946.4	7097.7
6950.7	7095.7
6960.65	7095.5
6964	7093.7
6966.0	7093.5
6975.9	7098.4

For Quick 2

③ Quick 2 RESULTS

WSEL	Depth	Top width	velocity
7094.18'	0.68'	4'	0.77 FPS

Check 12" Pipe @ sta 758+50 HY-8

① Area Contributing 36307.75 ⇒ 0.83 ac

for Q_{100} $(0.83)(0.3)(6.5) = 1.62$ CFS

for Q_{10} $(0.83)(03)(4.8) = 1.2$ CFS

② Irregular tail water (757+50)

slope 0.32% roughness 0.06

Sta	EL
-9.2	76.0
-5	74.0
5	73.8
8.4	72.1
10.4	71.8

③ Roadway Data

Crest EL 73.89

Length 100'

Top width 105'

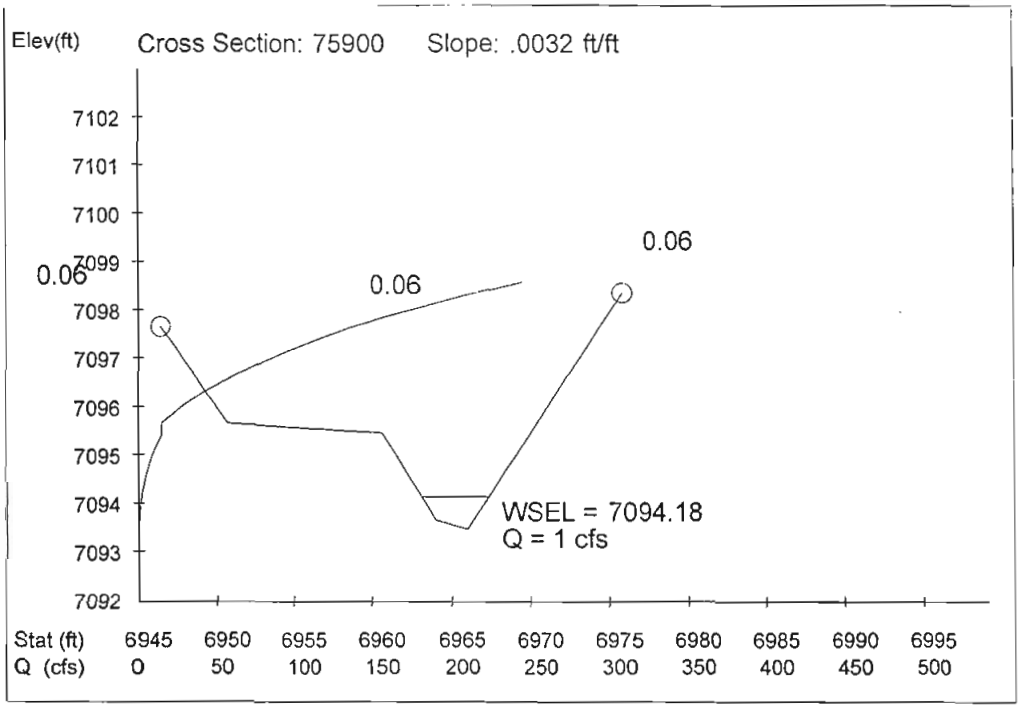
④ SITE DATA

inlet sta 758+75

inlet el 72.22

outlet sta 757+70

outlet el 71.89


Elev(ft)
Cross Section: 75900
Slope: .0032 ft/ft
7102
7101
7100
7099
7098
7097
7096
7095
7094
7093
7092
0.06
0.06
0.06
WSEL = 7094.18
Q = 1 cfs
Stat (ft) 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995
Q (cfs) 0 50 100 150 200 250 300 350 400 450 500

HY-8 Culvert Analysis Report Station 758+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
72.87	1.00	1.00	0.00	1
72.90	1.10	1.10	0.00	1
72.94	1.20	1.20	0.00	1
72.97	1.30	1.30	0.00	1
73.01	1.40	1.40	0.00	1
73.04	1.50	1.50	0.00	1
73.07	1.60	1.60	0.00	1
73.11	1.70	1.70	0.00	1
73.14	1.80	1.80	0.00	1
73.17	1.90	1.90	0.00	1
73.21	2.00	2.00	0.00	1
73.89	3.10	3.10	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 758+50

Rating Curve Plot for Crossing: 758+50

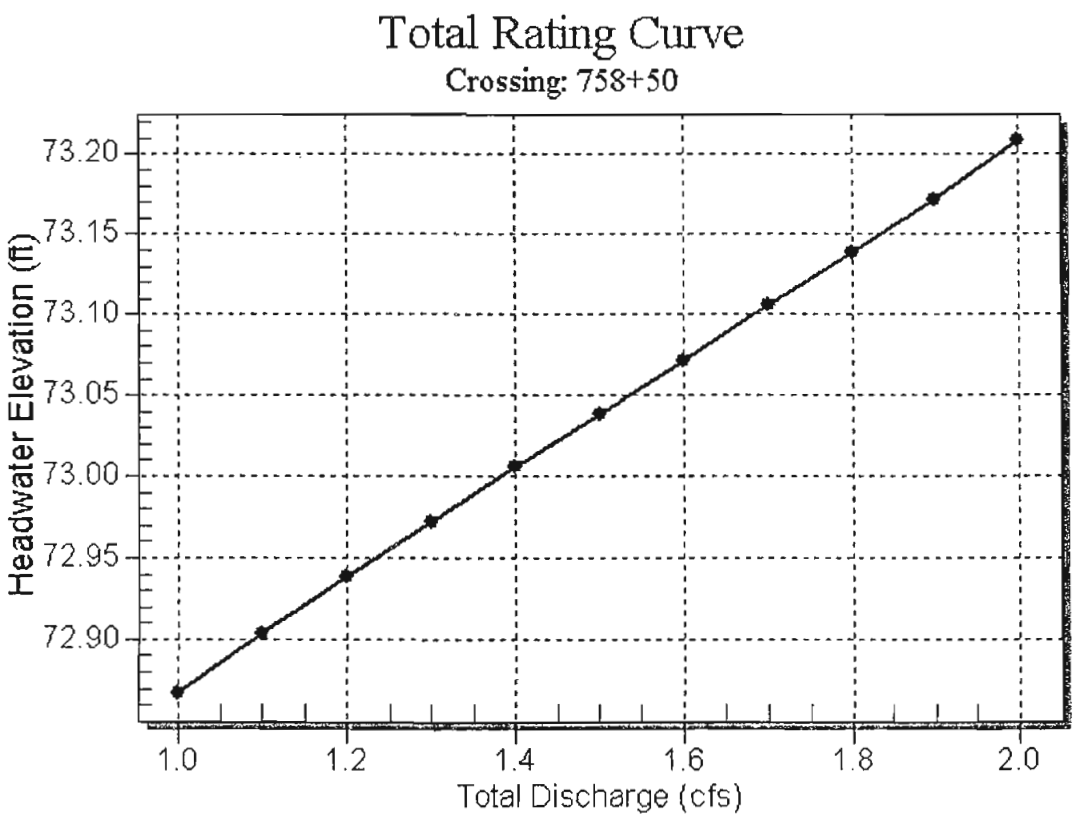


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	72.87	0.600	0.647	3-M1t	0.476	0.418	0.535	0.625	2.341	0.694
1.10	1.10	72.90	0.636	0.683	3-M1t	0.504	0.439	0.560	0.650	2.430	0.713
1.20	1.20	72.94	0.671	0.718	3-M1t	0.531	0.460	0.585	0.675	2.515	0.731
1.30	1.30	72.97	0.705	0.753	3-M1t	0.558	0.480	0.609	0.699	2.597	0.747
1.40	1.40	73.01	0.738	0.786	3-M1t	0.585	0.501	0.631	0.721	2.677	0.763
1.50	1.50	73.04	0.769	0.818	3-M1t	0.612	0.518	0.653	0.743	2.766	0.778
1.60	1.60	73.07	0.800	0.851	3-M1t	0.640	0.535	0.674	0.764	2.846	0.792
1.70	1.70	73.11	0.831	0.886	3-M1t	0.668	0.552	0.694	0.784	2.923	0.805
1.80	1.80	73.14	0.861	0.918	3-M1t	0.696	0.569	0.714	0.804	2.999	0.818
1.90	1.90	73.17	0.891	0.951	3-M1t	0.728	0.587	0.733	0.823	3.073	0.830
2.00	2.00	73.21	0.922	0.989	3-M2t	0.761	0.603	0.751	0.841	3.168	0.842

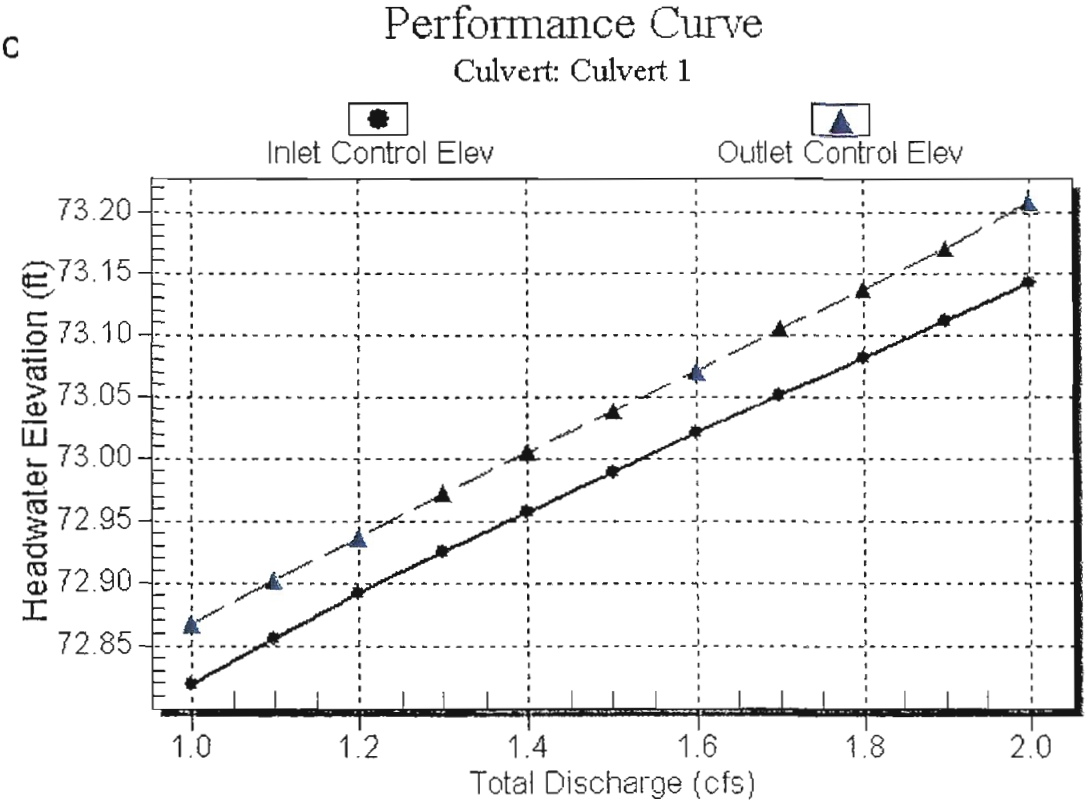
****

Inlet Elevation (invert): 72.22 ft, Outlet Elevation (invert): 71.89 ft

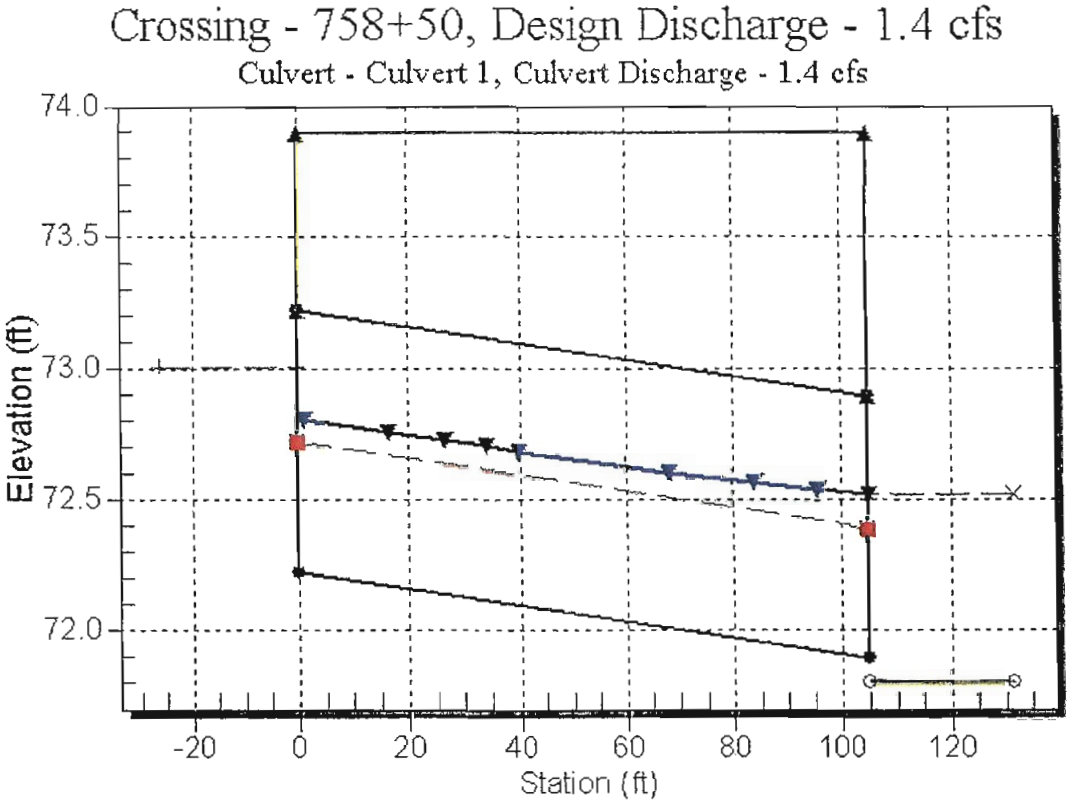
Culvert Length: 105.00 ft, Culvert Slope: 0.0031

****

c



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 72.22 ft

Outlet Station: 105.00 ft

Outlet Elevation: 71.89 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 758+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	72.42	0.62	0.69	0.12	0.20
1.10	72.45	0.65	0.71	0.13	0.20
1.20	72.48	0.68	0.73	0.13	0.20
1.30	72.50	0.70	0.75	0.14	0.20
1.40	72.52	0.72	0.76	0.14	0.21
1.50	72.54	0.74	0.78	0.15	0.21
1.60	72.56	0.76	0.79	0.15	0.21
1.70	72.58	0.78	0.81	0.16	0.21
1.80	72.60	0.80	0.82	0.16	0.21
1.90	72.62	0.82	0.83	0.16	0.21
2.00	72.64	0.84	0.84	0.17	0.21

Tailwater Channel Data - 758+50

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0032

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	-9.20	76.00	0.0600
2	-5.00	74.00	0.0600
3	5.00	73.80	0.0600
4	8.40	72.10	0.0600
5	10.40	71.80	0.0600
6	20.50	76.90	0.0000

Roadway Data for Crossing: 758+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 73.89 ft

Roadway Surface: Gravel

Roadway Top Width: 105.00 ft

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 1 Design Cont. Sheet 2 of 4

Station 756+00 Culvert Crossing

① Area Contributing 47106.25 Ft^2 ⇒ 1.08 ac

$Q_{100} = (1.08\,ac)(0.3)(6.5\,in/hr) = 2.1$ CFS

$Q_{10} = (1.08\,ac)(0.3)(4.8\,in/hr) = 1.5$ CFS

② irregular Tailwater (755+00)

slope 0.18% Roughness 0.06

Sta	EL
5.1	76.6
13.2	71.6
15.2	71.3
21.4	75.8

③ Roadway Data

Crest El -	74.86
length	100'
Top width	100'

④ Site Data

inlet Sta	0
El	71.49
outlet Sta	100
El	71.31

HY-8 Culvert Analysis Report Station 756+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
72.42	1.50	1.50	0.00	1
72.49	1.65	1.65	0.00	1
72.55	1.80	1.80	0.00	1
72.67	1.95	1.95	0.00	1
72.77	2.10	2.10	0.00	1
72.87	2.25	2.25	0.00	1
72.97	2.40	2.40	0.00	1
73.08	2.55	2.55	0.00	1
73.19	2.70	2.70	0.00	1
73.30	2.85	2.85	0.00	1
73.42	3.00	3.00	0.00	1
74.86	4.50	4.50	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 756+00

Rating Curve Plot for Crossing: 756+00

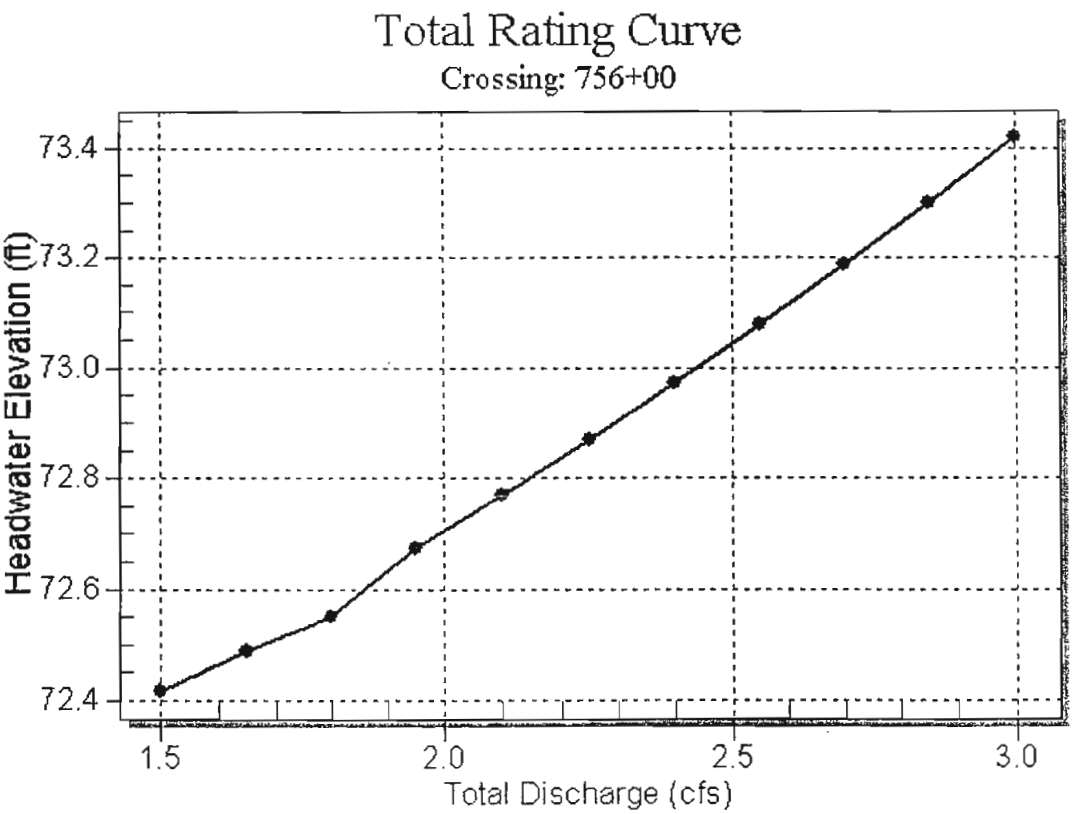


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.50	1.50	72.42	0.770	0.928	3-M1t	0.755	0.518	0.860	0.870	2.095	0.643
1.65	1.65	72.49	0.816	0.998	3-M1t	0.832	0.544	0.897	0.907	2.222	0.660
1.80	1.80	72.55	0.862	1.062	3-M2t	1.000	0.569	0.932	0.942	2.345	0.676
1.95	1.95	72.67	0.907	1.185	7-M2t	1.000	0.595	0.966	0.976	2.528	0.691
2.10	2.10	72.77	0.953	1.279	7-M2t	1.000	0.618	0.998	1.008	2.676	0.704
2.25	2.25	72.87	0.999	1.378	4-FFf	1.000	0.639	1.000	1.039	2.865	0.718
2.40	2.40	72.97	1.046	1.481	4-FFf	1.000	0.661	1.000	1.069	3.056	0.730
2.55	2.55	73.08	1.095	1.587	4-FFf	1.000	0.683	1.000	1.098	3.247	0.742
2.70	2.70	73.19	1.145	1.697	4-FFf	1.000	0.704	1.000	1.126	3.438	0.753
2.85	2.85	73.30	1.198	1.811	4-FFf	1.000	0.722	1.000	1.153	3.629	0.764
3.00	3.00	73.42	1.253	1.929	4-FFf	1.000	0.740	1.000	1.179	3.820	0.775

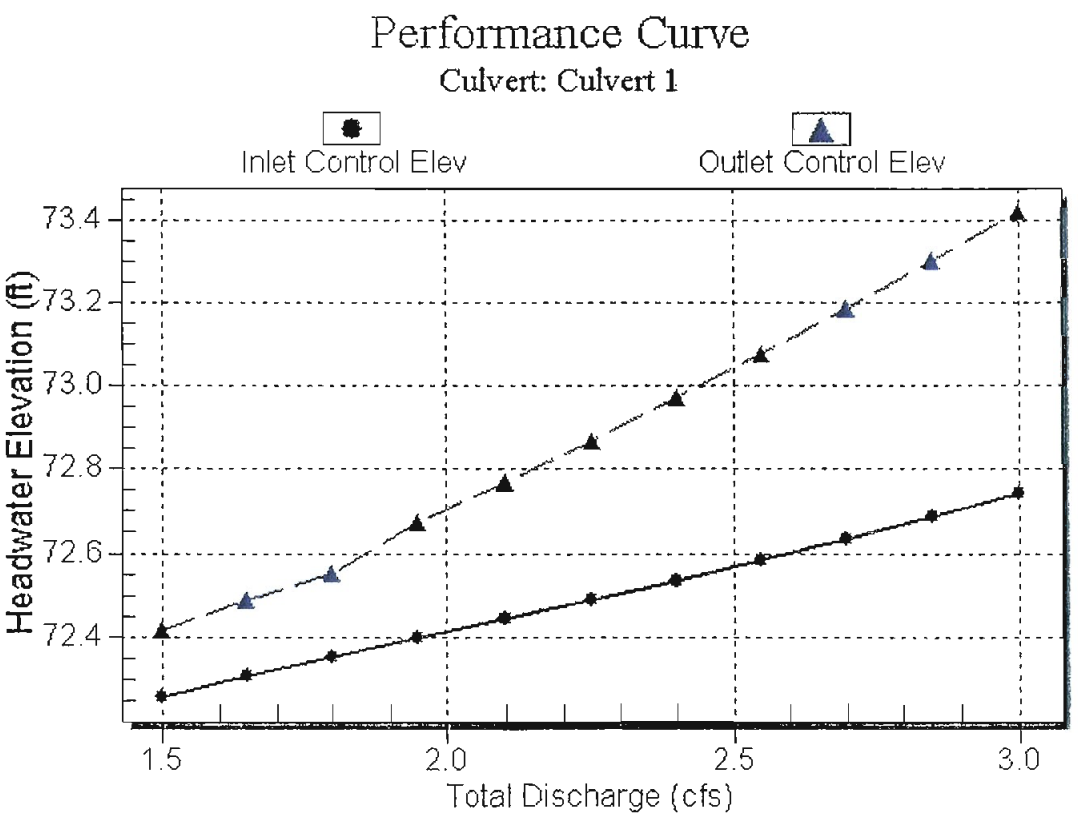
****

Inlet Elevation (invert): 71.49 ft, Outlet Elevation (invert): 71.31 ft

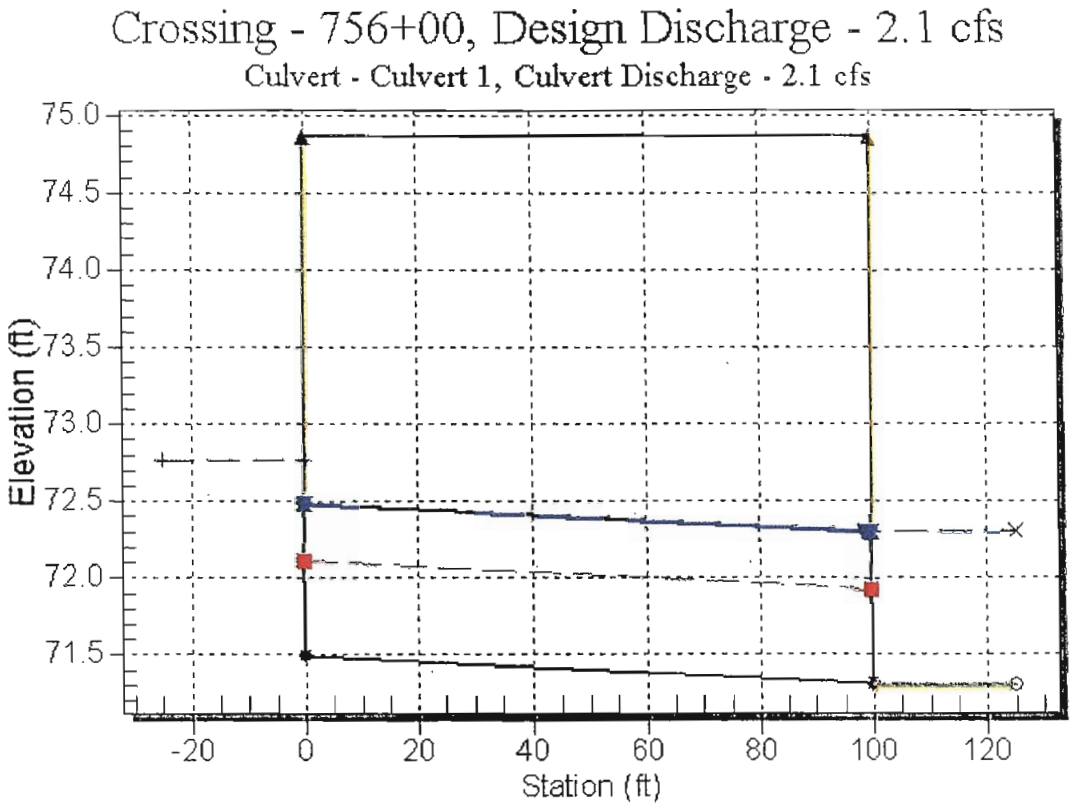
Culvert Length: 100.00 ft, Culvert Slope: 0.0018

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for **Culvert: Culvert 1**



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 71.49 ft

Outlet Station: 100.00 ft

Outlet Elevation: 71.31 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - **Downstream Channel Rating Curve (Crossing: 756+00)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.50	72.17	0.87	0.64	0.10	0.16
1.65	72.21	0.91	0.66	0.10	0.16
1.80	72.24	0.94	0.68	0.11	0.16
1.95	72.28	0.98	0.69	0.11	0.16
2.10	72.31	1.01	0.70	0.11	0.16
2.25	72.34	1.04	0.72	0.12	0.16
2.40	72.37	1.07	0.73	0.12	0.16
2.55	72.40	1.10	0.74	0.12	0.16
2.70	72.43	1.13	0.75	0.13	0.16
2.85	72.45	1.15	0.76	0.13	0.16
3.00	72.48	1.18	0.77	0.13	0.16

Tailwater Channel Data - 756+00

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0018

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	5.10	75.60	0.0600
2	13.20	71.60	0.0600
3	15.20	71.30	0.0600
4	21.90	75.80	0.0000

Roadway Data for Crossing: 756+00

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 74.86 ft

Roadway Surface: Gravel

Roadway Top Width: 100.00 ft

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 1 Design Cont. Sheet 3 of 4

Station 743+50 Culvert Crossing NEED 18" RCP

① Area Contributing 132441.25 Ft^2 ⇒ 3.04 ac

Q_{100} (3.04 ac X 0.3 X 6.5 in/hr) = 5.9 CFS

Q_{10} (3.04 ac X 0.3)(4.8 in/hr) = 4.4 CFS

② irregular tailwater (741+50)

Slope 0.24% Roughness 0.06

Sta	Ec
5	70.9
9.2	68.8
11.2	68.5
20.35	73.1

③ Roadway Data

Crest El	71.53
length	100
Top width	225

④ Site Data

inlet sta	0
Ec	69.08
outlet sta	225
Ec	68.54

HY-8 Culvert Analysis Report Station 743+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
70.39	4.40	4.40	0.00	1
70.42	4.56	4.56	0.00	1
70.46	4.72	4.72	0.00	1
70.49	4.88	4.88	0.00	1
70.53	5.04	5.04	0.00	1
70.56	5.20	5.20	0.00	1
70.59	5.36	5.36	0.00	1
70.64	5.52	5.52	0.00	1
70.67	5.68	5.68	0.00	1
70.71	5.84	5.84	0.00	1
70.73	5.90	5.90	0.00	1
71.53	7.59	7.59	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 743+50

Rating Curve Plot for Crossing: 743+50

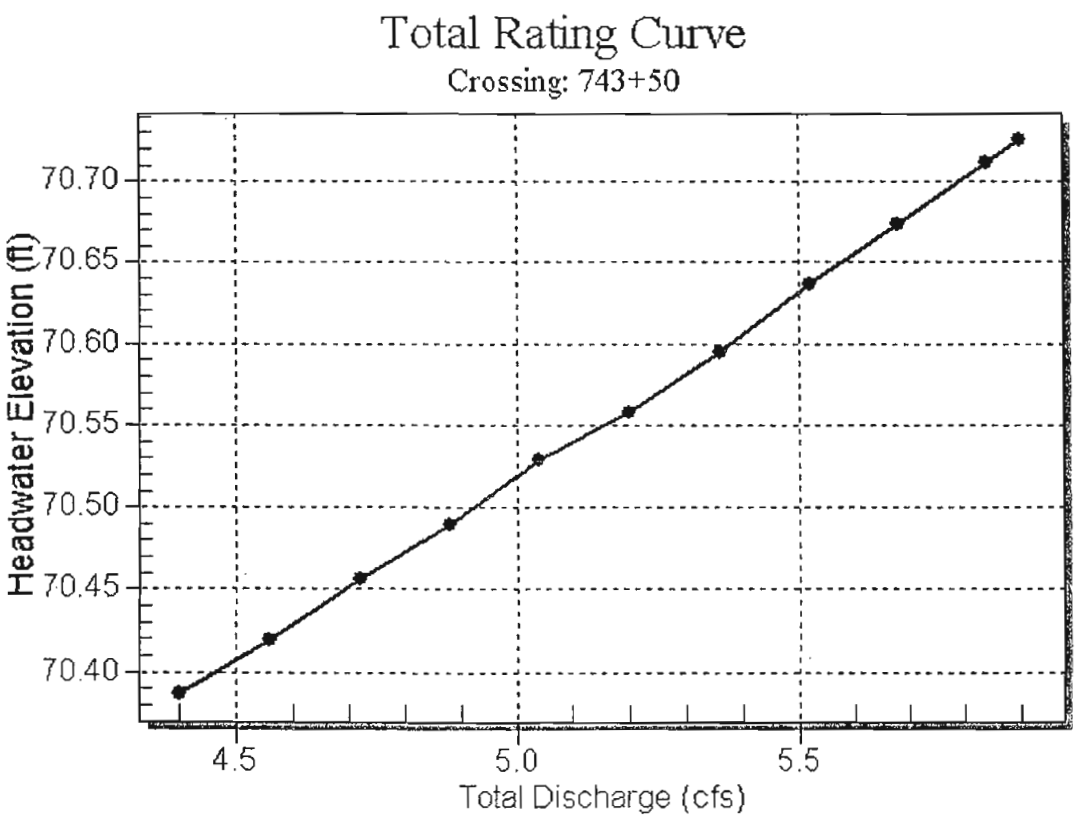


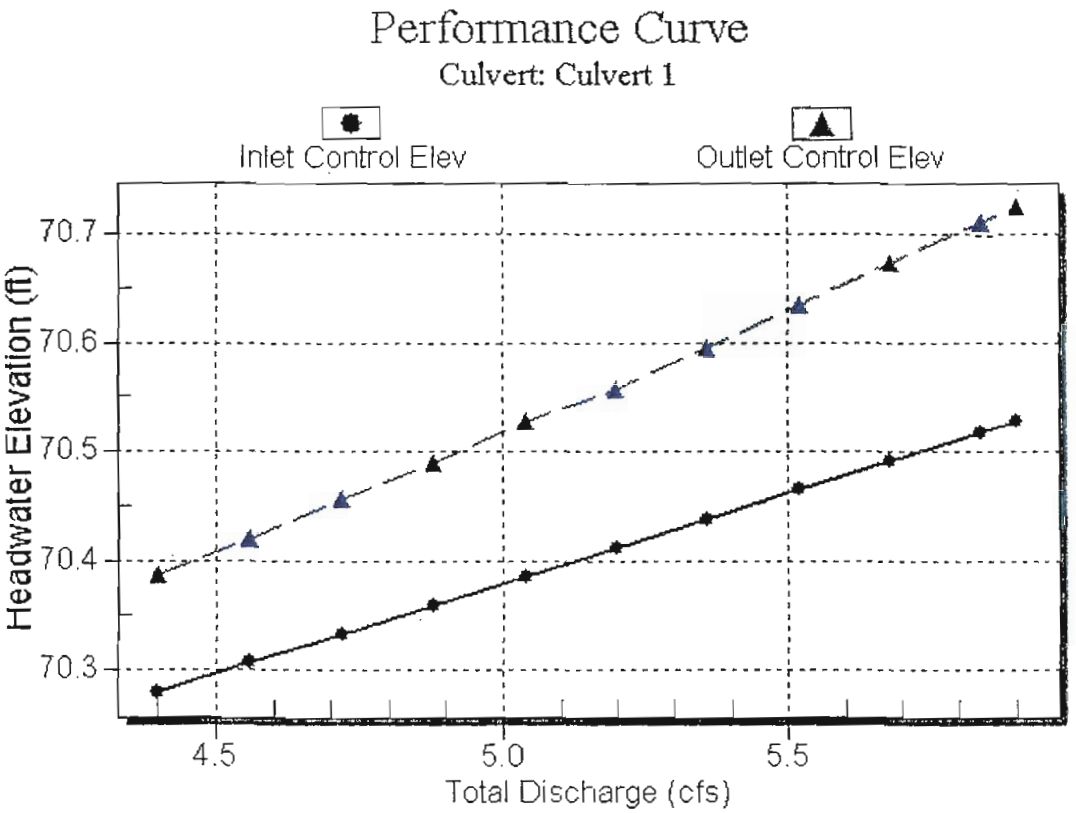
Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.40	4.40	70.39	1.200	1.307	3-M1t	1.005	0.802	1.218	1.258	2.859	0.934
4.56	4.56	70.42	1.226	1.339	3-M1t	1.031	0.817	1.238	1.278	2.915	0.943
4.72	4.72	70.46	1.253	1.377	3-M1t	1.058	0.832	1.257	1.297	2.995	0.952
4.88	4.88	70.49	1.279	1.410	3-M1t	1.089	0.846	1.275	1.315	3.058	0.960
5.04	5.04	70.53	1.306	1.449	3-M1t	1.120	0.861	1.294	1.334	3.120	0.968
5.20	5.20	70.56	1.332	1.478	3-M1t	1.150	0.876	1.312	1.352	3.181	0.976
5.36	5.36	70.59	1.358	1.515	7-M1t	1.181	0.891	1.330	1.370	3.242	0.984
5.52	5.52	70.64	1.384	1.556	7-M1t	1.218	0.905	1.347	1.387	3.302	0.991
5.68	5.68	70.67	1.411	1.594	7-M1t	1.267	0.918	1.364	1.404	3.361	0.999
5.84	5.84	70.71	1.437	1.632	7-M1t	1.315	0.931	1.381	1.421	3.419	1.006
5.90	5.90	70.73	1.447	1.646	7-M1t	1.334	0.935	1.387	1.427	3.441	1.009

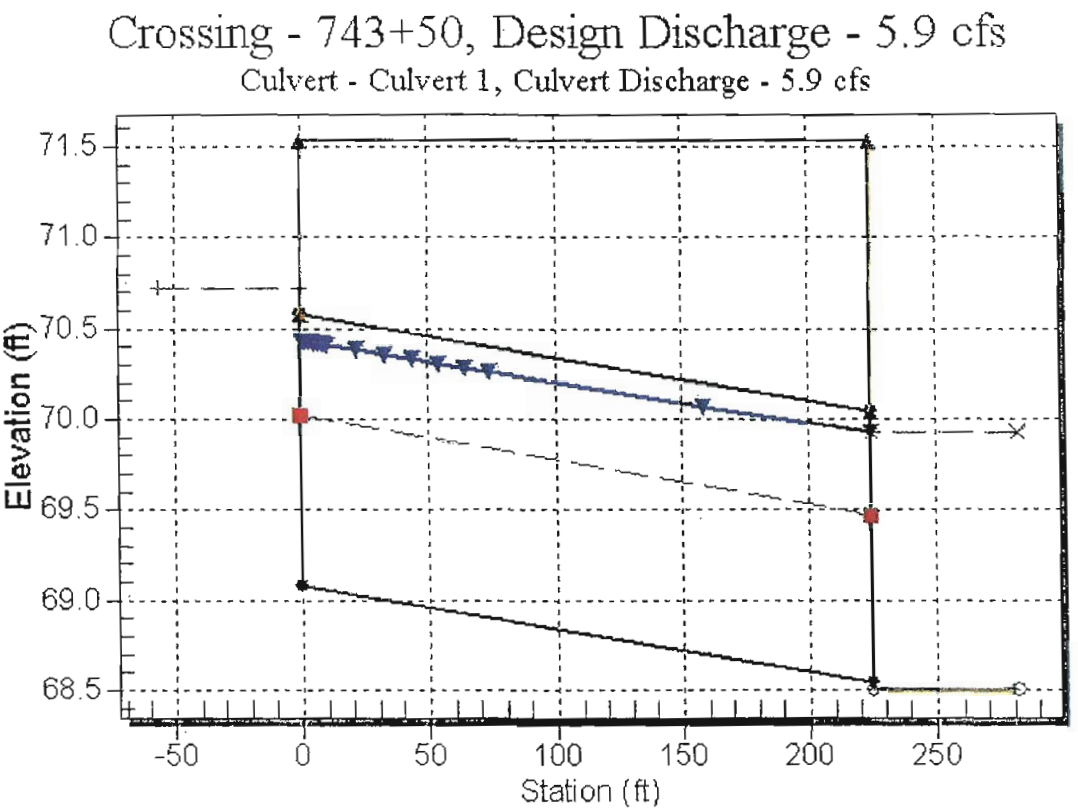
Inlet Elevation (invert): 69.08 ft, *Outlet Elevation (invert): 68.54 ft*

Culvert Length: 225.00 ft, Culvert Slope: 0.0024

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 69.08 ft

Outlet Station: 225.00 ft

Outlet Elevation: 68.54 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 743+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.40	69.76	1.26	0.93	0.19	0.19
4.56	69.78	1.28	0.94	0.19	0.19
4.72	69.80	1.30	0.95	0.19	0.19
4.88	69.82	1.32	0.96	0.20	0.19
5.04	69.83	1.33	0.97	0.20	0.19
5.20	69.85	1.35	0.98	0.20	0.19
5.36	69.87	1.37	0.98	0.21	0.19
5.52	69.89	1.39	0.99	0.21	0.19
5.68	69.90	1.40	1.00	0.21	0.20
5.84	69.92	1.42	1.01	0.21	0.20
5.90	69.93	1.43	1.01	0.21	0.20

Tailwater Channel Data - 743+50

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0024

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	5.00	70.90	0.0600
2	9.20	68.80	0.0600
3	11.20	68.50	0.0600
4	20.35	73.10	0.0000

Roadway Data for Crossing: 743+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 71.53 ft

Roadway Surface: Gravel

Roadway Top Width: 225.00 ft

Swale check @ 739+00

① Area Contributing 170816 Ft^2 = 3.92 ac
Q_{100} = (3.92 ac)(0.3)(6.5 in/hr) = 7.6 CFS
Q_{10} = (3.92 ac)(0.3)(4.8 in/hr) = 5.6 CFS

② Hydraulic Parameters
Stream slope 0.24%
Roughness 0.06
Irregular channel for Quick 2

Sta	EL
-197.1	11.8
-193.7	10.1
-183.75	9.9
-180.4	8.2
-178.4	7.9
-176.4	8.9
-163.7	9.7
-156.3	11.7

③ Quick 2 Results
WSEL -
Depth - 1.57'
Topwidth - 16'
Velocity - 0.83 FPS

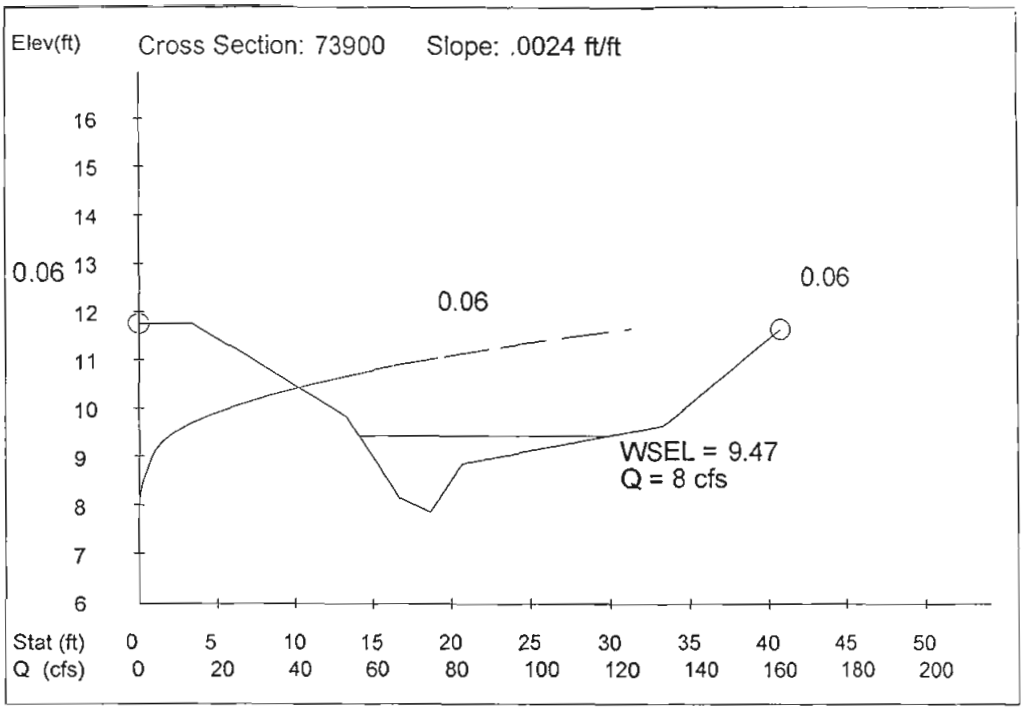
Swale check @ outlet 737+50

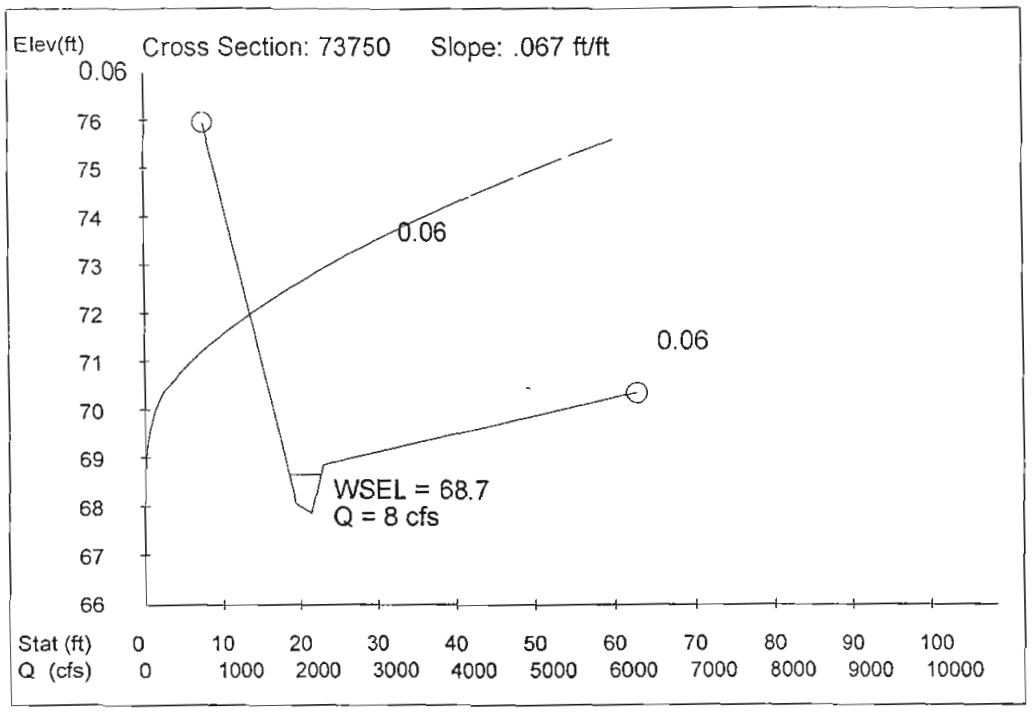
① Area Contributing 185816.25 Ft^2 = 4.27 ac
Q_{100} = (4.27 ac)(0.3)(6.5 in/hr) = 8.3 CFS
Q_{10} = (4.27 ac)(0.3)(4.8 in/hr) = 6.1 CFS

② Hydraulic Parameters
Stream slope 6.7%
Roughness 0.06
Irregular Channel for quick 2

Sta	EL
7.6	76.00
19.4	68.1
21.4	67.9
22.9	68.9
62.7	70.4

③ Quick 2 Results
WSEL - 68.7'
Depth - 0.8'
top width - 4'
Vel 3.9 FPS


Elev(ft)
Cross Section: 73900
Slope: .0024 ft/ft
16
15
14
0.06
13
12
11
10
9
8
7
6
0.06
0.06
WSEL = 9.47
Q = 8 cfs
Stat (ft) 0 5 10 15 20 25 30 35 40 45 50
Q (cfs) 0 20 40 60 80 100 120 140 160 180 200


Elev(ft)
Cross Section: 73750
Slope: .067 ft/ft
0.06
76
75
74
73
72
71
70
69
68
67
66
0.06
0.06
WSEL = 68.7
Q = 8 cfs
Stat (ft) 0 10 20 30 40 50 60 70 80 90 100
Q (cfs) 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

AMTRAK ACCESS ROAD SYSTEM 2 / TRACK DRAINAGE OUTLET 2
MANAGING AREAS BETWEEN 765+00 TO 787+50

Station 765+00 is the high point in the swale system between system 1 and system 2. AAR System 2 and Track Drainage 2 begin at this high point and flow north to New Britain Avenue.

Track Drainage

A swale has been designed to run the length of this area between the tracks and the Busway barrier. The low point of the swale is at station 787+50, which also is the last ground station before the bridge over New Britain Avenue. It is understood that the adjacent Busway Line Contract is in the process of designing a pipe to be installed using trenchless technologies and ultimately connecting to the Amtrak Access Road drainage system. From information available at the time of this design, it appears that the pipe to run from the Busway to the Access Road system will be at station 786+00. It is proposed to discharge collected runoff from the track swale to this jacked pipe with a "CL" type CB inlet. For hydraulic design of the track crossing, the area, runoff coefficient and assumed time of concentration developed for this swale will be made available. In this report, a swale capacity check and depth of flow over a "CL" type CB is presented.

Station 787+00

Swale capacity at the low point of the swale is based on 1.19 acres contributing (total drainage area). The flow rate is 2.32-cfs for the 100-year event. With this and the engineered geometry of the swale, the computed water surface elevation is 67.7'. The track elevation is 70.4 feet resulting in 2.7 feet of freeboard.

Station 787+50

If the proposed inlet servicing the track drainage swale is placed at the low point of the system (recommended to avoid ponding within the swale), the maximum flow depth over the grate was computed to be 0.26 feet. From this information it can be surmised that the controlling feature of the maximum water surface elevation is the swale flow, not the depth over the catch basin.

Access Road Drainage

Station 770+50

At station 770+50, the grade of the swale increases from 0.12% to 0.50%. This section represents the lowest section of the swale following a 0.12% grade, and as such was selected to represent the swale capacity for this grading. At station 770+50, the area contributing is 0.63 acres. For the 100-year event, this area produces 1.2-cfs of runoff. With the 0.12% swale slope and proposed channel geometry, the computed water surface elevation is 73.79 feet, providing 1.24 feet of freeboard to the roadway elevation.

Station 772+50

At station 772+50, there is a culvert conveying flows under a required turnoff for the access road. This culvert follows a 0.5% slope and conveys flows from a 0.85 acre drainage area contributing 1.7-cfs. For this slope and tailwater equal to normal depth in the receiving reach of the swale, a 12" conduit would be sufficient to manage the design flows. Resulting headwater elevation for the culvert would be 72.79 feet providing a freeboard of 1.26 feet to the roadway surface.

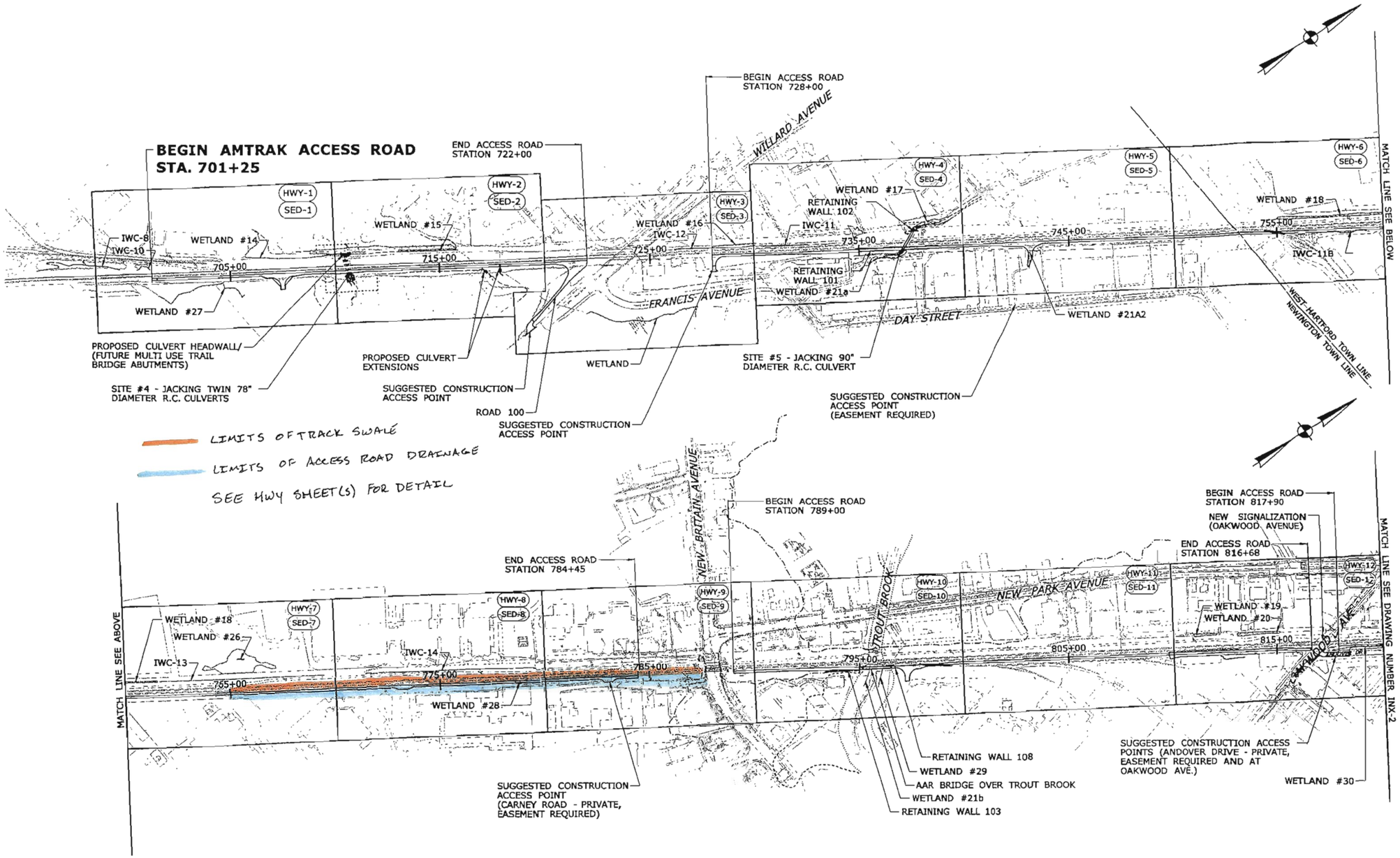
Station 782+50

At station 782+50 the flow line enters a sub-surface drainage system to tie in to the drainage system on New Britain Avenue. Drainage computations were facilitated by the Hydraflow StormSewer program. This system conveys flows from a contributing area of 2.14 acres which, using the global parameters for hydrology associated with this project results in a 100-year discharge of 4.17-cfs. At the outlet of this proposed system (tie-in to New Britain Ave. System) the starting water surface elevation was set to reflect the existing system at capacity. The pipe flowing out of the tie-in catch basin is a 12"x18" CMP with an invert elevation of 45.94. It is not known from the survey if the pipe has a horizontal or vertical primary axis, so for conservatism, the starting water surface elevation was taken as 1.5 feet above the invert or 47.44 feet. As a result, for the 100-year event, this proposed system will convey the design flows near capacity with a headwater elevation of 67.69 feet, providing a freeboard from the roadway surface of 1.18 feet.

This system was designed prior to the design of the track drainage swale and the proposal for a connection from the Busway to this system. It is understood that the line designers are to determine capacity of the receiving leg of this sub-surface system connecting to New Britain Avenue. For this reason, the pipe sizes from station 786+00 may increase depending on the findings of the tie in from the Busway.

All computations and program output are attached with this section

For the further design of the Busway to Access Road connection, the contribution in CxA from the track swale is 0.357, and the contribution from the Access Road is 0.642. The analysis presented herein used a time of concentration of 10 minutes.



NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

INDEX PLAN

SCALE: 1"=250'

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

FINAL PLANS FOR REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted: 9/2/2009

DESIGNER/DRAFTER: CJF

CHECKED BY: ALM

SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW_MSH_093_H052_INX-01.dgn

MICHAEL BAKER ENGINEERING, INC.

APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN:
NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE:
INDEX PLAN

PROJECT NO. 093-H052

DRAWING NO. INX-01

SHEET NO. 7

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Drainage

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 787+00

Notes: Swale capacity check near outlet

Parameters

Channel Type: Custom Cross Section

Flow: 2.3000 (cfs)

Depth: 0.8035 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0056 (ft/ft)

Area of Flow: 2.0946 (ft^2)

Wetted Perimeter: 4.5933 (ft)

Average Velocity: 1.0980 (ft/s)

Top Width: 4.2139 (ft)

Froude Number: 0.2745

Critical Depth: 0.4147 (ft)

Critical Velocity: 3.0315 (ft/s)

Critical Slope: 0.0877 (ft/ft)

Critical Top Width: 2.6589 (ft)

Calculated Max Shear Stress: 0.2808 (lb/ft^2)

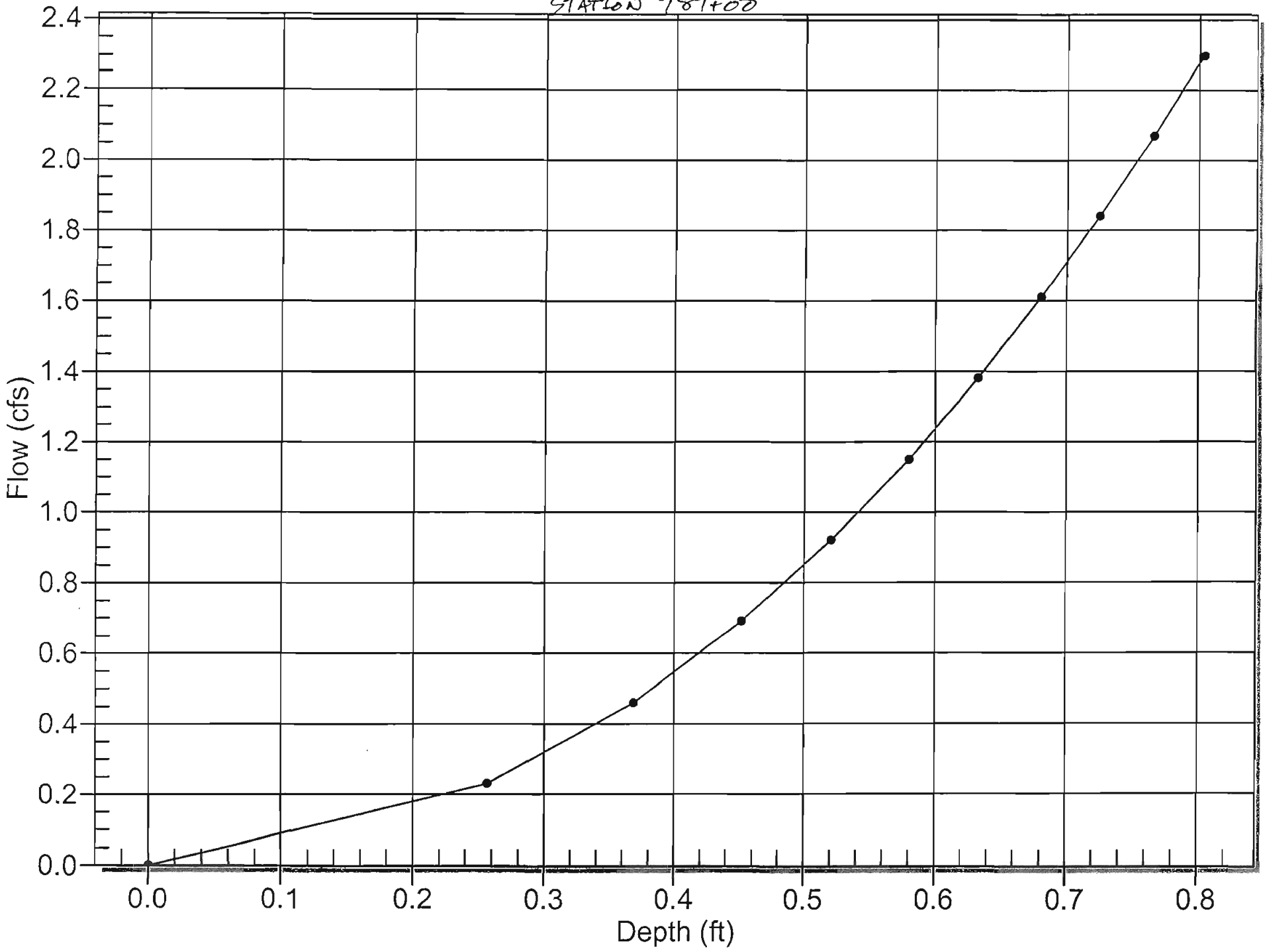
Calculated Avg Shear Stress: 0.1594 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
23.80	76.80	0.0600
25.50	67.90	0.0600
27.50	66.90	0.0600
28.50	66.90	0.0600
30.50	67.90	0.0600
32.50	68.10	0.0600
35.70	69.70	-----

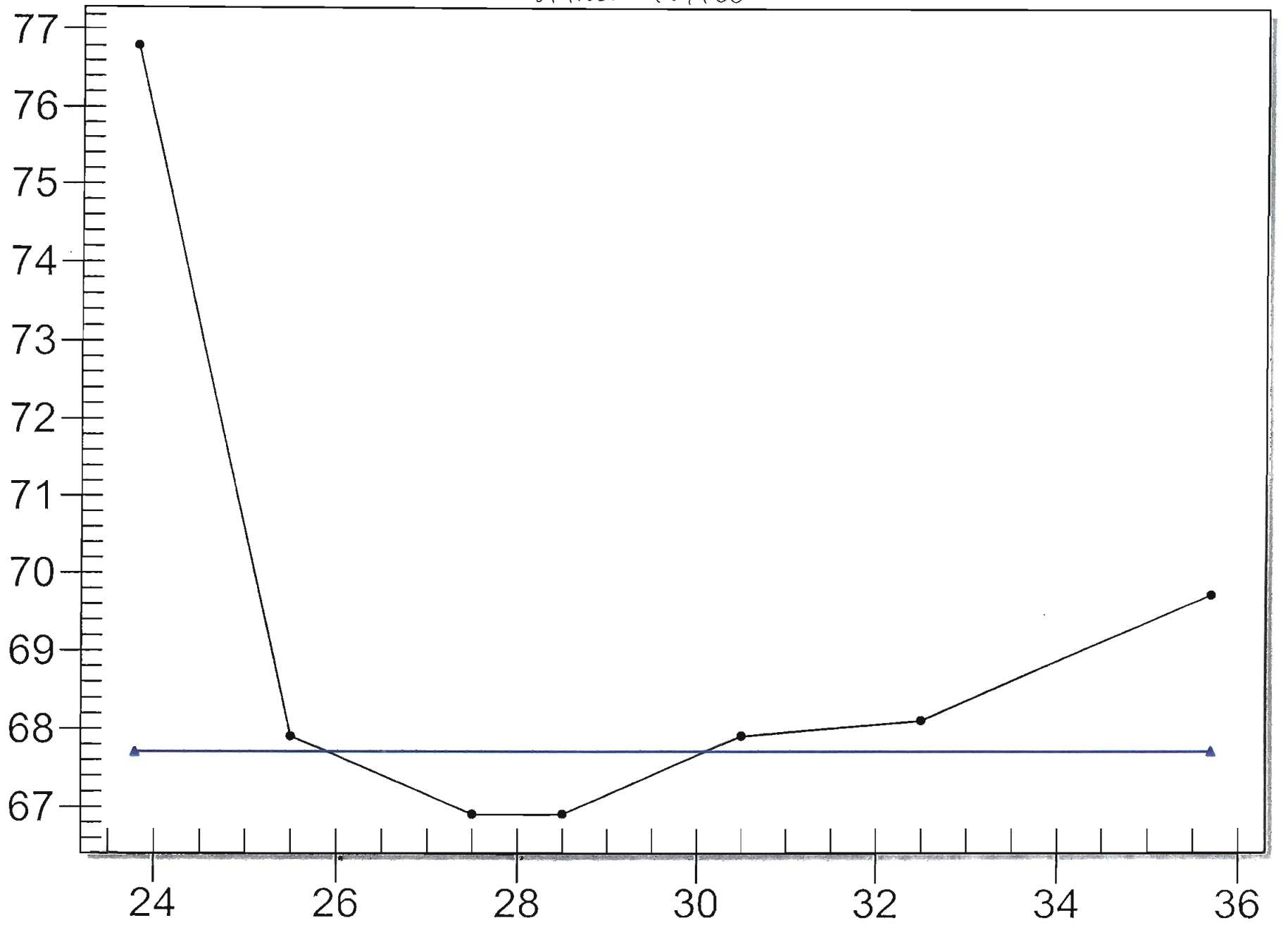
Flow vs. Depth

STATION 787+00



Cross Section

STATION 787+00



GM2 Associates

Engineers • Inspectors • Surveyors

Job Track Drainage — Computed By _____ — Date 2/3/10

Description _____ — Checked By _____ — Date _____

Area 2 from Stations — Sheet 1 of 1

Contributing Area from 765+50 → 787+50 [NEW Britain Ave receiving]

* To date – NO INFO ON WHERE Busway Jacked pipe will be.

Design point will be @ 787+50

Check Swale @ 787+00 for capacity

Provide line Contract w/ CA From this area

Swale 787+00

Station	Elevation
23.8	76.8
25.5	67.9
27.5	66.9
28.6	66.9
30.5	67.9
32.5	68.1
35.7	69.7

Slope = 0.66%

Q @ End of area 1.19 Ac C 0.3 I 6.5 in/hr = 2.3 CFS

	Depth	Trackel	Freeboard
Elev	67.7	70.44	2.74

Depth of Flow over inlet from weir → 0.26'

weir

$$d = \left(\frac{Q_i C_{FS}}{C_w P}\right)^{2/3}$$

$$0.26' = \left(\frac{2.3 \cdot 1.25}{3.0 \cdot 7.33}\right)^{2/3}$$

$Q = 2.3$

$C_{FS} = 1.25$

$C_{weir} = 3.0$

$P = 7.33'$

$C_{orifice} = 0.67$

$Area = 3.13\ Ft^2$

$g = 32.2$

orifice

$$d = \left(\frac{Q\ C_{FS}}{C_o A}\right)^2 \Big/ 2g$$

$$0.029' = \left(\frac{2.3 \cdot 1.25}{0.67 \cdot 3.13}\right)^2 \Big/ 2 \cdot 32.2$$

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 7 Design From 765+00 to outlet @ NB Ave Station 787+50 Sheet 1 of 2

Station 770+50 grade break @ Swale

① Area Contributing $27467.5\ Ft^2 = 0.63\ ac$

$Q_{100} = (0.63)(0.3)(6.5) = 1.2\ CFS$

$Q_{10} = (0.63)(0.3)(4.8) = 0.9\ CFS$

② Hydraulic Parameters

Stream slope 0.12%

Roughness 0.06

Irregular channel - For Quick2

Sta	El
5	74.9
8.9	73.2
10.4	73
22.9	79.2

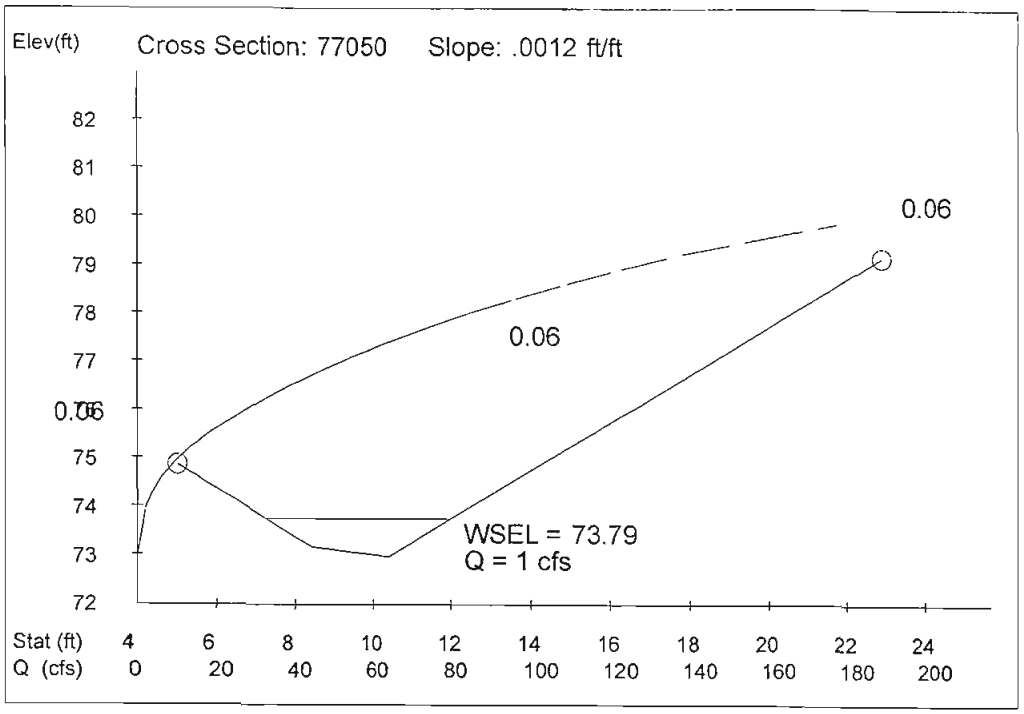
③ Quick 2 Results

WSEL - 73.79'

DEPth - 0.79'

Top width - 5'

Vel - 0.51 FPS


Elev(ft)
Cross Section: 77050
Slope: .0012 ft/ft
82
81
80
79
78
77
0.06
75
74
73
72
0.06
0.06
WSEL = 73.79
Q = 1 cfs
Stat (ft) 4 6 8 10 12 14 16 18 20 22 24
Q (cfs) 0 20 40 60 80 100 120 140 160 180 200

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amtrak Access Road — Computed By _____ — Date _____

Description _____ — Checked By _____ — Date _____

System 2 Design — Sheet 2 of 2

Station 772+50 Culvert Crossing

① Area Contributing 37216.25 Ft^2 = 0.85 ac

Q_{100} (0.85 ac)(0.3)(6.5 in/hr) = 1.7 CFS

Q_{10} (0.85 ac)(0.3)(4.8 in/hr) = 1.2 CFS

② irregular Tailwater

Slope 0.5% roughness 0.06

Sta	EL
5	73.2
8.4	71.5
10.4	71.3
26.2	79.2

③ Roadway Data

Crest EL	73.5
length	100
Topwidth	100

④ Site Data

inlet Sta	0
EL	71.91
outlet Sta	105
EL	71.39

→ Station 782+50 Sub Surface tie in to NEW BRITAIN AVE

① Area Contributing 93348.76 Ft^2 = 2.14 ac

Q_{100} (2.14 ac)(0.3)(6.5 in/hr) = 4.17 CFS

Q_{10} (2.14 ac)(0.3)(4.8 in/hr) = 3.08 CFS

★ Starting WSEL Set @ Crown of outlet pipe @ Tie in

HY-8 Culvert Analysis Report Station 772+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
71.91	0.00	0.00	0.00	1
72.16	0.20	0.20	0.00	1
72.27	0.40	0.40	0.00	1
72.35	0.60	0.60	0.00	1
72.43	0.80	0.80	0.00	1
72.57	1.00	1.00	0.00	1
72.64	1.20	1.20	0.00	1
72.70	1.40	1.40	0.00	1
72.76	1.60	1.60	0.00	1
72.79	1.70	1.70	0.00	1
72.88	2.00	2.00	0.00	1
73.50	3.34	3.34	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 772+50

Rating Curve Plot for Crossing: 772+50

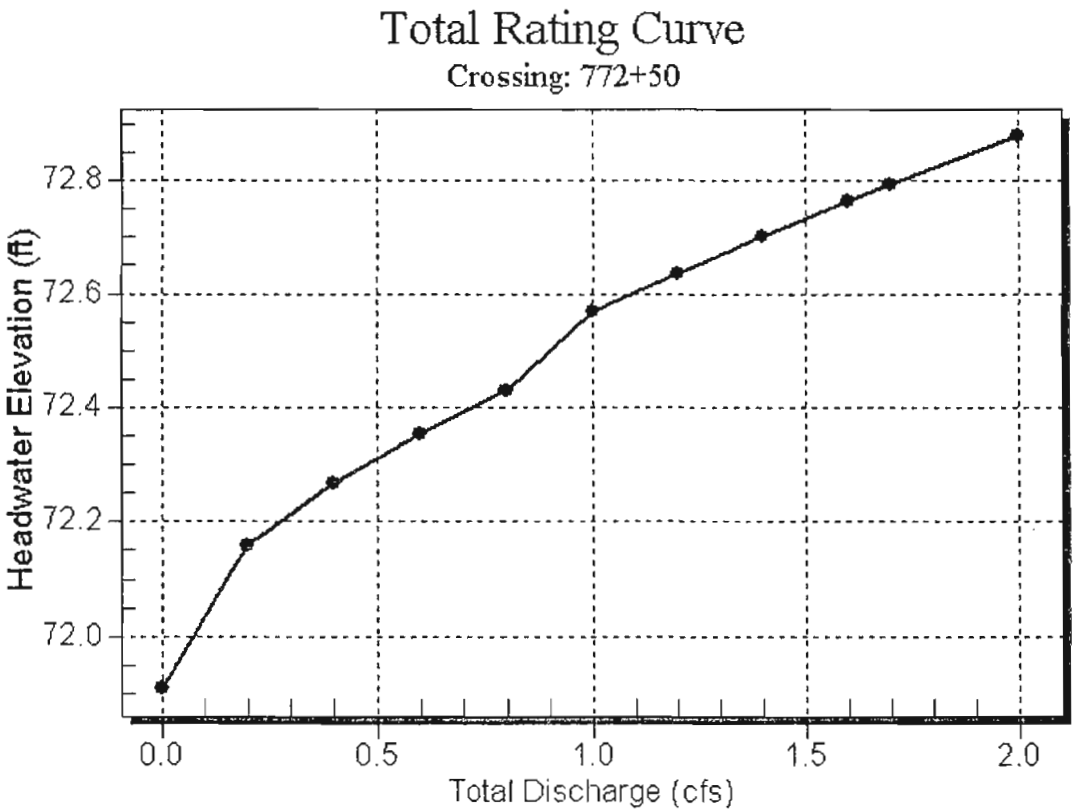


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	71.91	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.20	72.16	0.247	0.000	1-S2n	0.179	0.179	0.179	0.266	2.065	0.490
0.40	0.40	72.27	0.356	0.356	1-S2n	0.255	0.257	0.256	0.352	2.498	0.614
0.60	0.60	72.35	0.445	0.445	1-S2n	0.317	0.320	0.319	0.419	2.798	0.696
0.80	0.80	72.43	0.520	0.520	1-S2n	0.370	0.371	0.370	0.476	3.017	0.759
1.00	1.00	72.57	0.599	0.659	3-M1t	0.419	0.418	0.435	0.525	3.057	0.811
1.20	1.20	72.64	0.670	0.727	3-M1t	0.464	0.460	0.480	0.570	3.215	0.855
1.40	1.40	72.70	0.737	0.792	3-M1t	0.508	0.501	0.522	0.612	3.380	0.894
1.60	1.60	72.76	0.800	0.854	3-M1t	0.551	0.535	0.560	0.650	3.539	0.928
1.70	1.70	72.79	0.830	0.884	3-M1t	0.573	0.552	0.578	0.668	3.617	0.944
2.00	2.00	72.88	0.921	0.970	3-M2t	0.638	0.603	0.629	0.719	3.840	0.988

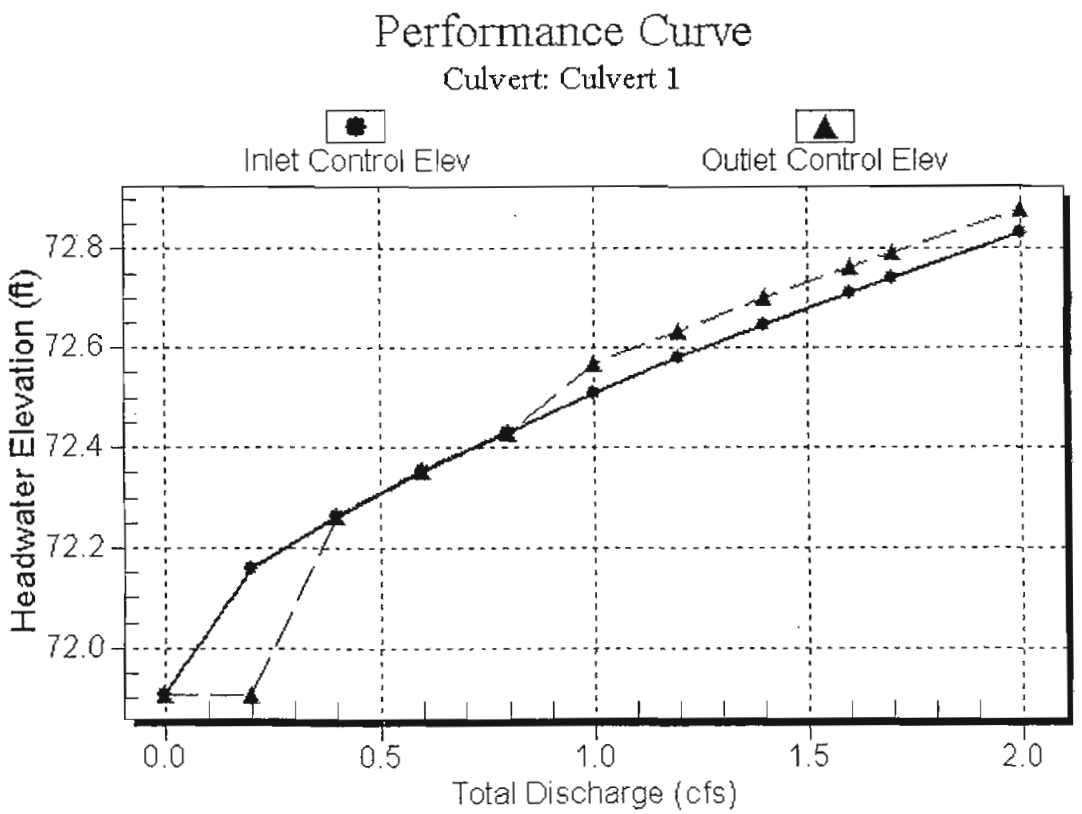
****

Inlet Elevation (invert): 71.91 ft, Outlet Elevation (invert): 71.39 ft

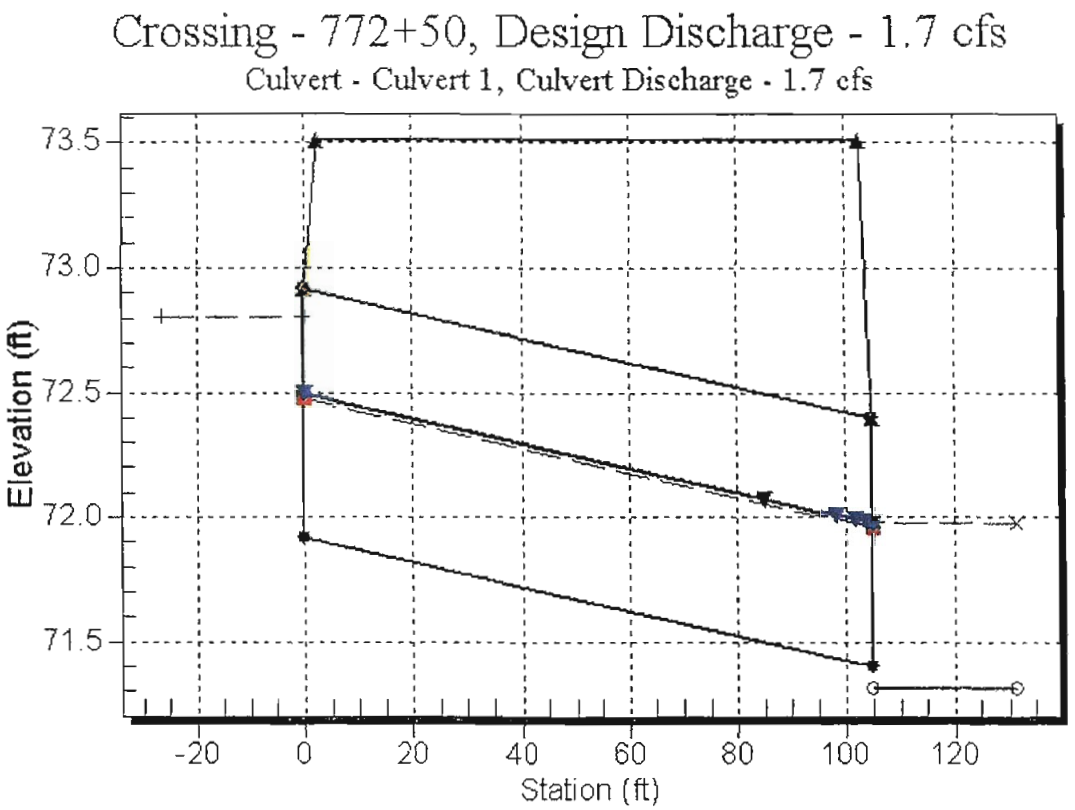
Culvert Length: 105.00 ft, Culvert Slope: 0.0050

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 71.91 ft

Outlet Station: 105.00 ft

Outlet Elevation: 71.39 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 772+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	71.30	0.00	0.00	0.00	0.00
0.20	71.57	0.27	0.49	0.08	0.22
0.40	71.65	0.35	0.61	0.11	0.23
0.60	71.72	0.42	0.70	0.13	0.24
0.80	71.78	0.48	0.76	0.15	0.24
1.00	71.83	0.53	0.81	0.16	0.25
1.20	71.87	0.57	0.86	0.18	0.25
1.40	71.91	0.61	0.89	0.19	0.25
1.60	71.95	0.65	0.93	0.20	0.26
1.70	71.97	0.67	0.94	0.21	0.26
2.00	72.02	0.72	0.99	0.22	0.26

Tailwater Channel Data - 772+50

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0050

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	5.00	73.20	0.0600
2	8.40	71.50	0.0600
3	10.40	71.30	0.0600
4	26.20	79.20	0.0000

Roadway Data for Crossing: 772+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

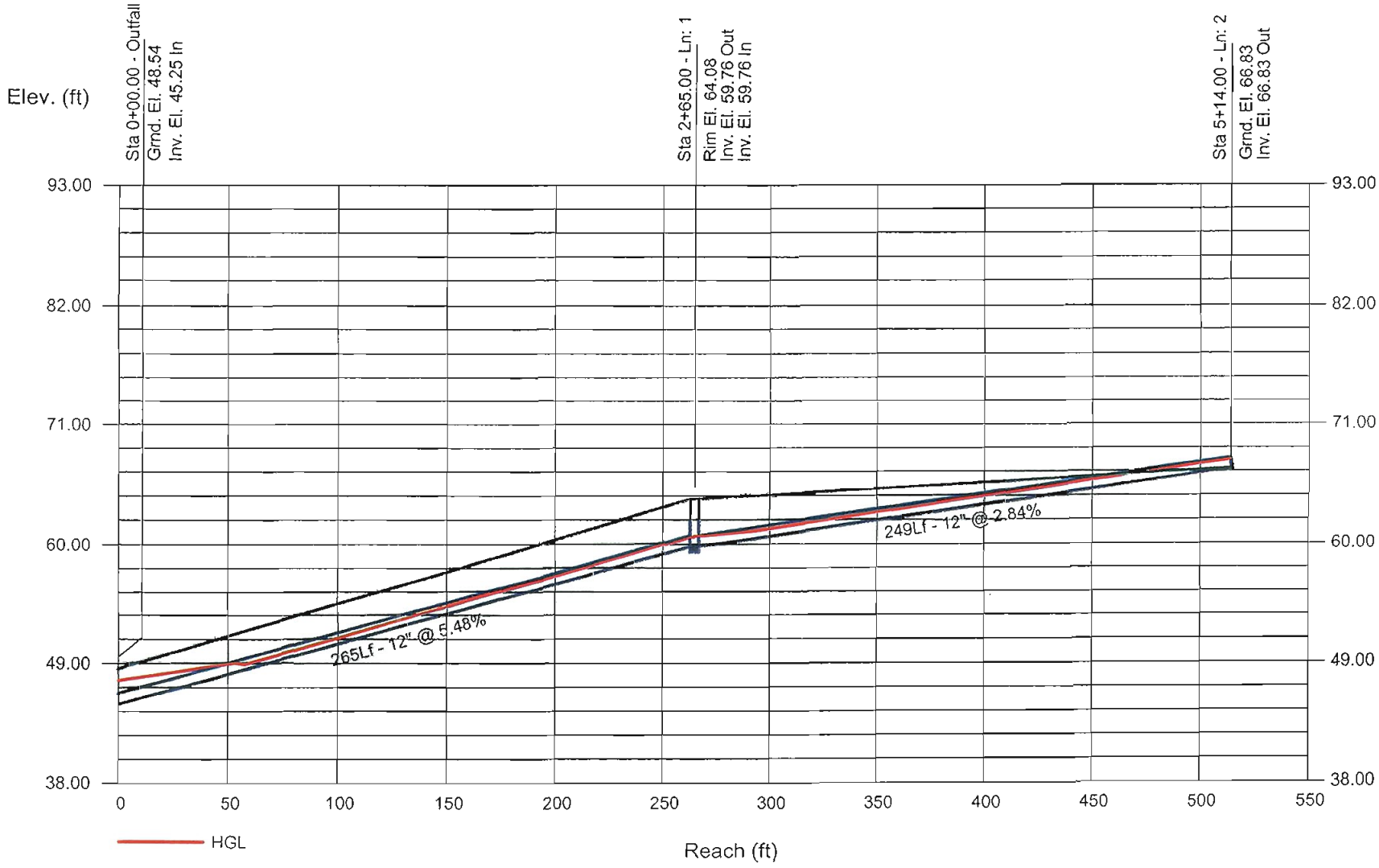
Crest Elevation: 73.50 ft

Roadway Surface: Gravel

Roadway Top Width: 100.00 ft

Storm Sewer Profile

Proj. file: Station_782+50.stm



Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	265	0.00	0.00	0.00	0.00	0.00	0.0	11.4	0.0	4.17	9.03	5.55	12	5.48	45.25	59.76	47.44	60.62	48.54	64.08	
2	1	249	0.00	0.00	0.00	0.00	0.00	10.0	10.0	0.0	4.17	6.50	5.60	12	2.84	59.76	66.83	60.71	67.69	64.08	66.83	

Project File: Station_782+50.stm

Number of lines: 2

Run Date: 09-01-2009

NOTES: Intensity = 106.59 / (Inlet time + 17.00) ^ 0.85; Return period = 100 Yrs. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
	(in)	(cfs)									(ft)											(K)	(ft)
1	12	4.17	45.25	47.44	1.00	0.72	5.31	0.44	47.88	1.169	265	59.76	60.62 j	0.86**	0.72	5.78	0.52	61.14	1.076	1.122	n/a	0.15	n/a
2	12	4.17	59.76	60.71	0.95	0.72	5.43	0.46	61.16	1.010	249	66.83	67.69 j	0.86**	0.72	5.78	0.52	68.21	1.076	1.043	n/a	1.00	0.52

Project File: Station_782+50.stm | Number of lines: 2 | Run Date: 09-01-2009

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

AMTRAK ACCESS ROAD SYSTEM 3 AREAS BETWEEN 796+50 TO 823+00
TRACK DRAINAGE OUTLET 3 AREAS BETWEEN 788+50 AND 816+50

Track Drainage

For this portion of the track drainage swale, the low point of the swale is at station 798+50 and extends both north and south to high points at stations 816+50 and 788+50, respectively. It is understood that the adjacent Busway Line Contract is in the process of designing a pipe installation (under the tracks) with trenchless technology to the Access Road at station 797+23. It is proposed to tie into this drainage lateral to outlet the runoff contained by this track drainage swale. For hydraulic design of the track crossing, the area, runoff coefficient and assumed time of concentration developed for this swale is made available to the Busway designer. In this report, a swale capacity check (for each segment) and depth of flow over a "CL" type CB is presented.

A primary assumption used in this analysis: the bridge over Trout Brook is ballasted and the swale will continue across the bridge. This assumption is used as directed by the Access Road Design Engineer, Baker Engineering.

Station 798+00

At this section, the swale capacity is determined for the segment contributing flows from the **south** to the design point at 798+50. The area contributing flows to this capacity check station is 0.61 acres. The computed water surface elevation is 62.92 feet. At this point, the track elevation is 65.29 feet, resulting in 2.4 feet of freeboard.

Station 799+00

At this section, the swale capacity is determined for the segment contributing flows from the **north** to the design point at 798+50. The area contributing flows to this capacity check station is 1.08 acres. The computed water surface elevation is 63.0 feet. At this point, the track elevation is 65.27 feet resulting in 2.3 feet of freeboard.

Station 798+50

This station is at the low point of the swale. Here depth of flow over a "CL" type CB is computed for the entire area contributing. Using the weir and orifice equations for catch basins in a sag location, the maximum flow depth over the grate is computed (with the weir producing the higher of the two computed depths). This depth over grate is 0.32-feet. From this information it can be surmised that the controlling feature of the maximum water surface elevation is the swale flow, not the depth over the catch basin.

Access Road Drainage

This access road drainage system maintains a positive flow from station 823+00 to an outlet into Trout Brook at station 796+50.

Station 818+50

At station 817+00, the Amtrak access road has an at grade crossing of Oakwood Avenue. It was necessary in this case to contain the accumulated flows from up-station of this crossing (beginning with an RCCE at station 818+50) in a sub-surface system consisting of manholes at station 817+00 and 816+50 with an outlet RCCE at 814+00 to continue the flow line within the Amtrak right-of-way. This was to avoid a municipal tie in of the drainage system. This system will convey flows from a contributing area of 0.52 acres

which generate a 100-year design event of 1.0-cfs. At the outlet of this pipe run (station 814+00), additional drainage area between Oakwood Ave. and the outlet contributes to the receiving swale. For this reason, the starting water surface elevation for this sub-surface system was determined by a normal depth computation of the receiving swale.

At **station 814+00**, the contributing area is 0.70 acres generating 1.4-cfs of flow for the 100-year event. Using Quick-2 with a stream slope of 0.5% and the irregular channel geometry provided with the sections, the resulting water surface elevation is 66.71 feet, providing a freeboard of 1.4 feet to the roadway surface.

Using the computed normal depth as the starting water surface elevation of the sub-surface system originating at station 818+50, it is found that the 12" pipes proposed for construction will be sufficient for conveyance of the 100-year event. The headwater elevation of the pipe system is computed to be 68.52 feet, 1.61 feet below the roadway elevation. Further, throughout the system, the computed hydraulic grade line results in greater than one foot of freeboard to the top of frame elevations for the entire length of system.

Station 809+50

At station 809+50, there is a grade change of the swale flow line from 0.48% to 0.54%. While not that significant, it was determined that this would be a convenient location to verify the capacity of the swale for the design event. The contributing area of 1.1 acres generates 2.1-cfs of runoff to this point. Using Quick-2, the computed water surface elevation is 64.74 feet, providing a freeboard of 1.31 feet to the roadway surface (which is below the track elevation).

Station 802+50

Again at station 802+50, there is a grade change in the swale flow line from 0.54% to 0.1% providing for a convenient design point for capacity analysis. At station 802+50, the area contributing is approximately 1.74 acres as determined from the design cross sections. This area generates 3.4-cfs for the 100-year event. The computed water surface elevation from this single section analysis indicates a design water surface elevation of 60.19 feet providing a freeboard of 2.9 feet from the roadway surface (which is below the track elevation).

Station 801+50

This station represents an inlet to a culvert crossing of the engineered swale by an active track spur line. The area contributing to this culvert is 1.83 acres generating a design flow rate of 3.6-cfs for the 100-year rainfall rate. The starting water surface elevation was taken as normal depth in the receiving reach of the swale for the design flows. The resulting headwater elevation for the 12" cross culvert is 61.54 feet which is 0.04 feet greater than the ground elevation above the crossing but does not overtop the track. The portion of flow that overtops is approximately 0.57-cfs, however, the adjacent land to the tracks grades away from the crossing, and it is not expected that any flows will accumulate for this crossing. Further, as this event is only predicted to occur with a 1% probability in any given year, it was not recommended to increase the barrels through the crossing. Increasing the barrel size was not investigated due to the limited cover from the tracks.

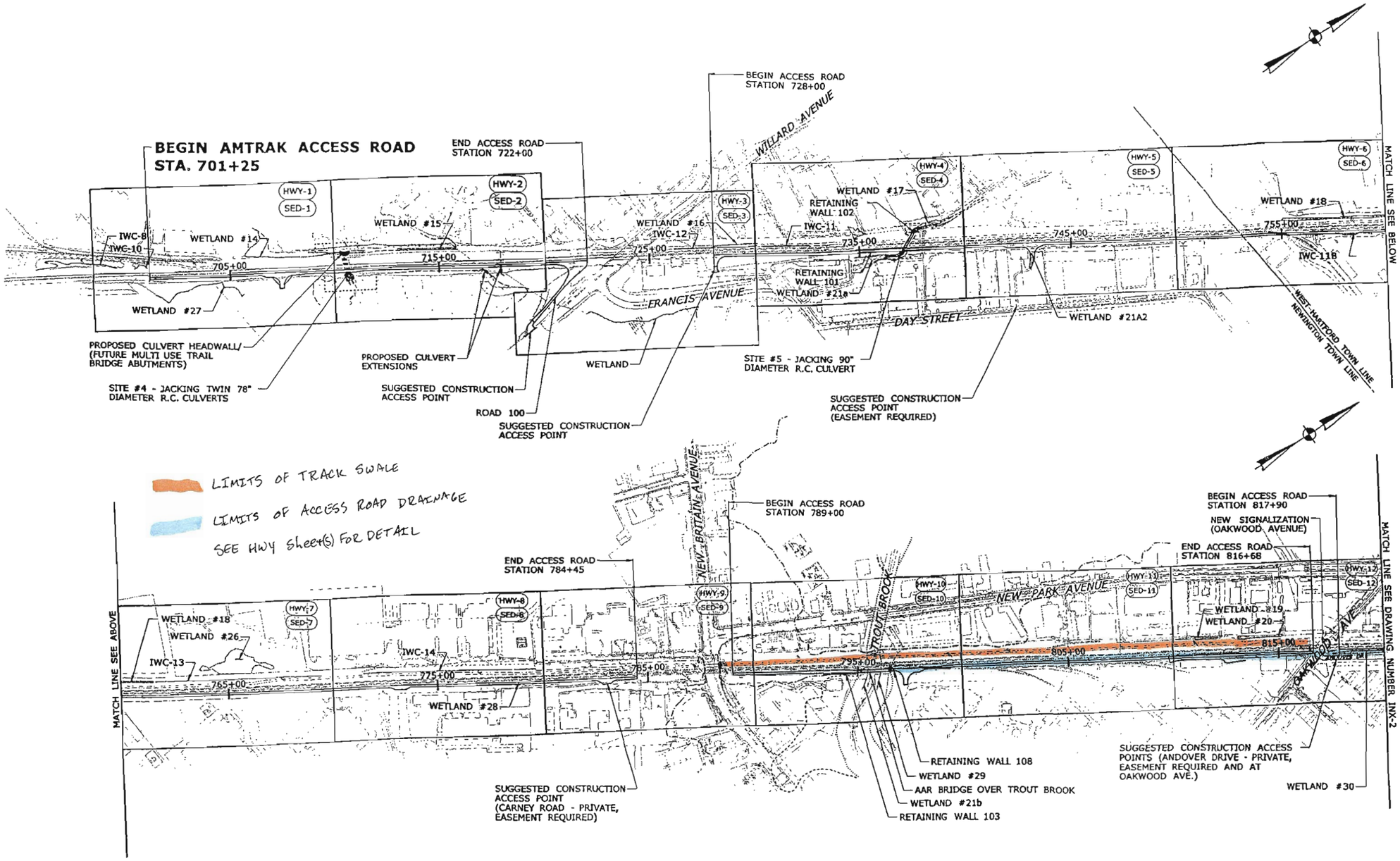
Station 798+20

Near station 798+20 is a required access road turn-around, which will necessitate continuing the approaching swale flow line through a culvert 144 feet in length. The area contributing to this culvert is 2.8 acres which generates 5.5-cfs of flow for the design event. At this point, the Access Road drainage is

proposed to be tied into the Busway drainage and it is understood that the Busway Line Designers are to be continuing the drainage design from this connection point to the outlet at Trout Brook. At this time, the continued design of this drainage system is not available and as such, for design purposes, the tailwater for the culvert design at station 798+20 was taken as a just-full pipe flow condition; tailwater was set equal to the crown of the subject pipe. The resulting headwater elevation is 61.78 feet providing approximately 1.8 feet of freeboard to the roadway.

All computations and program output are attached with this section

For the further design of the Busway to Access Road connection, the contribution in CxA from the track swale is 0.507, and the contribution from the Access Road is 0.84. The analysis presented herein used a time of concentration of 10 minutes.



NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

INDEX PLAN

SCALE: 1"=250'

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

FINAL PLANS FOR REVIEW

DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted: 9/2/2009

DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

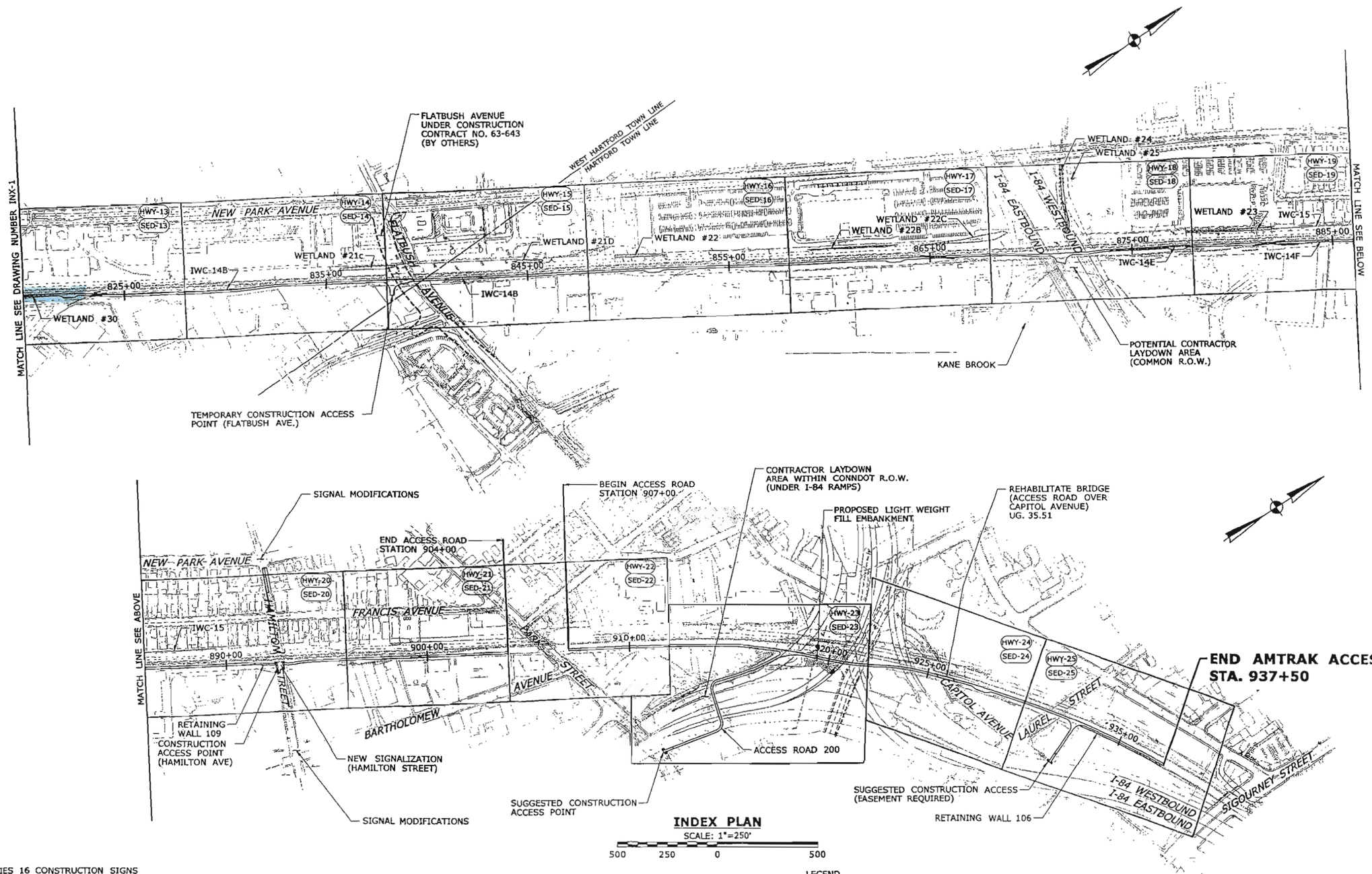
Filename: ...\HW.HSH.093.H052.INX-01.dgn

MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD
DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-01
SHEET NO. 7



INDEX PLAN

SCALE: 1"=250'

500 250 0 500

NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

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FINAL PLANS FOR REVIEW

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DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD
DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-02
SHEET NO. 8

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Drainage

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 798+00

Notes: Swale capacity check near the outlet

Parameters

Channel Type: Custom Cross Section

Flow: 1.2000 (cfs)

Depth: 1.1167 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0004 (ft/ft)

Area of Flow: 3.6544 (ft^2)

Wetted Perimeter: 6.7702 (ft)

Average Velocity: 0.3284 (ft/s)

Top Width: 6.2119 (ft)

Froude Number: 0.0754

Critical Depth: 0.2903 (ft)

Critical Velocity: 2.6150 (ft/s)

Critical Slope: 0.0955 (ft/ft)

Critical Top Width: 2.1613 (ft)

Calculated Max Shear Stress: 0.0279 (lb/ft^2)

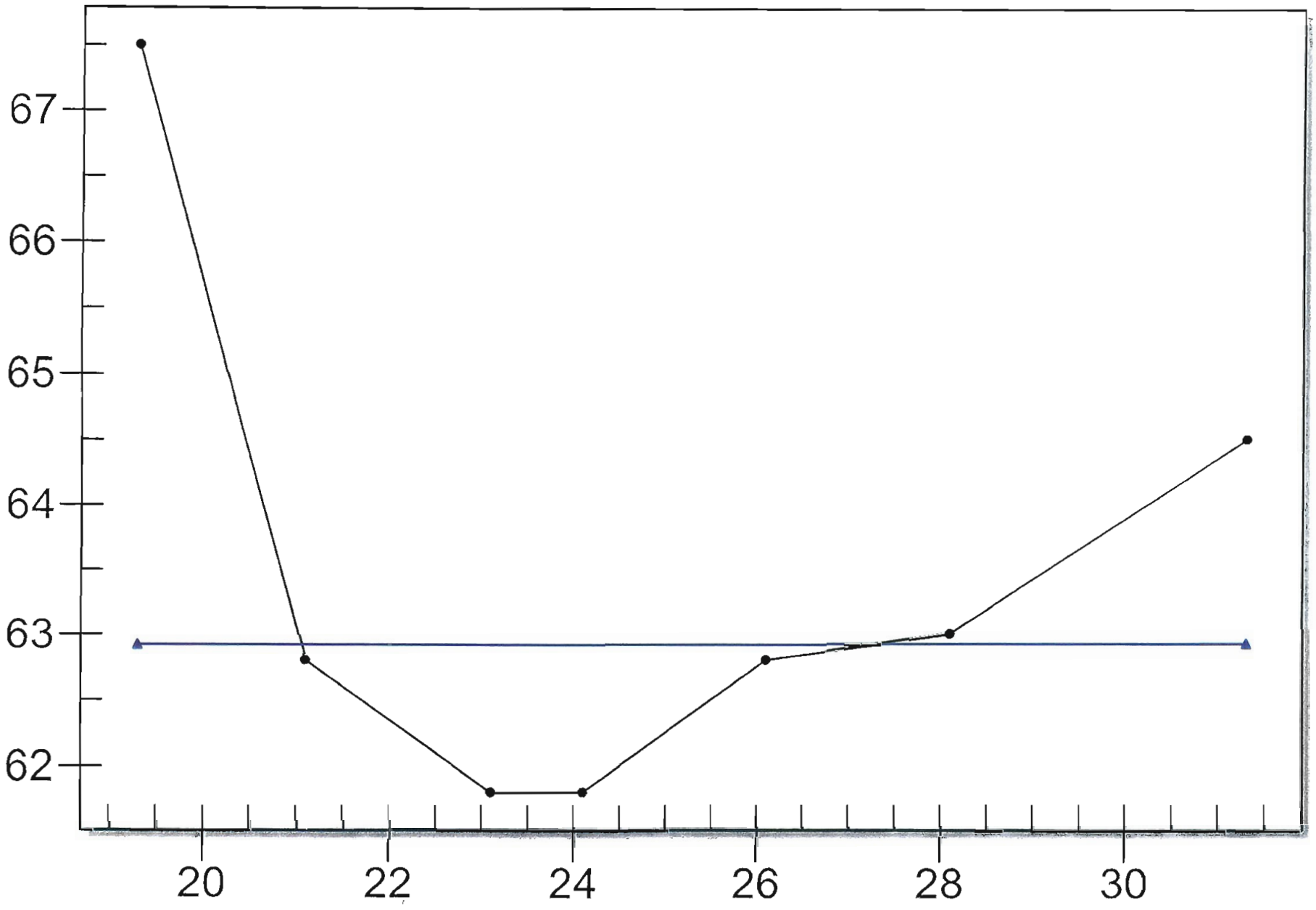
Calculated Avg Shear Stress: 0.0135 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
19.30	67.50	0.0600
21.10	62.80	0.0600
23.10	61.80	0.0600
24.10	61.80	0.0600
26.10	62.80	0.0600
28.10	63.00	0.0600
31.30	64.50	-----

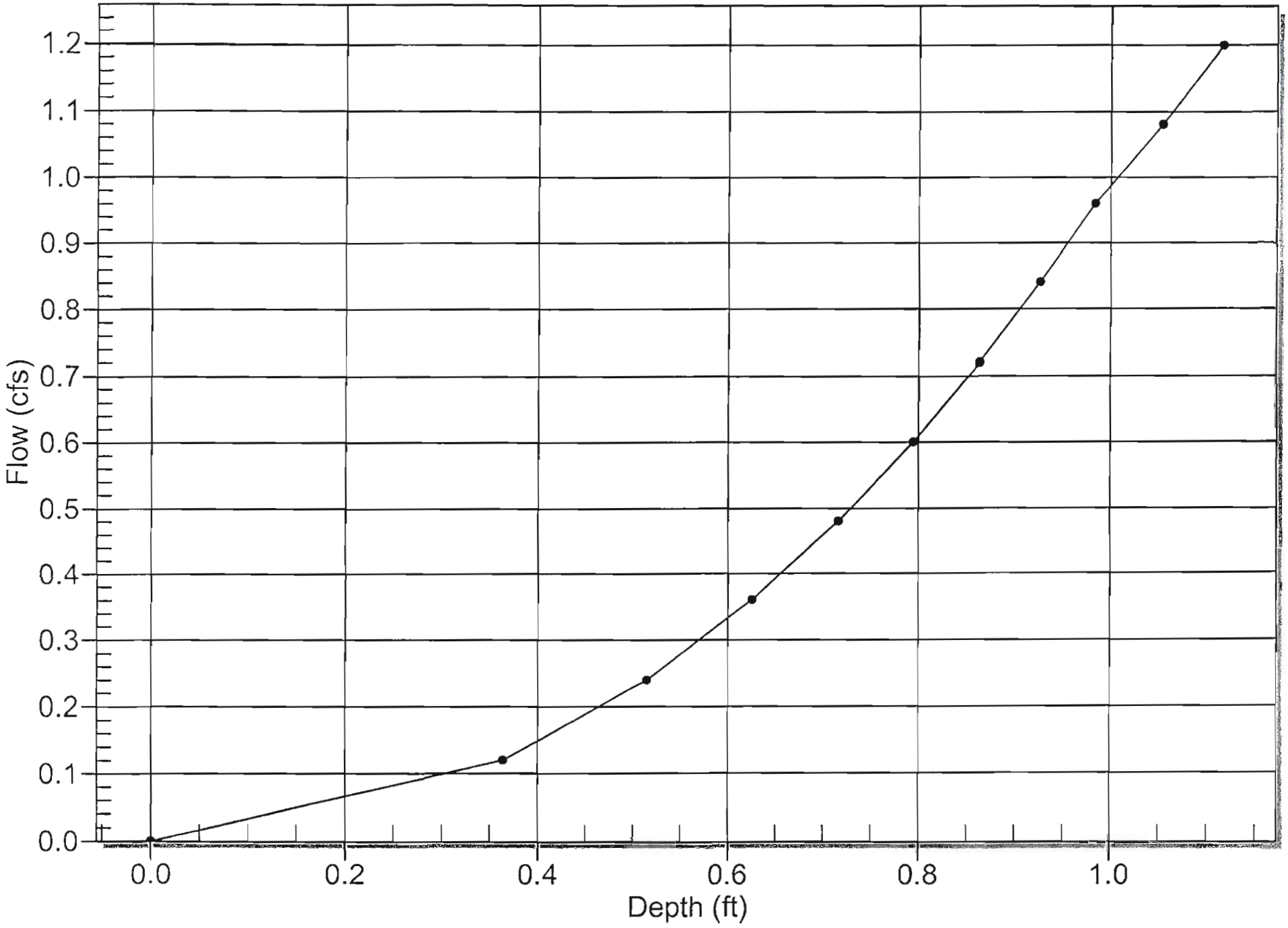
Cross Section

Station 798+00



Flow vs. Depth

Station 798+00



Hydraulic Analysis Report

Project Data

Project Title: AAR Track Drainage

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 799+00

Notes: Swale capacity check near outlet

Parameters

Channel Type: Custom Cross Section

Flow: 2.1000 (cfs)

Depth: 1.2155 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0008 (ft/ft)

Area of Flow: 4.4332 (ft^2)

Wetted Perimeter: 7.9722 (ft)

Average Velocity: 0.4737 (ft/s)

Top Width: 7.3348 (ft)

Froude Number: 0.1074

Critical Depth: 0.3950 (ft)

Critical Velocity: 2.9706 (ft/s)

Critical Slope: 0.0887 (ft/ft)

Critical Top Width: 2.5798 (ft)

Calculated Max Shear Stress: 0.0607 (lb/ft^2)

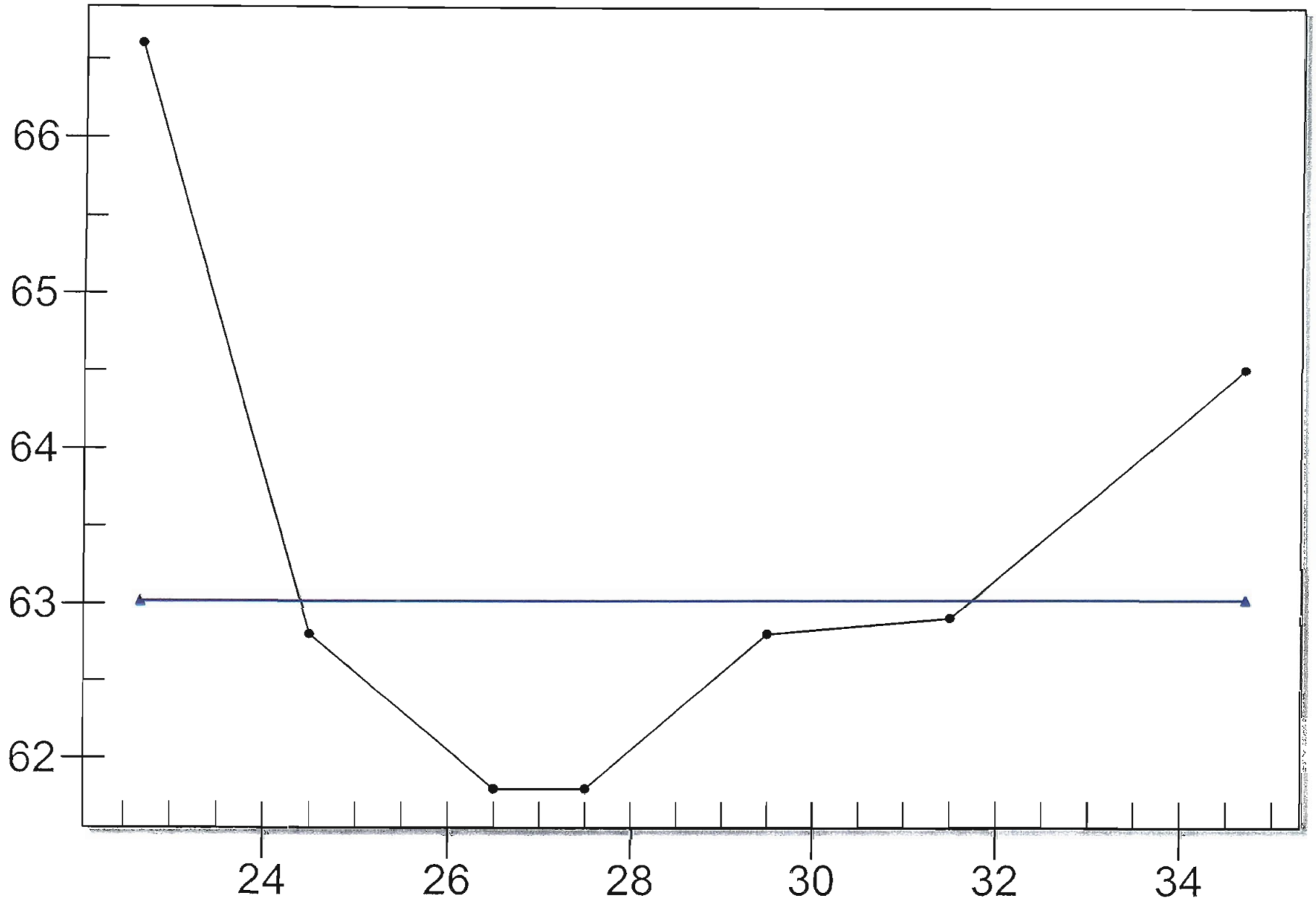
Calculated Avg Shear Stress: 0.0278 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
22.67	66.60	0.0600
24.50	62.80	0.0600
26.50	61.80	0.0600
27.50	61.80	0.0600
29.50	62.80	0.0600
31.50	62.90	0.0600
34.70	64.50	—

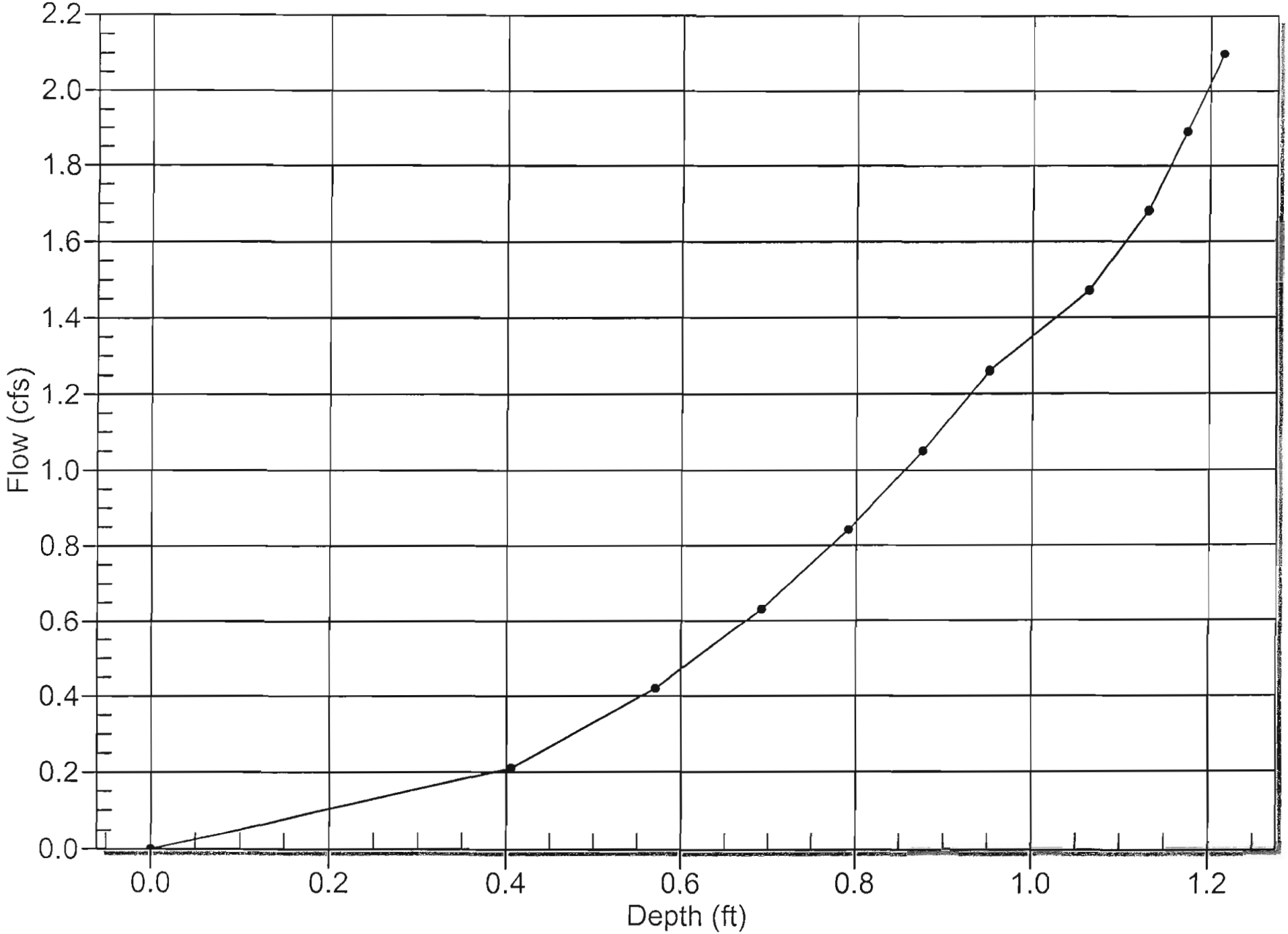
Cross Section

Station 799+00



Flow vs. Depth

Station 799+00



GM2 Associates

Engineers • Inspectors • Surveyors

Job Track Drainage Computed By _____ Date _____

Description _____ Checked By _____ Date _____

Area 3 from Stations 788+50 → 813+50 low point 798+50 Sheet _____ of _____

Primary Assumptions → Trout Brook Bridge Ballasted. Will carry open swale As directed by designer

