NEW BRITAIN – HARTFORD BUSWAY

STATE PROJECT NO. 171-305
CONTRACT NO. 88-H034

DRAINAGE DESIGN REPORT

November 25, 2008

Revised: April 10, 2009

Revised: September 8, 2009

Revised: March 17, 2010

Close, Jensen and Miller, P.C.
1137 Silas Deane Highway
Wethersfield, Connecticut 06109
(860) 563-9375

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STATE PROJECT NO. 171-305
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PROJECT DESCRIPTION:

The project will construct a new dedicated Bus Rapid Transit (BRT) facility along the abandoned railroad right-if-way from New Britain to Hartford. This busway will be exclusively reserved for buses. No automobiles and other personal motor vehicles are anticipated to use the facility. The typical roadway section will include 12-ft. wide travel lanes in each direction and 4-ft. wide shoulders for drainage and safety. Additionally, a 12.5-ft. wide multi-use trail will be constructed along the west side of the busway travel lanes. Protective fencing will be constructed between the multi-use trail and busway lanes. Concrete curbing will be installed along the southbound busway lanes to provide vertical separation between the multi-use trail and busway. The busway project consists of five individual contracts. Contract No. 88-H034 begins at Sta. 118+00 in the Town of New Britain/Newington town line and runs northerly into the Town of Newington and ends at Sta. 203+00 just south of Newington Junction. The total length of this contract is 8,500 ft. (1.61 miles).

Mapping:

Close, Jensen and Miller (CJM) utilized the existing survey mapping and information provided by the Connecticut Department of Transportation (ConnDOT) to develop the drainage design and estimate the contributing drainage areas that are collected by the proposed drainage systems. Additionally, CJM used topographic maps from the Metropolitan District Commission (MDC) to estimate the larger off-site contributing drainage areas and times of concentration for the applicable drainage systems that have watershed boundaries beyond the limits of the ConnDOT survey. Various as-built plans and field visits were used to supplement the survey information when necessary.

Storm Design Criteria:

The proposed busway drainage systems where designed utilizing the Rational Method and the ConnDOT 10-Year Storm to estimate the peak discharge rates for sizing drainage pipes, sumps, swales, ditches and channels. The time of concentration estimates were based on the methodology shown in the latest ConnDOT Drainage Manual. HEC-22 was used to calculate travel time for unpaved shallow concentrated flow sections to more accurately estimate travel time.

The temporary lining designs are sized using the ConnDOT 2-year storm peak discharges and the permanent lining designs are sized using the ConnDOT 10-year storm.

The proposed cross culverts were designed in accordance with the requirements of Chapter 8 in the ConnDOT Drainage Manual. In addition, CJM utilized the FHWA HY-8 Culvert analysis program to estimate the hydraulic characteristics of the proposed culverts.

Proposed outlet protection for the various drainage systems was designed using Chapter 8.7 of the Drainage Manual. Preformed scour holes were used at the culvert outlets to minimize the erosion potential to downstream properties and to reduce wetland impact.

DESIGN SCOPE:

This drainage design report contains all of the calculations required to evaluate and size the numerous drainage systems required to adequately drain stormwater from the project area. This report contains all the required gutter flow computations, swale/channel lining designs, sump design and storm sewer pipe system design computations required to construct the project.

It should be noted that the drainage condition survey report was previously submitted and is not included in this report.

Stormwater Quality:

The cleansing of stormwater will predominantly be done by the use of sheet flow over grass and grass lined swales. Half of the busway has no curbing which allows surface runoff to sheet-flow away. The other side of the Busway has a curb and the surface runoff is collected by catch basins. All systems catching runoff consist of one or two basins except one. These small systems either discharge into a swale or onto a riprap apron converting the discharge back to sheet flow. The one system that is larger which collects from the adjacent project HO-35 and the East Street Station area will pass through a water quality basin.

Computer Programs Used:

CJM utilized a storm sewer computer program developed by InteliSolve, called "HydraFlow Storm Sewers 2005, Version 11.0.0.09". This program performs both gutter flow and pipe system calculations using the HEC-22 methodology. Channel lining design was performed using the "Hydrain Intergrated Drainage Design Computer System, Version 6.1" computer program. The HYCHL computer program module for the Hydrain Program was used to verify stability of the proposed linings. This program is based on the HEC-15 and 11 methodology.

In addition, the "Hydrocad" program was used to develop time of concentration estimates and peak discharge rates for the proposed drainage systems.

Sedimentation and Erosion Control

The sedimentation and erosion control measures proposed are generally in compliance with the "2002 Connecticut Guidelines for Soil Erosion and Sedimentation Control" published by the Connecticut Council on Soil and Water Conservation." Stormwater quality measures will generally be in line with the "2004 Connecticut Stormwater Quality Manual" published by the Connecticut Department of Environmental Protection."

The proposed erosion and sedimentation control plan utilizes standard erosion control measures such as filter fabric fencing, hay bales, erosion control linings or matting, etc., to contain sediments within the project limits. Where special erosion control measures are required, (i.e. inlets and outlets of the major drainage culverts), measures such as riprap scour holes, riprap splash pads, hay bale dikes or stone dikes will be used to protect sensitive downstream areas from sediment. All new outlet pipes are protected with appropriate outlet protection measures to reduce erosion concerns.

STRUCTURE SUMMARY

Prepared for
State of Connecticut
Department of Transportation
New Britain-Hartford Busway
Contract No. 88-H035
April 10, 2009

Structure	Station	Offset	Type	Comment
SB Off-1 (URS)	118+00	42' Lt.	CL' CB	
SB-1 (URS)	118+00	16 Lt.	C' CB	
NB-3 (URS)	118+00	25' Rt.	C' CB	
SB-F1	121+12	31' Lt.	C' CB	Flanker Basin
SB-3	122+25	19' Lt.	C' CB	Low Point
NB-1	122+25	27' Rt.	CL' CB	Low Point
SB-F2	122+75	16' Lt.	C' CB	Flanker Basin
NB-2	123+30	17' Rt.	C' CB	
SB MH-1	130+17	42' Lt.	Manhole	At Ex. RCP
SB-8	135+50	25' Lt.	C' CB	
SB-9	138+50	18' Lt.	C' CB	
SB Off-2	141+50	39' Lt.	CL' CB	
NB Off-1	141+50	26' Rt.	CL' CB	
MH-1	141+50	20' Lt.	Manhole	
MH-2	144+50	20' Lt.	Manhole	
SB Off-3	145+25	35' Lt.	CL' CB	
MH-3	145+25	20' Lt.	Manhole	
SB-12	145+64	16' Lt.	C' CB	Low Point
NB-4	145+64	16' Rt.	CL' CB	Low Point
SB Off-4	148+00	38' Lt.	CL' CB	
MH-S52	148+00	24' Rt.	Manhole	
SB Off-5	150+09	41' Lt.	CL' CB	
MH-S51	150+09	20' Rt.	Manhole	
SB-15	153+00	31' Lt.	C' CB	
SB-16	155+80	20' Lt.	CL' CB	
MH-4	156+56	30' Rt.	Manhole	
SB-18	159+85	16' Lt.	C' CB	Low Point
NB-5	159+85	16' Rt.	CL' CB	Low Point
SB Off-7	164+50	46' Lt.	CL' CB	
SB-22	171+65	16 Lt.	C' CB	Low Point
NB-6	171+65	16' Rt.	CL' CB	Low Point
SB-24	179+50	16' Rt.	Manhole	
SB-25	180+40	16' Rt.	C' CB	
NB-7	180+40	16' Lt.	CL' CB	
SB-27	186+00	16' Rt.	C' CB	Low Point
NB-8	186+00	16' Lt.	CL' CB	Low Point
FMH-1	192+70	16' Rt.	Manhole	
FMH-2	193+35	58' Lt.	Manhole	
Site 4A Culvert	194+00	55' Lt.	CL' CB Dbl. Grate	
SB-30	194+00	42' Lt.	C' CB	
SB-31	196+99	16' Lt.	C' CB	Low Point
NB-9	196+99	16' Rt.	CL' CB	Low Point
SB-32	196+99	42' Lt.	C' CB	
LS-1 (Lester St.)	1+13	30' Lt.	C' CB	
LS-2 (Lester St.)	1+18	35' Rt.	C' CB	

Project No.	171-305
Roadway	NB-HARTFORD BUSWAY
Town	NB/NEWINGTON
Date	APRIL 2009
Designed By	CLOSE, JENSEN AND MILLER
Signature of Engineer	D.J. Hibbert

Drainage Design Checklist (Plans 50% Complete)

Allow a 6-8 week review time

See ***Note*** below.

Semi-Final Design Checklist (Plans 60% to 70% Complete)

Allow a 5-6 week review time

Note: A separate, earlier drainage submission (at approximately 50% completion) may be required if the drainage design is particularly complicated, requires significant right of way and/or otherwise might jeopardize the schedule of the project. **This checklist MUST accompany both of these submissions.**

Indicate which submission this checklist is for and include the following information:

☐ *Drainage Design Submission* ☒ *Semi-Final Design Submission*

a. Draft Drainage Report

1. Disposition of Preliminary Design/Drainage Design Submission comments with written responses justifying comments not incorporated.
   ☒ Included ☐ Not Included ☐ Not Applicable
2. A condition survey of the existing drainage pipes and structures that are to remain in use should be investigated for structural adequacy and documented. (See Section 3.6.3.)
   ☐ Included ☒ Not Included ☐ Not Applicable
3. The condition of existing ditches that are to remain in use should be field inspected, analyzed and results documented to verify their stability and the need for cleaning and reshaping.
   ☐ Included ☐ Not Included ☒ Not Applicable
4. The condition of the outlet at the existing discharge points should be investigated and documented to ensure no erosion or sediment problems exist. If outlet protection is required, it should be incorporated into the project and computations submitted.
   ☐ Included ☒ Not Included ☐ Not Applicable

5. A condition survey report including items 2, 3, and 4 above. (See Appendix A and B, Chapter 4)
   ☐ Included ☒ Not Included ☐ Not Applicable
6. Drainage design computations should include gutter flow analysis, storm sewer design, and hydraulic gradeline (HGL). The hydraulic gradeline should be analyzed to ensure 0.3m (1 ft) freeboard is maintained at drainage structures. This analysis should consider all friction, entrance, junction, exit and bend losses. Designer to verify that the proposed drainage will not adversely impact the existing downstream storm system or property owners. (See Chapter 11, Storm Drainage Systems.)
   ☒ Included ☐ Not Included ☐ Not Applicable
7. Drainage computations should identify structures by station and offset rather than by a numerical identifier. If station and offset is not feasible for the computations then include an index with the location of the structure corresponding to its numerical identifier. The watershed map should be prepared accordingly.
   ☒ Included ☐ Not Included ☐ Not Applicable
8. Existing drainage systems shall be analyzed for hydraulic adequacy to meet the proposed conditions and, if found inadequate, an upgrade will be designed in conformance with the criteria established in the Drainage Manual.
   ☐ Included ☒ Not Included ☐ Not Applicable
9. All roadway drainage systems should be brought to a suitable outlet.
   ☒ Included ☐ Not Included ☐ Not Applicable
10. If upgrading of pipes downstream of the project is necessary, then additional rights may need to be acquired.
    ☐ Included ☐ Not Included ☒ Not Applicable
11. The need for temporary drainage should be addressed. Temporary drainage computations should be prepared in accordance with criteria in the Drainage Manual. (See Section 3.6.11.)
    ☒ Included ☐ Not Included ☐ Not Applicable
12. Proposed swales, ditches and channels should be designed in accordance with HEC-15 for discharges 1.42 m^3/s (50 ft^3/s) and less or HEC-11 for discharges in excess of 1.42 m^3/s (50 ft^3/s). (See Chapter 7, Channels.)
    ☒ Included ☐ Not Included ☐ Not Applicable
13. Minor and small cross culvert design computations with culvert data sheet. (See Chapter 8, Culverts.)
    ☒ Included ☐ Not Included ☐ Not Applicable
14. Topographic mapping with watershed area delineated for each inlet and/or cross culverts as required to perform the drainage calculations. The flow path used in the time of concentration calculation and coefficient of imperviousness should be shown for each area. (See Chapter 6, Hydrology.)
    ☒ Included ☐ Not Included ☐ Not Applicable
15. Diversion identified.
    ☐ Included ☐ Not Included ☒ Not Applicable
16. All plans, computations and reports identify the responsible engineers who prepared and checked the work.
    ☒ Included ☐ Not Included ☐ Not Applicable
17. Alternate types of drainage pipe material have been considered and documented.
    ☒ Included ☐ Not Included ☐ Not Applicable

b. Plans, Profiles and Cross Sections

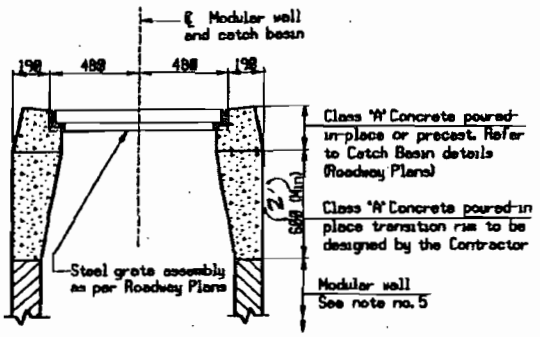
1. The existing and proposed storm drainage shown to their outlets.
   ☒ Included ☐ Not Included ☐ Not Applicable
2. Size and type of existing drainage pipes/structures and disposition of pipes/structures to be abandoned.
   ☒ Included ☐ Not Included ☐ Not Applicable
3. Properties affected by diversions should be shown on the plans so that proper rights can be acquired.
   ☐ Included ☐ Not Included ☒ Not Applicable
4. Drainage Rights and Easements.
   ☐ Included ☒ Not Included ☐ Not Applicable
5. Outlet Protection shown on plans and details provided.
   ☒ Included ☐ Not Included ☐ Not Applicable
6. Intersection grading plans to ensure inlets are located at the low points to alleviate ponding/icing conditions. Top of frame elevation should be shown.
   ☐ Included ☐ Not Included ☒ Not Applicable
7. In areas where cross culverts are being extended, replaced, or where outlet protection is proposed a profile or cross section of the natural ground should be provided to show how the inverts will tie into the existing topography.
   ☒ Included ☐ Not Included ☐ Not Applicable
8. The top of frame and invert elevations for each storm drainage structure shown. Proposed drainage structures shall be identified by station and offset on cross sections.
   ☒ Included ☐ Not Included ☐ Not Applicable
9. Existing and proposed drainage patterns (flow arrows) of pipes, ditches, channel and swales.
   ☒ Included ☐ Not Included ☐ Not Applicable
10. Details for any special drainage structures not found in the Standard Drawings.
    ☒ Included (SEE ATTACHED) ☐ Not Included ☐ Not Applicable
11. The direction of flow should be shown by arrows to 61m (200 ft.) beyond any drainage outlet, or shown to terminate by dissipation or entrance into a watercourse or body of water.
    ☒ Included ☐ Not Included ☐ Not Applicable

c. Structures with drainage areas > 2.59 km^2 (1 mi^2)

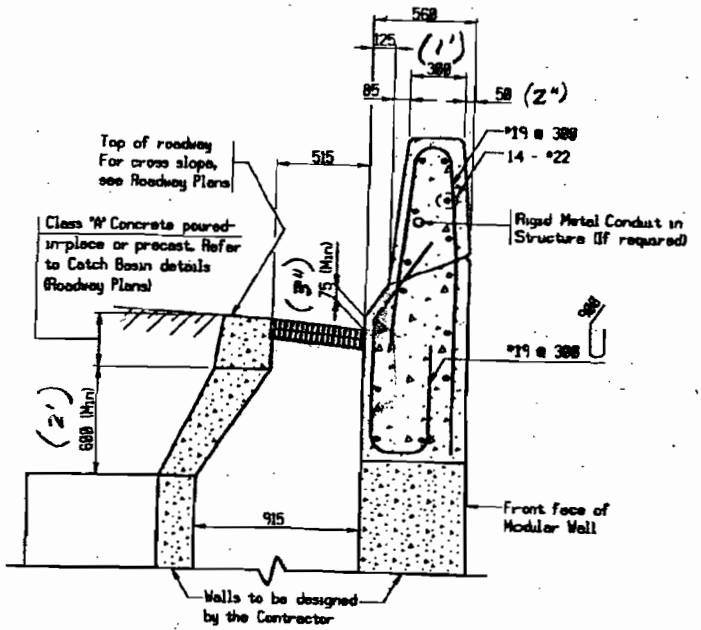
1. Draft hydraulic design report.
   ☐ Included ☐ Not Included ☒ Not Applicable
2. Draft scour report when the proposed structure spans the waterway.
   ☐ Included ☐ Not Included ☒ Not Applicable
3. Draft floodway report.
   ☐ Included ☐ Not Included ☒ Not Applicable
4. Draft SCEL report.
   ☐ Included ☐ Not Included ☒ Not Applicable
5. Draft scour report if required.
   ☐ Included ☐ Not Included ☒ Not Applicable

Provide justification for items **Not Included**. Justification should correspond to letter and number.

a.#2, a.#4, a.#5 – "PREVIOUSLY SUBMITTED"
a.#8 – "PREVIOUSLY SUBMITTED BY GARG CONSULTING SERVICES, INC."
b.#4 – "WILL BE PROVIDED IN SUBSEQUENT SUBMISSIONS"



SECTION AT CATCH BASIN
Scale 1:20



SECTION AT CATCH BASIN/PARAPET
Scale 1:20

NOTES:

1. The dimensions shown on these plans are intended for general reference only for the design and construction of a Modular Wall or Mechanically Stabilized Earth Wall. The Contractor shall verify actual dimensions at the site prior to design and construction.

2. The Contractor shall be responsible in designing and detailing the Modular Wall or Mechanically Stabilized Earth Wall based on the general information and parameters contained in these plans.

3. At locations where the continuity of the wall or footing is interrupted by the presence of pipes or other appurtenances, the integrity of the wall system shall be restored by remedial measures as suggested by the details in these plans.

4. Catch basins and other associated highway drainage items, within the lump sum payment limits for the proprietary wall system, shall be included in the design and construction of the proprietary wall system. These items shall be paid for under the appropriate highway items.

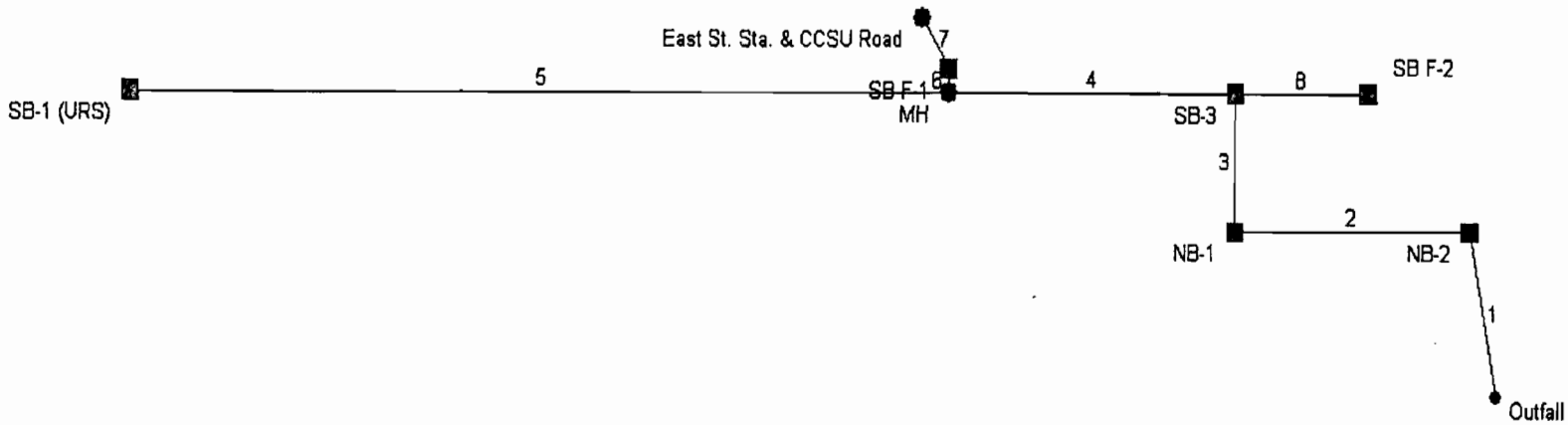
SPECIAL TYPE 'C'
CATCH BASIN
DETAIL
N.T.S.

DRAINAGE CALCULATIONS

SECTION I

STORM SEWER SYSTEM DESIGN

Hydraflow Plan View



Project File: BUSWAY SYSTEM 1.stm	No. Lines: 8	04-14-2010

Hydraflow Storm Sewers 2005

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	NB-2	27.69	30 c	56.0	82.00	82.28	0.500	86.99*	87.25*	0.73	87.98	End
2	NB-1	27.33	30 c	88.0	85.82	86.26	0.500	87.99	88.30	n/a	89.16 i	1
3	SB-3	26.11	30 c	46.0	86.26	86.49	0.500	89.16*	89.35*	0.66	90.01	2
4	MH	25.24	24 c	108.0	86.99	88.86	1.731	90.01*	91.36*	n/a	92.75 i	3
5	SB-1 (URS)	10.42	18 c	308.0	89.36	99.50	3.292	92.75	100.73	n/a	101.86 i	4
6	SB F-1	15.04	18 c	8.0	89.36	89.40	0.500	92.75*	92.92*	n/a	93.28 i	4
7	EAST ST. STA. & C	13.79	18 c	20.0	89.40	89.50	0.500	93.28*	93.63*	0.95	94.58	6
8	SB F-2	0.59	12 c	50.0	87.99	90.39	4.800	90.44	90.72	n/a	90.82 i	3

Project File: BUSWAY SYSTEM 1.stm | Number of lines: 8 | Run Date: 04-14-2010

NOTES: c = cir; e = ellip; b = box; Return period = 10 Yrs. ; *Surcharged (HGL above crown). ; i - Inlet control.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet Ht (In)	Curb Inlet L (ft)	Grate Inlet area (sqft)	Grate Inlet L (ft)	Grate Inlet W (ft)	Gutter So (ft/ft)	Gutter W (ft)	Gutter Sw (ft/ft)	Gutter Sx (ft/ft)	Gutter n	Gutter Depth (ft)	Gutter Spread (ft)	Inlet Depth (ft)	Inlet Spread (ft)	Inlet Depr (in)	Byp line No
1	NB-2	0.66	0.00	0.66	0.00	Grate	0.0	0.00	0.00	3.15	1.64	0.014	4.00	0.040	0.020	0.013	0.14	3.50	0.14	3.50	0.00	2
** 2	NB-1	2.11	0.00	2.11	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.27	9.46	0.27	9.46	0.00	Off
** 3	SB-3	0.84	0.00	0.84	0.00	Grate	0.0	0.00	2.50 *	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.15	3.65	0.15	3.65	0.00	Off
4	MH	0.00	0.03	0.00	0.03	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
5	SB-1 (URS)	0.01*	0.00	0.01	0.00	Grate	0.0	0.00	0.00	3.15	1.64	0.005	4.00	0.040	0.020	0.013	0.04	0.90	0.04	0.90	0.00	4
6	SB F-1	1.75	0.00	1.72	0.03	Grate	0.0	0.00	0.00	3.15	1.64	0.014	4.00	0.040	0.020	0.013	0.20	6.00	0.24	3.83	2.00	4
7	East St. Sta. & C	0.01*	0.00	0.00	0.01	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
8	SB F-2	0.66	0.00	0.66	0.00	Grate	0.0	0.00	0.00	3.15	1.64	0.014	4.00	0.040	0.020	0.013	0.14	3.50	0.17	2.68	2.00	3

* Closing factor of 20%

** Low Point in Sag Condition

Allowable Spread is the gutter + ½ Lane (4' + ½ 12') = 10'

Project File: BUSWAY SYSTEM 1.stm | Number of lines: 8 | Run Date: 04-14-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 101.98 / (Inlet time + 15.80) ^ 0.90; Return period = 25 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	56.0	0.11	1.00	0.90	0.10	0.90	5.0	16.5	3.9	27.69	29.00	5.64	30	0.50	82.28	82.00	87.25	86.99	94.37	82.00	NB-2
2	1	88.0	0.35	0.89	0.90	0.32	0.80	5.0	16.2	3.9	27.33	29.00	6.21	30	0.50	86.26	85.82	88.30	87.99	93.86	94.37	NB-1
3	2	46.0	0.14	0.54	0.90	0.13	0.49	5.0	16.1	3.9	26.11	29.00	5.32	30	0.50	86.49	86.26	89.35	89.16	93.89	93.86	SB-3
4	3	108.0	0.00	0.29	0.00	0.00	0.26	0.0	15.9	3.9	25.24	29.76	8.03	24	1.73	88.86	86.99	91.36	90.01	94.54	93.89	MH
* 5	4	308.0	0.00	0.00	0.00	0.00	0.00	15.0	15.0	0.0	10.42	19.05	6.30	18	3.29	99.50	89.36	100.73	92.75	103.46	94.54	SB-1 (URS)
** 6	4	8.0	0.29	0.29	0.90	0.26	0.26	5.0	10.0	4.8	15.04	7.43	8.51	18	0.50	89.40	89.36	92.92	92.75	94.16	94.54	SB F-1
7	6	20.0	0.00	0.00	0.00	0.00	0.00	10.0	10.0	0.0	13.79	7.43	7.80	18	0.50	89.50	89.40	93.63	93.28	95.11	94.16	EAST ST. STA. &
8	3	50.0	0.11	0.11	0.90	0.10	0.10	5.0	5.0	6.0	0.59	7.80	1.71	12	4.80	90.39	87.99	90.72	90.44	94.09	93.89	SB F-2

* Flow Recieved from Contract HO-35

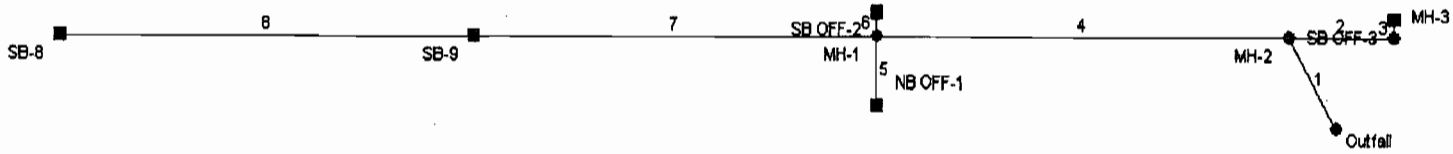
** Flow Recieved from East St Station and Future CCSU Road

Project File: BUSWAY SYSTEM 1.stm | Number of lines: 8 | Run Date: 04-14-2010

NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs.

51

Hydraflow Plan View



Project File: BUSWAY SYSTEM 2.stm	No. Lines: 8	09-17-2009

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	MH-2	14.21	24 c	68.0	77.00	77.72	1.059	78.97	79.06	n/a	79.90 i	End
2	MH-3	8.82	24 c	76.0	77.72	78.10	0.500	79.90	80.01	0.13	80.14	1
3	SB-OFF-3	8.85	24 c	12.0	78.10	78.16	0.500	80.14	80.16	0.12	80.28	2
4	MH-1	10.61	24 c	300.0	77.72	79.22	0.500	79.90	80.58	n/a	81.03 i	1
5	NB OFF-1	1.16	12 c	44.0	80.22	81.10	2.000	81.03	81.56	n/a	81.76 i	4
6	SB OFF-2	8.58	24 c	16.0	79.22	79.30	0.500	81.03	81.05	0.14	81.18	4
7	SB-9	4.12	15 c	294.0	82.00	85.05	1.037	82.81	85.86	n/a	86.36 i	4
8	SB-8	3.07	15 c	300.0	85.05	88.51	1.153	86.36	89.21	n/a	89.60 i	7

Project File: BUSWAY SYSTEM 2.stm | Number of lines: 8 | Run Date: 09-24-2009

NOTES: c = cir; e = ellip; b = box; Return period = 10 Yrs. ; i - Inlet control.

Inlet Report

	Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet Ht (in)	Curb Inlet L (ft)	Grate Inlet area (sqft)	Grate Inlet L (ft)	Grate Inlet W (ft)	Gutter So (ft/ft)	Gutter W (ft)	Gutter Sw (ft/ft)	Gutter Sx (ft/ft)	Gutter n	Gutter Depth (ft)	Gutter Spread (ft)	Inlet Depth (ft)	Inlet Spread (ft)	Inlet Depr (in)	Byp line No
	1	MH-2	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
	2	MH-3	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
*	3	SB OFF-3	8.85	0.00	8.85	0.00	Grate	0.0	0.00	2.50	1.64	3.15	Sag	4.00	0.040	0.020	0.000	0.52	21.82	0.52	21.82	0.00	Off
	4	MH-1	0.00	0.04	0.00	0.04	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
*	5	NB OFF-1	1.16	0.00	1.16	0.00	Grate	0.0	0.00	2.50	1.64	3.15	Sag	4.00	0.040	0.020	0.000	0.13	3.32	0.13	3.32	0.00	Off
*	6	SB OFF-2	8.58	0.00	8.58	0.00	Grate	0.0	0.00	2.50	1.64	3.15	Sag	4.00	0.040	0.020	0.000	0.51	21.30	0.51	21.30	0.00	Off
	7	SB-9	1.35	0.34	1.65	0.04	Grate	0.0	0.00	0.00	1.64	3.15	0.012	4.00	0.040	0.020	0.013	0.20	6.15	0.24	3.89	2.00	4
	8	SB-8	3.07	0.00	2.74	0.34	Grate	0.0	0.00	0.00	1.64	3.15	0.012	4.00	0.040	0.020	0.013	0.25	8.50	0.30	6.57	2.00	7

bypass for 25yr storm is 0.09 CFS

* Includes Clogging factor of 20%

Project File: BUSWAY SYSTEM 2.stm | Number of lines: 8 | Run Date: 02-16-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	68.0	0.00	13.61	0.00	0.00	6.93	5.0	49.6	2.0	14.17	23.27	5.45	24	1.06	77.72	77.00	79.05	78.97	81.90	77.14	MH-2
2	1	76.0	0.00	2.36	0.00	0.00	1.84	5.0	10.1	4.8	8.82	15.99	2.83	24	0.50	78.10	77.72	80.00	79.90	82.10	81.90	MH-3
3	2	12.0	2.36	2.36	0.78	1.84	1.84	10.0	10.0	4.8	8.85	15.99	2.82	24	0.50	78.16	78.10	80.15	80.13	84.40	82.10	SB-OFF-3
4	1	300.0	0.00	11.25	0.00	0.00	5.09	5.0	48.1	2.1	10.61	15.99	4.02	24	0.50	79.22	77.72	80.58	79.90	86.00	81.90	MH-1
5	4	44.0	0.65	0.65	0.37	0.24	0.24	10.0	10.0	4.8	1.16	5.04	2.50	12	2.00	81.10	80.22	81.56	81.03	84.96	86.00	NB OFF-1
6	4	16.0	9.78	9.78	0.42	4.11	4.11	48.0	48.0	2.1	8.58	15.99	2.91	24	0.50	79.30	79.22	81.05	81.03	82.78	86.00	SB OFF-2
7	4	294.0	0.25	0.82	0.90	0.23	0.74	5.0	7.0	5.4	4.02	6.58	4.83	15	1.04	85.05	82.00	85.85	82.80	89.03	86.00	SB-9
8	7	300.0	0.57	0.57	0.90	0.51	0.51	5.0	5.0	6.0	3.07	6.93	3.42	15	1.15	88.51	85.05	89.21	86.34	92.49	89.03	SB-8

Project File: BUSWAY SYSTEM 2.stm | Number of lines: 8 | Run Date: 02-16-2010

NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs.

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	24	23.00	77.00	78.97	1.97	3.13	7.34	0.84	79.81	n/a	68.0	77.72	79.49	1.77	2.94	7.81	0.95	80.44i	n/a	n/a	-0.316	1.00	n/a
2	24	8.85	77.72	81.18	2.00	3.14	2.82	0.12	81.31	0.153	76.0	78.10	81.30	2.00	3.14	2.82	0.12	81.42	0.153	0.153	0.116	1.00	0.12
3	24	8.85	78.10	81.42	2.00	3.14	2.82	0.12	81.55	0.153	12.0	78.16	81.44	2.00	3.14	2.82	0.12	81.56	0.153	0.153	0.018	1.00	0.12
4	24	14.16	77.72	81.18	2.00	3.14	4.51	0.32	81.50	0.392	300	79.22	82.36	2.00	3.14	4.51	0.32	82.67	0.392	0.392	1.176	1.00	0.32
5	12	1.16	80.22	82.96	1.00	0.79	1.47	0.03	82.99	0.105	44.0	81.10	83.00	1.00	0.79	1.47	0.03	83.04	0.105	0.105	0.046	1.00	0.03
6	24	8.58	79.22	82.87	2.00	3.14	2.73	0.12	82.99	0.144	16.0	79.30	82.90	2.00	3.14	2.73	0.12	83.01	0.144	0.144	0.023	1.00	0.12
7	15	4.42	82.00	82.84	0.84*	0.88	5.03	0.39	83.23	n/a	294	85.05	85.89	0.84**	0.88	5.03	0.39	86.29i	n/a	n/a	n/a	0.50	n/a
8	15	3.07	85.05	86.42	1.25	1.23	2.50	0.10	86.52	n/a	300	88.51	89.21 j	0.70**	0.71	4.33	0.29	89.50i	n/a	n/a	2.692	1.00	n/a

Project File: BUSWAY SYSTEM 2.stm | Number of lines: 8 | Run Date: 09-17-2009

Notes: * Critical depth assumed.; ** Critical depth.; j-Line contains hyd. jump.

SYSTEM 2

24" RCP $Q = 20.27$ CFS $V_{el.} = 7.13$ Ft/s

Based on Table 11-12.1 In The Drainage Manual
A Scour Hole will Be Used

TYPE 1

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

$$d_{50} = (0.0125 (2)^2/2)(23.00/2^{2.5})^{1.333} = 0.162$$

$0.162 < 0.42$ USE MODIFIED RIPRAP

From Table 11-14.1 Drainage Manual

$B = 10'$ $C = 12'$ $d = 12"$ $1\,Sp = 4'$ $3\,Sp = 6'$

$F = 1'$

```
      ******  HYCHL  ****** (Version 6.1) ******          Date 08-24-2009
Commands Read From File: E:\HYCHL\DATA\BUSWAY.CHL

      JOB BUSWAY CH2
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .0163  26.66
      TRP 10 3 3
** LEFT SIDE SLOPE    3.0 AND RIGHT SIDE SLOPE    3.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)   10.00
      END
***************END OF COMMAND FILE************
```

CHANNEL LOCATED AT SYSTEM OUTLET 2
FLOW TO CHANNEL FROM SYSTEM 3 23.00CFS, SYSTEM 4 2.8CFS, SWALE 4 0.71CFS, SWALE 7 0.15CFS TOTAL OF 26.66CFS

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s): 26.66
CHANNEL SHAPE: TRAPEZOIDAL
CHANNEL SLOPE (ft/ft): .016

RESULTS

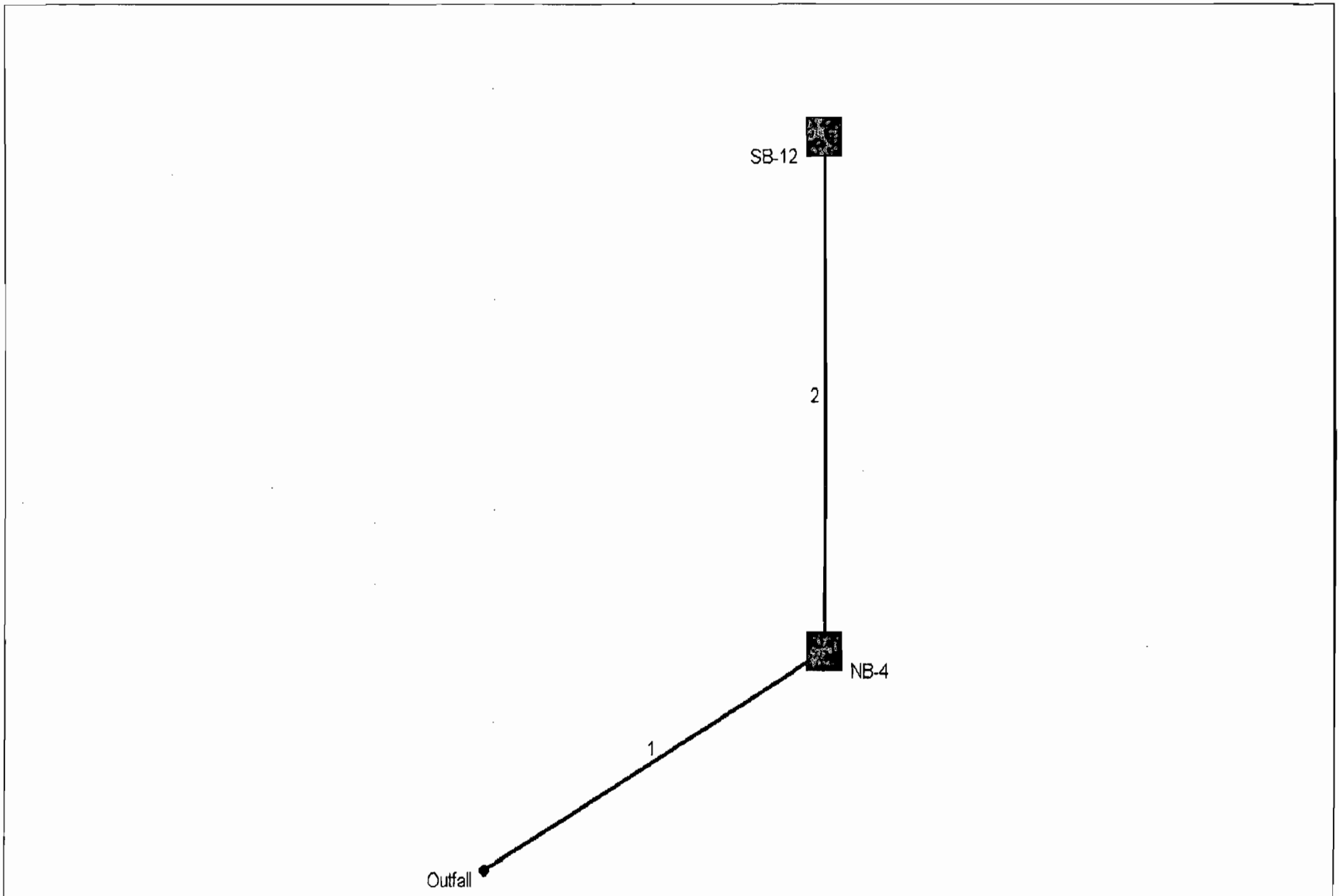
Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.37	.00	0.	UNSTAB	.41	5.5	.36	.014
JUTE NET	.45	.52	.00	0.	UNSTAB	.86	20.2	.51	.025
FIBERGLASS SINGLE	.60	.51	.00	0.	STABLE	1.17	35.8	.50	.024
FIBERGLASS DOUBLE	.85	.53	.00	0.	STABLE	1.59	65.1	.52	.026
STRAW WITH NET	**1.45**	**.69**	**.00**	**0.**	**STABLE**	**2.11**	**124.5**	**.67**	**.040**
CURLED WOOD MAT	1.55	.70	.00	0.	STABLE	2.20	134.1	.69	.041
SYNTHETIC MAT	2.00	.57	.00	0.	STABLE	3.50	315.1	.56	.029
PERMANENT (FLEXIBLE)									

*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE

VEGETATIVE	A	3.70	1.80	.00	0.	STABLE	2.05	256.4	1.77	.228
VEGETATIVE	B	2.10	1.28	.00	0.	STABLE	1.64	101.2	1.26	.120
VEGETATIVE	**C**	**1.00**	**.98**	**.00**	**0.**	**STABLE**	**1.02**	**27.7**	**.97**	**.075**
VEGETATIVE	D	.60	.86	.00	0.	UNSTAB	.69	11.2	.85	.059
VEGETATIVE	E	.35	.80	.00	0.	UNSTAB	.44	3.7	.78	.051

USE EROSION CONTROL LINING TYPE G

Hydraflow Plan View



Project File: BUSWAY SYSTEM 3.stm	No. Lines: 2	09-17-2009

Hydraflow Storm Sewers 2005

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	NB-4	2.75	12 c	24.0	77.68	77.92	1.000	78.51	78.63	n/a	79.08 i	End
2	SB-12	2.75	12 c	28.0	77.92	78.20	1.000	79.08	79.20	n/a	79.36 i	1

Project File: BUSWAY SYSTEM 3.stm | Number of lines: 2 | Run Date: 09-17-2009

NOTES: c = cir; e = ellip; b = box; Return period = 10 Yrs. ; i - Inlet control.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	NB-4	0.00	0.00	0.00	0.00	Grate	0.0	0.00	3.12	2.31	1.36	Sag	4.00	0.040	0.020	0.000	-0.09	-2.17	0.00	0.00	2.00	Off
* 2	SB-12	3.17*	0.00	3.17	0.00	Grate	0.0	0.00	3.12	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.27	9.30	0.35	9.30	2.00	Off

Includes 25 yr bypass 0.09 CFS from SB-9

* Low Point Allowable Spread is 10'

Project File: BUSWAY SYSTEM 3.stm | Number of lines: 2 | Run Date: 02-17-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 101.98 / (Inlet time + 15.80) ^ 0.90; Return period = (25 Yrs.) * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	24.0	0.00	0.51	0.90	0.00	0.46	5.0	5.1	6.0	2.79	3.56	4.34	12	1.00	77.92	77.68	78.63	78.51	81.08	77.75	NB-4
2	1	28.0	0.51	0.51	0.90	0.46	0.46	5.0	5.0	6.0	2.79	3.56	3.55	12	1.00	78.20	77.92	79.26	79.09	81.31	81.08	SB-12

Project File: BUSWAY SYSTEM 3.stm | Number of lines: 2 | Run Date: 02-17-2010

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

```
      ******  HYCHL  ****** (Version 6.1) ******          Date 04-06-2009
 Commands Read From File: E:\HYCHL\BUSWAY.CHL

      JOB BUSWAY
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .012   2.8
      TRP 4      2      2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
      NEQ 1
      END
***************END OF COMMAND FILE************
```

CHANNEL LOCATED AT SYSTEM 3 OUTLET

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	2.80
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.012