Intermediate Design points

① Check Swale Capacity for Segment from NEW Britain Ave STATION 798+00 (from 788+50)

Area = 0.62 ac $\overset{C}{0.3}$ 6.5 in/hr = 1.2 CFS

Swale

Station	Elevation
19.3	67.5
21.1	62.8
23.1	61.8
24.1	61.8
26.1	62.8
28.1	63.0
31.3	64.5

Slope = 0.0004

depth 1.12'

Elev 62.92

Track el, 65.29

Freeboard 2.37'

② Check Swale Capacity for Segment from oakwood avenue Station 799+00 (from 816+50)

Area = 1.07 $\overset{C}{0.3}$ 6.5 = 2.08 CFS

Swale

Station	Elevation
22.67	66.6
24.5	62.8
26.5	61.8
27.5	61.8
29.5	62.8
31.5	62.9
34.7	64.5

Slope = 0.0008

depth 1.2'

Elev 63'

track el 65.27

Freeboard. 2.27

Location of Jacked pipe from bucway Currently unknown

Comp of Depth of flow over CLCB

weir

$$d = \left(\frac{Q \cdot C_{FS}}{C_w P}\right)^{2/3}$$

$$0.32 = \left(\frac{3.3 \cdot 1.25}{3.0 \cdot 7.33}\right)^{2/3}$$

Q = 3.3 cfs

C_{FS} 1.25

C_{weir} 3.0

P = 7.33

C_{orif} = .67

Area 3.13

orifice

$$d = \left(\frac{Q\, C_{FS}}{C_o\, A}\right)^2 \Big/ 2g$$

$$0.06 = \left(\frac{3.3 \cdot 1.25}{0.67 \cdot 3.13}\right)^2 \Big/ 2 \cdot 32.2$$

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 3 Design From Sta 823+00 to outlet @ trout brook Sheet 1 of 4

Station 818+50 Subsurface System to 814+00

① Area Contributing to FES 22 712.5 Ft^2 ⇒ 0.52 ac

Q_{100} (0.52 ac)(0.3)(6.5 in/hr) = 1.0 CFS

Q_{10} (0.52 ac)(0.3)(4.8 in/hr) = 0.7 CFS

Starting WSEL SET as NORMAL DEPTH OF RECEIVING Swale

Station 814+00

① Area Contributing 30615 Ft^2 ⇒ 0.70 ac

Q_{100} (0.70 ac)(0.3)(6.5 in/hr) = 1.4

Q_{10} (0.70 ac)(0.3)(4.8 in/hr) = 1.0 CFS

② Hydraulic Parameters

Stream Slope 0.5 %

Roughness 0.06

Irregular Channel for Quick 2

Sta	EL
5	68.0
8.4	66.3
10.4	66.1
13.0	67.4

③ Quick 2 RESULTS

WSEL 66.71'

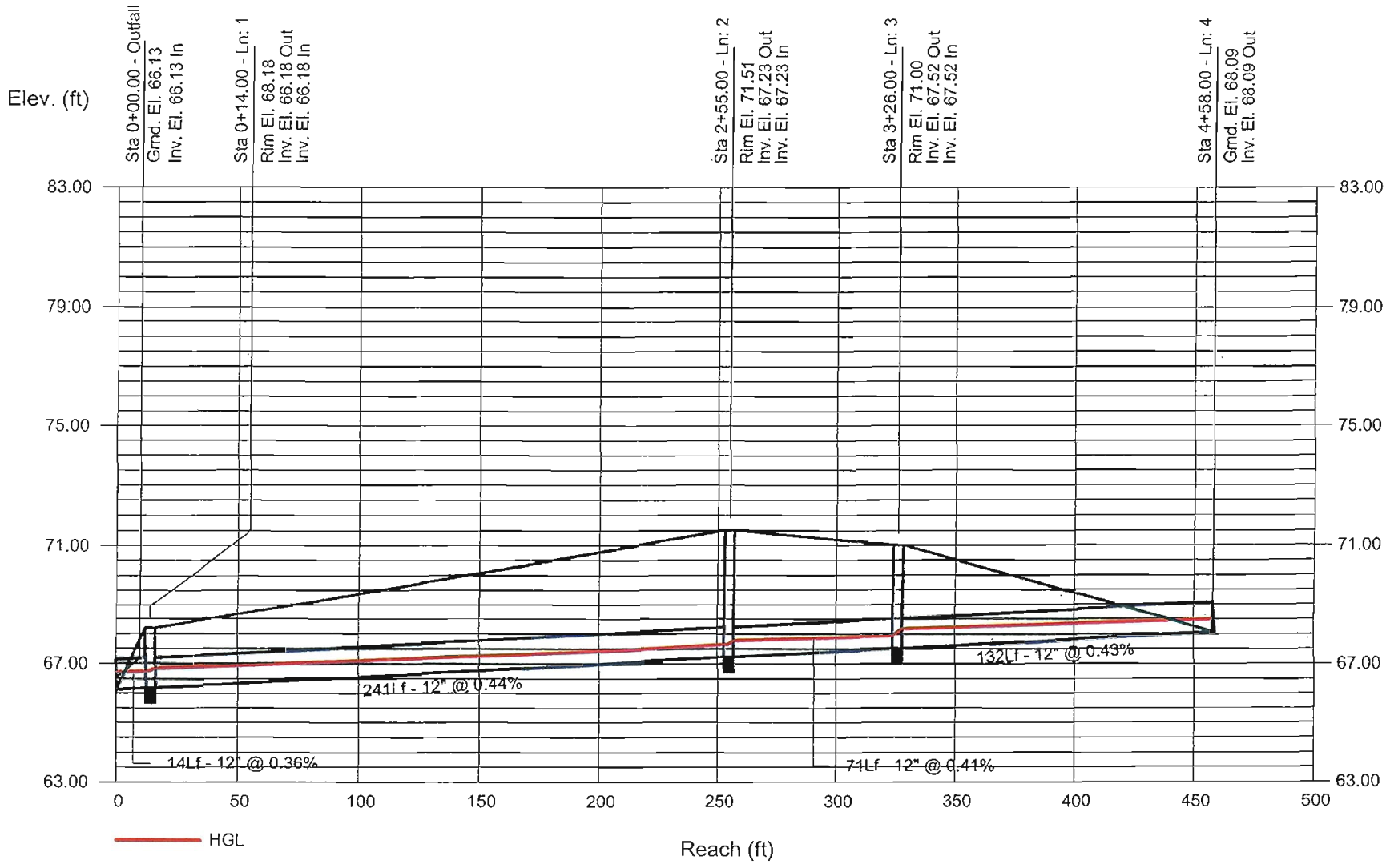
Depth 0.61'

Top Width 4'

Vel 0.89 FPS

Storm Sewer Profile

Proj. file: New.stm



Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
4	3	132	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	1.00	2.54	2.46	12	0.43	67.52	68.09	68.19	68.52	71.00	68.09	
3	2	71	0.00	0.00	0.00	0.00	0.00	0.0	1.7	0.0	1.00	2.47	2.69	12	0.41	67.23	67.52	67.78	67.95	71.51	71.00	
2	1	241	0.00	0.00	0.00	0.00	0.00	0.0	2.7	0.0	1.00	2.55	2.51	12	0.44	66.18	67.23	66.83	67.65	68.18	71.51	
1	End	14	0.00	0.00	0.00	0.00	0.00	0.0	5.8	0.0	1.00	2.31	2.20	12	0.36	66.13	66.18	66.71	66.72	66.13	68.18	

818+50

Number of lines: 4

Run Date: 08-19-2009

NOTES: Intensity = 106.59 / (Inlet time + 17.00) ^ 0.85; Return period = 100 Yrs. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

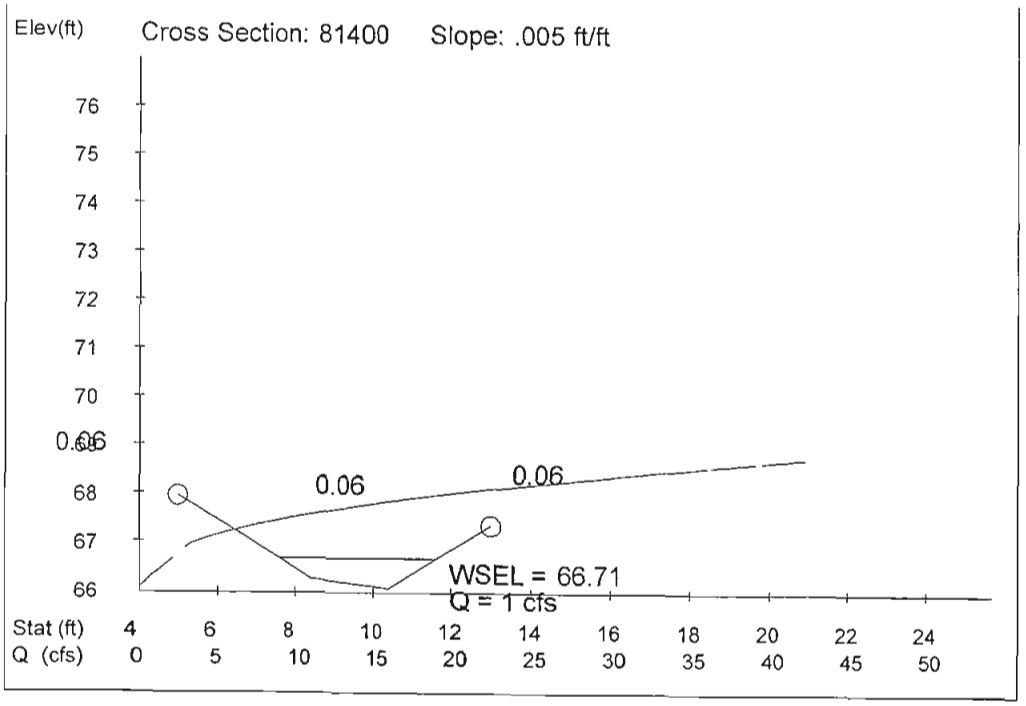
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
4	12	1.00	67.52	68.19	0.67	0.56	1.79	0.05	68.24	0.107	132	68.09	68.52	0.43**	0.32	3.13	0.15	68.67	0.469	0.288	0.380	1.00	0.15
3	12	1.00	67.23	67.78	0.55	0.45	2.24	0.08	67.86	0.192	71	67.52	67.95	0.43**	0.32	3.13	0.15	68.10	0.469	0.330	0.234	0.77	0.12
2	12	1.00	66.18	66.83	0.65	0.54	1.86	0.05	66.88	0.119	241	67.23	67.65 j	0.42**	0.32	3.15	0.15	67.81	0.478	0.299	n/a	0.60	0.09
1	12	1.00	66.13	66.71	0.58	0.47	2.12	0.07	66.78	0.165	14	66.18	66.72	0.54	0.44	2.29	0.08	66.81	0.203	0.184	0.026	0.57	0.05

818+50

Number of lines: 4

Run Date: 08-19-2009

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box


Elev(ft)
Cross Section: 81400
Slope: .005 ft/ft
76
75
74
73
72
71
70
69
68
67
66
0.06
0.06
WSEL = 66.71
Q = 1 cfs
Stat (ft) 4 6 8 10 12 14 16 18 20 22 24
Q (cfs) 0 5 10 15 20 25 30 35 40 45 50

GM2 Associates
Engineers • Inspectors • Surveyors

Job Amorak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 3 cont Sheet 2 of 4

Section 809+50 Grade Break

① Area Contributing 46516.25 Ft^2 ⇒ 1.1 ac

Q_{100} (1.1 ac X 0.3 X 6.5 in/hr) = 2.1 CFS

Q_{10} (1.1 ac X 0.3 X 4.8 in/hr) = 1.6 CFS

② Hydraulic Parameters

Stream slope 0.48%

Roughness 0.06

Irregular Channel

Sta	El
5	65.9
8.44	64.2
10.4	64.0
13.48	65.5

for Quick 2

③ Quick 2 Results

WSEL 64.74'

Depth 0.74'

Top width 5'

Vel 0.98 Fps

Section 802+60 Grade Break

① Area Contributing 75708.75 Ft^2 ⇒ 1.74 ac

Q_{100} (1.74 ac X 0.3 X 6.5 in/hr) = 3.4 CFS

Q_{10} (1.74 ac X 0.3 X 4.8 in/hr) = 2.5 CFS

② Hydraulic Parameters

Stream Slope 0.54%

Roughness 0.06

Irregular Channel

Sta	El
5	63.0
11.26	59.9
13.26	59.6
16.71	61.9

For Quick-2

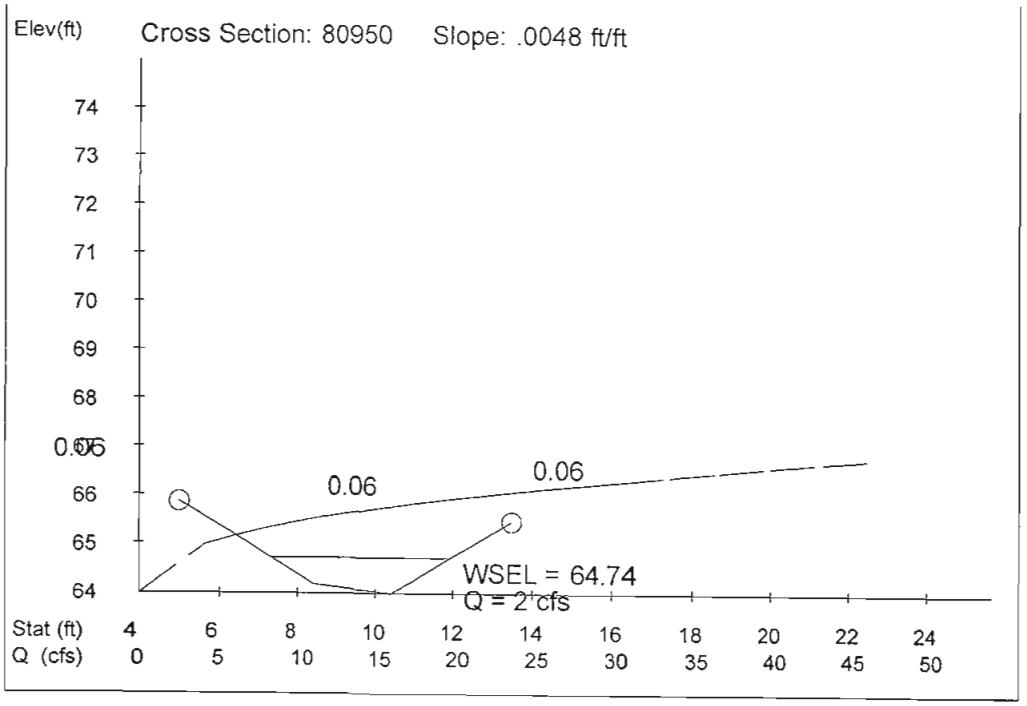
③ Quick 2 Results

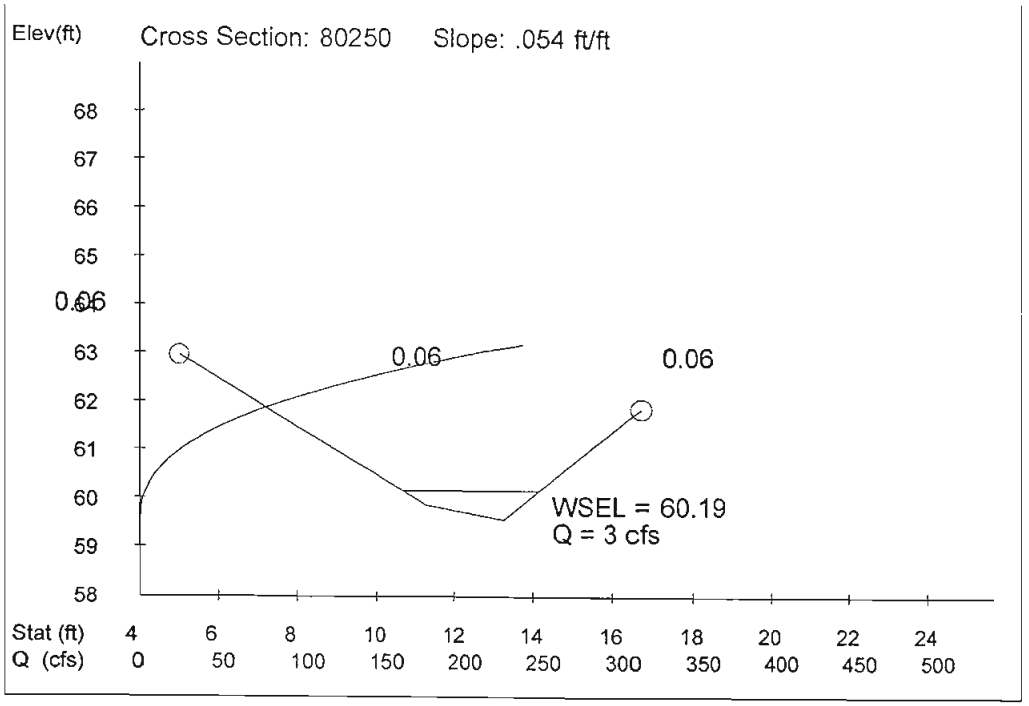
WSEL 60.19'

Depth 0.59'

top width 3'

Vel 2.75 Fps


Elev(ft)
Cross Section: 80950
Slope: .0048 ft/ft
74
73
72
71
70
69
68
0.06
66
65
64
0.06
0.06
WSEL = 64.74
Q = 2 cfs
Stat (ft) 4 6 8 10 12 14 16 18 20 22 24
Q (cfs) 0 5 10 15 20 25 30 35 40 45 50


Elev(ft)
Cross Section: 80250
Slope: .054 ft/ft
68
67
66
65
0.06
63
62
61
60
59
58
0.06
0.06
WSEL = 60.19
Q = 3 cfs
Stat (ft) 4 6 8 10 12 14 16 18 20 22 24
Q (cfs) 0 50 100 150 200 250 300 350 400 450 500

Station 801 +50 Culvert Crossing

① Area Contributing 79506.25 Ft² ⇒ 1.83 ac
Q_{100} (1.83 ac)(0.3)(6.5 in/hr) = 3.6 CFS
Q_{10} (1.83 ac)(0.3)(4.8 in/hr) = 2.6 CFS

② Irregular Tailwater
Slope 0.1% roughness 0.06

Sta	EL
22.62	61.6
26.4	59.7
28.4	59.5
31.2	61.3

③ Roadway Data

Crest El	60.45
length	100
Topwidth	50

④ Site Data

inlet sta	0
El	59.53
outlet sta	50
EL	59.48

Station 797 +00 GRADE BREAK

① Area Contributing 124995.25 Ft² ⇒ 2.87 ac
Q_{100} (2.87ac)(0.3)(6.5 in/hr) = 5.6 CFS
Q_{10} (2.87ac)(0.3)(4.8 in/hr) = 4.1 CFS

② Hydraulic Parameters
Stream Slope 0.1%
Roughness 0.06
Irregular Channel

Sta	EL
5	62.4
11.1	59.3
13.1	59.1
19.7	62.3

For quick2

REMOVED SINCE LAST SET OF PLANS CAME IN

③ WSEL 60.72'
Depth 1.62'
Topwidth 8'
vel 0.72 FPS

HY-8 Culvert Analysis Report Station 801+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
59.53	0.00	0.00	0.00	1
60.05	0.40	0.40	0.00	1
60.27	0.80	0.80	0.00	1
60.46	1.20	1.20	0.00	1
60.65	1.60	1.60	0.00	1
60.85	2.00	2.00	0.00	1
61.07	2.40	2.40	0.00	1
61.30	2.80	2.80	0.00	1
61.52	3.20	3.14	0.03	37
61.54	3.60	3.01	0.57	5
61.55	4.00	2.87	1.12	4
61.52	3.15	3.15	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 801+50

Rating Curve Plot for Crossing: 801+50

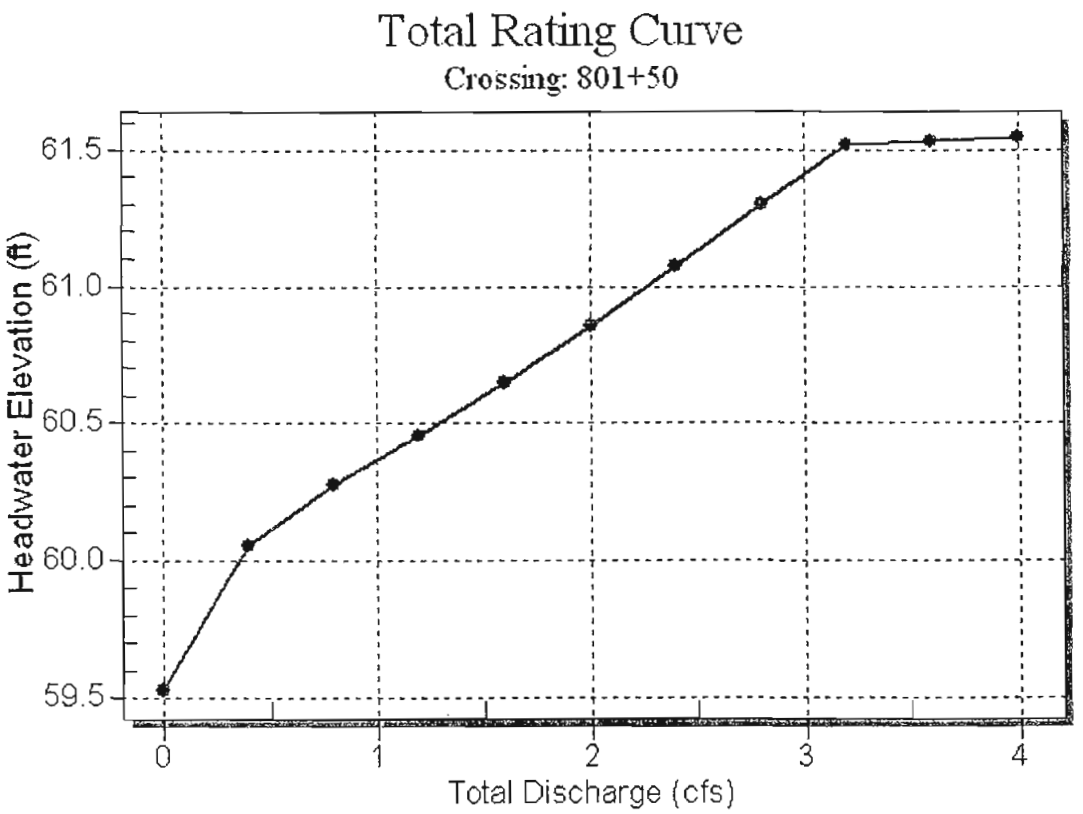


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	59.53	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.40	0.40	60.05	0.357	0.523	3-M1t	0.393	0.257	0.531	0.511	0.944	0.357
0.80	0.80	60.27	0.522	0.742	3-M1t	0.590	0.371	0.722	0.702	1.319	0.436
1.20	1.20	60.46	0.672	0.926	3-M1t	0.804	0.460	0.865	0.845	1.661	0.488
1.60	1.60	60.65	0.802	1.118	7-M2t	1.000	0.535	0.985	0.965	2.044	0.527
2.00	2.00	60.85	0.923	1.323	4-FFf	1.000	0.603	1.000	1.068	2.546	0.560
2.40	2.40	61.07	1.046	1.540	4-FFf	1.000	0.661	1.000	1.161	3.056	0.587
2.80	2.80	61.30	1.180	1.772	4-FFf	1.000	0.716	1.000	1.245	3.565	0.611
3.20	3.14	61.52	1.306	1.992	4-FFf	1.000	0.756	1.000	1.322	3.995	0.633
3.60	3.01	61.54	1.255	2.006	4-FFf	1.000	0.740	1.000	1.393	3.828	0.653
4.00	2.87	61.55	1.205	2.016	4-FFf	1.000	0.724	1.000	1.461	3.654	0.671

* theoretical depth is impractical. Depth reported is corrected.

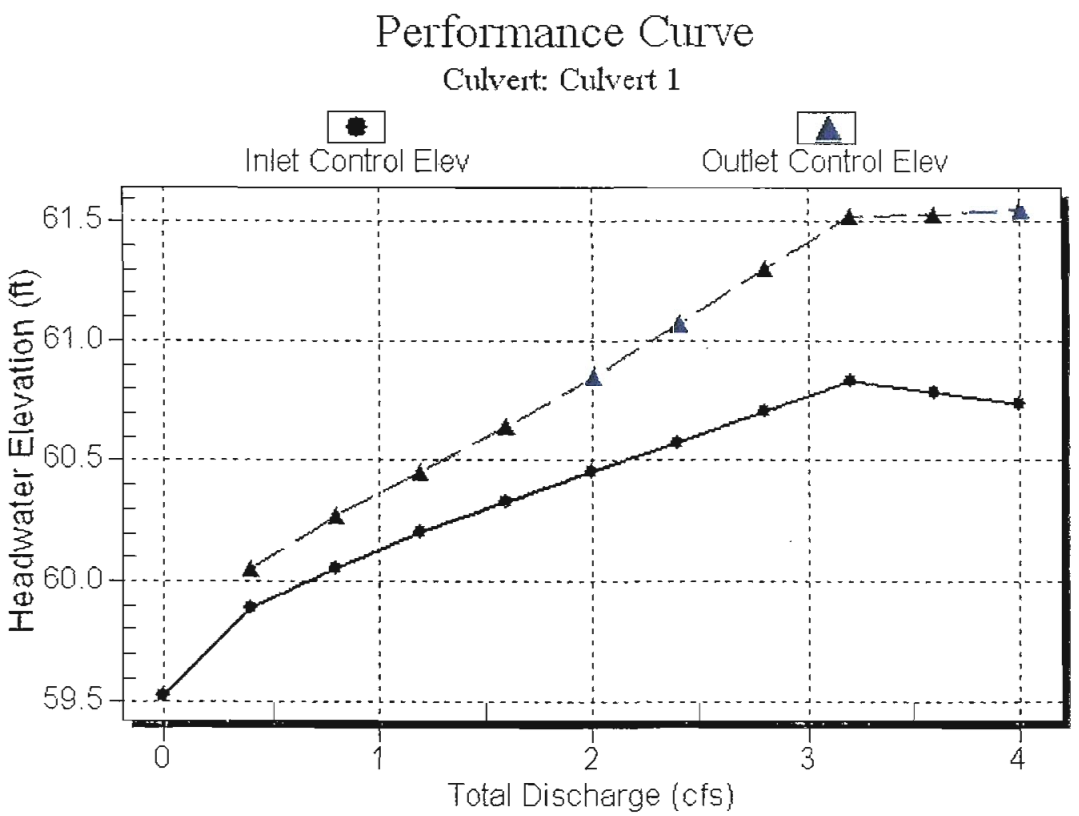
****

Inlet Elevation (invert): 59.53 ft, Outlet Elevation (invert): 59.48 ft

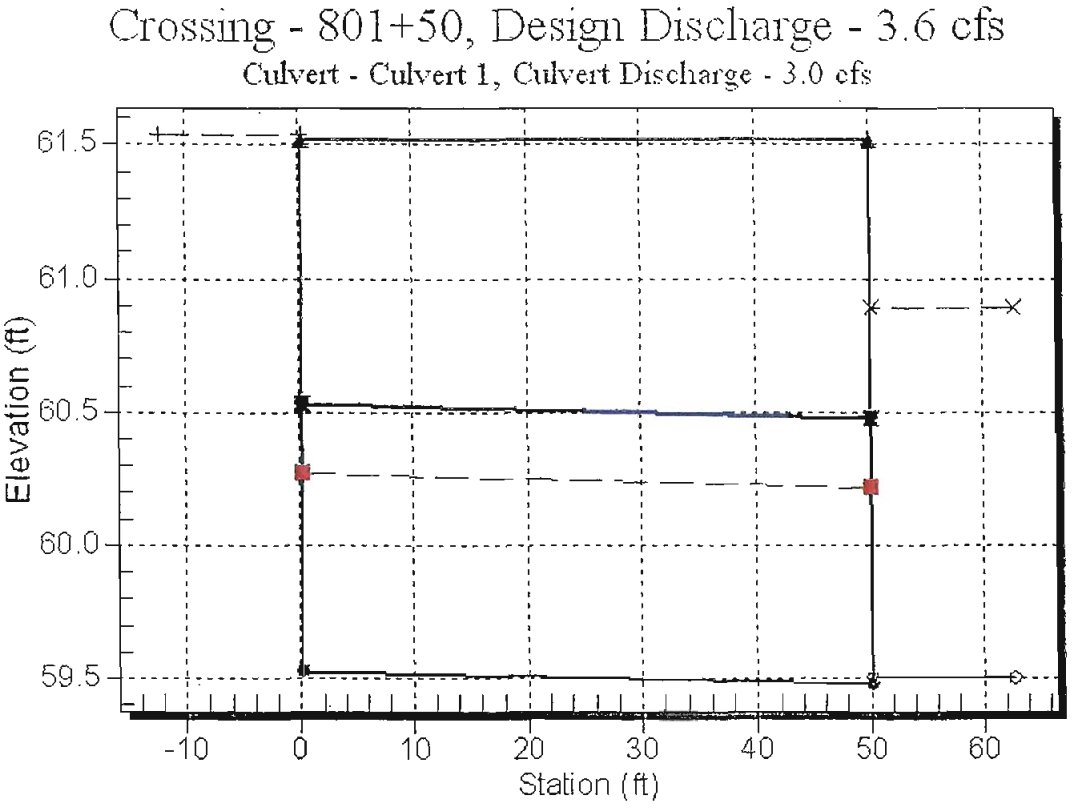
Culvert Length: 50.00 ft, Culvert Slope: 0.0010

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 59.53 ft

Outlet Station: 50.00 ft

Outlet Elevation: 59.48 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 801+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	59.50	0.00	0.00	0.00	0.00
0.40	60.01	0.51	0.36	0.03	0.11
0.80	60.20	0.70	0.44	0.04	0.11
1.20	60.35	0.85	0.49	0.05	0.12
1.60	60.46	0.96	0.53	0.06	0.12
2.00	60.57	1.07	0.56	0.07	0.12
2.40	60.66	1.16	0.59	0.07	0.12
2.80	60.74	1.24	0.61	0.08	0.12
3.20	60.82	1.32	0.63	0.08	0.12
3.60	60.89	1.39	0.65	0.09	0.13
4.00	60.96	1.46	0.67	0.09	0.13

Tailwater Channel Data - 801+50

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0010

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	22.62	61.60	0.0600
2	26.40	59.70	0.0600
3	28.40	59.50	0.0600
4	31.20	61.30	0.0000

Roadway Data for Crossing: 801+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 61.52 ft

Roadway Surface: Gravel

Roadway Top Width: 50.00 ft

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: 798+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
60.49	1.00	1.00	0.00	1
60.56	1.60	1.60	0.00	1
60.66	2.20	2.20	0.00	1
60.79	2.80	2.80	0.00	1
60.96	3.40	3.40	0.00	1
61.15	4.00	4.00	0.00	1
61.38	4.60	4.60	0.00	1
61.64	5.20	5.20	0.00	1
61.78	5.50	5.50	0.00	1
62.25	6.40	6.40	0.00	1
62.60	7.00	7.00	0.00	1
63.65	8.54	8.54	0.00	Overtopping

Rating Curve Plot for Crossing: 798+50

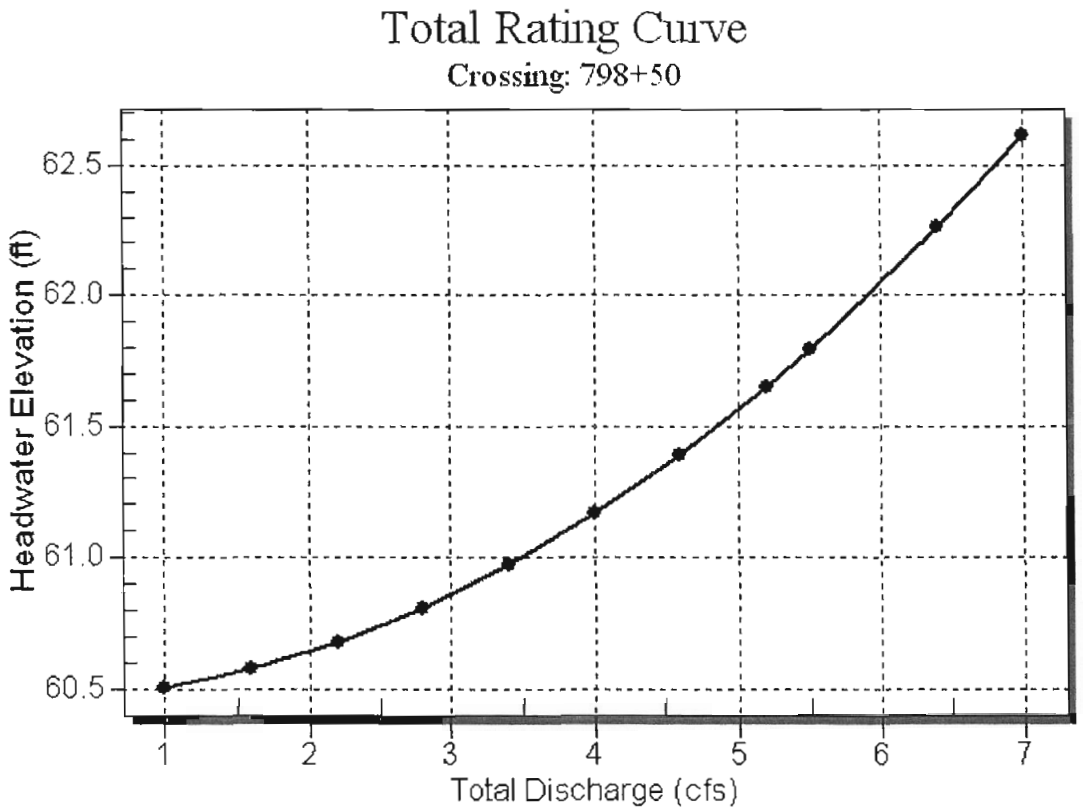


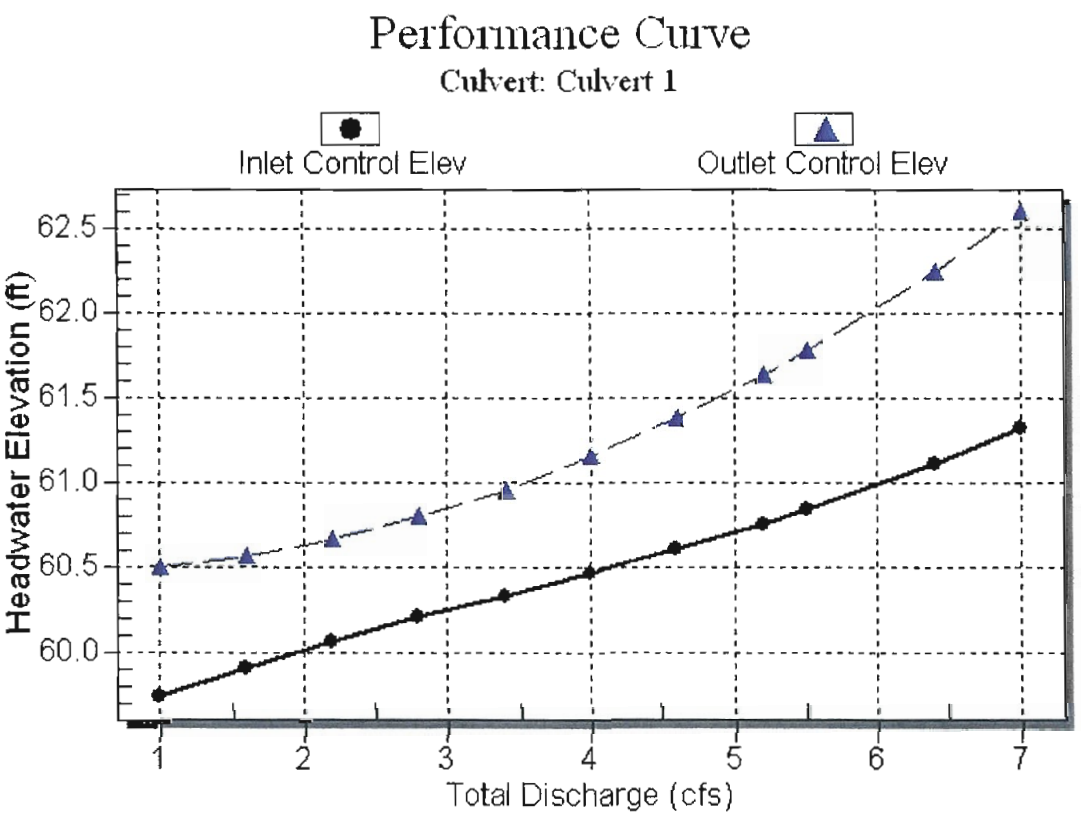
Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	60.49	0.544	1.294	4-FFf	1.250	0.391	1.250	1.250	0.815	0.000
1.60	1.60	60.56	0.711	1.362	4-FFf	1.250	0.501	1.250	1.250	1.304	0.000
2.20	2.20	60.66	0.866	1.462	4-FFf	1.250	0.590	1.250	1.250	1.793	0.000
2.80	2.80	60.79	1.004	1.594	4-FFf	1.250	0.669	1.250	1.250	2.282	0.000
3.40	3.40	60.96	1.134	1.757	4-FFf	1.250	0.743	1.250	1.250	2.771	0.000
4.00	4.00	61.15	1.265	1.952	4-FFf	1.250	0.806	1.250	1.250	3.259	0.000
4.60	4.60	61.38	1.404	2.179	4-FFf	1.250	0.869	1.250	1.250	3.748	0.000
5.20	5.20	61.64	1.556	2.437	4-FFf	1.250	0.921	1.250	1.250	4.237	0.000
5.50	5.50	61.78	1.638	2.578	4-FFf	1.250	0.947	1.250	1.250	4.482	0.000
6.40	6.40	62.25	1.912	3.048	4-FFf	1.250	1.016	1.250	1.250	5.215	0.000
7.00	7.00	62.60	2.120	3.401	4-FFf	1.250	1.052	1.250	1.250	5.704	0.000

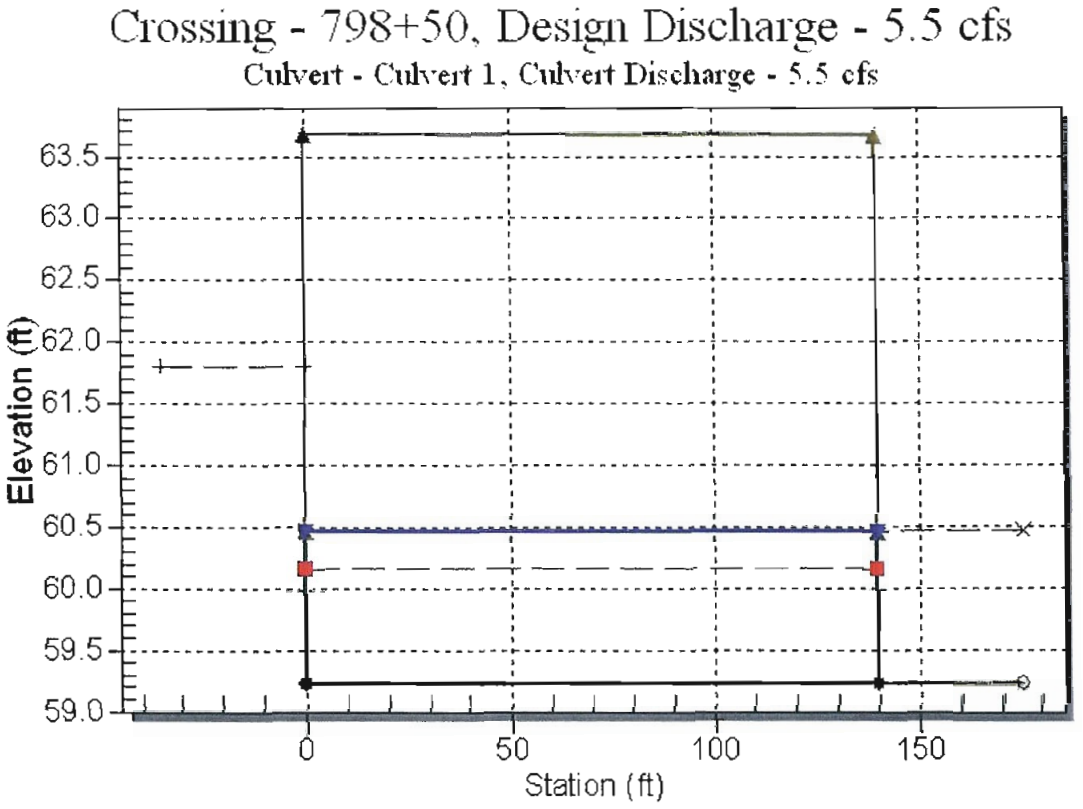
Inlet Elevation (invert): 59.20 ft, Outlet Elevation (invert): 59.20 ft

Culvert Length: 140.00 ft, Culvert Slope: 0.0000

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 59.20 ft

Outlet Station: 140.00 ft

Outlet Elevation: 59.20 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 798+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.00	60.45	1.25
1.60	60.45	1.25
2.20	60.45	1.25
2.80	60.45	1.25
3.40	60.45	1.25
4.00	60.45	1.25
4.60	60.45	1.25
5.20	60.45	1.25
5.50	60.45	1.25
6.40	60.45	1.25
7.00	60.45	1.25

Tailwater Channel Data - 798+50

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 60.45 ft

Roadway Data for Crossing: 798+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 63.65 ft

Roadway Surface: Gravel

Roadway Top Width: 140.00 ft

AMTRAK ACCESS ROAD SYSTEM 4 AREAS BETWEEN 823+00 TO 904+00
TRACK DRAINAGE OUTLET 4 AREAS BETWEEN 823+50 AND 892+00

Track Drainage

A swale system has been designed to run the length of area between stations 823+50 and 892+00. The low point of the swale is at station 892+00, immediately before the at grade track crossing of Hamilton Street. Following an exhaustive search of viable outlet points, it was finally determined that the most efficient discharge point would be to discharge to a drainage system servicing the adjacent Amtrak Access Road which terminates at Kane Brook. The location of the outlet of this swale was determined by preserving a 5'minimum cover to the bottom of the railroad ties, (as required for trenchless installation) while not increasing the depth of the receiving system and maintaining a negative slope of the pipe. It is not known what method of trenchless pipe installation will be used, however this design calls for a 18" diameter pipe as required/requested by Amtrak. The location of the inlet to this tie in is at station 887+00.

An additional design point is documented here to compute the hydraulics at an elevated swale configuration near station 865+50, similar to that documented for area 1. Further a swale capacity analysis was performed at the end of the swale to document the freeboard from the tracks under design hydrologic conditions.

Station 865+50

Steps taken to compute the hydraulics for the proposed 6" pipe and elevated swale are identical to those taken for a similar computation within area 1.

For this analysis 4.7-cfs of runoff for the 100-year event was computed at the inlet of the proposed pipe (generated from a 2.41 acre contributing area). Using the tailwater rating curve computed for station 876+50 (receiving reach of the normal swale), the capacity of the pipe at design flow is 0.27-cfs with 4.42-cfs contributing to the elevated swale flow. At the end of the elevated swale, the total runoff computed – with the overtopping of the culvert crossing – is 5.4-cfs. From this analysis, freeboard to the tracks was computed. At station 876+00, the CWSEL is 65.8 feet, the track elevation is 66.7 feet providing 0.9 feet of freeboard. At station 876+50 (receiving section of normal swale), the CWSEL is 64.6 feet, the track elevation is 66.6 feet providing 2.0 feet of freeboard.

Station 892+00

This section represents the limits of the swale immediately adjacent to the at grade track crossing of Hamilton Street. This section was chosen to represent the swale capacity due to the area contributing to this point (3.76 acres). CWSEL is 63.2' (2.0 feet deep), the track elevation is 64.7' resulting in 1.5 feet of freeboard.

Outlet at 886+50

A "CL" type catch basin is proposed to intercept runoff from the swale and convey the flows laterally to the Kane Brook System. The lateral pipe has the following design parameters to maintain 5' of clearance from the bottom of the railroad tie: pipe length is 42 feet, upstream invert is 57.20 feet, downstream invert is 57.16 giving the pipe a slope of 0.1% slope. The contribution of this pipe to the AAR drainage system is accounted for in the AAR system 4 design computations. The depth of flow over the inlet was computed to

be 0.5 feet. From this information it can be surmised that the controlling feature of the maximum water surface elevation is the swale flow, not the depth over the catch basin. It should be noted that the proposed inlet in the swale is on grade, not at the sag location of the swale. This was necessary due to the cover requirement from the railroad ties to the top of pipe. The elevation of the inlet, however, is only 0.57 feet above the sag point in the swale, so at most, there will be 0.6 feet of standing water in the lowest portion of the swale (any volume greater will back up and enter the inlet, which is almost 3 feet from the track elevation.

Access Road Drainage

Station 824+50 to 833+00

Due to site restrictions, the roadway between stations 824+50 and 833+00 is designed with a cross slope draining towards the track. This area is proposed to be maintained by an 820 foot underdrain following along the roadway, between the road and adjacent tracks. At station 832+00, the roadway cross slope once again becomes typical, sloping away from the tracks. At station 832+00 the roadway cross slope once again becomes typical, sloping away from the tracks. Between stations 832+50 and 833+00, this underdrain crosses the baseline of the access road and daylights to an engineered swale at station 833+00. To verify capacity of this underdrain, the FHWA utility, Visual Urban (HY-22) was used to size the underdrain based on the total flow generated by the area contributing to the outlet point. At station 833+00 the contributing area was calculated to be 1.1 acres based on the associated design cross sections. This resulted in a total discharge for the 100-year event of 2.15-cfs. With an average pipe slope of 0.34%, the size required to convey these flows would be an 8" perforated plastic pipe. To verify that the track would not be overtopped due to a surcharge in the underdrain, this pipe was analyzed with HY-8. The crest elevation of the weir was taken as the lowest adjacent track for the length of the pipe run. The result of the HY-8 analysis has indicated that while, during the design storm event (Q_{100}), the pipe will be at pressure flow, the surcharge elevation will only reach elevation 71.47, which is 3-hundredths greater than the lowest adjacent track. These results justify the use of an 8" underdrain due to the conservatism of the assumptions made in this analysis.

Station 834+15

This sub-surface system was to be modeled as a 520 foot long culvert because there are no appreciable losses throughout the system outside of the pipe losses accounted for by HY-8. The area contributing flows to the inlet of this culvert is 1.42 acres, which in turn generates a design flow (Q_{100}) of 2.8-cfs. At the outlet of the culvert, the contributing area to the drainage swale is greater, from the grading over the culvert. For this reason, the tailwater elevation for this culvert analysis was taken as normal depth of flow in the receiving swale.

Station 839+50 – Contributing area to this section is approximately 1.9 acres generating 3.7-cfs of flow. Using Quick-2 with a stream slope of 0.1% and the irregular channel geometry provided with the sections, the resulting water surface elevation is 67.36 feet. This design water surface elevation, for the purposes of the HY-8 analysis defined a constant tailwater elevation.

With the computed tailwater elevation, it was found that a 15" RCP would be sufficient to convey the 100-year event with a headwater of 68.29 feet providing approximately 0.2 feet of freeboard to the roadway elevation.

Station 844+00

Due to grading requirements and limitations of area to engineer an open swale, a 260 foot long culvert is proposed to continue the flow line from station 844+00 to 846+50. The area contributing flows to the inlet of the crossing is 2.34 acres generating a design runoff amount of 4.6-cfs. Similar to the approach for the system at station 834+15, the tailwater elevation was calculated separately to account for the additional contributing area to the outlet. Section 847+00 was selected for the normal depth computation.

Station 847+00 – Contributing area to this section is approximately 2.59 acres, generating a design flow of 5.0-cfs. A single section hydraulic analysis based on a stream slope of 0.16% and the given irregular channel geometry from the design cross sections revealed a water surface elevation of 66.24 feet.

Using this constant tailwater elevation for the design event, it was found that a twin 12" RCP would reduce the overtopping of the roadway to less than one cfs (0.6-cfs) with a headwater elevation of 67.22 feet. This headwater will overtop the roadway by 0.02 feet at the bottom edge of the cross slope, but still provides 2.95 feet of freeboard to the track elevation. It should be noted that a twin culvert crossing was designed as opposed to increasing the size of a single pipe crossing due to cover restraints in relation to the prescribed flowline.

Station 850+70

Between station 851+00 and 851+50, a turnoff for the access road was required. For this reason, a 110 foot long culvert has been designed to convey the flow line beneath the roadway. The area contributing to the inlet of the culvert is 2.88 acres, generating a design runoff rate of 5.6-cfs. The tailwater for the crossing was determined using the typical swale design throughout this project with a slope of 0.12% as determined from the design plans. Using HY-8, it was determined that a twin 12" culvert crossing would be required to convey the flow line under the roadway. The resulting headwater for this crossing was computed at 65.86 feet, providing 0.5 feet of freeboard to the roadway surface. A single pipe with a larger diameter was investigated for this site, however, clearance to the top of road was a restricting factor to the design discounting that consideration

Subsurface System – Outlet at Kane Brook

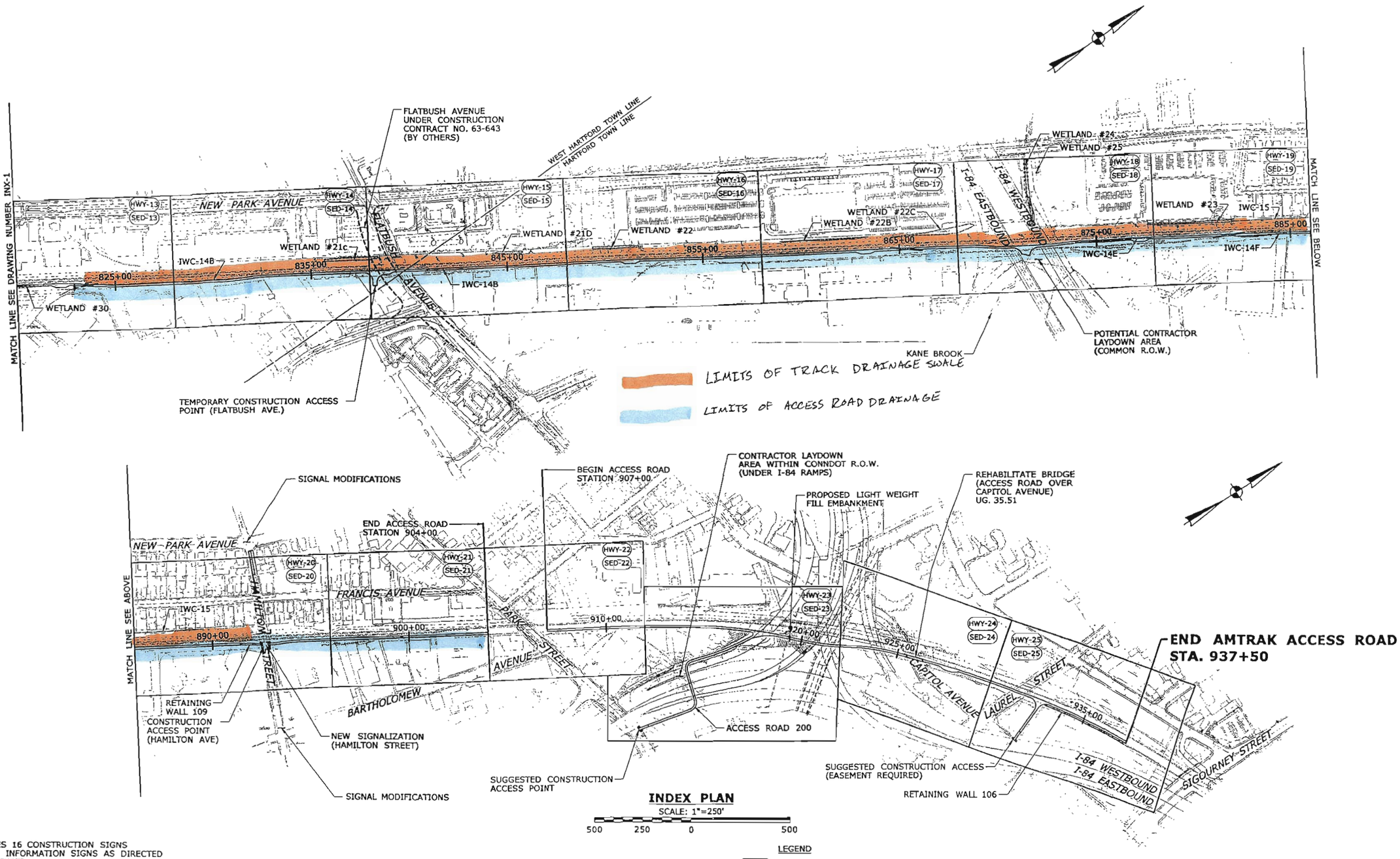
Leg 1 from 866+50 to outlet – At station 866+50, due to grading conflictions to the flow line, a subsurface drainage system has been designed to convey the flows contributing from this inlet point to the proposed outlet at Kane Brook. At 866+50, approximately 4.5 acres contribute to design flows totaling 8.9-cfs based on the previously documented global design parameters. Continuing down system to the manhole upstream from the outlet pipe, there are two additional inlets. Each inlet was given a time of concentration of 10 minutes to determine the contribution of flows from each incremental area. At station 867+00, a drainage inlet adds 0.1 acre to the system, and at station 869+00, another 0.18 acres are added. At the inlet of the last manhole of the system, this leg of the drainage contributes 4.81 acres to the outlet.

Leg 2 from 893+50 to outlet – At station 893+50, a second leg to the subject system carries the flow line beneath Hamilton Street and continues to the manhole at station 870+25. Design parameters for this leg of the system are the same as the previously documented leg. The following table documents each inlet and contributing incremental area to the junction with the first leg.

Station	Inlet area (incremental)	Inlet area (total)
893+50	0.55 ac	0.55 ac
891+50	0.45 ac	1.00 ac
888+00	0.20 ac	1.20 ac
886+50	0.47 ac + 3.76 ac from tracks	5.43 ac
881+70	0.11 ac	5.54 ac
878+70	1.07 ac	6.61 ac
876+75	0.54 ac	7.15 ac
874+20	0.22 ac	7.37 ac
872+10	0.32 ac	7.69 ac

These drainage systems come together at a manhole at station 870+25. With the total area contributing for a 100-year design event, the outlet discharge from this total system is calculated at 24.6-cfs (Q_{100}) from a total area of 12.51 acres. The outlet pipe has been designed with a 0.5% slope in order to slow the outlet velocity as much as possible. The outlet pupe was sized with this prescribed slope and it has been determined that a 30 inch pipe would be required to handle the design flow rate.

Outlet Protection – In order to carry the flow line down the toe of the 2:1 slope adjacent to Kane Brook, it was necessary to utilize a drop manhole in conjunction with a u-type endwall. At the outlet of the pipe system, a 15' long preformed scour hole has been hydraulically designed lined with modified riprap. The flow line exiting the riprap will have approximately 25-30 feet of overland flow down a 5:1 gently sloping undisturbed forest land. Attached with the computations in this section is a plan and detail sheet depicting this outlet condition.