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.14	.00	0.	STABLE	1.09	3.2	.18	.014
JUTE NET	.45	.21	.00	0.	STABLE	2.16	12.6	.28	.029
FIBERGLASS SINGLE	.60	.21	.00	0.	STABLE	2.92	22.7	.27	.028
FIBERGLASS DOUBLE	.85	.21	.00	0.	STABLE	3.96	42.6	.29	.030
STRAW WITH NET	**1.45**	**.30**	**.00**	**0.**	**STABLE**	**4.90**	**89.1**	**.40**	**.052**
CURLED WOOD MAT	1.55	.30	.00	0.	STABLE	5.16	96.8	.40	.054
SYNTHETIC MAT	2.00	.24	.00	0.	STABLE	8.51	236.6	.31	.035
PERMANENT (FLEXIBLE)									
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE A	3.70	1.24	.00	0.	STABLE	2.98	221.5	1.66	.733
VEGETATIVE B	2.10	.75	.00	0.	STABLE	2.82	76.1	1.00	.275
VEGETATIVE C	**1.00**	**.50**	**.00**	**0.**	**STABLE**	**1.99**	**18.5**	**.67**	**.133**
VEGETATIVE D	.60	.42	.00	0.	STABLE	1.44	7.2	.55	.095
VEGETATIVE E	.35	.37	.00	0.	UNSTAB	.95	2.4	.49	.077

USE EROSION CONTROL LINING TYPE G

```
          ******  HYCHL  ****** (Version 6.1) ******          Date 04-06-2009
 Commands Read From File: E:\HYCHL\BUSWAY.CHL

       JOB BUSWAY
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .012   2.8
       TRP 4 2 2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
       NEQ 1
       LRR .42    2 0 2.65   0.047
 ** D50 (ft)     .42
 ** SPECIFIC GRAVITY    2.65
 ** SHIELDS PARAMETER    .047
       END
***************END OF COMMAND FILE************

 SYSTEM 3 OUTLET RIPRAP APRON
 ------------
 INPUT REVIEW
 ------------
   DEFAULT ANGLE OF REPOSE (degrees):     41.18
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):            2.80
       CHANNEL SHAPE:                  TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):               .012
 ----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 ----------------------------------------

                          DESIGN     MAXIMUM
                          ------     -------
 FLOW (cfs)                 2.80       87.04
 DEPTH (ft)                  .31        1.99
 AREA (ft^2)                1.43       15.90
 WETTED PERIMETER (ft)      5.38       12.91
 HYDRAULIC RADIUS (ft)       .26        1.23
 VELOCITY (ft/s)            1.96        5.47
 MANNINGS N (LOW FLOW)       .034        .034
 REYNOLDS NUMBER (10^5)      .35

 ------------------
 STABILITY ANALYSIS
 ------------------

                     LINING    PERMIS SHR   CALC. SHR  STAB.
    CONDITION        TYPE      (LB/FT^2)    (LB/FT^2)  FACTOR   REMARKS
    ---------         ------    ----------   ---------  ------   -------
  BOTTOM; STRAIGHT   RIPRAP        2.03         .23       8.79   STABLE
  SIDE; STRAIGHT     RIPRAP        1.49         .18       8.27   STABLE

 *** NORMAL END OF HYCHL ***
```

SYSTEM 3

12" RCP Q = 2.8 CFS Vel. = 4.35 ft/s

Based on Table 11-12.1 In The Drainage Manual

USE TYPE C RIPRAP APRON

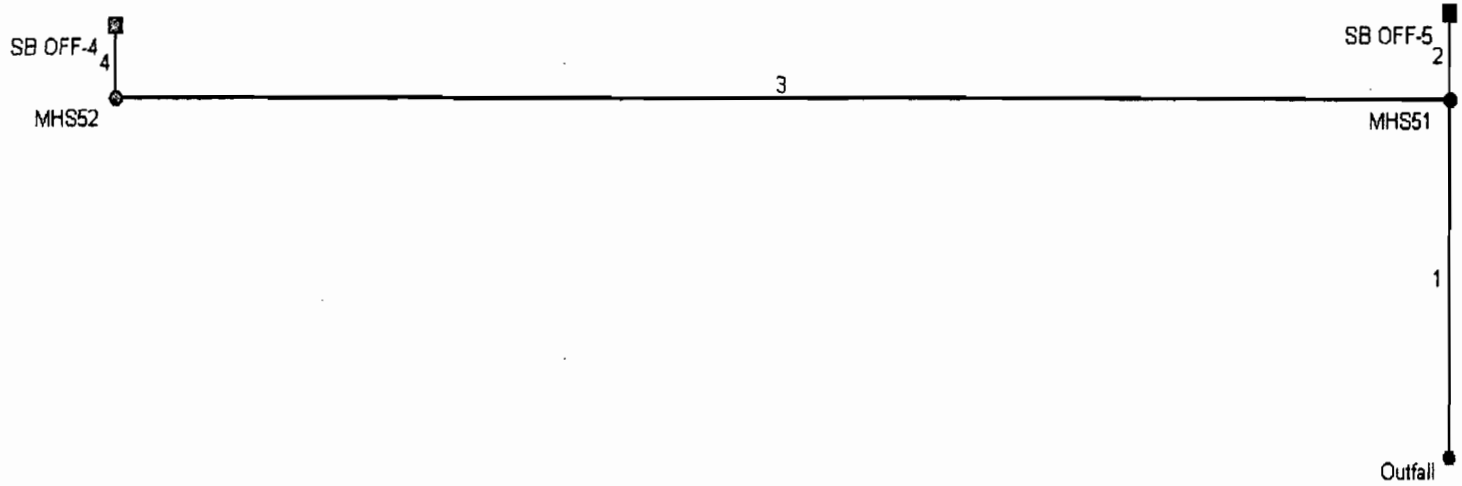
La = 10'

Vel = 4.35 < 8 ∴ USE MODIFIED RIPRAP

DEPTH OF FLOW IN RIPRAP IS 0.31 ft

MAKE DEPTH OF CHANNEL 1.5'

Hydraflow Plan View



Project File: BUSWAY SYSTEM 4.stm	No. Lines: 4	09-17-2009

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	MHS51	10.10	24 c	50.0	75.00	75.25	0.500	78.25*	78.35*	0.16	78.51	End
2	SB OFF5	9.49	18 c	12.0	75.75	75.85	0.833	78.51*	78.61*	0.45	79.06	1
3	MHS52	3.04	15 c	208.0	76.00	77.10	0.529	78.58*	79.04*	0.10	79.13	1
4	SB OFF-4	3.04	15 c	10.0	79.10	79.20	1.000	79.80	79.90	n/a	80.28 i	3

Project File: BUSWAY SYSTEM 4.stm | Number of lines: 4 | Run Date: 09-24-2009

NOTES: c = cir; e = ellip; b = box; Return period = 10 Yrs. ; *Surcharged (HGL above crown). ; i - Inlet control.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	MHS51	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	SB OFF-5	9.49	0.00	9.49	0.00	Grate	0.0	0.00	2.00	4.00	2.00	Sag	2.00	0.080	0.050	0.000	0.67	12.26	0.78	12.26	2.00	Off
3	MHS52	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
4	SB OFF-4	3.04	0.00	3.04	0.00	Grate	0.0	0.00	2.00	4.00	2.00	Sag	2.00	0.080	0.050	0.000	0.15	1.82	0.25	1.89	2.00	Off

Project File: BUSWAY SYSTEM 4.stm | Number of lines: 4 | Run Date: 09-17-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	50.0	0.00	2.89	0.00	0.00	2.22	0.0	11.4	4.6	10.10	15.99	3.21	24	0.50	75.25	75.00	78.35	78.25	84.67	77.00	MHS51
2	1	12.0	1.76	1.76	0.90	1.58	1.58	5.0	5.0	6.0	9.49	9.59	5.37	18	0.83	75.85	75.75	78.61	78.51	82.00	84.67	SB OFF5
3	1	208.0	0.00	1.13	0.00	0.00	0.63	0.0	10.0	4.8	3.04	4.70	2.47	15	0.53	77.10	76.00	79.04	78.58	83.65	84.67	MHS52
4	3	10.0	1.13	1.13	0.56	0.63	0.63	10.0	10.0	4.8	3.04	6.46	4.30	15	1.00	79.20	79.10	79.90	79.80	82.50	83.65	SB OFF-4

Project File: BUSWAY SYSTEM 4.stm

Number of lines: 4

Run Date: 09-24-2009

NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs.

SYSTEM 4

24" RCP $Q = 12.53$ CFS $Vel. = 3.99$ ft/s

Based on Table 11-12.1 In The Drainage Manual

USE TYPE A RIPRAP APRON

$L_a = 16'$

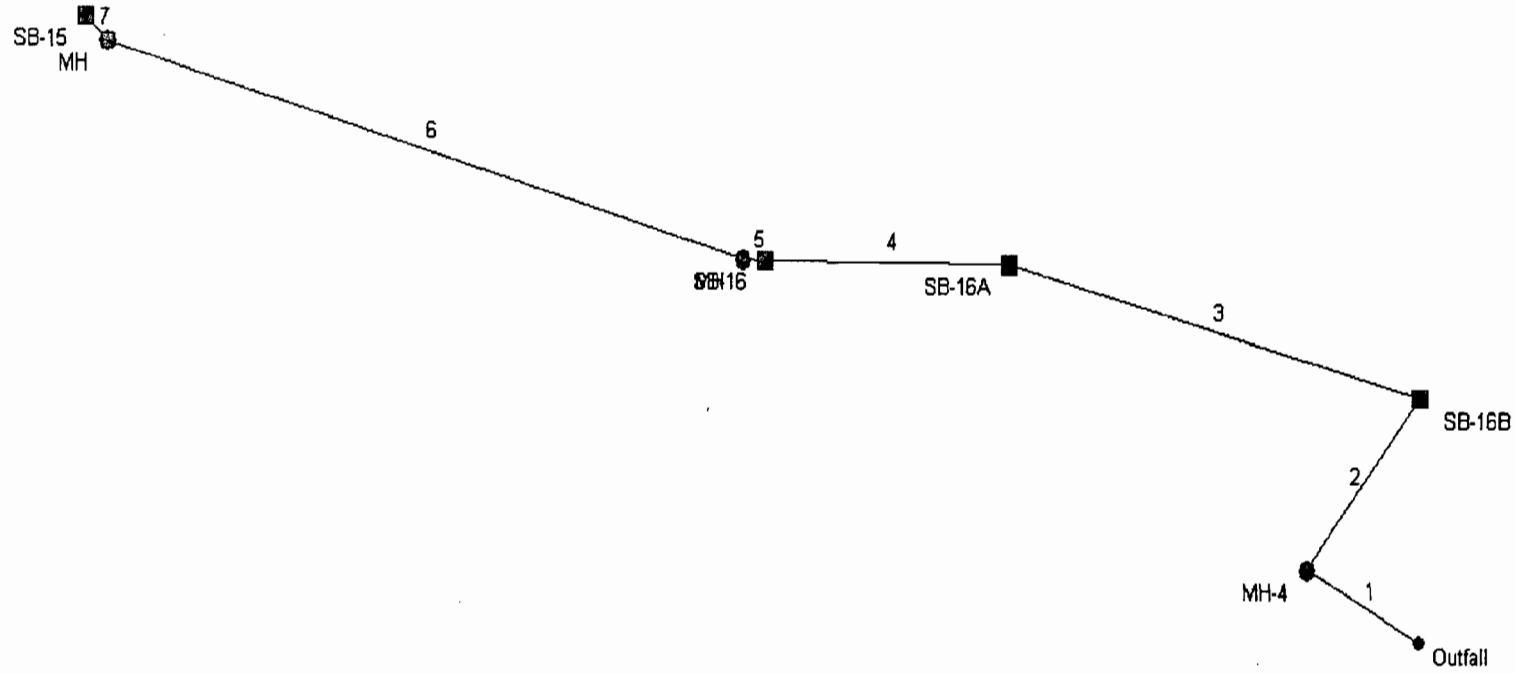
$Vel. = 3.99$ ft/s < 8 ∴ USE MODIFIED RIPRAP

$X = 3$

$W_1 = 3 S_p = 3(2') = 6'$

$W_2 = 3 S_p + 0.7 L_a = 3(2') + 0.7(16') = 17.2'$

Hydraflow Plan View



Project File: BUSWAY SYSTEM 5.stm	No. Lines: 7	04-15-2010

Hydraflow Storm Sewers 2005

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	MH-4	1.98	15 c	34.0	72.40	72.60	0.588	73.73	73.76	0.04	73.80	End
2	SB-16B	2.02	15 c	50.0	75.97	76.47	1.000	76.54	77.04	n/a	77.30 i	1
3	SB-16A	1.92	15 c	112.0	76.47	77.25	0.696	77.30	77.81	n/a	78.06 i	2
4	SB-16	1.75	15 c	64.0	77.25	77.70	0.703	78.06	78.23	n/a	78.46 i	3
5	MH	0.76	12 c	6.0	77.95	77.98	0.500	78.46	78.46	n/a	78.49 i	4
6	MH	0.86	12 c	174.0	77.98	78.86	0.506	78.49	79.25	n/a	79.41 i	5
7	SB-15	0.86	12 c	8.0	78.86	78.90	0.500	79.41	79.41	n/a	79.45 i	6

Project File: BUSWAY SYSTEM 5.stm | Number of lines: 7 | Run Date: 04-15-2010

NOTES: c = cir; e = ellip; b = box; Return period = 10 Yrs. ; i - Inlet control.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	MH-4	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	SB-16B	0.22	0.00	0.22	0.00	Grate	0.0	0.00	0.00	3.15	1.64	0.005	4.00	0.020	0.020	0.013	0.09	4.30	0.13	2.12	2.00	1
3	SB-16A	0.27	0.10	0.37	0.00	Grate	0.0	0.00	2.50	2.31	1.36	Sag	4.00	0.020	0.020	0.000	-0.08	-4.11	0.08	1.37	2.00	Off
4	SB-16	1.13	0.00	1.03	0.10	Grate	0.0	0.00	0.00	3.15	1.64	0.005	4.00	0.020	0.020	0.013	0.16	8.00	0.24	3.96	2.00	3
5	MH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
6	MH	0.00	0.05	0.00	0.05	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
7	SB-15	0.86	0.00	0.81	0.05	Grate	0.0	0.00	0.00	3.15	1.64	0.005	4.00	0.020	0.020	0.013	0.15	7.25	0.22	3.57	2.00	6

Project File: BUSWAY SYSTEM 5.stm | Number of lines: 7 | Run Date: 04-15-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	34.0	0.00	0.46	0.00	0.00	0.41	5.0	10.1	4.8	1.98	4.95	1.64	15	0.59	72.60	72.40	73.76	73.73	81.00	72.00	MH-4
2	1	50.0	0.04	0.46	0.90	0.04	0.41	5.0	9.6	4.9	2.02	6.46	3.72	15	1.00	76.47	75.97	77.04	76.54	81.90	81.00	SB-16B
3	2	112.0	0.05	0.42	0.90	0.05	0.38	5.0	8.6	5.1	1.92	5.39	2.94	15	0.70	77.25	76.47	77.81	77.30	81.09	81.90	SB-16A
4	3	64.0	0.21	0.37	0.90	0.19	0.33	5.0	7.9	5.2	1.75	5.41	2.81	15	0.70	77.70	77.25	78.23	78.06	81.89	81.09	SB-16
5	4	6.0	0.00	0.16	0.00	0.00	0.14	0.0	7.8	5.3	0.76	2.52	1.96	12	0.50	77.98	77.95	78.46	78.46	82.08	81.89	MH
6	5	174.0	0.00	0.16	0.00	0.00	0.14	0.0	5.1	6.0	0.86	2.53	2.57	12	0.51	78.86	77.98	79.25	78.49	82.88	82.08	MH
7	6	8.0	0.16	0.16	0.90	0.14	0.14	5.0	5.0	6.0	0.86	2.52	2.04	12	0.50	78.90	78.86	79.41	79.41	82.71	82.88	SB-15

Project File: BUSWAY SYSTEM 5.stm | Number of lines: 7 | Run Date: 04-15-2010

NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs.

SYSTEM 5

15" RCP $Q = 1.59$ CFS $Vel. = 1.29$ ft/s

Based on Table 11-12.1 In The Drainage Manual

USE TYPE A RIPRAP APRON

$L_a = 10'$

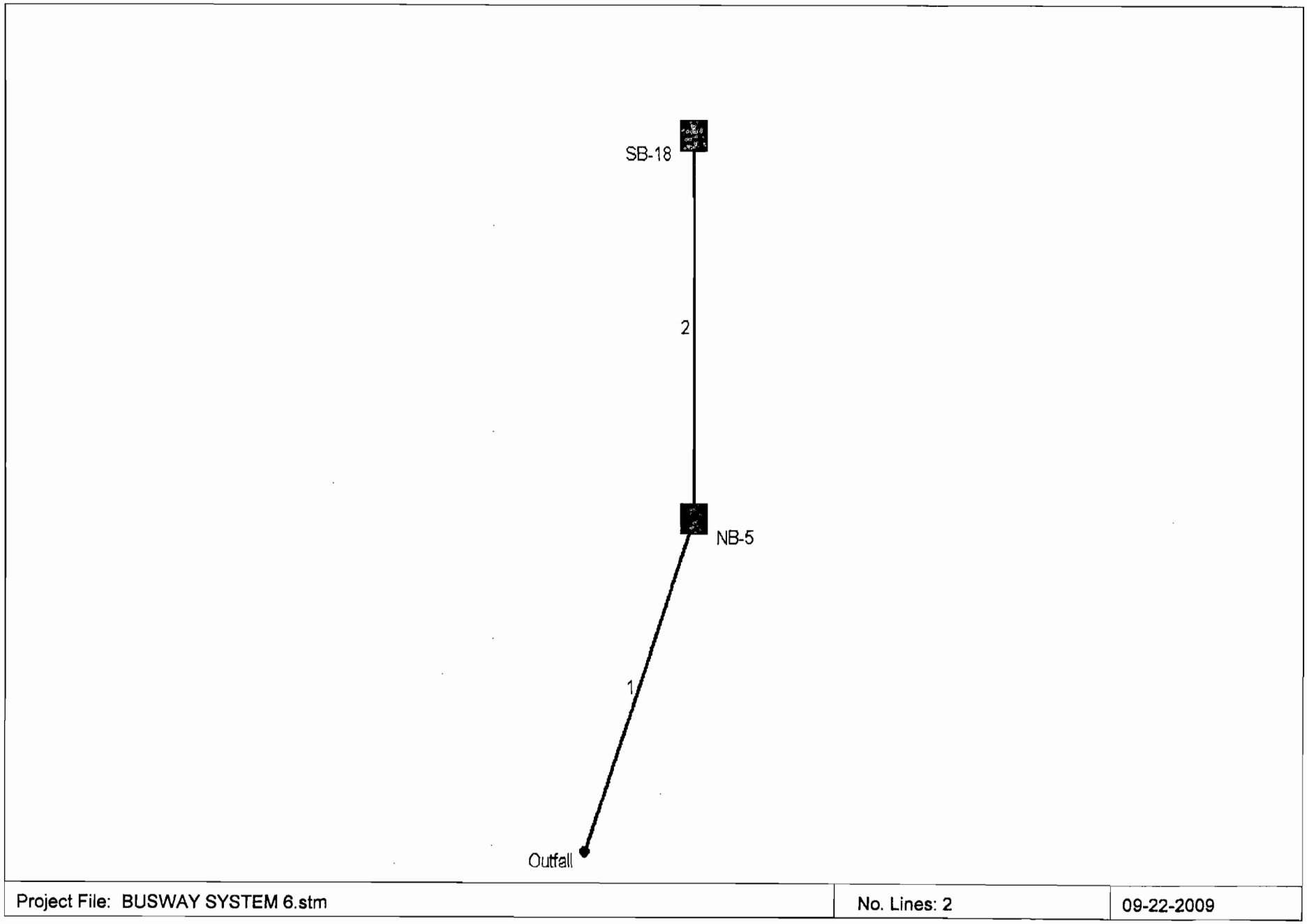
$Vel. = 1.29$ ft/s < 8 ft/s $\therefore$ USE MODIFIED RIPRAP

$X = 3$

$W_1 = 3S_P = 3(1.25') = 3.75'$ USE $4'$

$W_2 = 3S_P + 0.7L_a = 3(1.25') + 0.7(10') = 10.75'$ USE $11'$

Hydraflow Plan View



Project File: BUSWAY SYSTEM 6.stm	No. Lines: 2	09-22-2009

Hydraflow Storm Sewers 2005

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	NB-5	1.49	15 c	26.0	74.00	74.15	0.577	74.49	74.64	n/a	74.83 i	End
2	SB-18	1.51	12 c	28.0	76.86	77.00	0.500	77.38	77.58	n/a	77.79 i	1

Project File: BUSWAY SYSTEM 6.stm | Number of lines: 2 | Run Date: 09-22-2009

NOTES: c = cir; e = ellip; b = box; Return period = 10 Yrs. ; i - Inlet control.

Inlet Report

	Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
								Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
	1	NB-5	0.00	0.00	0.00	0.00	Grate	0.0	0.00	3.12	2.31	1.36	Sag	4.00	0.032	0.038	0.000	0.00	0.00	0.00	0.00	0.00	Off
*	2	SB-18	1.69	0.00	1.69	0.00	Grate	0.0	0.00	3.12	2.31	1.36	Sag	4.00	0.032	0.038	0.000	0.04	1.30	0.23	2.92	2.00	Off

* Low Point on High Side Of Superelevation Allowable Spread is 4'

Project File: BUSWAY SYSTEM 6.stm | Number of lines: 2 | Run Date: 04-15-2010

NOTES: Inlet N-Values = 0.016 ; Intensity = 101.98 / (Inlet time + 15.80) ^ 0.90; Return period = 25 Yrs. ; * Indicates Known Q added

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	Up	Dn	Up	Dn	Up	Dn	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	26.0	0.00	0.28	0.90	0.00	0.25	5.0	5.2	5.9	1.64	4.90	3.45	15	0.58	74.15	74.00	74.67	74.51	79.93	70.00	NB-5
2	1	28.0	0.28	0.28	0.90	0.25	0.25	5.0	5.0	6.0	1.66	2.52	3.53	12	0.50	77.00	76.86	77.62	77.41	80.71	79.93	SB-18

Project File: BUSWAY SYSTEM 6.stm | Number of lines: 2 | Run Date: 02-17-2010

NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs.

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	15	1.49	74.00	74.49	0.49	0.45	3.34	0.17	74.66	n/a	26.0	74.15	74.64 j	0.49**	0.45	3.33	0.17	74.81i	n/a	n/a	-0.022	0.59	n/a
2	12	1.51	76.86	77.38	0.52*	0.41	3.65	0.21	77.59	n/a	28.0	77.00	77.58	0.58	0.47	3.21	0.16	77.74i	n/a	n/a	-0.010	1.00	n/a

Project File: BUSWAY SYSTEM 6.stm | Number of lines: 2 | Run Date: 09-22-2009

Notes: * Critical depth assumed.; ** Critical depth.; j-Line contains hyd. jump.

SYSTEM 6

15" RCP $Q = 1.5$ CFS Vel. = 3.34 ft/s

Based on Table 11-12.1 In The Drainage Manual

USE TYPE A RIPRAP APRON

$L_a = 10'$

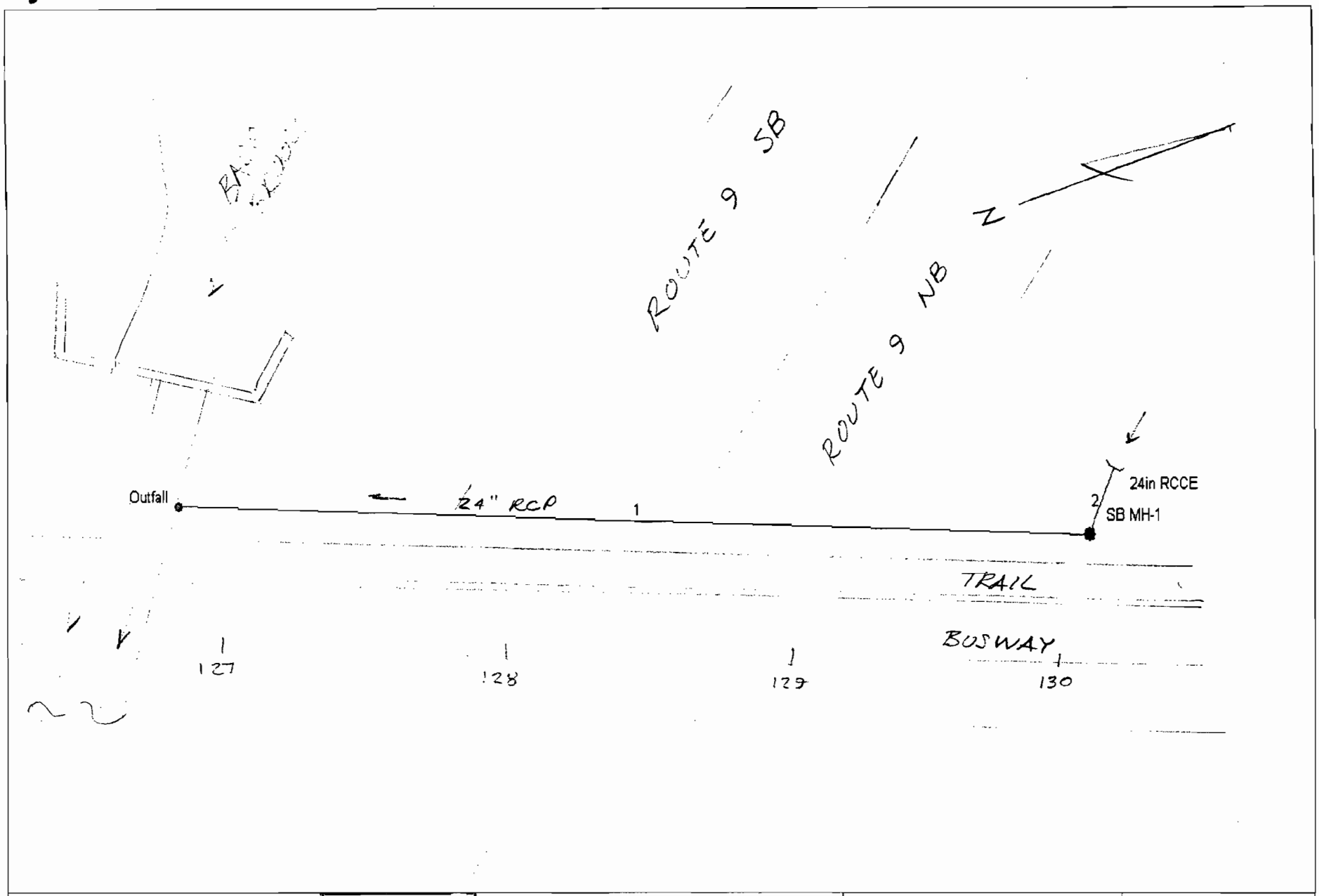
Vel. = 3.34 ft/s < 8 ft/s ∴ USE MODIFIED RIPRAP

$X = 3$

$W_1 = 3 S_p = 3(1.25') = 3.75'$

$W_2 = 3 S_p + 0.7 L_a = 3(1.25') + 0.7(14') = 13.6'$

Hydraflow Plan View



Project File: Busway SB MH-1.stm	SYSTEM 7	No. Lines: 2	03-31-2009

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	24	5.43	77.83	78.66	0.83	1.22	4.44	0.31	78.96	n/a	315	84.77	85.60	0.83**	1.22	4.44	0.31	85.90i	n/a	n/a	n/a	0.94	n/a
2	24	5.45	84.77	85.95	1.18	1.93	2.82	0.12	86.07	n/a	22.0	86.50	87.33 j	0.83**	1.23	4.44	0.31	87.63i	n/a	n/a	n/a	1.00	n/a

Project File: Busway SB MH-1.stm | Number of lines: 2 | Run Date: 03-31-2009

Notes: ; ** Critical depth.; j-Line contains hyd. jump.

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	315.0	0.00	6.26	0.00	0.00	2.00	0.0	41.2	2.7	5.43	36.37	4.44	24	2.20	84.77	77.83	85.60	78.66*	89.00	79.83	SB MH-1
2	1	22.0	6.26	6.26	0.32	2.00	2.00	41.0	41.0	2.7	5.45	68.71	3.63	24	7.86	86.50	84.77	87.33	85.95	86.50	89.00	24in RCCE

* CRITICAL DEPTH

BASE BROOK – 2YR EVENT
HW ELEV = 77.41'
FROM HEC-RAS

CRITICAL DEPTH
GOVERNS TW
STARTING ELEV.

Project File: Busway SB MH-1.stm | Number of lines: 2 | Run Date: 03-31-2009

NOTES: Intensity = 101.98 / (Inlet time + 15.80) ^ 0.90; Return period = 25 Yrs.

SB MH-1 (STA. 130+25, 60' LT)

EXISTING SYSTEM WILL BE MODIFIED TO ALLOW RELOCATION OF THE CULVERT INLET. EXISTING INLET WILL BE REPLACED WITH A MANHOLE, THEN EQUIPPED WITH A NEW EXTENSION PIPE AS SHOWN ON THE DESIGN PLANS.

SYSTEM FUNCTIONS AS A CROSS CULVERT AND DISCHARGES INTO THE TWIN BOX CULVERT AT EASS BROOK (STA. 126+75±).

DETERMINE TAILWATER CONDITIONS FOR NEW CULVERT DESIGN:

FROM "THE PRELIMINARY HYDRAULIC REPORT FOR SITE 2 BY EARG CONSULTING SERVICES, INC. DATED MAY 2008"

- EASS BROOK CULVERT DRAINAGE AREA IS APPROXIMATELY 10.51 mi² (6,726± Ac).
- 24" CULVERT SYSTEM DRAINAGE AREA IS APPROXIMATELY 6.26± AC

DRAINAGE AREA RATIO = 1074:1

⇒ FROM CONNDOT DRAINAGE MANUAL, PG. 8.3-4, TABLE 5-3 JOINT PROBABILITY ANALYSIS

FREQUENCIES FOR CONCURRENCE TAILWATER & RAINFALL TO USE THE FOLLOWING:

25 YR STORM (MAIN DRAINAGE) FOR PROPOSED EXTENSION OF 24" RCP CULVERT AND ESTABLISHED WATER SURFACE

- EASS BROOK TWIN BOX STORM
- EXISTING CULVERT @ 126+75± STORM

FROM "APPENDIX C" OF THE BASS BROOK HYDRAULIC REPORT. HEC-RAS OUTPUT FOR EXISTING CULVERT INLET (SECTION 2654), PG. C14-C15.

W.S. ELEV = 77.41 (PROFILE 2YR)

USE THIS STARTING TW ELEV TO EVALUATE THE CULVERT EXTENSION.

Exhibit 12
Site 2
Hydraulic Cross Section
Ex 2
Page 1 of 2
NEW BRITAIN
NEWINGTON
Rte 9
CHANNEL
ENCROACHMENT LINE
RAILROAD
2022
2131
2207
2222
2165
2654
2672
2672
2692
N

Sta	n Val	Sta	n Val	Sta	n Val
0	.015	95	.04	120.31	.015

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
95	120.31	433	433	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
888	F		
888	F		

RS # 2654

CROSS SECTION OUTPUT Profile #2 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	77.81				
Vel Head (ft)	0.39	Wt. n-Val.		0.040	
W.S. Elev (ft)	77.41	Reach Len. (ft)	433.00	433.00	433.00
Crit W.S. (ft)	75.44	Flow Area (sq ft)		107.34	
E.G. Slope (ft/ft)	0.005228	Area (sq ft)		107.34	
Q Total (cfs)	540.00	Flow (cfs)		540.00	
Top Width (ft)	24.00	Top Width (ft)		24.00	
Vel Total (ft/s)	5.03	Avg. Vel. (ft/s)		5.03	
Max Chl Dpth (ft)	4.47	Hydr. Depth (ft)		4.47	
Conv. Total (cfs)	7468.2	Conv. (cfs)		7468.2	
Length Wtd. (ft)	433.00	Wetted Per. (ft)		41.88	
Min Ch El (ft)	72.94	Shear (lb/sq ft)		0.84	
Alpha	1.00	Stream Power (lb/ft s)		4.21	
Frctn Loss (ft)		Cum Volume (acre-ft)	0.21	2.01	0.12
C & E Loss (ft)		Cum SA (acres)	0.20	0.41	0.14

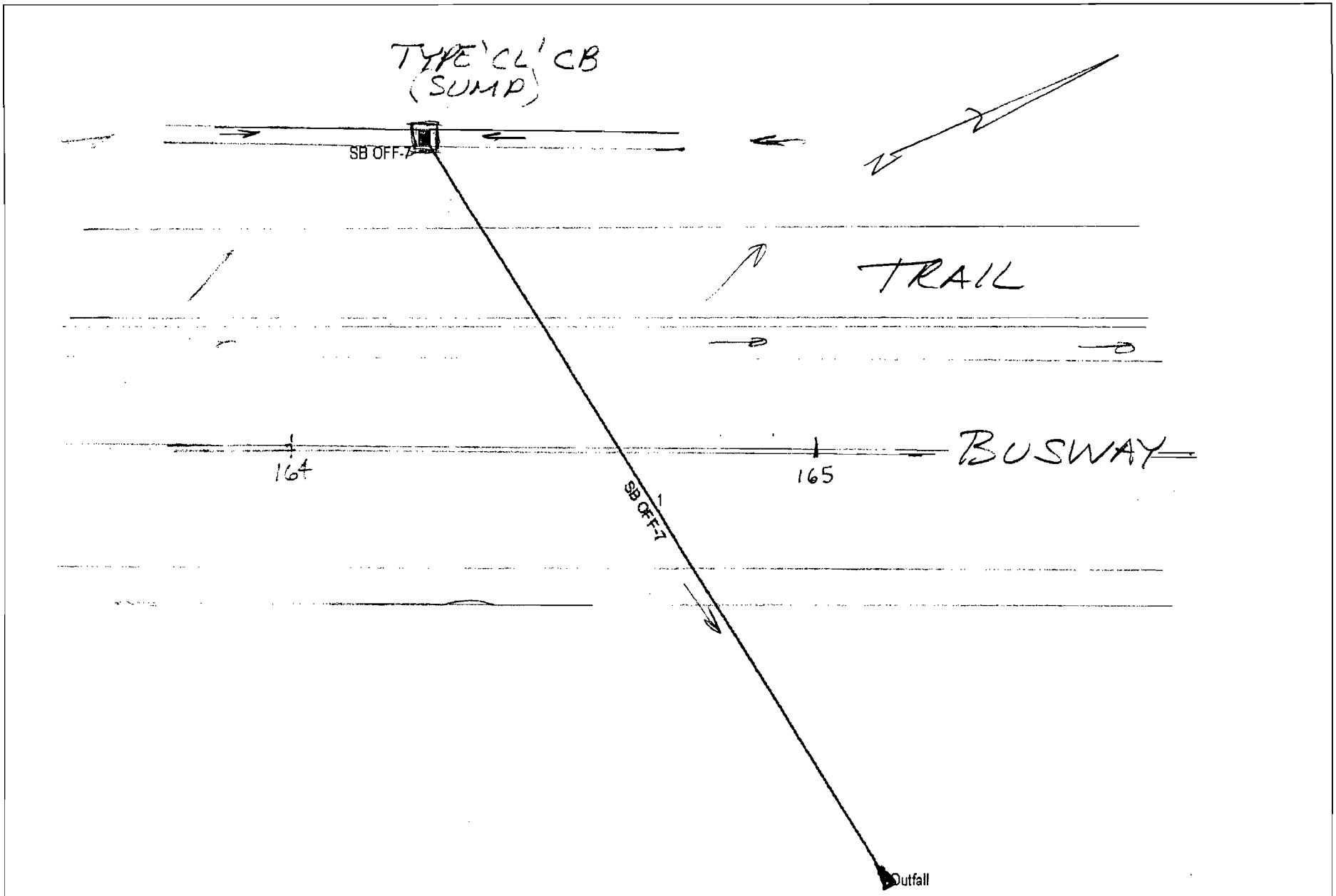
FROM PRELIMINARY HYDRAULICS

CROSS SECTION OUTPUT Profile #10 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	79.64				
Vel Head (ft)	0.93	Wt. n-Val.		0.040	
W.S. Elev (ft)	78.71	Reach Len. (ft)	433.00	433.00	433.00
Crit W.S. (ft)	76.88	Flow Area (sq ft)		138.34	
E.G. Slope (ft/ft)	0.010308	Area (sq ft)		138.34	
Q Total (cfs)	1071.00	Flow (cfs)		1071.00	
Top Width (ft)	24.01	Top Width (ft)		24.01	
Vel Total (ft/s)	7.74	Avg. Vel. (ft/s)		7.74	
Max Chl Dpth (ft)	5.77	Hydr. Depth (ft)		5.76	
Conv. Total (cfs)	10549.0	Conv. (cfs)		10549.0	
Length Wtd. (ft)	433.00	Wetted Per. (ft)		47.04	
Min Ch El (ft)	72.94	Shear (lb/sq ft)		1.89	
Alpha	1.00	Stream Power (lb/ft s)		14.65	
Frctn Loss (ft)		Cum Volume (acre-ft)	0.31	2.29	0.17
C & E Loss (ft)		Cum SA (acres)	0.24	0.41	0.18

C15

Hydraflow Plan View



Project File: Busway SB OFF-7 to Outlet.stm	SYSTEM 8		No. Lines: 1	03-05-2009

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	SB OFF-7	3.43	0.00	3.43	0.00	Grate	0.0	0.00	1.57	1.16	0.68	Sag	10.00	0.500	0.500	0.000	0.59	1.18	0.59	1.18	0.00	Off

Project File: Busway SB OFF-7 to Outlet.stm | Number of lines: 1 | Run Date: 08-25-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	134.0	2.16	2.16	0.33	0.71	0.71	10.0	10.0	4.8	3.43	5.89	4.52	15	0.71	73.45	72.50	74.19	73.24	75.75	73.75	SB OFF-7

Project File: Busway SB OFF-7 to Outlet.stm

Number of lines: 1

Run Date: 08-25-2009

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

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	15	3.43	72.50	73.24	0.74	0.76	4.52	0.32	73.56	n/a	134	73.45	74.19	0.74**	0.76	4.52	0.32	74.51i	n/a	n/a	n/a	1.00	n/a

Project File: Busway SB OFF-7 to Outlet.stm | Number of lines: 1 | Run Date: 08-25-2009

Notes: ; ** Critical depth.

OUTLET PROTECTION DESIGN CALCS

SYSTEM OUTLET LOCATION: STA. 165+20, 80' ⊥ RT

OUTLET PIPE SIZE/TYPE: 15" RCP

PROPOSED DESIGN DISCHARGE: 3.43 CFS

1.) PROPOSED OUTLET PROTECTION DEVICE:

TRY A TYPE "A" APRON

- REFER TO THE "CONDOT DRAINAGE MANUAL" PAGE 11.13-7, TABLE 11-12-1

USE 10' LONG APRON ⇒ $L_{a_{min}} = 10'$

- FROM PAGE 11.13-17, FIG. 11-13

S_p = DIA. = 15" (1.25')
L_a = APRON LENGTH

$W_1 = 3S_p$
$W_2 = 3S_p + 0.7L_a$

$W_1 = 3(1.25') = 4.75' \Rightarrow W_1 = 4.75'$

$W_2 = 3(1.25) + 0.7(10') = 11.75 \Rightarrow W_2 = 11.75'$

2.) RIPRAP SIZE REQUIREMENTS

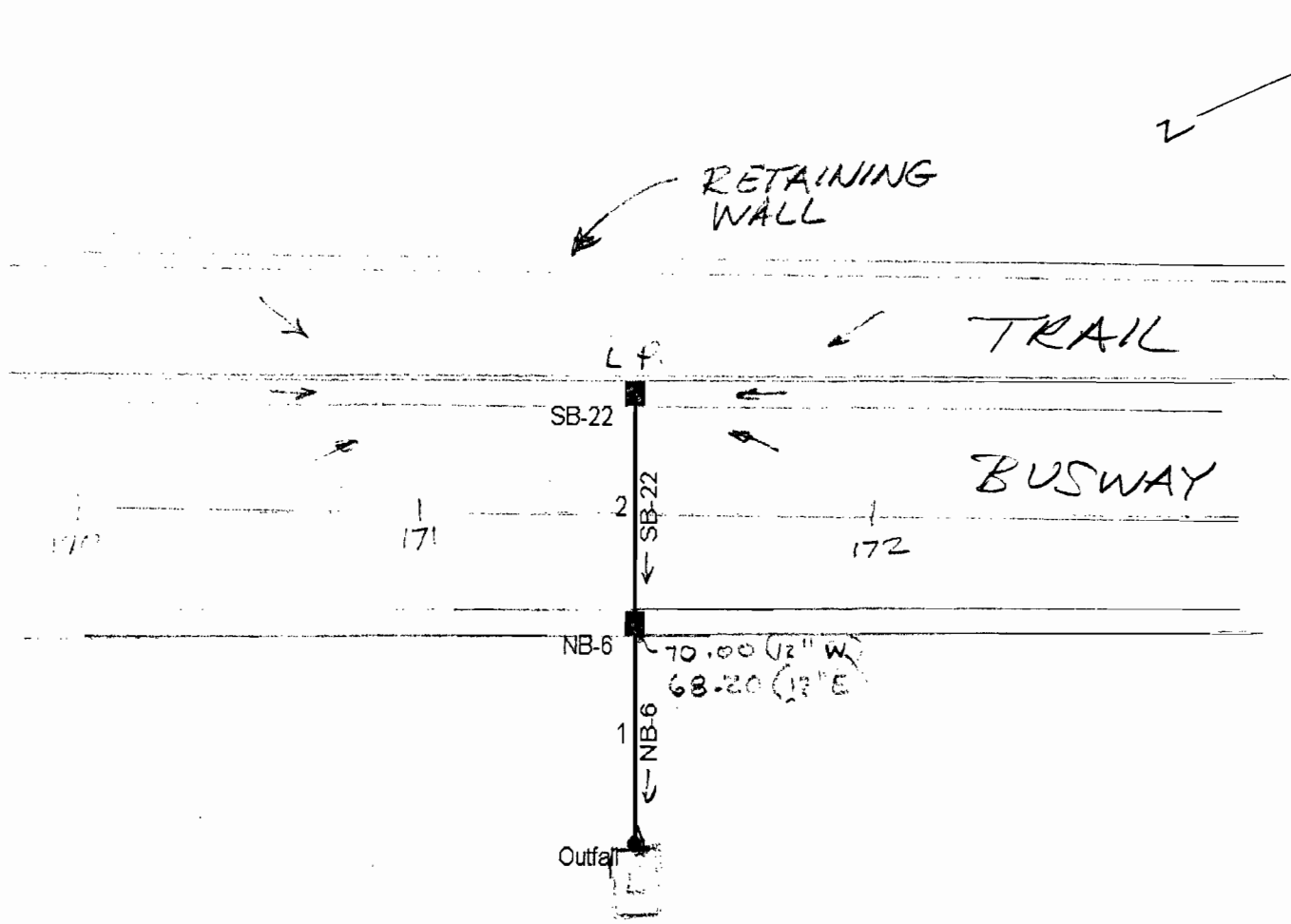
FROM CALCS ⇒ OUTLET VEL. = 4.52 fps

FROM CONDOT MANUAL, PG. 11.13.3 TABLE 11.11

12" MODIFIED RIPRAP STONE ON TOP OF 6" GRANULAR FILL
GEOMETRIC CLASSIFICATION

$W_1 = 4.75'$ $W_2 = 11.75'$ $L_a = 10'$ MIN.

Hydraflow Plan View



Project File: Busway SB-22 to NB-6.stm	SYSTEM 9	No. Lines: 2	03-06-2009

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	NB-6	0.00	0.00	0.00	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	SB-22	3.07	0.00	3.07	0.00	Grate	0.0	0.00	6.24	4.63	1.36	Sag	4.00	0.040	0.020	0.000	0.27	9.43	0.27	9.43	0.00	Off

Project File: Busway SB-22 to NB-6.stm | Number of lines: 2 | Run Date: 03-30-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	23.0	0.00	0.57	0.90	0.00	0.51	5.0	5.1	6.0	3.07	11.93	4.91	12	9.57	68.20	66.00	68.94	66.74	74.88	67.00	NB-6
2	1	26.0	0.57	0.57	0.90	0.51	0.51	5.0	5.0	6.0	3.07	7.57	4.91	12	3.85	71.00	70.00	71.74	70.74	74.84	74.88	SB-22

Project File: Busway SB-22 to NB-6.stm | Number of lines: 2 | Run Date: 03-30-2009

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

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	3.07	66.00	66.74	0.74	0.63	4.91	0.37	67.12	n/a	23.0	68.20	68.94	0.74**	0.63	4.91	0.37	69.32i	n/a	n/a	n/a	0.50	n/a
2	12	3.07	70.00	70.74	0.74*	0.63	4.91	0.37	71.12	n/a	26.0	71.00	71.74	0.74**	0.63	4.91	0.37	72.12i	n/a	n/a	n/a	1.00	n/a

Project File: Busway SB-22 to NB-6.stm | Number of lines: 2 | Run Date: 03-30-2009

Notes: * Critical depth assumed.; ** Critical depth.

OUTLET PROTECTION

LOCATION: 12" R.C.C.E @ STA. 171+65,32' RT

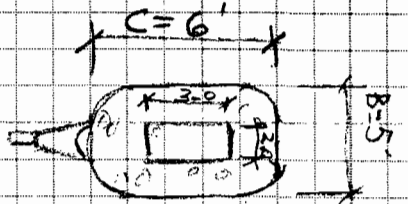
Q_{10YR} = 3.07 cfs V = 4.91 ft/sec

USE TYPE I SCOUR HOLE TO REDUCE IMPACT TO WETLAND AND S.C.E.L.

OUTLET PIPE DIA = 12" RCCE

FROM CONNDOT DRAINAGE MANUAL, PG. 11.13-11, TABLE 11-14.1

FOR 12" PIPE →
B = 5'
C = 6'
2Sp = 2.0'
3Sp = 3.0'
F = 0.5'



PLAN

RIPRAP STONE SIZE (d_{50}):

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

TW = 0.74'
Q_{10} = 3.07 cfs
R_p = 1'

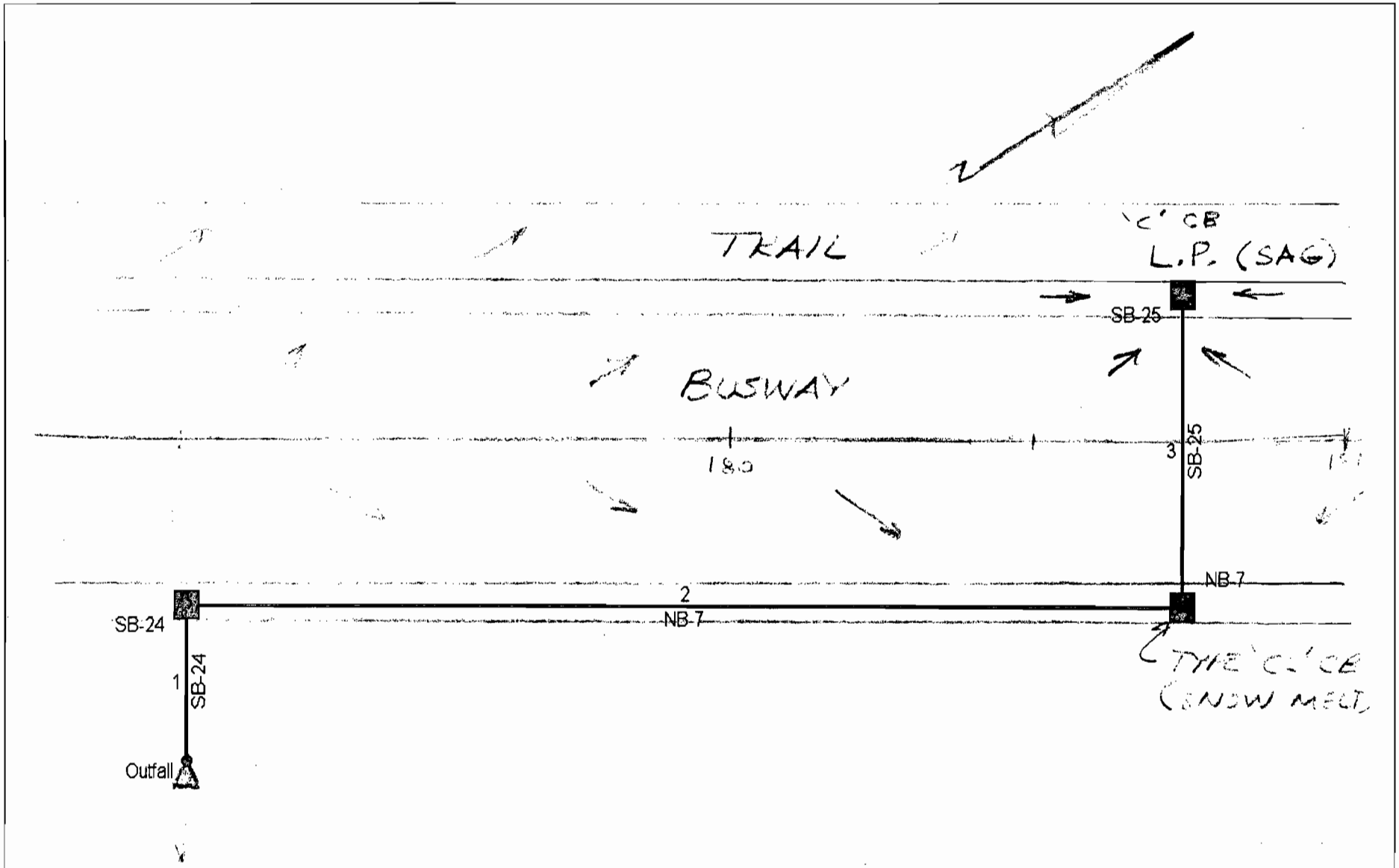
$$d_{50} = (0.0125(1')^2/0.74')(3.07/(1)^{2.5})^{1.333}$$

$$d_{50} = (0.016891892)(4.460211514)$$

d_{50} = 0.075' => USE MODIFIED RIPRAP
d_{50} = 0.42' (OK)

=> 12" MIN. THICK STONE w/ 6" GRANULAR FILL

Hydraflow Plan View



Project File: Busway SB-24 to SB-26rev1A.stm	SYSTEM 10	No. Lines: 3	02-23-2009

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	SB-24	0.00	0.00	0.00	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	NB-7	0.00	0.00	0.00	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.00	0.00	0.00	0.00	0.00	Off
3	SB-25	1.94	0.00	1.94	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.25	8.73	0.25	8.73	0.00	Off

Project File: Busway SB-24 to SB-26rev1A.stm | Number of lines: 3 | Run Date: 03-30-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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	Up	Dn	Up	Dn	Up	Dn	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	14.0	0.00	0.36	0.00	0.00	0.32	5.0	5.8	5.8	1.94	4.25	4.02	12	1.21	70.17	70.00	70.76	70.59	74.84	71.00	SB-24
2	1	86.0	0.00	0.36	0.90	0.00	0.32	5.0	5.2	5.9	1.94	2.97	3.22	12	0.59	70.68	70.17	71.29	71.10	74.58	74.84	NB-7
3	2	26.0	0.36	0.36	0.90	0.32	0.32	5.0	5.0	6.0	1.94	2.93	2.69	12	0.58	70.83	70.68	71.65	71.61	74.53	74.58	SB-25

Project File: Busway SB-24 to SB-26rev1A.stm | Number of lines: 3 | Run Date: 03-30-2009

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

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	1.94	70.00	70.59	0.59	0.48	4.02	0.25	70.84	n/a	14.0	70.17	70.76	0.59**	0.48	4.02	0.25	71.01i	n/a	n/a	n/a	1.50	n/a
2	12	1.94	70.17	71.10	0.93	0.76	2.56	0.10	71.20	n/a	86.0	70.68	71.29	0.61	0.50	3.88	0.23	71.52i	n/a	n/a	0.090	1.50	n/a
3	12	1.94	70.68	71.61	0.93	0.76	2.56	0.10	71.71	n/a	26.0	70.83	71.65	0.82	0.69	2.83	0.12	71.77i	n/a	n/a	-0.062	1.00	n/a

Project File: Busway SB-24 to SB-26rev1A.stm | Number of lines: 3 | Run Date: 03-30-2009

Notes: ; ** Critical depth.

OUTLET PROTECTION

LOCATION: 12" RCCE @ STA. 179+50 RT

$Q_{10} = 1.94$ cfs

USE TYPE "A" APRON

FROM CONNDOT DRAINAGE MANUAL, PG. 8.7-7, TABLE 8-6.1

USE 10' LONG APRON $\Rightarrow$ $L_a = 10'$

FROM PG. 8.7-17, FIG. 8-9

$W1 = 3Sp = 3(1) = 3'$ $\quad W1 = 3'$

$W2 = 3Sp + 0.7La = 3(1') + 0.7(10') = 10'$ $\quad W_2 = 10'$

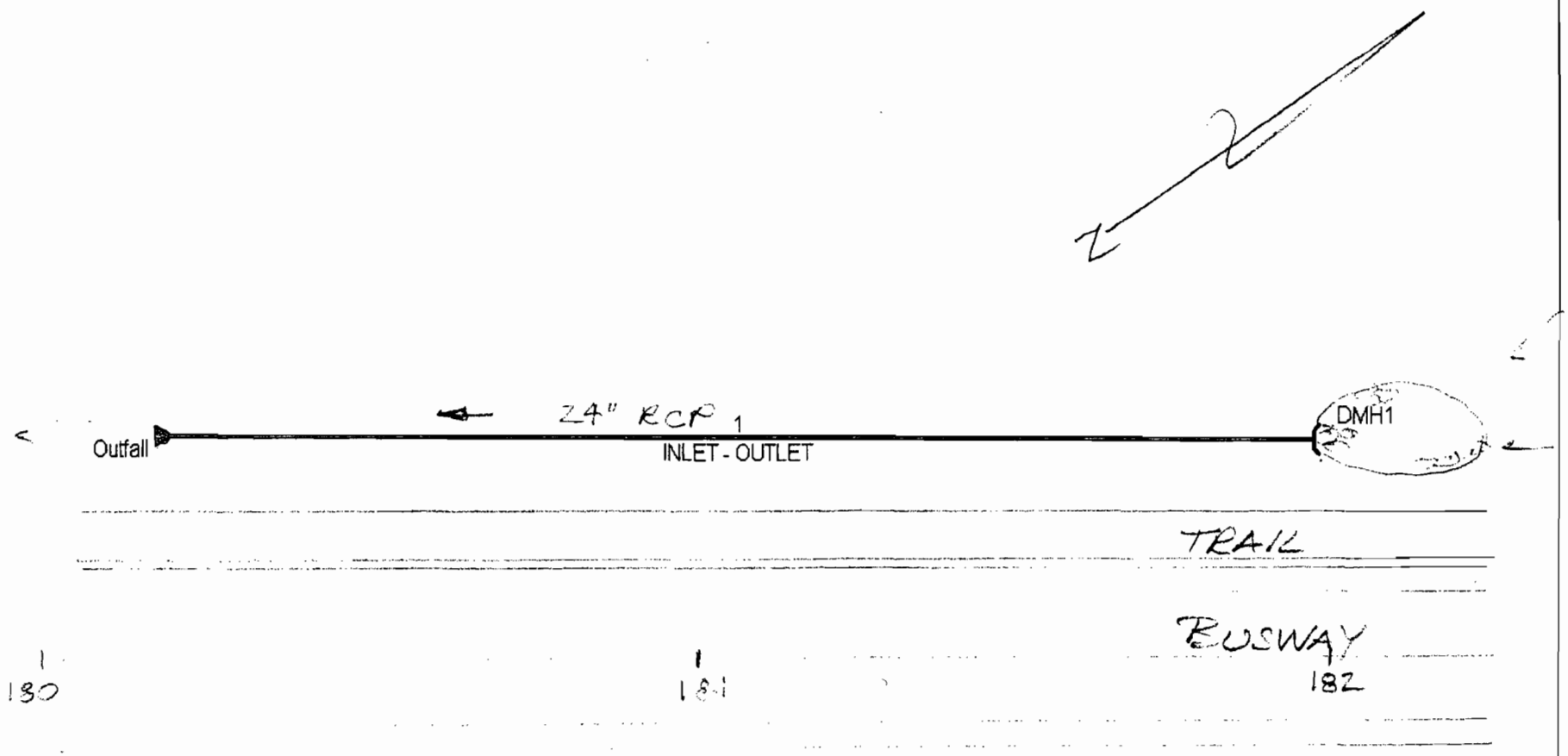
RIPRAP STONE SIZING:

OUTLET VELOCITY = 4.02 fps (SEE CALCS)

FROM PG. 11.13-2, TABLE 11.11

USE MODIFIED RIPRAP

Hydraflow Plan View



Project File: 24in culvert.stm	SYSTEM 11	No. Lines: 1	01-07-2009

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	Up	Dn	Up	Dn	Up	Dn	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	150.0	5.28	5.28	0.60	3.17	3.17	32.0	32.0	2.7	8.54	18.44	5.20	24	0.57	70.00	69.15	71.03	70.18	74.00	71.50	INLET - OUTLET

Project File: 24in culvert.stm | Number of lines: 1 | Run Date: 01-07-2009

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

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	24	8.54	69.15	70.18	1.03	1.64	5.20	0.42	70.61	n/a	150	70.00	71.03	1.03**	1.64	5.20	0.42	71.46i	n/a	n/a	n/a	1.00	n/a

Project File: 24in culvert.stm | Number of lines: 1 | Run Date: 01-07-2009

Notes: ; ** Critical depth.

OFF ROAD DRAINAGE SYSTEM

STA. 180+45 TO STA. 182+10 LT

DRAINAGE AREA = 5.28 Ac

RUNOFF COEF. (C):

GRASS A = 2.67 Ac C = 0.3

PAVED A = 2.61 Ac C = 0.9

TIME OF CONCENTRATION ESTIMATE (T_c):

SHEET FLOW: A → B L = 165' $S_{AVG} = \frac{65-74}{165}(100) = 6.67'$
(DENSE GRASS) ⇒ n = 0.24

T_{T_1} = 13.3 MINS

SHALLOW CONC. FLOW: B → C L = 180' $S_{AVG} = \frac{74-72.6}{100}(100)$
GRASS K = 0.457 S_{AVG} = 0.78%

$T_{T_2} = \frac{180'}{0.4\%(60)} = 7.5$ MINS $V = K S_{AVG}^{0.5} = 0.457(0.78)^{0.5} = 0.40$ fps

SHALLOW CONC FLOW: C → D L = 275' $S_{AVG} = \frac{72.6-70}{275}(100)$
PAVED K = 0.457 S_{AVG} = 0.945%

$V_{AVG} = K S^{0.5} = 0.457(0.945)^{0.5} = 0.44$ fps

$T_{T_3} = \frac{275'}{0.44\%(60)}$ = 10.4 MINS

T_c = 13.3 + 7.5 + 10.4 = 31.1' ⇒ 32 MINS

SYSTEM OUTLET LOCATION: STA. 180+50, 44' LT

OUTLET PIPE SIZE/TYPE: 24" RCP

PROPOSED DESIGN DISCHARGE: 8.54 cfs (10YR)

1.) PROPOSED OUTLET PROTECTION DEVICE:

SINCE DISCHARGE PIPE IS INLINE WITH A PROPOSED DRAINAGE CHANNEL, USE A TYPE "C" RIPRAP APRON.

FROM PAGE 11.13-9, TABLE 11-13.1
(MINIMUM LENGTH OF PROTECTION)

$La = 14'$ MIN. $\Rightarrow$ USE $La = 14'$

DETERMINE MIN. WIDTH REQUIRED:

$W_3 =$ $3(Sp)$ OR $2(Z)(TWE + 1') + Cb$ OR $2(Z)(0.7\,Rp) + Cb$

USE LARGEST WIDTH

$Cb = 4'$
$Sp = Rp = 2'$
$Z = 2$

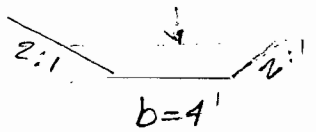
- $3\,Sp = 3(2') = 6'$
- $2(Z)(TWD + 1') + Cb = 2(2')(1.64' + 1') + 4' = 14.56'$
- $2(Z)(0.7\,Rp) + Cb = 2(2')(0.7(2')) + 4' = 9.6'$

USE $W_3 = 14.56'$ SAY 15' WIDE

$\therefore W_3 = 15'$

```
          ******  HYCHL  ****** (Version 6.1) ******          Date 01-07-2009
Commands Read From File: E:\HYCHL\DATA\CH24IN.CHL

      JOB 24RCPOUTLET
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .007   11.00
      TRP 4 2 2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
      N   .062 .062
** LOW  FLOW N VALUE=   .062
** SIDE SLOPE N VALUE=  .062
      LRR .42 2 0 2.65 0.047
** D50 (ft)     .42
** SPECIFIC GRAVITY    2.65
** SHIELDS PARAMETER    .047
      END
***************END OF COMMAND FILE************

24RCPOUTLET
------------
INPUT REVIEW
------------
  DEFAULT ANGLE OF REPOSE (degrees):     41.18
  DESIGN PARAMETERS:
      DESIGN DISCHARGE (ft^3/s):          11.00
      CHANNEL SHAPE:                  TRAPEZOIDAL
      CHANNEL SLOPE (ft/ft):              .007
----------------------------------------
HYDRAULIC CALCULATIONS USING NORMAL DEPTH
----------------------------------------

                          DESIGN     MAXIMUM
                          ------     -------
FLOW (cfs)                 11.00      114.52
DEPTH (ft)                  1.08        3.41
AREA (ft^2)                 6.63       36.98
WETTED PERIMETER (ft)       8.82       19.27
HYDRAULIC RADIUS (ft)        .75        1.92
VELOCITY (ft/s)             1.66        3.10
MANNINGS N (LOW FLOW)        .062        .062
REYNOLDS NUMBER (10^5)       .35

------------------
STABILITY ANALYSIS
------------------

                    LINING    PERMIS SHR   CALC. SHR  STAB.
   CONDITION        TYPE      (LB/FT^2)    (LB/FT^2)  FACTOR   REMARKS
   ---------         ------    ----------   ---------  ------   -------
  BOTTOM; STRAIGHT  RIPRAP        2.03         .47       4.32   STABLE
  SIDE; STRAIGHT    RIPRAP        1.49         .36       4.10   STABLE

*** NORMAL END OF HYCHL ***
```

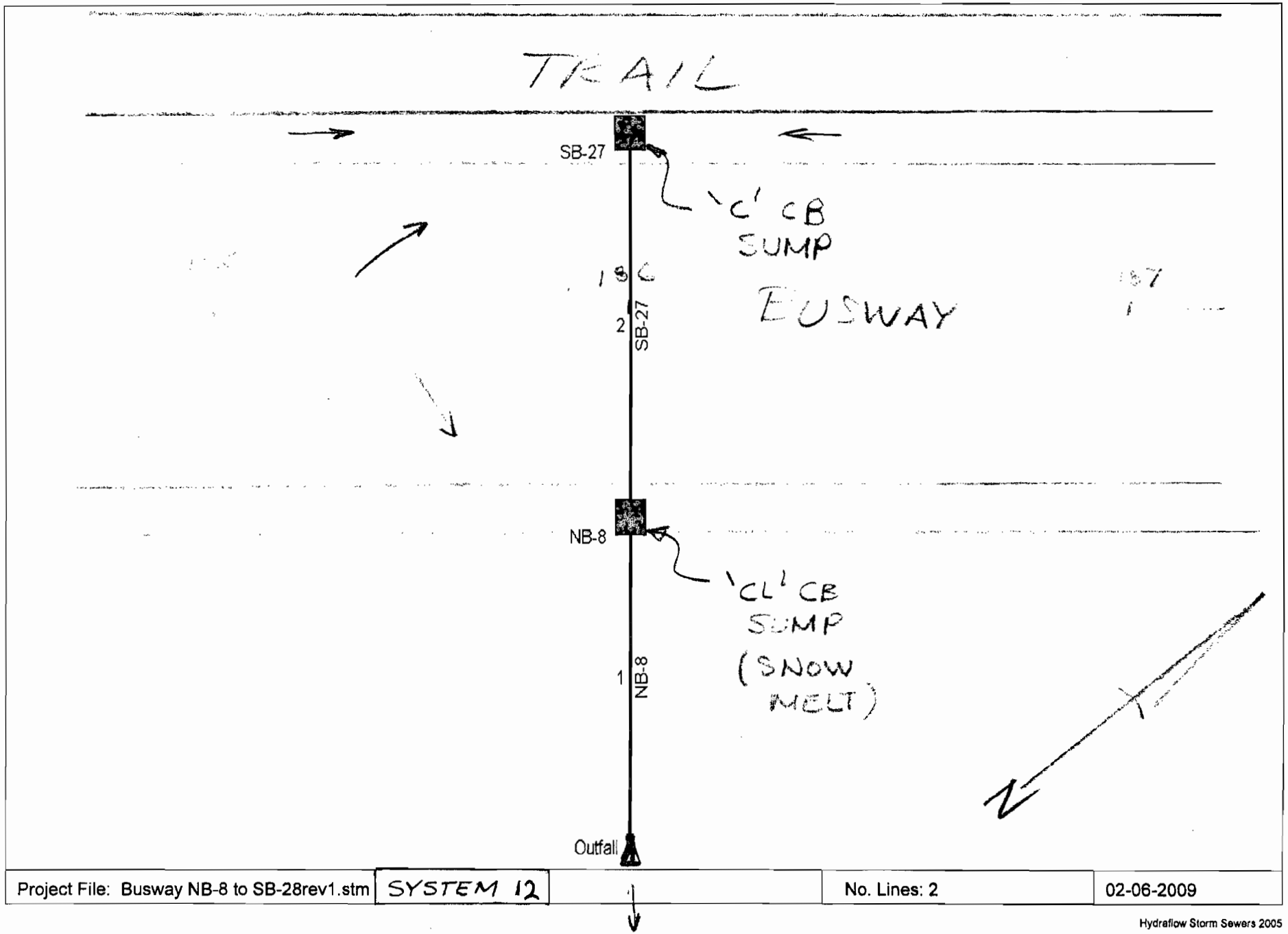
STA. 180+50, 44' LT



TRY MOD. RIPRAP
d_{50} = 0.42' (5")

TYPE 'C' APRON

Hydraflow Plan View



Project File: Busway NB-8 to SB-28rev1.stm	SYSTEM 12	No. Lines: 2	02-06-2009

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	NB-8	0.05	0.00	0.05	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.02	0.58	0.02	0.58	0.00	Off
2	SB-27	1.78	0.00	1.78	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.24	8.01	0.24	8.01	0.00	Off

Project File: Busway NB-8 to SB-28rev1.stm | Number of lines: 2 | Run Date: 09-11-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	10.0	0.01	0.34	0.90	0.01	0.31	5.0	5.2	5.9	1.83	7.72	3.93	12	4.00	70.90	70.50	71.47	71.07	74.77	72.00	NB-8
2	1	32.0	0.33	0.33	0.90	0.30	0.30	5.0	5.0	6.0	1.78	3.86	3.13	12	1.00	71.22	70.90	71.79	71.79	74.73	74.77	SB-27

Project File: Busway NB-8 to SB-28rev1.stm | Number of lines: 2 | Run Date: 09-11-2009

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

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	1.83	70.50	71.07	0.57	0.47	3.93	0.24	71.31	n/a	10.0	70.90	71.47	0.57**	0.47	3.93	0.24	71.71i	n/a	n/a	n/a	0.50	n/a
2	12	1.78	70.90	71.79	0.89	0.74	2.40	0.09	71.88	n/a	32.0	71.22	71.79 j	0.57**	0.46	3.86	0.23	72.02i	n/a	n/a	-0.094	1.00	n/a

Project File: Busway NB-8 to SB-28rev1.stm | Number of lines: 2 | Run Date: 09-11-2009

Notes: ; ** Critical depth.; j-Line contains hyd. jump.

SYSTEM OUTLET LOCATION: STA. 186+0, 40' ± RT

OUTLET PIPE SIZE/TYPE: 12" RCP

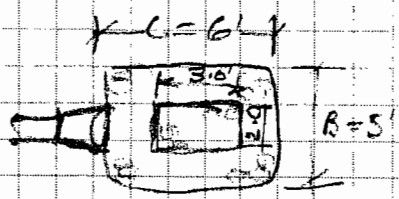
PROPOSED DESIGN DISCHARGE: 1.83 cfs

1.) PROPOSED OUTLET PROTECTION DEVICE:

TRY A PREFORMED SCOUR HOLE – TYPE I TO MINIMIZE DISTURBANCE AND EROSION CONCERN)

FROM CONNDOT DRAINAGE MANUAL, PAGE 11.12-11, TABLE 11-14.1

FOR 12" DIA. OUTLETS ⇒ E = 5'
C = 6'
2.5D = 2.0'
3.5D = 3.0
F ± 1/2 5D = 0.5'



PLAN

2.) RIPRAP STONE SIZE (d_{50}):

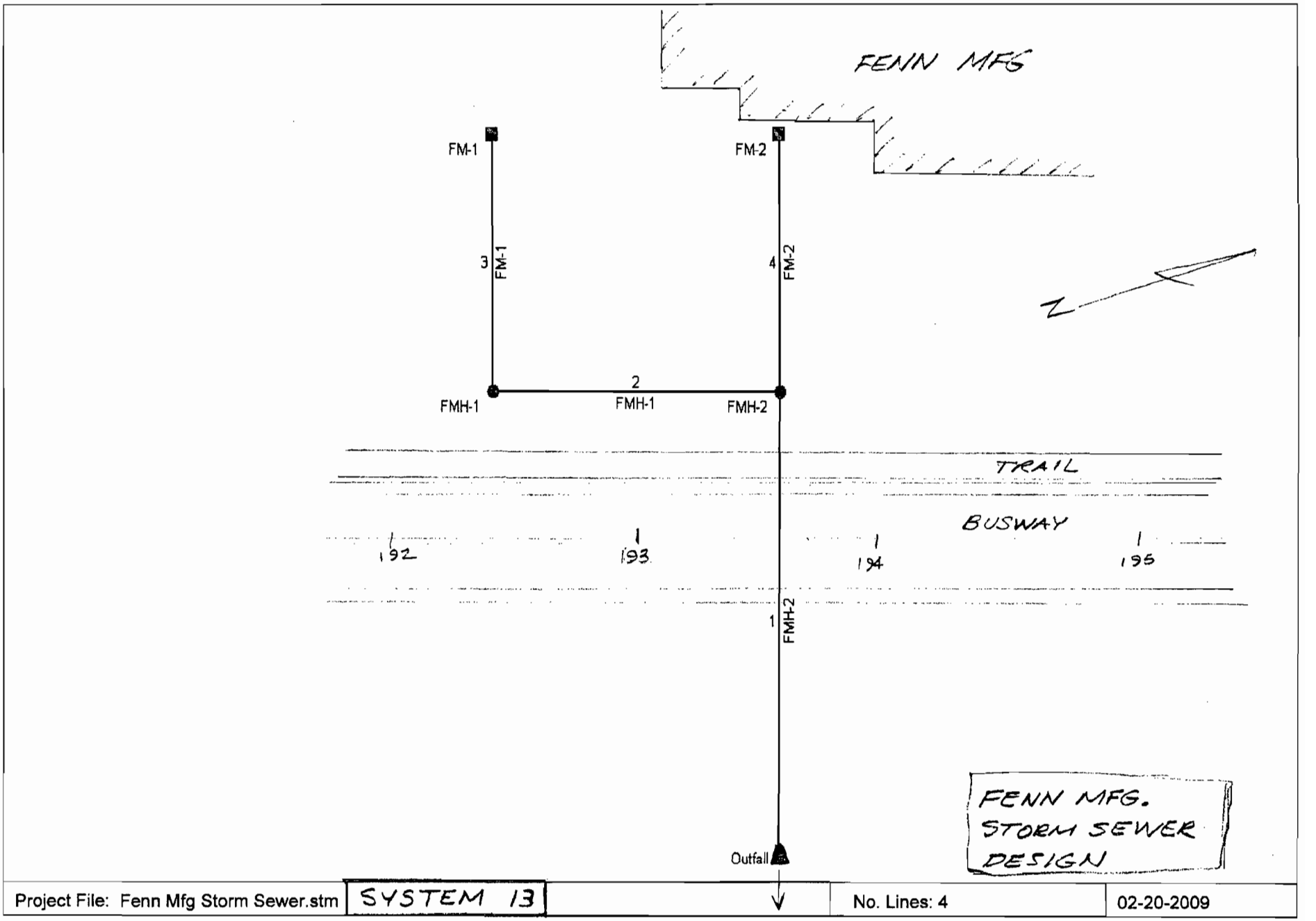
$d_{50} = (0.0125 R_p^2 / TW)(Q / R_p^{2.5})^{1.333}$

$d_{50} = (0.0125(1')^2 / 0.57')(1.83 / (1)^{2.5})^{1.333}$ $TW = 0.57'$ $Q_o = 1.83$ cfs $R_p = 12'' (1')$

$d_{50} = 0.049'$ ⇒ USE MIN. RIPRAP STONE, $d_{50} = 3.42''$ (OK)

⇒ USE 12" MIN. STONE OR 5' DIAMETER PDL

Hydraflow Plan View



Project File: Fenn Mfg Storm Sewer.stm	SYSTEM 13	No. Lines: 4	02-20-2009

FENN MANUFACTURING STORM SEWER SYSTEM MODIFICATIONS

FENN MFG HAS TWO 12" STORM SEWER SYSTEMS THAT DISCHARGE JUST WEST OF BUSWAY. SUGGEST REROUTING AND COMBINING SYSTEMS AND DISCHARGING EAST OF BUSWAY AT STA. 193+30 ± RT.

DRAINAGE SYSTEM INFORMATION

CB FM-1 (STA. 192+70, 100' LT)

$A_T = 0.77 \pm Ac$

GRASS = $0.08 \pm Ac$ $C = 0.3$

PAVED = $0.69 \pm Ac$ $C = 0.9$

$T_C = 5 \pm$ MINS (MOSTLY PAVED)

$Q_{10} = [(0.08)(0.3) + (0.69)(0.9)]\,6.0''/hr = 3.87 \pm cfs$

CB FM-2 (STA. 193+35, 100' LT) ROOF LEADER CONN.

$A_T = 1.753 \pm Ac$ (ROOF AREA ONLY)

$A_P = 1.753\ Ac$ $C = 0.9$

$T_C = 5$ MINS

$Q_{10} = [1.753\ (0.9)]\,(6.0''/hr) = 9.47 \pm cfs$

$Q_{10_T} = 3.87 + 9.47 = 13.34\ cfs$

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	FMH-2	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	FMH-1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
3	FM-1	3.83	0.00	3.83	0.00	Grate	0.0	0.00	0.13	1.00	2.00	Sag	2.00	0.080	0.050	0.000	30.00	598.80	30.00	598.80	0.00	Off
4	FM-2	9.47*	0.00	9.47	0.00	Grate	0.0	0.00	0.32	1.00	2.00	Sag	2.00	0.080	0.050	0.000	30.00	598.80	30.00	598.80	0.00	Off

Project File: Fenn Mfg Storm Sewer.stm | Number of lines: 4 | Run Date: 03-03-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	90.0	0.00	0.77	0.00	0.00	0.64	0.0	5.4	5.9	13.30	11.99	7.70	18	1.11	68.00	67.00	69.60	68.36	73.25	68.75	FMH-2
2	1	58.0	0.00	0.77	0.00	0.00	0.64	0.0	5.2	5.9	3.83	3.86	4.87	12	1.00	69.69	69.11	71.82	71.25	73.25	73.25	FMH-1
3	2	46.0	0.77	0.77	0.83	0.64	0.64	5.0	5.0	6.0	3.83	2.84	4.87	12	0.54	69.94	69.69	72.64	72.19	73.31	73.25	FM-1
4	1	46.0	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	9.47	2.73	12.06	12	0.50	69.61	69.38	74.02	71.25	72.81	73.25	FM-2

Project File: Fenn Mfg Storm Sewer.stm | Number of lines: 4 | Run Date: 03-03-2009

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

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	18	13.30	67.00	68.36	1.36	1.69	7.88	0.97	69.33	n/a	90.0	68.00	69.60	1.50	1.77	7.53	0.88	70.48i	n/a	n/a	0.272	1.00	n/a
2	12	3.83	69.11	71.25	1.00	0.79	4.88	0.37	71.62	0.985	58.0	69.69	71.82	1.00	0.79	4.87	0.37	72.19	0.985	0.985	0.571	1.00	0.37
3	12	3.83	69.69	72.19	1.00	0.79	4.88	0.37	72.56	0.985	46.0	69.94	72.64	1.00	0.79	4.87	0.37	73.01	0.985	0.985	0.453	1.00	0.37
4	12	9.47	69.38	71.25	1.00	0.79	12.06	2.26	73.51	n/a	46.0	69.61	74.02	1.00**	0.79	12.06	2.26	76.28i	n/a	n/a	0.512	1.00	n/a

Project File: Fenn Mfg Storm Sewer.stm | Number of lines: 4 | Run Date: 03-03-2009

Notes: ; ** Critical depth.

OUTLET PROTECTION

LOCATION: 18" RCCE @ STA. 193+35 RT

THIS STORM SEWER SYSTEM WILL CONVEY PRIVATE (FENN MFG) DRAINAGE ACROSS BUSWAY.

$Q_{10} = 13.3 \pm cfs$

TO REDUCE EROSION AND IMPART TO SCEL USE SCOUR HOLE

USE TYPE I SCOUR HOLE

FROM CONNDOT DRAINAGE MANUAL, PG. 8.7-11 TABLE 8-8.1

FOR TYPE I, 18" RCP OUTLET PIPE

R = 8' 2Sp = 3.0' Sp = Rp = 1.5'
C = 9' 3Sp = 4.5'
F = 0.5(1.5') = 0.75' TW = 1.36' (SEE CALCS)

RIPRAP STONE SIZE REQ'D

$d_{50} = ?$

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

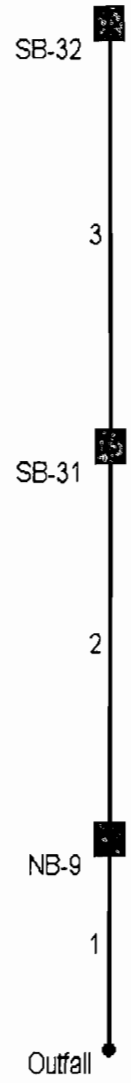
$$d_{50} = (0.0125(1.5)^2 / 1.36)(13.3 / 1.5^{2.5})^{1.333} =$$

$$d_{50} = (0.020680)(8.152116) = 0.1685' < 0.42'$$

MOD. RIPRAP OK

⇒ USE MIN. 12" THICK RIPRAP STONE ON 6" GRANULAR FILL

Hydraflow Plan View



Project File: Busway SB-32 to NB-9.stm	SYSTEM 14	No. Lines: 3	08-31-2009

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (In)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	NB-9	0.05	0.00	0.05	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.02	0.58	0.02	0.58	0.00	Off
2	SB-31	1.19	0.35	1.54	0.00	Grate	0.0	0.00	3.13	2.31	1.36	Sag	4.00	0.040	0.020	0.000	0.22	6.90	0.22	6.90	0.00	Off
3	SB-32	2.73	0.00	2.38	0.35	Grate	0.0	0.00	0.00	3.15	1.64	0.005	4.00	0.040	0.020	0.013	0.28	9.90	0.28	9.90	0.00	2

Project File: Busway SB-32 to NB-9.stm | Number of lines: 3 | Run Date: 08-31-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	14.0	0.01	1.18	0.90	0.01	0.66	5.0	5.2	5.9	3.93	6.68	5.57	12	3.00	68.92	68.50	69.76	69.34	73.08	69.50	NB-9
2	1	26.0	0.22	1.17	0.90	0.20	0.65	5.0	5.1	5.9	3.89	4.07	4.95	12	1.12	69.21	68.92	70.83	70.57	73.03	73.08	SB-31
3	2	28.0	0.95	0.95	0.48	0.46	0.46	5.0	5.0	6.0	2.73	2.82	3.48	12	0.54	69.36	69.21	70.99	70.85	74.10	73.03	SB-32

Project File: Busway SB-32 to NB-9.stm | Number of lines: 3 | Run Date: 08-31-2009

NOTES: Intensity = 54.74 / (Inlet time + 10.80) ^ 0.80; Return period = 10 Yrs.

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	3.93	68.50	69.34	0.84	0.70	5.57	0.48	69.82	n/a	14.0	68.92	69.76	0.84**	0.70	5.57	0.48	70.24i	n/a	n/a	n/a	0.50	n/a
2	12	3.89	68.92	70.57	1.00	0.79	4.96	0.38	70.95	n/a	26.0	69.21	70.83	1.00	0.79	4.95	0.38	71.22i	n/a	n/a	-0.117	0.50	n/a
3	12	2.73	69.21	70.85	1.00	0.79	3.48	0.19	71.04	0.501	28.0	69.36	70.99	1.00	0.79	3.48	0.19	71.18	0.501	0.501	0.140	1.00	0.19

Project File: Busway SB-32 to NB-9.stm | Number of lines: 3 | Run Date: 08-31-2009

Notes: ; ** Critical depth.

Close, Jensen and Miller, P.C.