INDEX PLAN

SCALE: 1"=250'

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

FINAL PLANS FOR REVIEW

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD
DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-02
SHEET NO. 8

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Draiange

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 876+50

Notes: Development of tailwater rating curve for HY-8 analysis of PVC pipe at station 865+50

Parameters

Channel Type: Custom Cross Section

Flow: 5.7000 (cfs)

Depth: 1.5153 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0018 (ft/ft)

Area of Flow: 6.5706 (ft^2)

Wetted Perimeter: 8.7591 (ft)

Average Velocity: 0.8675 (ft/s)

Top Width: 7.8788 (ft)

Froude Number: 0.1674

Critical Depth: 0.6638 (ft)

Critical Velocity: 3.6894 (ft/s)

Critical Slope: 0.0781 (ft/ft)

Critical Top Width: 3.6551 (ft)

Calculated Max Shear Stress: 0.1702 (lb/ft^2)

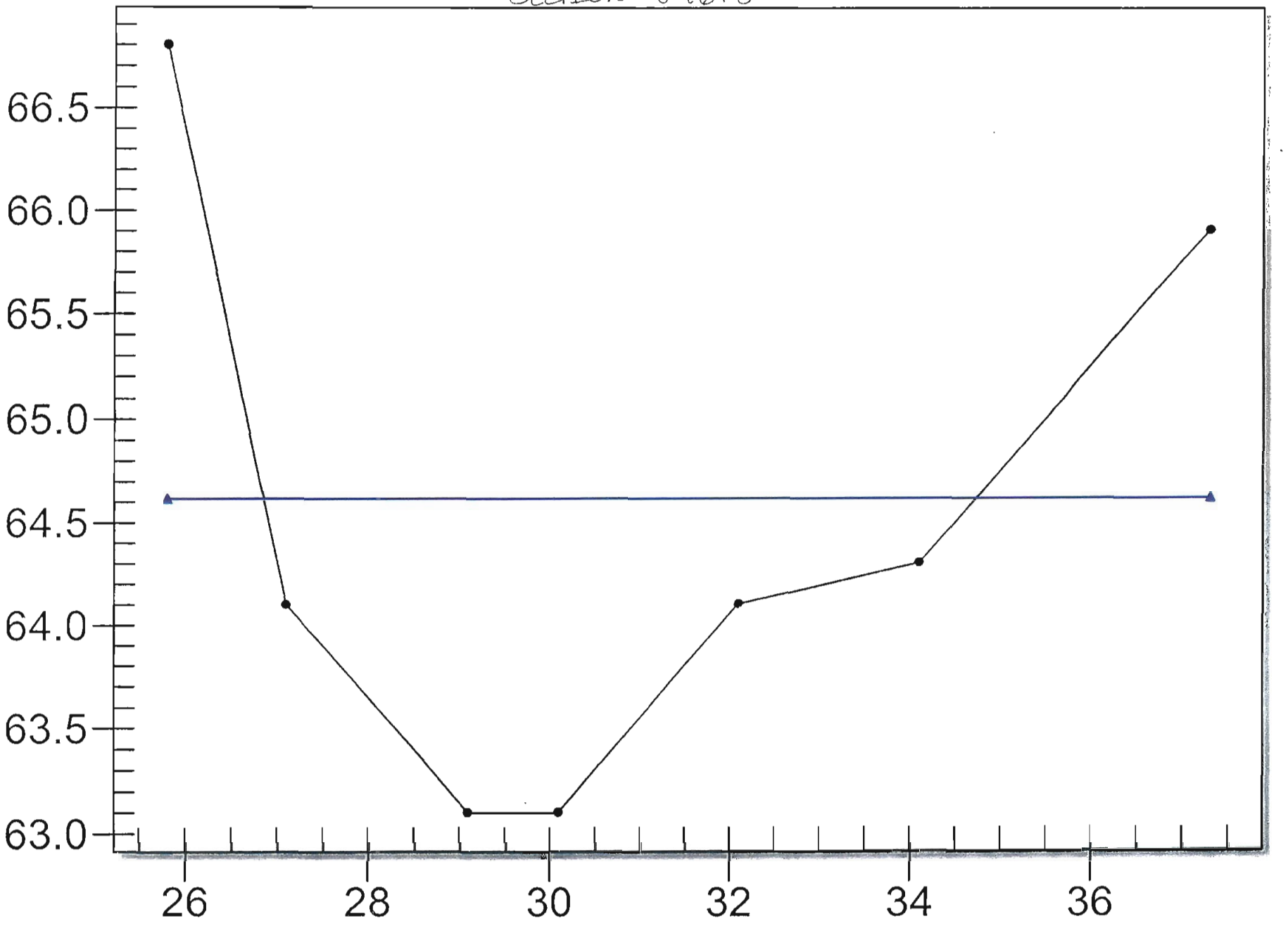
Calculated Avg Shear Stress: 0.0843 (lb/ft^2)

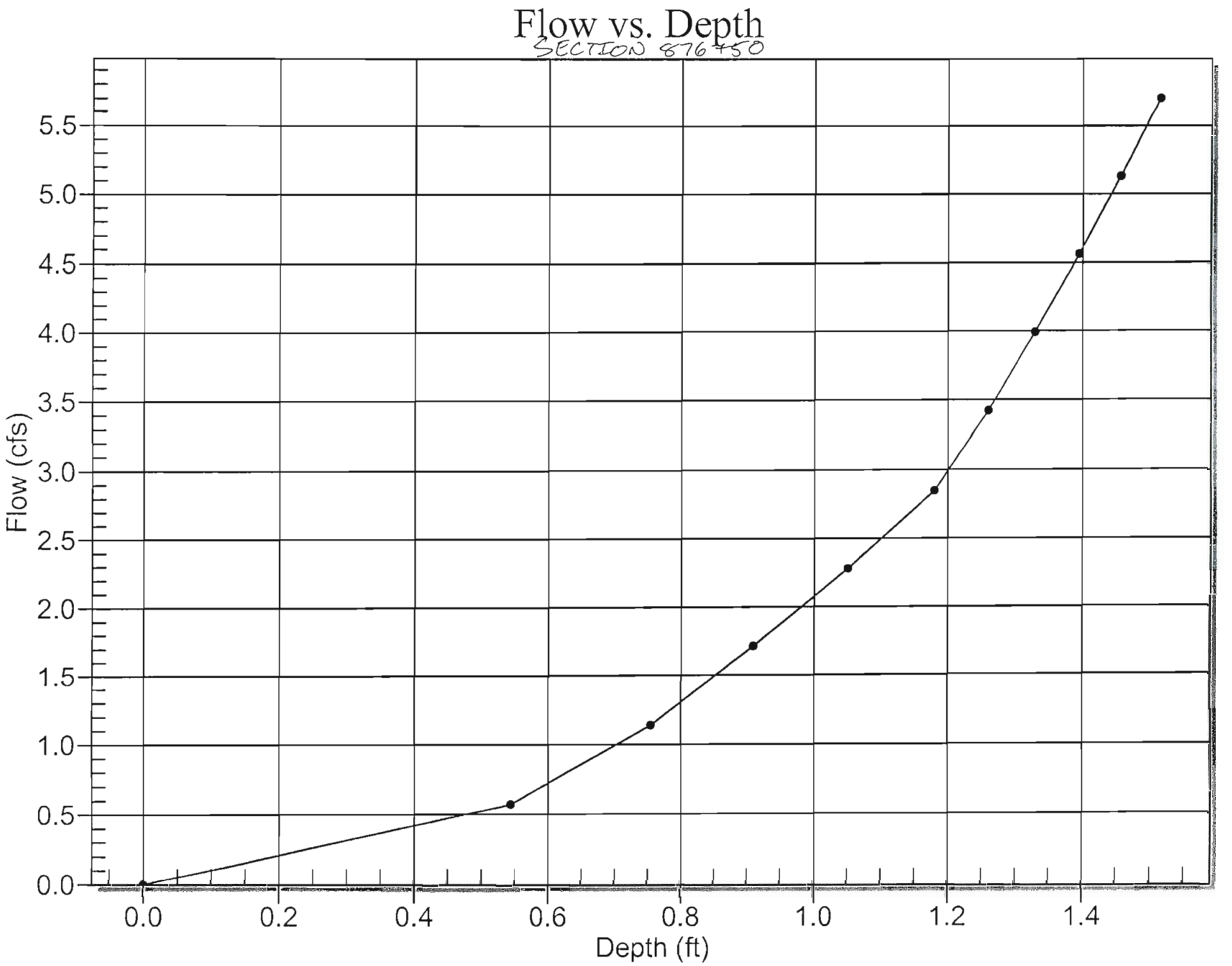
Cross Section Data

Station (ft)	Elevation (ft)	Mannings
25.80	66.80	0.0600
27.10	64.10	0.0600
29.10	63.10	0.0600
30.10	63.10	0.0600
32.10	64.10	0.0600
34.10	64.30	0.0600
37.30	65.90	-----

Cross Section

SECTION 876+50




Flow vs. Depth
SECTION 876450
Flow (cfs)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Depth (ft)

HY-8 Culvert Analysis Report
Proposed Pipe at 865+50

Table 1 - Summary of Culvert Flows at Crossing: Pipe at 865+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
64.49	0.00	0.00	0.00	1
65.78	0.57	0.28	0.28	11
65.93	1.14	0.28	0.86	6
66.05	1.71	0.28	1.43	5
66.15	2.28	0.27	2.00	4
66.24	2.85	0.27	2.58	4
66.32	3.42	0.27	3.15	4
66.40	3.99	0.27	3.71	3
66.47	4.56	0.27	4.29	3
66.49	4.70	0.27	4.42	2
66.61	5.70	0.27	5.43	3
65.63	0.29	0.29	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe at 865+50

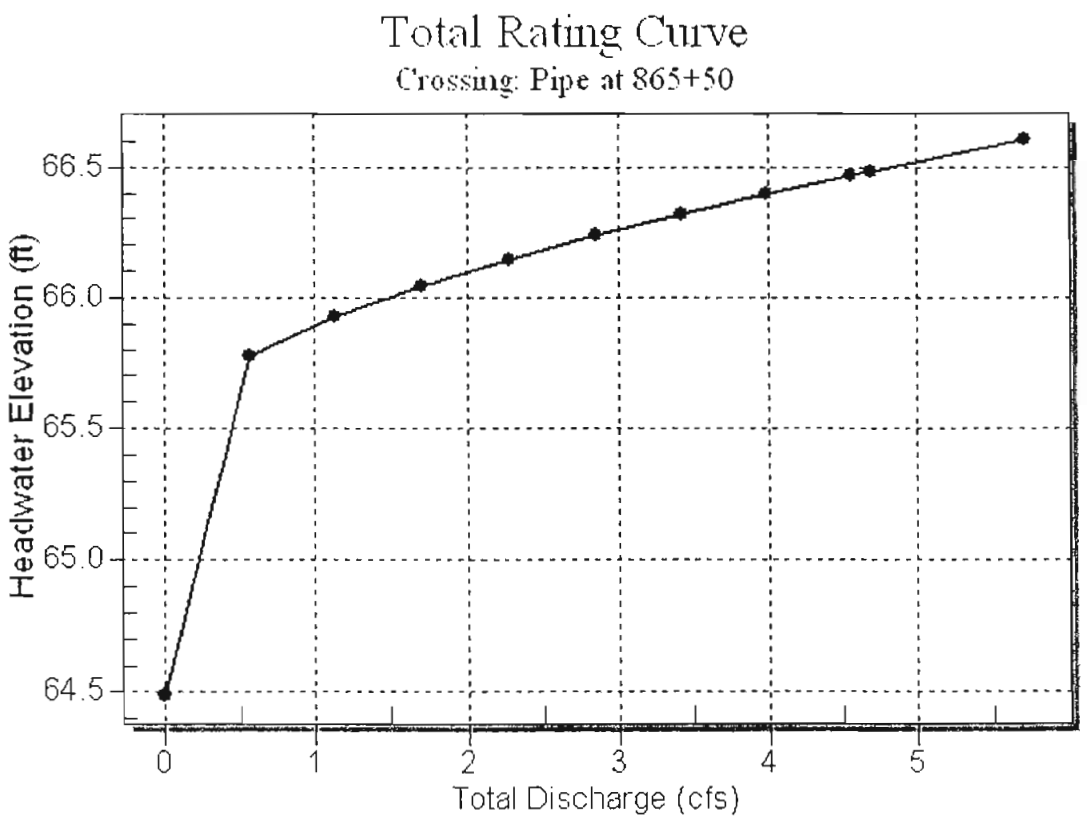


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	64.49	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.57	0.28	65.78	0.399	1.251	4-FFf	0.500	0.266	0.500	0.544	1.430	0.000
1.14	0.28	65.93	0.396	1.411	4-FFf	0.500	0.265	0.500	0.755	1.412	0.000
1.71	0.28	66.05	0.394	1.536	4-FFf	0.500	0.264	0.500	0.909	1.402	0.000
2.28	0.27	66.15	0.392	1.647	4-FFf	0.500	0.263	0.500	1.051	1.391	0.000
2.85	0.27	66.24	0.391	1.752	4-FFf	0.500	0.262	0.500	1.180	1.383	0.000
3.42	0.27	66.32	0.391	1.833	4-FFf	0.500	0.262	0.500	1.260	1.383	0.000
3.99	0.27	66.40	0.391	1.908	4-FFf	0.500	0.262	0.500	1.330	1.385	0.000
4.56	0.27	66.47	0.391	1.978	4-FFf	0.500	0.262	0.500	1.395	1.387	0.000
4.70	0.27	66.49	0.392	1.991	4-FFf	0.500	0.263	0.500	1.400	1.389	0.000
5.70	0.27	66.61	0.392	2.107	4-FFf	0.500	0.263	0.500	1.510	1.392	0.000

* theoretical depth is impractical. Depth reported is corrected.

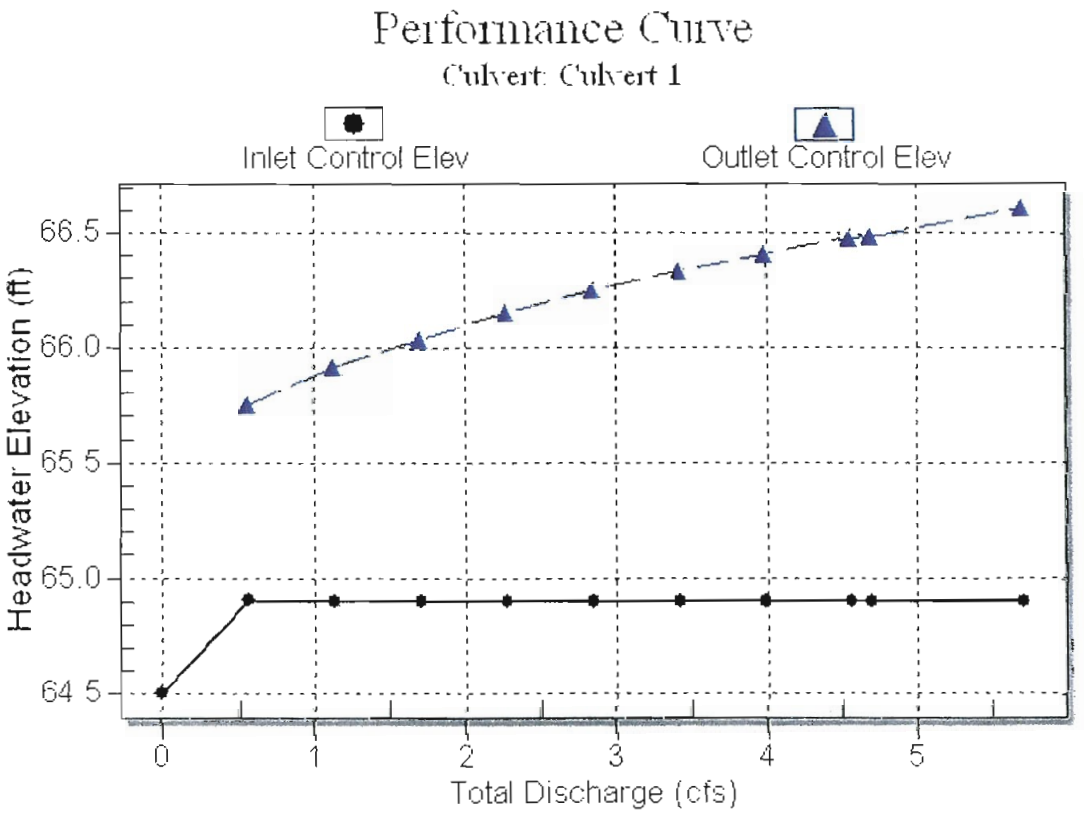
****

Inlet Elevation (invert): 64.49 ft, Outlet Elevation (invert): 63.10 ft

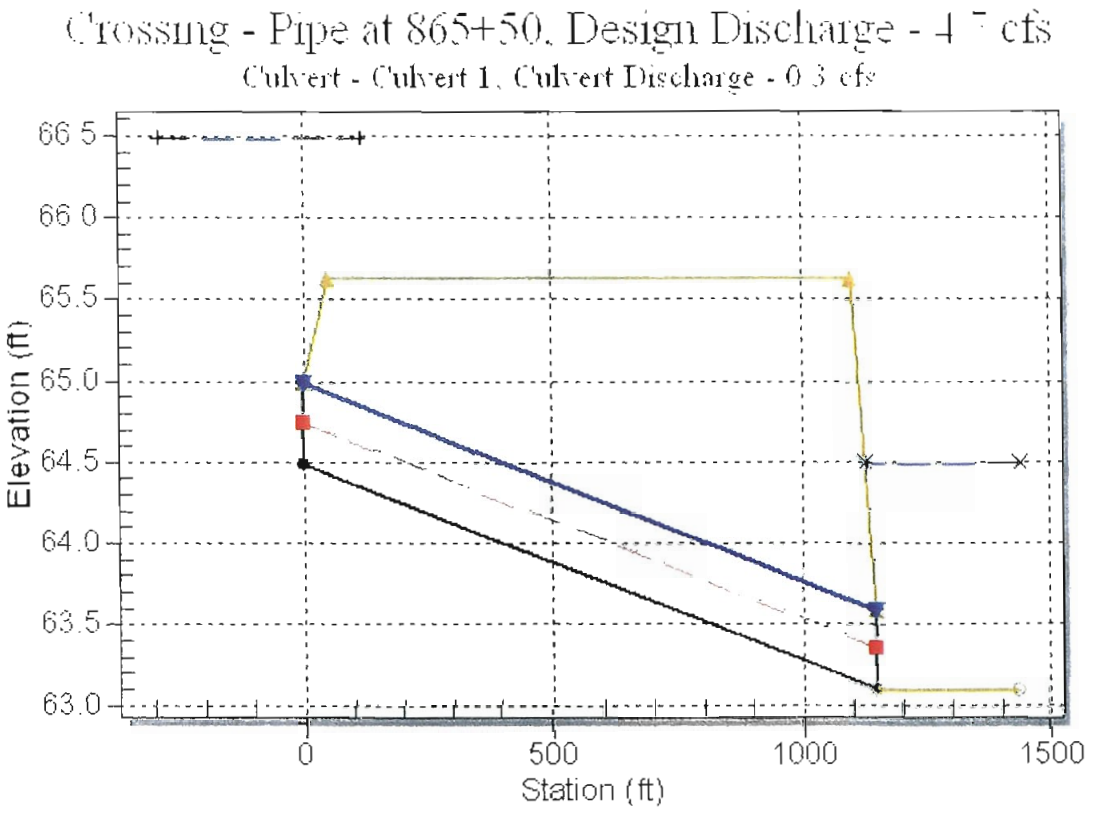
Culvert Length: 1150.00 ft, Culvert Slope: 0.0012

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 64.49 ft

Outlet Station: 1150.00 ft

Outlet Elevation: 63.10 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 0.50 ft

Barrel Material: PVC

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Pipe at 865+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	63.10	0.00
0.57	63.64	0.54
1.14	63.85	0.75
1.71	64.01	0.91
2.28	64.15	1.05
2.85	64.28	1.18
3.42	64.36	1.26
3.99	64.43	1.33
4.56	64.50	1.40
4.70	64.50	1.40
5.70	64.61	1.51

Tailwater Channel Data - Pipe at 865+50

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Pipe at 865+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 2.00 ft

Crest Elevation: 65.63 ft

Roadway Surface: Gravel

Roadway Top Width: 1050.00 ft

Hydraulic Analysis Report

Project Data

Project Title: AAR Track Draiange

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 876+00

Notes: Elevated Swale capacity check

Parameters

Channel Type: Custom Cross Section

Flow: 5.4000 (cfs)

Depth: 1.5375 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0012 (ft/ft)

Area of Flow: 6.8460 (ft^2)

Wetted Perimeter: 7.7657 (ft)

Average Velocity: 0.7888 (ft/s)

Top Width: 6.6262 (ft)

Froude Number: 0.1368

Critical Depth: 0.5606 (ft)

Critical Velocity: 3.5731 (ft/s)

Critical Slope: 0.0782 (ft/ft)

Critical Top Width: 3.8119 (ft)

Calculated Max Shear Stress: 0.1151 (lb/ft^2)

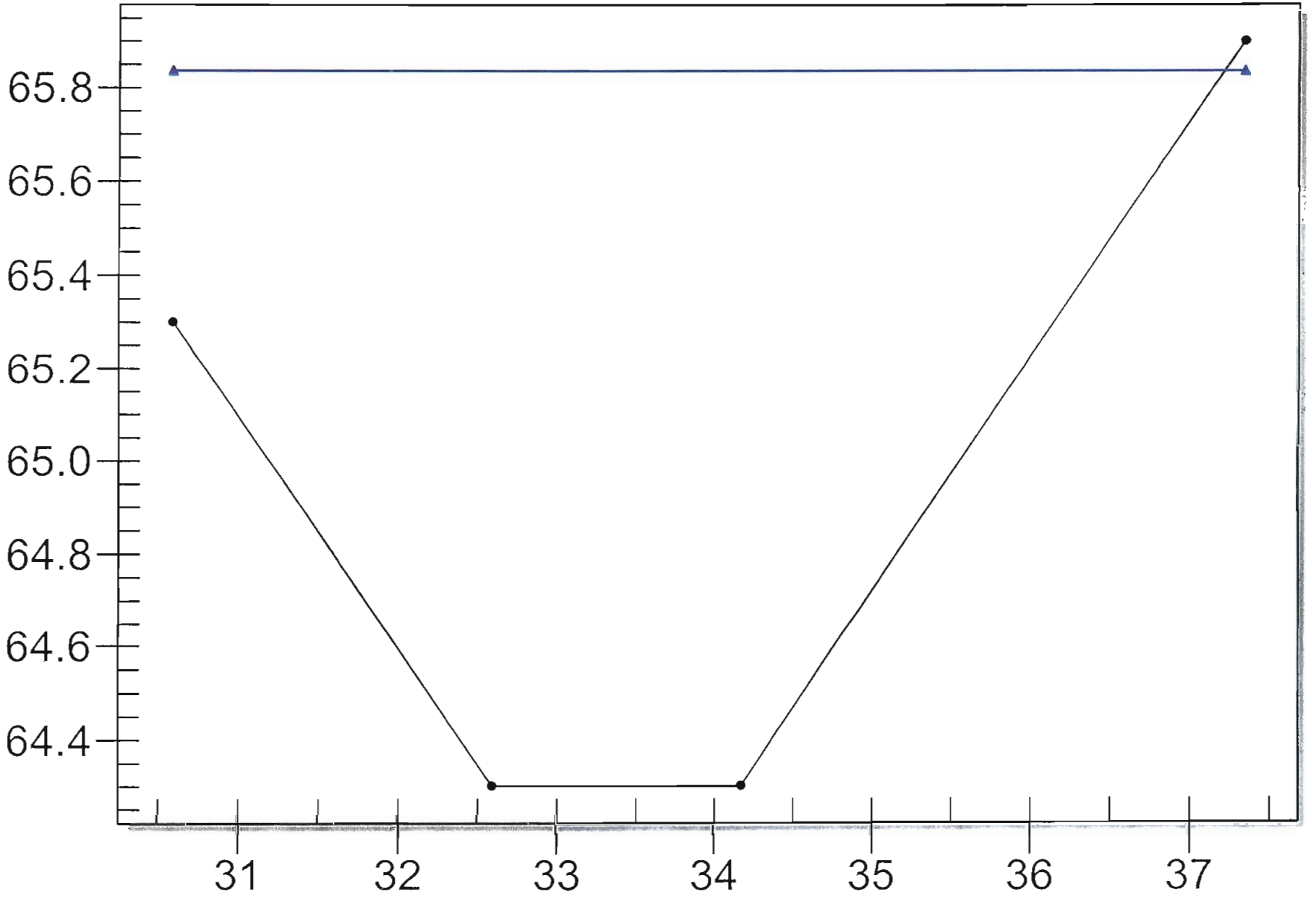
Calculated Avg Shear Stress: 0.0660 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
30.59	65.30	0.0600
32.59	64.30	0.0600
34.17	64.30	0.0600
37.34	65.90	----

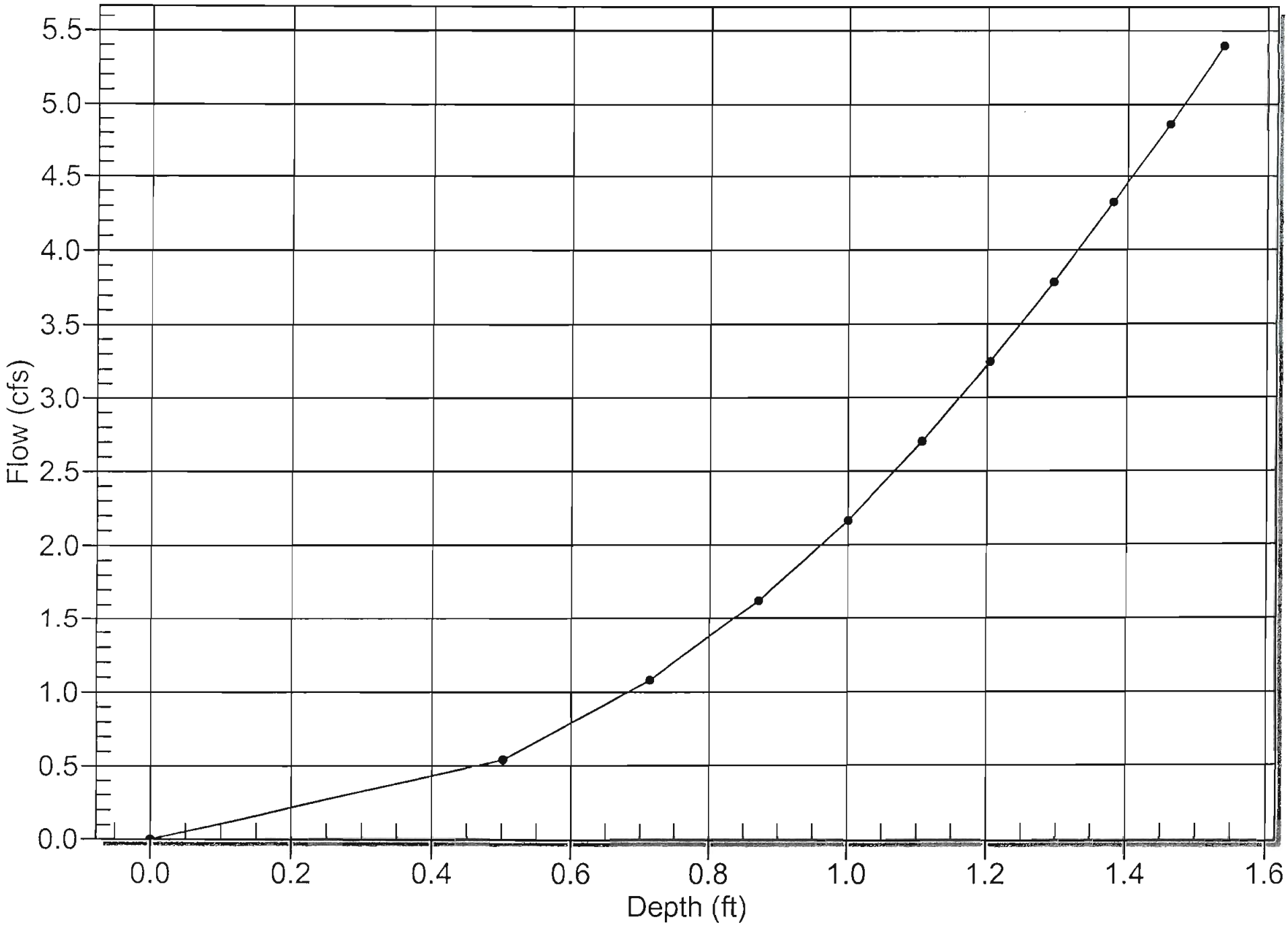
Cross Section

Station 876+00



Flow vs. Depth

Station 876+00



Hydraulic Analysis Report

Project Data

Project Title: AAR Track Drainage

Designer: Eric Buckley

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 892+00

Notes: Section analysis to check swale capacity

Parameters

Channel Type: Custom Cross Section

Flow: 7.3300 (cfs)

Depth: 2.0239 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0006 (ft/ft)

Area of Flow: 11.7171 (ft^2)

Wetted Perimeter: 11.1894 (ft)

Average Velocity: 0.6256 (ft/s)

Top Width: 9.9333 (ft)

Froude Number: 0.1015

Critical Depth: 0.7523 (ft)

Critical Velocity: 3.8902 (ft/s)

Critical Slope: 0.0756 (ft/ft)

Critical Top Width: 4.0092 (ft)

Calculated Max Shear Stress: 0.0758 (lb/ft^2)

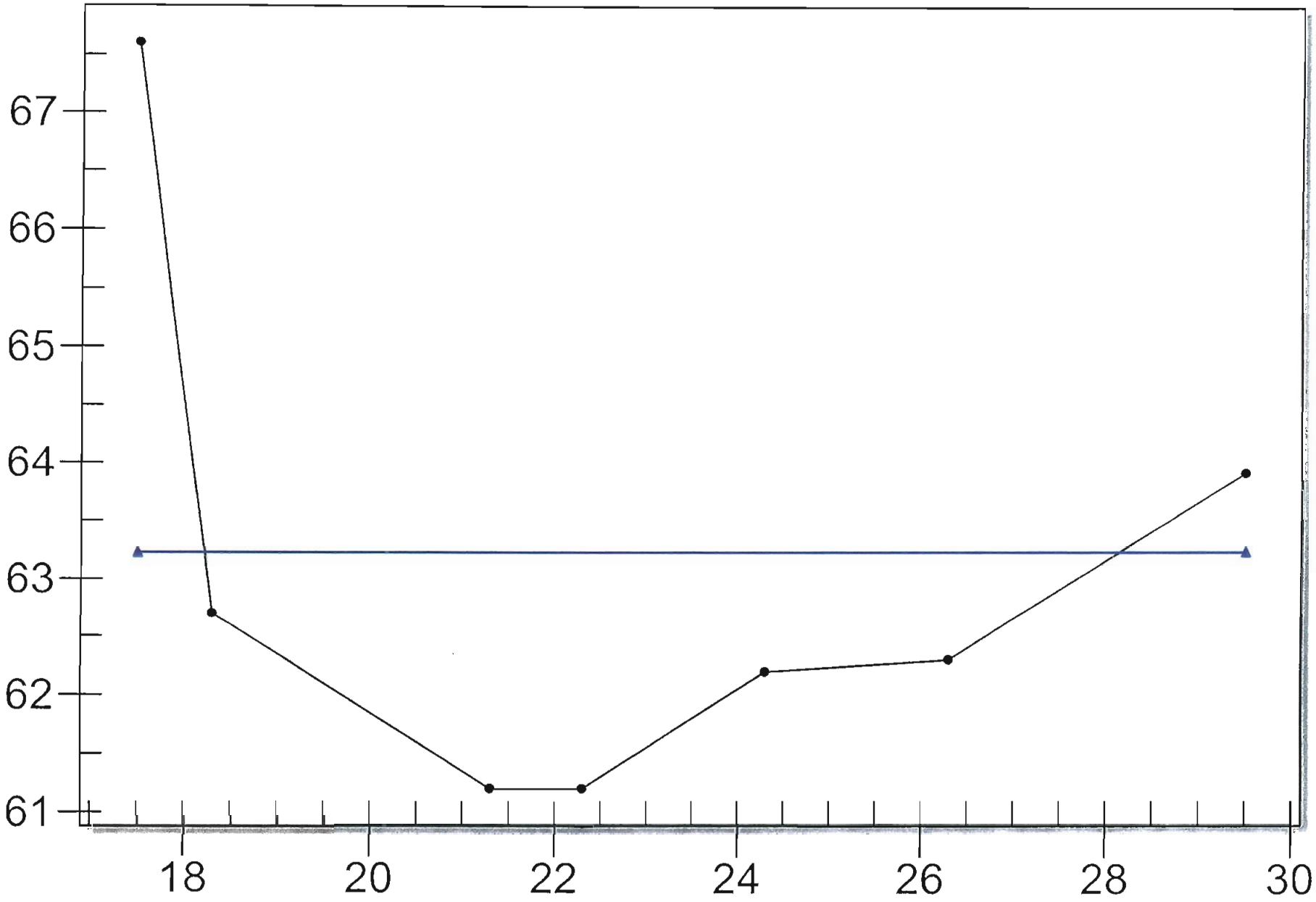
Calculated Avg Shear Stress: 0.0392 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
17.50	67.60	0.0600
18.30	62.70	0.0600
21.30	61.20	0.0600
22.30	61.20	0.0600
24.30	62.20	0.0600
26.30	62.30	0.0600
29.50	63.90	----

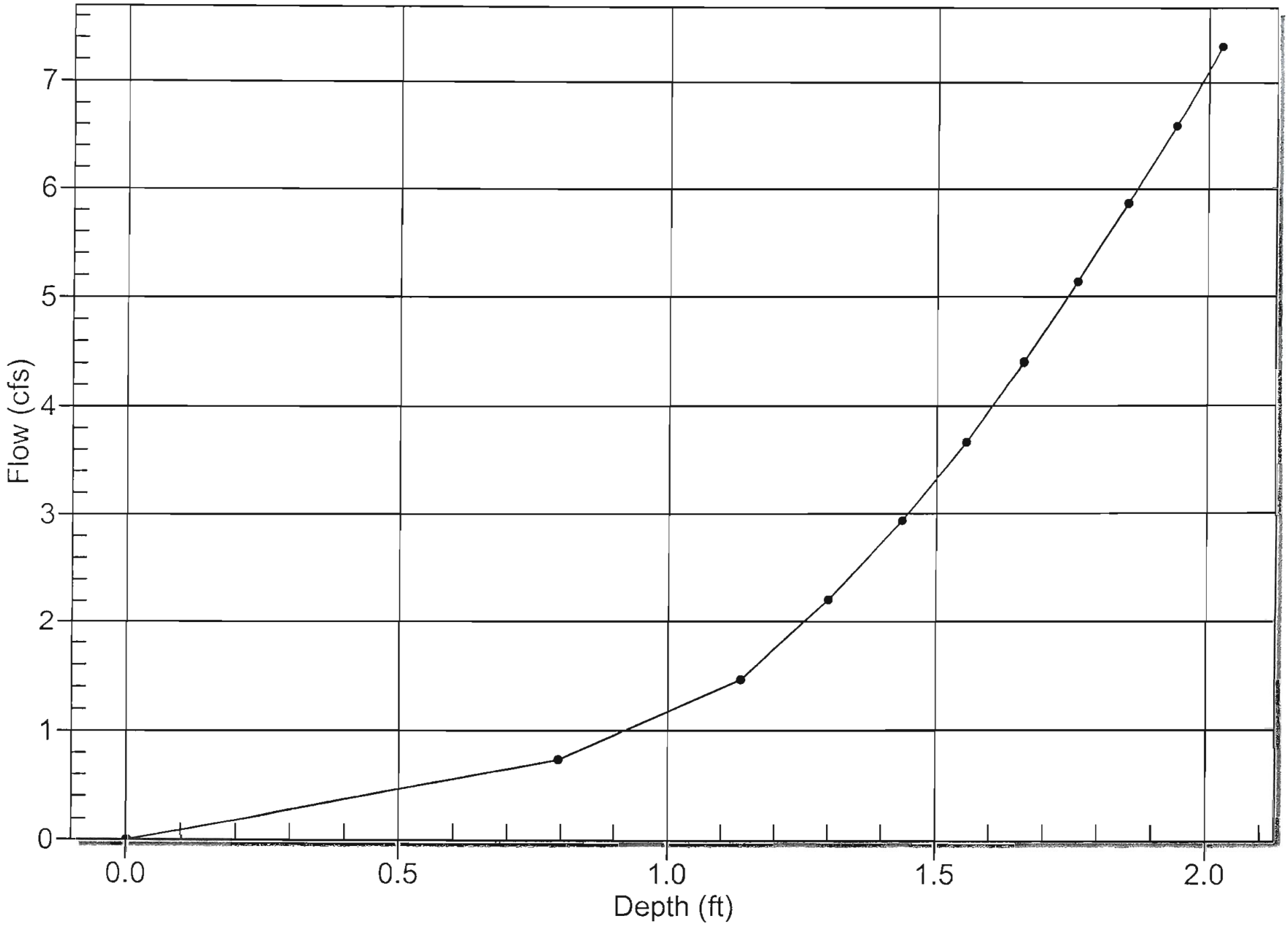
Cross Section

Section 892+00



Flow vs. Depth

Section 892+00



GM2 Associates

Engineers • Inspectors • Surveyors

Job Track Drainage Computed By _____ Date _____

Description _____ Checked By _____ Date _____

Area 4 from Stations 823+50 to 892+00 Sheet 1 of _____

NOTE - Likely have to jack pipe under tracks to System on Access Road outletting to Kane Brook. Jacked pipe must be 5' VERTICALLY (NO less) to TIE OF TRACK 1ST REASONABLE TIE in @ Station 887+50

2 Design Points @ 865+50 NEED pipe UNDER ELEVATED SWALE
@ 888+00 catchbasin.

① Station 866+50 Design pipe For Elevated Swale

2.4 acres contribute to inlet
0.3
6.5 ⇒ 4.68 CFS (Q_{100})

Roadway Data Crest el 65.63

Culvert data 64.49 inv in Length 1150
63.1 inv out
slope 0.0012

@ design flow Culvert discharge 0.27 CFS

$2.4 \cdot 0.3 \cdot x = 0.29$
$x = 0.4$ "/hr rainfall Rate

Roadway discharge 4.42 CFS
CA = 0.68 overtop

Tailwater flow @ Station 876+50

2.9 acres
0.3
6.5 ⇒ 5.7 CFS
slope = 0.0018

Sta	EL
25.8	66.8
27.1	64.1
29.1	63.1
30.1	63.1
32.1	64.1
34.1	64.3
37.3	65.9

Area @ End of Elevated swale 0.5 ac
CA from Elevated Swale 0.15

$CA_{over} + CA_{elevated} = 0.83$

$0.83 \cdot 6.5 = \underline{5.4}$ CFS in Elevated Swale

Elevated Swale Section 876+00

STA	EL
30.59	65.3
32.59	64.3
34.17	64.3
37.34	65.9

Slope = 0.0012
depth 1.53
Elev 65.8
Track el 66.7
0.9' freeboard

GM2 Associates

Engineers • Inspectors • Surveyors

Job _____ Computed By _____ Date _____

Description _____ Checked By _____ Date _____

Area 4 Cont. Sheet 2 of _____

887+50

(2) Catch basin @ ~~888+00~~ Needs to be incorporated to Kane brook System

Tying into ~~888+00~~ 887+50

US inv 57.8 DS inv 57.6 0.2 42

$0.2^2 + b^2 = 42^2$

$b = 42.0$ 0.48 %

* move CB from 888 → 887+50

Tabulate TOTAL C & A 3.76 · 0.3

(3) Swale Capacity

Slope 0.0006

STA	EL
17.5	67.6
18.3	62.7
21.3	61.2
22.3	61.2
24.3	62.2
26.3	62.3
29.5	63.9

GM2 Associates

Engineers • Inspectors • Surveyors

Job AMTRAK ACCESS ROAD Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 4 Design From 823+00 to 904+00 outlet @ Kane Brook Sta 870+50 Sheet 1 of 3

System 4.a

underdrain starts @ 824+50 - Lets out @ Swale 833+00

underdrain size Required for average slope of ~~0.1%~~ 0.34%

pipe length 850' ☆ VIS URBAN

① AREA Contributing 48412.50 Ft^2 = 1.1 ac recommend 8" pipe

Q_{100} (1.1 ac X 0.3 X 6.5 in/hr) = 2.15 CFS

Q_{10} (1.1 ac)(0.3)(4.8 in/hr) = 1.6 CFS

Station 834+15 Subsurface System to 839+25

model as culvert - NO losses throughout system

① Area Contributing 61981.25 Ft^2 ⇒ 1.42 ac

Q_{100} (1.42 ac X 0.3 X 6.5 in/hr) = 2.8 CFS

Q_{10} (1.42 ac X 0.3 X 4.8 in/hr) = 2.0 CFS

☆ Starting WSEL Based ON NORMAL DEPTH of RECEIVING Swale 839+50

② Constant wsel for Q_{100} 67.36

③ Roadway Data

Crest el 68.30'

length 100

Top width 450

④ Site Data inlet Sta = 0

inlet El = 66.50

outlet Sta = 510

outlet El = 65.99

Station 839+50 Swale Rating Curve

Sta	El
5	67.9
8.4	66.2
10.4	66.0
19.8	70.7

Slope 0.1%

Roughness 0.06

Q_{100} = 3.7 CFS

RESULTS WSEL 67.36

Depth 1.36

Top Width 7

Vel .65

Hy 8 for Underdrain

Tailwater data
Irregular channel Slope 0.1%
'n' : 0.06

Sta	El
5	68.51
8.39	66.82
10.39	66.57
16.82	69.78

Roadway Crest El taken as lowest Point Top of track = 71.44
Top width 850'
length wier 100

US inv El 69.53
DS inv El 66.57

HY-8 Culvert Analysis Report
Underdrain to station 833+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
70.02	0.50	0.50	0.00	1
70.19	0.75	0.75	0.00	1
70.38	1.00	1.00	0.00	1
71.44	1.25	1.18	0.06	39
71.45	1.50	1.17	0.32	5
71.46	1.75	1.16	0.58	4
71.46	2.00	1.15	0.83	3
71.47	2.15	1.15	0.99	3
71.47	2.50	1.14	1.35	3
71.47	2.75	1.13	1.62	3
71.48	3.00	1.12	1.88	3
71.44	1.18	1.18	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: drain to 833+00

Rating Curve Plot for Crossing: drain to 833+00

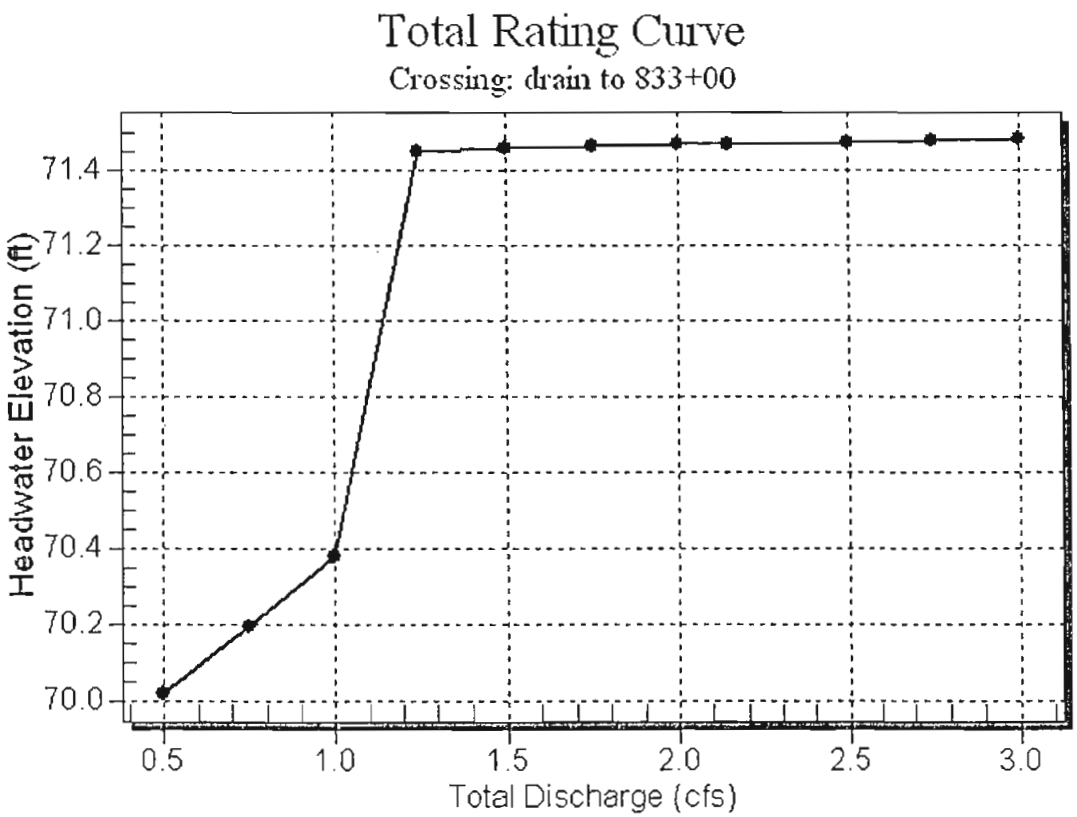


Table 2 - Culvert Summary Table: Culvert 1

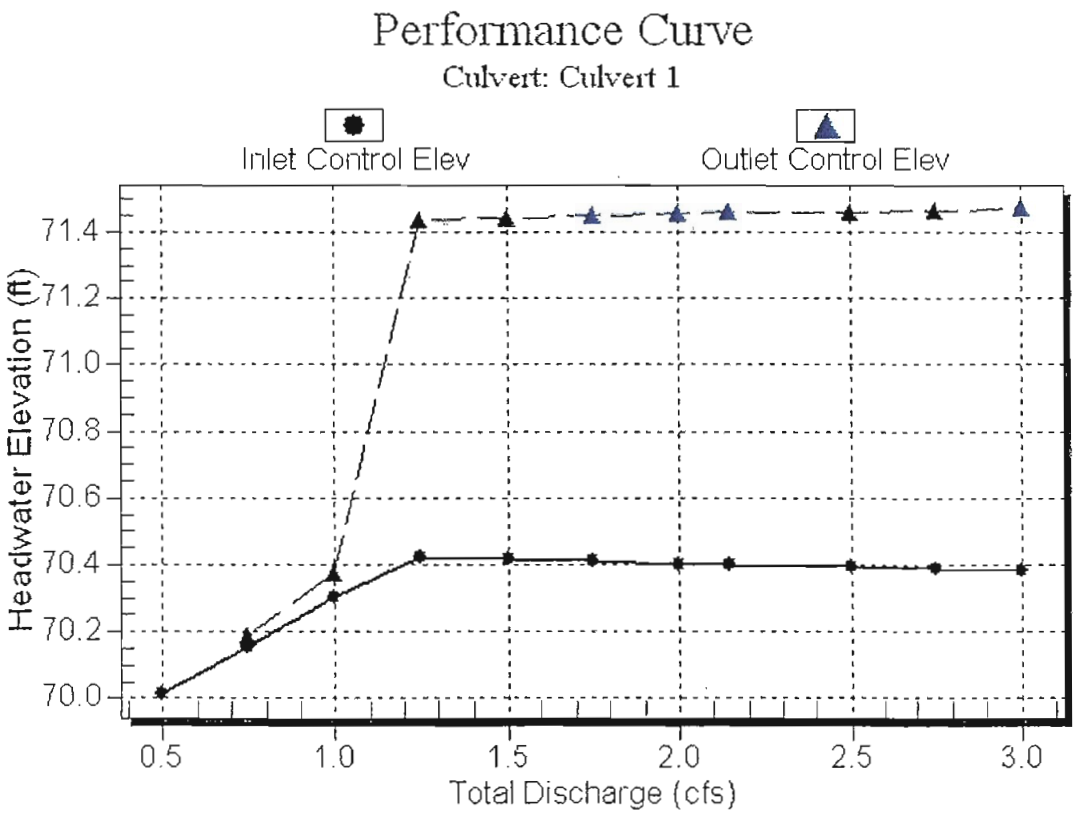
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.50	0.50	70.02	0.486	0.0*	1-S2n	0.326	0.330	0.326	0.574	2.935	0.375
0.75	0.75	70.19	0.626	0.661	3-M1f	0.420	0.408	0.670	0.686	2.127	0.421
1.00	1.00	70.38	0.772	0.845	3-M1f	0.526	0.473	0.670	0.779	2.836	0.456
1.25	1.18	71.44	0.892	1.910	4-FFf	0.670	0.512	0.670	0.859	3.342	0.484
1.50	1.17	71.45	0.885	1.917	4-FFf	0.670	0.510	0.670	0.931	3.315	0.509
1.75	1.16	71.46	0.879	1.923	4-FFf	0.670	0.508	0.670	0.997	3.290	0.530
2.00	1.15	71.46	0.873	1.927	4-FFf	0.670	0.506	0.670	1.058	3.266	0.549
2.15	1.15	71.47	0.869	1.930	4-FFf	0.670	0.505	0.670	1.092	3.252	0.560
2.50	1.14	71.47	0.862	1.935	4-FFf	0.670	0.503	0.670	1.167	3.222	0.583
2.75	1.13	71.47	0.857	1.938	4-FFf	0.670	0.501	0.670	1.217	3.202	0.598
3.00	1.12	71.48	0.852	1.942	4-FFf	0.653	0.500	0.670	1.264	3.183	0.611

* theoretical depth is impractical. Depth reported is corrected.

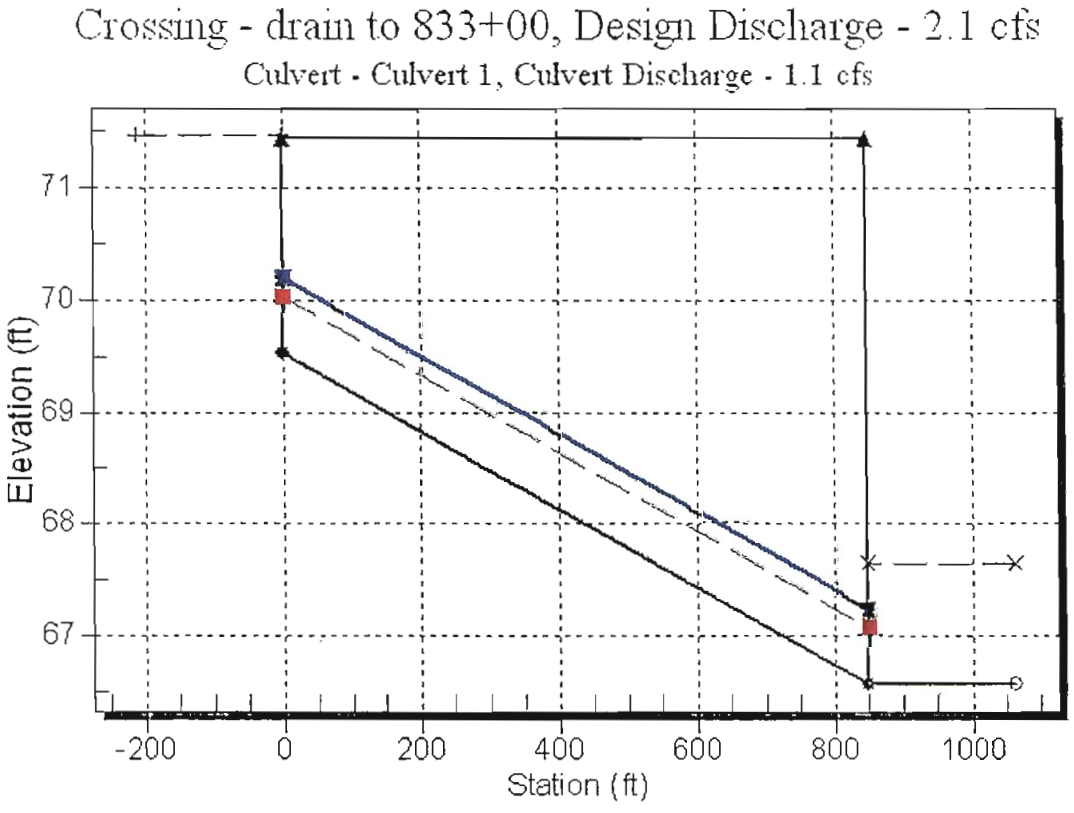
Inlet Elevation (invert): 69.53 ft, Outlet Elevation (invert): 66.57 ft

Culvert Length: 850.01 ft, Culvert Slope: 0.0035

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 69.53 ft

Outlet Station: 850.00 ft

Outlet Elevation: 66.57 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 0.67 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0090

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: drain to 833+00)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.50	67.14	0.57	0.37	0.04	0.11
0.75	67.26	0.69	0.42	0.04	0.11
1.00	67.35	0.78	0.46	0.05	0.12
1.25	67.43	0.86	0.48	0.05	0.12
1.50	67.50	0.93	0.51	0.06	0.12
1.75	67.57	1.00	0.53	0.06	0.12
2.00	67.63	1.06	0.55	0.07	0.12
2.15	67.66	1.09	0.56	0.07	0.12
2.50	67.74	1.17	0.58	0.07	0.12
2.75	67.79	1.22	0.60	0.08	0.12
3.00	67.83	1.26	0.61	0.08	0.12

Tailwater Channel Data - drain to 833+00

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0010

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	5.00	68.51	0.0600
2	8.39	66.82	0.0600
3	10.39	66.57	0.0600
4	16.82	69.78	0.0000

Roadway Data for Crossing: drain to 833+00

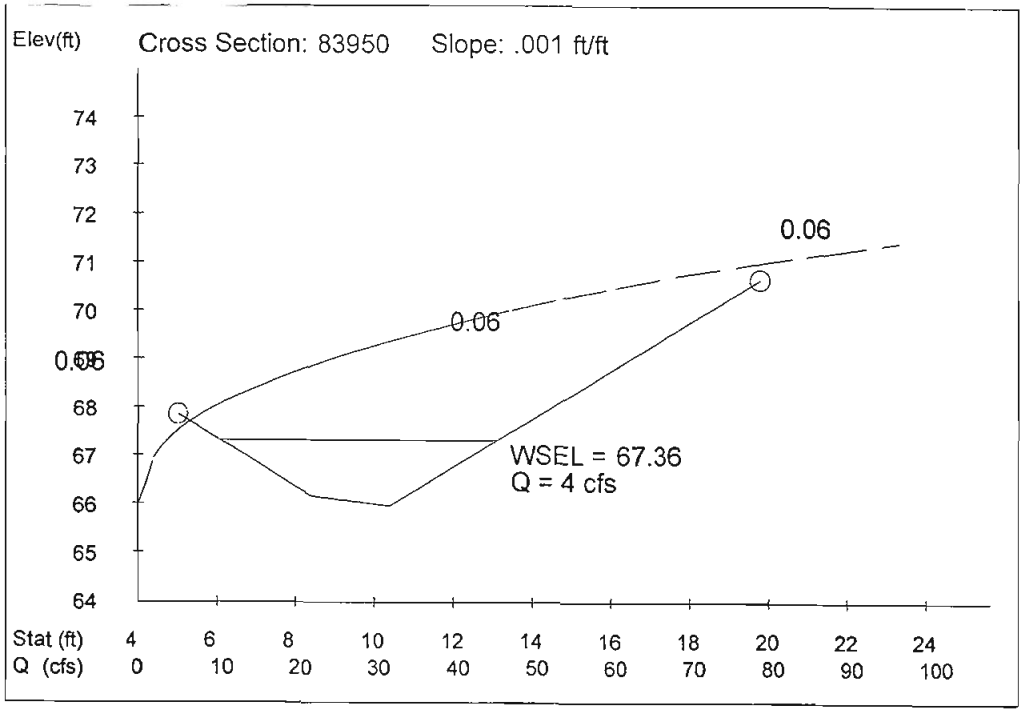
Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 71.44 ft

Roadway Surface: Gravel

Roadway Top Width: 850.00 ft


Elev(ft)
Cross Section: 83950
Slope: .001 ft/ft
74
73
72
71
70
0.06
68
67
66
65
64
0.06
0.06
WSEL = 67.36
Q = 4 cfs
Stat (ft) 4 6 8 10 12 14 16 18 20 22 24
Q (cfs) 0 10 20 30 40 50 60 70 80 90 100

HY-8 Culvert Analysis Report Station 834+15

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
67.84	2.00	2.00	0.00	1
67.88	2.10	2.10	0.00	1
67.94	2.20	2.20	0.00	1
67.99	2.30	2.30	0.00	1
68.05	2.40	2.40	0.00	1
68.10	2.50	2.50	0.00	1
68.16	2.60	2.60	0.00	1
68.23	2.70	2.70	0.00	1
68.29	2.80	2.80	0.00	1
68.30	2.90	2.82	0.07	9
68.31	3.00	2.82	0.16	4
68.30	2.81	2.81	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 834+15

Rating Curve Plot for Crossing: 834+15

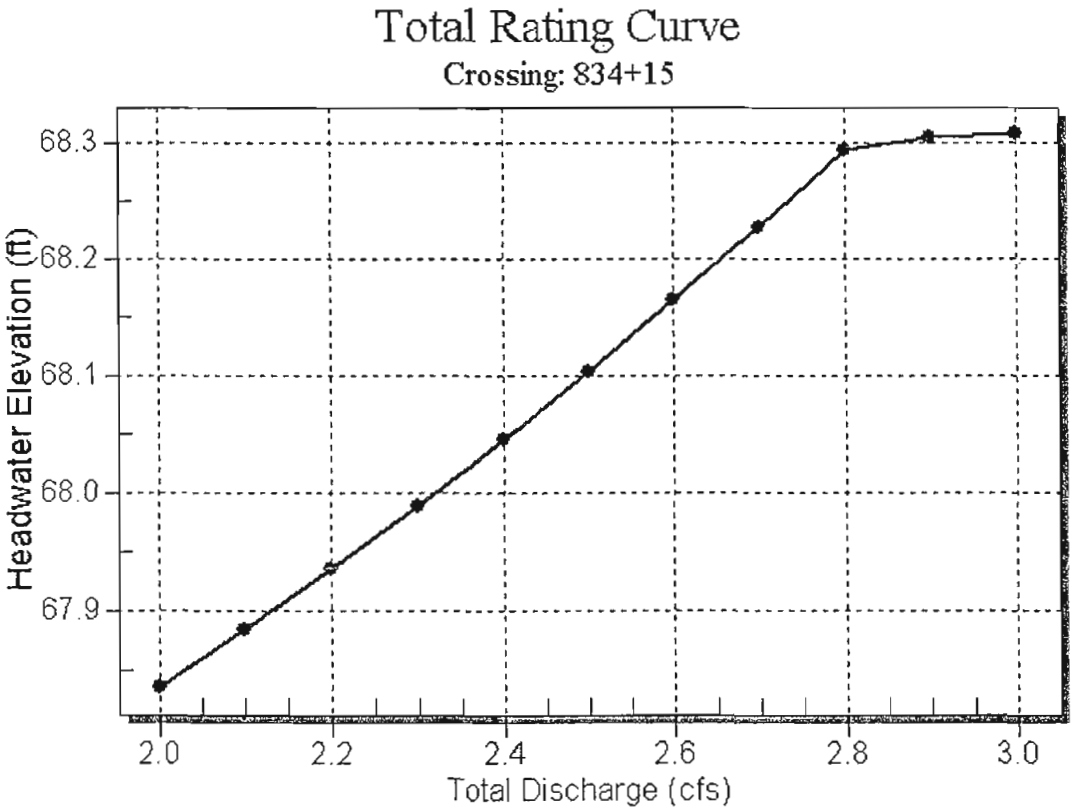


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.00	2.00	67.84	0.816	1.336	4-FFf	0.933	0.560	1.250	1.360	1.630	0.000
2.10	2.10	67.88	0.841	1.385	4-FFf	0.973	0.575	1.250	1.360	1.711	0.000
2.20	2.20	67.94	0.866	1.436	4-FFf	1.021	0.590	1.250	1.360	1.793	0.000
2.30	2.30	67.99	0.889	1.490	4-FFf	1.085	0.604	1.250	1.360	1.874	0.000
2.40	2.40	68.05	0.913	1.546	4-FFf	1.250	0.619	1.250	1.360	1.956	0.000
2.50	2.50	68.10	0.936	1.604	4-FFf	1.250	0.632	1.250	1.360	2.037	0.000
2.60	2.60	68.16	0.958	1.665	4-FFf	1.250	0.645	1.250	1.360	2.119	0.000
2.70	2.70	68.23	0.981	1.728	4-FFf	1.250	0.657	1.250	1.360	2.200	0.000
2.80	2.80	68.29	1.003	1.793	4-FFf	1.250	0.669	1.250	1.360	2.282	0.000
2.90	2.82	68.30	1.007	1.804	4-FFf	1.250	0.671	1.250	1.360	2.295	0.000
3.00	2.82	68.31	1.008	1.807	4-FFf	1.250	0.672	1.250	1.360	2.299	0.000