BY DJP DATE 3/9/09 SUBJECT BUSWAY SHEET NO. 105 OF .....
CHKD. BY RJF DATE 4/9/09 PROJECT NO. 171-305 JOB NO. 8002
CONTRACT # 88-H034

SYSTEM OUTLET LOCATION: STA. 197+0, 30' RT

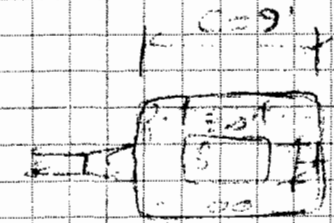
OUTLET PIPE SIZE/TYPE: 12" RCP

PROPOSED DESIGN DISCHARGE: 3.93 cfs

1.) PROPOSED OUTLET PROTECTION DEVICE:

TRY A TYPE 2 PREFORMED SCOUR HOLE FROM CONNDOT DRAINAGE MANUAL, PAGE 11.13-11, TABLE 11-14.1

FOR 12" DIA. OUTLET ⇒ B = 8'
C = 9'
TSP = 2.0'
DSP = 3.0'
TE DP = 1'



PLAN

Q = 3.93 cfs
Kp = 12" (1')
TW = 0.56'

2.) RIPRAP STONE SIZE (d_{50}):

$d_{50} = (0.0115 K_p^2/TW)(Q/K_p^{2.5})^{1.33}$

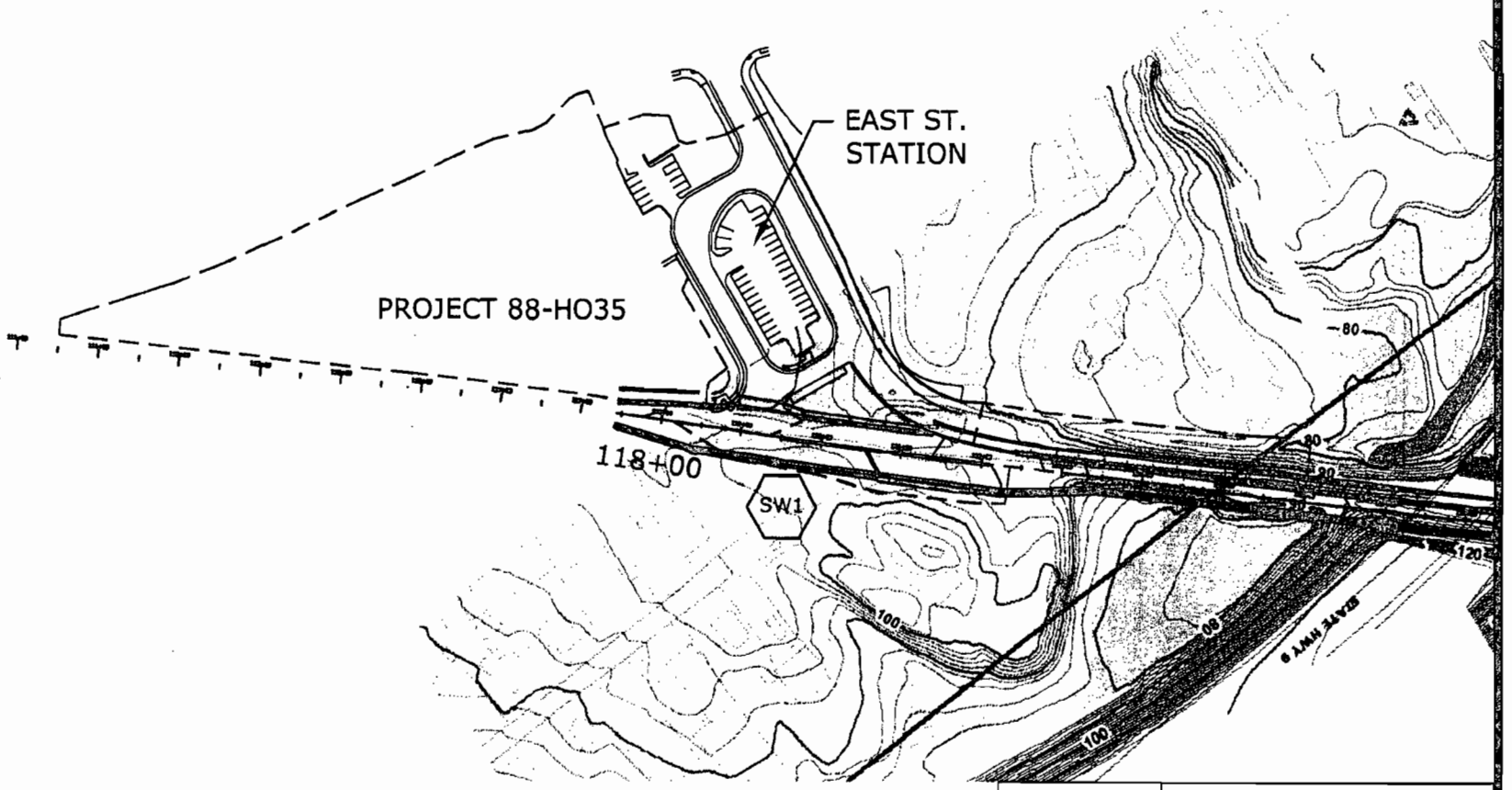
$d_{50} = (0.0115(1')^2/0.56')(3.93/(1)^{2.5})^{1.33}$

$d_{50} = 0.138' \leq 0.42'$ USE MUNI. RIPRAP STONE
$d_{50} = 0.42'$

USE 12" MIN. MODIFIED RIPRAP STONE ON 6" GRANULAR FILL

SECTION II

CHANNEL, DITCH AND SWALE DESIGN



LEGEND:

SW1 — SWALE

- - - - - - - - - - - - WATERSHED LIMIT

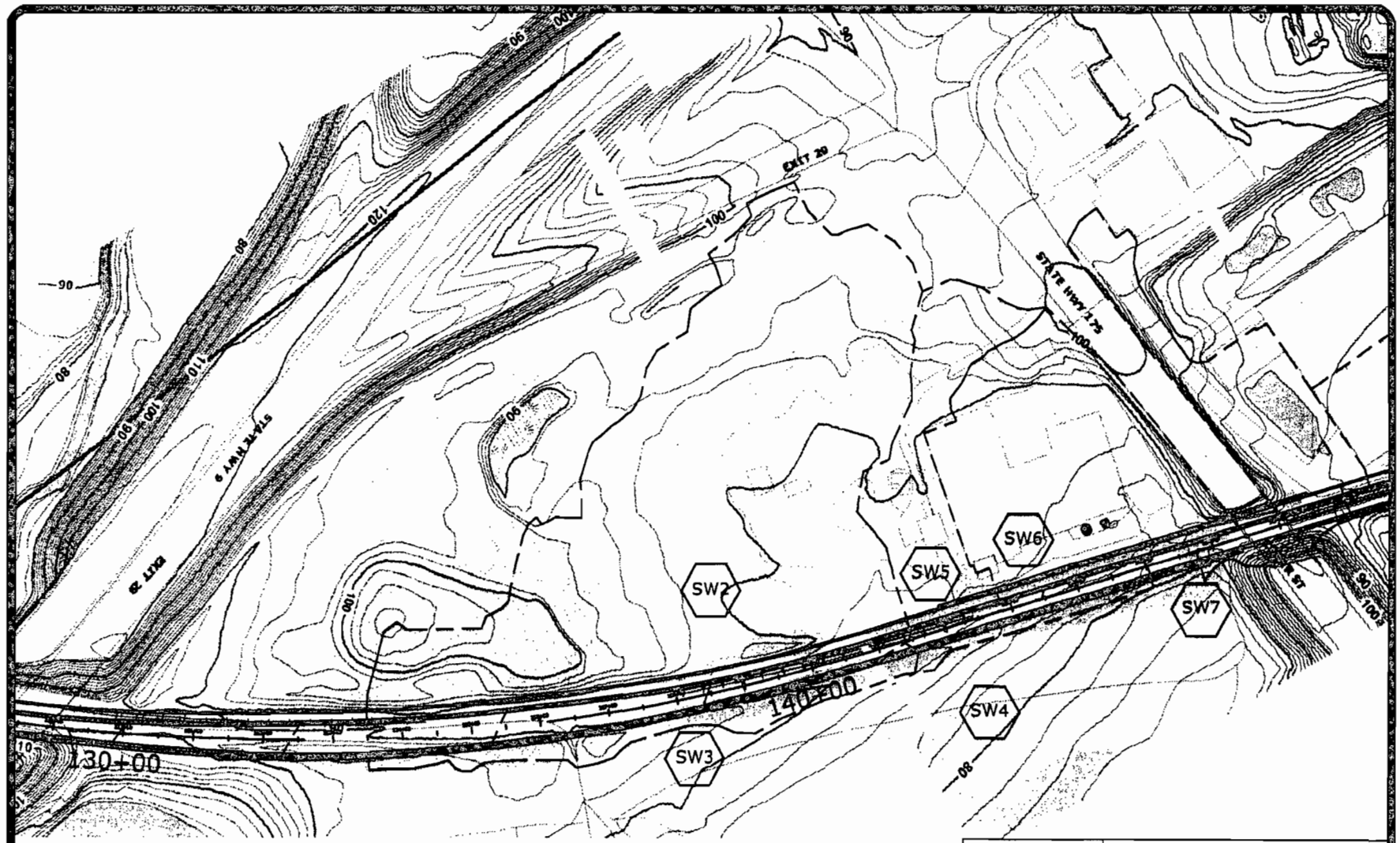
SEE DRG-1 TO DRG-8 FOR ADDITIONAL WATERSHED DETAIL.

DRAINAGE AREA PLAN 118+00 TO 129+50
NEW BRITAIN-HARTFORD BUSWAY
CONTRACT NO. 88-H034

L.P. Consultants, LLC
252 Hazard Avenue
Enfield, CT 06082-4613

SIZE:	WBS No.:	PROJECT No.:	REVISION
A			

AUTH: KSM DATE: 11-17-08 SHEET: DA-1
SCALE: 1" = 200'



LEGEND:

SW1 — SWALE

- - - - - - - - - - - - WATERSHED LIMIT

SEE DRG-1 TO DRG-8 FOR ADDITIONAL WATERSHED DETAIL.

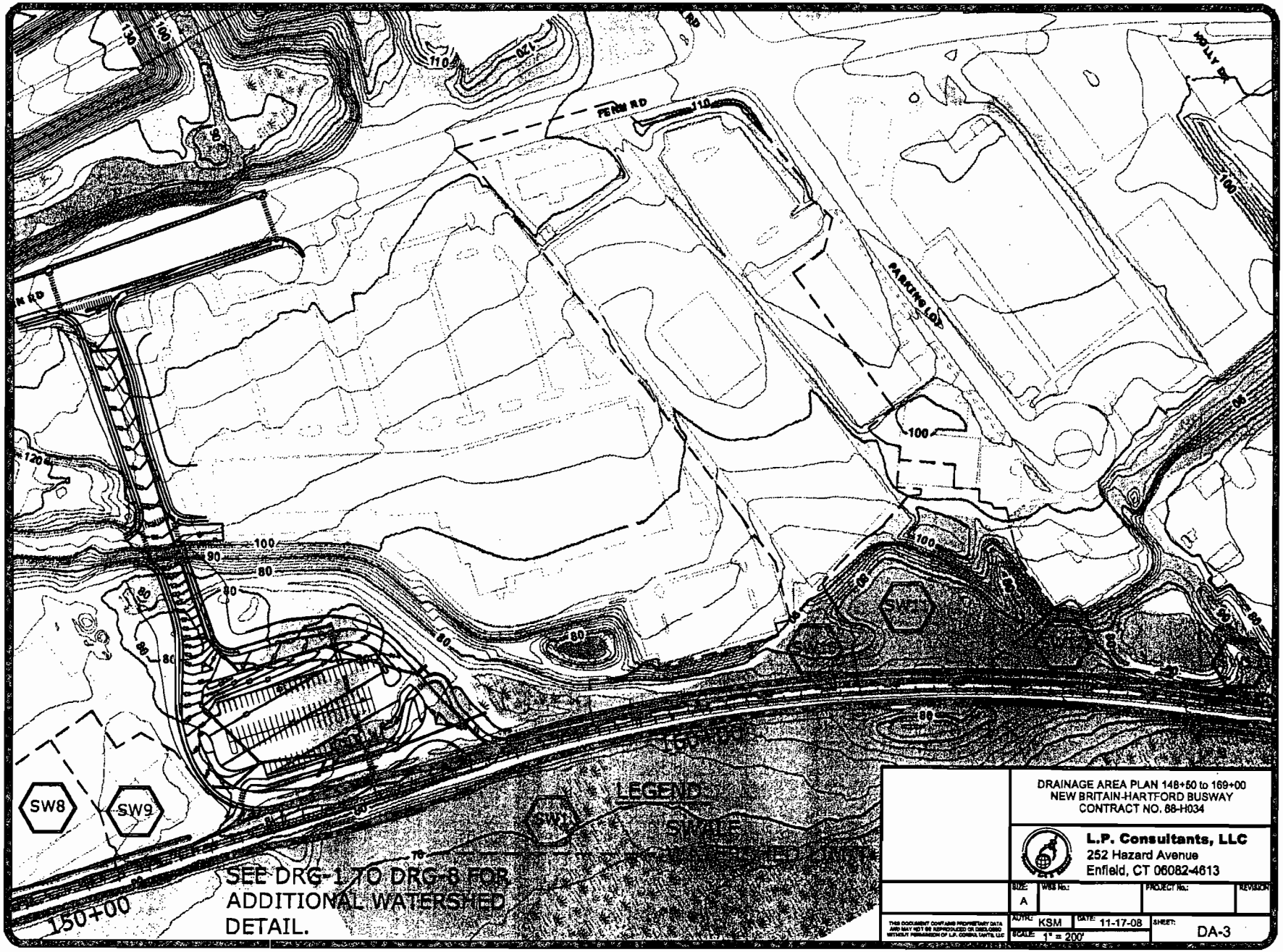
DRAINAGE AREA PLAN 129+50 TO 148+50
NEW BRITAIN-HARTFORD BUSWAY
CONTRACT NO. 88-H034

L.P. Consultants, LLC
252 Hazard Avenue
Enfield, CT 06082-4613

SIZE:	WBS No.:	PROJECT No.:	REVISION
A			

AUTH.:	DATE:	SHEET:
KSM	11-17-08	DA-2

SCALE: 1" = 200'



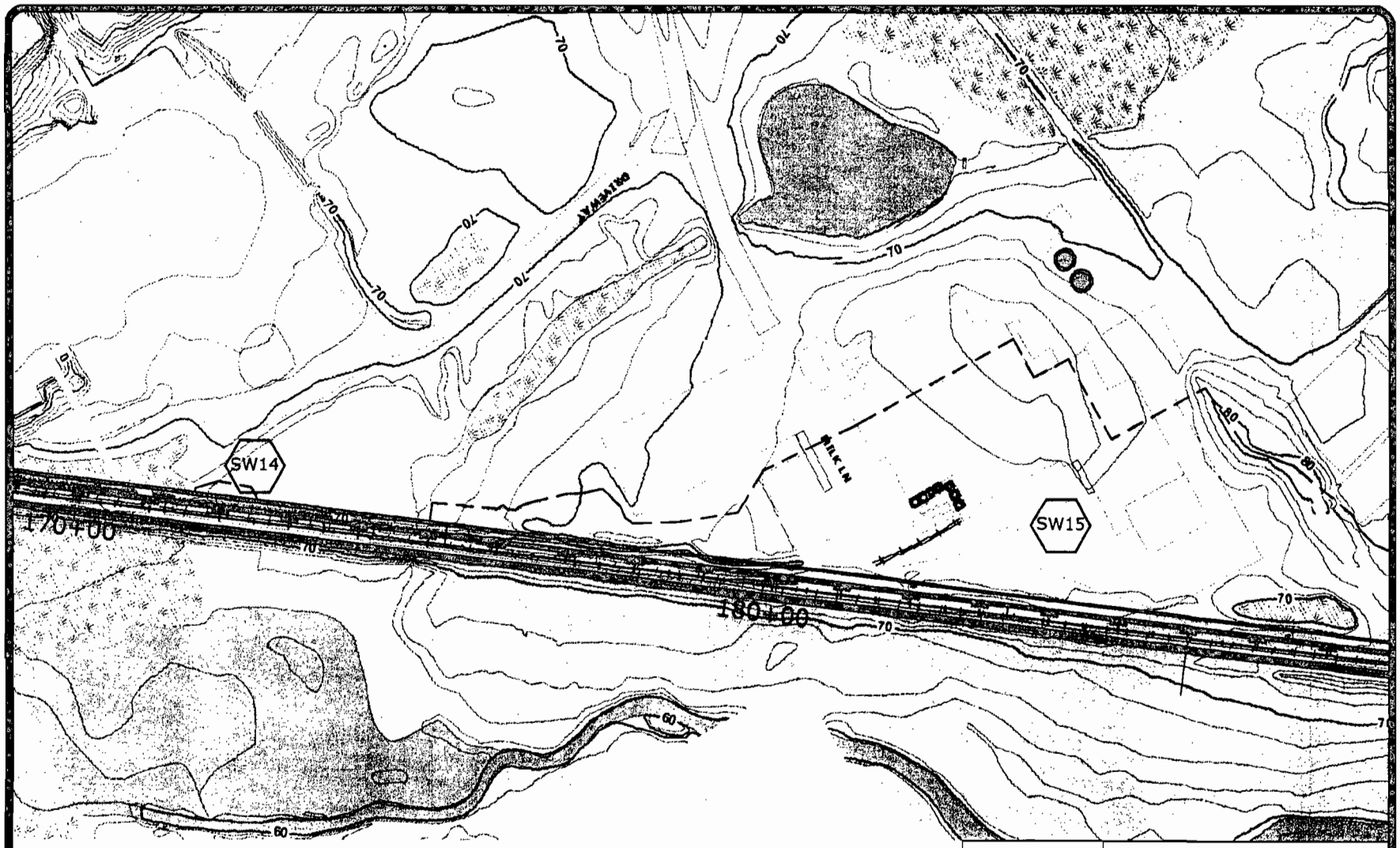
DRAINAGE AREA PLAN 148+50 to 169+00
NEW BRITAIN-HARTFORD BUSWAY
CONTRACT NO. 88-H034

L.P. Consultants, LLC
252 Hazard Avenue
Enfield, CT 06082-4613

SIZE:	WBS No.:	PROJECT No.:	REVISION
A			

AUTH:	DATE:	SHEET:
KSM	11-17-08	DA-3

SCALE: 1" = 200'



LEGEND:

SW1 — SWALE

- - - - - - - - - - - - WATERSHED LIMIT

SEE DRG-1 TO DRG-8 FOR ADDITIONAL WATERSHED DETAIL.

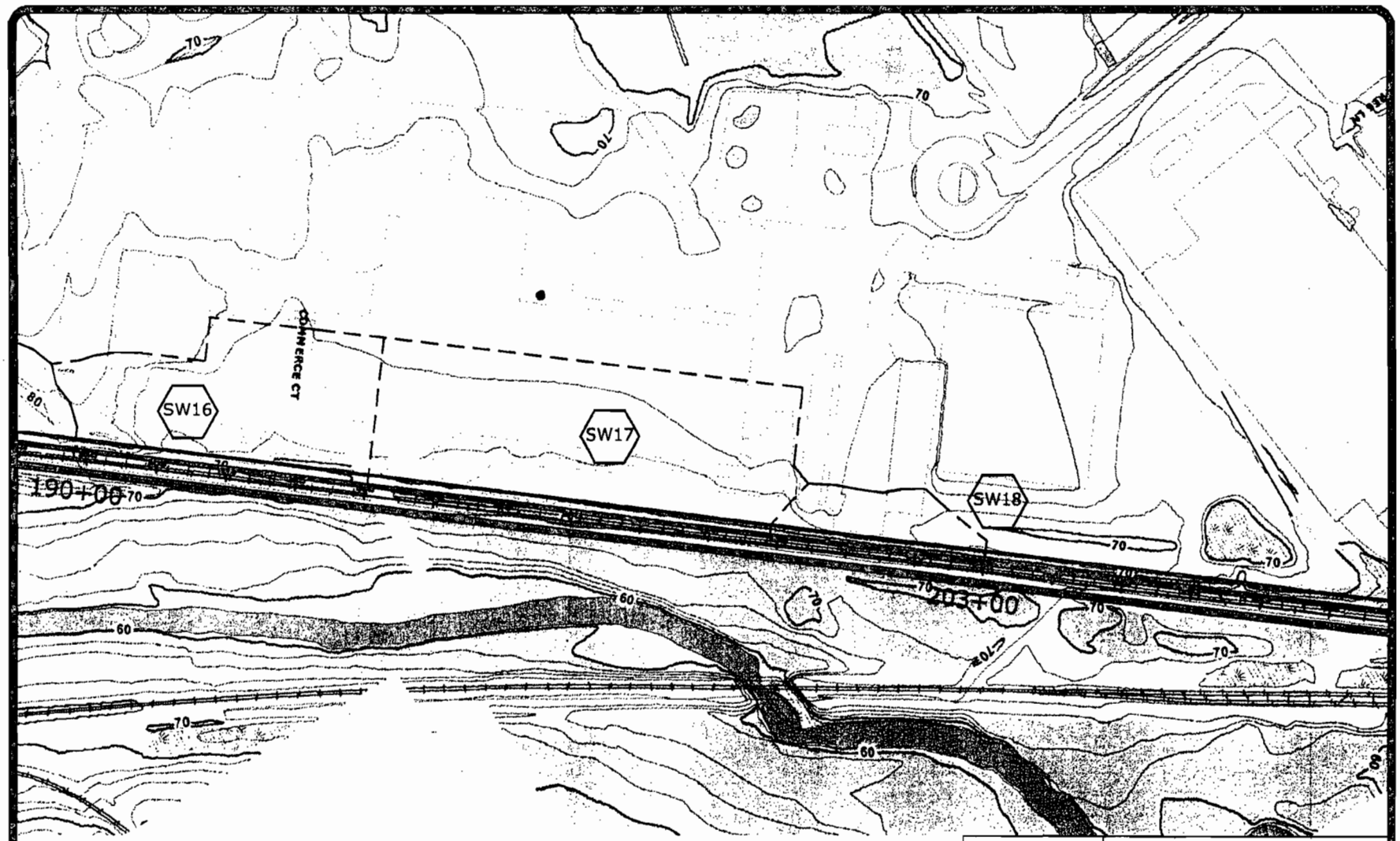
DRAINAGE AREA PLAN 169+00TO 189+00
NEW BRITAIN-HARTFORD BUSWAY
CONTRACT NO. 88-H034

L.P. Consultants, LLC
252 Hazard Avenue
Enfield, CT 06082-4613

SIZE:	WBS No.:	PROJECT No.:	REVISION
A			

AUTH.: KSM | DATE: 11-17-08 | SHEET: DA-4

SCALE: 1" = 200'



LEGEND:

SW1 — SWALE

WATERSHED LIMIT

SEE DRG-1 TO DRG-8 FOR ADDITIONAL WATERSHED DETAIL.

DRAINAGE AREA PLAN 189+00 to 202+50
NEW BRITAIN-HARTFORD BUSWAY
CONTRACT NO. 88-H034

L.P. Consultants, LLC
252 Hazard Avenue
Enfield, CT 06082-4613

SIZE:	WBS No.:	PROJECT No.:	REVISION
A			

AUTH:	DATE:	SHEET:
KSM	11-17-08	DA-5

SCALE: 1" = 200'

SWALE SW2 Station 133+50 TO 141+50 LT

PAVEMENT Area = 0.92 Ac C = 0.9
GRASS Area = 7.11 Ac C = 0.3

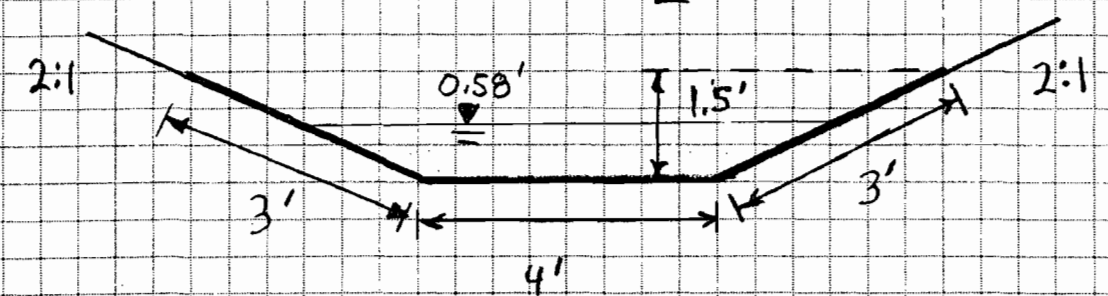
T_c = 27 min.
I_{2yr} = 2.1 in/hr
I_{10yr} = 3.0 in/hr

$$C_{avg} = \frac{(0.92)(0.9) + (7.11)(0.3)}{8.03} = 0.368$$

$Q_{2yr} = 0.368\,(2.1)(8.03) = 6.22$ cfs

$Q_{10yr} = 0.368\,(3.0)(8.03) = 8.88$ cfs

CHANNEL



SLOPE VARIES 1% - 4%

WORST CASES: DEPTH @ 1% = 0.58'

STRESS @ 4% USE SYNTHETIC MAT

USE 10' WIDE EROSION CONTROL MATTING TYPE H

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-25-2009
 Commands Read From File: E:\HYCHL\SW2.CHL

       JOB SW2
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .01     8.880
       TRP 4 2 2
 ** LEFT SIDE SLOPE     2.0 AND RIGHT SIDE SLOPE     2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)     4.00
       END
***************END OF COMMAND FILE************
```

SWALE 2 STA 133+50 TO 141+50 LT: TEMPORARY AND PERMANET LINING

```
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):            8.88
       CHANNEL SHAPE:                  TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):                .010

 -------
 RESULTS
 -------
                 SHEAR STRESS(psf) Len of Super                          ---DESIGN--
                  ---------------- Protect Elev          Stab.   Max Q  Depth  Mann
 Lining Type      Permiss  Bottom   (ft)   (ft) Remark   Factor  (cfs)   (ft)    n
 ---------------- ------- ------- ------ ----- ------ ------ ------- ------ ----
     TEMPORARY (FLEXIBLE)

 WOVEN PAPER NET      .15     .23    .00    0. UNSTAB    .65     4.1    .37 .014
 JUTE NET             .45     .33    .00    0. STABLE   1.37    16.5    .53 .025
 FIBERGLASS SINGLE    .60     .32    .00    0. STABLE   1.85    29.6    .52 .024
 FIBERGLASS DOUBLE    .85     .34    .00    0. STABLE   2.53    56.4    .54 .026
 STRAW WITH NET      1.45     .43    .00    0. STABLE   3.34   122.2    .70 .041
 CURLED WOOD MAT     1.55     .44    .00    0. STABLE   3.49   132.9    .71 .043
 SYNTHETIC MAT       2.00     .36    .00    0. STABLE   5.55   325.2    .58 .029

     PERMANENT (FLEXIBLE)

 VEGETATIVE  A       3.70    1.32    .00    0. STABLE   2.80   331.9   2.12 .347
 VEGETATIVE  B       2.10     .89    .00    0. STABLE   2.36   109.4   1.43 .157
 VEGETATIVE  C       1.00     .66    .00    0. STABLE   1.51    25.5   1.06 .090
 VEGETATIVE  D        .60     .58    .00    0. STABLE   1.04     9.8    .92 .069
 VEGETATIVE  E        .35     .53    .00    0. UNSTAB    .67     3.3    .84 .058

     RIGID

 CONCRETE          *******     .25    .00    0. STABLE ******      .0    .39 .015
 GROUTED RIPRAP    *******     .39    .00    0. STABLE ******      .0    .62 .033
 STONE MASONRY     *******     .39    .00    0. STABLE ******      .0    .63 .034
 SOIL CEMENT       *******     .33    .00    0. STABLE ******      .0    .52 .025
 ASPHALT           *******     .27    .00    0. STABLE ******      .0    .44 .018

 SOME RIPRAP AND GABION LININGS MAY ALSO BE STABLE
 *** NORMAL END OF HYCHL ***
```

```
      ******  HYCHL  ****** (Version 6.1) ******          Date 12-11-2008
 Commands Read From File: E:\HYCHL\BUSWAY.CHL

       JOB SW2
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .04    8.88
       TRP 4      2      2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
       NEQ 1
       END
***************END OF COMMAND FILE*************
```

SWALE 2 STA 133+50 TO 141+50 LT: TEMPORARY AND PERMANET LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	8.88
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.040

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.63	.00	0.	UNSTAB	.24	.7	.25	.014
JUTE NET	.45	.92	.00	0.	UNSTAB	.49	2.1	.37	.027
FIBERGLASS SINGLE	.60	.91	.00	0.	UNSTAB	.66	3.9	.36	.026
FIBERGLASS DOUBLE	.85	.95	.00	0.	UNSTAB	.90	7.2	.38	.028
STRAW WITH NET	1.45	1.26	.00	0.	STABLE	1.15	12.0	.51	.046
CURLED WOOD MAT	1.55	1.29	.00	0.	STABLE	1.21	13.3	.51	.048
SYNTHETIC MAT	**2.00**	**1.02**	**.00**	**0.**	**STABLE**	**1.95**	**34.4**	**.41**	**.032**
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	3.38	.00	0.	STABLE	1.09	13.1	1.36	.285
VEGETATIVE B	2.10	2.30	.00	0.	UNSTAB	.91	6.6	.92	.137
VEGETATIVE C	1.00	1.72	.00	0.	UNSTAB	.58	1.9	.69	.081
VEGETATIVE D	.60	1.49	.00	0.	UNSTAB	.40	.7	.60	.062
VEGETATIVE E	.35	1.36	.00	0.	UNSTAB	.26	.1	.55	.053

USE SYNTHETIC MAT FOR TEMPORARY AND PERMANENT LINING

Summary for Subcatchment S2: Swale 133+50 to 141+50

Runoff = 4.22 cfs @ 0.46 hrs, Volume= 0.395 af, Depth= 0.72"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
CT-DOT 10-year Duration=68 min, Inten=1.68 in/hr

Area (ac)	C	Description
5.650	0.30	Grass
0.920	0.90	Pavement
6.570	0.38	Weighted Average
6.570		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	110	0.0136	0.15		**Sheet Flow, overland sheet** Grass: Short n= 0.150 P2= 3.20"
6.8	305	0.0115	0.75		**Shallow Concentrated Flow, shallow concentrated** Short Grass Pasture Kv= 7.0 fps
8.2	444	0.0167	0.90		**Shallow Concentrated Flow, shallow concentrated** Short Grass Pasture Kv= 7.0 fps
27.3	859	Total			

SWALE SW3 134+50 TO 141+50 RT

PAVEMENT AREA = 0.005 Ac C = 0.9

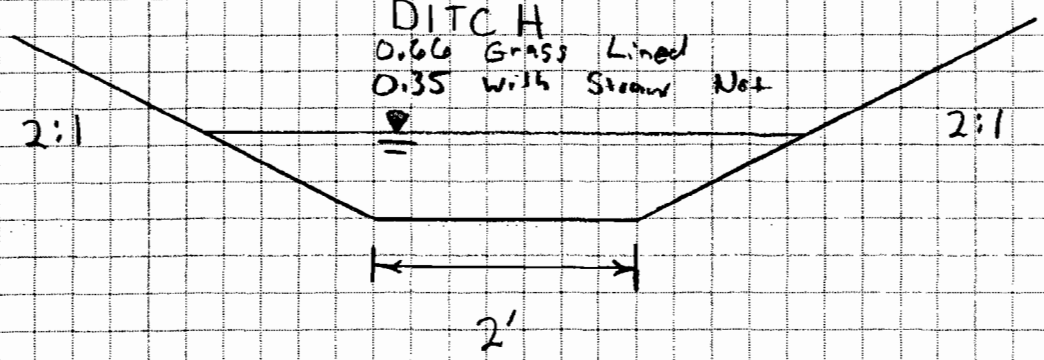
GRASS AREA = 0.634 Ac C = 0.3

Tc = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{0.005(0.9) + 0.634(0.3)}{0.639} = 0.305$$

$Q_{2yr} = 0.305\,(3.6)(0.639) = 0.70$ CFS

$Q_{10yr} = 0.305(4.8)(0.639) = 0.93$ CFS



SLOPE VARIES 1% - 2%

WORST CASE : DEPTH @ 1% = 0.35'

USE 8' WIDE STRAW WITH NET FOR TEMPORARY CONDITION UNTIL GRASS IS ESTABLISHED. TYPE G

Commands Read From File: E:\HYCHL\BUSWAY.CHL

```
      JOB SW3
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .01    .93
      TRP 2      2      2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      NEQ 1
      END
***************END OF COMMAND FILE*************
```

SW3 STA 134+50 TO 141+50 RT: TEMPORARY AND PERMANET LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s): .93
CHANNEL SHAPE: TRAPEZOIDAL
CHANNEL SLOPE (ft/ft): .010

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.10	.00	0.	STABLE	1.57	2.1	.15	.015
JUTE NET	.45	.15	.00	0.	STABLE	3.05	9.3	.24	.031
FIBERGLASS SINGLE	.60	.15	.00	0.	STABLE	4.14	17.6	.23	.030
FIBERGLASS DOUBLE	.85	.15	.00	0.	STABLE	5.57	35.6	.24	.033
STRAW WITH NET	1.45	.22	.00	0.	STABLE	6.67	85.0	.35	.062
CURLED WOOD MAT	1.55	.22	.00	0.	STABLE	7.09	93.9	.35	.062
SYNTHETIC MAT	2.00	.17	.00	0.	STABLE	11.87	243.4	.27	.039
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	.85	.00	0.	STABLE	4.36	263.7	1.36	.880
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	.70	.00	0.	STABLE	2.99	78.2	1.12	.585
VEGETATIVE C	**1.00**	**.41**	**.00**	**0.**	**STABLE**	**2.43**	**15.4**	**.66**	**.203**
VEGETATIVE D	.60	.33	.00	0.	STABLE	1.83	5.4	.52	.131
VEGETATIVE E	.35	.28	.00	0.	STABLE	1.23	1.7	.46	.101

USE STRAW WITH NET FOR TEMPORARY LINING AND VEGETATIVE C FOR PERMANENT LINING

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-25-2009
 Commands Read From File: E:\HYCHL\SW3.CHL

       JOB SW3
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .02     0.930
       TRP 2       2       2
 ** LEFT SIDE SLOPE     2.0 AND RIGHT SIDE SLOPE     2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)     2.00
       END
***************END OF COMMAND FILE************
```

SW3 STA 134+50 TO 141+50 RT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:
- DESIGN DISCHARGE (ft^3/s): .93
- CHANNEL SHAPE: TRAPEZOIDAL
- CHANNEL SLOPE (ft/ft): .020

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.16	.00	0.	UNSTAB	.95	.9	.13	.015
JUTE NET	.45	.25	.00	0.	STABLE	1.80	3.1	.20	.033
FIBERGLASS SINGLE	.60	.25	.00	0.	STABLE	2.44	5.8	.20	.032
FIBERGLASS DOUBLE	.85	.26	.00	0.	STABLE	3.28	11.1	.21	.035
STRAW WITH NET	1.45	.38	.00	0.	STABLE	3.83	22.6	.30	.068
CURLED WOOD MAT	1.55	.38	.00	0.	STABLE	4.08	25.0	.30	.068
SYNTHETIC MAT	2.00	.29	.00	0.	STABLE	6.94	65.7	.23	.042
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.42	.00	0.	STABLE	2.61	46.1	1.14	.851
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	1.06	.00	0.	STABLE	1.99	16.2	.85	.450
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE C	**1.00**	**.65**	**.00**	**0.**	**STABLE**	**1.53**	**3.8**	**.52**	**.185**
VEGETATIVE D	.60	.52	.00	0.	STABLE	1.14	1.4	.42	.123
VEGETATIVE E	.35	.46	.00	0.	UNSTAB	.77	.4	.37	.095
RIGID									
CONCRETE	*******	.16	.00	0.	STABLE	******	.0	.13	.015
GROUTED RIPRAP	*******	.28	.00	0.	STABLE	******	.0	.22	.040
STONE MASONRY	*******	.29	.00	0.	STABLE	******	.0	.23	.042
SOIL CEMENT	*******	.21	.00	0.	STABLE	******	.0	.17	.025
ASPHALT	*******	.18	.00	0.	STABLE	******	.0	.14	.018

SOME RIPRAP AND GABION LININGS MAY ALSO BE STABLE
*** NORMAL END OF HYCHL ***

SWALE SW4 STATION 141+50 TO 145+00 RT

PAVEMENT AREA = 0.096 Ac C = 0.9

GRASS AREA = 0.207 Ac C = 0.3

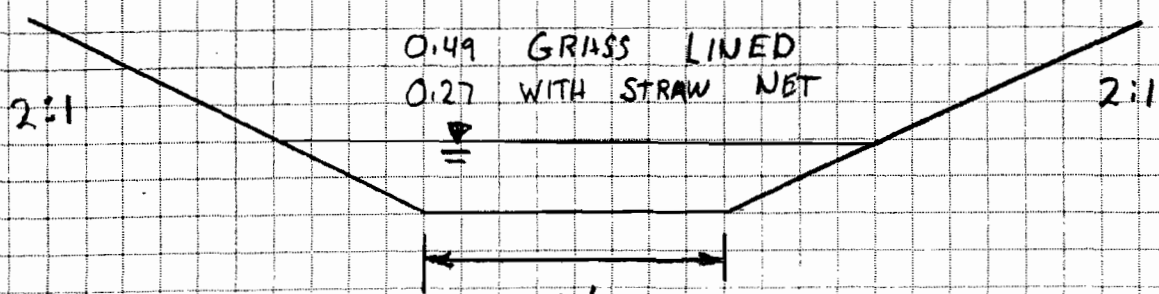
T_c = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{0.096(0.9) + 0.207(0.3)}{0.303} = 0.49$$

$Q_{2yr} = 0.49\,(3.6)(0.303) = 0.53$ CFS

$Q_{10yr} = 0.49\,(4.8)(0.303) = 0.71$ CFS

DITCH



SLOPE = 2% 3' END OF DITCH SLOPE = 5%

USE 6' WIDE STRAW WITH NET FOR TEMPORARY CONDITION UNTIL GRASS IS ESTABLISHED TYPE G

Commands Read From File: E:\HYCHL\BUSWAY.CHL

```
      JOB SW4
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .02     .71
      TRP 2       2       2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      NEQ 1
      END
***************END OF COMMAND FILE************
```

SWALE 4 STA 141+50 TO 145+63 RT: TEMPORARY AND PERMANET LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s): .71
CHANNEL SHAPE: TRAPEZOIDAL
CHANNEL SLOPE (ft/ft): .020

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.14	.00	0.	STABLE	1.11	.9	.11	.015
JUTE NET	.45	.22	.00	0.	STABLE	2.04	3.1	.18	.035
FIBERGLASS SINGLE	.60	.22	.00	0.	STABLE	2.78	5.8	.17	.033
FIBERGLASS DOUBLE	.85	.23	.00	0.	STABLE	3.72	11.1	.18	.037
STRAW WITH NET	**1.45**	**.34**	**.00**	**0.**	**STABLE**	**4.24**	**22.6**	**.27**	**.074**
CURLED WOOD MAT	1.55	.34	.00	0.	STABLE	4.54	25.0	.27	.074
SYNTHETIC MAT	2.00	.26	.00	0.	STABLE	7.81	65.7	.21	.045
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.24	.00	0.	STABLE	2.98	46.1	1.00	.851
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	1.04	.00	0.	STABLE	2.03	16.2	.83	.530
VEGETATIVE C	**1.00**	**.62**	**.00**	**0.**	**STABLE**	**1.62**	**3.8**	**.49**	**.217**
VEGETATIVE D	.60	.48	.00	0.	STABLE	1.24	1.4	.39	.138
VEGETATIVE E	.35	.42	.00	0.	UNSTAB	.84	.4	.33	.106

USE STRAW WITH NET FOR TEMPORARY LINING AND VEGETATIVE C FOR PERMANENT LINING

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-25-2009
 Commands Read From File: E:\HYCHL\SW4.CHL

       JOB SW4
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .05     0.710
       TRP 3       2       2
 ** LEFT SIDE SLOPE     2.0 AND RIGHT SIDE SLOPE     2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)     3.00
       END
***************END OF COMMAND FILE************
```

END OF SW4 STA 145+00 RT: TEMPORARY AND PERMANET LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	.71
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.050

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.21	.00	0.	UNSTAB	.71	.4	.07	.016
JUTE NET	.45	.37	.00	0.	STABLE	1.22	1.1	.12	.041
FIBERGLASS SINGLE	.60	.36	.00	0.	STABLE	1.66	2.1	.12	.039
FIBERGLASS DOUBLE	.85	.39	.00	0.	STABLE	2.20	3.9	.12	.044
STRAW WITH NET	**1.45**	**.62**	**.00**	**0.**	**STABLE**	**2.33**	**6.2**	**.20**	**.099**
CURLED WOOD MAT	1.55	.61	.00	0.	STABLE	2.53	6.9	.20	.096
SYNTHETIC MAT	2.00	.44	.00	0.	STABLE	4.52	18.9	.14	.055
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	2.06	.00	0.	STABLE	1.80	4.1	.66	.815
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	1.62	.00	0.	STABLE	1.30	2.6	.52	.519
VEGETATIVE C	**1.00**	**1.00**	**.00**	**0.**	**STABLE**	**1.00**	**.7**	**.32**	**.224**
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE D	.60	.78	.00	0.	UNSTAB	.77	.2	.25	.145
VEGETATIVE E	.35	.67	.00	0.	UNSTAB	.53	.0	.21	.111
RIGID									
CONCRETE	*******	.20	.00	0.	STABLE	******	.0	.07	.015
GROUTED RIPRAP	*******	.37	.00	0.	STABLE	******	.0	.12	.040
STONE MASONRY	*******	.38	.00	0.	STABLE	******	.0	.12	.042
SOIL CEMENT	*******	.28	.00	0.	STABLE	******	.0	.09	.025
ASPHALT	*******	.23	.00	0.	STABLE	******	.0	.07	.018

SOME RIPRAP AND GABION LININGS MAY ALSO BE STABLE
*** NORMAL END OF HYCHL ***

Close, Jensen and Miller, P.C.

BY ASB DATE 11/15/08 SUBJECT Busway SHEET NO 121 OF
CHKD. BY RJF DATE 3/25/09 New Britain - Hartford JOB NO. 88-H034
Drainage Design

SWALE SW5 STATION 141+50 TO 143+00 LT

PAVEMENT AREA = 0.45 Ac. C=0.9

GRASS AREA = 0.71 Ac C=0.3

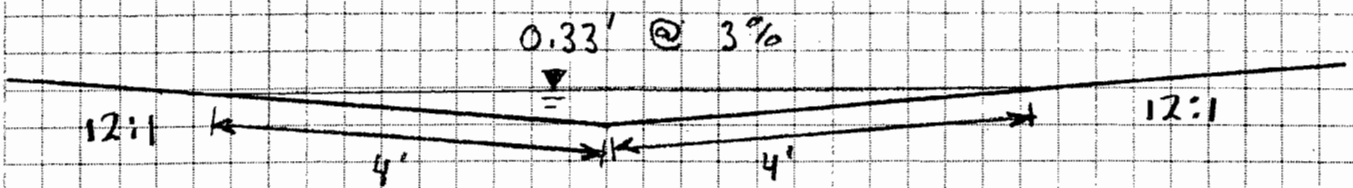
T_c = 20 min
I_{2yr} = 2.5 in/hr
I_{10yr} = 3.6 in/hr

$$C_{avg} = \frac{0.45(0.9) + 0.71(0.3)}{1.16} = 0.532$$

$Q_{2yr} = 0.532(2.5)(1.16) = 1.55$ CFS

$Q_{10yr} = 0.532(3.6)(1.16) = 2.22$ CFS

SWALE



SLOPE = 3% - 4.2%

USE 10' WIDE SYNTHETIC MAT TYPE H

Commands Read From File: E:\HYCHL\SW5.CHL

```
      JOB SW5
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .03    2.220
      VSH 12 12
** V-SHAPE RIGHT Z1 = 12.0  AND LEFT Z2 = 12.0
      END
***************END OF COMMAND FILE************
```

SWALE SW5 STA 141+50 TO 143+00 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	2.22
CHANNEL SHAPE:	VSHAPED
CHANNEL SLOPE (ft/ft):	.030

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.41	.00	0.	UNSTAB	.37	.1	.22	.015
JUTE NET	.45	.56	.00	0.	UNSTAB	.81	1.1	.30	.035
FIBERGLASS SINGLE	.60	.55	.00	0.	STABLE	1.09	2.9	.29	.033
FIBERGLASS DOUBLE	.85	.57	.00	0.	STABLE	1.49	7.6	.31	.037
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
STRAW WITH NET	1.45	.78	.00	0.	STABLE	1.87	20.6	.41	.082
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
CURLED WOOD MAT	1.55	.76	.00	0.	STABLE	2.04	24.6	.41	.079
SYNTHETIC MAT	**2.00**	**.62**	**.00**	**0.**	**STABLE**	**3.23**	**82.4**	**.33**	**.046**
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.84	.00	0.	STABLE	2.01	41.8	.98	.835
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	1.76	.00	0.	STABLE	1.19	11.0	.94	.715
VEGETATIVE C	1.00	1.14	.00	0.	UNSTAB	.88	.9	.61	.232
VEGETATIVE D	.60	.94	.00	0.	UNSTAB	.64	.1	.50	.141
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE E	.35	.85	.00	0.	UNSTAB	.41	.0	.45	.107

Commands Read From File: E:\HYCHL\SW5.CHL