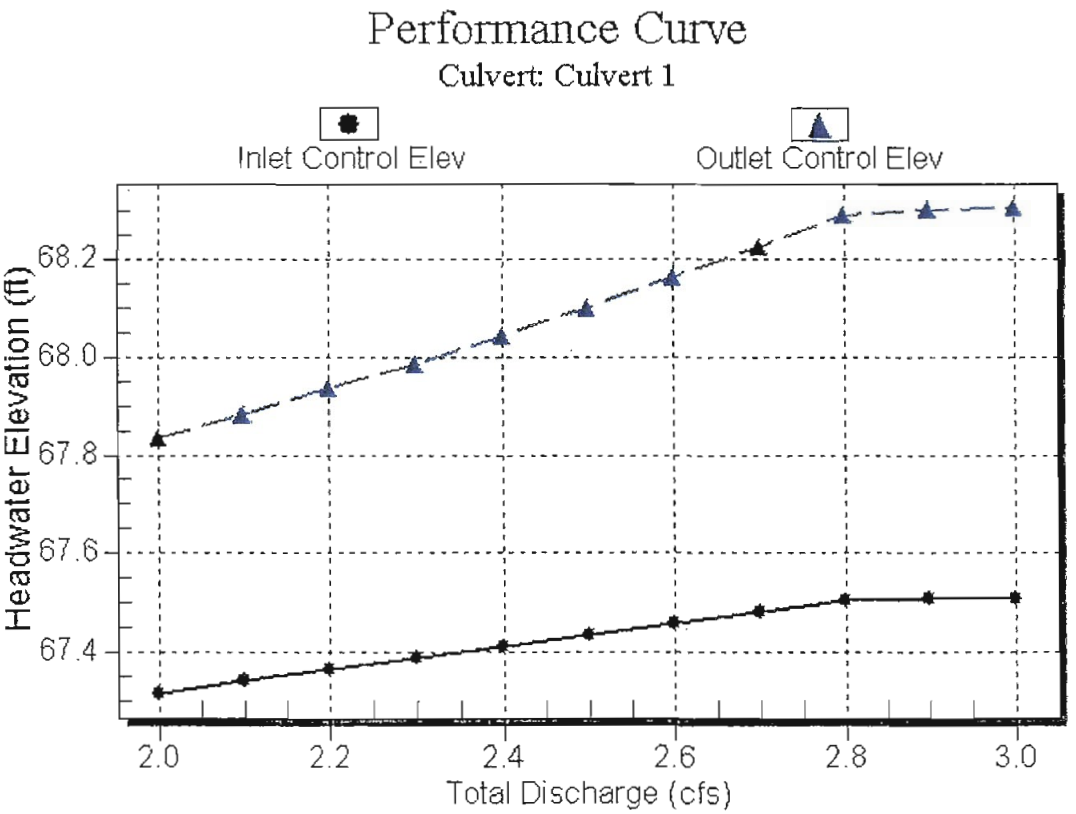
****

Inlet Elevation (invert): 66.50 ft, Outlet Elevation (invert): 65.99 ft

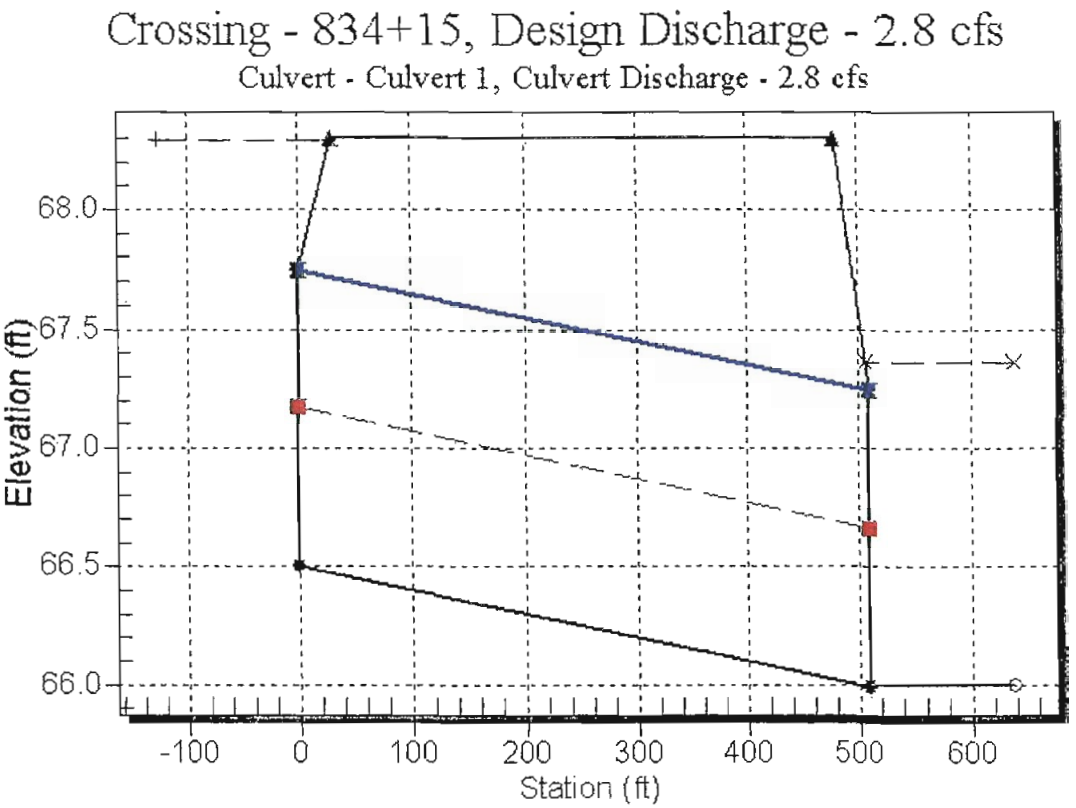
Culvert Length: 510.00 ft, Culvert Slope: 0.0010

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 66.50 ft

Outlet Station: 510.00 ft

Outlet Elevation: 65.99 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 834+15)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
2.00	67.36	1.36
2.10	67.36	1.36
2.20	67.36	1.36
2.30	67.36	1.36
2.40	67.36	1.36
2.50	67.36	1.36
2.60	67.36	1.36
2.70	67.36	1.36
2.80	67.36	1.36
2.90	67.36	1.36
3.00	67.36	1.36

Tailwater Channel Data - 834+15

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 67.36 ft

Roadway Data for Crossing: 834+15

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 68.30 ft

Roadway Surface: Gravel

Roadway Top Width: 450.00 ft

GM2 Associates
Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 4 Design Cont... Sheet 2 of 3

System 4.a

Station 844+00 Culvert Crossing

① Area Contributing 102111.25 Ft^2 = 2.34ac

Q_{100} (2.34ac)(0.3)(6.5 in/hr) = 4.6 CFS

Q_{10} (2.34ac)(0.3)(4.8 in/hr) = 3.4 CFS

* Tailwater based on Normal Depth of receiving Swale

Double Barrel 1'x2'
Reduces overtopping to < 1 CFS

② Constant WSEL For Q_{100} = 66.24'

③ Roadway Data
- Crest EL 67.2
- length 100
- top width 250

④ Site Data
- inlet STA 0
- inlet EL 65.26
- outlet Sta 250
- outlet El 64.90

Station 847+00 Swale Calc for Tailwater of 844+00 Culvert

① Slope 0.16%
Roughness 0.06
Irregular Channel Sta EL for Quick-2

Sta	EL
5	66.7
8.3	65.1
10.3	64.8
14.24	66.7

① Contributing Area 112635 ft^2
2.59 ac
Q_{100} = 5.0 CFS

③ Quick 2 Results
- WSEL 66.24
- Depth 1.44
- Topwidth 7
- Vel 0.82

HY-8 Culvert Analysis Report Station 844+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
66.70	3.00	3.00	0.00	1
66.76	3.20	3.20	0.00	1
66.83	3.40	3.40	0.00	1
66.90	3.60	3.60	0.00	1
66.98	3.80	3.80	0.00	1
67.06	4.00	4.00	0.00	1
67.14	4.20	4.20	0.00	1
67.20	4.40	4.34	0.03	29
67.21	4.60	4.35	0.22	5
67.21	4.80	4.36	0.42	4
67.22	5.00	4.37	0.59	3
67.20	4.33	4.33	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 844+00

Rating Curve Plot for Crossing: 844+00

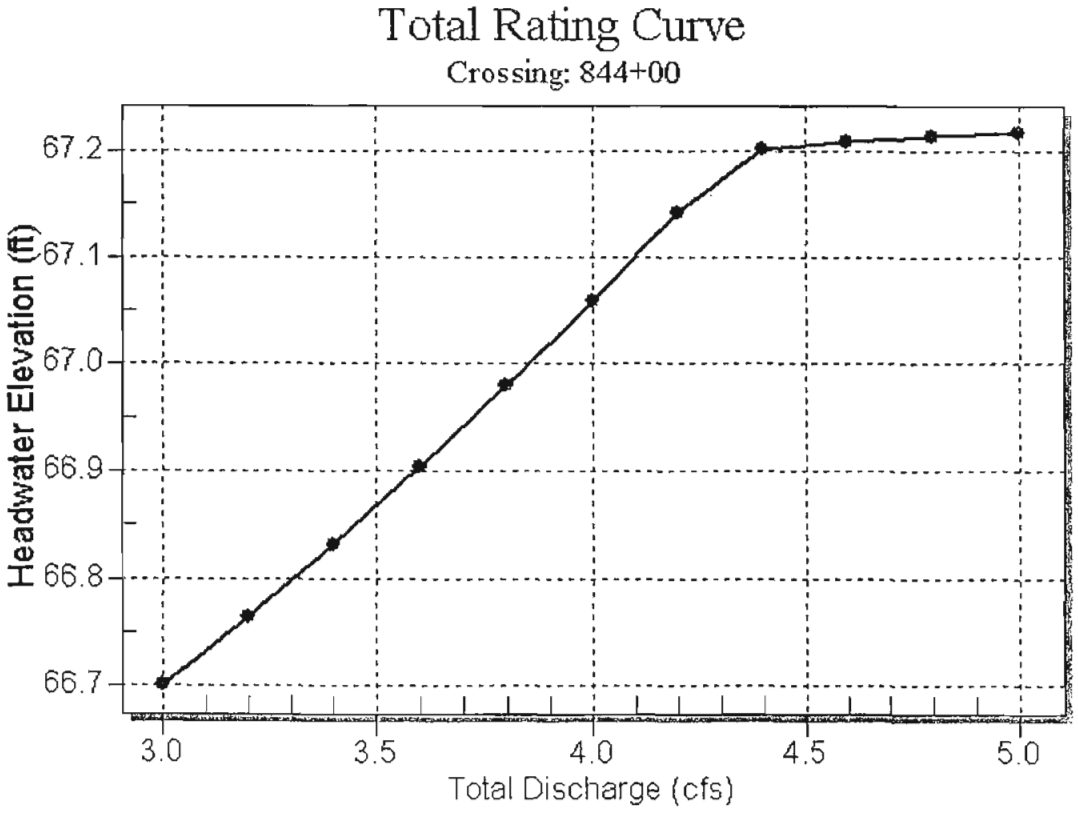


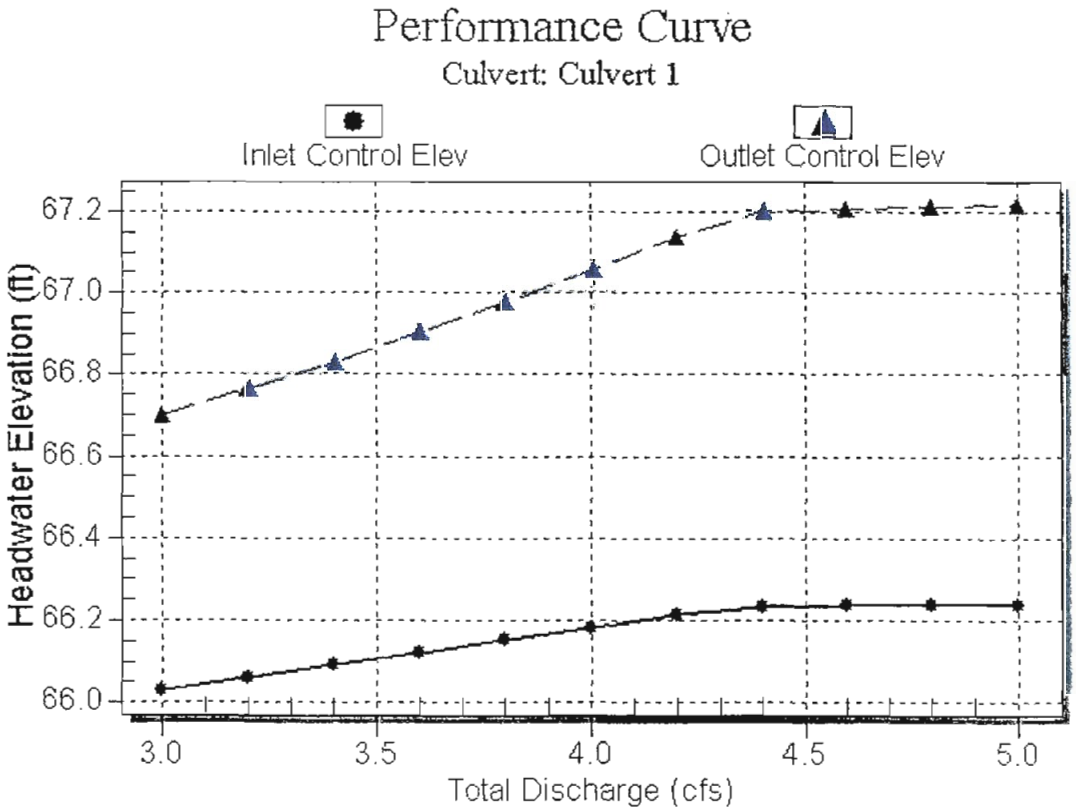
Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.00	3.00	66.70	0.770	1.440	4-FFf	0.850	0.518	1.000	1.440	1.910	0.000
3.20	3.20	66.76	0.801	1.504	4-FFf	1.000	0.535	1.000	1.440	2.037	0.000
3.40	3.40	66.83	0.832	1.571	4-FFf	1.000	0.552	1.000	1.440	2.165	0.000
3.60	3.60	66.90	0.862	1.643	4-FFf	1.000	0.569	1.000	1.440	2.292	0.000
3.80	3.80	66.98	0.892	1.719	4-FFf	1.000	0.587	1.000	1.440	2.419	0.000
4.00	4.00	67.06	0.922	1.799	4-FFf	1.000	0.603	1.000	1.440	2.546	0.000
4.20	4.20	67.14	0.953	1.882	4-FFf	1.000	0.618	1.000	1.440	2.674	0.000
4.40	4.34	67.20	0.974	1.942	4-FFf	1.000	0.628	1.000	1.440	2.761	0.000
4.60	4.35	67.21	0.976	1.949	4-FFf	1.000	0.629	1.000	1.440	2.771	0.000
4.80	4.36	67.21	0.978	1.954	4-FFf	1.000	0.629	1.000	1.440	2.777	0.000
5.00	4.37	67.22	0.979	1.957	4-FFf	1.000	0.630	1.000	1.440	2.783	0.000

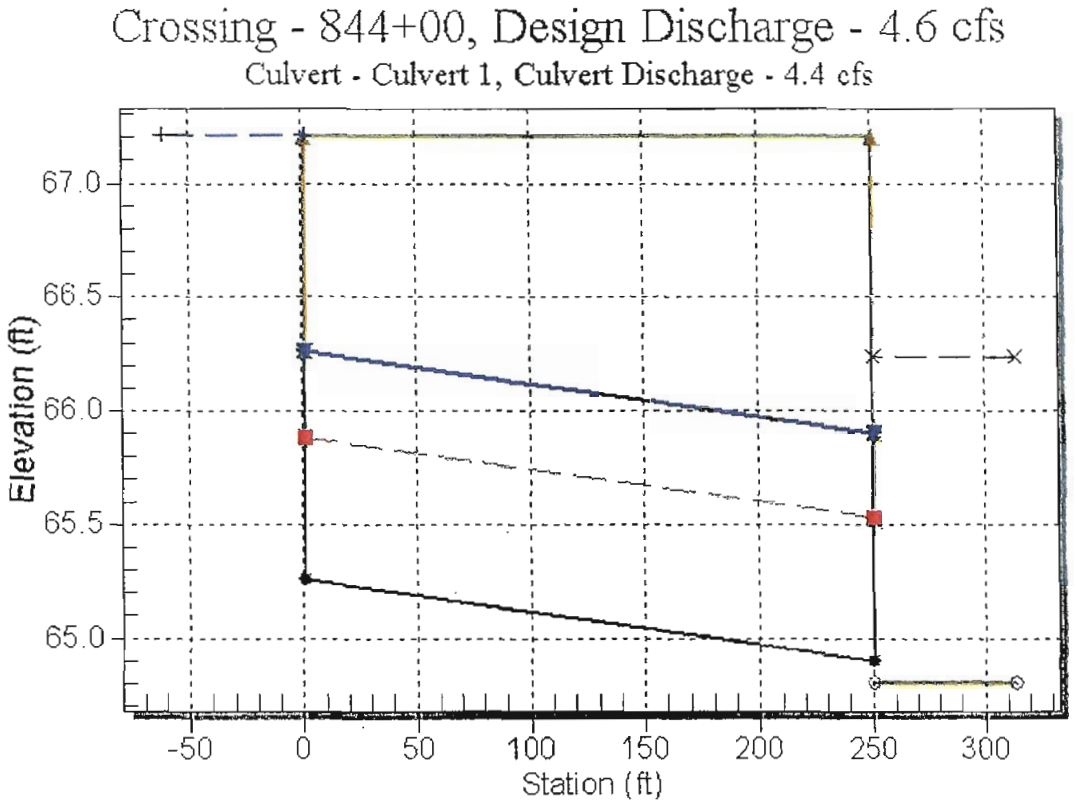
Inlet Elevation (invert): 65.26 ft, Outlet Elevation (invert): 64.90 ft

Culvert Length: 250.00 ft, Culvert Slope: 0.0014

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for **Culvert: Culvert 1**



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 65.26 ft

Outlet Station: 250.00 ft

Outlet Elevation: 64.90 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream **Channel Rating Curve (Crossing: 844+00)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
3.00	66.24	1.44
3.20	66.24	1.44
3.40	66.24	1.44
3.60	66.24	1.44
3.80	66.24	1.44
4.00	66.24	1.44
4.20	66.24	1.44
4.40	66.24	1.44
4.60	66.24	1.44
4.80	66.24	1.44
5.00	66.24	1.44

Tailwater Channel Data - 844+00

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 66.24 ft

Roadway Data for Crossing: 844+00

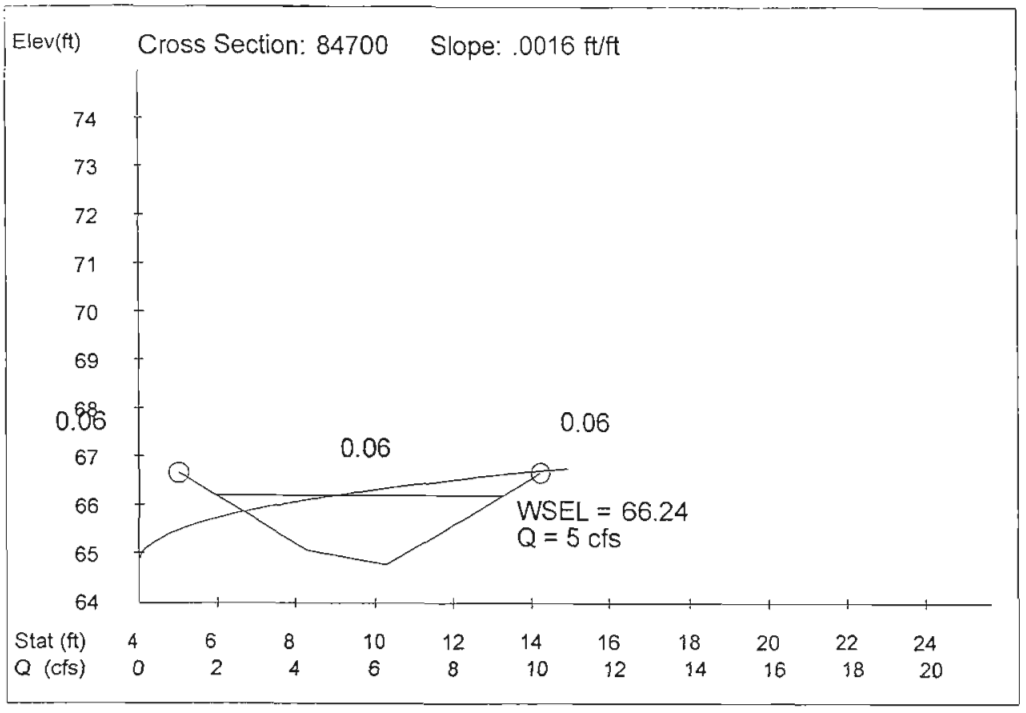
Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 67.20 ft

Roadway Surface: Gravel

Roadway Top Width: 250.00 ft


Elev(ft)
Cross Section: 84700
Slope: .0016 ft/ft
74
73
72
71
70
69
68
67
66
65
64
0.06
0.06
0.06
WSEL = 66.24
Q = 5 cfs
Stat (ft) 4 6 8 10 12 14 16 18 20 22 24
Q (cfs) 0 2 4 6 8 10 12 14 16 18 20

GM2 Associates

Engineers • Inspectors • Surveyors

Job _____ Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 4 Design Cont Sheet 3 of 3

System 4.a

Station 850+70 Culvert Crossing

① Area Contributing 125304 Ft^2 = 2.88 ac

Q_{100} = (2.88 ac)(0.3)(6.5 in/hr) = 5.6 CFS

Q_{10} = (2.88ac)(0.3)(4.8 in/hr) = 4.1 CFS

② Tailwater

Slope 0.12 %

roughness 0.06

irregular section

Sta	El
5	66.1
8.4	64.4
10.4	64.1
14.2	66.0

③ Roadway Data

Crest el 65.81

length = 100'

Topwidth 105

④ Site data

inlet sta = 0

El = 64.31

outlet sta = 105

El = 64.16

HY-8 Culvert Analysis Report Station 850+70

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
65.83	4.00	3.47	0.51	14
65.83	4.20	3.34	0.83	4
65.84	4.40	3.22	1.17	4
65.84	4.60	3.08	1.51	4
65.85	4.80	2.94	1.82	3
65.85	5.00	2.79	2.16	3
65.86	5.20	2.65	2.52	3
65.86	5.40	2.50	2.88	3
65.86	5.60	2.34	3.24	3
65.87	5.80	2.17	3.61	3
65.87	6.00	1.99	3.99	3
65.81	3.38	3.38	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 850+70

Rating Curve Plot for Crossing: 850+70

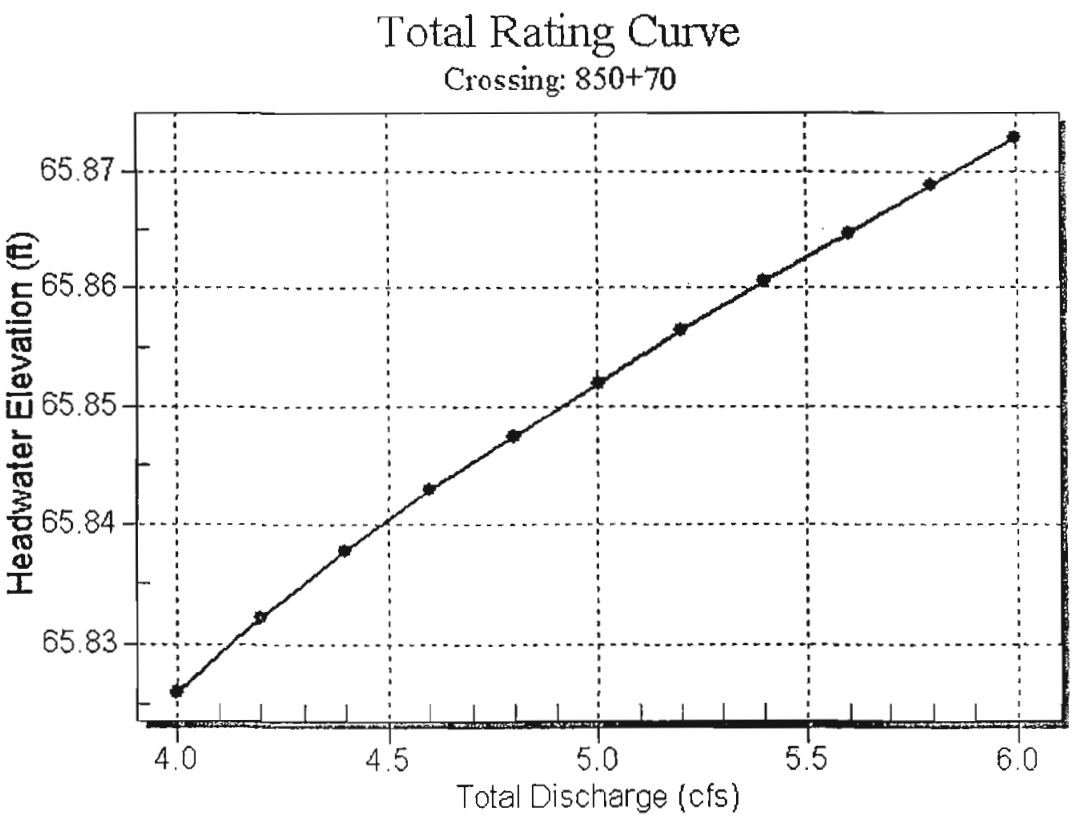


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.00	3.47	65.83	0.843	1.516	4-FFf	1.000	0.558	1.000	1.400	2.211	0.705
4.20	3.34	65.83	0.823	1.521	4-FFf	1.000	0.547	1.000	1.430	2.128	0.714
4.40	3.22	65.84	0.804	1.528	4-FFf	1.000	0.536	1.000	1.459	2.047	0.723
4.60	3.08	65.84	0.783	1.533	4-FFf	1.000	0.525	1.000	1.487	1.961	0.731
4.80	2.94	65.85	0.761	1.537	4-FFf	1.000	0.512	1.000	1.514	1.871	0.739
5.00	2.79	65.85	0.738	1.541	4-FFf	0.855	0.500	1.000	1.541	1.778	0.747
5.20	2.65	65.86	0.714	1.546	4-FFf	0.797	0.485	1.000	1.567	1.687	0.754
5.40	2.50	65.86	0.689	1.550	4-FFf	0.757	0.470	1.000	1.592	1.590	0.762
5.60	2.34	65.86	0.661	1.554	4-FFf	0.715	0.453	1.000	1.617	1.487	0.769
5.80	2.17	65.87	0.632	1.558	4-FFf	0.676	0.436	1.000	1.641	1.383	0.776
6.00	1.99	65.87	0.599	1.562	4-FFf	0.637	0.418	1.000	1.665	1.270	0.783

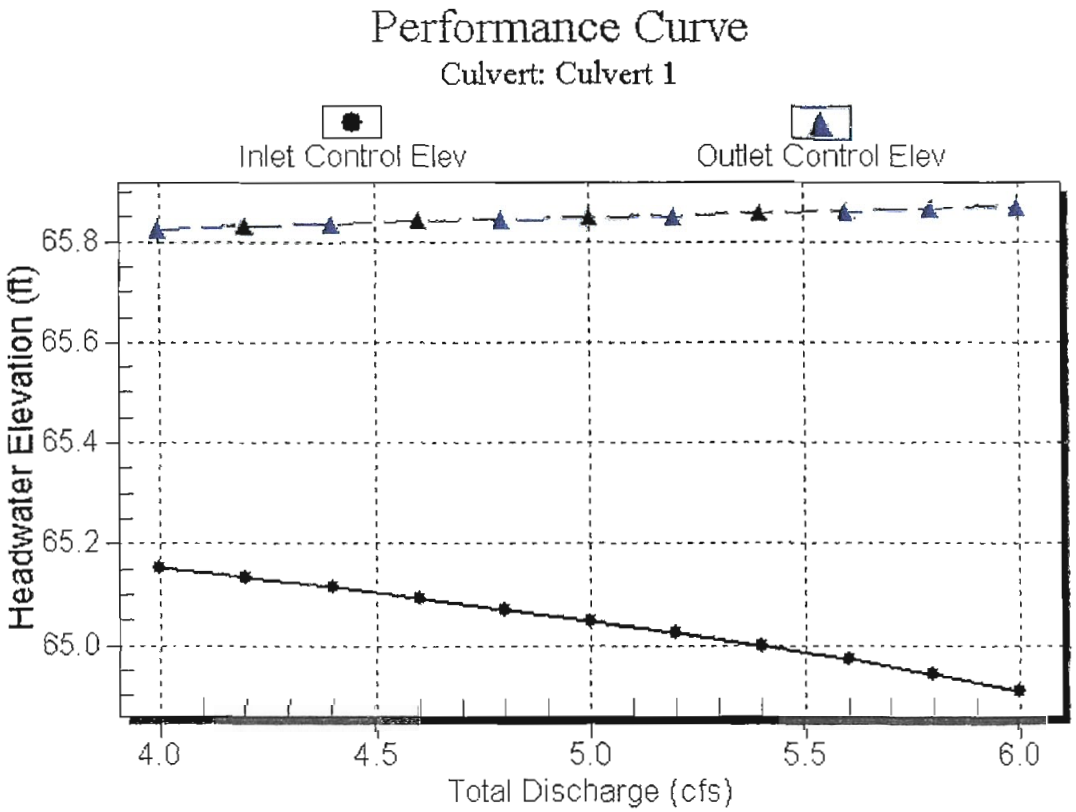
****

Inlet Elevation (invert): 64.31 ft, Outlet Elevation (invert): 64.18 ft

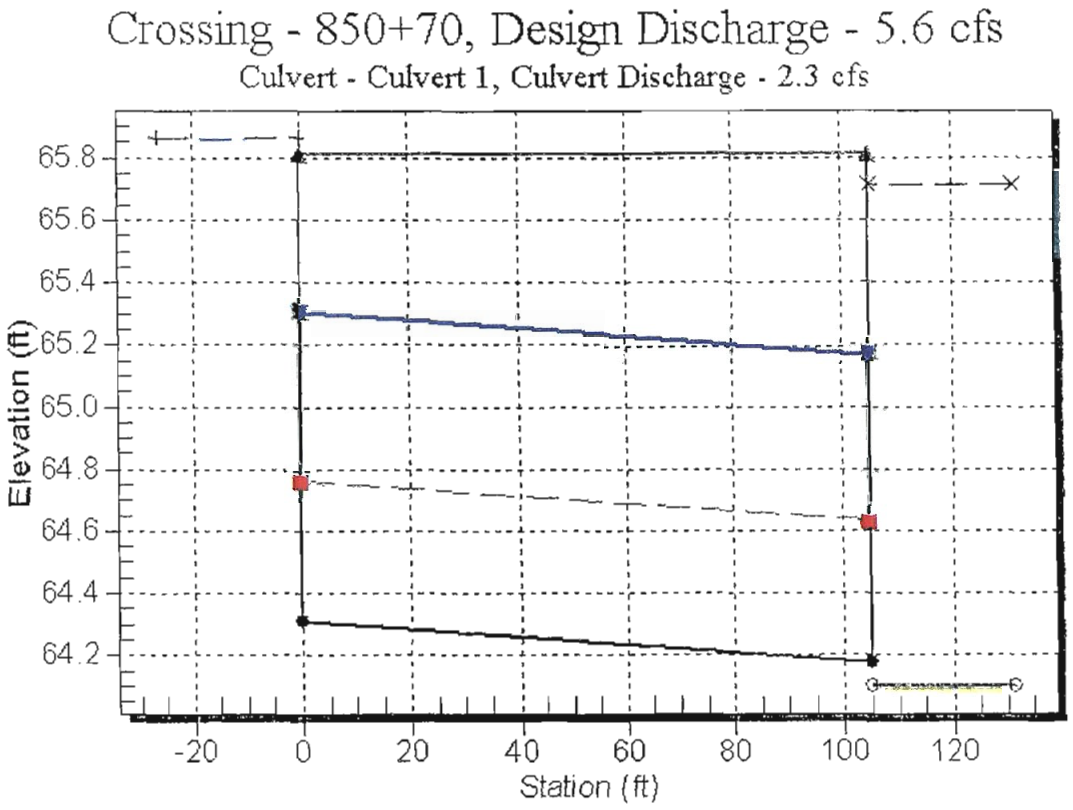
Culvert Length: 105.00 ft, Culvert Slope: 0.0012

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for **Culvert: Culvert 1**



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 64.31 ft

Outlet Station: 105.00 ft

Outlet Elevation: 64.18 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream **Channel Rating Curve (Crossing: 850+70)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
4.00	65.50	1.40	0.71	0.10	0.14
4.20	65.53	1.43	0.71	0.11	0.14
4.40	65.56	1.46	0.72	0.11	0.14
4.60	65.59	1.49	0.73	0.11	0.14
4.80	65.61	1.51	0.74	0.11	0.14
5.00	65.64	1.54	0.75	0.12	0.14
5.20	65.67	1.57	0.75	0.12	0.14
5.40	65.69	1.59	0.76	0.12	0.14
5.60	65.72	1.62	0.77	0.12	0.14
5.80	65.74	1.64	0.78	0.12	0.14
6.00	65.77	1.67	0.78	0.12	0.14

Tailwater Channel Data - 850+70

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0012

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	5.00	66.10	0.0600
2	8.40	64.40	0.0600
3	10.40	64.10	0.0600
4	14.20	66.00	0.0000

Roadway Data for Crossing: 850+70

Roadway Profile Shape: Constant Roadway Elevation

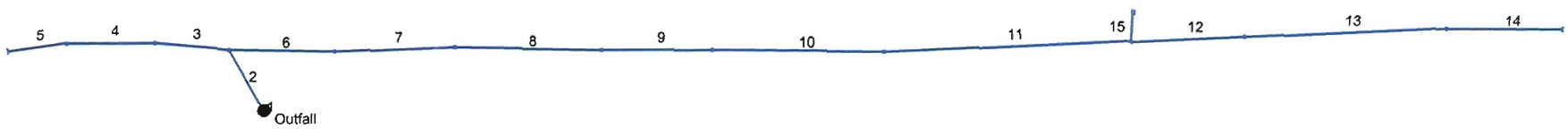
Crest Length: 100.00 ft

Crest Elevation: 65.81 ft

Roadway Surface: Gravel

Roadway Top Width: 105.00 ft

Hydraflow Storm Sewers Plan



Project File: Kane Brook System with swale.stm	Number of lines: 15	Date: 07-28-2010

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	8	0.00	12.51	0.00	0.00	3.75	0.0	22.6	4.7	24.60	15.08	5.78	30	0.50	40.00	40.04	41.96	42.13	40.04	58.25	Inserted Line
2	1	114	0.00	12.51	0.00	0.00	3.75	0.0	22.3	4.8	24.60	31.42	7.09	30	0.50	47.63	48.20	49.30	49.86	58.25	63.77	
3	2	126	0.18	4.81	0.30	0.05	1.44	10.0	10.8	6.4	9.46	11.38	6.79	18	1.00	57.55	58.81	58.60	59.98	63.77	64.35	
4	3	150	0.10	4.63	0.30	0.03	1.39	10.0	10.3	6.5	9.10	11.38	5.79	18	1.00	58.81	60.31	60.20	61.46	64.35	64.87	
5	4	99	4.53	4.53	0.30	1.36	1.36	10.0	10.0	6.6	8.91	11.43	5.73	18	1.01	60.31	61.31	61.67	62.45	64.87	61.06	
6	2	179	0.32	7.70	0.30	0.10	2.31	10.0	21.6	4.8	15.14	16.58	5.31	24	0.46	49.20	50.02	51.07	51.61	63.77	63.65	
7	6	205	0.22	7.38	0.30	0.07	2.21	10.0	20.9	4.9	14.51	16.77	4.91	24	0.47	50.02	50.98	52.02	52.64	63.65	63.47	
8	7	250	0.54	7.16	0.30	0.16	2.15	10.0	20.0	5.0	14.08	16.83	5.01	24	0.47	50.98	52.16	52.96	53.67	63.47	62.98	
9	8	190	1.07	6.62	0.30	0.32	1.99	10.0	19.2	5.1	13.02	16.77	4.68	24	0.47	52.16	53.05	54.12	54.54	62.98	62.99	
10	9	295	0.11	5.55	0.30	0.03	1.67	10.0	17.8	5.3	10.91	18.27	4.61	24	0.56	53.05	54.69	54.98	55.86	62.99	63.42	
11	10	425	0.47	5.44	0.30	0.14	1.63	10.0	15.7	5.6	10.70	16.81	4.95	24	0.47	54.69	56.69	56.19	57.85	63.42	61.91	
12	11	194	0.20	1.21	0.30	0.06	0.36	10.0	14.7	5.7	2.38	2.64	3.03	12	0.47	56.94	57.85	58.21	58.94	61.91	61.60	
13	12	344	0.46	1.01	0.30	0.14	0.30	10.0	12.4	6.1	1.99	2.65	3.03	12	0.47	57.85	59.47	59.06	60.14	61.60	61.27	
14	13	197	0.55	0.55	0.30	0.17	0.17	10.0	10.0	6.6	1.08	1.72	1.63	12	0.20	59.47	59.86	60.40	60.56	61.27	59.86	
15	11	50	3.76	3.76	0.30	1.13	1.13	10.0	10.0	6.6	7.39	11.38	5.07	18	1.00	56.75	57.25	58.08	58.29	61.91	61.61	

Project File: Kane Brook System with swale.stm | Number of lines: 15 | Run Date: 07-28-2010

NOTES: Intensity = 106.59 / (Inlet time + 17.00) ^ 0.85; Return period = 100 Yrs. ; Total flows limited to inlet captured flows. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

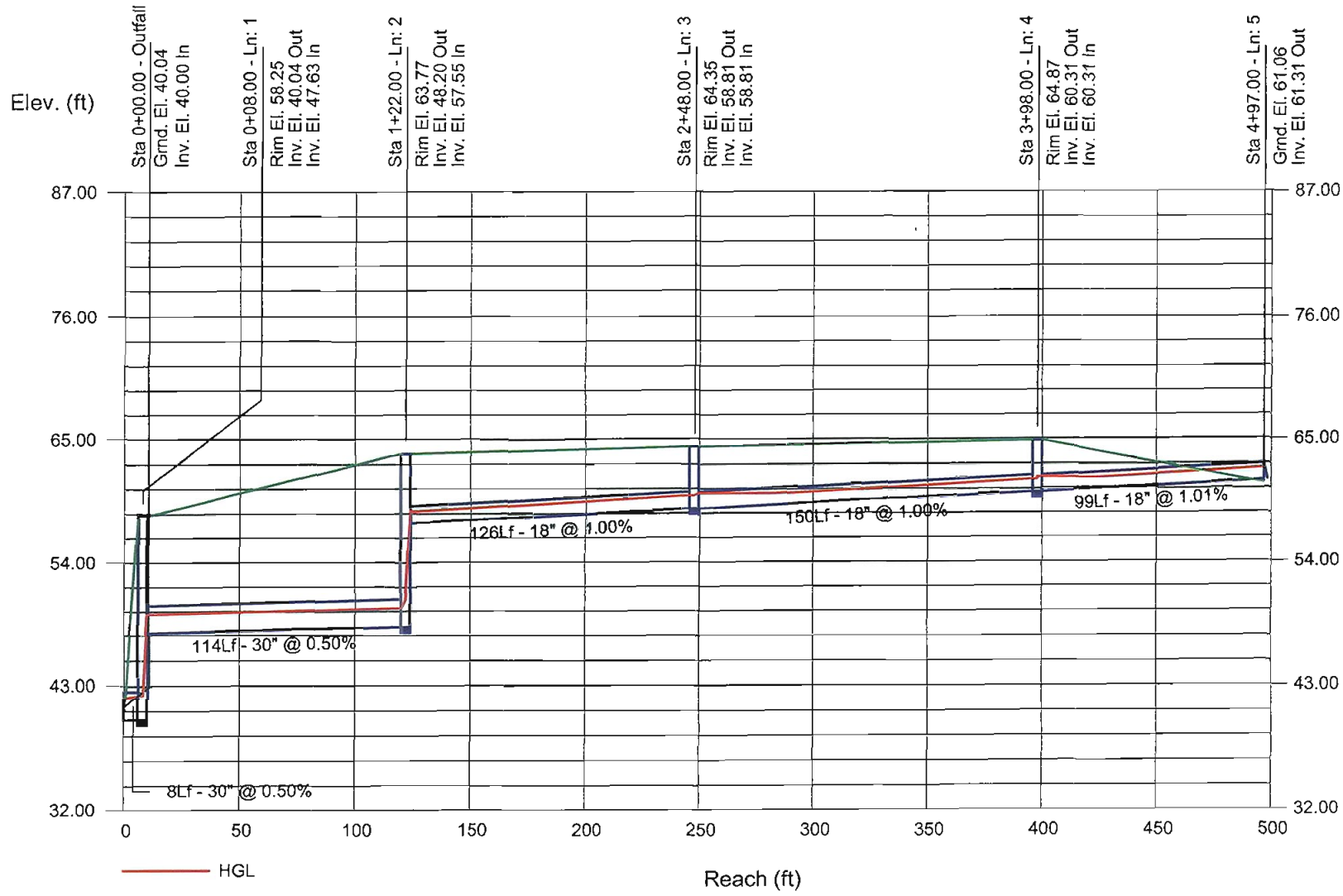
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	30	24.60	40.00	41.96	1.96	4.13	5.96	0.55	42.51	1.450	8	40.04	42.13	2.09	4.39	5.60	0.49	42.62	1.281	1.366	0.109	0.15	0.07
2	30	24.60	47.63	49.30	1.67*	3.47	7.08	0.78	50.08	0.500	114	48.20	49.86	1.66**	3.47	7.09	0.78	50.65	0.501	0.501	0.571	1.00	0.78
3	18	9.46	57.55	58.60	1.04*	1.31	7.20	0.81	59.40	0.999	126	58.81	59.98	1.17**	1.48	6.37	0.63	60.62	0.756	0.878	n/a	0.50	0.32
4	18	9.10	58.81	60.20	1.39	1.71	5.32	0.44	60.64	0.554	150	60.31	61.46 j	1.15**	1.46	6.25	0.61	62.07	0.730	0.642	n/a	0.50	n/a
5	18	8.91	60.31	61.67	1.36	1.69	5.28	0.43	62.11	0.535	99	61.31	62.45 j	1.14**	1.44	6.19	0.59	63.04	0.716	0.626	n/a	1.00	0.59
6	24	15.14	49.20	51.07	1.87	3.05	4.96	0.38	51.45	0.330	179	50.02	51.61	1.59	2.67	5.66	0.50	52.11	0.406	0.368	0.659	0.50	0.25
7	24	14.51	50.02	52.02	2.00	3.14	4.62	0.33	52.35	0.351	205	50.98	52.64	1.66	2.79	5.19	0.42	53.06	0.342	0.346	0.710	0.50	0.21
8	24	14.08	50.98	52.96	1.98	3.14	4.49	0.31	53.27	0.305	250	52.16	53.67	1.51	2.54	5.53	0.48	54.15	0.391	0.348	0.869	0.50	0.24
9	24	13.02	52.16	54.12	1.96	3.12	4.17	0.27	54.39	0.252	190	53.05	54.54	1.49	2.50	5.20	0.42	54.96	0.347	0.300	0.569	0.50	0.21
10	24	10.91	53.05	54.98	1.93	3.11	3.51	0.19	55.17	0.173	295	54.69	55.86 j	1.17**	1.91	5.72	0.51	56.37	0.475	0.324	n/a	0.50	n/a
11	24	10.70	54.69	56.19	1.50	2.52	4.24	0.28	56.47	0.230	425	56.69	57.85	1.16**	1.89	5.67	0.50	58.35	0.471	0.351	n/a	1.50	0.75
12	12	2.38	56.94	58.21	1.00	0.79	3.03	0.14	58.35	0.380	194	57.85	58.94	1.00	0.79	3.03	0.14	59.09	0.380	0.380	0.738	0.50	0.07
13	12	1.99	57.85	59.06	1.00	0.79	2.53	0.10	59.16	0.265	344	59.47	60.14	0.67	0.56	3.54	0.19	60.34	0.421	0.343	1.181	0.50	0.10
14	12	1.08	59.47	60.40	0.93	0.76	1.42	0.03	60.44	0.068	197	59.86	60.56	0.70	0.59	1.84	0.05	60.61	0.112	0.090	0.177	1.00	0.05
15	18	7.39	56.75	58.08	1.33	1.65	4.47	0.31	58.39	0.378	50	57.25	58.29 j	1.04**	1.30	5.67	0.50	58.79	0.621	0.500	n/a	1.00	0.50

Project File: Kane Brook System with swale.stm | Number of lines: 15 | Run Date: 07-28-2010

Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

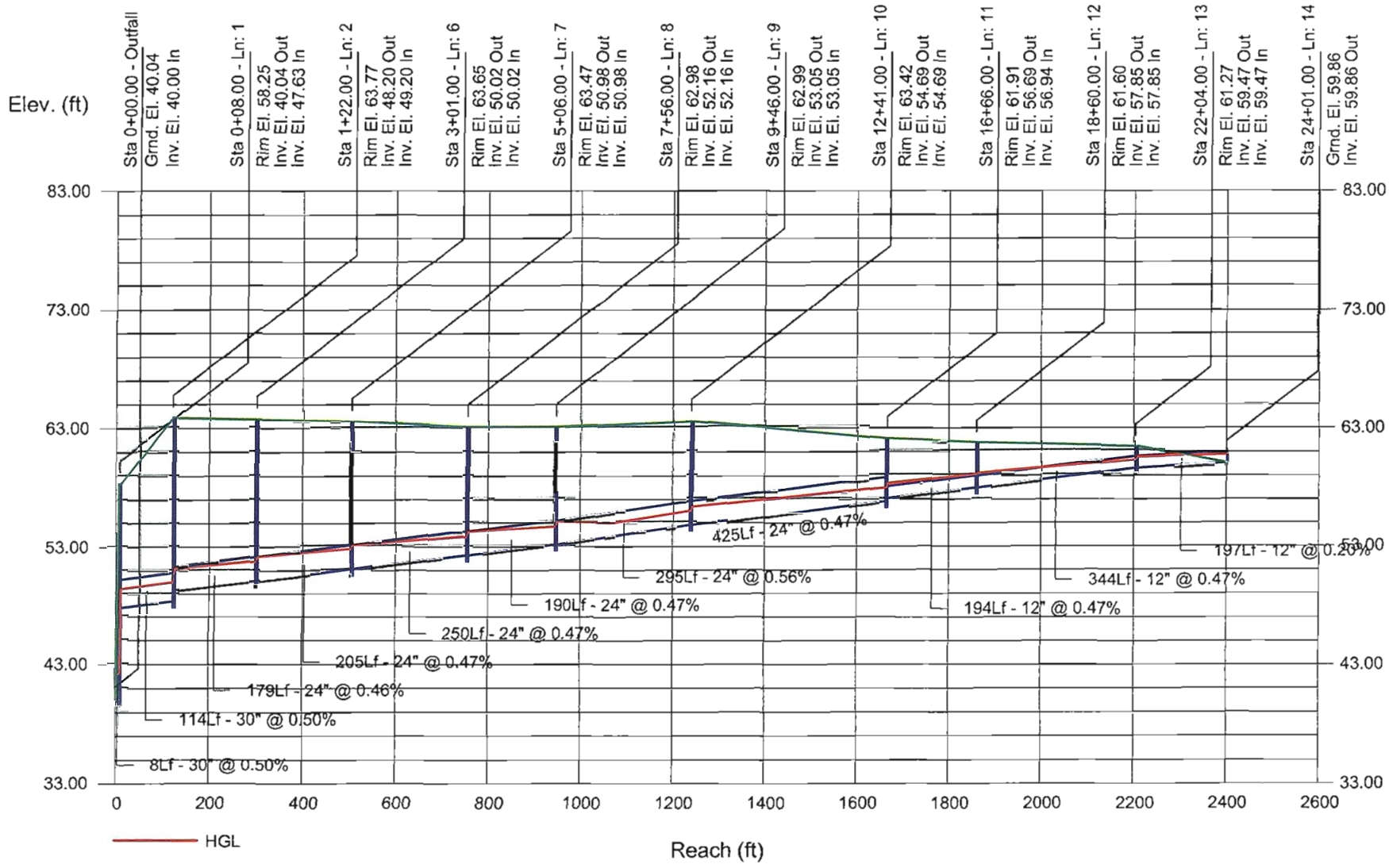
Storm Sewer Profile

Proj. file: Kane Brook System with swale.stm



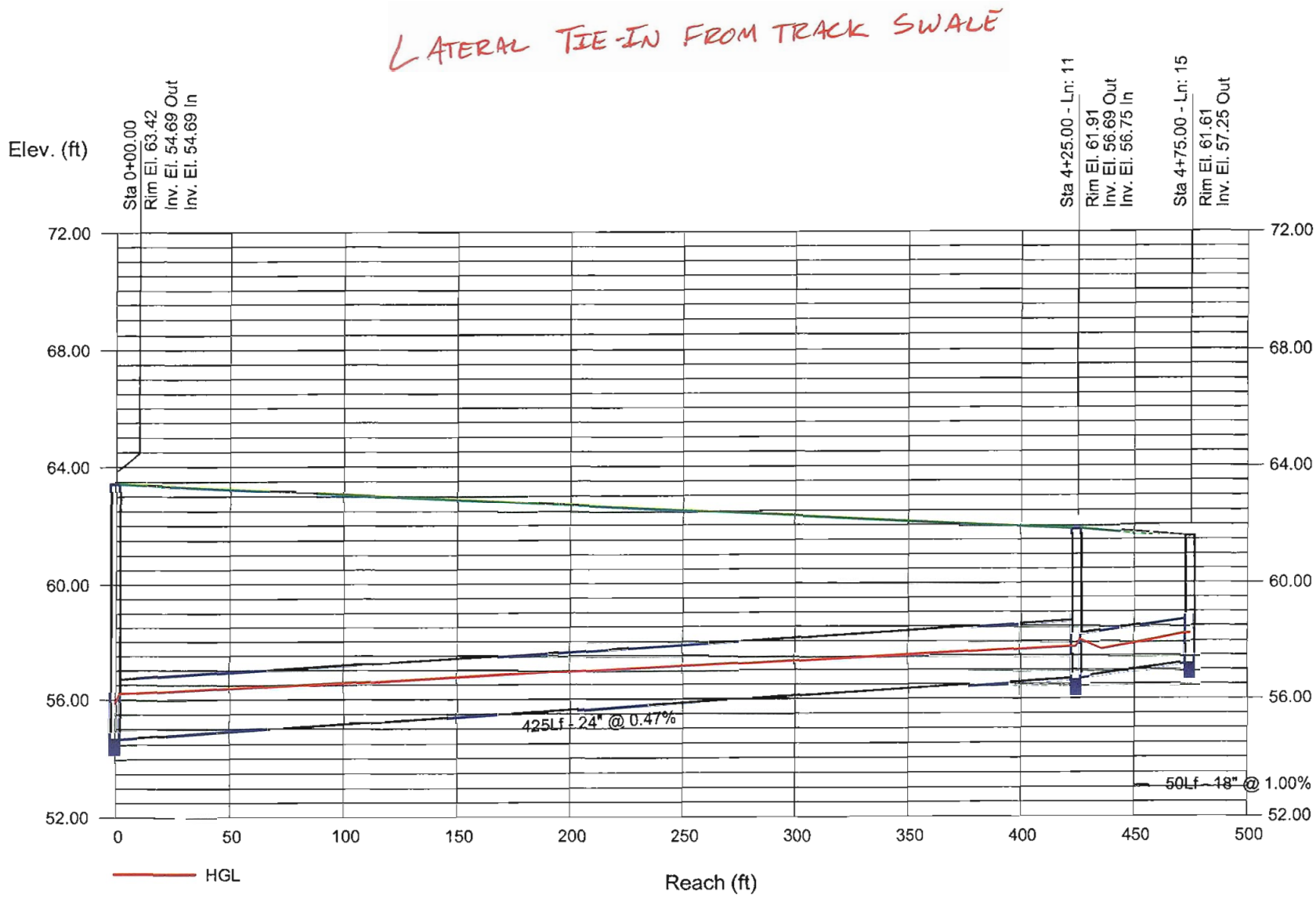
Storm Sewer Profile

Proj. file: Kane Brook System with swale.stm



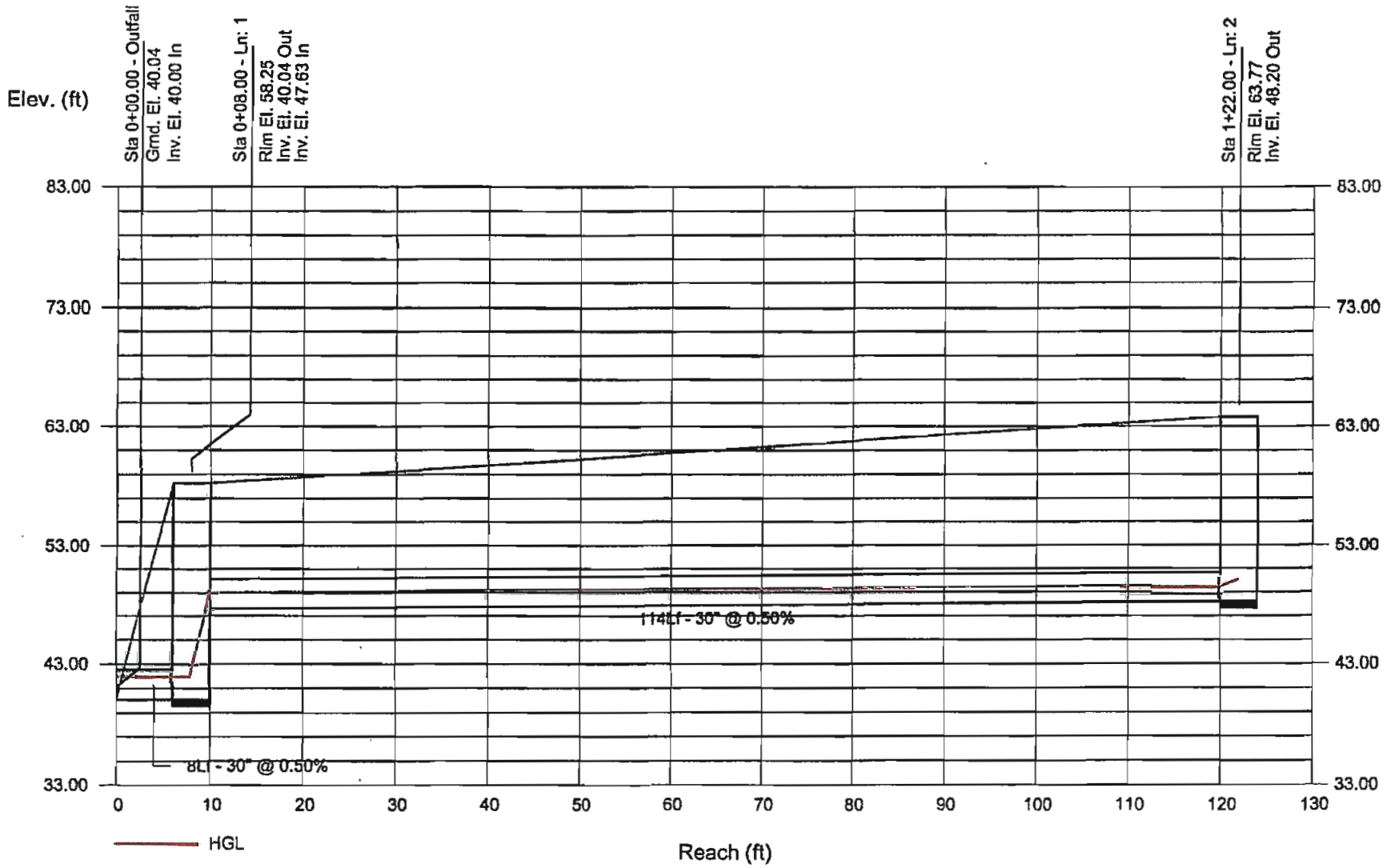
Storm Sewer Profile

Proj. file: Kane Brook System with swale.stm



Storm Sewer Profile

Proj. file: Kane Brook System with swale.stm



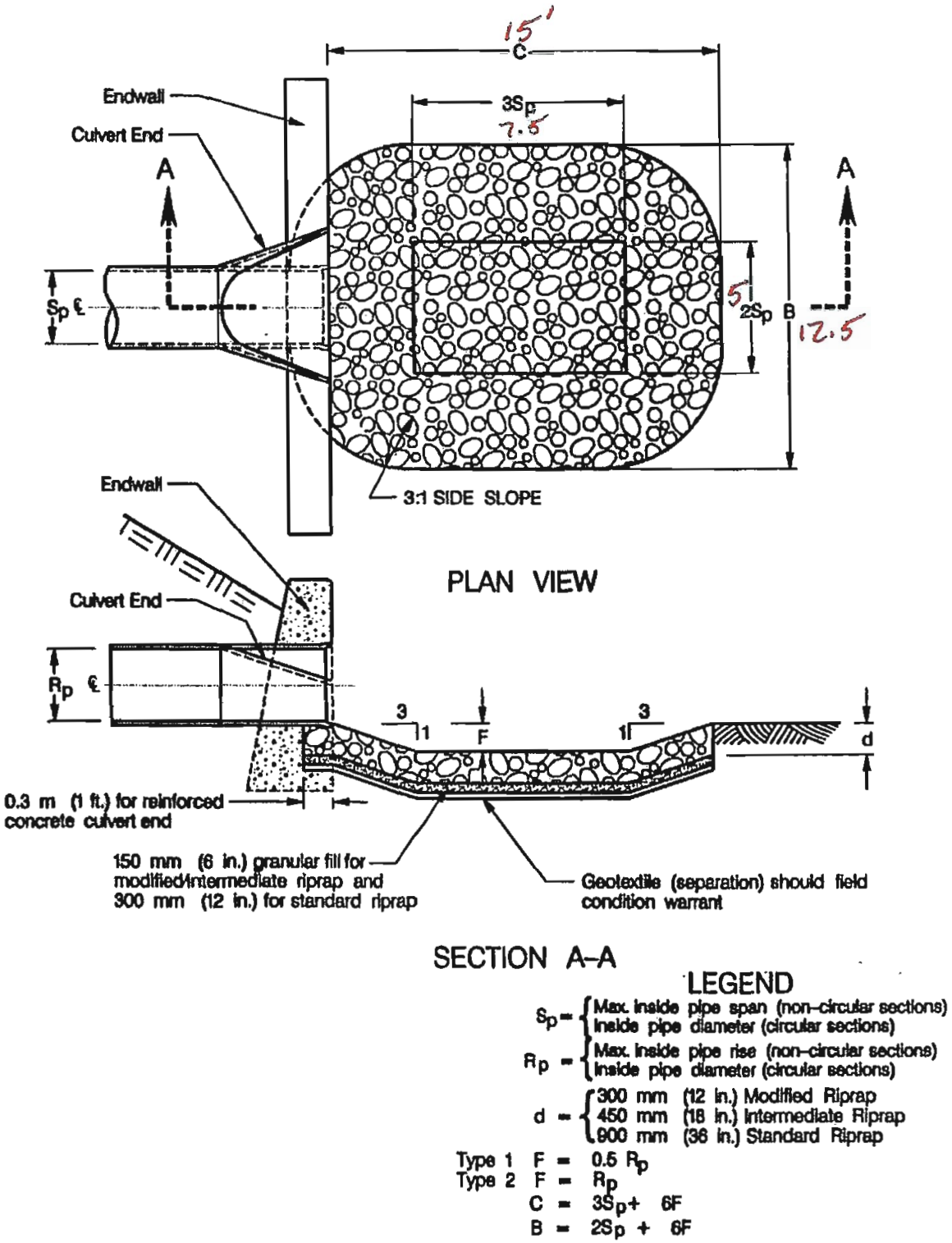


Figure 11-15 Preformed Scour Hole Type 1 and Type 2

GM2 Associates

Engineers • Inspectors • Surveyors

Job _____ Computed By _____ Date _____

Description _____ Checked By _____ Date _____

_____ Sheet _____ of _____

$D_{50} = (0.0125 \cdot R_p^2/TW)(Q/R_p^{2.5})^{1.333}$

$= (0.0125 \cdot 2.5^2/1.96)(18/2.5^{2.5})^{1.333}$

$0.040 \cdot 1.82^{1.333}$

0.09 Ft $\Rightarrow$ Modified Riprap

$R_p = 2.5$

$TW = 1.96$

$Q = 18$ CFS FOR 10-YR DESIGN (CDOT)