```
      JOB SW5
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .0420  2.220
      VSH 12     12
** V-SHAPE RIGHT Z1 = 12.0  AND LEFT Z2 = 12.0
      END
***************END OF COMMAND FILE************
```

SWALE SW5 STA 141+50 TO 143+00 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s): 2.22
CHANNEL SHAPE: VSHAPED
CHANNEL SLOPE (ft/ft): .042

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.54	.00	0.	UNSTAB	.28	.1	.20	.015
JUTE NET	.45	.74	.00	0.	UNSTAB	.61	.4	.28	.036
FIBERGLASS SINGLE	.60	.73	.00	0.	UNSTAB	.82	1.2	.28	.034
FIBERGLASS DOUBLE	.85	.76	.00	0.	STABLE	1.12	3.2	.29	.038
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
STRAW WITH NET	1.45	1.01	.00	0.	STABLE	1.43	8.0	.39	.083
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
CURLED WOOD MAT	1.55	1.03	.00	0.	STABLE	1.51	9.8	.39	.084
SYNTHETIC MAT	**2.00**	**.82**	**.00**	**0.**	**STABLE**	**2.43**	**36.1**	**.31**	**.047**
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	2.40	.00	0.	STABLE	1.54	7.0	.92	.821
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	2.17	.00	0.	UNSTAB	.97	1.7	.83	.623
VEGETATIVE C	1.00	1.47	.00	0.	UNSTAB	.68	.3	.56	.220
VEGETATIVE D	.60	1.22	.00	0.	UNSTAB	.49	.1	.47	.135
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE E	.35	1.09	.00	0.	UNSTAB	.32	.0	.42	.102

Summary for Subcatchment S5: Swale 141+50 to 142+70

Runoff = 1.04 cfs @ 0.33 hrs, Volume= 0.097 af, Depth= 1.01"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
CT-DOT 10-year Duration=68 min, Inten=1.68 in/hr

Area (ac)	C	Description
0.710	0.30	Grass
0.450	0.90	Pavement
1.160	0.53	Weighted Average
1.160		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.5	190	0.0270	0.22		**Sheet Flow, overland sheet** Grass: Short n= 0.150 P2= 3.20"
5.0	252	0.0143	0.84		**Shallow Concentrated Flow, shallow concentrated** Short Grass Pasture Kv= 7.0 fps
19.5	442	Total			

SWALE SW6 STA 143+00 TO 145+25 LT

PAVEMENT AREA = 2.05 Ac C = 0.9

GRASS AREA = 0.29 Ac C = 0.3

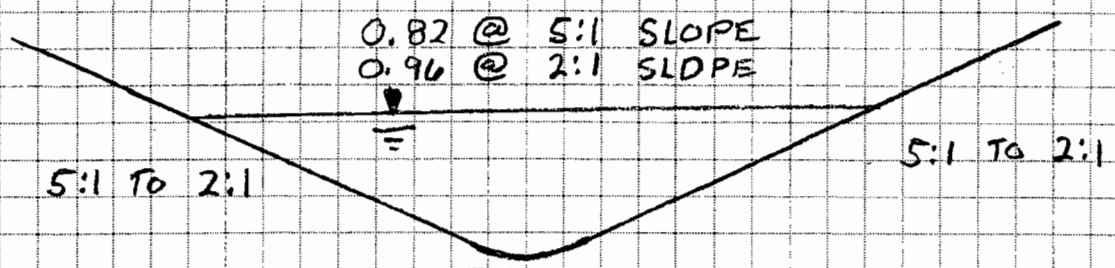
T_c = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{2.05(0.9) + 0.29(0.3)}{2.34} = 0.826$$

$Q_{2yr} = 0.826(3.6)(2.34) = 6.96$ CFS

$Q_{10yr} = 0.826(4.8)(2.34) = 9.27$ CFS

SWALE



SLOPE = 1.4%

USE 8' WIDE STRAW WITH NET FOR TEMPORARY CONDITION UNTIL GRASS IS ESTABLISHED TYPE G

Commands Read From File: E:\HYCHL\SW6.CHL

```
      JOB SW6
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .014    9.270
      VRB 5
** THE V-SHAPE W ROUND BOT HAS SIDE SLOPES OF    5.0
      END
***************END OF COMMAND FILE************
```

SWALE SW6 STATION 143+00 TO 145+25 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	9.27
CHANNEL SHAPE:	VSWRB
CHANNEL SLOPE (ft/ft):	.014

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.30	.00	0.	UNSTAB	.49	1.2	.35	.014
JUTE NET	.45	.39	.00	0.	STABLE	1.14	12.8	.45	.025
FIBERGLASS SINGLE	.60	.39	.00	0.	STABLE	1.54	25.5	.45	.025
FIBERGLASS DOUBLE	.85	.40	.00	0.	STABLE	2.11	52.8	.46	.026
STRAW WITH NET	**1.45**	**.50**	**.00**	**0.**	**STABLE**	**2.90**	**122.3**	**.57**	**.043**
CURLED WOOD MAT	1.55	.51	.00	0.	STABLE	3.04	134.7	.58	.045
SYNTHETIC MAT	2.00	.43	.00	0.	STABLE	4.69	346.6	.49	.030
PERMANENT (FLEXIBLE)									
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE A	3.70	1.46	.00	0.	STABLE	2.53	348.0	1.68	.434
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	.97	.00	0.	STABLE	2.17	110.7	1.11	.176
VEGETATIVE C	**1.00**	**.72**	**.00**	**0.**	**STABLE**	**1.39**	**23.6**	**.82**	**.093**
VEGETATIVE D	.60	.63	.00	0.	UNSTAB	.95	8.1	.72	.070
VEGETATIVE E	.35	.58	.00	0.	UNSTAB	.60	2.1	.66	.059

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-26-2009
Commands Read From File: E:\HYCHL\SW6.CHL

      JOB SW6
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .014    9.270
      VRB 2
** THE V-SHAPE W ROUND BOT HAS SIDE SLOPES OF     2.0
      END
***************END OF COMMAND FILE************
```

SWALE SW6 STATION 143+00 TO 145+25 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	9.27
CHANNEL SHAPE:	VSWRB
CHANNEL SLOPE (ft/ft):	.014

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.45	.00	0.	UNSTAB	.33	.7	.52	.014
JUTE NET	.45	.54	.00	0.	UNSTAB	.83	4.7	.62	.024
FIBERGLASS SINGLE	.60	.54	.00	0.	STABLE	1.12	13.2	.61	.024
FIBERGLASS DOUBLE	.85	.55	.00	0.	STABLE	1.55	32.0	.63	.025
STRAW WITH NET	**1.45**	**.64**	**.00**	**0.**	**STABLE**	**2.26**	**77.1**	**.73**	**.039**
CURLED WOOD MAT	1.55	.65	.00	0.	STABLE	2.38	84.2	.75	.041
SYNTHETIC MAT	2.00	.57	.00	0.	STABLE	3.50	206.7	.65	.029
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.46	.00	0.	STABLE	2.53	193.4	1.68	.266
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	1.05	.00	0.	STABLE	2.00	70.2	1.20	.129
VEGETATIVE C	**1.00**	**.84**	**.00**	**0.**	**STABLE**	**1.19**	**15.6**	**.96**	**.078**
VEGETATIVE D	.60	.76	.00	0.	UNSTAB	.79	4.1	.87	.061
VEGETATIVE E	.35	.72	.00	0.	UNSTAB	.49	.6	.82	.052

SWALE SW7 STATION 145+70 TO 146+50 RT

PAVEMENT AREA = 0.031 Ac C = 0.9

GRASS AREA = 0.013 Ac C = 0.3

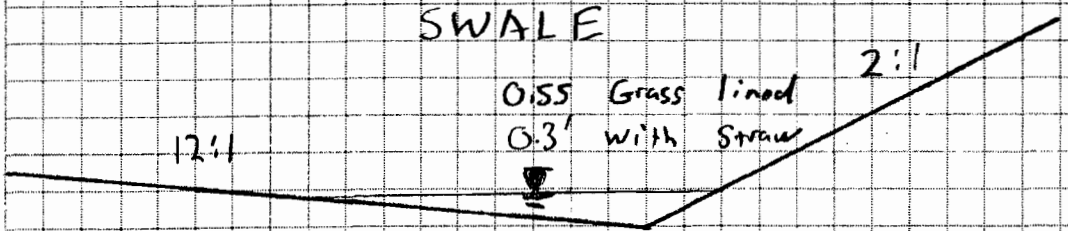
T_c = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{0.031(0.9) + 0.013(0.3)}{0.044} = 0.722$$

$Q_{2yr} = 0.722(3.6)(0.044) = 0.11$ CFS

$Q_{10yr} = 0.722(4.8)(0.044) = 0.15$ CFS

SWALE



SLOPE = 0.69 %

USE 6' WIDE STRAW WITH NET FOR TEMPORARY CONDITION UNTIL GRASS IS ESTABLISHED TYPE G

```
      ******  HYCHL  ****** (Version 6.1) ******          Date 03-26-2009
Commands Read From File: E:\HYCHL\SW7.CHL

      JOB SW7
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.0069 0.150
      TRP 0      12     2
** LEFT SIDE SLOPE   12.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)      .00
      END
***************END OF COMMAND FILE************
```

SWALE SW7 STA 145+70 TO 146+50 RT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:
- DESIGN DISCHARGE (ft^3/s): .15
- CHANNEL SHAPE: VSHAPED
- CHANNEL SLOPE (ft/ft): .007

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.06	.00	0.	STABLE	2.65	2.3	.13	.016
JUTE NET	.45	.08	.00	0.	STABLE	5.40	25.4	.19	.045
FIBERGLASS SINGLE	.60	.08	.00	0.	STABLE	7.34	58.6	.19	.043
FIBERGLASS DOUBLE	.85	.09	.00	0.	STABLE	9.89	146.9	.20	.049
STRAW WITH NET	**1.45**	**.13**	**.00**	**0.**	**STABLE**	**11.38**	**463.5**	**.30**	**.139**
CURLED WOOD MAT	1.55	.12	.00	0.	STABLE	12.43	523.3	.29	.131
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
SYNTHETIC MAT	2.00	.10	.00	0.	STABLE	20.66	1452.8	.22	.066
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	.26	.00	0.	STABLE	14.45	2101.3	.59	.895
VEGETATIVE B	2.10	.25	.00	0.	STABLE	8.51	519.2	.57	.811
VEGETATIVE C	**1.00**	**.24**	**.00**	**0.**	**STABLE**	**4.21**	**72.1**	**.55**	**.735**
VEGETATIVE D	.60	.23	.00	0.	STABLE	2.58	17.6	.54	.692
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE E	.35	.20	.00	0.	STABLE	1.77	3.3	.46	.371

SWALE SW8 STA 148+00 TO 150+00 LT

PAVEMENT AREA = 0.91 Ac C = 0.9

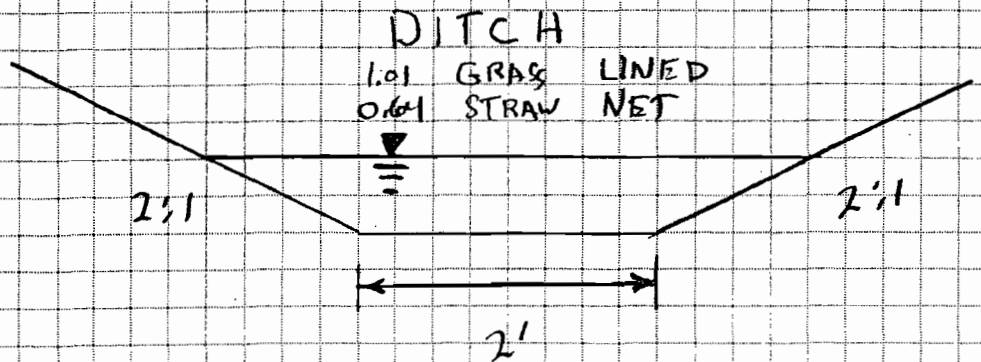
GRASS AREA = 0.04 Ac C = 0.3

T_c = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{0.91(0.9) + 0.04(0.3)}{0.95} = 0.875$$

$Q_{2yr} = 0.875(3.6)(0.95) = 2.99$ CFS

$Q_{10yr} = 0.875(4.8)(0.95) = 3.99$ CFS



SLOPE = 1%

USE 6' WIDE STRAW WITH NET FOR TEMPORARY CONDITION UNTIL GRASS IS ESTABLISHED. TYPE G

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 12-15-2008
  □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
Commands Read From File: E:\HYCHL\BUSWAY.CHL

      JOB SW8
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .01    3.99
      TRP 2      2      2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      NEQ 1
      END
***************END OF COMMAND FILE************
```

SWALE 8 STA 148+50 TO 150+50 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:
- DESIGN DISCHARGE (ft^3/s): 3.99
- CHANNEL SHAPE: TRAPEZOIDAL
- CHANNEL SLOPE (ft/ft): .010

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	DESIGN Depth (ft)	DESIGN Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.21	.00	0.	UNSTAB	.71	2.1	.34	.014
JUTE NET	.45	.30	.00	0.	STABLE	1.50	9.3	.48	.026
FIBERGLASS SINGLE	.60	.30	.00	0.	STABLE	2.03	17.6	.47	.025
FIBERGLASS DOUBLE	.85	.31	.00	0.	STABLE	2.76	35.6	.49	.027
STRAW WITH NET	**1.45**	**.40**	**.00**	**0.**	**STABLE**	**3.62**	**85.0**	**.64**	**.045**
CURLED WOOD MAT	1.55	.41	.00	0.	STABLE	3.80	93.9	.65	.046
SYNTHETIC MAT	2.00	.33	.00	0.	STABLE	6.05	243.4	.53	.031
PERMANENT (FLEXIBLE)									

*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE

VEGETATIVE	A	3.70	1.26	.00	0.	STABLE	2.94	263.7	2.02	.490
VEGETATIVE	B	2.10	.87	.00	0.	STABLE	2.42	78.2	1.39	.216
VEGETATIVE	**C**	**1.00**	**.63**	**.00**	**0.**	**STABLE**	**1.59**	**15.4**	**1.01**	**.110**
VEGETATIVE	D	.60	.54	.00	0.	STABLE	1.12	5.4	.86	.080
VEGETATIVE	E	.35	.49	.00	0.	UNSTAB	.72	1.7	.78	.066

USE STRAW WITH NET FOR TEMPORARY LINING AND VEGETATIVE C FOR PERMANENT LINING

SWALE SW9 STA 150+00 TO 151+20 LT

PAVEMENT AREA = 0.68 Ac C=0.9
GRASS AREA = 0.13 Ac C=0.3

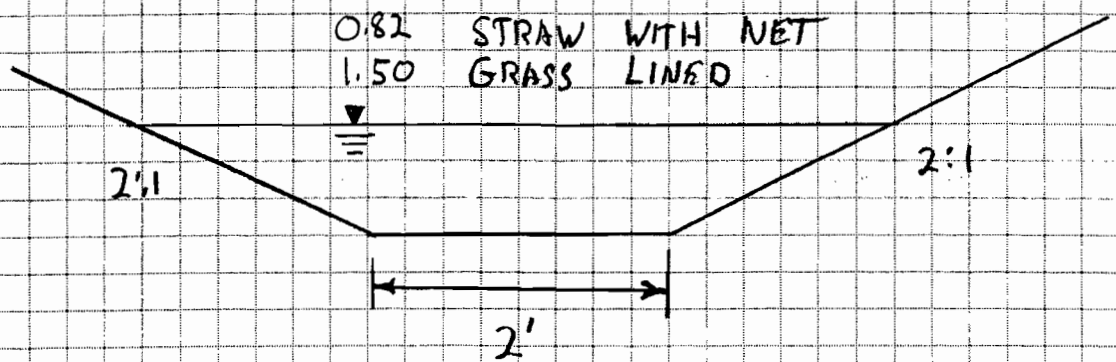
T_c = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{0.68(0.9) + 0.13(0.3)}{0.91} = 0.715$$

$Q_{2yr} = 0.715\,(3.6)(0.91) = 2.34$ CFS

$Q_{10yr} = 0.715\,(4.8)(0.91) = 3.12$ CFS

DITCH



SLOPE = 2%

USE 8' WIDE STRAW WITH NET FOR TEMPORARY CONDITION UNTIL GRASS IS ESTABLISHED. TYPE G

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-30-2009
 Commands Read From File: E:\HYCHL\SW9.CHL

      JOB SW9
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .002    3.120
      TRP 2       2       2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      END
***************END OF COMMAND FILE************
```

SW9 STA 150+00 TO 151+70 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	3.12
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.002

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.06	.00	0.	STABLE	2.63	21.4	.46	.014
JUTE NET	.45	.08	.00	0.	STABLE	5.73	162.9	.63	.025
FIBERGLASS SINGLE	.60	.08	.00	0.	STABLE	7.73	336.2	.62	.024
FIBERGLASS DOUBLE	.85	.08	.00	0.	STABLE	10.59	774.9	.64	.026
STRAW WITH NET	**1.45**	**.10**	**.00**	**0.**	**STABLE**	**14.25**	**2374.8**	**.82**	**.041**
CURLED WOOD MAT	1.55	.10	.00	0.	STABLE	14.92	2621.9	.83	.043
SYNTHETIC MAT	2.00	.09	.00	0.	STABLE	23.33	6666.5	.69	.029
PERMANENT (FLEXIBLE)									
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE A	3.70	.43	.00	0.	STABLE	8.57	11488.6	3.46	.950
VEGETATIVE B	2.10	.27	.00	0.	STABLE	7.88	2926.6	2.14	.315
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE C	**1.00**	**.19**	**.00**	**0.**	**STABLE**	**5.36**	**466.8**	**1.50**	**.144**
VEGETATIVE D	.60	.16	.00	0.	STABLE	3.80	134.5	1.26	.100
VEGETATIVE E	.35	.14	.00	0.	STABLE	2.46	35.7	1.14	.081

SWALE SW 10 STA 158+50 TO 164+50 LT

PAVEMENT AREA = 4.89 Ac C=0.9

GRASS AREA = 1.55 Ac C=0.3

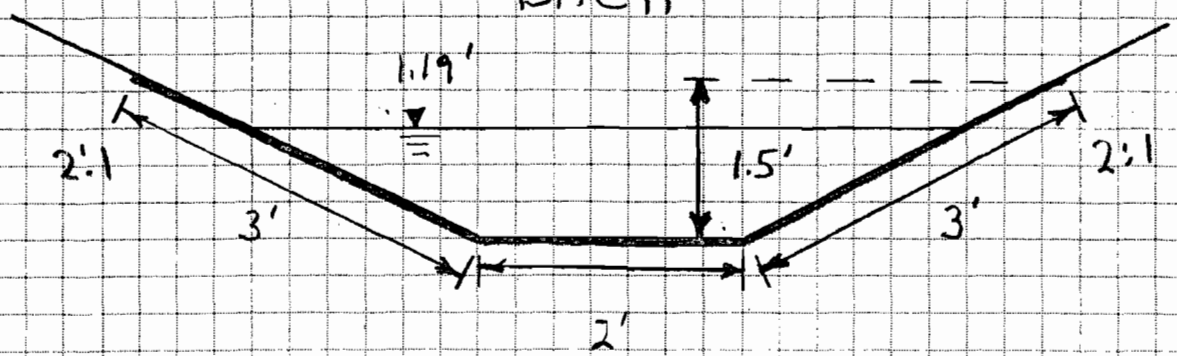
T_c = 10 min
I_{2yr} = 3.6 in/hr
I_{10yr} = 4.8 in/hr

$$C_{avg} = \frac{4.89(0.9) + 1.55(0.3)}{6.44} = 0.756$$

$Q_{2yr} = 0.756(3.6)(6.44) = 17.52$ cfs

$Q_{10yr} = 0.756(4.8)(6.44) = 23.36$ CFS

DITCH



SLOPE VARIES 1% - 2.4%

WORST CASE DEPTH @ 1% = 1.19' STRESS @ 2%

USE 8' WIDE SYNTHETIC MAT TYPE H
TEMPORARY AND PERMANENT CONDITIONS

```
      ******  HYCHL  ****** (Version 6.1) ******          Date 03-30-2009
Commands Read From File: E:\HYCHL\SW10.CHL

      JOB SW10
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .01     23.36
      TRP 2       2       2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      END
***************END OF COMMAND FILE************
```

SW10 STA 158+50 TO 164+50 LT: TEMPORAY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	23.36
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.010

RESULTS

	SHEAR STRESS(psf)		Len of Super Protect	Elev		Stab.	Max Q	---DESIGN-- Depth	Mann
Lining Type	Permiss	Bottom	(ft)	(ft)	Remark	Factor	(cfs)	(ft)	n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.53	.00	0.	UNSTAB	.28	2.1	.85	.013
JUTE NET	.45	.69	.00	0.	UNSTAB	.65	9.3	1.11	.023
FIBERGLASS SINGLE	.60	.68	.00	0.	UNSTAB	.88	17.6	1.10	.022
FIBERGLASS DOUBLE	.85	.70	.00	0.	STABLE	1.21	35.6	1.13	.024
STRAW WITH NET	1.45	.85	.00	0.	STABLE	1.70	85.0	1.36	.035
CURLED WOOD MAT	1.55	.87	.00	0.	STABLE	1.78	93.9	1.40	.037
SYNTHETIC MAT	**2.00**	**.74**	**.00**	**0.**	**STABLE**	**2.70**	**243.4**	**1.19**	**.026**
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.87	.00	0.	STABLE	1.98	263.7	3.00	.205
VEGETATIVE B	2.10	1.42	.00	0.	STABLE	1.48	78.2	2.28	.109
VEGETATIVE C	1.00	1.16	.00	0.	UNSTAB	.86	15.4	1.86	.069
VEGETATIVE D	.60	1.05	.00	0.	UNSTAB	.57	5.4	1.68	.055
VEGETATIVE E	.35	.98	.00	0.	UNSTAB	.36	1.7	1.58	.048

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-30-2009
 Commands Read From File: E:\HYCHL\SW10.CHL

      JOB SW10
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .024   23.36
      TRP 2 2 2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      END
***************END OF COMMAND FILE************
```

SW10 STA 158+00 TO 164+50 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	23.36
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.024

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	1.02	.00	0.	UNSTAB	.15	.7	.68	.013
JUTE NET	.45	1.36	.00	0.	UNSTAB	.33	2.4	.91	.023
FIBERGLASS SINGLE	.60	1.34	.00	0.	UNSTAB	.45	4.4	.90	.023
FIBERGLASS DOUBLE	.85	1.38	.00	0.	UNSTAB	.61	8.3	.92	.024
STRAW WITH NET	1.45	1.70	.00	0.	UNSTAB	.85	16.1	1.13	.037
CURLED WOOD MAT	1.55	1.74	.00	0.	UNSTAB	.89	17.9	1.16	.039
SYNTHETIC MAT	**2.00**	**1.46**	**.00**	**0.**	**STABLE**	**1.37**	**47.3**	**.98**	**.027**
PERMANENT (FLEXIBLE)									

*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE

VEGETATIVE	A	3.70	3.51	.00	0.	STABLE	1.05	28.2	2.35	.181
VEGETATIVE	B	2.10	2.69	.00	0.	UNSTAB	.78	10.6	1.80	.099
VEGETATIVE	C	1.00	2.20	.00	0.	UNSTAB	.45	2.6	1.47	.064
VEGETATIVE	D	.60	1.99	.00	0.	UNSTAB	.30	1.0	1.33	.052
VEGETATIVE	E	.35	1.87	.00	0.	UNSTAB	.19	.3	1.25	.045

SLOPE PROTECTION

****** HYCHL ****** (Version 6.1) ****** Date 06-08-2009

Commands Read From File: E:\HYCHL\BUSWAY.CHL

```
      JOB BUSWAY
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .01    23.36
      TRP 2      1.5    2
** LEFT SIDE SLOPE    1.5 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      NEQ 1
      LRR .42    2 0 2.65   0.047
** D50 (ft)    .42
** SPECIFIC GRAVITY    2.65
** SHIELDS PARAMETER    .047
      END
***************END OF COMMAND FILE************
```

BUSWAY

INPUT REVIEW

DEFAULT ANGLE OF REPOSE (degrees): 41.18

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	23.36
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.010

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM
FLOW (cfs)	23.36	38.13
DEPTH (ft)	1.39	1.75
AREA (ft^2)	6.18	8.90
WETTED PERIMETER (ft)	7.63	9.09
HYDRAULIC RADIUS (ft)	.81	.98
VELOCITY (ft/s)	3.78	4.29
MANNINGS N (LOW FLOW)	.034	.034
REYNOLDS NUMBER (10^5)	.35	

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (LB/FT^2)	CALC. SHR (LB/FT^2)	STAB. FACTOR	REMARKS
BOTTOM; STRAIGHT	RIPRAP	2.03	.87	2.34	STABLE
SIDE; STRAIGHT	RIPRAP	1.09	.65	1.69	STABLE

*** NORMAL END OF HYCHL ***

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Designed By: ASB
Date: 11-15-08
Checked By: KSM
Date: 11-15-08

Project No.:
88-H034

Subject: New Britain-Hartford Busway Drainage Computations

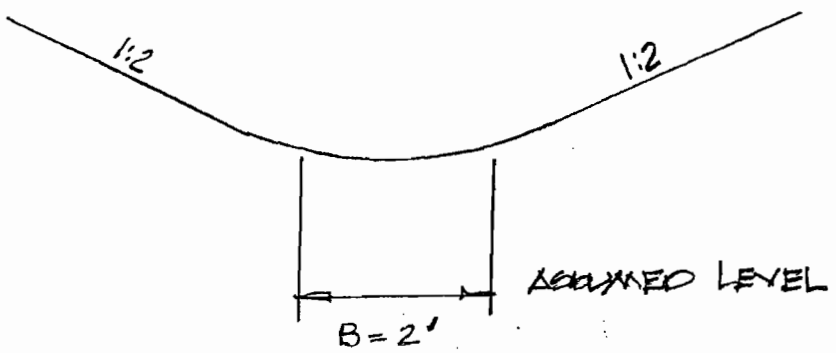
SWALE S11 163+15 TO 164+50 LT

PAVEMENT: A = 0.06 ac @ I = 0.9
GRASS: A = 1.73 ac @ I = 0.3

Tc = 10 min.
R_2 = 3.6 in/hr
R_{10} = 4.8 in/hr

Q_2 = [(0.06)(0.9)+(1.73)(0.3)] 3.6 in/hr = 2.06 cfs

Q_{10} = [(0.06)(0.9)+(1.73)(0.3)] 4.8 in/hr = 2.75 cfs



AVE. SLOPE = 0.74%

```
      ******  HYCHL  ****** (Version 6.1) ******          Date 09-08-2009
Commands Read From File: E:\HYCHL\DATA\SW11.CHL

      JOB SW11
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.005  2.750
      TRP 2 2 2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      END
***************END OF COMMAND FILE************
```

STA 163+15 TO 164+50 LT: TEMPORARY AND PERMANENT

INPUT REVIEW

DESIGN PARAMETERS:
- DESIGN DISCHARGE (ft^3/s): **2.75 (Q 10yr)**
- CHANNEL SHAPE: TRAPEZOIDAL
- CHANNEL SLOPE (ft/ft): .005

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.10	.00	0.	STABLE	1.44	5.4	.33	.014
JUTE NET	.45	.15	.00	0.	STABLE	3.04	29.8	.47	.026
FIBERGLASS SINGLE	.60	.15	.00	0.	STABLE	4.10	58.5	.47	.025
FIBERGLASS DOUBLE	.85	.15	.00	0.	STABLE	5.60	126.3	.49	.027
STRAW WITH NET	1.45	.20	.00	0.	STABLE	7.33	344.4	.63	.045
CURLED WOOD MAT	1.55	.20	.00	0.	STABLE	7.69	380.5	.65	.047
SYNTHETIC MAT	2.00	.16	.00	0.	STABLE	12.24	980.1	.52	.031
PERMANENT (FLEXIBLE)									
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE A	3.70	.81	.00	0.	STABLE	4.59	1377.2	2.59	.791
VEGETATIVE B	2.10	.49	.00	0.	STABLE	4.25	372.4	1.58	.292
VEGETATIVE C	**1.00**	**.34**	**.00**	**0.**	**STABLE**	**2.91**	**65.1**	**1.10**	**.135**
VEGETATIVE D	.60	.29	.00	0.	STABLE	2.07	20.6	.93	.095
VEGETATIVE E	.35	.26	.00	0.	STABLE	1.34	6.0	.83	.077

LINING

USE STRAW WITH NET FOR TEMPORARY LINING AND VEGETATIVE C FOR PERMANENT LINING

CALCULATE WIDTH OF PROTECTION REQUIRED USING VEGETATIVE C LINING;
WIDTH = 2' + (0.63)(2+2) = 4.52' USE 6.00 WIDE E.C.M TYPE "G" LINING

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Designed By: ASB
Date: 11-15-08
Checked By: KSM
Date: 11-15-08

Project No.:
88-H034

Subject: New Britain-Hartford Busway Drainage Computations

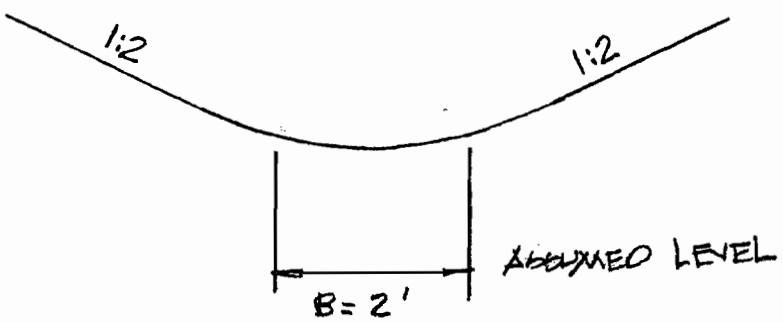
SWALE S12 164+50 TO 166+50 LT

PAVEMENT: A = 0.06 ac @ I = 0.9
GRASS: A = 0.31 ac @ I = 0.3

Tc = 10 min.
R_2 = 3.6 in/hr
R_{10} = 4.8 in/hr

Q_2 = [(0.06)(0.9)+(0.31)(0.3)] 3.6 in/hr = 0.53 cfs

Q_{10} = [(0.06)(0.9)+(0.31)(0.3)] 4.8 in/hr = 0.66 cfs



AVE. SLOPE = 0.05%

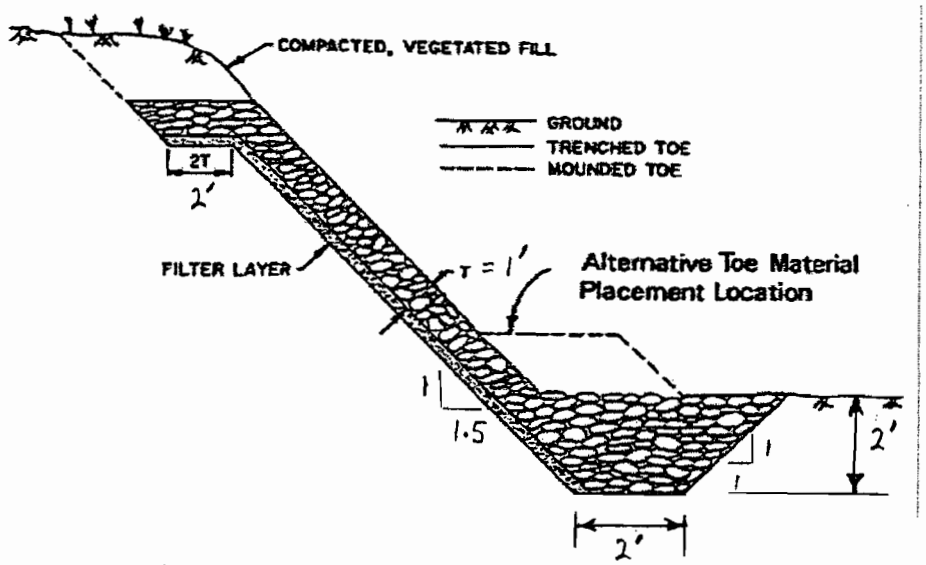


Figure 7-32 Typical Riprap Installation: End View (Bank Protection Only)

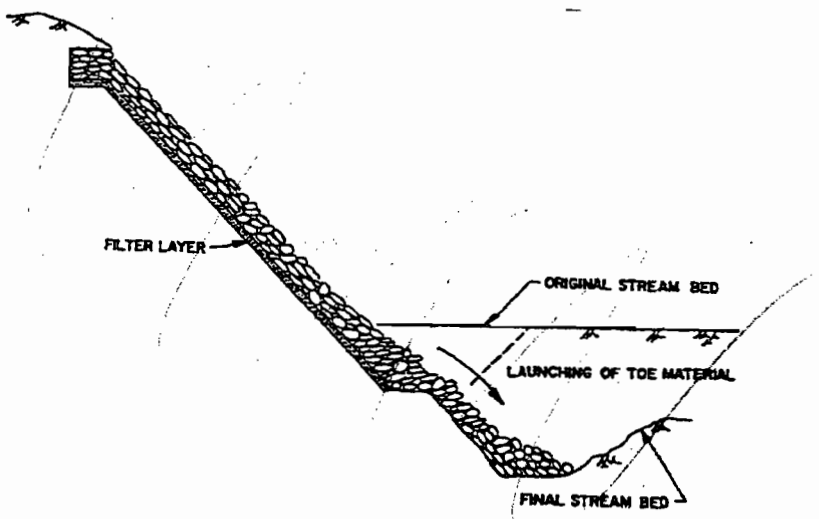


Figure 7-33 Launching Of Riprap Toe Material

Commands Read From File: E:\HYCHL\BUSWAY.CHL

```
      JOB SW12
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .005    .66
      TRP 2       2       2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      NEQ 1
      END
***************END OF COMMAND FILE************
```

SWALE 12 STA 164+50 TO 166+50 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s): .66
CHANNEL SHAPE: TRAPEZOIDAL
CHANNEL SLOPE (ft/ft): .005

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.05	.00	0.	STABLE	3.14	5.4	.15	.015
JUTE NET	.45	.07	.00	0.	STABLE	6.08	29.8	.24	.031
FIBERGLASS SINGLE	.60	.07	.00	0.	STABLE	8.26	58.5	.23	.030
FIBERGLASS DOUBLE	.85	.08	.00	0.	STABLE	11.12	126.3	.24	.033
STRAW WITH NET	**1.45**	**.11**	**.00**	**0.**	**STABLE**	**13.33**	**344.4**	**.35**	**.062**
CURLED WOOD MAT	1.55	.11	.00	0.	STABLE	14.16	380.5	.35	.062
SYNTHETIC MAT	2.00	.08	.00	0.	STABLE	23.69	980.1	.27	.039
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	.43	.00	0.	STABLE	8.58	1377.2	1.38	.909
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE B	2.10	.40	.00	0.	STABLE	5.24	372.4	1.28	.775
VEGETATIVE C	**1.00**	**.24**	**.00**	**0.**	**STABLE**	**4.20**	**65.1**	**.76**	**.269**
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE D	.60	.19	.00	0.	STABLE	3.24	20.6	.59	.165
VEGETATIVE E	.35	.16	.00	0.	STABLE	2.21	6.0	.51	.123

USE STRAW NET FOR TEMPORARY LINING AND VEGETIVE C FOR PERMANENT LINING

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Designed By: ASB
Date: 11-21-08
Checked By: KSM
Date: 11-21-08

Project No.:
88-H034

Subject: New Britain-Hartford Busway Drainage Computations

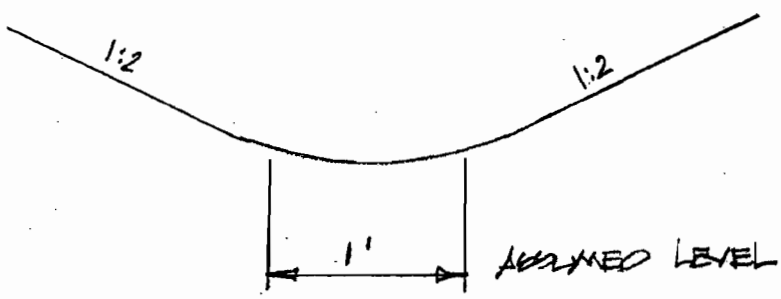
SWALE S13A 166+50 TO 168+00 LT

PAVEMENT: A = 0.045 ac @ I = 0.9
GRASS: A = 0.045 ac @ I = 0.3

Tc = 10 min.
R_2 = 3.6 in/hr
R_{10} = 4.8 in/hr

Q_2 = [(0.045)(0.9)+(0.045)(0.3)] 3.6 in/hr = 0.19 cfs

Q_{10} = [(0.045)(0.9)+(0.045)(0.3)] 4.8 in/hr = 0.26 cfs



AVE. SLOPE = 1.0%

****** HYCHL ****** (Version 6.1) ****** Date 11-21-2008

Commands Read From File: E:\HYCHL\SW13A.CHL

```
      JOB SW13A
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.0100 0.260
      TRP 1      2      2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    1.00
      END
***************END OF COMMAND FILE************
```

STA 166+50 TO 168+00 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:
DESIGN DISCHARGE (ft^3/s): **.26 ((Q 10yr)**
CHANNEL SHAPE: TRAPEZOIDAL
CHANNEL SLOPE (ft/ft): .010

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Super Protect (ft)	Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.07	.00	0.	STABLE	2.20	1.2	.11	.015
JUTE NET	.45	.11	.00	0.	STABLE	4.04	5.9	.18	.036
FIBERGLASS SINGLE	.60	.11	.00	0.	STABLE	5.51	11.8	.17	.035
FIBERGLASS DOUBLE	.85	.12	.00	0.	STABLE	7.37	25.7	.18	.039
STRAW WITH NET	1.45	.18	.00	0.	STABLE	8.27	67.2	.28	.084
CURLED WOOD MAT	1.55	.17	.00	0.	STABLE	8.90	75.2	.28	.083
SYNTHETIC MAT	2.00	.13	.00	0.	STABLE	15.39	204.0	.21	.048
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	.55	.00	0.	STABLE	6.69	230.9	.89	.880
VEGETATIVE B	2.10	.53	.00	0.	STABLE	3.97	63.5	.85	.797
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE C	1.00	.39	.00	0.	STABLE	2.58	10.8	.62	.399
VEGETATIVE D	.60	.29	.00	0.	STABLE	2.07	3.3	.46	.225
*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE									
VEGETATIVE E	.35	.24	.00	0.	STABLE	1.45	.9	.39	.155

USE STRAW WITH NET FOR TEMPORARY LINING AND VEGETATIVE C FOR PERMANENT LINING

CALCULATE WIDTH OF PROTECTION REQUIRED USING VEGETATIVE C LINING;
WIDTH = 1' + (0.28')(2+2) = 2.12' USE 4.00' WIDE E.C.M TYPE "G" LINING

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Designed By: ASB
Date: 11-21-08
Checked By: KSM
Date: 11-21-08

Project No.:
88-H034

Subject: New Britain-Hartford Busway Drainage Computations

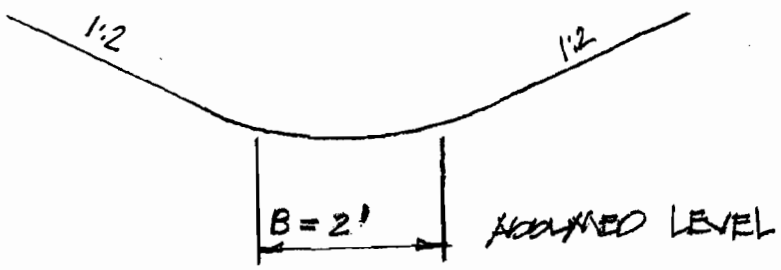
SWALE S13B 168+00 TO 168+50 LT

PAVEMENT: A = 0.05 ac @ I = 0.9
GRASS: A = 0.06 ac @ I = 0.3

Tc = 10 min.
R_2 = 3.6 in/hr
R_{10} = 4.8 in/hr

Q_2 = [(0.05)(0.9)+(0.06)(0.3)] 3.6 in/hr = 0.23 cfs

Q_{10} = [(0.05)(0.9)+(0.06)(0.3)] 4.8 in/hr = 0.30 cfs



AVE. SLOPE = 16.00%

****** HYCHL ****** (Version 6.1) ****** Date 11-21-2008

Commands Read From File: E:\HYCHL\SW13B.CHL

```
      JOB SW13B
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.1600 0.300
      TRP 2      2      2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      LTM 7
      END
***************END OF COMMAND FILE************
```

STA 168+00 TO 168+50 LT: TEMPORARY AND PERMANENT LINING

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s): **.30 (Q 10yr)**

CHANNEL SHAPE: TRAPEZOIDAL

CHANNEL SLOPE (ft/ft): .160

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM
FLOW (cfs)	.30	1.90
DEPTH (ft)	.10	**.20**
AREA (ft^2)	.22	.48
WETTED PERIMETER (ft)	2.44	2.90
HYDRAULIC RADIUS (ft)	.09	.17
VELOCITY (ft/s)	1.39	3.95
MANNINGS N (LOW FLOW)	.085	.045

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (lb/ft^2)	CALC. SHR (lb/ft^2)	STAB. FACTOR	REMARKS
LOW FLOW LINING BOTTOM; STRAIGHT	SYNTHETIC MAT	2.00	.98	2.04	STABLE

*** NORMAL END OF HYCHL ***

USE SYNTHETIC MAT FOR TEMPORARY AND PERMANENT LINING

CALCULATE WIDTH OF PROTECTION REQUIRED USING SYNTHETIC MAT;

WIDTH = 2' + (0.10')(2+2) = 2.40' USE 4.00' WIDE E.C.M TYPE "H" LINING

SWALE (515) : STA. 175+00 TO STA. 180+50 LT

PAVEMENT: $A = 3.82\ Ac$ $C = 0.9$

GRASS: $A = 3.16\ Ac$ $C = 0.3$

$A_T = 6.99\ Ac$

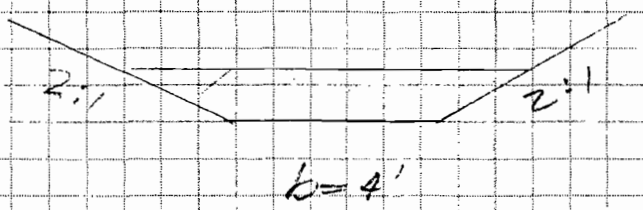
$T_c = 32$ MINS. (SEE 24" RCP CULVERT CALCS)

$R_2 = 1.9"/hr$

$R_{10} = 2.7"/hr$

$Q_2 = [(3.82)(0.9) + (3.16)(0.3)](1.9"/hr) = 8.4 \pm cfs$

$Q_{10} = [(3.83)(0.9) + (3.16)(0.3)](2.7"/hr) = 11.9 \pm cfs$



CHANNEL SLOPE 0.8%

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 12-09-2008
 Commands Read From File: E:\HYCHL\DATA\SW15.CHL

       JOB SW15
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .00750 8.40
       TRP 4 2 2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
       END
***************END OF COMMAND FILE************
```

SWALE 15 STA. 175+0 TO STA. 186+50 LT

INPUT REVIEW

DESIGN PARAMETERS:
DESIGN DISCHARGE (ft^3/s): **8.40** (Q2yr)
CHANNEL SHAPE: TRAPEZOIDAL
CHANNEL SLOPE (ft/ft): .008

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.18	.00	0.	UNSTAB	.82	5.9	.39	.014
JUTE NET	.45	.26	.00	0.	STABLE	1.75	25.1	.55	.025
FIBERGLASS SINGLE	.60	.25	.00	0.	STABLE	2.36	45.7	.54	.024
FIBERGLASS DOUBLE	.85	.26	.00	0.	STABLE	3.22	88.8	.56	.026
STRAW WITH NET	1.45	.34	.00	0.	**STABLE**	4.28	203.9	**.72**	.040
CURLED WOOD MAT	1.55	.35	.00	0.	STABLE	4.47	222.1	.74	.042
SYNTHETIC MAT	2.00	.28	.00	0.	STABLE	7.08	545.3	.60	.029
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.08	.00	0.	STABLE	3.44	629.0	2.30	.376

*** WARNING: DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE WITH MOST RECENT VALUE

VEGETATIVE B	2.10	.72	.00	0.	STABLE	2.92	195.3	1.54	.166
VEGETATIVE C	1.00	.53	.00	0.	STABLE	1.88	42.7	1.14	.093
VEGETATIVE D	.60	.46	.00	0.	STABLE	1.30	15.9	.99	.071
VEGETATIVE E	.35	.42	.00	0.	UNSTAB	.83	5.4	.90	.060

==>**USE STRAW WITH NET FOR TEMPORARY LINING** D=0.72'
WIDTH=4'+(0.72')(2+2)=6.88'==>**USE 7' WIDE E.C.M. TYPE "G" LINING**

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 12-09-2008
 Commands Read From File: E:\HYCHL\DATA\SW15.CHL

      JOB SW15
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .00750 11.9
      TRP 4 2 2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
      END
***************END OF COMMAND FILE************
```

SWALE 15 STA. 175+00 TO STA. 186+50 LT

INPUT REVIEW

DESIGN PARAMETERS:
- DESIGN DISCHARGE (ft^3/s): **11.90** (Q10yr)
- CHANNEL SHAPE: TRAPEZOIDAL
- CHANNEL SLOPE (ft/ft): .008

RESULTS

Lining Type	SHEAR STRESS(psf) Permiss	Bottom	Len of Protect (ft)	Super Elev (ft)	Remark	Stab. Factor	Max Q (cfs)	---DESIGN-- Depth (ft)	Mann n
TEMPORARY (FLEXIBLE)									
WOVEN PAPER NET	.15	.22	.00	0.	UNSTAB	.67	5.9	.48	.013
JUTE NET	.45	.31	.00	0.	STABLE	1.46	25.1	.66	.024
FIBERGLASS SINGLE	.60	.30	.00	0.	STABLE	1.97	45.7	.65	.023
FIBERGLASS DOUBLE	.85	.31	.00	0.	STABLE	2.70	88.8	.67	.025
STRAW WITH NET	1.45	.40	.00	0.	STABLE	3.64	203.9	.85	.038
CURLED WOOD MAT	1.55	.41	.00	0.	STABLE	3.79	222.1	.87	.040
SYNTHETIC MAT	2.00	.34	.00	0.	STABLE	5.96	545.3	.72	.028
PERMANENT (FLEXIBLE)									
VEGETATIVE A	3.70	1.15	.00	0.	STABLE	3.21	629.0	2.46	.306
VEGETATIVE B	2.10	.80	.00	0.	STABLE	2.64	195.3	1.70	.144
VEGETATIVE C	1.00	.61	.00	0.	**STABLE**	1.65	42.7	**1.30**	.085
VEGETATIVE D	.60	.53	.00	0.	STABLE	1.13	15.9	1.14	.066
VEGETATIVE E	.35	.49	.00	0.	UNSTAB	.72	5.4	1.04	.056

==>**USE GRASS (VEGETATIVE TYPE C) FOR PERMANET LINING**

SWALE - (S16) STA. 192+50 TO STA. 194+0 LT

TOTAL AREA = 1.225± Ac

PAVEMENT:	A = 0.265 Ac	C = 0.9	$\Sigma C = 0.574$
GRAVEL:	A = 0.06 Ac	C = 0.7	
GRASS:	A = 0.810 Ac	C = 0.3	
WOODS:	A = 0.900 Ac	C = 0.2	

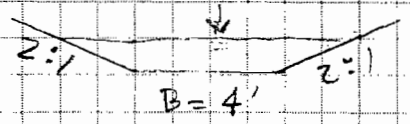
T_c = 15± MINS (MOSTLY GRASSED/WOODS)

$Q_2 = 1.225(0.574)(2.8"/hr) = 1.97^{\pm}$ cfs

$Q_{10} = 1.225(0.574)(4.0"/hr) = 2.8^{\pm}$ cfs

TRY 4' WIDE DITCH

S_{AVG} = 0.8%



```
          ******  HYCHL  ****** (Version 6.1) ******          Date 03-04-2009
 Commands Read From File: E:\HYCHL\DATA\SW16TEMP.CHL

       JOB SWALE 16 (STA.192+50 TO STA.194+0 LT)
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .0080  1.97
       TRP 4 2 2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
       LTM 5
       END
***************END OF COMMAND FILE************

 SW16
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):            1.97 (Q2yr)
       CHANNEL SHAPE:                  TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):                .008
 ----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 ----------------------------------------

                           DESIGN     MAXIMUM
                           ------     -------
 FLOW (cfs)                  1.97      181.50
 DEPTH (ft)                   .37        2.90
 AREA (ft^2)                 1.76       28.49
 WETTED PERIMETER (ft)       5.66       16.99
 HYDRAULIC RADIUS (ft)        .31        1.68
 VELOCITY (ft/s)             1.12        6.37
 MANNINGS N (LOW FLOW)        .054        .029

 ------------------
 STABILITY ANALYSIS
 ------------------

                      LINING       PERMIS SHR   CALC. SHR  STAB.
    CONDITION         TYPE         (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
    ---------         ---------    ----------   ---------  ------   -------
 LOW FLOW LINING
   BOTTOM; STRAIGHT   STRAW WITH NET     1.45        .19      7.83   STABLE

 *** NORMAL END OF HYCHL ***

==> USE 7' WIDE E.C.M. TYPE "G" FOR TEMPORARY LINING
```

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 03-04-2009
 Commands Read From File: E:\HYCHL\DATA\SW16.CHL

       JOB SWALE 16(STA.192+50 TO STA.194+0 LT)
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .0080  2.80
       TRP 4 2 2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    4.00
       LVG C
       END
***************END OF COMMAND FILE*************

 SW16
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):            2.80 (Q10yr)
       CHANNEL SHAPE:                   TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):                .008
 ----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 ----------------------------------------

                           DESIGN      MAXIMUM
                           ------      -------
 FLOW (cfs)                  2.80        37.99
 DEPTH (ft)                   .76         2.00
 AREA (ft^2)                 4.23        16.04
 WETTED PERIMETER (ft)       7.42        12.96
 HYDRAULIC RADIUS (ft)        .57         1.24
 VELOCITY (ft/s)              .66         2.37
 MANNINGS N (LOW FLOW)        .138         .065

 ------------------
 STABILITY ANALYSIS
 ------------------

                     LINING       PERMIS SHR   CALC. SHR  STAB.
    CONDITION        TYPE         (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
    ---------        ---------    ----------   ---------  ------   -------
 LOW FLOW LINING
   BOTTOM; STRAIGHT  VEGETATIVE  C     1.00        .38       2.62   STABLE

 *** NORMAL END OF HYCHL ***

==> USE GRASS AS PERMANENT LINING
```

Close, Jensen and Miller, P.C.

BY DJP DATE 3/27/09 SUBJECT BUSWAY SHEET NO. 151 OF .....
CHKD. BY RJF DATE 4/9/09 PROJECT NO. 171-305 JOB NO. 8000

SWALE - S16A (STA. 194+0 TO STA. 194+75 LT)

TOTAL A = 0.14 Ac

PAVEMENT A = 0.027 Ac C = 0.9
GRASS A = 0.113 Ac C = 0.3

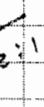
T_c = 10 MINS R_2 = 3.6"/hr R_{10} = 4.8"/hr

$$\Sigma C = \frac{(0.027)(0.9) + (0.113)(0.3)}{0.14} = 0.416$$

$Q_2 = 0.14 Ac\ (0.416)(3.6"/hr) = 0.21$ cfs

$Q_{10} = 0.14 Ac\ (0.416)(4.8"/hr) = 0.28$ cfs

TRY 2' WIDE DITCH



S_{AVG} = 0.5%

```
          ******  HYCHL  ****** (Version 6.1) ******          Date 02-27-2009
 Commands Read From File: E:\HYCHL\DATA\SW16ATEMP.CHL

       JOB SWALE 16A (STA.194+0 TO STA.194+75 LT)
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL .0050  0.21
       TRP 2      2      2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
       LTM 5
       END
***************END OF COMMAND FILE************

 SW16A
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):              .21 (Q2yr)
       CHANNEL SHAPE:                   TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):                .005
 ----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 ----------------------------------------

                           DESIGN      MAXIMUM
                           ------      -------
 FLOW (cfs)                   .21       344.38
 DEPTH (ft)                   .23         4.65
 AREA (ft^2)                  .56        52.49
 WETTED PERIMETER (ft)       3.01        22.78
 HYDRAULIC RADIUS (ft)        .18         2.30
 VELOCITY (ft/s)              .38         6.56
 MANNINGS N (LOW FLOW)        .090         .028

 ------------------
 STABILITY ANALYSIS
 ------------------

                      LINING       PERMIS SHR   CALC. SHR  STAB.
    CONDITION         TYPE         (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
    ---------         ---------    ----------   ---------  ------   -------
 LOW FLOW LINING
   BOTTOM; STRAIGHT   STRAW WITH NET     1.45        .07     20.48   STABLE

 *** NORMAL END OF HYCHL ***
=>>USE 4' WIDE TEMPORARY LINING
```

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 02-27-2009
 Commands Read From File: E:\HYCHL\DATA\SWALE16A.CHL

      JOB SWALE 16A (STA.194+0 TO STA.194+75 LT)
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .0050  0.28
      TRP 2      2      2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      LVG C
      END
***************END OF COMMAND FILE************

 SW16A
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
      DESIGN DISCHARGE (ft^3/s):              .28 (Q10yr)
      CHANNEL SHAPE:                   TRAPEZOIDAL
      CHANNEL SLOPE (ft/ft):                .005

 *** WARNING:  DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE
                 WITH MOST RECENT VALUE
 ----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 ----------------------------------------

                          DESIGN     MAXIMUM
                          ------     -------
 FLOW (cfs)                  .28       65.07
 DEPTH (ft)                  .63        3.21
 AREA (ft^2)                2.25       26.96
 WETTED PERIMETER (ft)      5.01       16.33
 HYDRAULIC RADIUS (ft)       .45        1.65
 VELOCITY (ft/s)             .12        2.41
 MANNINGS N (LOW FLOW)       .418        .061

 ------------------
 STABILITY ANALYSIS
 ------------------

                      LINING       PERMIS SHR   CALC. SHR  STAB.
    CONDITION         TYPE         (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
    ---------         ---------    ----------   ---------  ------   -------
 LOW FLOW LINING
   BOTTOM; STRAIGHT   VEGETATIVE  C      1.00       .20      5.09   STABLE

 *** NORMAL END OF HYCHL ***
=>>USE GRASS TYPE C FOR PERMANENT  LINING
```

Close, Jensen and Miller, P

BY DJP DATE 3/27/09 SUBJECT

CHKD. BY RJF DATE 4/19/09

SWALE (S17) (STA. 195+0 TO STA.

TOTAL A = 0.415± Ac

PAVEMENT A = 0.057 Ac C = 0.9
GRAVEL A = 0.073 Ac C = 0.7
GRASS A = 0.285 Ac C = 0.

Tc = 10 mins K_2 = 3.6"/hr

$$\Sigma C = \frac{0.057(0.9) + (0.073)(0.7) + (0.285}{0.415\ Ac}$$

ΣC = 0.453

Q_2 = 0.415 (0.453) (3.6"/hr) = 0.6

Q_{10} = " " (4.8"/hr) = 0.9

TRY GRASS LINED SWALE

12:1

S_{AVG} = 1.0%

****** HYCHL ****** (Version 6.1) ******

Commands Read From File: E:\HYCHL\DATA\SW17TEMP.CHL

```
      JOB SWALE 17 (STA.195+0 TO STA.~~197+0~~ 196+50 LT)
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL .0100  0.680
      TRP 2 2 12
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE   12.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      LTM 5
      END
***************END OF COMMAND FILE************
```

SW17

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	**.68** (Q2yr)
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.010

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM	
FLOW (cfs)	.68	226.78	
DEPTH (ft)	**.29**	2.32	
AREA (ft^2)	1.18	42.45	
WETTED PERIMETER (ft)	6.17	35.18	USE 8' W
HYDRAULIC RADIUS (ft)	.19	1.21	
VELOCITY (ft/s)	.57	5.34	
MANNINGS N (LOW FLOW)	.086	.032	

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (lb/ft^2)	CALC. SHR (lb/ft^2)
LOW FLOW LINING			
BOTTOM; STRAIGHT	**STRAW WITH NET**	1.45	.18

*** NORMAL END OF HYCHL ***

USE 8' WIDE E.C.M. TYPE 'C'

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 02-27-2009
Commands Read From File: E:\HYCHL\DATA\SW17.CHL

      JOB SWALE 17 (STA.195+0 TO STA.197+0 LT)
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.010  0.900
      TRP 2      2      12
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE   12.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      LVG C
      END
***************END OF COMMAND FILE************

SW17
------------
INPUT REVIEW
------------
  DESIGN PARAMETERS:
      DESIGN DISCHARGE (ft^3/s):              .90 (Q10yr)
      CHANNEL SHAPE:                    TRAPEZOIDAL
      CHANNEL SLOPE (ft/ft):                 .010

*** WARNING:  DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE
                WITH MOST RECENT VALUE
-----------------------------------------
HYDRAULIC CALCULATIONS USING NORMAL DEPTH
-----------------------------------------

                          DESIGN     MAXIMUM
                          ------     -------
FLOW (cfs)                   .90       35.58
DEPTH (ft)                   .65        1.60
AREA (ft^2)                 4.24       21.18
WETTED PERIMETER (ft)      11.26       24.88
HYDRAULIC RADIUS (ft)        .38         .85
VELOCITY (ft/s)              .21        1.68
MANNINGS N (LOW FLOW)        .361        .079

------------------
STABILITY ANALYSIS
------------------

                     LINING       PERMIS SHR   CALC. SHR  STAB.
   CONDITION         TYPE         (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
   ---------         ---------    ----------   ---------  ------   -------
LOW FLOW LINING
  BOTTOM; STRAIGHT   VEGETATIVE C      1.00        .40      2.47   STABLE

*** NORMAL END OF HYCHL ***
```

GRASS IS OK FOR NORMAL LINING

SWALE S17A (STA. 196+50 ± TO STA. 199+60 ± LT)

TOTAL A = 0.539 Ac

PAVEMENT A = 0.075 Ac C = 0.9
GRAVEL A = 0.144 Ac C = 0.7
GRASS A = 0.320 Ac C = 0.3

T_c = 10 MINS K_2 = 3.6"/hr K_{10} = 4.8"/hr

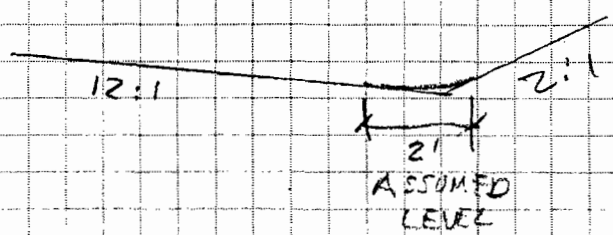
$$\Sigma C = \frac{0.075(0.9) + (0.144)(0.7) + (0.320)(0.3)}{0.539 Ac} = 0.490$$

ΣC = 0.490

Q_2 = 0.539(0.490)(3.6"/hr) = 0.95 cfs

Q_{10} = " " (4.8"/hr) = 1.27 cfs

TRY GRASS LINED CHANNEL



S_{AVG} = 0.5%

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 02-27-2009
 Commands Read From File: E:\HYCHL\DATA\SW17ATEM.CHL

      JOB SWALE 17A (STA.197+0 TO STA. 199+60 LT)
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.005  0.950
      TRP 2 2 12
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE   12.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      LTM 5
      END
***************END OF COMMAND FILE*************

SW17A
------------
INPUT REVIEW
------------
  DESIGN PARAMETERS:
      DESIGN DISCHARGE (ft^3/s):              .95 (Q2yr)
      CHANNEL SHAPE:                   TRAPEZOIDAL
      CHANNEL SLOPE (ft/ft):                .005
----------------------------------------
HYDRAULIC CALCULATIONS USING NORMAL DEPTH
----------------------------------------

                          DESIGN      MAXIMUM
                          ------      -------
FLOW (cfs)                   .95      1069.20
DEPTH (ft)                  .37         4.65
AREA (ft^2)                1.67       160.49
WETTED PERIMETER (ft)      7.22        68.35
HYDRAULIC RADIUS (ft)       .23         2.35
VELOCITY (ft/s)             .57         6.66
MANNINGS N (LOW FLOW)       .070         .028

------------------
STABILITY ANALYSIS
------------------

                     LINING        PERMIS SHR   CALC. SHR  STAB.
   CONDITION         TYPE          (lb/ft^2)    (lb/ft^2)  FACTOR  REMARKS
   ---------         ---------     ----------   ---------  ------  -------
LOW FLOW LINING
  BOTTOM; STRAIGHT   STRAW WITH NET     1.45        .11     12.70   STABLE

*** NORMAL END OF HYCHL ***
```

USE 8' WIDE LINING

USE 8' WIDE E.C.M. TYPE "S"

```
      ******  HYCHL  ******  (Version 6.1) ******           Date 02-27-2009
   □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
 Commands Read From File: E:\HYCHL\DATA\SW17A.CHL

       JOB SWALE 17A (STA.197+0 TO STA.199+60 LT)
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL 0.005  1.270
       TRP 2       2      12
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE   12.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)     2.00
       LVG C
       END
***************END OF COMMAND FILE************

 SW17A
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):           1.27 (Q10yr)
       CHANNEL SHAPE:                 TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):              .005
 -----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 -----------------------------------------

                          DESIGN     MAXIMUM
                          ------     -------
 FLOW (cfs)                 1.27      187.65
 DEPTH (ft)                  .84        3.21
 AREA (ft^2)                6.58       78.32
 WETTED PERIMETER (ft)     13.95       47.76
 HYDRAULIC RADIUS (ft)       .47        1.64
 VELOCITY (ft/s)             .19        2.40
 MANNINGS N (LOW FLOW)       .330        .061

 ------------------
 STABILITY ANALYSIS
 ------------------

                     LINING        PERMIS SHR   CALC. SHR  STAB.
     CONDITION       TYPE          (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
     ---------       ---------     ----------   ---------  ------   -------
 LOW FLOW LINING
   BOTTOM; STRAIGHT  VEGETATIVE  C      1.00        .26      3.83   STABLE

 *** NORMAL END OF HYCHL ***
```

GRASS IS OK FOR PERMANENT LINING

Close, Jensen and Miller, P.C.

BY DJP DATE 2/27/09 SUBJECT BUSWAY SHEET NO. 160 OF
CHKD. BY RSF DATE 4/9/09 PROJ. NO. 171-305 JOB NO. 8000
CONTRACT NO. 88-H034

SWALE-(S18) (STA. 199+50 TO STA. 203+0 LT)

TOTAL A = 0.814 Ac

PAVEMENT A = 0.10 Ac C = 0.9
GRAVEL A = 0.08 Ac C = 0.7
GRASS A = 0.354 Ac C = 0.3
TREES A = 0.28 Ac C = 0.2

T_c = 10 MINS R_2 = 2.6"/hr R_{10} = 4.8"/hr

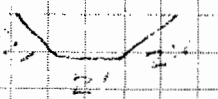
$$C = \frac{[(0.10)(0.9) + (0.08)(0.7) + (0.354)(0.3) + (0.28)(0.2)]}{0.814}$$

C = 0.379

Q_2 = (0.814 Ac)(0.379)(2.6"/hr) = 1.1 cfs

Q_{10} = " " (4.8"/hr) = 1.5 cfs

TRY 2' WIDE TRAPEZOIDAL DITCH

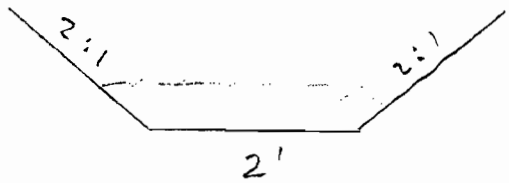


S_{AVG} = 0.5%

****** HYCHL ****** (Version 6.1) ****** Date 02-27-2009

Commands Read From File: E:\HYCHL\DATA\SW18TEMP.CHL

```
      JOB SWALE 18 (STA.199+50 TO STA.203+0 LT)
      UNI 0
** UNITS PARAMETER = 0 (ENGLISH)
      CHL 0.005  1.100
      TRP 2 2 2
** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
      LTM 5
      END
***************END OF COMMAND FILE************
```



SW18

INPUT REVIEW

DESIGN PARAMETERS:

DESIGN DISCHARGE (ft^3/s):	**1.10** (Q2yr)
CHANNEL SHAPE:	TRAPEZOIDAL
CHANNEL SLOPE (ft/ft):	.005

HYDRAULIC CALCULATIONS USING NORMAL DEPTH

	DESIGN	MAXIMUM
FLOW (cfs)	1.10	344.38
DEPTH (ft)	.43	4.65
AREA (ft^2)	1.23	52.49
WETTED PERIMETER (ft)	3.92	22.78
HYDRAULIC RADIUS (ft)	.31	2.30
VELOCITY (ft/s)	.89	6.56
MANNINGS N (LOW FLOW)	.054	.028

STABILITY ANALYSIS

CONDITION	LINING TYPE	PERMIS SHR (lb/ft^2)	CALC. SHR (lb/ft^2)	STAB. FACTOR	REMARKS
LOW FLOW LINING					
BOTTOM; STRAIGHT	**STRAW WITH NET**	1.45	.13	10.81	**STABLE**

*** NORMAL END OF HYCHL ***

USE STRAW WITH NET AS TEMPORARY LINING=> WIDTH =3.92+2=5.92' =>> **USE 6' WIDE LINING**

```
        ******  HYCHL  ****** (Version 6.1) ******          Date 02-27-2009
  □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
 Commands Read From File: E:\HYCHL\DATA\SW18.CHL

       JOB SWALE 18 (STA.199+50 TO STA.203+0 LT)
       UNI 0
 ** UNITS PARAMETER = 0 (ENGLISH)
       CHL 0.005  1.580
       TRP 2 2 2
 ** LEFT SIDE SLOPE    2.0 AND RIGHT SIDE SLOPE    2.0
 ** THE BASE WIDTH OF THE TRAPEZOID (ft)    2.00
       LVG C
       END
***************END OF COMMAND FILE*************

 SW18
 ------------
 INPUT REVIEW
 ------------
   DESIGN PARAMETERS:
       DESIGN DISCHARGE (ft^3/s):            1.58 (Q10yr)
       CHANNEL SHAPE:                  TRAPEZOIDAL
       CHANNEL SLOPE (ft/ft):               .005

 *** WARNING:  DEPTH DID NOT CONVERGE. PROGRAM WILL CONTINUE
                 WITH MOST RECENT VALUE
 ----------------------------------------
 HYDRAULIC CALCULATIONS USING NORMAL DEPTH
 ----------------------------------------

                          DESIGN     MAXIMUM
                          ------     -------
 FLOW (cfs)                 1.58       65.07
 DEPTH (ft)                  .94        3.21
 AREA (ft^2)                3.64       26.96
 WETTED PERIMETER (ft)      6.20       16.33
 HYDRAULIC RADIUS (ft)       .59        1.65
 VELOCITY (ft/s)             .43        2.41
 MANNINGS N (LOW FLOW)       .171        .061

 ------------------
 STABILITY ANALYSIS
 ------------------

                      LINING       PERMIS SHR   CALC. SHR  STAB.
    CONDITION         TYPE         (lb/ft^2)    (lb/ft^2)  FACTOR   REMARKS
    ---------         ---------    ----------   ---------  ------   -------
 LOW FLOW LINING
   BOTTOM; STRAIGHT   VEGETATIVE  C     1.00        .29      3.40   STABLE