$F = 1.25'$

$C = 3S_p + 6F \quad 15.0' \qquad 3S_p = 7.5$

$B = 2S_p + 6F \quad 12.5 \qquad 2S_p = 5$

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(In/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	8	0.00	12.51	0.00	0.00	3.75	0.0	27.3	3.0	18.03	15.08	4.34	30	0.50	40.00	40.04	41.96	42.03	40.04	58.25	Inserted Line
2	1	114	0.00	12.51	0.00	0.00	3.75	0.0	26.7	3.0	18.03	31.42	6.43	30	0.50	47.63	48.20	48.99	49.63	58.25	63.77	
3	2	126	0.18	4.81	0.30	0.05	1.44	10.0	11.1	4.6	6.93	11.38	6.13	18	1.00	57.55	58.81	58.40	59.82	63.77	64.35	
4	3	150	0.10	4.63	0.30	0.03	1.39	10.0	10.4	4.7	6.67	11.38	4.82	18	1.00	58.81	60.31	60.07	61.30	64.35	64.87	
5	4	99	4.53	4.53	0.30	1.36	1.36	10.0	10.0	4.8	6.53	11.43	4.79	18	1.01	60.31	61.31	61.54	62.29	64.87	61.06	
6	2	179	0.32	7.70	0.30	0.10	2.31	10.0	25.9	3.0	11.10	16.58	5.17	24	0.46	49.20	50.02	50.64	51.20	63.77	63.65	
7	6	205	0.22	7.38	0.30	0.07	2.21	10.0	24.9	3.1	10.64	16.77	4.91	24	0.47	50.02	50.98	51.54	52.14	63.65	63.47	
8	7	250	0.54	7.16	0.30	0.16	2.15	10.0	23.6	3.2	10.32	16.83	4.86	24	0.47	50.98	52.16	52.47	53.30	63.47	62.98	
9	8	190	1.07	6.62	0.30	0.32	1.99	10.0	22.6	3.3	9.54	16.77	4.63	24	0.47	52.16	53.05	53.64	54.14	62.98	62.99	
10	9	295	0.11	5.55	0.30	0.03	1.67	10.0	20.6	3.5	8.00	16.27	4.18	24	0.56	53.05	54.69	54.50	55.69	62.99	63.42	
11	10	425	0.47	5.44	0.30	0.14	1.63	10.0	17.8	3.7	7.84	16.81	4.33	24	0.47	54.69	56.69	56.00	57.68	63.42	61.91	
12	11	194	0.20	1.21	0.30	0.06	0.36	10.0	16.3	3.9	1.74	2.64	2.78	12	0.47	56.94	57.85	58.00	58.48	61.91	61.60	
13	12	344	0.46	1.01	0.30	0.14	0.30	10.0	13.3	4.3	1.46	2.65	2.84	12	0.47	57.85	59.47	58.69	59.98	61.60	61.27	
14	13	197	0.55	0.55	0.30	0.17	0.17	10.0	10.0	4.8	0.79	1.72	1.69	12	0.20	59.47	59.86	60.17	60.36	61.27	59.86	
15	11	50	3.76	3.76	0.30	1.13	1.13	10.0	10.0	4.8	5.42	11.38	4.30	18	1.00	56.75	57.25	57.93	58.14	61.91	61.61	

Project File: Kane Brook System with swale.stm | Number of lines: 15 | Run Date: 07-16-2010

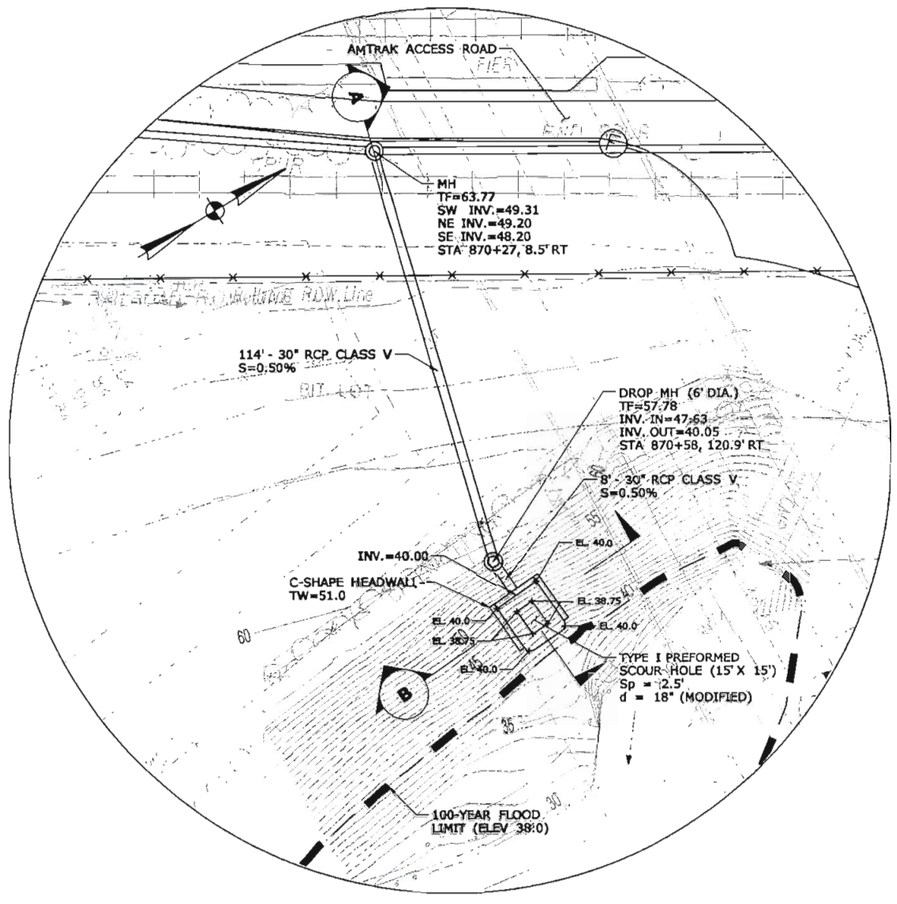
NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; Total flows limited to inlet captured flows. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

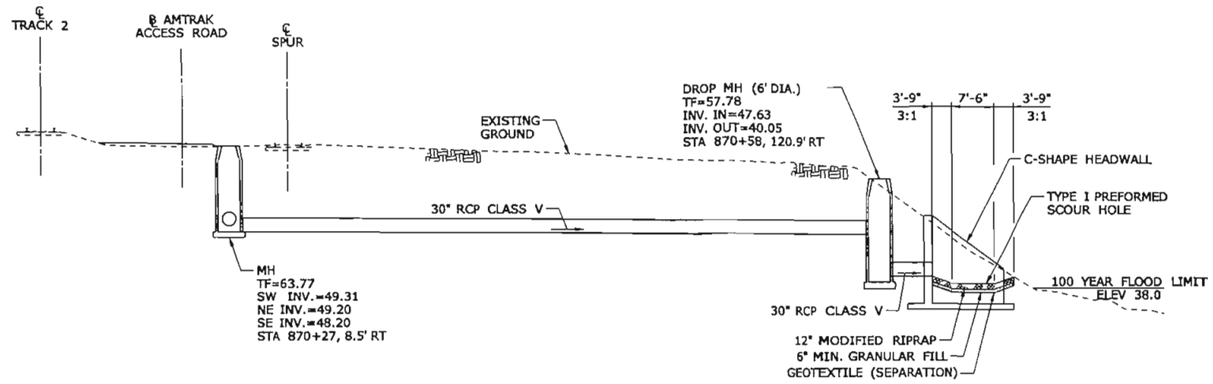
Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	30	18.03	40.00	41.96	1.96	4.13	4.37	0.30	42.26	0.780	8	40.04	42.03	1.99	4.18	4.31	0.29	42.32	0.758	0.769	0.062	0.15	0.04
2	30	18.03	47.63	48.99	1.36*	2.72	6.62	0.68	49.67	0.500	114	48.20	49.63	1.43**	2.89	6.24	0.60	50.23	0.428	0.464	0.529	1.00	0.60
3	18	6.93	57.55	58.40	0.85*	1.03	6.75	0.71	59.11	0.999	126	58.81	59.82	1.01**	1.26	5.51	0.47	60.29	0.596	0.798	n/a	0.50	n/a
4	18	6.67	58.81	60.07	1.26	1.58	4.23	0.28	60.34	0.332	150	60.31	61.30 j	0.99**	1.23	5.42	0.46	61.75	0.583	0.457	n/a	0.50	n/a
5	18	6.53	60.31	61.54	1.23	1.55	4.21	0.28	61.82	0.329	99	61.31	62.29 j	0.98**	1.22	5.37	0.45	62.73	0.575	0.452	n/a	1.00	n/a
6	24	11.10	49.20	50.64	1.44	2.42	4.58	0.33	50.97	0.272	179	50.02	51.20 j	1.18**	1.93	5.75	0.51	51.71	0.479	0.375	n/a	0.50	n/a
7	24	10.64	50.02	51.54	1.52	2.56	4.16	0.27	51.81	0.221	205	50.98	52.14	1.16**	1.88	5.66	0.50	52.63	0.470	0.346	n/a	0.50	n/a
8	24	10.32	50.98	52.47	1.49	2.50	4.13	0.26	52.73	0.218	250	52.16	53.30	1.14**	1.85	5.59	0.49	53.78	0.464	0.341	n/a	0.50	n/a
9	24	9.54	52.16	53.64	1.48	2.49	3.83	0.23	53.87	0.188	190	53.05	54.14 j	1.09**	1.76	5.43	0.46	54.60	0.450	0.319	n/a	0.50	n/a
10	24	8.00	53.05	54.50	1.45	2.44	3.28	0.17	54.67	0.139	295	54.69	55.69 j	1.00**	1.57	5.08	0.40	56.09	0.424	0.281	n/a	0.50	0.20
11	24	7.84	54.69	56.00	1.31	2.17	3.61	0.20	56.20	0.177	425	56.69	57.68 j	0.99**	1.55	5.04	0.40	58.08	0.421	0.299	n/a	1.50	n/a
12	12	1.74	56.94	58.00	1.00	0.79	2.22	0.08	58.08	0.204	194	57.85	58.48	0.63	0.52	3.34	0.17	58.65	0.389	0.297	0.576	0.50	0.09
13	12	1.46	57.85	58.69	0.84	0.70	2.07	0.07	58.75	0.137	344	59.47	59.98	0.51**	0.40	3.60	0.20	60.18	0.527	0.332	n/a	0.50	n/a
14	12	0.79	59.47	60.17	0.70	0.58	1.36	0.03	60.20	0.061	197	59.86	60.36	0.50	0.39	2.02	0.06	60.42	0.170	0.116	0.228	1.00	0.06
15	18	5.42	56.75	57.93	1.18	1.49	3.63	0.20	58.14	0.245	50	57.25	58.14 j	0.89**	1.09	4.97	0.38	58.52	0.523	0.384	n/a	1.00	n/a

Project File: Kane Brook System with swale.stm | Number of lines: 15 | Run Date: 07-16-2010

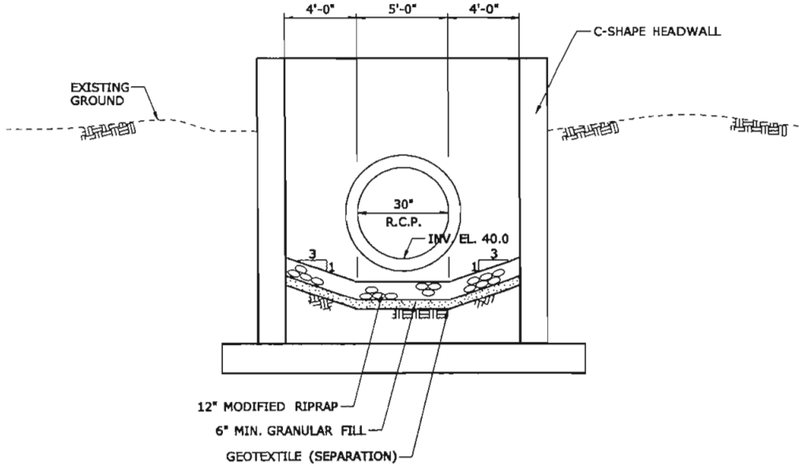
Notes: * Normal depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box



GRADING PLAN
OUTFALL TO KANE BROOK



SECTION A
SCALE: NTS



SECTION B
SCALE: NTS

FINAL DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted: $DATE$

DESIGNER/DRAFTER: -
CHECKED BY: -
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILEA$

MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN:
NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE:
MISCELLANEOUS DETAILS

PROJECT NO.: 093-H052
DRAWING NO.: -
SHEET NO.: S

AMTRAK ACCESS ROAD SYSTEM 5 AREAS BETWEEN 927+00 AND 937+37

Station 930+90

Due to the presence of the Laurel Street Bridge Abutment, it is not possible to continue the open swale beneath the bridge. For this reason, the flow line is to be conveyed through the bridge crossing with a sub-surface drainage system. This system employs two mid-line inlets; however these inlets don't appear to have much area contributing to them. Therefore, the contributing area to the system was taken as the total area contributing to a point immediately downstream of the last inlet. These flows were then computed for the system as a whole.

The area contributing to this system is 0.88 acres which generates a total of 1.72-cfs. The starting water surface elevation for the system design was taken as normal depth in the receiving swale for Q_{100}.

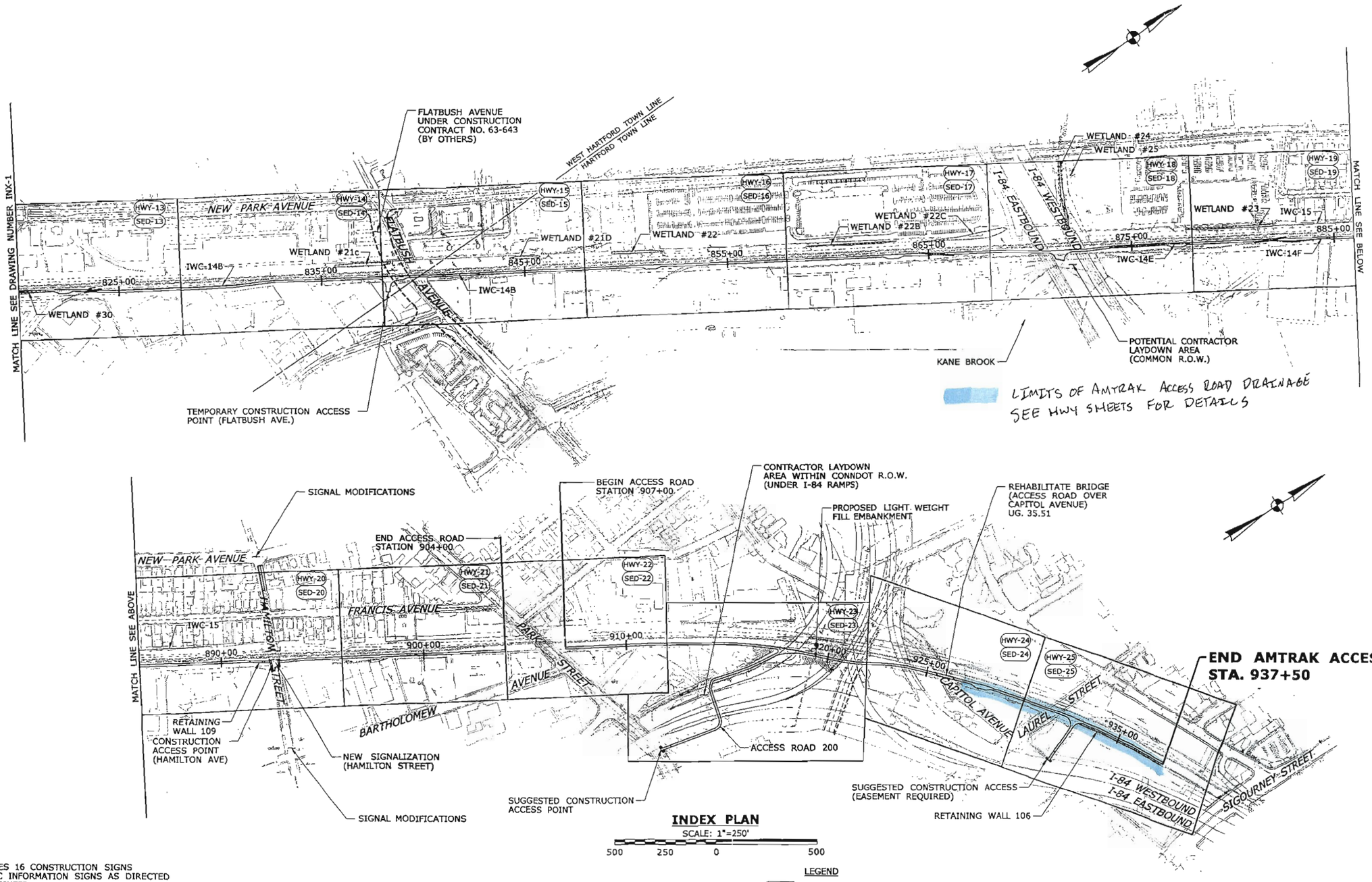
Station 933+50 - Contributing area to this section is approximately 1.9 acres generating 3.7-cfs of flow. For a slope of 0.14% and the typical project swale geometry, a single section hydraulic analysis returned a water surface elevation of 50.32 feet, which is to be used for the evaluation of the upstream drainage system.

Station 937+50

This station falls at the limits of construction. At this point flow has been concentrated and conveyed through an open and closed drainage system. From the limits of construction, the only suitable outlet for the access road system is into a catch basin servicing the Aetna parking lot. Currently there is no structure information on this receiving system so conservative assumptions for the condition of the outlet have been formed.

The outlet pipe from station 937+50 is proposed to have a 0.5% slope, with the understanding that the capacity of the pipe will increase if the slope increases. We are also proposing to match the existing invert or provide the Access Road outlet pipe with no less than 2' of cover.

The area contributing to the project outlet pipe is 1.62 acres, which generates a flow rate of 3.16-cfs for the 100-year event. The starting water surface elevation was set at the crown of the outlet pipe to model a submerged outlet (worst case scenario). The resulting headwater of the system was calculated at 50.06 feet, providing a freeboard of 2.11 feet to the roadway elevation.



INDEX PLAN

SCALE: 1"=250'

500 250 0 500

NOTES:

1. PLACE SERIES 16 CONSTRUCTION SIGNS AND PUBLIC INFORMATION SIGNS AS DIRECTED BY THE ENGINEER.
2. FOR BASELINE GEOMETRY AND SOIL TEST BORING LOCATIONS SEE DWG. HWY-1 THRU HWY-25.

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

FINAL PLANS FOR REVIEW

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THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

DESIGNER/DRAFTER: CJF

CHECKED BY: ALM

SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

MICHAEL BAKER ENGINEERING, INC.

APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052

DRAWING NO. INX-02

SHEET NO. 8

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 5 Drainage From 927+00 to 937+37 Sheet 1 of 2

Station 930+90 Subsurface System to 933+10

* Catch basins in System Dont appear to have much interception potential, therefore Contributing Area to system taken @ outlet and Flows computed used throughout System

① Area Contributing @ 933+00 38305.5 sf = 0.88 ac

Q_{100} = (0.88 ac X 0.3 X 6.5 in/hr) = 1.72 cfs

Q_{10} = (0.88 ac X 0.3 X 4.8 in/hr) = 1.27 cfs

② Starting Wsel @ outlet Computed @ 933+50 using Quick-2

	Sta.	El.
0	-6.24	52.12
1.24	-5.0	51.50
11.24	5	51.30
14.63	8.39	49.60
16.63	10.39	49.35
18.63	12.39	50.35
18.63	12.39	60.38

Slope = 0.14%

Roughness = 0.06

Q_{100} = 1.93 cfs

Quick 2 Results	
WSEL	50.32
Depth	0.97
Top Width	6'
Vel	6.62

Infiltration Requirements At 937+00

① Area Contributing ~~to End of Project~~ - 937+50 - 1.62 ac

Design infiltration For 100 yr storm

* 3' ABOVE Groundwater

1.5" ⇒ 3" Stone

gives Porosity @ 40%

100-yr 24-hr rainFall

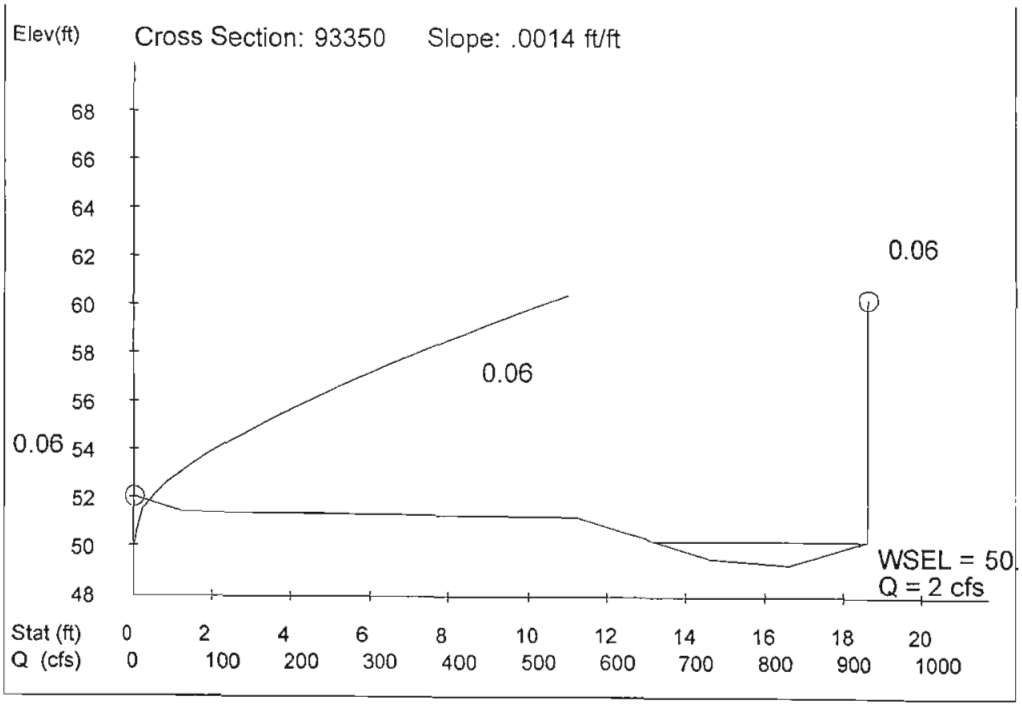
6.9" ⇒ 0.57'

0.92 ac-Ft

Volume of Water From 100 yr event = 0.92 ac-FT

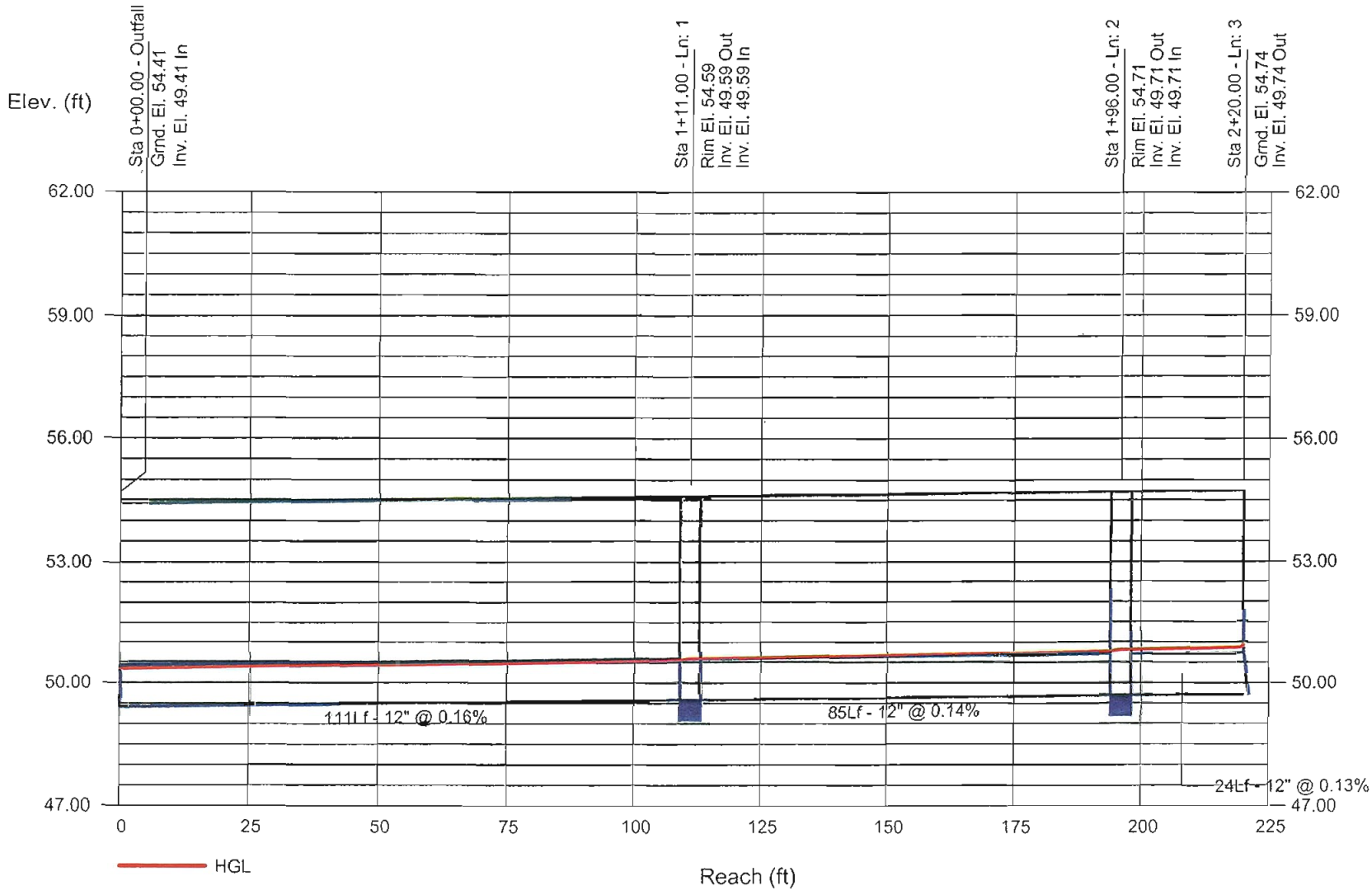
= 40,075 Ft³

Cont...


Elev(ft)
Cross Section: 93350
Slope: .0014 ft/ft
68
66
64
62
60
58
56
0.06 54
52
50
48
0.06
0.06
WSEL = 50.32
Q = 2 cfs
Stat (ft) 0 2 4 6 8 10 12 14 16 18 20
Q (cfs) 0 100 200 300 400 500 600 700 800 900 1000

Storm Sewer Profile

Proj. file: New.stm



Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	111	0.00	0.00	0.00	0.00	0.00	0.0	0.6	0.0	1.72	1.43	2.26	12	0.16	49.41	49.59	50.32	50.55	0.00	0.00	
2	1	85	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.0	1.72	1.34	2.19	12	0.14	49.59	49.71	50.59	50.79	0.00	0.00	
3	2	24	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	1.72	1.26	2.19	12	0.13	49.71	49.74	50.83	50.88	0.00	0.00	

Project File: New.stm | Number of lines: 3 | Run Date: 08-25-2009

NOTES: Intensity = 106.59 / (Inlet time + 17.00) ^ 0.85; Return period = 100 Yrs. ; Total flows limited to inlet captured flows. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	12	1.72	49.41	50.32	0.91	0.75	2.29	0.08	50.40	0.204	111	49.59	50.55	0.96	0.78	2.22	0.08	50.63	0.203	0.204	0.226	0.50	0.04
2	12	1.72	49.59	50.59	1.00*	0.79	2.19	0.07	50.66	0.233	85	49.71	50.79	1.00	0.79	2.19	0.07	50.86	0.233	0.233	0.198	0.54	0.04
3	12	1.72	49.71	50.83	1.00	0.79	2.19	0.07	50.90	0.233	24	49.74	50.88	1.00	0.79	2.19	0.07	50.96	0.233	0.233	0.056	1.00	0.07

Project File: New.stm | Number of lines: 3 | Run Date: 08-25-2009

Notes: * Normal depth assumed. ; c = cir e = ellip b = box

GM2 Associates

Engineers • Inspectors • Surveyors

Job Amtrak Access Road Computed By _____ Date _____

Description _____ Checked By _____ Date _____

System 5 cont... Sheet 2 of 2

Cont.. Infiltration Requirements at 937+00

Trench Surface Area From 2004 CT SQM

$A = \frac{12 \cdot \text{Volume}}{P \, n \, t}$

$= 55660 \text{ Ft}^2$

Assume MAX drain time 72 hrs

$n = 0.4$

$R = 0.3$ in/hr minimum (Assumed)

Borings AARW 11-43
-45

Wont work Groundwater too high.

No info on AETNA CB. Assume minimum slope 0.5%. IF Slope greater Pipe Capacity increases.

Contributing Area to 937+50 1.62 ac

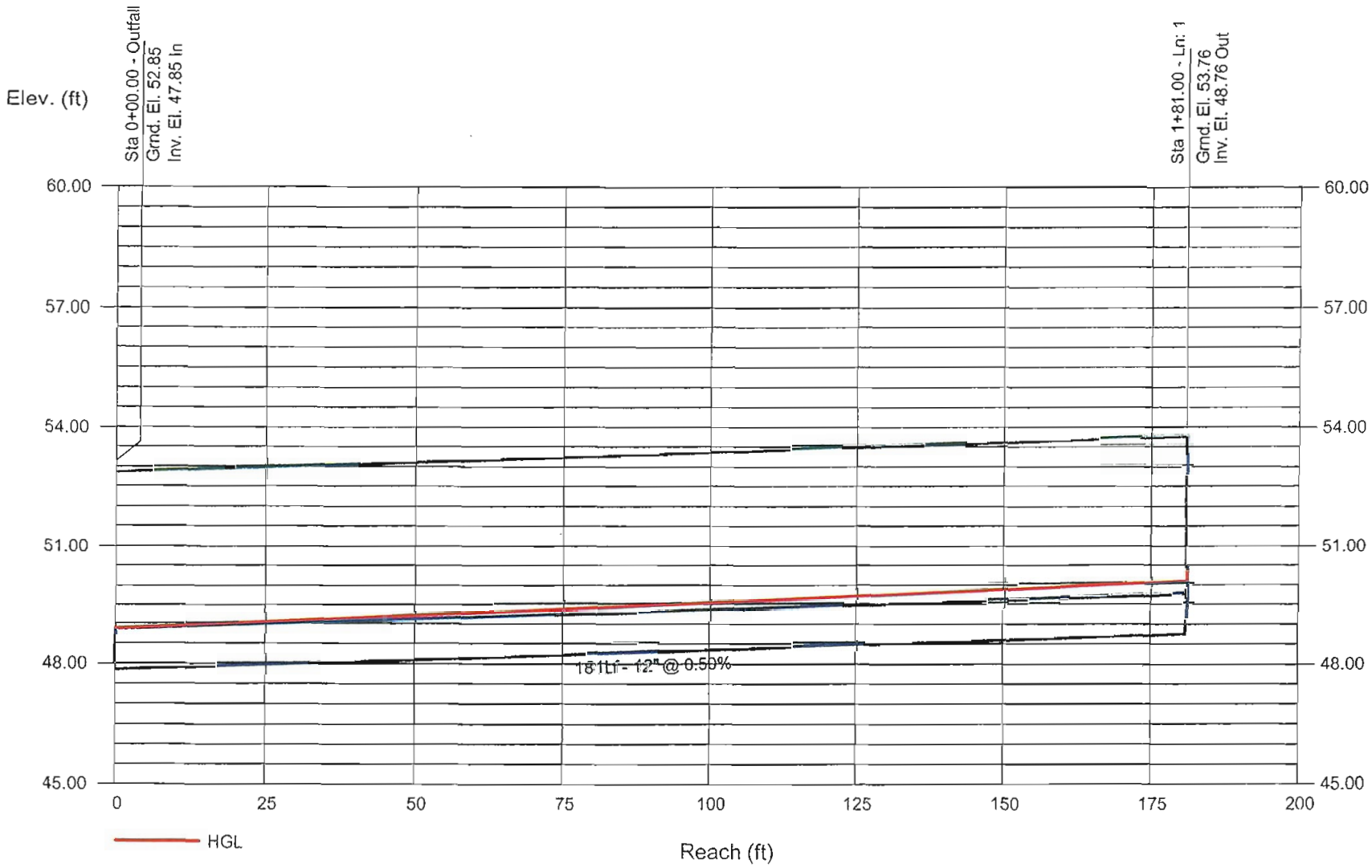
$Q_{100} = (1.62 \text{ ac} \times 0.3)(6.5 \text{ in/hr}) = 3.16 \text{ CFS}$

$Q_{10} = (1.62 \text{ ac} \times 0.3 \times 4.8 \text{ in/hr}) = 2.33 \text{ CFS}$

Length 12" pipe 181'

Storm Sewer Profile

Proj. file: New.stm



Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	181	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	3.16	2.74	4.02	12	0.50	47.85	48.76	48.85	50.06	0.00	0.00	

Project File: New.stm

Number of lines: 1

Run Date: 08-26-2009

NOTES: Intensity = 106.59 / (Inlet time + 17.00) ^ 0.85; Return period = 100 Yrs. ; Total flows limited to inlet captured flows. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	12	3.16	47.85	48.85	1.00	0.79	4.02	0.25	49.10	0.671	181	48.76	50.06	1.00	0.79	4.02	0.25	50.32	0.671	0.671	1.215	1.00	0.25

Project File: New.stm | Number of lines: 1 | Run Date: 08-26-2009

; c = cir e = ellip b = box

TRACK DRAINAGE OUTLET 5 AREAS BETWEEN STATION 907+00 (BASELINE FOR 093-H052) AND STATION SM 52+50 (BASELINE FOR 063-H157) / 483+00 (BASELINE FOR 063-H137)

The engineered track drainage swale that was requested by Amtrak as part of the Access Road Design (093-H052) and the Track Relocation Design (063-H157) as defined in the stationing, overlaps adjacent project limits. As such, various sources of design data were used to design the swale servicing the area between the Amtrak Tracks to the right of the baseline (east) and the barrier curb to the left of the baseline (west).

To determine contributing areas for the swale computations at required design points, the average end area method as has been used throughout this design report was employed. Sections used for the portion of swale designed under the Access Road Relocation Project (093-H052) fall between 898+50 and 937+50 (limit of project). Continuing, the cross sections developed for the design of the Busway (along baseline alignment for 063-H137) continue the swale drainage between station 450+50 to 483+00. The low point of this swale is at station 476+50, just east of Broad Street. It is proposed to tie in to the Busway drainage system being designed under contract 063-H137. The outfall for the Busway drainage system is a 48" pipe that conveys collected stormwater to Outfall Gate 8 of the Park River Conduit as documented in the 90% Drainage Report prepared for 063-H137 (Lochner, June 2009). The following subsections define the designed drainage for the referenced area to the outlet and narrate computations used to verify the design.

Prior to documenting drainage design, it should be mentioned that there is a small stretch of area between Hamilton Street and the Park Street Bridge (stations 893+50 and 904+50, respectively) with a high point between the two crossings at station 898+50. The contributing flows (Q_{100}) for these two adjacent areas were computed to be 0.5-cfs at Hamilton Street and 0.7-cfs at the Park Street Bridge. For this limited amount of design flow, it does not seem prudent to concentrate in a defined drainage swale and determine a suitable outlet within this urban area. It is recommended to remove the swale from the design plans and allow the flows to sheet with the natural contours of the area.

Station 922+50

At station 924+00, the tracks are carried by a bridge over Capitol Avenue. Due to this crossing, an outlet for the concentrated swale flows was required prior to approaching the bridge. At station 22+50, an inlet is proposed to capture the flows generated and convey those flows to an infield area within the I-84 highway lines. The contributing area to this inlet is 0.77 acres which, with the global design parameters used for this project, would generate 1.50-cfs of flow for the 100-year event. This is an intermediate outlet for this segment of track swale drainage design (has been referenced as discharge point 5A).

Station 929+50

At station 929+50, due to the proximity of the Busway to the active tracks, it was necessary to elevate the swale flow line as was done in other similar locations throughout the project. As such, to ensure that there are no areas of unnecessary ponding, a 6" pipe has been proposed to carry the flow line of the "normal" swale beneath the "elevated" swale.

For this analysis, 0.35-cfs of runoff (Q_{100}) was computed from a contributing area of 0.18 acres approaching the inlet of the proposed 6" pipe and elevated swale. At section 933+50 (receiving section of the "normal" swale) a channel rating curve was developed to be used as the starting tailwater rating curve for the culvert

analysis. Downstream of this pipe exit section, there is a mild high point in the swale with an elevation 0.17' greater than the outlet of the proposed PVC pipe. In order to reflect this in the tailwater rating curve, 0.17 feet was added to the computed elevations of the exit section's rating curve to represent the "ponded" portion of the channel (due to this mild high point). With this adjusted tailwater rating curve, the capacity of the pipe at the design flow event is 0.31-cfs; the remaining 1.98-cfs contributes to the flows conveyed by the elevated swale. At the end of the elevated swale (section 933+00) the total runoff computed – with the overtopping of the culvert crossing – is 2.1-cfs. Freeboard from the water surface in the elevated swale was computed as 1.33 feet (CWSEL=52.09', Track elevation 53.42'). As a final check of the capacity of the normal swale, the computed water surface elevation at 933+50 is 51.1', the track elevation is 53.4' resulting in a freeboard of 2.3 feet.

Station 937+50

Station 937+50 represents the limit of project 093-H052. At this point, the contribution of runoff in form CxA is 0.15 (0.50 acres).

The following portions of this report section are in reference to section geometry as provided by the design engineer for Project No. 063-H157. Section geometry used for the swale design comes from sections generated under Project No. 063-H137 (Busway) and Project No. 063-H157 (Track Relocation).

Designations for the baselines are as follows: Busway Sections → 4xx+xx, Track Relocation Sections → SMxx+xx

Station 450+50

At station 450+50, it was necessary to elevate the swale due to the proximity of the Busway to the active tracks as has been done at various locations throughout the project. As such, to ensure drainage following a flood event, a 6" diameter pipe has been designed to carry the flow line of the "normal" swale under the "elevated" swale. For this analysis, 0.98-cfs of runoff (Q_{100}) was computed from a drainage area of 0.5 acres approaching the inlet of the proposed 6" pipe and elevated swale. At **section 455+50** (receiving section of the "normal" swale) a channel rating curve was developed to be used as the starting tailwater rating curve for the culvert analysis. At the end of the elevated swale (section 455+50) the total runoff computed – with the overtopping of the culvert crossing – is 1.23-cfs as determined from a contributing area of 0.63 acres. Using this tailwater rating curve, a culvert analysis was performed on the 6" proposed pipe. The results of the culvert analysis indicate that at the design flow for a 100-year event, the headwater elevation would be 51.22 feet, with .63-cfs overtopping and being conveyed downstream by the "elevated" swale. The track elevation at this section is 53.51 feet, resulting in a freeboard of 2.29 feet to the tracks.

Station 464+50

At station 464+50, again due to the proximity of the Busway to the tracks, an "elevated" swale was required. Similar to other areas along this project, a 6" pipe is provided to ensure drainage upon recession of the design event. At the inlet of the proposed 6" culvert, a drainage area of 0.91 acres generates 1.77-cfs of flow. At **section 474+00** (receiving section of the "normal" swale) a channel rating curve was developed

based on the swale geometry and the flows contributing to the receiving section. For the 100-year event, 2.34-cfs of flow is computed from the 1.20 acres contributing the runoff. This rating curve was then applied as the starting tailwater rating curve of the culvert analysis at station 464+50. The design flow at the inlet is 1.77-cfs as computed from the contributing area of 0.91 acres. Results of the analysis indicate that the culvert conveys 0.34-cfs with the remaining 1.43-cfs being conveyed by the "elevated" swale. The maximum computed headwater elevation is 48.55 feet. At that same section, the track elevation is 50.71 feet which provides a freeboard of 2.16 feet to the tracks.

Station 476+75 - Outlet

This section is a low point in the profile of the tracks, Busway and subject drainage swale. Due to the urban nature of this area, there are very limited locations for discharge of stormwater runoff. For this reason, the subject drainage swale will connect to the adjacent Busway drainage system via an inlet and 12" pipe to the catch basin at Busway station 476+50. Correspondence with the Busway line designer gives, at the point of the proposed system tie in, the CxA contributing from the Busway is 0.332 with a system time of 6.4 minutes.

In order to verify that the contribution of the track drainage swale to the Busway drainage system will not impose an adverse burden on the Busway system, the time of concentration of flows from the limits of the track drainage swale was calculated in an attempt to demonstrate that the Busway system would peak and recede prior to the full contribution of the track swale drainage area. This was accomplished by determining the flow velocity at representative sections along the swale, and with the distances associated for the swale segments, the travel time for a unit of water could be defined. A representative section along the swale segment from access road stations 926+00 to 937+00 had an average flow velocity of 0.41 fps. For this 1150 foot section of swale, that equates to a travel time of 47 minutes. Then again from station 450+50 to 476+50, a representative section reveals that the design flow velocity is 1.1 fps. For that 2600 foot segment, the travel time was computed as 39 minutes. The two representative swale reaches, when summed for the total time of concentration, indicate a system time of 86 minutes (1.4 hours)[2].

From the IDF curves published in the ConnDOT Drainage Manual (§ 6.B-1), an area with a system time of 86 minutes would have an associated 100-year rainfall rate of 2.2 $^{in}/_{hr}$. Using this design rainfall intensity with the 1.63 acres contributing stormwater runoff results in a design flow of 1.1-cfs of flow at station 476+75. In comparison, the Busway system is designed for a 10-year flow of 1.93-cfs as determined from 0.332 CA and 5.8 $^{in}/_{hr}$ for a time of concentration of 6.4-cfs. In summary of this paragraph, the Busway system is adequate for the 100-year design flow contributed from the track swale if the flows from the Busway contributing areas were neglected.

Continuing on, the total flow from both the track drainage system and the Busway system downstream of the proposed tie in would be $(0.332_{(Busway)} + 0.489_{(track\ swale)})$ x 2.2 $^{in}/_{hr}$ = 1.81-cfs; 0.12-cfs less than the 10-year flow imposed on the design of the Busway system.

For further verification on the capacity of the system, a hydrograph analysis was performed for each of the systems and then added to verify the flows in relation to the timing of the flood events. This was also done

---

[2] Note is made that this travel time computation method did not employ any detention time routing that would result from the ponding of flows upstream from the 6" pipes under the "elevated" swale segments. True travel time would likely be slightly longer resulting in a lower design rainfall rate.

because it was expected that the peak flow for the Busway system would likely be higher than the peak flow when both systems were contributing. To generate the hydrographs using the rational method, the CA from each system[3] was used in conjunction with the respective times of concentration. The ascending and receding limbs were set equal to the time of concentration as recommended by HDS 2 (§ 6.4.2). The resulting hydrographs were then added to determine the true peak flow WRT time for the flooding period. This was completed for the 10-year, 25-year and the 100-year flow rates to satisfy the design requirements and check storms for each of the systems. The following image is the resultant hydrograph downstream from the junction at the 100-year design event.

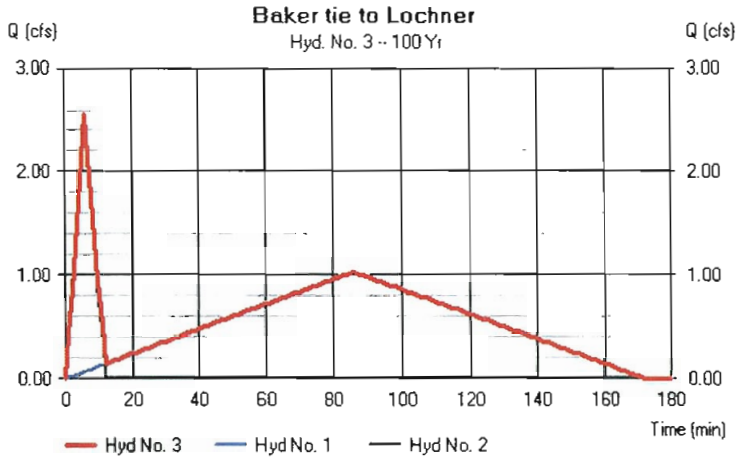


Figure 1 – Flow hydrograph for 100-year event downstream of the tie-in with Busway system

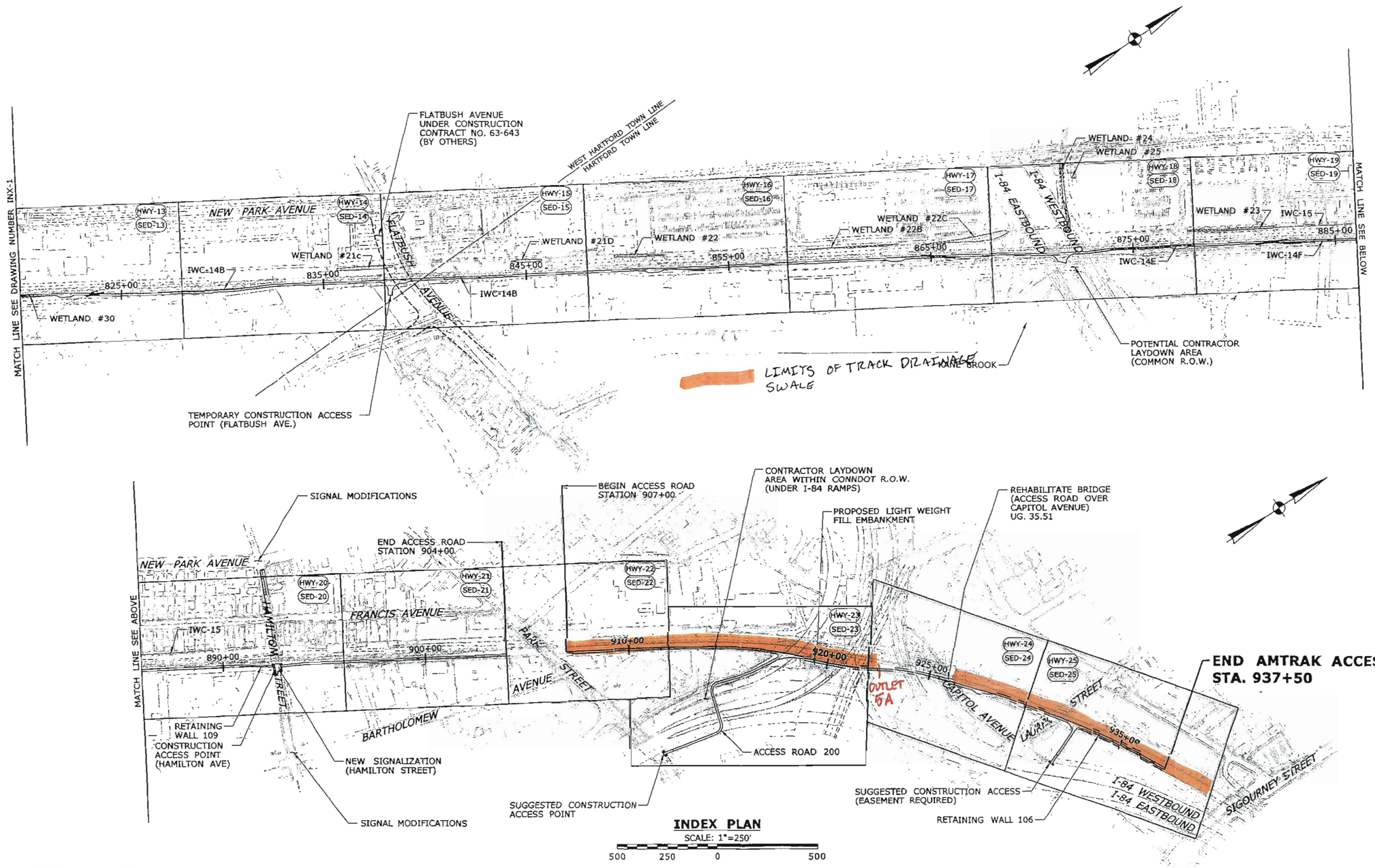
This analysis shows that the Busway system peaks and recedes 74 minutes prior to the peak of the track swale system. During that time a small volume of rainfall from the swale contributes to the flow in the Busway system, increasing the 100-year peak flow from 2.49-cfs to 2.56-cfs. For reference, the system full flow capacity that was designed for the Busway is 2.52-cfs. It is not expected that 0.04-cfs will cause an adverse impact to the hydraulic grade line for the 100-year event. Further, at the time that the track swale system peaks, the flow is computed as 1.03-cfs, well within the capacity of the receiving system.

In conclusion, due to the timings and flow rates of each of these systems, and the inherent capacity of the Busway system, tying-in to the Busway system will not cause any adverse impacts to either drainage systems.

Computations associated with the design of the track swale and tie in to the Busway system are included as part of this report section.

---

[3] Note that correspondence with the Busway line designer gave the CA directly. For the Hydraflow Program, an area and a runoff coefficient are input individually. The C for the Busway system was assumed as 0.5 to compute an area of 0.664 acres. The individual coefficient and area are not important to the results of the computation; the resulting CxA is what must be accurate.



INDEX PLAN

SCALE: 1"=250'

500 250 0 500

NOTES:

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LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

FINAL PLANS FOR REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

Plotted: 9/2/2009

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DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW_MSH_093_H052_INX-02.dgn

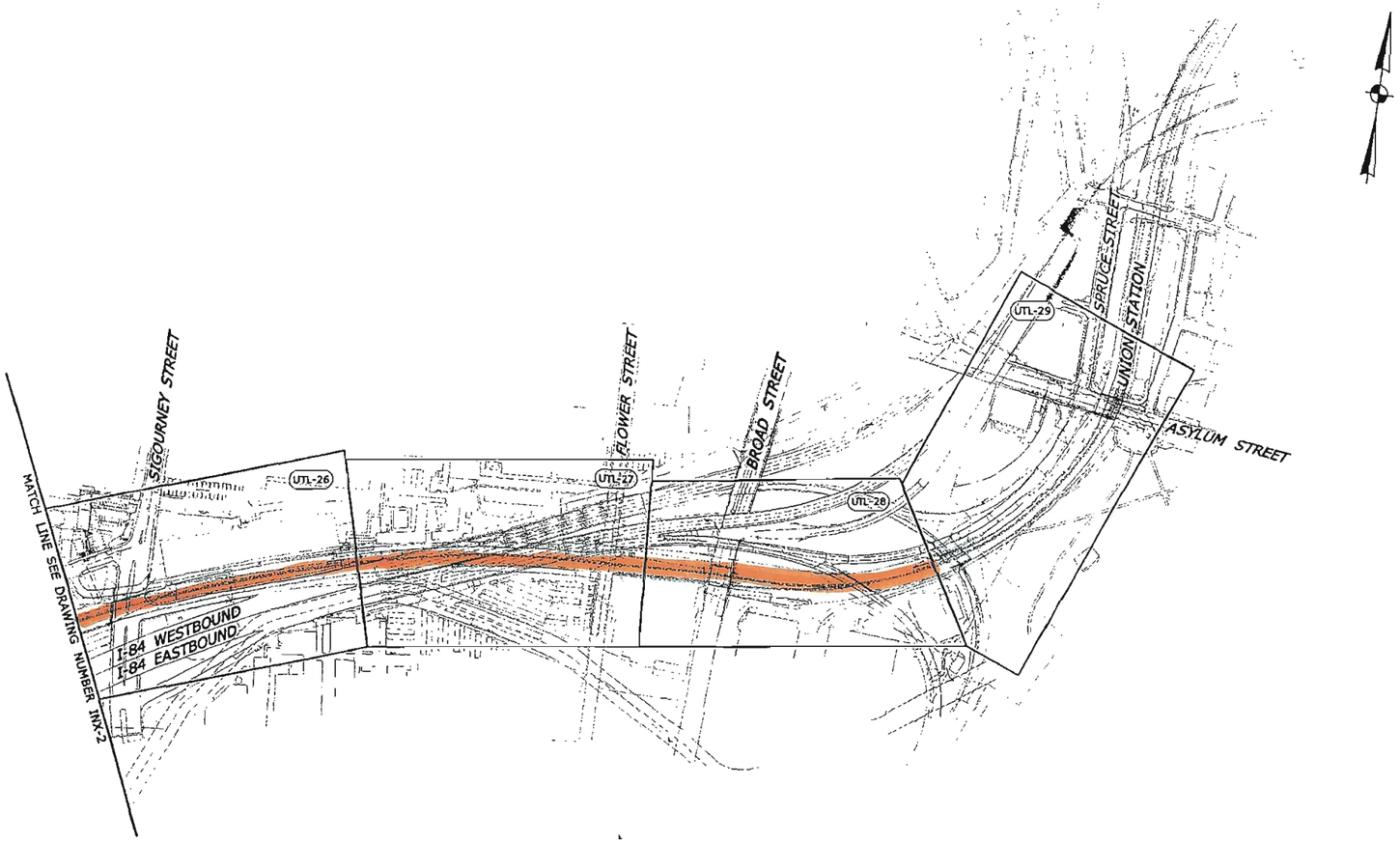
MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN: NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE: INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-02
SHEET NO. 8



INDEX PLAN

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

(UTL-XX) AMTRAK C&S AND LEVEL 3 RELOCATION DWGS.

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
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Plotted: 5/20/2010

DESIGNER/DRAFTER: CJF

CHECKED BY: ALM

SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW_MSH_093_H052_INX-03.dgn

MICHAEL BAKER ENGINEERING, INC.

APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN:
NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE:
INDEX PLAN

PROJECT NO.
093-H052

DRAWING NO.
INX-03

SHEET NO.
S

Hydraulic Analysis Report
Station 933+50

Project Data

Project Title:

Designer:

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 933+50

Notes:

Parameters

Channel Type: Custom Cross Section

Flow: 0.6240 (cfs)

Depth: 0.6534 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0010 (ft/ft)

Area of Flow: 1.5073 (ft^2)

Wetted Perimeter: 3.9221 (ft)

Average Velocity: 0.4140 (ft/s)

Top Width: 3.6136 (ft)

Froude Number: 0.1130

Critical Depth: 0.1995 (ft)

Critical Velocity: 2.2361 (ft/s)

Critical Slope: 0.1046 (ft/ft)

Critical Top Width: 1.7979 (ft)

Calculated Max Shear Stress: 0.0408 (lb/ft^2)

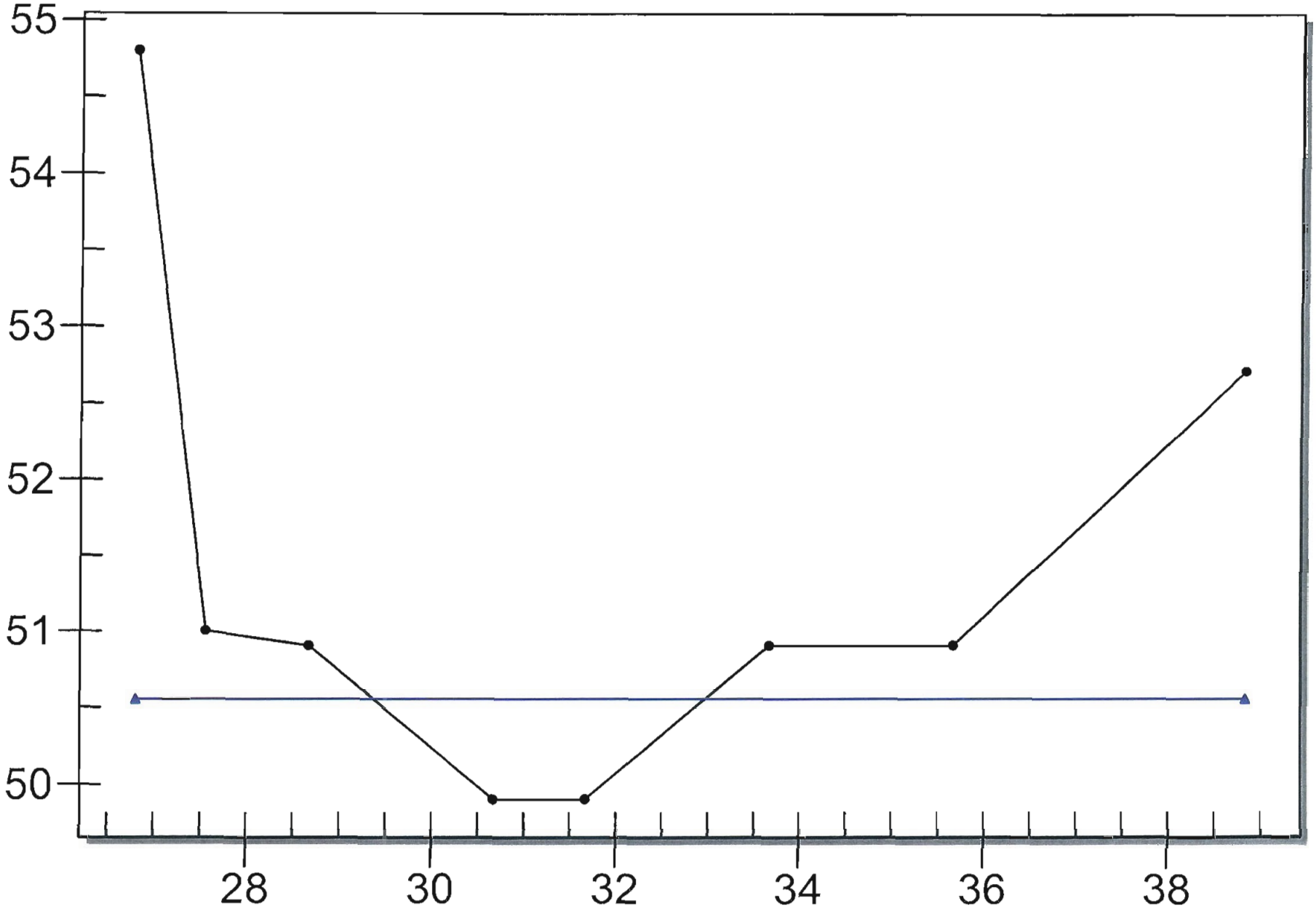
Calculated Avg Shear Stress: 0.0240 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
26.81	54.80	0.0600
27.56	51.00	0.0600
28.67	50.90	0.0600
30.67	49.90	0.0600
31.67	49.90	0.0600
33.67	50.90	0.0600
35.67	50.90	0.0600
38.83	52.70	----

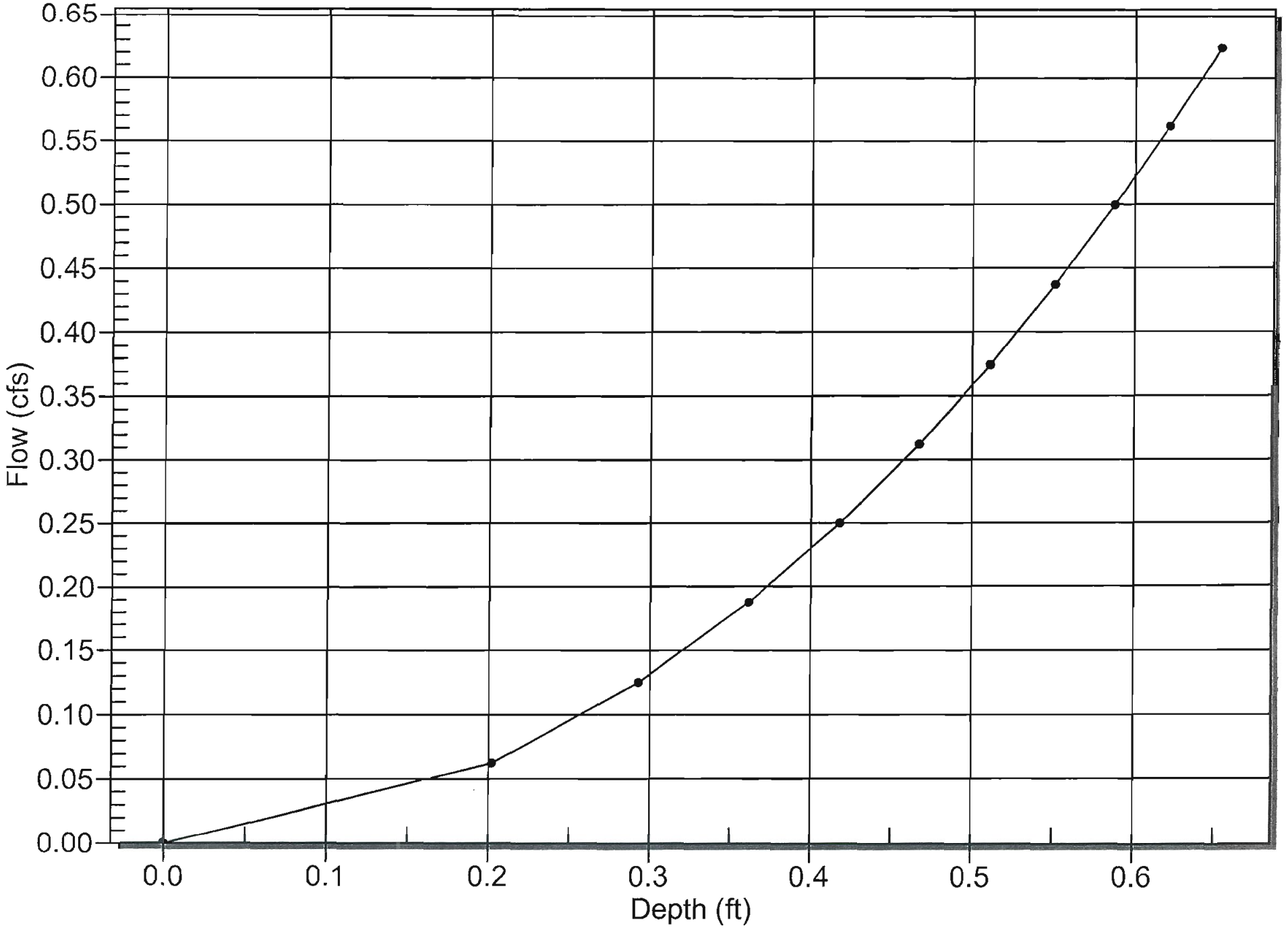
Cross Section

Station 933+50



Flow vs. Depth

Station 933+50



HY-8 Culvert Analysis Report
Proposed Pipe at Station 929+50

Table 1 - Summary of Culvert Flows at Crossing: Pipe at 929+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
50.72	0.00	0.00	0.00	1
51.72	0.03	0.03	0.00	9
51.76	0.07	0.03	0.04	7
51.78	0.10	0.03	0.07	5
51.80	0.14	0.03	0.11	4
51.81	0.17	0.03	0.13	3
51.83	0.21	0.03	0.17	3
51.84	0.24	0.03	0.21	3
51.85	0.28	0.03	0.24	2
51.86	0.31	0.03	0.28	3
51.87	0.35	0.03	0.31	2
51.72	0.03	0.03	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe at 929+00

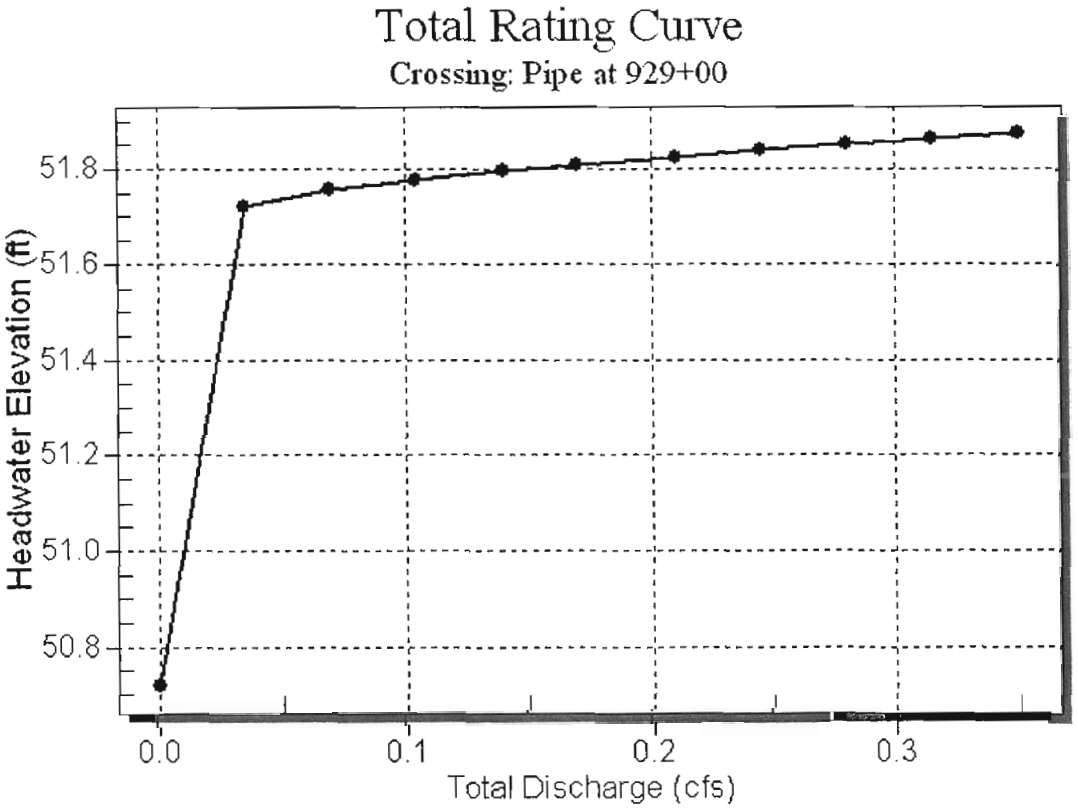


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	50.72	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.03	0.03	51.72	1.002	0.141	3-M1t	0.114	0.088	0.142	0.202	0.797	0.000
0.07	0.03	51.76	1.036	0.141	3-M1t	0.114	0.088	0.233	0.293	0.385	0.000
0.10	0.03	51.78	1.057	0.141	3-M1t	0.114	0.088	0.301	0.361	0.278	0.000
0.14	0.03	51.80	1.075	0.141	3-M1t	0.114	0.088	0.358	0.418	0.229	0.000
0.17	0.03	51.81	1.089	0.141	3-M1t	0.115	0.088	0.407	0.467	0.201	0.000
0.21	0.03	51.83	1.105	0.142	3-M1t	0.115	0.088	0.451	0.511	0.185	0.000
0.24	0.03	51.84	1.118	0.142	3-M1t	0.115	0.088	0.491	0.551	0.172	0.000
0.28	0.03	51.85	1.130	0.142	3-M1f	0.115	0.088	0.500	0.588	0.176	0.000
0.31	0.03	51.86	1.143	0.142	3-M1f	0.115	0.088	0.500	0.622	0.177	0.000
0.35	0.03	51.87	1.155	0.142	3-M1f	0.115	0.088	0.500	0.653	0.177	0.000

* theoretical depth is impractical. *Depth reported is corrected.*

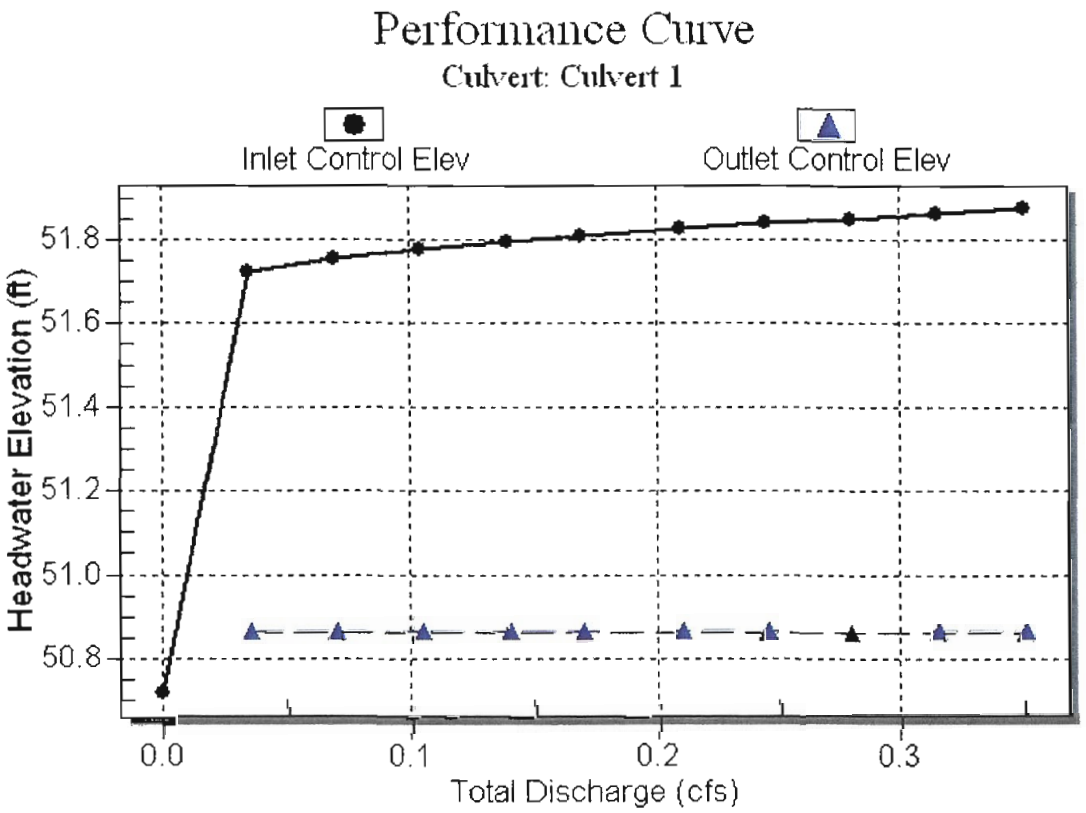
****

Inlet Elevation (invert): 50.72 ft, Outlet Elevation (invert): 49.96 ft

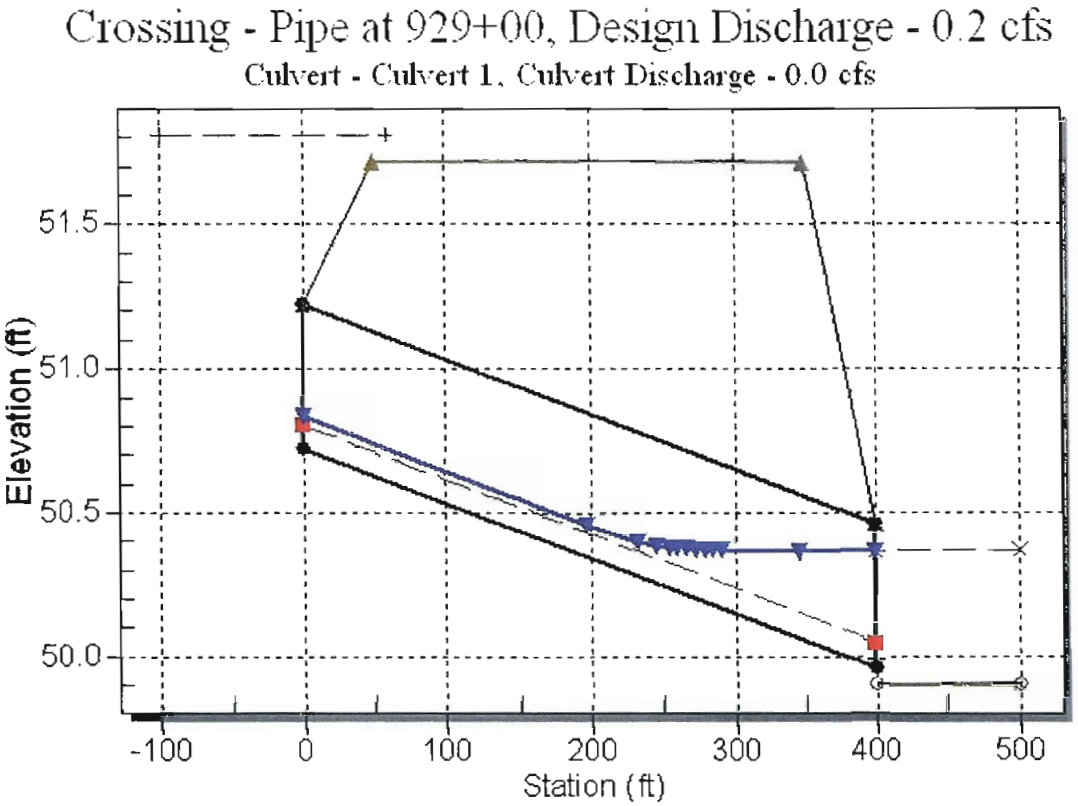
Culvert Length: 400.00 ft, Culvert Slope: 0.0019

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 50.72 ft

Outlet Station: 400.00 ft

Outlet Elevation: 49.96 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 0.50 ft

Barrel Material: PVC

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Pipe at 929+00)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	49.90	0.00
0.03	50.10	0.20
0.07	50.19	0.29
0.10	50.26	0.36
0.14	50.32	0.42
0.17	50.37	0.47
0.21	50.41	0.51
0.24	50.45	0.55
0.28	50.49	0.59
0.31	50.52	0.62
0.35	50.55	0.65

Tailwater Channel Data - Pipe at 929+00

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Pipe at 929+00

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 2.00 ft

Crest Elevation: 51.72 ft

Roadway Surface: Gravel

Roadway Top Width: 300.00 ft

Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Tuesday, February 02, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Swale at 933+00

Notes:

Parameters

Channel Type: Custom Cross Section

Flow: 0.5850 (cfs)

Depth: 0.5211 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0012 (ft/ft)

Area of Flow: 1.3715 (ft^2)

Wetted Perimeter: 3.9124 (ft)

Average Velocity: 0.4265 (ft/s)

Top Width: 3.6642 (ft)

Froude Number: 0.1229

Critical Depth: 0.1506 (ft)

Critical Velocity: 2.0469 (ft/s)

Critical Slope: 0.1081 (ft/ft)

Critical Top Width: 2.1964 (ft)

Calculated Max Shear Stress: 0.0390 (lb/ft^2)

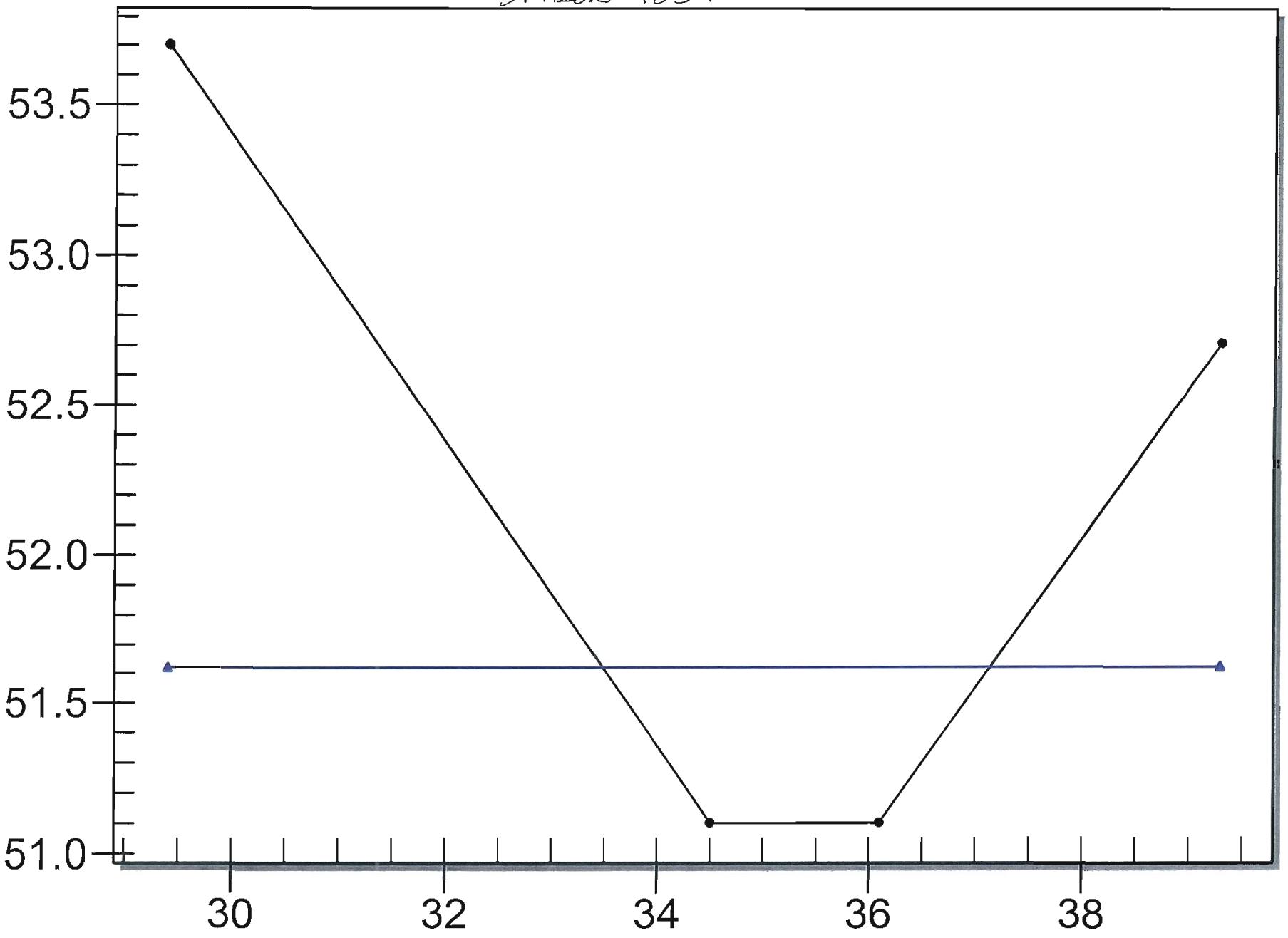
Calculated Avg Shear Stress: 0.0262 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
29.40	53.70	0.0600
34.50	51.10	0.0600
36.10	51.10	0.0600
39.30	52.70	-----

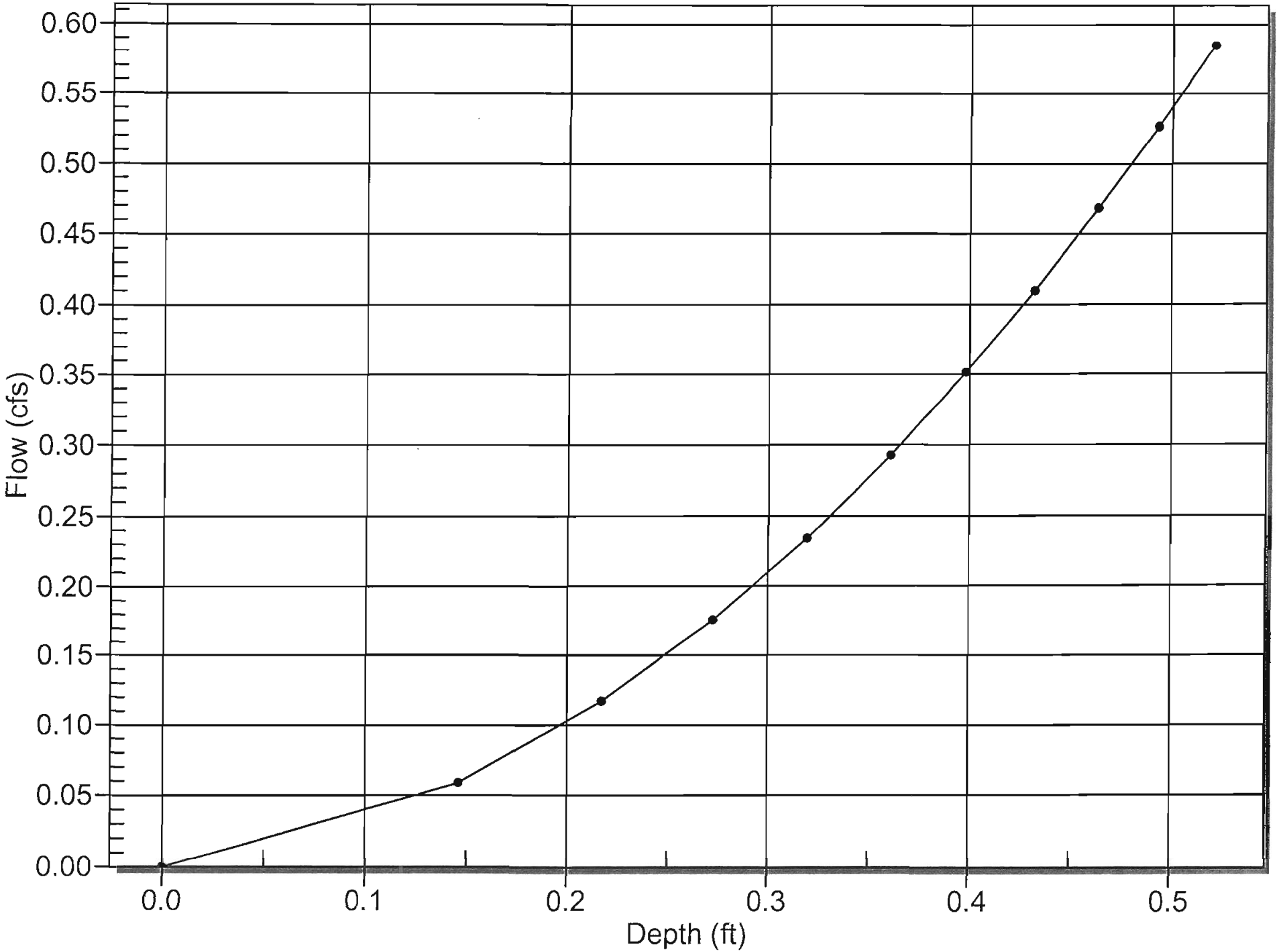
Cross Section

STATION 933+00



STATION 93+00

Flow vs. Depth



GM2 Associates

Engineers • Inspectors • Surveyors

Job Track Drainage Computed By _____ Date _____

Description _____ Checked By _____ Date _____

_____ Sheet _____ of _____

Area 5.

There is a slight swale draining towards Hamilton St.

898+50 → 893+00 Q_{100} contributing = 0.5 CFS NO Treatment necessary

* Recommend removing swale

Swale @ project limits to be picked up by Contract # 03-H157
Railroad Relocation Contract

Design point @ 929+50 - Elevated Swale
Check Swale @ End.

Tailwater @ 933+50 assume minimum slope for Calculation 0.1%
there will be 2" of water ponded @ outlet due to adverse slope from 933+50 to 936+50. Add 0.17' to tailwater computed.

Section @ 933+50

Sta	El
26.81	54.8
27.56	51.0
28.67	50.9
30.67	49.9
31.67	49.9
33.67	50.9
35.67	51.1
38.83	52.7

assumed slope 0.001
flow @ 933+50
Acres 1.3 · .3 · 6.5 2.53 CFS
& tailwater rating curve + 0.17'

Culvert @ 929+50 - Elevated Swale Acres 1.16 · .3 · 6.5 = 2.3 CFS
design flow through culvert 0.31 CFS
1.98 overtop 0.3 CA_{over}
0.04 $CA_{elevated}$
0.34 · 6.5 = 2.1 CFS in Elevated Swale

GM2 Associates

Engineers • Inspectors • Surveyors

Job _____ Computed By _____ Date _____

Description _____ Checked By _____ Date _____

_____ Sheet _____ of _____

Area 5 cont

Station 933+00 Design Section for Elevated Swale

Sta	El	
29.4	53.7	slope 0.0012
34.5	51.1	depth 0.99'
36.1	51.1	WSEL 52.09
39.3	52.7	Track El 63.42
		Freeboard 1.33'

@ End- Total CA = 1.47 · 0.3 = 0.441 To be picked up by CDOT PRS 03-H157

HY-8 Culvert Analysis Report
6" pipe at station 450+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
49.73	0.00	0.00	0.00	1
49.98	0.10	0.10	0.00	1
50.11	0.20	0.20	0.00	1
50.27	0.29	0.29	0.00	1
51.16	0.39	0.37	0.02	68
51.17	0.49	0.37	0.12	5
51.18	0.59	0.36	0.22	4
51.19	0.69	0.36	0.32	3
51.20	0.78	0.36	0.42	3
51.21	0.88	0.35	0.53	3
51.22	0.98	0.35	0.63	3
51.15	0.37	0.37	0.00	Overtopping

Table 1 - Summary of Culvert Flows at Crossing: 450+50

Rating Curve Plot for Crossing: 450+50

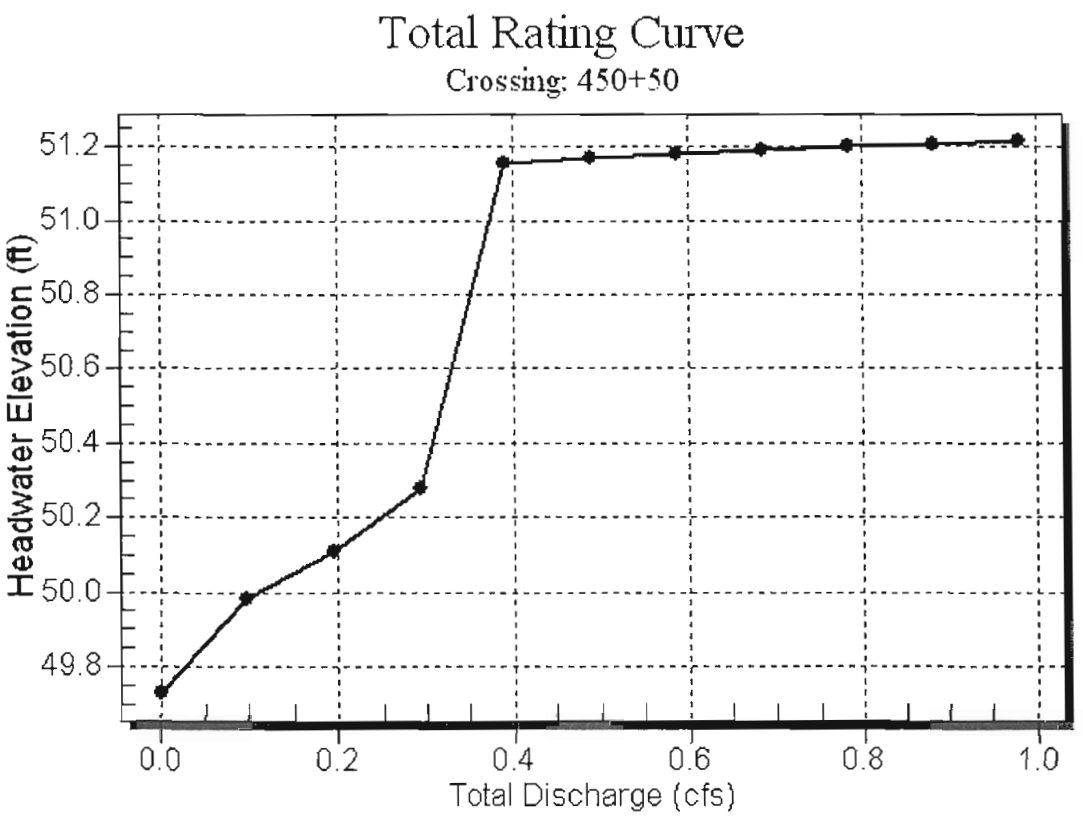


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	49.73	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.10	49.98	0.219	0.253	3-M1t	0.213	0.154	0.255	0.255	0.973	0.000
0.20	0.20	50.11	0.324	0.381	3-M1t	0.326	0.220	0.366	0.366	1.273	0.000
0.29	0.29	50.27	0.411	0.545	3-M2t	0.500	0.273	0.449	0.449	1.582	0.000
0.39	0.37	51.16	0.485	1.427	4-FFf	0.500	0.310	0.500	0.517	1.901	0.000
0.49	0.37	51.17	0.480	1.443	4-FFf	0.500	0.308	0.500	0.575	1.877	0.000
0.59	0.36	51.18	0.476	1.456	4-FFf	0.500	0.306	0.500	0.627	1.854	0.000
0.69	0.36	51.19	0.472	1.467	4-FFf	0.500	0.304	0.500	0.675	1.832	0.000
0.78	0.36	51.20	0.468	1.478	4-FFf	0.500	0.303	0.500	0.718	1.813	0.000
0.88	0.35	51.21	0.465	1.488	4-FFf	0.500	0.301	0.500	0.758	1.795	0.000
0.98	0.35	51.22	0.462	1.497	4-FFf	0.500	0.300	0.500	0.796	1.778	0.000

* theoretical depth is impractical. Depth reported is corrected.

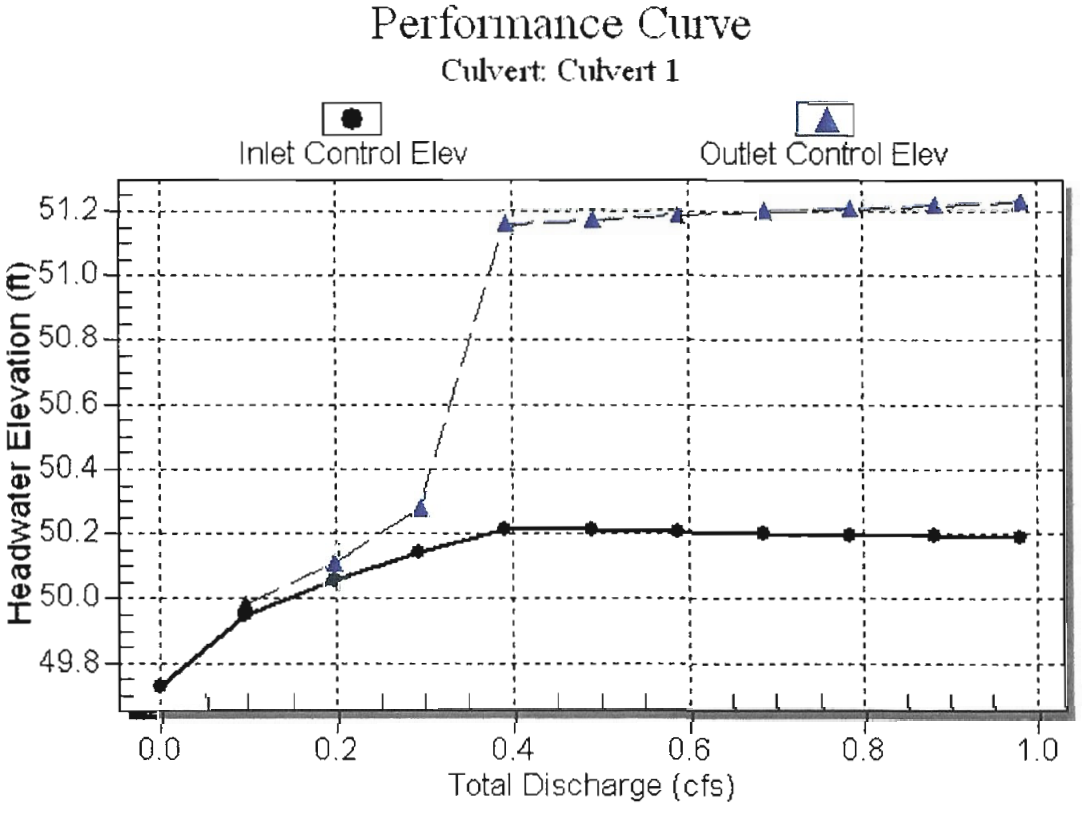
****

Inlet Elevation (invert): 49.73 ft, Outlet Elevation (invert): 48.97 ft

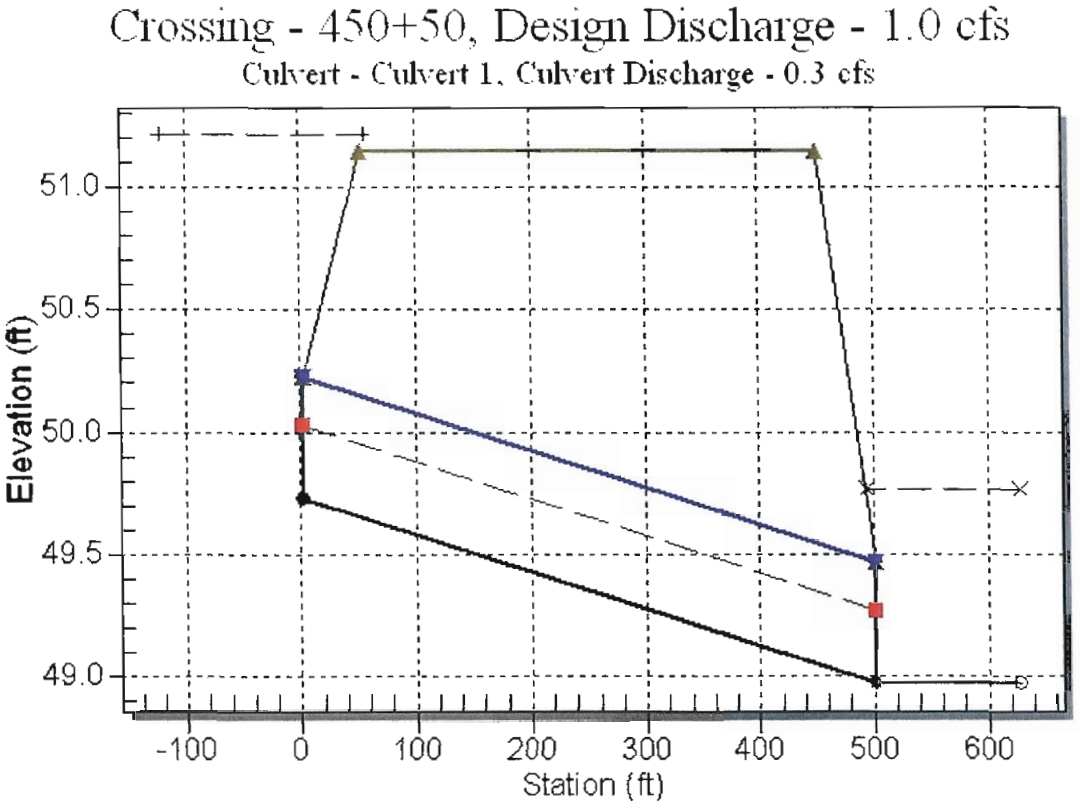
Culvert Length: 500.00 ft, Culvert Slope: 0.0015

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 49.73 ft

Outlet Station: 500.00 ft

Outlet Elevation: 48.97 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 0.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 450+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	48.97	0.00
0.10	49.23	0.26
0.20	49.34	0.37
0.29	49.42	0.45
0.39	49.49	0.52
0.49	49.55	0.58
0.59	49.60	0.63
0.69	49.65	0.68
0.78	49.69	0.72
0.88	49.73	0.76
0.98	49.77	0.80

Tailwater Channel Data - 450+50

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: 450+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 15.00 ft

Crest Elevation: 51.15 ft

Roadway Surface: Gravel

Roadway Top Width: 400.00 ft

Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Friday, May 07, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: station 455+50

Notes:

Parameters

Channel Type: Custom Cross Section

Flow: 1.2300 (cfs)

Depth: 0.7959 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0016 (ft/ft)

Area of Flow: 2.1074 (ft^2)

Wetted Perimeter: 4.6599 (ft)

Average Velocity: 0.5837 (ft/s)

Top Width: 4.2955 (ft)

Froude Number: 0.1469

Critical Depth: 0.2927 (ft)

Critical Velocity: 2.6161 (ft/s)

Critical Slope: 0.0951 (ft/ft)

Critical Top Width: 2.2121 (ft)

Calculated Max Shear Stress: 0.0795 (lb/ft^2)

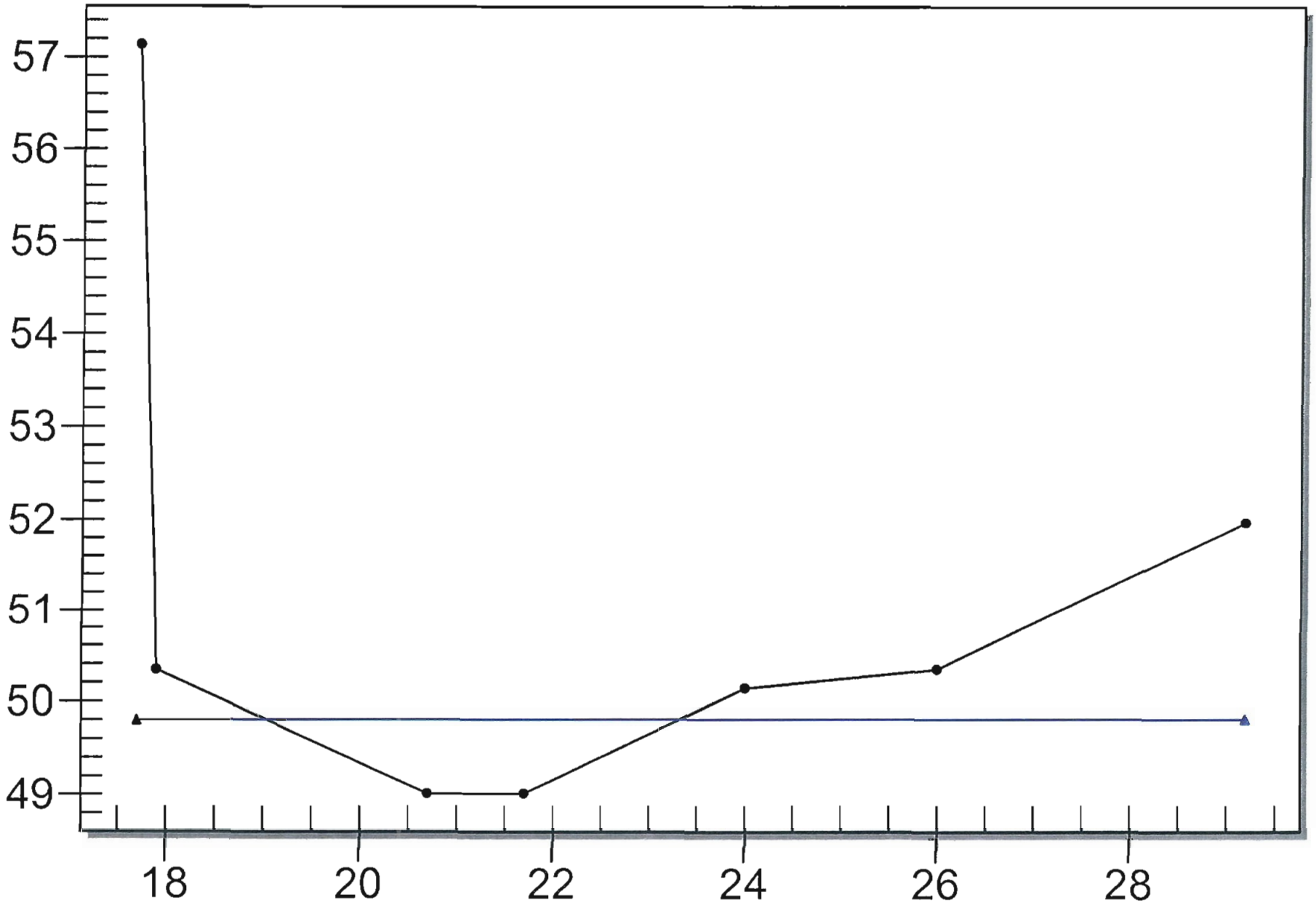
Calculated Avg Shear Stress: 0.0452 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
17.70	57.10	0.0600
17.90	50.30	0.0600
20.70	48.97	0.0600
21.70	48.97	0.0600
24.00	50.10	0.0600
26.00	50.30	0.0600
29.19	51.90	-----

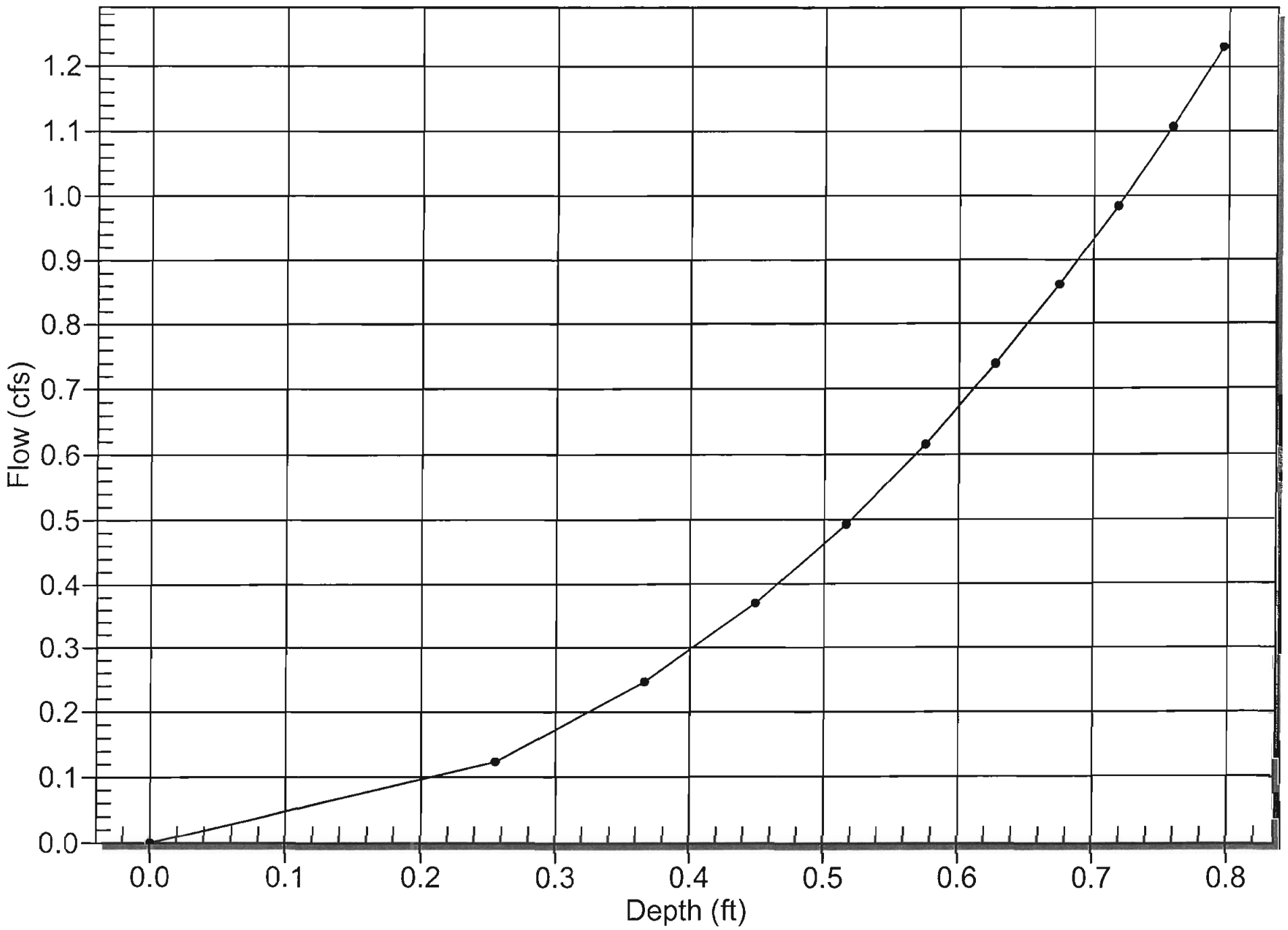
Cross Section

Station 455+50



Flow vs. Depth

Station 455+50



HY-8 Culvert Analysis Report
6" Pipe at station 464+50

Table 1 - Summary of Culvert Flows at Crossing: 464+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
47.20	0.00	0.00	0.00	1
47.56	0.18	0.18	0.00	1
48.42	0.35	0.35	0.00	187
48.45	0.53	0.35	0.18	6
48.47	0.71	0.35	0.36	4
48.49	0.89	0.34	0.54	4
48.50	1.06	0.34	0.72	3
48.52	1.24	0.34	0.90	3
48.53	1.42	0.34	1.08	3
48.54	1.59	0.34	1.24	2
48.55	1.77	0.34	1.43	3
48.42	0.35	0.35	0.00	Overtopping

Rating Curve Plot for Crossing: 464+50

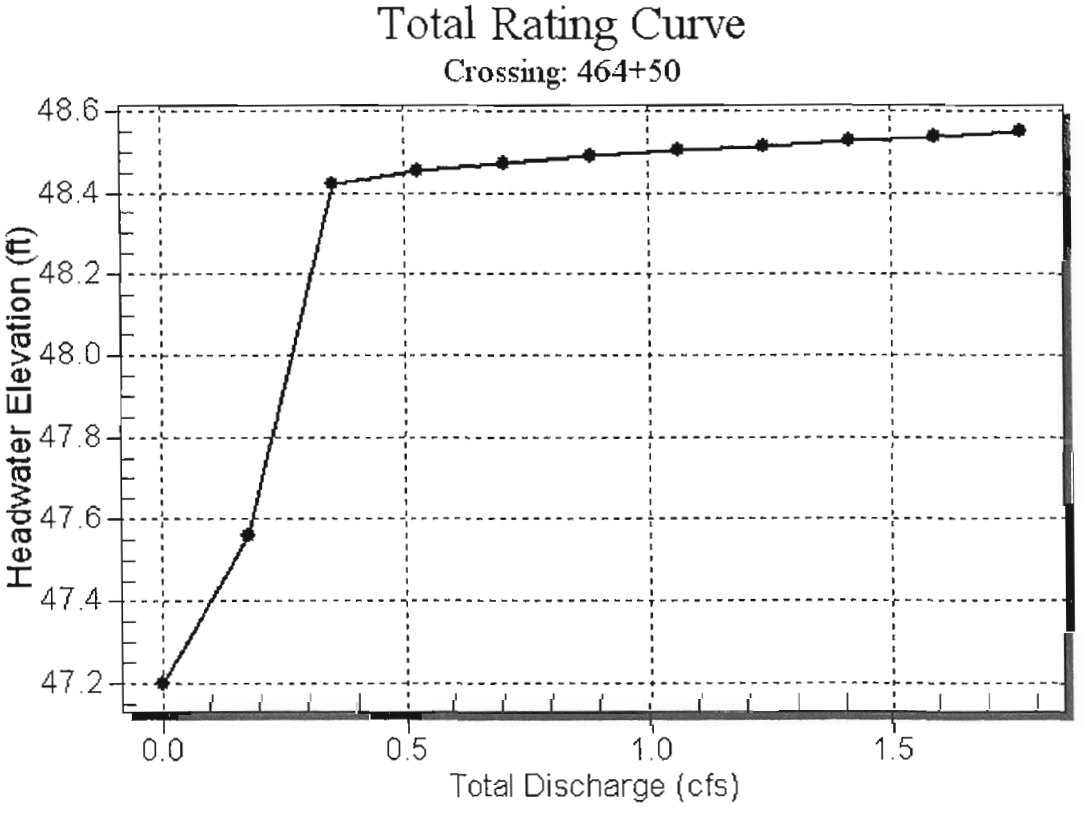


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	47.20	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.18	0.18	47.56	0.306	0.361	3-M2t	0.285	0.209	0.211	0.211	2.248	0.000
0.35	0.35	48.42	0.459	1.234	7-M2t	0.500	0.298	0.311	0.311	2.695	0.000
0.53	0.35	48.45	0.460	1.281	7-M2t	0.500	0.299	0.388	0.388	2.125	0.000
0.71	0.35	48.47	0.458	1.294	7-M2t	0.500	0.298	0.452	0.452	1.850	0.000
0.89	0.34	48.49	0.456	1.368	4-FFf	0.500	0.297	0.500	0.508	1.747	0.000
1.06	0.34	48.50	0.454	1.386	4-FFf	0.500	0.296	0.500	0.558	1.737	0.000
1.24	0.34	48.52	0.452	1.405	4-FFf	0.500	0.295	0.500	0.604	1.728	0.000
1.42	0.34	48.53	0.451	1.424	4-FFf	0.500	0.294	0.500	0.646	1.720	0.000
1.59	0.34	48.54	0.449	1.442	4-FFf	0.500	0.293	0.500	0.686	1.712	0.000
1.77	0.34	48.55	0.448	1.461	4-FFf	0.500	0.293	0.500	0.723	1.706	0.000

* theoretical depth is impractical. Depth reported is corrected.