 *** NORMAL END OF HYCHL ***
```

SECTION III

CROSS CULVERT DESIGN

CULVERT DESIGN – SITE 2B

- LOCATION: STA. 158+25
- EXISTING CULVERT: 36" ROUND METAL PIPE
- HYDROLOGY: PREPARED BY GAKE CONSULTING SERVICES, INC. FOR BAKER ENGINEERING NY, INC.

  SEE "PRELIMINARY HYDRAULICS SUMMARY FOR STATE PROJECT NO. 171-305, LOCATION: UN-NAMED TRIBUTARY OF MINER KROOK – NEWINGTON, SITE 2B, DATED: JUNE 2008"
- RECOMMENDED PEAK DISCHARGES FOR NEW CULVERT:

(DESIGN) Q_{50} = 41.26 cfs + 0.43 cfs* = 42.08 cfs

(CHECK) Q_{50} = 47.98 cfs + 6.82 cfs* = 54.80 cfs

(SEE PAGE 3 OF GAKE'S ENGINEERING HYDRAULIC REPORT)

- [illegible] DRAINAGE AREA: 29.42 Ac.
- [illegible] FREEBOARD: 72 LF
- DESIGN SOFTWARE USED: HY-8 [illegible] CIRCULAR CULVERT ANALYSIS

* ADDED FLOWS FROM UNDEVELOPED, SEE CONSULTANTS REPORT ON 9320 TO FLOWS THROUGH FOR BUILDOUT CONDITIONS [illegible] TABLE CEDAR STREET STATION. CONSULTANT [illegible] DUE TO [illegible]

151

PROJECT: NEW BRITAIN - HARTFORD RAILWAY - PROJ. NO. 171-305

STATION: 158+25

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: RF / 12-25-10

REVIEWER / DATE: ____ / ____

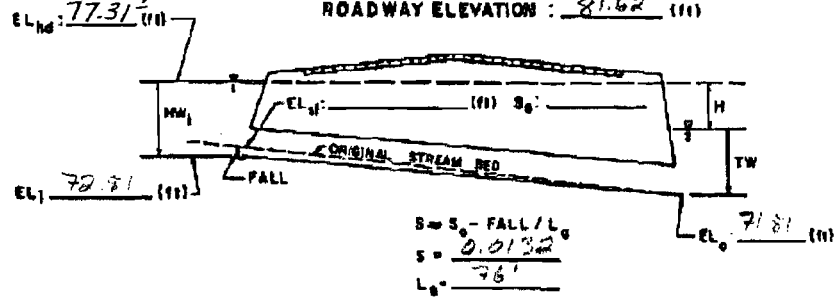
HYDROLOGICAL DATA

SITE CHARACTERISTICS:

- ☐ METHOD: TR-55
- ☒ DRAINAGE AREA: 2.48 Ac ☐ STREAM SLOPE: ____
- ☒ CHANNEL SHAPE: FLAT / SWAMP
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50 yr	42.08	
100 yr	54.8	



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_si (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	h_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
[illegible]	42.08	–	1.06	3.17	–	75.98	1.28	2.11	2.56	2.56	0.5	1.61	75.98	75.98	10.80	DESIGN (Q_{50})
[illegible]	54.8	–	1.29	3.88	–	76.69	1.44	2.40	2.70	2.70	0.5	2.18	76.69	76.69	11.54	CHECK (Q_{100})

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{si})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) EL_{hi} = HW_i + EL_i (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
c. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
si STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: 36"

SHAPE: Circular

MATERIAL: RCP

ENTRANCE: Flared End

CURRENT DATE: 03-09-2010
CURRENT TIME: 14:31:27

FILE DATE: 03-09-2010
FILE NAME: SITE2B

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULVERT NO.	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS	SHAPE	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	72.81	71.81	76.01	1	RCP	3.00	3.00	.012	CONVENTIONAL
2									
3									
4									
5									
6									

SUMMARY OF CULVERT FLOWS (cfs) FILE: SITE2B DATE: 03-09-2010

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
73.69	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
74.19	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
74.60	16.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
74.94	21.9	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
75.24	27.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
75.51	32.9	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
75.79	38.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
75.98	42.1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
76.37	49.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
76.69	54.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: SITE2B DATE: 03-09-2010

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
0.00	0.000	0.00	0.00	0.00
73.69	0.000	5.48	0.00	0.00
74.19	0.000	10.96	0.00	0.00
74.60	0.000	16.44	0.00	0.00
74.94	0.000	21.92	0.00	0.00
75.24	0.000	27.40	0.00	0.00
75.51	0.000	32.88	0.00	0.00
75.79	0.000	38.36	0.00	0.00
75.98	0.000	42.08	0.00	0.00
76.37	0.000	49.32	0.00	0.00
76.69	0.000	54.80	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-09-2010 FILE DATE: 03-09-2010
CURRENT TIME: 14:31:27 FILE NAME: SITE2B

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.00 (ft) BY 3.00 (ft)) RCP

	DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
	0.00	72.81	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
	5.48	73.69	0.88	0.88	1-S2n	0.50	0.72	0.42	0.48	8.79	2.35
	10.96	74.19	1.38	1.38	1-S2n	0.72	1.04	0.64	0.68	10.05	2.84
	16.44	74.60	1.79	1.79	1-S2n	0.90	1.29	0.95	0.82	8.64	3.17
	21.92	74.94	2.13	2.13	1-S2n	1.04	1.51	1.10	0.94	9.37	3.42
	27.40	75.24	2.43	2.43	1-S2n	1.18	1.69	1.26	1.05	9.76	3.63
	32.88	75.51	2.70	2.70	1-S2n	1.31	1.86	1.40	1.14	10.19	3.80
	38.36	75.79	2.98	2.98	1-S2n	1.43	2.01	1.53	1.23	10.59	3.96
Q_{50} →	42.08	75.98	3.17	3.17	5-S2n	1.51	2.11	1.62	1.28	10.80	4.05
	49.32	76.37	3.56	3.56	5-S2n	1.66	2.28	1.78	1.37	11.31	4.22
Q_{100} →	54.80	76.69	3.88	3.88	5-S2n	1.78	2.40	1.91	1.44	11.54	4.34

El. inlet face invert 72.81 ft El. outlet invert 71.81 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	72.81 ft
OUTLET STATION	76.00 ft
OUTLET ELEVATION	71.81 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0132
CULVERT LENGTH ALONG SLOPE	76.01 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	3.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	BEVELED EDGE (1.5:1)
INLET DEPRESSION	NONE

CURRENT DATE: 03-09-2010
CURRENT TIME: 14:31:27

FILE DATE: 03-09-2010
FILE NAME: SITE2B

ÃÃÃ
ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ TAILWATER ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ
ÃÃÃ

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	3.00 ft
SIDE SLOPE H/V (X:1)	4.0
CHANNEL SLOPE V/H (ft/ft)	0.017
MANNING'S n (.01-0.1)	0.040
CHANNEL INVERT ELEVATION	71.81 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	71.81 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	71.81	0.000	0.00	0.00	0.00
5.48	72.29	0.599	0.48	2.35	0.50
10.96	72.49	0.609	0.68	2.84	0.72
16.44	72.63	0.615	0.82	3.17	0.87
21.92	72.75	0.620	0.94	3.42	1.00
27.40	72.86	0.624	1.05	3.63	1.11
32.88	72.95	0.627	1.14	3.80	1.21
38.36	73.04	0.630	1.23	3.96	1.30
Q50 → 42.08	73.09	0.632	1.28	4.05	1.36
49.32	73.18	0.635	1.37	4.22	1.46
Q100 → 54.80	73.25	0.637	1.44	4.34	1.53

ÃÃÃ
ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ ROADWAY OVERTOPPING DATA ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ
ÃÃÃ

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	44.00 ft
CREST LENGTH	50.00 ft
OVERTOPPING CREST ELEVATION	81.62 ft

ÃÃÃ

Appendix A – Outlet Protection Form

OUTLET PROTECTION

Project No.: Busway **Designed By:** RF **Date:** 11/12/08
Town: Newington **Checked By:** _____ **Date:** _____
Route: Busway **Station:** Site 2B

1. Assess the erosion potential at the outlet and other critical site factors

Describe the conditions at the outlet location:

Sketch

☐ No well-defined channel
☑ Well-defined channel

2. Determine the tailwater (TW) conditions at the outlet

TW depth: _____ TW elevation: _____
TW computational method: Free Falling
Channel bed elevation: 71.81 Estimated velocity in channel: —

3. Calculate and evaluate the outlet velocity for the design discharge

Design Discharge: 42.08 cfs Design Frequency: 50 yr
Outlet Pipe Size: 36" Type: _____
Length: 76' Slope: 0.0132 Outlet Invert Elevation: 71.81
Outlet Velocity at design discharge: 10.80
Velocity computational method: HY8

4. Select the type of outlet protection

☐ Riprap Apron
(See Figures 11-13 & 11-14)

Type _____ (A,B,C)

Riprap type: _____
Length (L_a): _____
Width (W_1): _____
Width (W_2): _____
Width-Type C (W_3): _____

☑ Preformed Scour Hole
(See Figure 11-15)

	Type 1	Type 2
d_{50}	0.375	
F	1.5	
C	18	
B	15	
S_p	3	

Proposed Type: 1
Riprap Type: Modified

CULVERT OUTLET PROTECTION:

USE TYPE I - Scour Hole

$F = 0.5 R_p$

CULVERT SIZE: 36" DIA. RCP

$E = D_o = 36'' (3')$

$F = 3'/2 = 1.5'$ $F = 1.5'$

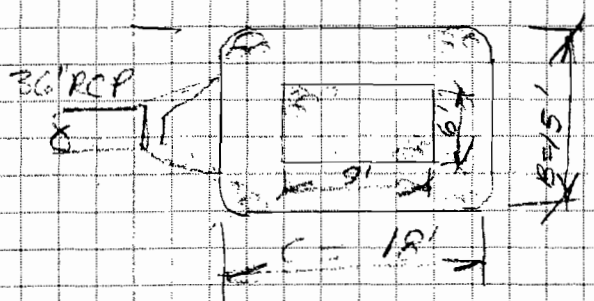
$A = B = 2(3') + 6(1.5') = 15'$

$C = 3(3') + 6(1.5') = 18'$

EXTRA DIMS:

$W = 24 - 2(3') = 6'$

$L = 24 - 3(2) = 9'$



DOWNSTREAM RIPRAP STONE SIZE:

FILE SUPPLEMENTAL COPY
3.25.07

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

PRELIMINARY HYDROLOGY REPORT

FOR

STATE PROJECT NO. 171-305

NEW BRITAIN TO HARTFORD BUSWAY
NEW BRITAIN, NEWINGTON, WEST HARTFORD, AND HARTFORD, CONNECTICUT

LOCATION: Un-Named Tributary of Piper Brook - Newington

SITE: 2B 36" Metal Pipe

PREPARED BY

GARG CONSULTING SERVICES, INC.
ROCKY HILL, CT

FOR

BAKER ENGINEERING NY, INC.
ROCKY HILL, CT

JUNE 2003

REVISIONS		
	DATE	ENGINEER

1. SITE NARRATIVE

The purpose of this project is to provide an exclusive busway system from the City of New Britain to the City of Hartford. The exclusive roadway will be constructed along the existing railroad corridor for approximately 9.4 miles. The roadway will be comprised of two lanes with minimal shoulders. Within the project limits, the busway crosses 7 waterways within the upper Connecticut River Basin.

Site 2B is associated with an un-named tributary of the Piper Brook crossing the railroad bed in the town of Newington. The area discharges into the tributary at approximate coordinate 41.69742 deg, 72.75350 deg. NAD83 datum.

The watershed area for this site is delineated and measured from MDC Sheet No. 204 dated March 1975 and Fenn Road Plaza maps dated February 12, 1990, revised March 19, 1990. In addition, the delineation was field reviewed.

The associated drainage area of 29.48 acres is developed with commercial and industrial properties. The TR-55 Method is appropriate for use at this site as the drainage area is less than 25 square miles with the number of reaches, sub watershed areas and time of concentration for any sub-area not exceeding 10, 10 and 10 hours, respectively. This watershed is highly developed with more than 30 percent urbanization. Backup computations and information is contained in subsequent sections of this report.
To verify the flow rate, TR-20 computer model was prepared.

2. SUMMARY OF DISCHARGES

METHODOLOGY	2	10	25	50	100	500
TR-55 Method	**19.96**	**29.08**	**35.09**	**41.65**	**47.98**	
TR-20	**13.69**	**21.89**			**27.97**	

3. RECOMMENDATIONS:

Flow Values for hydraulic analysis at the project crossings should be based on the TR-55 Method calculations. The recommended design flow rate should be based on the 50-year event with a calculated flow rate of 41.65 cfs.

Close, Jensen and Miller, P.C.

BY DP DATE 11/10/08 SUBJECT NB-HARTFORD SHEET NO. 173 OF .....
CHKD. BY RJF DATE 4/9/09 RUNWAY JOB NO. 8000
PROPOSED CULVERT

CULVERT REPLACEMENT FOR SITE 3

- LOCATION: STA. 174+62
- EXISTING CULVERT: 3.0'W x 3.5'H STONE BOX CULVERT
- HYDROLOGY: PROVIDED BY GANG CONSULTING SERVICES, INC. FOR BAKER ENGINEERING NY, INC.

  SEE "PRELIMINARY HYDRAULIC SUMMARY FOR STATE PROJECT NO. 171-305, LOCATION: UN-NAMED TRIBUTARY OF PINE BROOK NEWINGTON, SITE 3, DATED MARCH 2008."

- RECOMMENDED PEAK DISCHARGES FOR NEW CULVERT:

  Q_{50} = 151 cfs (DESIGN)

  Q_{100} = 180 cfs (CHECK)

  (SEE PAGE 3 OF GANG ENGINEERING HYDRAULIC REPORT)

- ESTIMATED DRAINAGE AREA: 0.31 mi² (198 ac)
- HYDRAULIC ANALYSIS USED: NATIONAL NOMOGRAPH
- CULVERT TO BE REPLACED WITH NEW CULVERT: PRECAST CONCRETE BOX CULVERT (PRECAST CONCRETE ARCH)

Close, Jensen and Miller, P.C.

BY DJP DATE 3/9/09 SUBJECT BUSWAY SHEET NO. 174 OF .....
CHKD. BY RJF DATE 4/9/09 PROJ. NO. 171-305 JOB NO. 8000

CONCLUSION:

THE EXISTING 3' WIDE X 3.5' HIGH STONE CULVERT WILL BE REMOVED AND REPLACED WITH A 6' WIDE X 6' HIGH CONCRETE BOX CULVERT. THE CULVERT INVERTS WILL BE DEPRESSED ONE FOOT BELOW THE EXISTING CHANNEL AND WILL BE FILLED WITH ONE FOOT OF NATIVE CHANNEL SOIL TO CREATE AND EFFECTIVE (6' WIDE X 5' HIGH OPENING.

THE CULVERT INLET WILL BE FLUSH WITH THE PROPOSED RETAINING WALL AND THE OUTLET UTILIZE A HEADWALL/WINGWALLS. A PREFORMED SCOUR HOLE WILL PROTECT THE DISCHARGE CREATING EROSION OR SEDIMENTATION PROBLEMS TO PINEY BROOK.

DESIGN SUMMARY

STORM FREQ. (YR)	DISCHARGE	AVAIL. FREEB.
50 (DESIGN)	151 CFS	68.24 (OK)
100 (CHECK)	180 CFS	68.23 (OK)

NOTE:
MINIMUM ROADWAY ELEVATION OF 68.50
[illegible]

MAXIMUM ALLOWABLE H_w: $H_w/D = 1.5$
MILK LANE CROSSING APPROX. 550' UPSTREAM
ALLOWABLE H_w ELEV = 68.5 (NGVD) (SEE SITE 3 HYDRAULIC REPORT)

PROPOSED CULVERT DESIGN

THE NEW CULVERT WILL BE LOCATED IN SAME LOCATION AS THE EXISTING STONE CULVERT. THIS WILL MAINTAIN THE EXISTING CULVERT AND ALIGNMENT PROFILE. DURING INSTALLATION A TEMPORARY CULVERT MAY BE NEEDED. THE TEMPORARY CULVERT WILL BE SIZED AS PER CONTRACTOR'S TEMPORARY FACILITIES REQUIREMENTS.

ASSUME INLET IS FLUSH WITH PROPOSED RETAINING WALL (WEST SIDE) AND OUTLET WILL BE LOCATED APPROXIMATELY IN SAME HORIZONTAL OFFSET OF EXISTING CULVERT.

DATA:

$L = 60' \pm$ INLET FL = 63.70

$n = 0.012$ OUTLET FL = 63.0

$Q_{50} = 151$ cfs (DESIGN) TW = $4.0' \pm$ (25YR FLOOD MILK BK)

TW EL. = $67.0 \pm$ (SEE SITE 3 HYDRAULIC REPORT)

$Q_{100} = 180$ cfs (CHECK) TW = $5.3' \pm$ (50YR FLOOD MILK BK)

TW EL. = 68.3 (SEE SITE 3 HYDRAULIC REPORT)

Appendix G – Culvert Design Data Form

Prepared by: D.J. PICKETT
Date: MARCH 5, 2009
Checked: RJF
Date: 4/9/09

Project No. 171-305
Town NEWINGTON
Route BUSWAY (COLD R
Location STA. 174+80

1. DRAINAGE AREA

a) Total area 0.315 mi² (201.6 ac)
b) Special Considerations N/A
c) Existing culverts 3.0'W x 3.5'H STONE BOX CULVERT w/ FLARED STONE ENDWALLS

2. DESIGN DISCHARGE 151 cfs for 50 year frequency

a) Rational Formula less than 81 ha (200 acres)
T_c (Min) _____ Rainfall intensity mm/hr (in/hr) _____
Coefficient of Imperviousness _____
b) _____ HEC-1 SCS _____ TR20 _____ TR55 _____
CN _____ T_c (Hr.) _____
Rainfall distribution: _____ SCS Type III-24 Hr.
c) Other FROM [illegible]

3. FISH PASSAGE REQUIRED? _____ Yes ✓ No

a) Special considerations OVERSIZE CULVERT BOX BY 1' TO ALLOW FILLING INSIDE OF CULVERT WITH 1' BELOW OF NATIVE STREAMBED SOILS

4. CULVERT HYDRAULIC DATA (EXISTING)

a) Size 6'X6' (6'X5') Type CONCRETE BOX CULVERT
b) Maximum permissible headwater elevation 68.50 (NGVD) MEADOWLAND (LOW ADT DEAD-END ROAD)
c) Proposed headwater elevation [illegible]
d) Elevation of channel bed at outlet 63.0 Inlet [illegible]
e) Length 60' Slope 0.017
f) Inlet invert elevation 62.70 Outlet [illegible]
g) Improved inlet Yes _____ No ✓
_____ Beveled Edge _____ Side-Tapered _____ Slope-Tapered
TAPER = ____:1 _____ (4:1 TO 6:1) FALL = ____ S_f _____:1 (2:1 to 3:1)
h) Entrance loss coefficient 0.50
i) Type and location of hydraulic control OUTLET CONTROL DUE TO [illegible]

5. MISCELLANEOUS DATA

a) Height of cover _____

b) Culvert strength requirements: CMP _____ (wall or plate thickness)
RCP _____ (Class)

c) End treatment WINGWALLS

d) Entrance channel N/A

e) Outlet channel SCOUR HOLE

f) Bank protection _____

Culvert Design Form – (English Version)

PROJECT: [illegible] STATION: 174+80

SHEET ____ OF ____

CULVERT DESIGN FORM

DESIGNER / DATE: BJP / 3/09

REVIEWER / DATE: ____ / ____

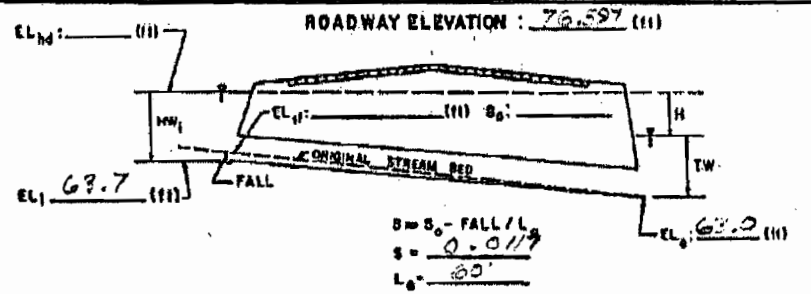
HYDROLOGICAL DATA

SEE ADDITIONAL SHEETS

- ☒ METHOD: [illegible]
- ☐ DRAINAGE AREA: [illegible] ☐ STREAM SLOPE: 0.0117
- ☒ CHANNEL SHAPE: [illegible]
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
[illegible]	[illegible]	67.0±
[illegible]	[illegible]	68.3±



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	h_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
CONC. BOX CULVERT	151	151	—	4.54	0	68.24	4.0'	2.71	3.86	4.0	0.5	1.24	68.24	68.24	12.25	SEE HY-8 OUTPUT
CONC. BOX CULVERT	180	180	—	5.13	0	68.83	5.3'	3.04	4.02	5.3	0.5	0.93	69.23	69.23	6.00	SEE HY-8 OUTPUT

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) HW_i/D = HW/D OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{if})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) EL_{hi} = HW_i + EL_i (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c+D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + h_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) EL_{ho} = EL_o + H + h_o

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

INLET IS CUT FLUSH WITH PROPOSED RETAINING WALL.

CULVERT BARREL SELECTED:

SIZE: 6'WX5'H

SHAPE: BOX

MATERIAL: CONCRETE n=0.012

ENTRANCE: C.5

CURRENT DATE: 03-09-2009
CURRENT TIME: 17:02:10

FILE DATE: 03-09-2009
FILE NAME: SITE3REV
50yr(DESIGN)

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULV NO.	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	63.70	63.00	60.00	1 RCB	6.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: SITE3REV DATE: 03-09-2009

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
67.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.12	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.17	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.26	54.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.30	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.48	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.33	108.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.72	126.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.10	144.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.24	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.83	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: SITE3REV DATE: 03-09-2009

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
67.00	0.000	0.00	0.00	0.00
67.12	0.000	18.00	0.00	0.00
67.17	0.000	36.00	0.00	0.00
67.26	0.000	54.00	0.00	0.00
67.30	0.000	72.00	0.00	0.00
67.48	0.000	90.00	0.00	0.00
67.33	0.000	108.00	0.00	0.00
67.72	0.000	126.00	0.00	0.00
68.10	0.000	144.00	0.00	0.00
68.24	0.000	151.00	0.00	0.00
68.83	0.000	180.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-09-2009
CURRENT TIME: 17:02:10

FILE DATE: 03-09-2009
FILE NAME: SITE3REV

PERFORMANCE CURVE FOR CULVERT 1 - 1(6.00 (ft) BY 5.00 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	67.00	0.00	3.30	0-NF	0.00	0.00	0.00	4.00	0.00	0.00
18.00	67.12	1.12	3.42	3-M1t	0.39	0.66	4.00	4.00	0.75	0.00
36.00	67.17	1.76	3.47	3-M1t	0.65	1.04	4.00	4.00	1.50	0.00
54.00	67.26	2.31	3.56	3-M1t	0.86	1.36	4.00	4.00	2.25	0.00
72.00	67.30	2.79	3.60	3-M1t	1.05	1.65	4.00	4.00	3.00	0.00
90.00	67.48	3.22	3.78	3-M1t	1.22	1.92	4.00	4.00	3.75	0.00
108.00	67.33	3.63	3.63	1-S2n	1.38	2.16	1.60	4.00	11.23	0.00
126.00	67.72	4.02	4.02	1-S2n	1.54	2.40	1.80	4.00	11.68	0.00
144.00	68.10	4.40	4.40	1-S2n	1.69	2.62	1.99	4.00	12.05	0.00
151.00	68.24	4.54	4.54	1-S2n	1.75	2.71	2.06	4.00	12.25	0.00
180.00	68.83	5.13	5.13	5-S2n	1.98	3.04	2.34	4.00	12.81	0.00

El. inlet face invert 63.70 ft El. outlet invert 63.00 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	63.70 ft
OUTLET STATION	60.00 ft
OUTLET ELEVATION	63.00 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0117
CULVERT LENGTH ALONG SLOPE	60.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	6.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-09-2009
CURRENT TIME: 17:02:10

FILE DATE: 03-09-2009
FILE NAME: SITE3REV

TAILWATER

CONSTANT WATER SURFACE ELEVATION
67.00 (PIPER BK 25yr TW ELEV.)

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	32.00 ft
CREST LENGTH	50.00 ft
OVERTOPPING CREST ELEVATION	76.75 ft

CURRENT DATE: 03-09-2009
CURRENT TIME: 17:14:03

FILE DATE: 03-09-2009
FILE NAME: SITE3REV

100yr(CHECK)

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULV NO.	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	63.70	63.00	60.00	1 RCB	6.00	5.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: SITE3REV DATE: 03-09-2009

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
68.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.31	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.34	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.38	54.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.45	72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.53	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.63	108.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.75	126.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.89	144.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.95	151.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
69.23	180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: SITE3REV DATE: 03-09-2009

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
68.30	0.000	0.00	0.00	0.00
68.31	0.000	18.00	0.00	0.00
68.34	0.000	36.00	0.00	0.00
68.38	0.000	54.00	0.00	0.00
68.45	0.000	72.00	0.00	0.00
68.53	0.000	90.00	0.00	0.00
68.63	0.000	108.00	0.00	0.00
68.75	0.000	126.00	0.00	0.00
68.89	0.000	144.00	0.00	0.00
68.95	0.000	151.00	0.00	0.00
69.23	0.000	180.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-09-2009 FILE DATE: 03-09-2009
CURRENT TIME: 17:14:03 FILE NAME: SITE3REV

PERFORMANCE CURVE FOR CULVERT 1 - 1(6.00 (ft) BY 5.00 (ft)) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	68.30	0.00	4.60	0-NF	0.00	0.00	0.00	5.30	0.00	0.00
18.00	68.31	1.12	4.61	1-S1f	0.39	0.66	5.00	5.30	0.60	0.00
36.00	68.34	1.76	4.64	1-S1f	0.65	1.04	5.00	5.30	1.20	0.00
54.00	68.38	2.31	4.68	1-S1f	0.86	1.36	5.00	5.30	1.80	0.00
72.00	68.45	2.79	4.75	1-S1f	1.05	1.65	5.00	5.30	2.40	0.00
90.00	68.53	3.22	4.83	1-S1f	1.22	1.92	5.00	5.30	3.00	0.00
108.00	68.63	3.63	4.93	1-S1f	1.38	2.16	5.00	5.30	3.60	0.00
126.00	68.75	4.02	5.05	4-FFt	1.54	2.40	5.00	5.30	4.20	0.00
144.00	68.89	4.40	5.19	4-FFt	1.69	2.62	5.00	5.30	4.80	0.00
151.00	68.95	4.54	5.25	4-FFt	1.75	2.71	5.00	5.30	5.03	0.00
180.00	69.23	5.13	5.53	4-FFt	1.98	3.04	5.00	5.30	6.00	0.00

El. inlet face invert 63.70 ft El. outlet invert 63.00 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	63.70 ft
OUTLET STATION	60.00 ft
OUTLET ELEVATION	63.00 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0117
CULVERT LENGTH ALONG SLOPE	60.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	6.00 ft
BARREL RISE	5.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 03-09-2009
CURRENT TIME: 17:14:03

FILE DATE: 03-09-2009
FILE NAME: SITE3REV

TAILWATER

CONSTANT WATER SURFACE ELEVATION
68.30 (PIPER BK 50yr TW ELEV.)

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	32.00 ft
CREST LENGTH	50.00 ft
OVERTOPPING CREST ELEVATION	76.75 ft

Appendix A – Outlet Protection Form

OUTLET PROTECTION

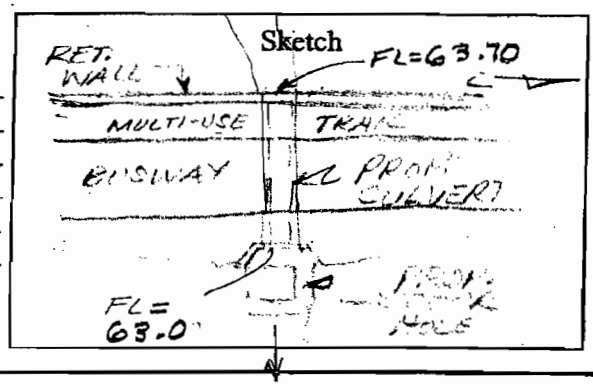
Project No.: 171-305 **Designed By:** DLP **Date:** 3-20-09
Town: NEWINGTON **Checked By:** RJF **Date:** 4/9/09
Route: RUSWAY **Station:** 174+80

1. Assess the erosion potential at the outlet and other critical site factors

Describe the conditions at the outlet location:
EXISTING WATERCOURSE AND WETLANDS AT PROPOSED CULVERT DISCHARGE.

☐ No well-defined channel
☒ Well-defined channel

Sketch



2. Determine the tailwater (TW) conditions at the outlet

TW depth: _____ TW elevation: _____
TW computational method: HDS-5 (dc+D)/2
Channel bed elevation: 63.0 Estimated velocity in channel: _____

3. Calculate and evaluate the outlet velocity for the design discharge

Design Discharge: 151cfs Design Frequency: 50YR STORM
Outlet Pipe Size: 6'W x 5'H Type: CONC. BOX
Length: 60' Slope: 0.0117 Outlet Invert Elevation: 63.0
Outlet Velocity at design discharge: _____ (50YR)
Velocity computational method: COMPUTER MODEL USING FHWA CULVERT ANALYSIS HY-8 PROGRAM

4. Select the type of outlet protection (SEE CALCS)

☐ Riprap Apron
(See Figures 11-13 & 11-14)

Type_____(A,B,C)

Riprap type: _____
Length (L_a): _____
Width (W_1): _____
Width (W_2): _____
Width-Type C (W_3): _____

☒ Preformed Scour Hole
(See Figure 11-15)

	Type 1	Type 2
d_{50}	0.42'	—
F	2.5'	—
C	33'	—
B	27'	—
S_p	6'	—

Proposed Type: TYPE 1
Riprap Type: INTERMEDIATE

CULVERT OUTLET PROTECTION

USE PREFORMED SCOUR HOLE TO MINIMIZE DISTURBANCE IN WATERCOURSE AND WETLAND AREAS.

USE TYPE I → F = 0.5 D_o

CULVERT SIZE : 6'W x 5'H CONC. BOX

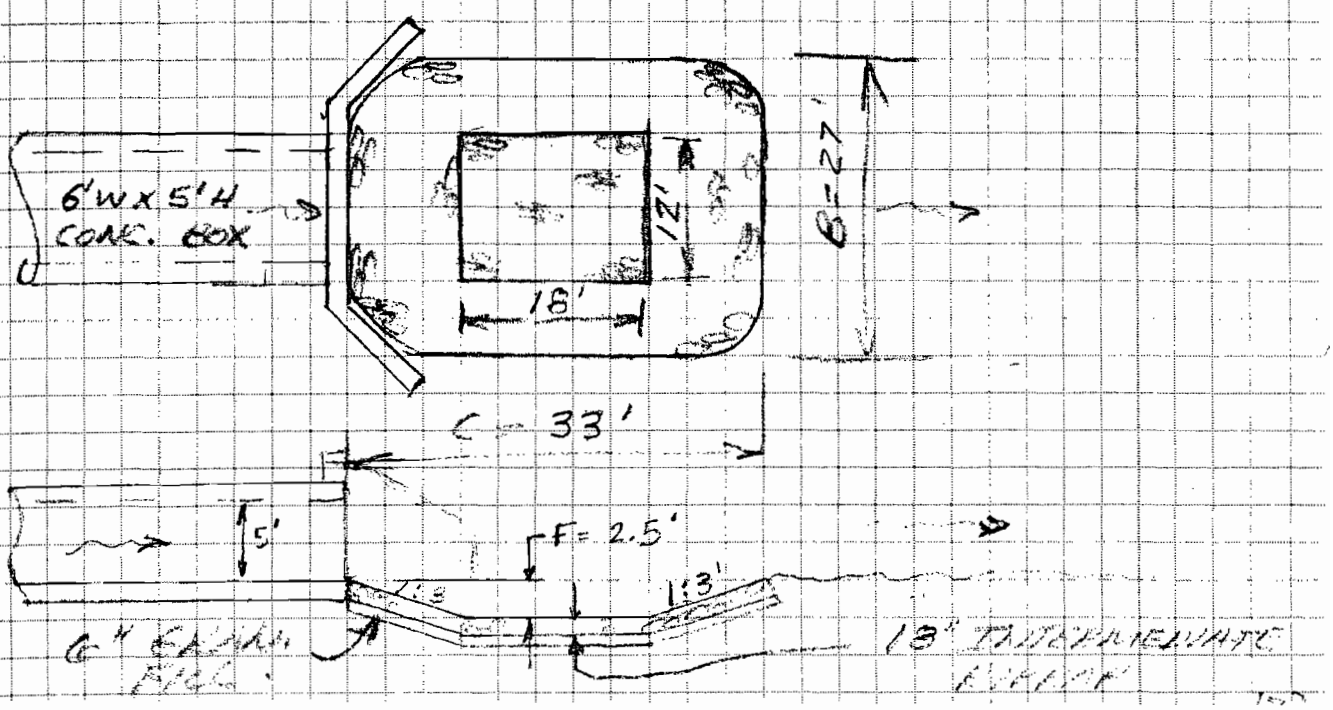
E = D_o = 6'
F = 0.5 (5.0') = 2.5'

A = B = $2D_o + 6F$ = 2(6') + 6(2.5') = 27.0'

C = $3D_o + 6F$ = 3(6') + 6(2.5') = 33.0'

BOTTOM DIMS

W = 2E = 2 (6') = 12'
L = 3E = 3 (6') = 18'



DETERMINE STONE SIZE:

FOR TYPE I HOLES: $Q_{50} = 151$ cfs TW = 2.62'
$R_p = 5'$

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

$$d_{50} = (0.0125(5')^2/2.62')(151/5^{2.5})^{1.333}$$

$d_{50} = 0.449' > 0.42'$ MOD. RIPRAP (NG)

USE INTERMEDIATE RIPRAP
$d_{50} = 0.67'$

⇒ USE 18" MIN. THICK INTERMEDIATE RIPRAP
W/ 6" GRANULAR FILL

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

PRELIMINARY HYDRAULIC SUMMARY

FOR

STATE PROJECT NO. 171-305

NEW BRITAIN TO HARTFORD BUSWAY
NEW BRITAIN, NEWINGTON, WEST HARTFORD, AND HARTFORD, CONNECTICUT

LOCATION: Un-Named Tributary of Piper Brook, Newington

SITE: 3

PREPARED BY

GARG CONSULTING SERVICES, INC.
ROCKY HILL, CT

FOR

BAKER ENGINEERING NY, INC.
ROCKY HILL, CT

MARCH 2003

REVISIONS		
	DATE	ENGINEER
☒	9/8/03	J. A. Scala
☒	12-15-03	
☒	7/30/04	

1 - EXECUTIVE SUMMARY

The purpose of this project is to provide an exclusive busway system from the City of New Britain to the City of Hartford. The exclusive roadway will be constructed along the existing railroad corridor for approximately 9.4 miles. The roadway will be comprised of two lanes with minimal shoulders. Within the project limits, the busway crosses a number of waterways within the upper Connecticut River Basin. The purpose of this hydraulic analysis was to determine if the existing structure is adequate to convey the design storm without adverse flooding.

Site 3 is associated with the crossing of an un-named tributary of Piper Brook in the Town of Newington. This area of approximately 0.315 sq. miles discharges into the tributary at coordinate 41.70052 deg, 72.75094 deg NAD83 datum, which is located approximately 2500 feet north northeast of the Route 175 crossing of the rail bed. This drainage area converges into an existing (3.0'W X 3.5'H) stone box culvert under the railroad bed.

The existing stone box culvert was determined to be hydraulically inadequate because the headwater depth exceeded 1.5D, thereby requiring replacement. In addition, the physical condition of the culvert is poor.

The replacement structure will be required. The replacement culvert must be designed to convey at least the 50-year storm.

BY DJP DATE 3/18/09 SUBJECT BUSWAY SHEET NO. ..... OF .....
CHKD. BY RJF DATE 4/9/09 PROJ. NO. 171-305 JOB NO. 8000

TEMPORARY DRAINAGE CULVERT DESIGN FOR INSTALLATION

USE CONNDOT DRAINAGE MANUAL APPENDIX F CRITERIA

RESULT OF RISK ANALYSIS REQUIRES 2 YR STORM BE USED FOR DESIGN (SEE WORKSHEETS)

Q_{2YR} = 63 cfs (FROM GARE ENG. HYDRAULIC REPORT)

USE CRITICAL DEPTH FOR TW

USE MILL LANE ROAD AS MAX. HW ELEV = 68.5 ±

TRY 48" RCP w/ L = 106' ± { INV. 64.10 INLET
INV. 64.00 OUTLET

FROM HY-8 PROGRAM

MAX. HW ELEV = 67.78' @ Q = 63 cfs

USE 106' ± LONG, 48" RCP AS TEMP. CULVERT DURING INSTALLATION

OUTLET PROTECTION FOR 48" RCP TEMPORARY CULVERT DESIGN

USE MIN. SIZE REQ'D TO MINIMIZE TEMPORARY WETLAND IMPACT DURING CONSTRUCTION.

TRY TYPE I PREFORMED SCOUR HOLE

FROM DRAINAGE MANUAL, PG. 8.7-11

FOR 48" Ø PIPE C = 24' B = 20' F = 2'

$A_{IMPACT} = 480\ FT^2$

TRY TYPE A APRON

FROM DRAINAGE MANUAL, PG. 8.7-7

FOR 48" Ø PIPE, Q = 63 cfs $L_a = 24' = Sp = 4'$

$W1 = 3Sp = 3(4') = 12'$

$W2 = 3Sp + 0.4(L_a) = 3(4') + 0.4(24') = 21.6'$ USE 22'

$A_{IMPACT} = [(12' + 22')/2][24'] = 408\ FT^2$

USE TYPE A APRON FOR OUTLET PROTECTION

RIPRAP SIZE = ? OUTLET VELOCITY = 9.3'/s

FROM TABLE 8.5, PG. 8.7-2

USE INTERMEDIATE RIPRAP

THICKNESS REQ'D = 18" MIN.
GRANULAR FILL = 6" MIN
OVERALL THICK = 24" (2')

Appendix F – Hydrology for Temporary Facilities

Step 1: Determine Impact Ratings

The following selection factors are rated considering their severity as 1, 2, or 3 for low, medium or high conditions.

Potential Loss of Life - If inhabited structures, permanent or temporary, can be inundated or are in the path of a flood wave caused by an embankment failure, then this item will have a multiple of 15 applied. If no possibility of the above exists, then loss of life will be the same as the severity used for the A.D.T.

Property Damages - Private and public structures (houses, commercial, or manufacturing); appurtenances such as sewage treatment and water supply; utility structures either above or below ground, are to have a multiple of 10 applied. Active cropland, parking lots, recreational areas are to have a multiple of 5 applied. All other areas shall use the severity determined by site conditions.

Traffic Interruption - Includes consideration for emergency supplies and rescue; delays; alternate routes; busses; etc. Short duration flooding of a low volume roadway might be acceptable. If the duration of flooding is long (more than a day), and there is a nearby good quality alternate route, then the flooding of a higher volume highway might also be acceptable. The severity of this component is determined by the detour length multiplied by the average daily traffic projected for bi-directional travel.

Detour Length - The length in kilometers (miles) of an emergency detour by other roads should the temporary facility fail.

Height Above Streambed - The difference in elevation in meters (feet) between the traveled roadway and the bed of the waterway.

Drainage Area - The total area contributing runoff to the temporary facility, in km^2 (mi^2).

Average Daily Traffic - The average amount of vehicles traveling bi-directional through the area in a 24-h period.

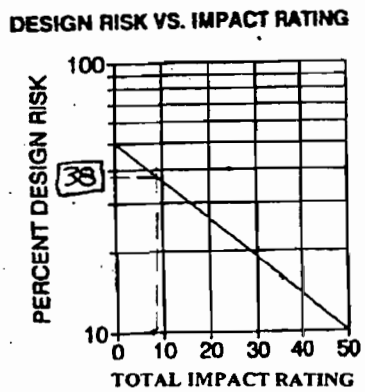
RATING SELECTION

Factor	Rating		
	1	2	3
Loss of Life	See Instructions		
Property Damage	See Instructions		
Traffic Interruptions	< 2000	2000-4000	> 4000
Detour Length, km (mi)	< 8 (< 5)	8-16 (5-10)	> 16 (> 10)
Height Above Streambed, m (ft)	< 3 (< 10)	3-6 (10-20)	> 6 (> 20)
Drainage Area, km^2 (mi^2)	< 2.6 (< 1)	2.6-26.0 (1-10)	> 26.0 (> 10)
Rural ADT	< 400	400-1500	> 1500
Suburban ADT	< 750	750-1500	> 1500
Urban ADT	< 1500	1500-3000	> 3000

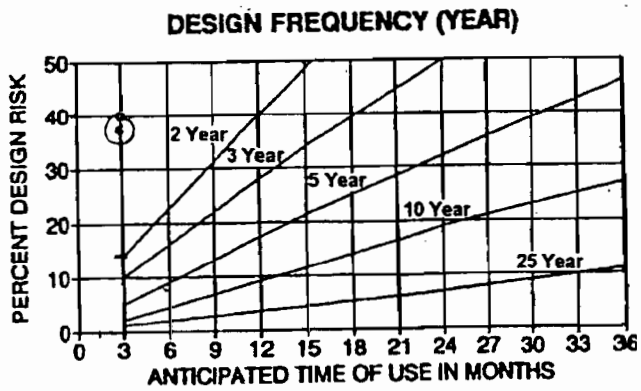
IMPACT RATING TABLE

Loss of Life Rating (See Instructions)=	1
Property Damage Rating (See Instructions) =	1
Traffic Interruption Rating =	1
Detour Length Rating =	1
Height Above Streambed Rating =	2
Drainage Area Rating =	1
Average Daily Traffic Rating =	1
Total Impact Rating = (sum of the above) =	8

Step 2: Determine risk percentage



Step 3: Determine Temporary Design Frequency



(for temporary facility)

Percent Design Risk = 38

Design Frequency = 2 **years**

Step 4: Determine Temporary Design Discharge

A. If sufficient discharges have been developed either by the designer or a Flood Insurance Study, then the Temporary Design Discharge should be taken either directly or from a frequency curve plot of the data, based on the design frequency determined in Step 3. Enter the Temporary Design Discharge below. *If Discharge – Frequency information is unavailable, proceed to Step 4 B.*

Temporary Design Discharge = _____ **m^3/s (** 63± **cfs)** *

* FROM HYDRAULIC REPORT DATED MARCH 2003 FOR SITE 3 (GARG CONSULTING SERVICES)

CURRENT DATE: 05-10-2010
CURRENT TIME: 15:35:22

FILE DATE: 05-10-2010
FILE NAME: TMPSITE3

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
NO.								
1	64.10	64.00	106.00	1 RCP	4.00	4.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: TMPSITE3 DATE: 05-10-2010

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
65.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
65.66	9.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
66.03	19.6	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
66.48	29.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
66.89	39.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.27	49.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.63	58.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
67.78	63.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.33	78.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
68.65	88.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
69.05	98.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: TMPSITE3 DATE: 05-10-2010

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
65.50	0.000	0.00	0.00	0.00
65.66	0.000	9.80	0.00	0.00
66.03	0.000	19.60	0.00	0.00
66.48	0.000	29.40	0.00	0.00
66.89	0.000	39.20	0.00	0.00
67.27	0.000	49.00	0.00	0.00
67.63	0.000	58.80	0.00	0.00
67.78	0.000	63.00	0.00	0.00
68.33	0.000	78.40	0.00	0.00
68.65	0.000	88.20	0.00	0.00
69.05	0.000	98.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT TIME: 15:35:22 FILE NAME: TMPSITE3

PERFORMANCE CURVE FOR CULVERT 1 - 1(4.00 (ft) BY 4.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	65.50	0.00	1.40	0-NF	0.00	0.00	0.00	1.50	0.00	0.00
9.80	65.66	1.16	1.56	3-M1t	1.24	0.90	1.50	1.50	2.27	0.00
19.60	66.03	1.76	1.93	3-M2t	1.80	1.29	1.50	1.50	4.54	0.00
29.40	66.48	2.24	2.38	2-M2c	2.30	1.61	1.61	1.50	6.23	0.00
39.20	66.89	2.65	2.79	2-M2c	2.80	1.86	1.86	1.50	6.85	0.00
49.00	67.27	3.01	3.17	2-M2c	3.52	2.09	2.09	1.50	7.37	0.00
58.80	67.63	3.35	3.53	2-M2c	4.00	2.30	2.30	1.50	7.85	0.00
→ 63.00	67.78	3.48	3.68	2-M2c	4.00	2.39	2.39	1.50	8.03	0.00
78.40	68.33	3.99	4.23	2-M2c	4.00	2.67	2.67	1.50	8.79	0.00
88.20	68.65	4.33	4.55	2-M2c	4.00	2.84	2.84	1.50	9.23	0.00
98.00	69.05	4.69	4.95	2-M2c	4.00	2.99	2.99	1.50	9.76	0.00

El. inlet face invert 64.10 ft El. outlet invert 64.00 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **********

INLET STATION	0.00 ft
INLET ELEVATION	64.10 ft
OUTLET STATION	106.00 ft
OUTLET ELEVATION	64.00 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0009
CULVERT LENGTH ALONG SLOPE	106.00 ft

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	4.00 ft
BARREL MATERIAL	CONCRETE
BARREL MANNING'S n	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	GROOVED END PROJECTION
INLET DEPRESSION	NONE

3

CURRENT DATE: 05-10-2010 FILE DATE: 05-10-2010
CURRENT TIME: 15:35:22 FILE NAME: TMPSITE3

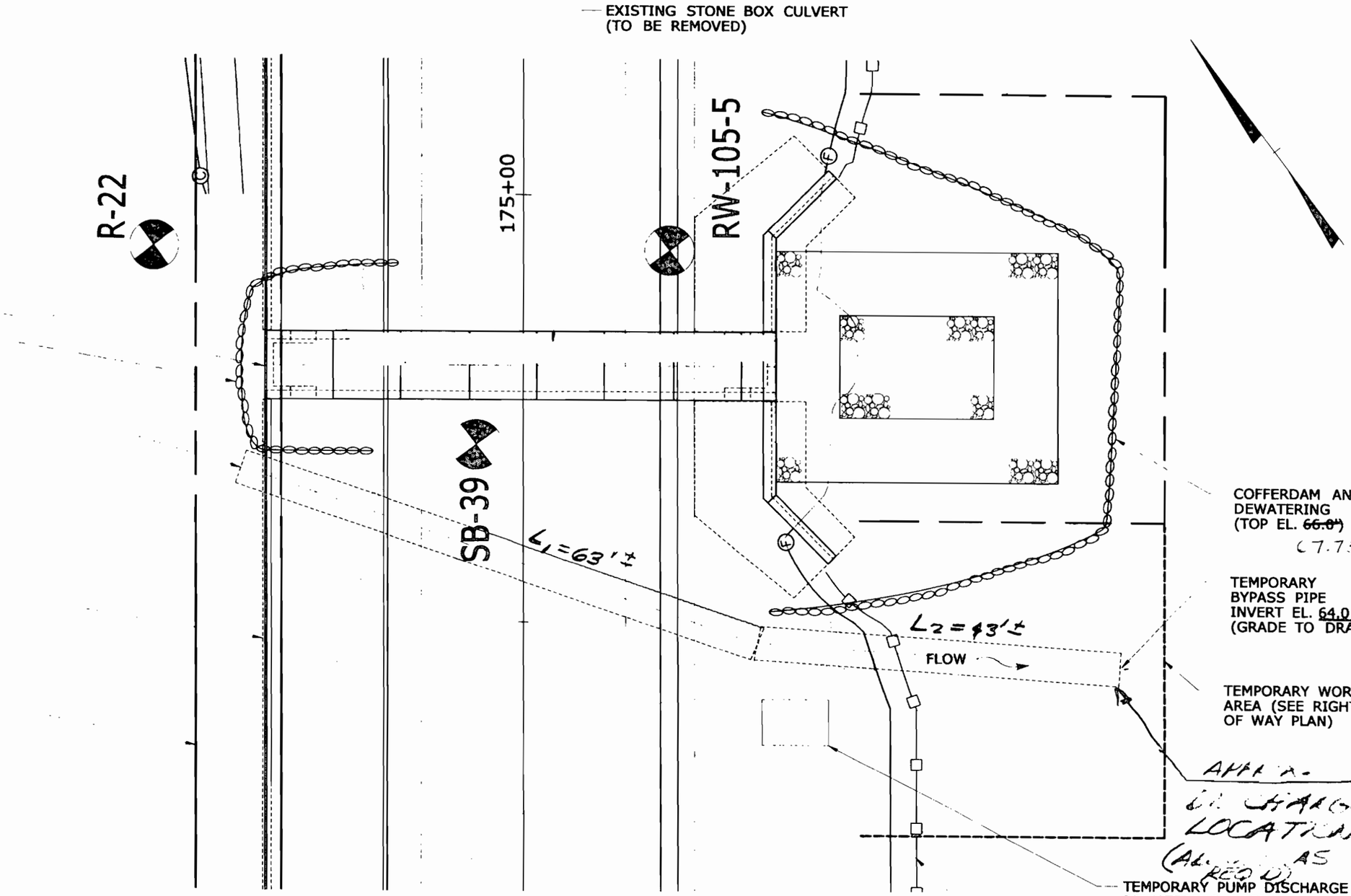
TAILWATER

CONSTANT WATER SURFACE ELEVATION
65.50

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE GRAVEL

EMBANKMENT TOP WIDTH	23.00 ft
CREST LENGTH	50.00 ft
OVERTOPPING CREST ELEVATION	75.40 ft



PROPOSED BOX CULVERT

COFFERDAM AND DEWATERING (TOP EL. ~~66.0'~~) 67.7±

TEMPORARY 48" BYPASS PIPE
INVERT EL. ~~64.0'+/-~~ 64.1
(MATCH EXISTING GROUND)

RETAINING WALL
(SEE RETAINING WALL PLANS)

EASEMENT LINE
(SEE RIGHT OF WAY PLAN)

PLAN

APPROX. DISCHARGE LOCATION (ALTERNATE)

TEMPORARY CULVERT

N.T.S.

3 - HYDROLOGY

Site 3 is associated with the crossing of an un-named tributary of Piper Brook in the Town of Newington. This area discharges into the tributary at coordinate 41.70052 deg, 72.75094 deg NAD83 datum, which is located approximately 2500 feet north northeast of the Route 175 crossing of the rail bed. This drainage area converges into an existing (3.0'W X 3.5'H) stone box culvert under the railroad bed.

The watershed area for this site is delineated and measured from U.S.G.S. quadrangle sheets New Britain and Hartford South. The drainage area has been verified using 200-scale mapping provided by MDC of Hartford. In addition, the delineation was field reviewed.

The associated drainage area of 0.315 (201.6± Ac) square miles is well developed with residential, commercial and individual properties. The Rational Method is appropriate for use at this site. This watershed is partially developed with approximately 15 percent of the land area urbanized.

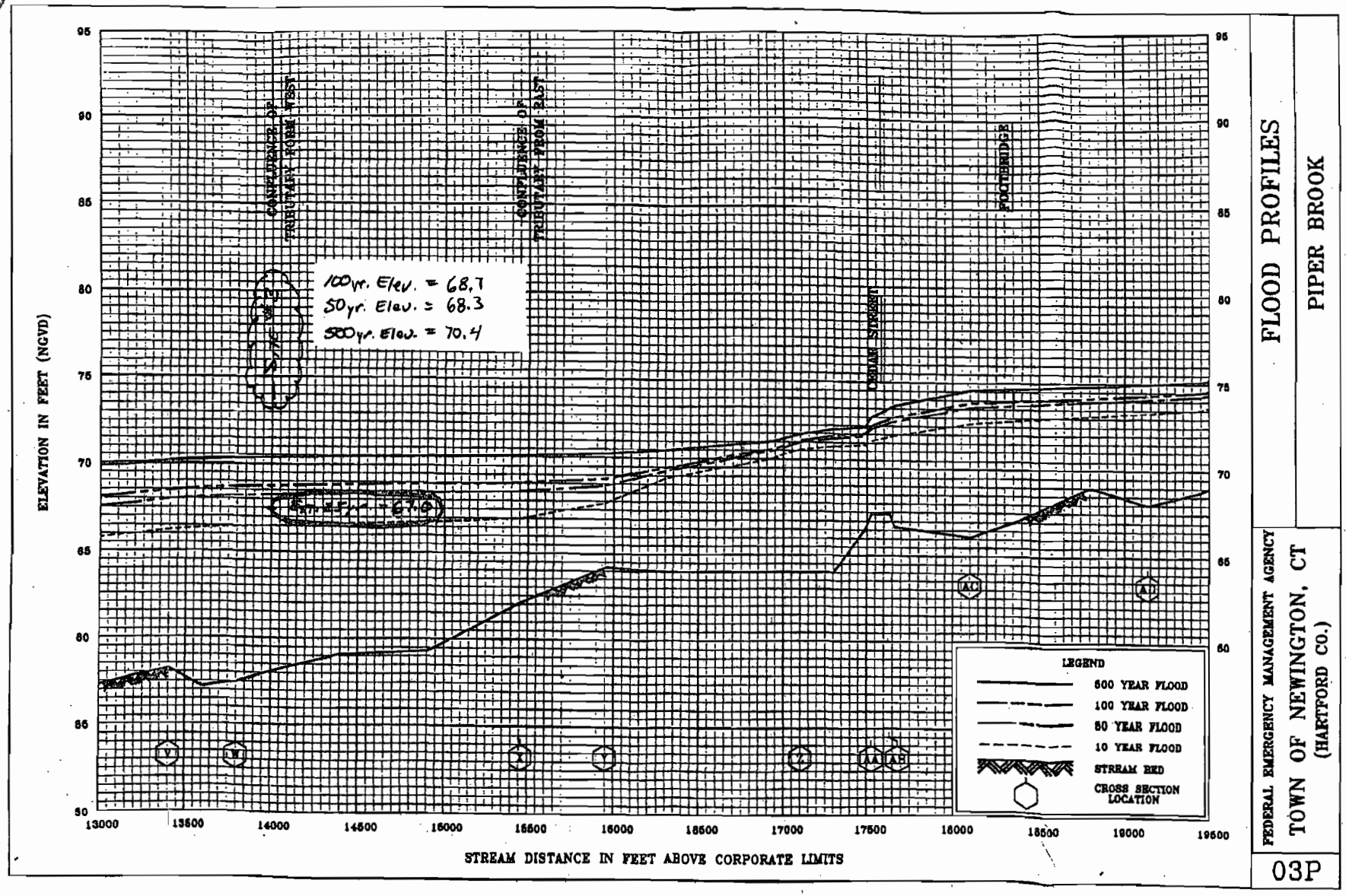
The recommended design flow rate should be based on the 50-year event with a calculated flow rate of 151 cfs.

Q_{DESIGN} & CHECK

METHODOLOGY	2-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Rational Method	63	98	126	151	180	
TR-55 Method	79	171	229	323	347	
USGS Regression w/ Urban Adjustments	32	65	95	123	137	

6 - FISHERIES CONCERNS

The Department of Environmental Protection Fisheries Division has field reviewed this site on July 24, 2003. Mr. Donald Mysling has indicated that fisheries passage is not a concern.



FLOOD PROFILES

PIPER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
TOWN OF NEWINGTON, CT
(HARTFORD CO.)

03P

FROM "SITE 3 HYDRAULIC REPORT"

CULVERT DESIGN – SITE 4A

- LOCATION: STA. 1940
- EXISTING CULVERT: 42" X 15" CMP
- HYDROLOGY: RATIONAL METHOD

  DRAINAGE AREA = 5.12 Ac – Fenn Mfg 2.52
  (2.6 Ac)
  Tc = 12 MINS C = 0.54
  (SEE CALCS)

- RECOMMENDED PEAK DISCHARGES FOR NEW CULVERT:

  Q50 = 12.2 CFS (DESIGN)
  Q100 = 13.3 CFS (CHECK)

- ESTIMATED DRAINAGE AREA: 5.12 ± Ac
- DESIGN SOFTWARE USED: HY-8 VERS. 6.1, FHWA CULVERT ANALYSIS

Close, Jensen and Miller, P.C.

BY RJF DATE 11/11/08 SUBJECT Busway SHEET NO. 201 OF .....
CHKD. BY DJP DATE 4/8/09 Culvert Design JOB NO. 8000
Site 4A

From Swale S17

Area = .415 Acres Cavg = 0.45 Tc = 10.0 min

From Swale S17A

Area = 0.539 Acres Cavg = 0.49 Tc = 10 min

Combination S17 & S17A Entering Culvert at Site 4A

Area = 0.415 + 0.539 = 0.954 Acres

$$C_{avg} = \frac{0.415(0.45) + 0.539(0.49)}{0.954} = 0.47$$

USE Tc 10.0 min $I_{50} = 6.0$ in/hr $I_{100} = 6.5$ in/hr

$Q_{50yr} = 0.47(6.0)(0.954) = \underline{2.69 CFS}$

Tail water elev 50yr @ pipe break 67.4

$Q_{100yr} = 0.47(6.5)(0.954) = 2.91$ CFS

SWALE (S17) (STA. 195+0 TO STA. 196+50±T)

TOTAL A = 0.415± Ac

PAVEMENT	A = 0.057 Ac	C = 0.9
GRAVEL	A = 0.073 Ac	C = 0.7
GRASS	A = 0.285 Ac	C = 0.3

Tc = 10 mins R_2 = 3.6"/hr R_{10} = 4.8"/hr

$$\Sigma C = \frac{0.057(0.9) + (0.073)(0.7) + (0.285)(0.3)}{0.415\ Ac} = 0.453$$

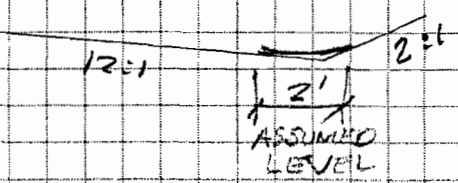
ΣC = 0.453

Q_2 = 0.415 (0.453)(3.6"/hr) = 0.68 c.f.s

Q_{10} = " " (4.8"/hr) = 0.90 c.f.s

TRY GRASS LINED SWALE

S_{AVG} = 1.0%



SWALE S-17A (STA. 196+50± TO STA. 199+60± LT)

TOTAL A = 0.539 Ac

PAVEMENT A = 0.075 Ac C = 0.9
GRAVEL A = 0.144 Ac C = 0.7
GRASS A = 0.320 Ac C = 0.3

T_c = 10 MINS R_2 = 3.6"/hr R_{10} = 4.8"/hr

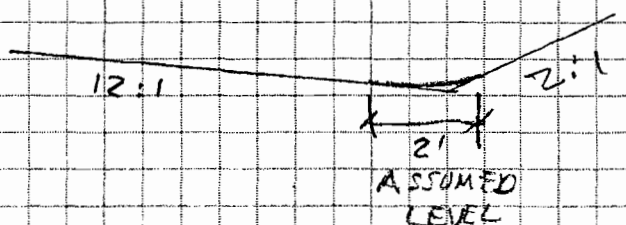
$$\Sigma C = \frac{0.075(0.9) + (0.144)(0.7) + (0.320)(0.3)}{0.539 Ac} = 0.490$$

ΣC = 0.490

Q_2 = 0.539(0.490)(3.6"/hr) = 0.95 cfs

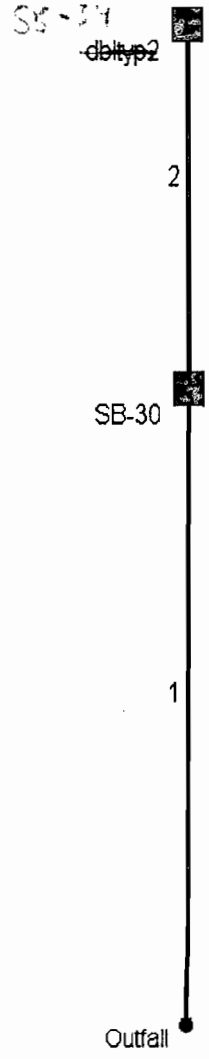
Q_{10} = " " (4.8"/hr) = 1.27 cfs

TRY GRASS LINED CHANNEL



S_{AVG} = 0.5%

Hydraflow Plan View



Project File: BUSWAY SITE 4A.stm	No. Lines: 2	09-01-2009

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.
1	SB-30	3.50	15 c	42.0	67.80	68.06	0.619	68.55	68.84	n/a	69.24 i	End
2	~~dbltyp2~~ SB-31	2.71	15 c	24.0	68.06	68.20	0.583	69.24	69.27	0.09	69.36	1

Project File: BUSWAY SITE 4A.stm | Number of lines: 2 | Run Date: 09-01-2009

NOTES: c = cir; e = ellip; b = box; Return period = 50 Yrs. ; i - Inlet control.

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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	42.0	0.15	1.10	0.90	0.14	0.58	5.0	10.2	6.0	3.50	5.08	4.47	15	0.62	68.06	67.80	68.84	68.55	74.43	67.80	SB-30
2	1	24.0	0.95	0.95	0.47	0.45	0.45	10.0	10.0	6.1	2.71	4.93	2.34	15	0.58	68.20	68.06	69.27	69.24	71.50	74.43	dbltyp2

Project File: BUSWAY SITE 4A.stm | Number of lines: 2 | Run Date: 09-01-2009

NOTES: Intensity = 98.16 / (Inlet time + 15.70) ^ 0.86; Return period = 50 Yrs.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (In)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	SB-30	0.99	0.00	0.98	0.01	Grate	0.0	0.00	0.00	3.15	1.64	0.005	4.00	0.040	0.020	0.013	0.20	5.80	0.23	3.75	2.00	Off
2	dbltyp2	2.71	0.00	2.71	0.00	Grate	0.0	0.00	4.99	3.70	1.09	Sag	4.00	0.020	0.020	0.000	0.29	14.32	0.29	14.32	0.00	Off

With Clogging Factor of 1.25

Project File: BUSWAY SITE 4A.stm | Number of lines: 2 | Run Date: 09-01-2009