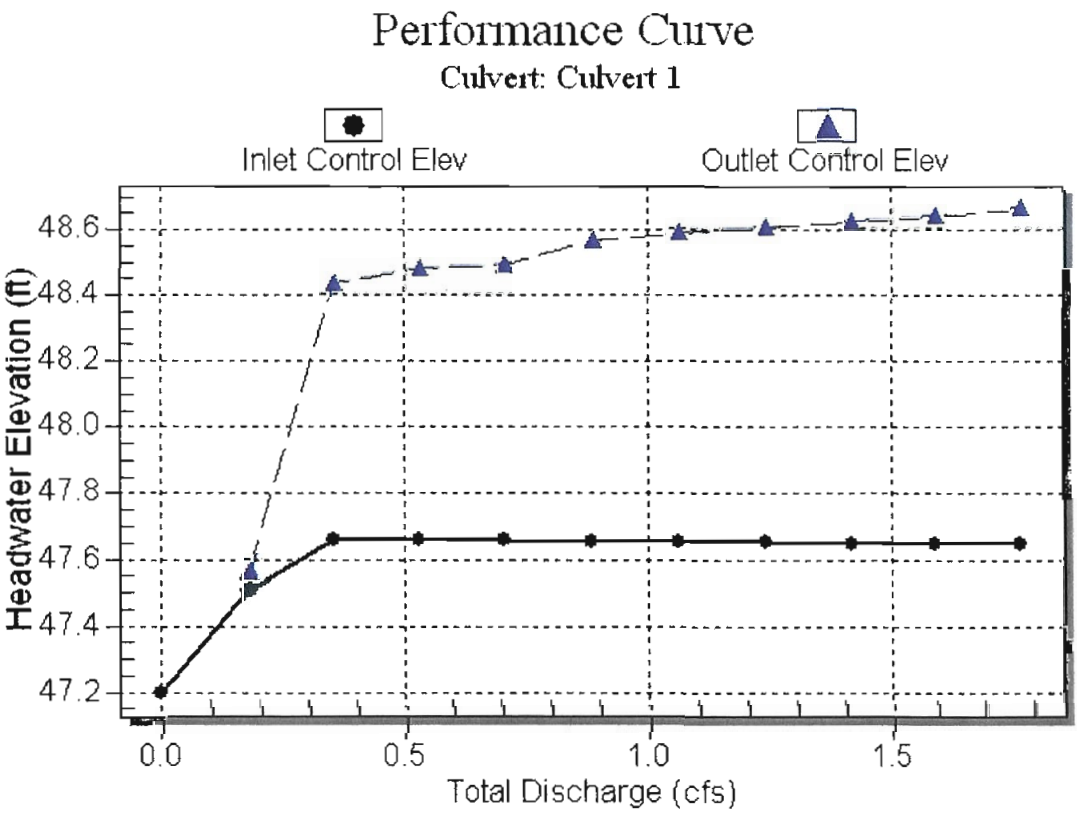
****

Inlet Elevation (invert): 47.20 ft, Outlet Elevation (invert): 45.45 ft

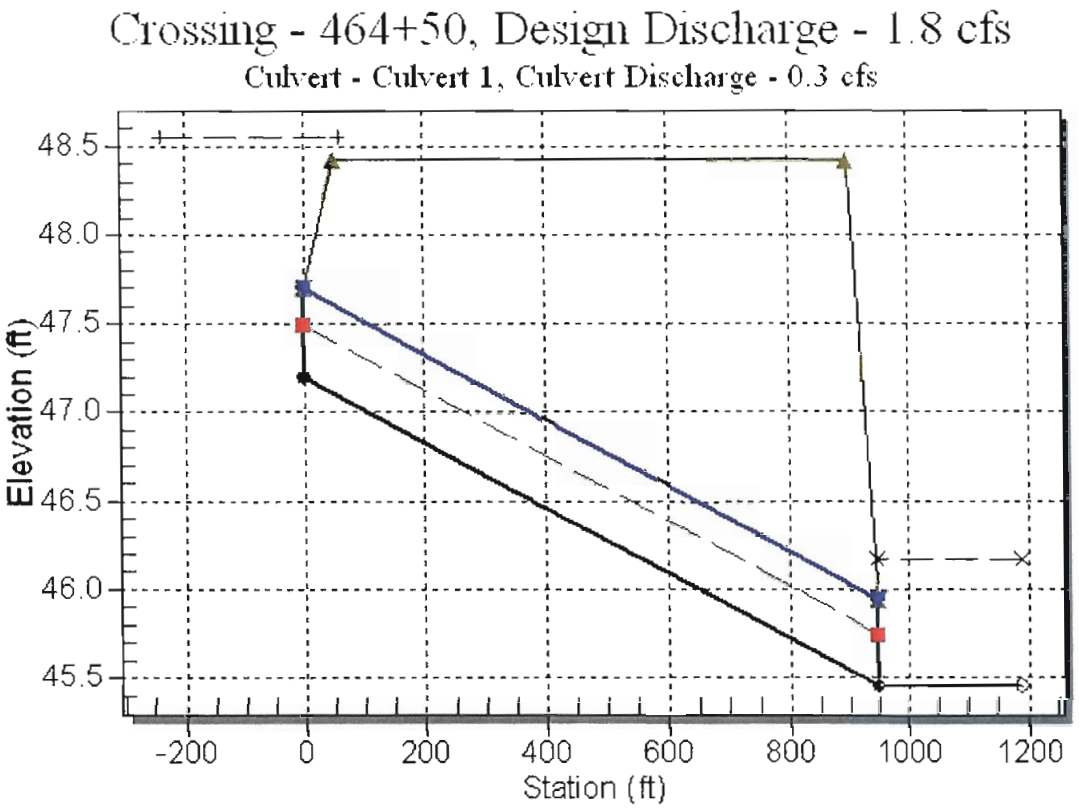
Culvert Length: 950.00 ft, Culvert Slope: 0.0018

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 47.20 ft

Outlet Station: 950.00 ft

Outlet Elevation: 45.45 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 0.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0110

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 464+50)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	45.45	0.00
0.18	45.66	0.21
0.35	45.76	0.31
0.53	45.84	0.39
0.71	45.90	0.45
0.89	45.96	0.51
1.06	46.01	0.56
1.24	46.05	0.60
1.42	46.10	0.65
1.59	46.14	0.69
1.77	46.17	0.72

Tailwater Channel Data - 464+50

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: 464+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 12.00 ft

Crest Elevation: 48.42 ft

Roadway Surface: Gravel

Roadway Top Width: 850.00 ft

Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Friday, May 07, 2010

Project Units: U.S. Customary Units

Notes:

Channel Analysis: station 474+00

Notes:

Parameters

Channel Type: Custom Cross Section

Flow: 2.3400 (cfs)

Depth: 0.7227 (ft)

Mannings 0.0600

Longitudinal Slope: 0.0054 (ft/ft)

Area of Flow: 2.1743 (ft^2)

Wetted Perimeter: 4.7818 (ft)

Average Velocity: 1.0762 (ft/s)

Top Width: 4.4369 (ft)

Froude Number: 0.2709

Critical Depth: 0.3503 (ft)

Critical Velocity: 2.9402 (ft/s)

Critical Slope: 0.0875 (ft/ft)

Critical Top Width: 2.9645 (ft)

Calculated Max Shear Stress: 0.2435 (lb/ft^2)

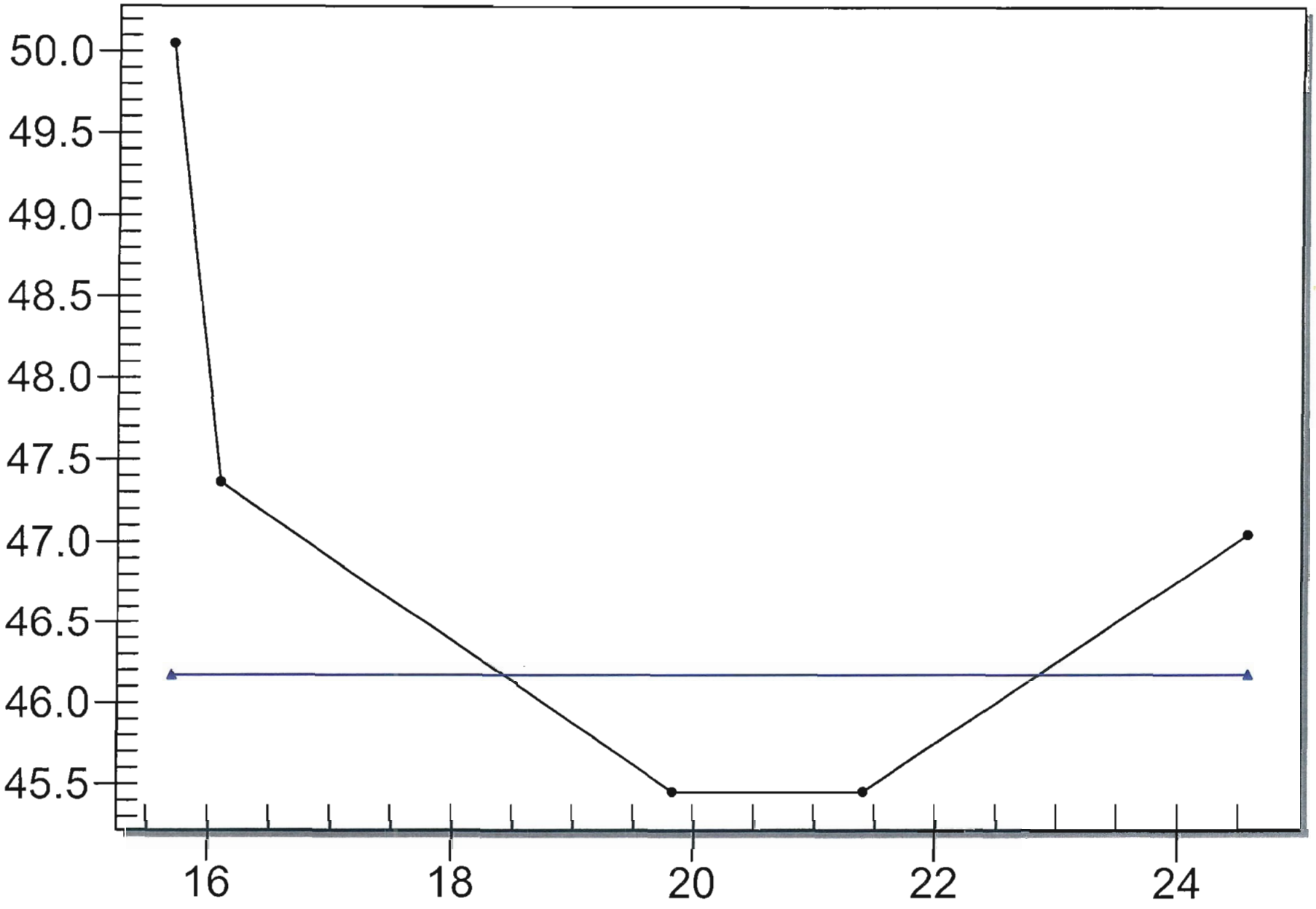
Calculated Avg Shear Stress: 0.1532 (lb/ft^2)

Cross Section Data

Station (ft)	Elevation (ft)	Mannings
15.70	50.05	0.0600
16.10	47.36	0.0600
19.83	45.45	0.0600
21.41	45.45	0.0600
24.57	47.03	-----

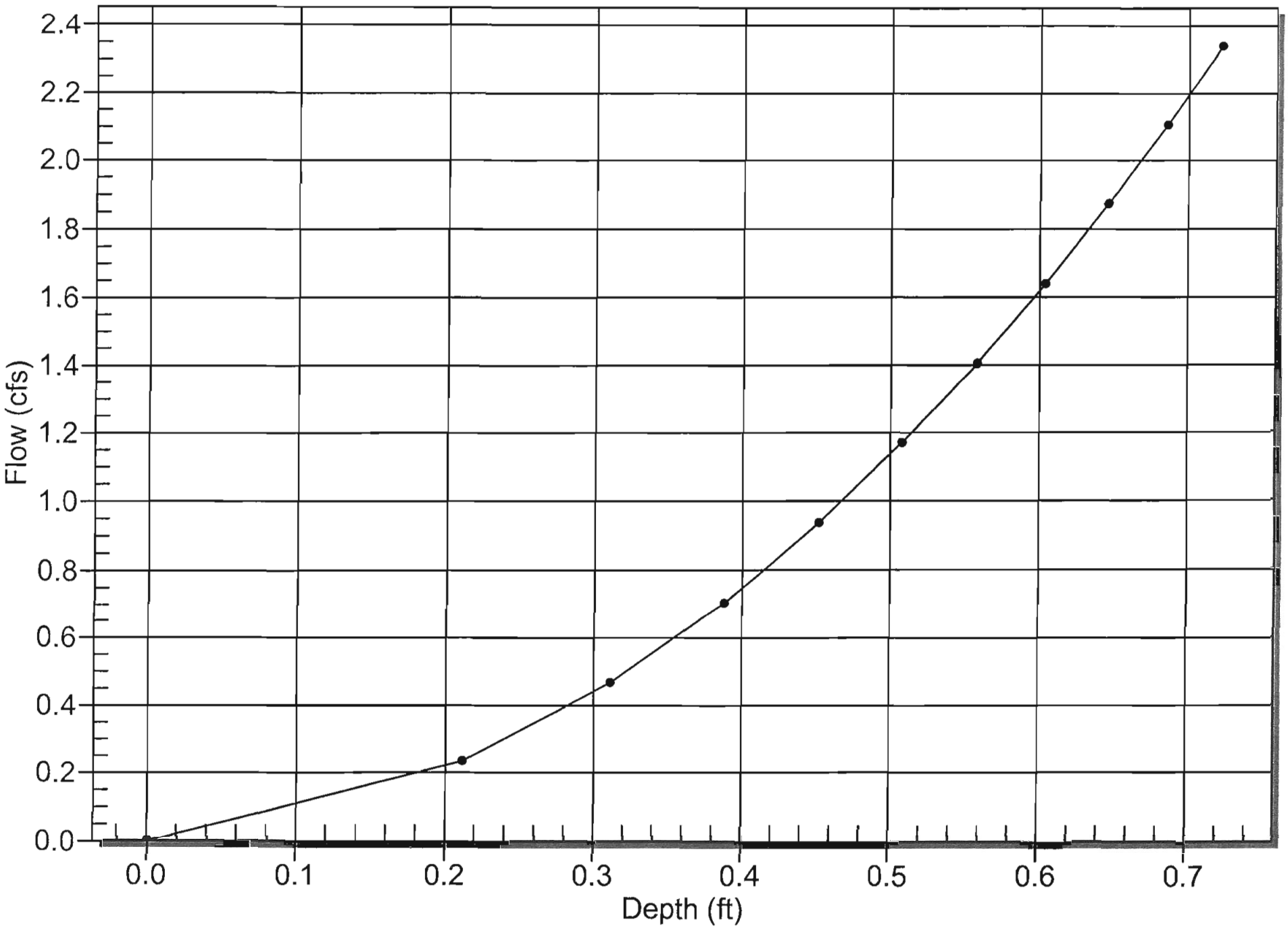
Cross Section

Station 474+00



Flow vs. Depth

Station 474+00



GM2 Associates

Engineers • Inspectors • Surveyors

Job _____ Computed By _____ Date _____

Description _____ Checked By _____ Date _____

Tie In To Busway @ 476+75 _____ Sheet ____ of ____

From Lochner Line Designer

@ Tie in, $CA = 0.332$

System Time = 6.43 min

Swale T_c from Sta 926+00 TO 937+50 0.50 acres

average velocity = 0.41 ft/s

Distance = 1150 Ft $\Rightarrow$ $\frac{1150}{0.41} = 2805$ sec

= 47 min @ 937+50

Swale T_c from Sta 450+50 TO 476+50

average velocity = 1.10 Ft/s

Distance = 2600 Ft $\Rightarrow$ $\frac{2600}{1.10} = 2364$ sec

= 39 min

Total T_c = 86 min

1.43 h $\therefore$ 2.2 in/hr

So flow To low point is

1.13 acres from Track relocation

0.50 acres from Access road

1.63 total acres · 2.2 in/hr · 0.3 = 1.07 CFS TO LOCHNER

Lochner System sized For $\underset{0.332}{CXA}\left(\underset{6.4}{t_c}\right) = \overset{10\text{-yr}}{5.8\ in/hr} = \overset{CFS}{1.93}$

Summary from lochner, System Capacity @ 476+75 2.52 CFS

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

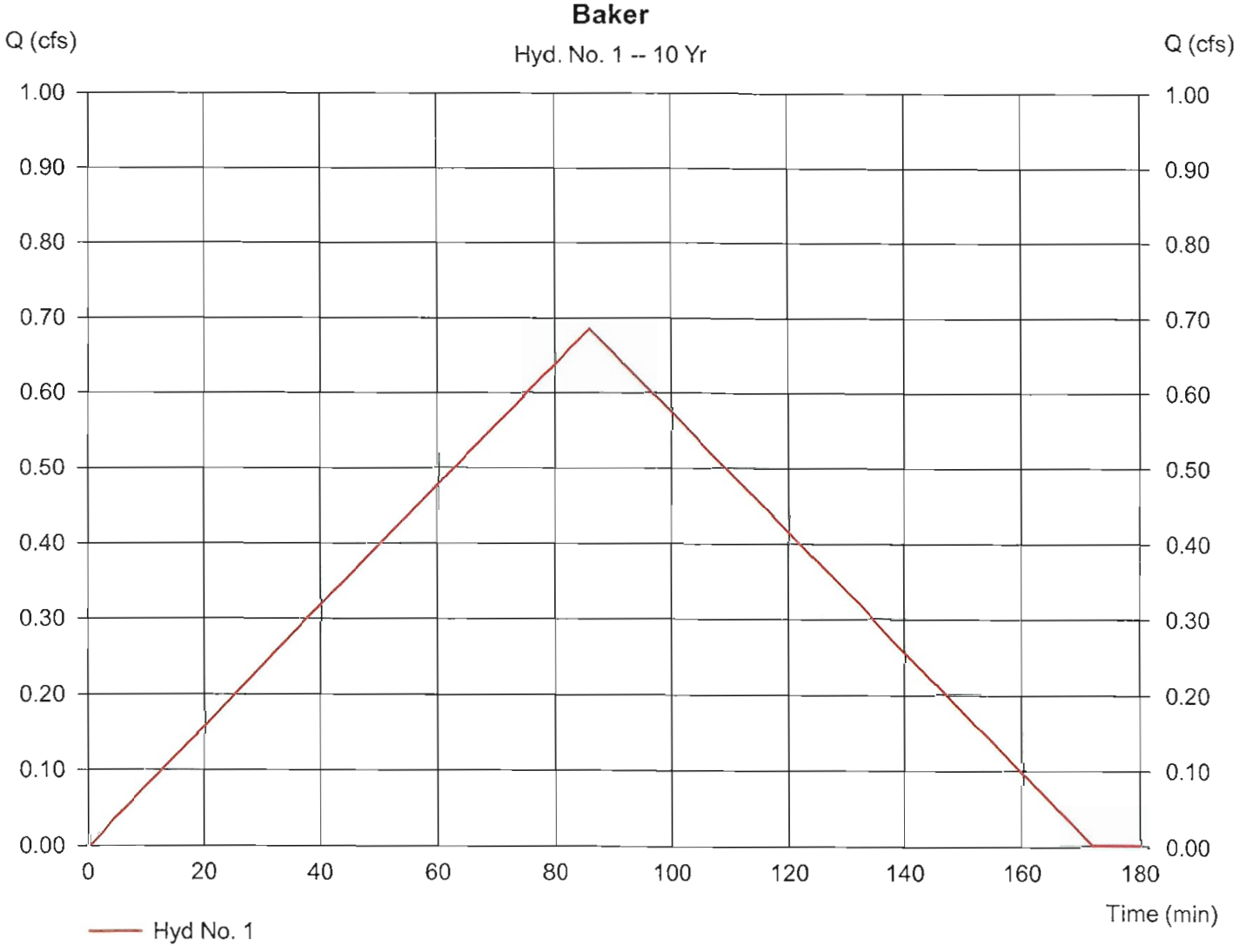
Tuesday, May 11 2010, 2:6 PM

Hyd. No. 1

Baker

Hydrograph type	= Rational	Peak discharge	= 0.68 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 1.630 ac	Runoff coeff.	= 0.3
Intensity	= 1.401 in/hr	Tc by User	= 86.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 3,535 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

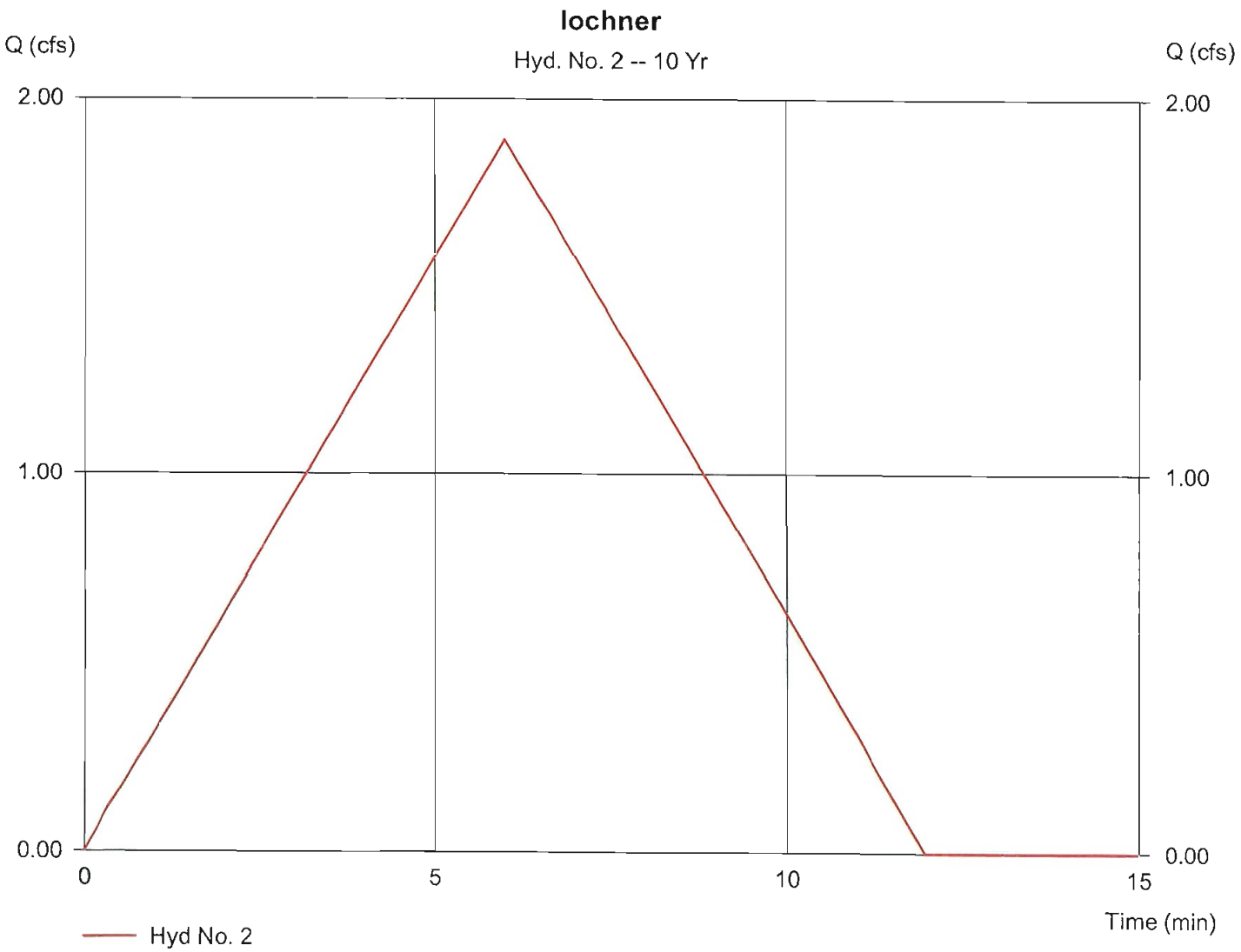
Tuesday, May 11 2010, 2:6 PM

Hyd. No. 2

lochner

Hydrograph type	= Rational	Peak discharge	= 1.89 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 0.664 ac	Runoff coeff.	= 0.5
Intensity	= 5.702 in/hr	Tc by User	= 6.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 682 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

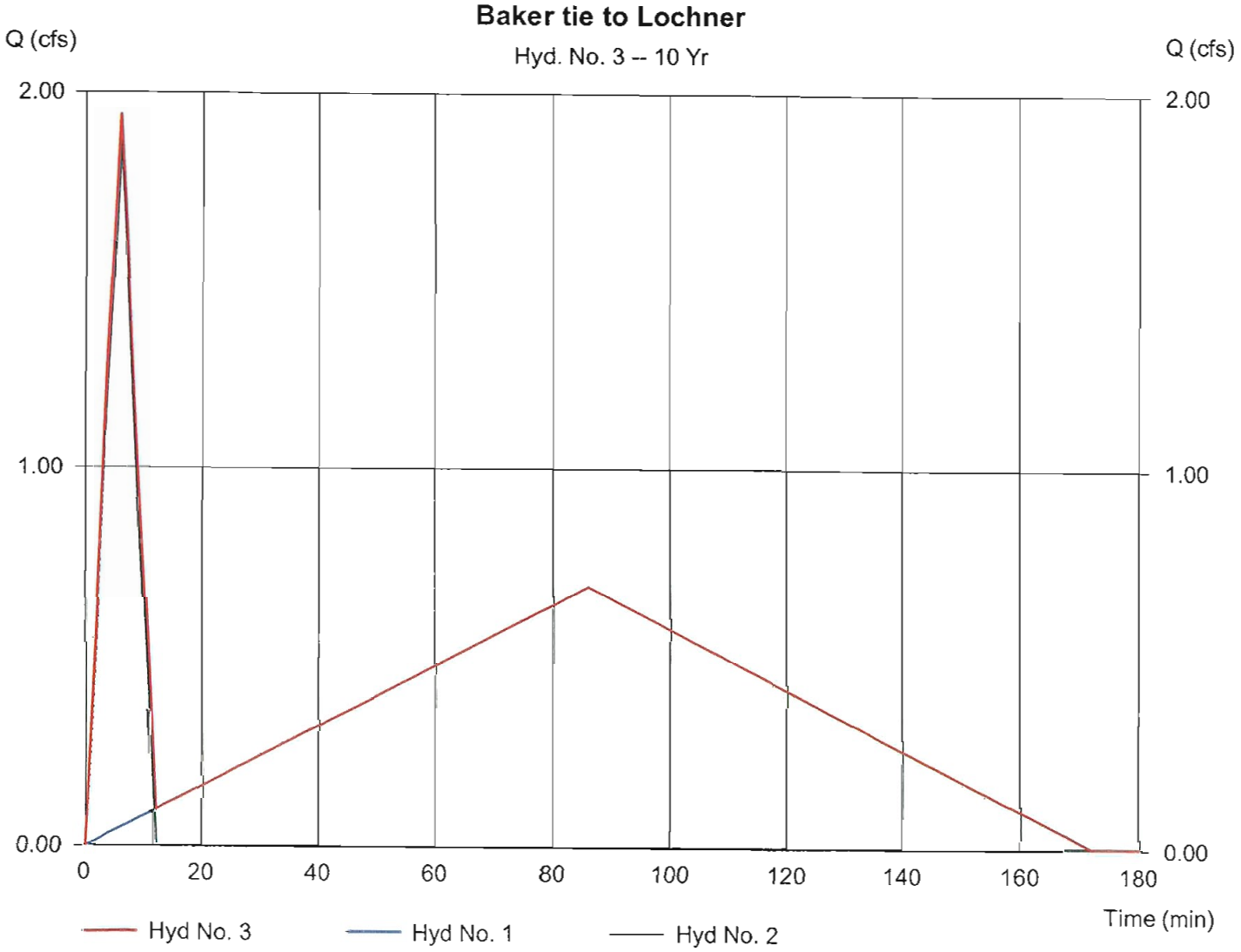
Tuesday, May 11 2010, 2:6 PM

Hyd. No. 3

Baker tie to Lochner

Hydrograph type	= Combine	Peak discharge	= 1.94 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Inflow hyds.	= 1, 2		

Hydrograph Volume = 4,216 cuft



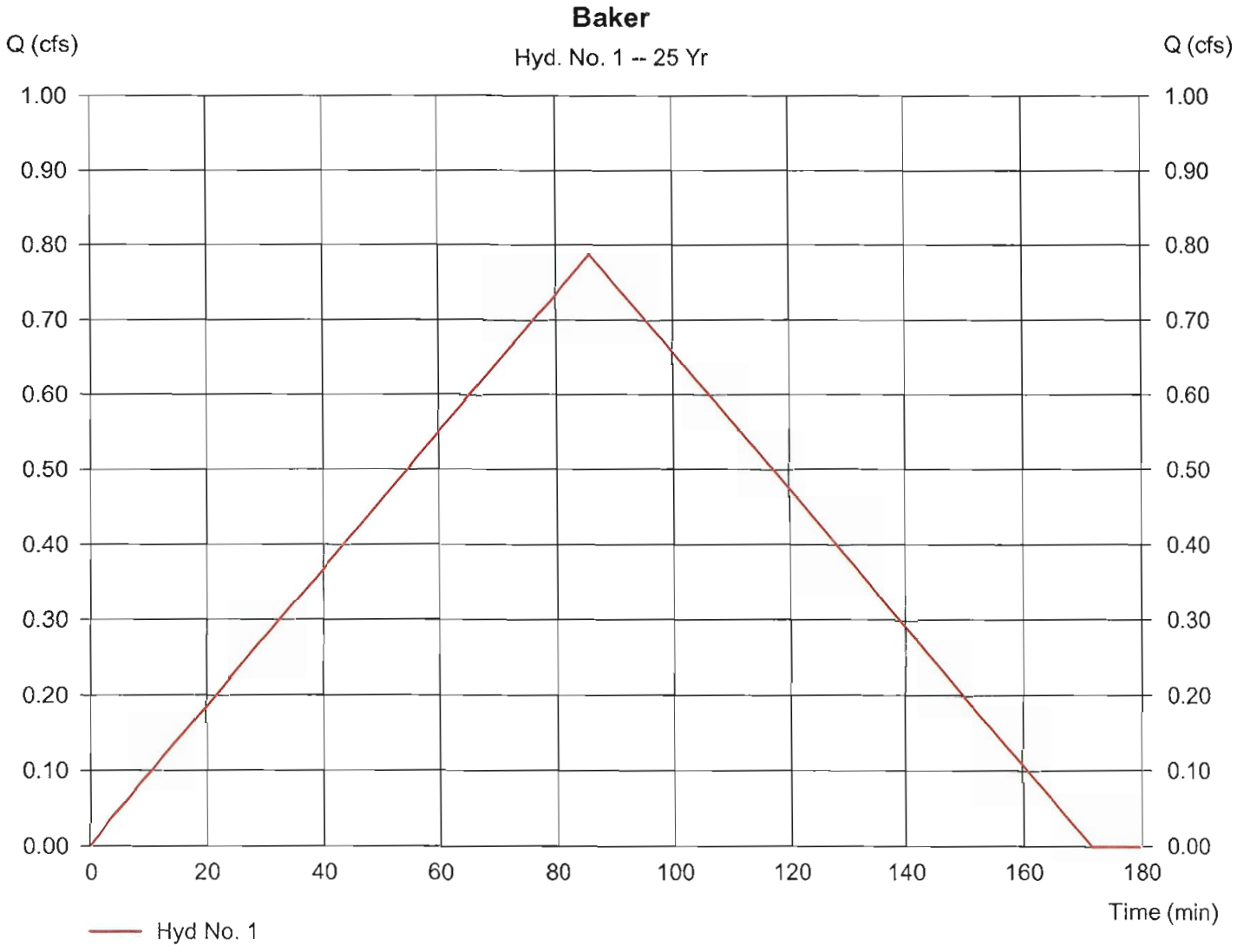
Hydrograph Plot

Hyd. No. 1

Baker

Hydrograph type	= Rational	Peak discharge	= 0.79 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 1.630 ac	Runoff coeff.	= 0.3
Intensity	= 1.612 in/hr	Tc by User	= 86.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 4,067 cuft



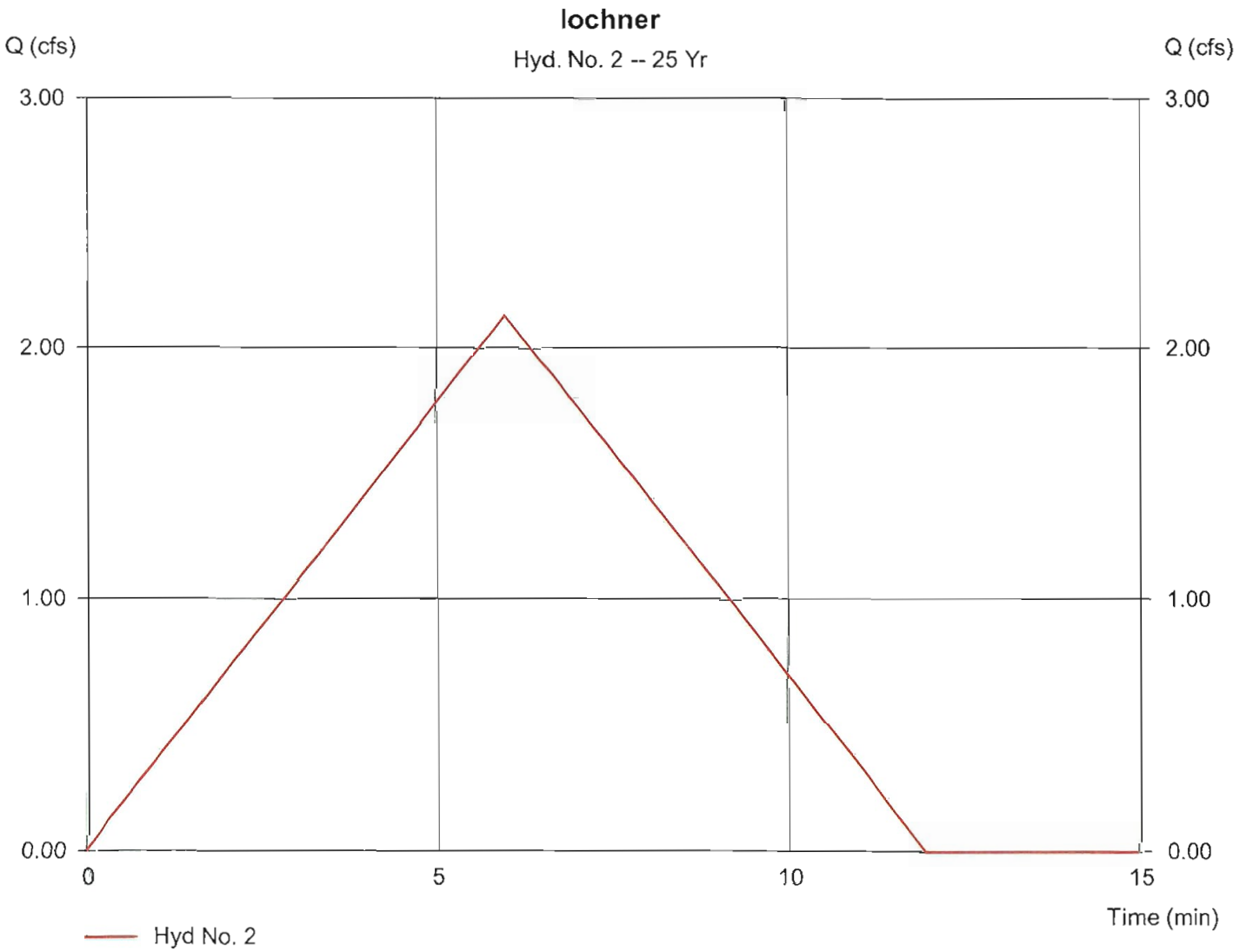
Hydrograph Plot

Hyd. No. 2

lochner

Hydrograph type	= Rational	Peak discharge	= 2.13 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 0.664 ac	Runoff coeff.	= 0.5
Intensity	= 6.423 in/hr	Tc by User	= 6.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 768 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

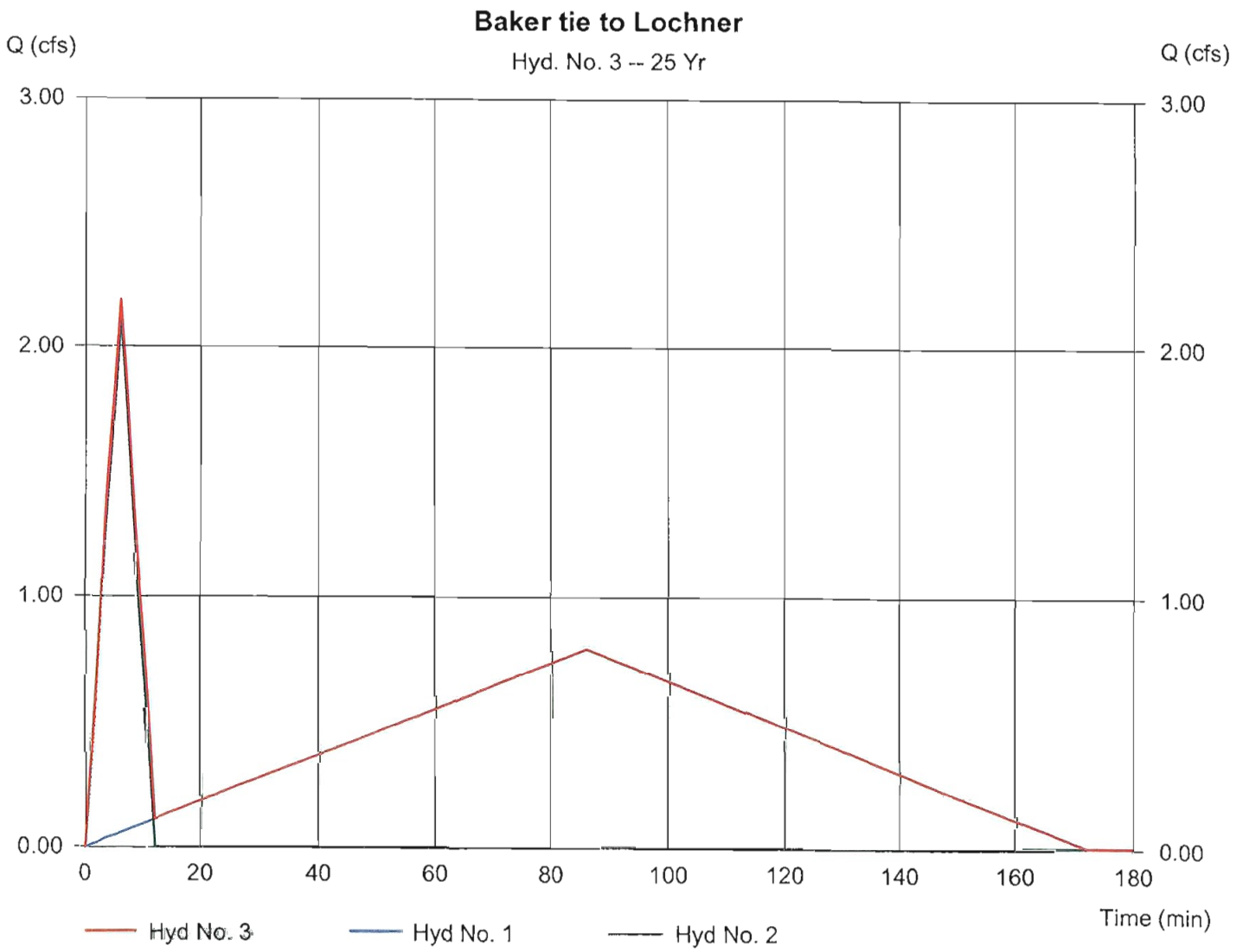
Tuesday, May 11 2010, 2:6 PM

Hyd. No. 3

Baker tie to Lochner

Hydrograph type	= Combine	Peak discharge	= 2.19 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Inflow hyds.	= 1, 2		

Hydrograph Volume = 4,835 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

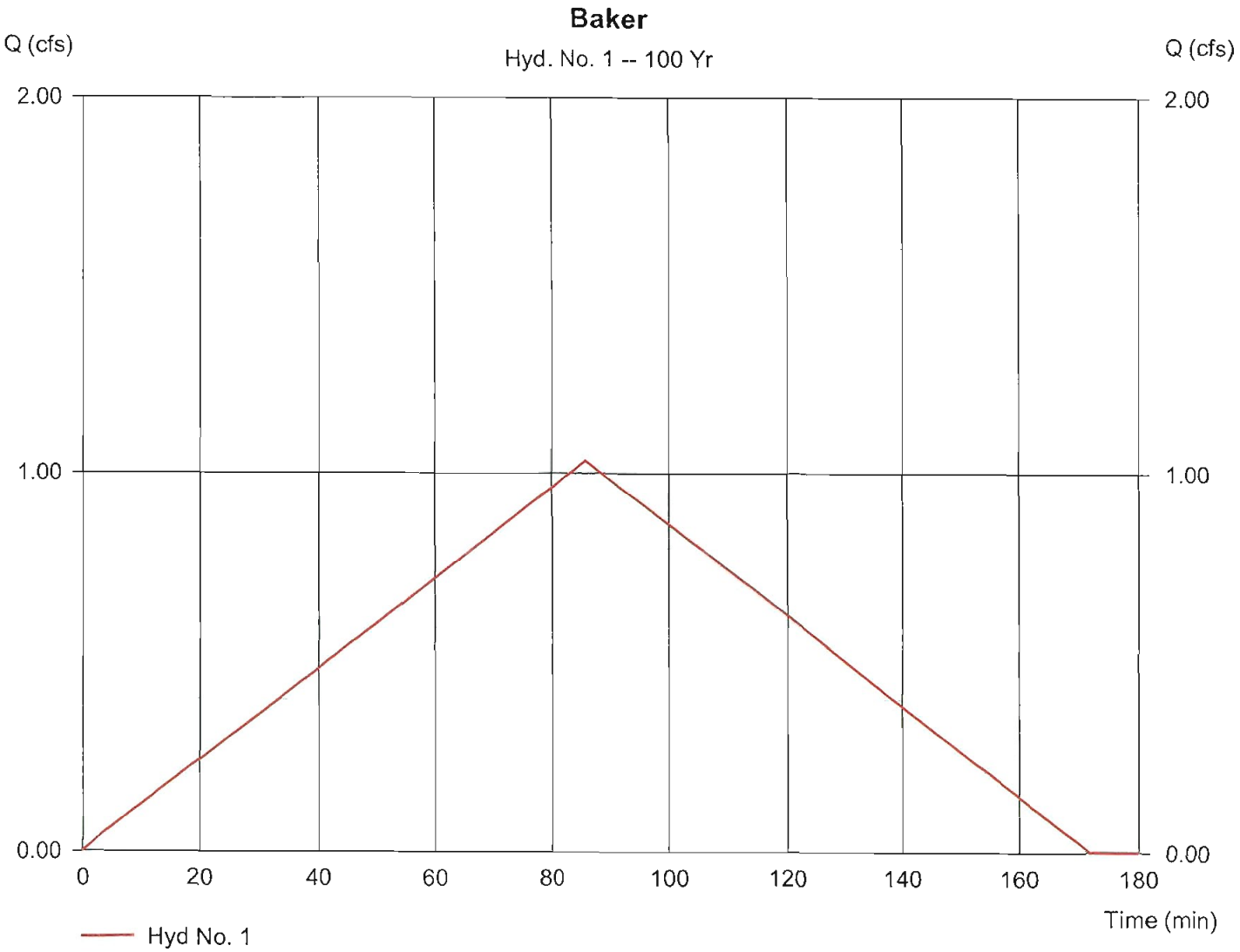
Tuesday, May 11 2010, 2:6 PM

Hyd. No. 1

Baker

Hydrograph type	= Rational	Peak discharge	= 1.03 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.630 ac	Runoff coeff.	= 0.3
Intensity	= 2.111 in/hr	Tc by User	= 86.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 5,326 cuft



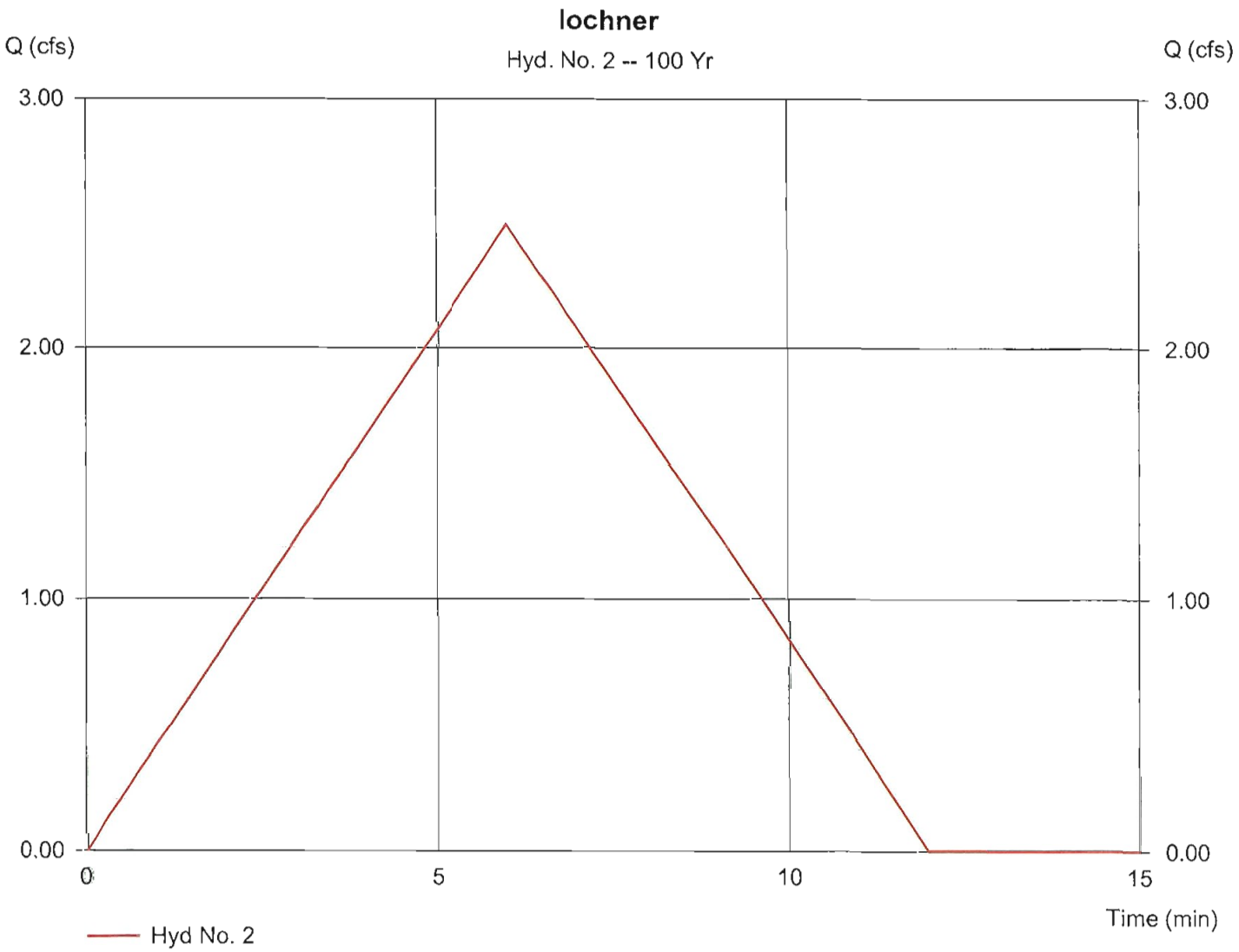
Hydrograph Plot

Hyd. No. 2

lochner

Hydrograph type	= Rational	Peak discharge	= 2.49 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.664 ac	Runoff coeff.	= 0.5
Intensity	= 7.506 in/hr	Tc by User	= 6.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 897 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

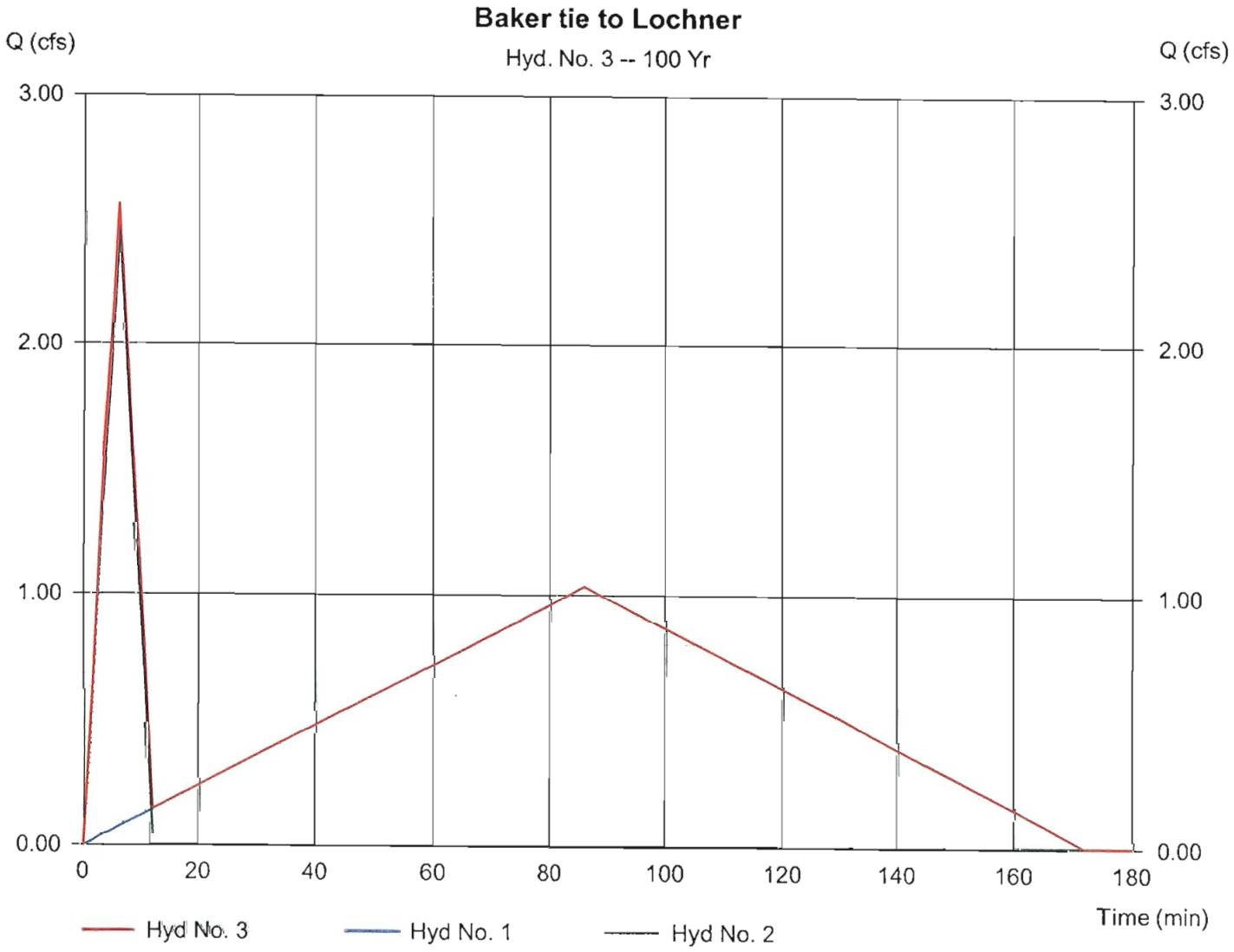
Tuesday, May 11 2010, 2:6 PM

Hyd. No. 3

Baker tie to Lochner

Hydrograph type	= Combine	Peak discharge	= 2.56 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Inflow hyds.	= 1, 2		

Hydrograph Volume = 6,223 cuft



TRACK DRAINAGE OUTLET 6 AREAS BETWEEN STATION SM 53+50 AND STATION SM 59+50 (BASELINE FOR 063-H157)

At the limits of the track relocation project, there is a track drainage swale engineered along the relocated track to collect stormwater runoff. The location of this swale does not lend itself well to feasible outlet points and as such, an infiltration trench has been designed to treat and manage the water. Discussion with the lead design engineer for the Track Relocation Project indicates that the trench will be 2 feet deep and 2 feet wide, constructed beneath the swale. The objective for this design was to determine the minimum length of trench required to treat and manage the 100-year event for this swale.

The contributing area for this swale as determined from the design cross sections is 0.54 acres. The 100-year flow rate was computed using the global parameters as documented in the report introduction (runoff coefficient of 0.3 and time of concentration of 10 min). This design flow rate is 1.0-cfs.

The volume of runoff associated with the 100-year event was determined by generating a 100-year flood hydrograph using the rational method. Parameters for this hydrograph are as stated before, with the time base of the hydrograph being set equal to $2T_c$ and the time to peak equal to T_c. The time base was established following guidelines set forth in HDS 2 (§ 6.4.2). As a result, the infiltration trench would need to be able to store 637 cu ft of runoff.

Given that the gradation of stone for an infiltration trench is between 1.5 and 3 inches, porosity for that material is generally accepted as 40% void space. Knowing the depth and width of the trench, the length required to provide the required storage was computed:

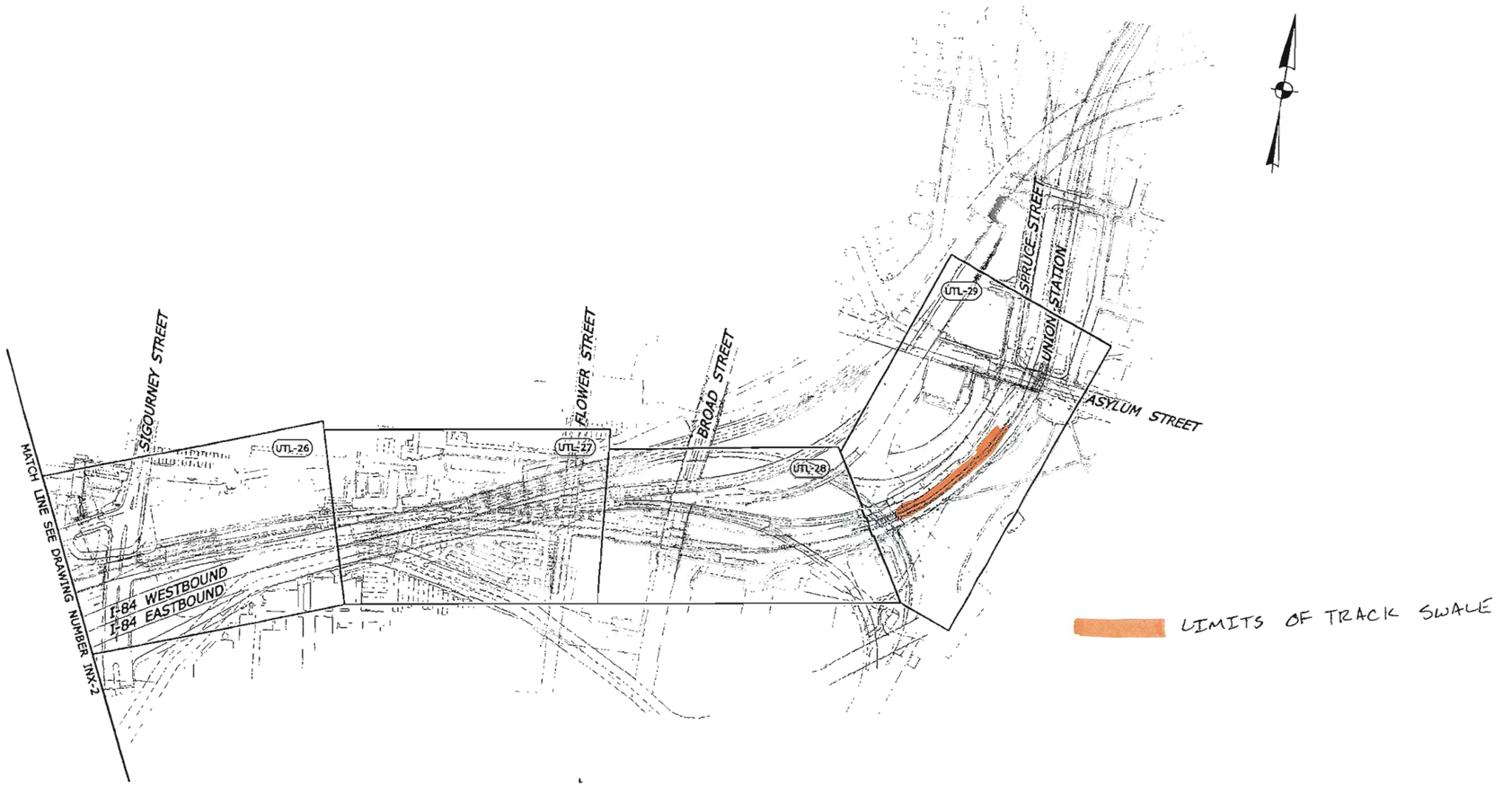
$$D \cdot W \cdot L \cdot 0.40 = 640 cuft$$

Depth and width were given as 2 feet (square), which resulted in a length of trench required as 400'.

Associated with infiltration trench design is the detention time of the stored water. Following best management practices as recommended in the DEP 2004 Stormwater Quality Manual, infiltration trenches should be designed to fully drain within 72 hours (maximum). The effective surface area of the proposed trench is 800 sf, which with an infiltration rate of 0.3 inches per hour (minimum/assumed) would yield full infiltration of the 100-year event at 80 hours. To achieve the 72 hour maximum detention time, the required surface area for the trench was reassessed and computed to be 890 sf. This would equate to a trench 2 feet wide by **445 feet long.**

All computations associated with the design of the infiltration trench are included within this report section.

Field verification of the infiltration assumptions should be conducted prior to the construction of the swale (percolation test). Additionally test pits or borings may be required if not yet available. The bottom of the infiltration trench should be 5 feet above any restrictive layer including bedrock or seasonal high soil water. Results from the field verification may require a trench design change if the percolation rate is less than .3 inches/hour or if a restrictive layer is within 5 feet of the trench.



INDEX PLAN

500 250 0 500

LEGEND

(HWY-XX) GENERAL ROADWAY PLAN DWG NO.

(SED-XX) SEDIMENTATION AND EROSION CONTROL PLAN DWG NO.

(UTL-XX) AMTRAK C&S AND LEVEL 3 RELOCATION DWGS.

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK, SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE CONDITIONS OF ACTUAL QUANTITIES OF WORK WHICH WILL BE REQUIRED.

Plotted: 5/20/2010

DESIGNER/DRAFTER: CJF
CHECKED BY: ALM
SCALE AS NOTED

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\NW_MSH_093_H052_INX-03.dgn

MICHAEL BAKER ENGINEERING, INC.
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY
AMTRAK ACCESS ROAD

TOWN:
NEWINGTON, WEST HARTFORD & HARTFORD

DRAWING TITLE:
INDEX PLAN

PROJECT NO. 093-H052
DRAWING NO. INX-03
SHEET NO. S

GM2 Associates

Engineers • Inspectors • Surveyors

Job _____ Computed By _____ Date _____

Description _____ Checked By _____ Date _____

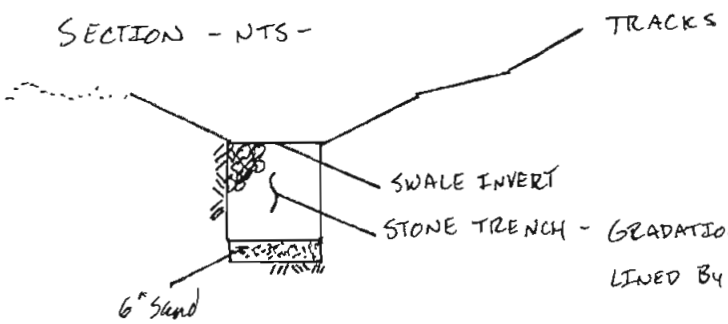
_____ Sheet _____ of _____

SWALE BETWEEN SM 59+50 and SM 53+50

OBJECTIVE - DETERMINE LENGTH OF INFILTRATION TRENCH FOR SWALE

- DISCUSSION WITH LEAD DESIGN ENGINEER INDICATES TRENCH WILL BE 2' DEEP & 2' WIDE, BENEATH SWALE INVERT

SECTION - NTS -



DESIGN Contributing area = 0.54 ac

Runoff Coef = 0.3

Design Storm (100-yr) = 6.5"

LENGTH FOR STORAGE - ASSUME 40% VOIDS

RUNOFF VOLUME = 637 CUFT Say 640 CUFT

	D	W	L	VOIDS	STORAGE
Trench area =	2'	x 2'	x L	x 0.40	= 640

$L = 400'$

THIS YIELDS SURFACE AREA OF 800 SF

DETENTION TIME ASSOCIATED IS 24" / 0.3 in/hr = 80 hrs - TOO LONG

72 hrs MAX. SURFACE AREA NEEDED

$A = \frac{12 \cdot V}{P N T} = 889$ Say 890 SF

V = VOLUME = 640 CUFT

P = infiltration rate = 0.3 in/hr

N = Void space = 0.4

T = Time = 72 hrs

Trench = 445' LONG

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Thursday, May 13 2010, 8:24 AM

Hyd. No. 1

Infiltration trench

Hydrograph type	= Rational	Peak discharge	= 1.06 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.540 ac	Runoff coeff.	= 0.3
Intensity	= 6.554 in/hr	Tc by User	= 10.00 min
IDF Curve	= connecticut.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 637 cuft