NOTES: Inlet N-Values = 0.016 ; Intensity = 98.16 / (Inlet time + 15.70) ^ 0.86; Return period = 50 Yrs. ; * Indicates Known Q added

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	15	3.50	67.80	68.55	0.75	0.77	4.56	0.32	68.87	n/a	42.0	68.06	68.84	0.78	0.80	4.37	0.30	69.13i	n/a	n/a	-0.036	0.50	n/a
2	15	2.71	68.06	69.24	1.18	1.20	2.25	0.08	69.32	0.152	24.0	68.20	69.27	1.07	1.12	2.42	0.09	69.36	0.164	0.158	0.038	1.00	0.09

Project File: BUSWAY SITE 4A.stm | Number of lines: 2 | Run Date: 09-01-2009

CULVERT OUTLET PROTECTION:

USE TYPE I - SCOUR HOLE

$F = 0.5 R_p$

CULVERT SIZE: 15" RCP

$C = D_o = 15" (1.25')$

$F = 0.5 (1.25') = 0.625$ $F = 0.625'$

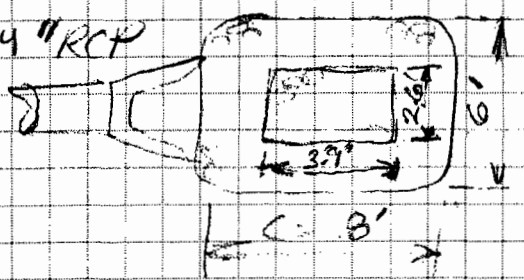
$A = B = 2(1.25) + 6(0.625) = 6.25'$ USE 6'

$C = 2(1.25) + 6(0.625) = 7.5'$ USE 8'

BOTTOM DIMS:

$W = 2L = 2 (1.26') = 2.5'$ USE 2.6'

$L = 3L = 3 (1.25') = 3.75'$ USE 3.9'



ULTIMATE RIPRAP SIZE:

TYPE I

$d_{50} = (0.02 S_o^{0.21} / (W/D)^{0.53}) D_o$ $K_1 = 1.25$

$d_{50} = (0.02 (1.25)^{0.21} / 0.51^{0.53}) (1.25)$ $W = 0.51'$

$d_{50} = 0.07'$ < [illegible]

⇒ USE 12" MODIFIED [illegible]

SECTION IV

WATER QUALITY BASIN DESIGN

WATER QUALITY BASIN 1

The water quality basin will service flow from four areas

1. East St Station 1.89 Acres (1.01 Acres Impervious)
2. Future CCSH Roadway 1.29 Acres all Impervious
3. Contract HO-35 Drainage System connecting Contract HO-34 Drainage System 1. Flow from this area consists of 0.67 Acres from the Busway (Impervious) and 1.68 Acres from an existing Condo complex which will not be treated and is considered Impervious.
4. Contract HO-34 Busway drainage entering System 1 0.89 Acres (Impervious)

The total area serviced by the water quality basin is 6.42 Acres of which 3.86 Acres is Impervious

$$I = \%\ \text{Impervious} = \frac{3.86}{6.42}\ (100) = 60\%$$

Close, Jensen and Miller, P.C.

BY RJF DATE 10/13/09 SUBJECT Busway SHEET NO. OF

CHKD. BY DATE Water Quality Volume JOB NO.

Water Quality Volume (WQV)

$$WQV = \frac{1'' RA}{12}$$

$R = 0.05 + 0.009(I) = 0.05 + 0.009(40) = 0.59$

A = Total Area = 6.42 Acres

$$WQV = \frac{1''(0.59)(6.42)}{12} = 0.316 \text{ Acft}$$

$0.316 \text{ Acft} \left(43560 \text{ ft}^2/\text{Ac}\right) = 13750 \text{ ft}^3$

REQUIRED WQV: 13750 ft³

SEE APPENDIX E WATER QUALITY BASIN 1

GRADING DETAIL

- Provided Storage is 14,201 ft³ > Required 13,750 ft³
- 100 year flood elevation is 86.81
- Construction of the basin will require a net fill of 12 cubic yards

SECTION V

EXISTING AND PROPOSED RUNOFF COMPARISONS

The following table is a comparison of existing and proposed discharges for the drainage systems of the project. Flows are based on a 2-year, 10-year storm and 100-year event and measured at the outlet.

Discharge Summary Table

System	2-Year		10-Year		100-Year	
	Existing Discharge CFS	Proposed Discharge CFS	Existing Discharge CFS	Proposed Discharge CFS	Existing Discharge CFS	Proposed Discharge CFS
1	16.7	18.6	22.8	25.4	30.9	34.3
2	9.7	10.4	13.6	14.6	20.7	22.2
3	0.7	2.1	0.9	2.7	1.2	3.6
4	7.5	7.5	10.2	10.2	14.0	14.0
5	0.4	1.2	0.6	1.6	0.8	2.1
6	0.4	1.2	0.5	1.5	0.7	2.0
7	*	*	*	*	*	*
8	2.6	2.6	3.4	3.4	4.6	4.6
9	0.9	2.3	1.2	3.1	1.6	4.0
10	0.6	1.4	0.8	1.9	1.0	2.4
11	6.0	6.0	8.5	8.5	12.7	12.7
12	0.6	1.4	0.7	1.8	1.0	2.4
13	10.2	10.2	13.2	13.2	17.3	17.3
14	2.5	3.1	3.2	4.0	4.3	5.2

*This system watershed will not be developed therefore no change in runoff.

The following tables are a comparison of existing and proposed watershed area runoff coefficient. The purpose is to compare how the development will change the runoff flow of stormwater. The areas for existing and proposed will not change, and the time of concentration will also remain the same for each condition.

- See Section I - Storm Sewer Tabulation for time of concentration.
- See Appendix B for Existing Watershed Map.
- See Appendix C for Proposed Water Shed Map

System 1	Tc = 11.7 min.	I_2 = 3.3 in./hr.	I_{10} = 4.5 in./hr.	I_{100} = 6.1 in./hr.	
		Existing		**Proposed**	
Basin ID	Area (Ac)	C	Ac	C	Ac
SB-1 URS	0.08	0.9	0.072	0.9	0.072
East St. Sta.	1.51	0.75	1.133	0.75	1.133
SB F-1	0.29	0.37	0.107	0.9	0.261
SB F-2	0.11	0.38	0.042	0.9	0.099
CCSU-1	1.29	0.9	1.161	0.9	1.161
SB-3	0.14	0.39	0.055	0.9	0.126
NB-1	0.35	0.31	0.109	0.9	0.315
NB-2	0.11	0.30	0.033	0.9	0.099
		Total	5.067		5.622

System 2	Tc = 49.3 min.	I_2 = 1.5 in./hr.		I_{10} = 2.1 in./hr	I_{100} = 3.2 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
SB-8	0.57	0.35	0.200	0.9	0.513
SB-9	0.25	0.36	0.090	0.9	0.225
SB OFF-2	9.78	0.42	4.108	0.42	4.108
NB OFF-1	0.65	0.37	0.241	0.37	0.241
		Total	6.478		6.927

System 3	Tc = 5 min.	I_2 = 4.6 in./hr.		I_{10} = 5.9 in./hr	I_{100} = 7.8 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
SB-12	0.51	0.31	0.158	0.9	0.46
		Total	0.158		0.46

System 4	Tc = 11.4 min.	I_2 = 3.4 in./hr.		I_{10} = 4.6 in./hr	I_{100} = 6.3 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
SB OFF-4	1.13	0.56	0.63	0.56	0.63
SB OFF-5	1.76	0.9	1.58	0.9	1.58
		Total	2.22		2.22

System 5	Tc = 10.2 min.	I_2 = 3.6 in./hr.		I_{10} = 4.8 in./hr		I_{100} = 6.5 in./hr.
		Existing		Proposed		
Basin ID	Area (Ac)	C	Ac	C	Ac	
SB-15	0.16	0.31	0.050	0.9	0.14	
SB-16	0.21	0.32	0.067	0.9	0.19	
		Total	0.117		0.33	

System 6	Tc = 5.2 min.	I_2 = 4.6 in./hr.		I_{10} = 5.9 in./hr		I_{100} = 7.8 in./hr.
		Existing		Proposed		
Basin ID	Area (Ac)	C	Ac	C	Ac	
SB-18	0.28	0.3	0.084	0.9	0.25	
NB-5	0	0	0	0	0	
		Total	0.084		0.25	

System 8	Tc = 10 min.	I_2 = 3.6 in./hr.		I_{10} = 4.8 in./hr		I_{100} = 6.5 in./hr.
		Existing		Proposed		
Basin ID	Area (Ac)	C	Ac	C	Ac	
SB OFF-7	2.16	0.33	0.71	0.33	0.71	
		Total	0.71		0.71	

System 9	Tc = 5.1 min.	I_2 = 4.6 in./ hr.		I_{10} = 6 in./hr		I_{100} = 7.8 in./hr.
		Existing		Proposed		
Basin ID	Area (Ac)	C	Ac	C	Ac	
SB-22	0.57	0.35	0.2	0.9	0.51	
		Total	0.2		0.51	

System 10	Tc = 5.8 min.	I_2 = 4.4 in./hr.		I_{10} = 5.8 in./hr	I_{100} = 7.5 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
SB-25	0.36	0.37	0.133	0.9	0.32
		Total	0.133		0.32

System 11	Tc = 32 min.	I_2 = 1.9 in./hr.		I_{10} = 2.7 in./hr	I_{100} = 4.0 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
Inlet	5.28	0.6	3.17	0.6	3.17
		Total	3.17		3.17

System 12	Tc = 5.2 min.	I_2 = 4.6 in./hr.		I_{10} = 5.9 in./hr.	I_{100} = 7.8 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
SB-27	0.33	0.37	1.122	0.9	0.3
NB-8	0.01	0.37	0.004	0.9	0.01
		Total	0.126		0.31

System 13	Tc = 5.4 min.	I_2 = 4.6 in./hr.		I_{10} = 5.9 in./hr	I_{100} = 7.8 in./hr.
		Existing		Proposed	
Basin ID	Area (Ac)	C	Ac	C	Ac
FM-1	0.77	0.83	0.64	0.83	0.64
FM-2	1.57	0.9	1.58	0.9	1.58
		Total	2.22		2.22

System 14	Tc = 5.2 min.	I_2 = 4.6 in./hr.		I_{10} = 5.9 in./hr	I_{100} = 7.8 in./hr.
		Existing		**Proposed**	
Basin ID	Area (Ac)	C	AC	C	AC
SB-32	0.95	0.48	0.46	0.48	0.46
SB-31	0.22	0.57	0.08	0.9	0.20
NB-9	0.01	0.4	0.004	0.9	0.01
		Total	0.55		0.67

APPENDIX A-1

RESPONSES TO DRAINAGE AND FORMAL FIELD REVIEW COMMENTS

Unit	Date
1 Environmental Planning	December 11, 2008
2. Highway Operations	December 18, 2008
3. Environmental Planning	January 6, 2009
4. Hydraulics and Drainage	January 29, 2009

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

COM-09A REV. 2/91 Printer on Recycled or Reclaimed Paper

subject: **Subject Drainage Design**
Project 88-H034
Hartford-New Britain
Busway - Newington

date: December 11, 2008

to
Brian Cunningham
Supervising Transportation Engineer
Bureau of Engineering & Highway Operations

from
Mark Alexander
Supervising Transportation Planner
Environmental Planning
Bureau of Policy and Planning

ext.

☐ Schematic Design ☐ Preliminary Design ☐ Semi-Final Design ☐ Final Design ☒ Other Drainage design review

My staff has reviewed the Drainage Design submission for the above mentioned project and offers the following comments:

Comment #	Loc. or Sheet #	Comment	Inc.	Not Inc. (if not, WHY)
1	General - stormwater	- Details for the grassed lined swales are required and should be in conformance with the 2004 Stormwater Quality Manual to the extent possible. - This office recommends not labeling / depicting the future work proposed by CCSU.	✓	
2	Sheet 1	- In the vicinity of Station 119+90 (Left) there is a note indicating "assumed future drainage connection". Please clarify – Is this the expected drainage from the Station? If it is simply local drainage, it should not be brought into the busway drainage system. - The outfall at Station 123+20 (Right) appears to warrant additional stormwater treatment. Please investigate options.	✓ from Station ✓	
3	Sheet 4	A catch basin at Station 158+28 (Left) appears to possibly be located within the cross culvert for a stream. Drainage should not be directly tied into the cross culvert and should be outleted along side the culvert, not within it.	✓	

If you have any questions regarding these comments please contact Kim Lesay, Transportation Planner 2 of my staff at 594-2933.

Kimberly Lesay/kl(w)
cc: Cynthia Holden - Mark Alexander
Paul Corrente - Andrew Piraneo
Dennis Guyette

FROM THE DESK OF
RICHARD B. ARMSTRONG

NAME.	F.Y.I.	PLS. DO	PLS. SEE ME
DEC 11 2008			
B.T. CUNNINGHAM			
B.J. NATWICK			
A.A. FESENMEYER			
L.I. LaROCCA			

1-1-1

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
Office of Construction

MEMORANDUM

REVIEW COMMENTS
Project No: 88-H034 (171-305)
Town: Newington Section
Project Description: New Britain-Hartford Busway

Date: December 18, 2008

TO: Richard B. Armstrong
Transportation Principal Engineer
Bureau of Engineering and
Highway Operations

FROM: Principal Engineer
Office of Construction
Bureau of Engineering and
Highway Operations

- ☐ Preliminary Studies
- ☐ Preliminary Design
- ☐ Structure Type Study
- ☐ Drainage
- ☐ Other Field Review
- ☒ Semifinal (60% – 70%)
- ☐ Structural Layout for Design
- ☐ Final Plan for Review (85% - 90%)
- ☐ Final Design (100%)
- ☐ Other – M & P of Traffic

Comment	Comment Inc.	Comment Not Inc.
The Constructibility Review Unit has reviewed the drainage submission including plans and drainage report for the above noted project and we have the following comments:		
GENERAL		
1. The submission did not include PD comments as noted in the memo.	✓	
2. The memo did not state what percent submission was being sent; we assumed it to be the 60% (Semifinal) submission.	✓ drainage & Formula Field	
3. Miscellaneous Detail Sheets were not included in this submission therefore we assume the Special Type 'C' Catch Basins are being installed because of the Retaining Wall.	✓ correct	
4. In several locations catch basins should be reviewed whether they need to be oversized to accommodate 30" and 36" pipes.	✓	✓
5. More details are needed for the Retaining Walls, Grass Lined Swales, Scour Holes, Modified Riprap Aprons, 72" X 60" Box Culvert, Concrete Wingwalls and the extension of the Existing Culvert at Site 3 (if the call out is correct – See later comment).	✓ will be provided at 60% design submission	
DRAINAGE REPORT *		
1. In the Structure Summary (and on the plans) there is no structure labeled SB-5 – is this correct or will it be added later?	✓ Structure No's have been updated	
2. Why are the culvert at Site 3 and the 72" X 60" Box Culvert at Station 174+55± not listed in either the Structure Summary or Outlet Summary?	✓ corrected in revised report	✓
3. The Swale Summary had various stations listed incorrectly compared to the swales shown on the plans. For example, SW5 appears to begin at Station 133+50 not 134+50; SW11 appears to begin at 162+50 not 163+50	✓ corrected in revised report	✓

FROM THE DESK OF
RICHARD B. ARMSTRONG
P.E. | PLS | PLS SEE ML
DEC 22 2008

* Drainage Report will be resubmitted at a later date

B.T. CUNNINGHAM
R.J. HATWOOD
A.A. RESEMEYER
T.T. LaROCCA

Project No.

4. The Swale Summary also appears to have several outlet elevations incorrect as compared to the plans. For example, SW2 outlet elevation (85.00) should be close to the Top of Frame elevation of the Type 'C-L' Catch Basin (SB OFF-2) which is at elevation 82.78. Please review the outlet elevations given for Swales SW4, SW5, SW6, SW10, SW11, SW16, SW17 and SW18.
5. Also, some of the slopes listed for the swales in the Swale Summary appear to be incorrect in that the computation of the outlet elevation comes out different than listed. Please review.
6. The Outlet Summary has some incorrect entries. For example, SB-30 Pipe Size should be 36" not 24"; the Invert at SB-17 should be 72.81; and the Invert at SB-25 should be 70.50. (These differences do not appear to affect the Apron Types listed in the Summary.)

✓ Drainage has been updated and corrected ✓

✓ these have been reviewed & corrected ✓

PLANS

1. Sheet DRG-01: There seems to be some unlabeled drainage proposed for the cul de sac on Lester Street. Please review.
2. Sheet DRG-01: Should the Swale SW-1 outlet be shown ending at the Type 'C-L' Catch Basin, NB-1 at Station 122+24.94 Rt.? Please review.
3. Sheet DRG-02: It appears that the 24" RCCE at Station 130+30± Lt. is an inlet with 24" piping to proposed manhole MH-1, as there is no flow direction arrow. The existing drainage is unclear and the inlet flow line elevation is the only pipe listed for the manhole.
4. Sheet DRG-03: Swale SW-7 should be shown heading to the Type 'C-L' Catch Basin NB OFF-2 since the Swale Summary lists the Outlet Elevation the same as the Top of Frame elevation for that catch basin.
5. Sheet DRG-04: The 36" RCCE at Station 158+28± Lt. does not show up well. Please draw in the trapezoid shape at the proper location and add a flow direction arrow for the 36" RCP.
6. Sheet DRG-04: At Station 158+28 there is no need to call out removal of the existing culvert since the proposed culvert is in the same location. The removal falls under the applicable proposed culvert item and should not be paid for separately.
7. Sheet DRG-05: More details are needed to show how the 18" RCP goes through the Retaining Wall.
8. Sheet DRG-06: The Existing Culvert (Site 3) at Station 174+82± is called out to be extended on the southbound side of the Busway and to be removed on the northbound side. Which is correct?
9. Sheets DRG-06 and DRG-07 both include call outs for Catch Basins NB-8 and SB-27. It would be better to cut the sheet at a different station so that the call outs show up on only one sheet.
10. Sheet DRG-07: Are the inlet and outlet 36" RCP elevations the same at the Type 'C' Catch Basin SB-30? Only one flow line elevation is given.

✓ Drainage revised. Water Quality Basin provided.

✓ this is an inlet pipe

✓ new culvert is being installed

✓ callouts will be on one sheet only

✓ this area has been modified

If you have any questions, contact Janet Mazeau at (860) 594-2674.

cc: James Fallon
Michael Masayda – Hydraulics and Drainage
Mark D. Rolfe
David C. Lavado – James E. Hamilton
Mary K. Baier – Michelle A. Lynch

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

subject: Drainage Design Review
88-H034
New Britain – Hartford Busway
Newington Section
Town of Newington

date: January 6, 2009

to
Brain Cunningham
Transportation Supervising Engineer
Consultant Design – Highway Design
Bureau of Engineering and Highway Operations

from
Paul Corrente
Transportation Supervising Planner
Environmental Planning
Bureau of Policy and Planning

ext.

Type of Design Review:

☐ Schematic ☒ Preliminary ☐ Semi-Final ☐ Final ☐ Permit ☒ Other: **Drainage Review**

My staff has reviewed the above mentioned project and the water resource compliance section of this office offers the following comments:

Comment #	Loc. or Sheet #	Comment	Inc.	Not Inc. (If not, WHY)
1	TYP	• Legend G and I. Plans do not show locations. Under all guide rail and split rail fence locations, place process aggregate and in those areas adjacent to a wetland, place pavement. • Legend H. A minimum of 4-inches of topsoil is also needed. • The typical sections are useless without providing stations to provide an adequate determination.	✓ ✓	✓ Section & Plans clarify
2	General Comments	• There is to be no staging and or storing of material on-site without review and approval by the Department to ensure no environmental impacts. Provide NTC. • Where full depth reconstruction is to occur and wherever possible, all existing drainage shall be removed and not abandon, filled or plugged. • Since this roadway will have limited access, the drainage design should consider alternative pipe selections. Determination should be based on overall cost savings. • Retaining Walls should be numbered. • Provide design details for splash pad, scour holes, swales, sizes, CB types, etc... • Are edge drains being proposed? If so, will edge drain outlets be required? Please clarify. If so, indicate and show on plan sheets. • Ensure all state and town drainage is separated to the extent possible. If not, please identify. • The 100-year floodplain, SCEL and wetland limits need to be clearly visible. • For slopes greater than 15-feet, reverse slope benching may be required if soil conditions are not adequate. • SCS is not considered containment when doing open water excavation. Full containment and water-handling is required in those areas where existing cross culverts, splash pads and or scour holes are being proposed adjacent to a wetland.	✓ will be incorporated as a "Notice to Contractor" ✓ ✓ pipe selection submitted to H&D unit and has been approved ✓ ✓ edge drains will terminate @ C.B.'s ✓ ✓ ✓ there are no slopes greater than 15-feet ✓	✓ ✓ ✓

A-1-4

3	DRG-01	• At Sta. 118+00, what level of stormwater treatment is being provided from project 88-H035 (New Britain Section), prior to entering the drainage system for project 88-H034? • What level of stormwater treatment is being provided from project 88-H039 (East Street Station), prior to entering the drainage system for project 88-H034? • At Sta. 122+24.94 RT, should this be a Type 'C' CB rather than a Type 'C-L' as proposed? Please clarify. • Will the northbound platform (not shown) for the East Street Station interfere with SW-1? Please clarify. • Where will SW-1 discharge? • At Sta. 123+50 RT, there appears to be ample room to design an outlet with a swale for additional overland flow leading into the wetland area. The current proposal has a short run and should be modified. • Between Sta. 121+00 LT and 129+50 LT, shouldn't the retaining wall be on the outside of the trail?	✓ treated in proj. 88-H034 ✓ ✓ treated in proj. 88-H034 ✓ ✓ drainage has been revised ✓ ✓ drainage has been revised ✓ ✓ drainage revised ✓ ✓ water quality basin included ✓ ✓ no. Eventually it will separate Busway & CCSU drive
4	DRG-02	• At Sta. 126+50, provide a tributary sign for Bass Brook. • Between Sta. 129+50 and 141+50, why sheet flow LT and away from a curbless section RT? Why is SW-3 needed?	? ✓ superelevated roadway to the LT
5	DRG-03	• At Sta. 138+50 LT, why is a 28-foot 15-inch Class V RCP required outside of the roadway? Please clarify. • At Sta. 145+75 RT, there is no need to directly discharge stormwater into the wetland. Pull the drainage south and design an outlet with a swale for additional overland flow leading into the wetland area. The impact here is avoidable. • SW-8 appears to be within the multi-use trail. Please clarify.	✓ there are no class V pipes in project ✓ ✓ ✓
6	DRG-04	• Where is SW-10 discharging? • At Sta. 158+25, if the existing culvert is conveying clean water from an upstream location to a downstream location, then do not tie the proposed drainage (dirty water) into the system with clean water. The systems need to be separated. Pull the proposed system south. • If the cross culvert at Sta. 158+25 needs to be upgraded, then a water-handling and sequencing plan is required for review and consideration.	✓ drainage has been revised ✓ ✓
7	DRG-05	• Take the upstream drainage and discharge at Sta. 168+00 LT with SW-13A. • At Sta. 171+65.31 LT, it is impossible to determine the impact the discharge will have without knowing where the wetland limits are. Direct discharges should be avoided.	✓ ✓
8	DRG-06	• For the proposed concrete box culvert, a water-handling plan and sequencing plan is required for review and consideration.	✓
9	DRG-06 & 07	• At Sta. 186+00 RT, pull the 68-foot 12-inch RCP back to the extent possible and provide additional overland flow.	✓
10	DRG-07	• If the existing cross culvert requires an upgrade, a water-handling plan and sequencing plan is required for review and consideration. • See comment 6 regarding mixing clean and dirty water. • At Sta. 197+00 RT, pull the 28-foot 12-inch RCP back to the extent possible and provide additional overland flow.	✓ there is no base flow for this culvert ✓ ✓

If you have any questions regarding these comments, please contact Mr. Paul Corrente at 860-594-2932.

Andrew Piraneo/ap

cc: Cynthia Holden – Paul Corrente
Mark Alexander – Kim Lesay – Amanda Freitas
Dave Mancini – Dave Cutler
Bob Reilly – Jacob Argiro (See comment 3)
Chung Lung Chow – Yolanda Antoniak
Dennis Guyette

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

subject: Project No. 88-H034 (171-305 P.E.)
New Britain – Hartford Busway
Drainage Design Review
Newington Section

date: January 29, 2009

to: Mr. Richard B. Armstrong
Trans. Principal Engineer
Consultant Design
Bureau of Engineering
and Highway Operations

from: Michael E. Masayda
Trans. Principal Engineer
Hydraulics and Drainage
Bureau of Engineering
and Highway Operations

Michael Masayda

We have reviewed the drainage submission, together with the designer's responses to our previous comments, dated August 2, 2007. This submission only included the drainage plans and supporting drainage report. We offer the following comments:

No.	Comment	Inc.	Not Inc.
1	Our previous comments have been adequately addressed with the exception of previous comment no. 6, which concerns the environmental and hydraulic impacts that will result if the twin box culverts at Sta. 126 + 82 (Site 2) are extended upstream. The designer's response indicates that this issue will be addressed at Final Design. **We recommend that this issue be resolved as soon as possible in order to maintain the project schedule.** See our previous comments dated July 5, 2007 (which were referenced in previous comment 6) that enumerate the additional environmental and hydraulic impacts that will be introduced if the Bass Brook crossing is extended upstream.		✓ ①
2	A review of the storm drainage calculations shows that design velocities are below the recommended 3'/sec for self cleaning at numerous pipe segments. The proposed storm drainage systems should be revisited and revised as necessary to ensure these self cleansing velocities are achieved. See section 11.11.9 of the Drainage Manual.	✓	Design uses minimum pipe sizes at minimum slope. Design is optimized for site conditions. Obtained velocities are average for inlet and outlet, where flow should be slower to allow settlement in CB. sumps. ✓
3	All drainage calculations should be checked and initialed for accuracy. See Item a.16 of the Drainage Design checklist.	✓	
4	Justify the need for the class V RCP pipe that is being proposed at a number of locations throughout the project.	✓	Due to drainage revisions, no class V pipe is proposed. ✓
5	Drainage rights and easements were not identified on the drainage plans. The impact of outletting busway drainage at the proposed locations cannot be adequately evaluated until the DOT ROW limits together with the existing and proposed drainage rights and easement are depicted on the plans.	✓	✓ this issue will be addressed at a future ROW meeting

① Culvert extension is not required by this contract as the scope was A-1-6 revised

No.	Comment	Inc.	Not Inc.
5 cont.	For example: Sta. 145 + 64 Far right – The outlet location is proposed outside the ROW limits for the Cedar Street (Route 175) roadway. Who owns the property and where along the property line is the new outlet proposed?	✓ owned by State	✓
6	Flow arrows should be shown 200' beyond all drainage outlets or shown to terminate by dissipation or entrance into a watercourse or body of water as requested in Item b.11 of the Drainage Checklist. For example: No flow arrows are shown for the proposed outlet at Sta. 171 + 65 Far Left.	✓	✓
7	The established stream channel encroachment lines (SCEL), as presented on the plans in the vicinity of the project, are unclear and should be better defined in order to accurately assess any project impacts to the regulated boundary. Include Piper Brook's 100 year flood elevation and floodway boundary limits on the plans. Project outfalls that will extend into the SCEL and Piper Brook's 100 year flood boundary should be shown on the plans and identified in the drainage report.	✓	✓
8	Identify the hydraulic control (i.e. house sill elevation, roadway elevation, etc.) and tailwater assumptions used to design and evaluate the cross culverts so that the proposed culvert dimensions and allowable freeboard requirements can be adequately reviewed and verified.	✓ will be submitted with next drainage report	✓
9	Sta. 118+00 Left to 123+30 Left – Six catch basins are proposed on the left side of the busway within a total distance of 540 feet. The number of inlets seems excessive since they will intercept the left side of the busway pavement only. The gutter flow calculations show that five of these inlets will each intercept less than 0.5 cfs with computed gutter spread widths that are well within the allowable. Reevaluate the design to avoid an excessive number of basins in this location.	✓ 2 are flanker basins in sag condition	✓
10	Sta. 126 + 82 (Site 2) – The existing twin box culverts convey Bass Brook and are listed in the NBIS as Bridge No. 05357. The hydraulic crossing was analyzed in preliminary design and determined to be hydraulically adequate. See Preliminary Hydraulic Report for Site No. 2, dated May 2003. The Site No. and Bridge No. should be referenced on the plans.	✓ Site No. and Bridge No. are referenced on the plans	✓

No.	Comment	Inc.	Not Inc.
11	Sta. 130 +00 Far Left – The new 24" diameter pipe inlet will replace the existing one before connecting to the existing 24" diameter pipe and ultimately to the twin box culverts at Sta. 126 +82. The storm drainage computations at this location begin at the 24" outlet at the twin box culverts and extend upstream to the new 24" inlet.		
	a. It is uncertain how the 0.76 feet tailwater depth was determined and if the water depth carried by the twin boxes was considered in developing the starting tailwater elevation. Include the supporting information that documents how the tailwater elevation was established.	will be included in next Drainage report	
	b. The pipe system functions as a culvert and should be analyzed as such. Consider both inlet and outlet control in the calculations.		
	c. The proposed pipe should be designed for the 25 year storm since it is a cross culvert under Route 9.		
12	Sta. 158 + 25 (Site 2B)		
	a. The proposed 36" diameter inlet is labeled on the plans but is not included in the storm drainage computations. Review and revise the storm drainage computations to ensure the additional drainage area intercepted by the 36" diameter inlet is reflected in the storm drainage computations.	✓	✓
	b. Reference the inlet as Site 2B to be consistent with the previously prepared hydraulic report at this location.		✓
13	Sta. 174 + 55 – A new 6 'w x 5' h box culvert will replace the existing 3' w x 3.5' h stone box culvert that is located at Sta. 174 + 82 (Site 3). The drainage report indicates that the new cross culvert is proposed 30' south of the existing crossing in order to maintain flows through the existing pipe during construction. The existing stone box culvert was hydraulically analyzed in preliminary design and is referenced as Site 3. (Excerpts from the Preliminary Hydraulic Summary for Site 3, dated March 2003 (rev. 7/04) were included in the current drainage report.)		
	a. We recommend that the new cross culvert be located as close to the existing stone box as possible to provide a proper alignment between the watercourse and the proposed cross culvert. This will also minimize the environmental impacts in the watercourse.	✓ Proposed culvert has been located at existing culvert location	

No.	Comment	Inc.	Not Inc.
13 cont.	b. Include a channel profile to show how the proposed invert elevations will match into the existing topography and channel bed elevations. See Item b.7 in the Drainage Design Checklist.	✓ proposed inverts match existing inverts	
	c. Channel revetment calculations should be provided following the guidelines in Chapter 7 of the Drainage Manual and the FHWA publication entitled, HEC-11 Design of Riprap Revetment.	✓ same channel being utilized	
	d. Document the hydraulic control and tailwater assumptions in the drainage report.	✓ hydraulic control is upstream crossing	
14	Sta. 194 +00 a. The storm drainage computations do not include the additional 5.19 acres contributing from the inlet pipe at Sta. 194+00 Far Right. The calculations should be revised to reflect the entire drainage area conveyed by new 36" diameter pipe.	✓ Entire area is included ✓	
	b. The contours shown for the delineated drainage area to the cross culvert were not provided in their entirety and consequently the drainage area that contributes to the pipe at this location cannot be verified.	✓	✓
	c. The calculations reference the proposed 36" diameter cross culvert as Site 4 which is the same reference used for another hydraulic crossing that is located in adjacent Project No. 93-H046, at Sta. 223 +50. Eliminate the reference to Site 4 for the crossing at Sta. 194+00 to avoid confusion between the two projects.	✓	

Yolanda Antoniak/ya:sd
cc: Joseph J. Obara
Julie F. Georges – See comment no. 1
Mark W. Alexander – See comment nos. 1, 7 and 13
Paul N. Corrente – See comment nos. 1, 7 and 13
Chong Lung Chow ✓
088-H034B

APPENDIX A-2

RESPONSES TO REVISED PRELIMINARY DESIGN COMMENTS

Responses to comments received from Theodore D. Lapierre, Bureau of Engineering and Highway Operations, dated July 6, 2007:

1. As requested in your memorandum dated July 3, 2007, we have reviewed the revised Preliminary Design Plans for the subject project, and have no comments to offer at this time.

   Response: No response required.

A-3

Responses to comments received from Mario Marrero, Project Development Unit, dated July 19, 2007:

1. The PDU emphasizes that the full access drive to the new CCSU campus should be located along Route 175 east of Route 9 and east of the bridge over the rail line in a location similar to where a drive with a right-turn-in/right-turn-out restriction has been shown on other plans. This would have major advantages for everyone compared to any location west of Route 9 which requires the CCSU drive to pass under the freeway as shown in the plans which were submitted for this review.

   If the CCSU major access is provided east of the railroad, it does not eliminate the direct pedestrian/bicycle connection under Route 9. However, it could be reduced in scale to an emergency vehicle drive and there would be more space available for the Busway and bike trail facilities.

   Response: Full access to the new CCSU campus from Route 175 has been discussed at meetings with the Department and with CCSU. The Department is proposing to replace the Route 175 bridge over the abandoned rail line/proposed Busway with a structure that would allow for future expansion should access be provided at this point. In addition, lowering the profile of Route 175 in this area to accommodate such access is also being investigated. Design and construction responsibility would need to be discussed and agreed upon between the Department and CCSU.

   In the meeting held on September 5th between the Department and CCSU, it was agreed that the two-way access road, as shown on the Revised PD plans, would be provided even if major access to the new campus is ultimately off of Route 175. (CCSU roadway has been eliminated from this Project.)

2. There is no engineering reason why the CCSU drive east of the railroad structure, which is the natural location for a CCSU site drive, cannot have full access. The current proposed drive in this location is planned to have a "right-turn-in and right-turn-out only" restriction, which forces the circuitous entry route that is shown on these P.D. plans. There is plenty of separation between this drive location and both the Route 9 northbound exit ramp intersection to the west and the nearest major intersection further to the east. Signal timing should not be a problem; and, any necessary turn lanes can be constructed without widening the bridge. If more separation is required for lane transitions, there is room to adjust the intersection location. We can also deal with any limitations in sight distance, if any, which are created by the vertical curve over the railroad.

   Response: Full access to the new CCSU campus from Route 175 has been discussed at meetings with the Department and with CCSU. The Department is proposing to replace the Route 175 bridge over the abandoned rail line/proposed Busway with a structure that would allow for future expansion should access be provided at this point. In addition, lowering the profile of Route 175 in this area to accommodate such access is also being investigated. Design and construction responsibility would need to be discussed and agreed upon between the Department and CCSU.
   (Busway Profile was lowered to accomodate new Rte 75 structure)

3. There are so many advantages to CCSU for reconfiguring their site drive so that major full access is on their Route 175 frontage in the location where they are now proposing a restricted use drive. They include, but are not limited to the following:

   A. The major access would be in a location where the new campus can't be seen from Route 175. This must be compared to the current proposal, which has the only full access drive

about a half mile to the west, a quarter mile past the point where the campus can be seen from Route 175. Between the distance from the front of the CCSU site and the long drive required to bring entering traffic back under Route 9, the entering driver must travel almost an additional mile. This is guaranteed to cause confusion on the part of campus visitors who may not be familiar with the details of the campus.

B. The full access drive would be dedicated to CCSU only. This avoids all the complicated bus station operations inherent to the current combined drive. Signing for the university would be much simpler and more visible without any complications from Busway and bus station signs. There would be no confusion caused by the bus station connections and operations, because campus traffic would be mixed with Busway traffic. There would be no potential backups or delays caused by campus traffic entering the bus station or waiting for busses to complete their maneuvers.

C. The drive could have a far superior alignment. In the current PD plans, the curve at the bus station has a 25 mph design speed and the curve on the east side of the overpass has 30 mph with close to the minimum Stopping Sight Distance of 200 feet. We expect that both of these curves will be driven at higher speeds on a routine basis. It is common driver behavior in this type of alignment for speeds to be ten miles per hour faster that the design radius and for drivers to cross the centerline. This would indicate that a SSD greater than 300 feet should be provided in this type of alignment.

Response: See response to Comment No. 1 above.

4. In addition to the advantages to CCSU noted above, there are additional reasons why the Department should push for elimination of this PD plan location as a full access drive. These include, but are not limited to the following:

A. The cross section under the Route 9 will be much easier to construct. It is not clear to this unit that there is a practical means of installing the initial sheet piling which will be required to construct the cross section shown on the plans.

B. The CCSU drive would be located where there are no traffic complications along Route 175 other than the drive itself. In the PD plans, there is potential for backups out of the drive because of conflicts with the bus station and there is potential that traffic queues would block other streets and possibly even the already marginal operations of the Route 9 southbound entrance ramp intersection.

C. Additional undesirable effects of driver confusion for people when they first arrive from the east and find that they can not legally turn left into the drive is that some number of them will make the illegal left turn into the site while others turn around in the gas station drive at Fenn Road before they ever reach the full access drive.

Response: In May, Baker submitted a structure type study for the Retaining Walls below Bridge No. 05358 – Route 9 Over Busway to the Department for review. This study detailed the construction methods for installing the recommended micropile tie-back walls under the Route 9 bridge.

See response to comment No. 1 above.

5. The PDU points out that the "right-turn-in and right-turn-out only" restriction in the PD plans results in all traffic from the east having to drive past the initial site drive and pass through both already congested intersections between Route 175 and the Route 9 ramps before they can legally turn left into the site drive. It is not clear whether this number is larger or smaller than the number who would have to pass through those intersections coming from the west if the drive is relocated.

   Response: The Revised PD plans only show access from East Street and do NOT show "right-turn-in and right-turn-out only" access off of Route 175. In addition, see response to Comment No. 1 above.

6. The retaining wall between the Busway and the access road would have "softer hit" characteristics if it could be formed with a safety shape rather than the vertical wall shown. This would affect the thickness of the wall because of the slant of the safety shape.

   Response: A vertical face wall was proposed in accordance with Section 13-3.04 of the CDOT Highway Design Manual. (SL for A plans have been submitted for this wall)

7. If the Department continues with alternative, it would be highly desirable to increase sight distance to a forty mile per hour design for the curves on this entrance drive as noted above.

   Response: This can be investigated during Final Design, however, the physical restrictions of the existing Essex Place condominiums, the existing Route 9 bridge and matching into the proposed East Campus work (by others) limit the alternatives available. (Access Road has been eliminated from this Project)

A-3-4

Responses to comments received from Charles S. Harlow, Traffic Engineering, dated July 26, 2007:

1. The Busway driveway should be located so that the queue on the CCSU Access Road approach to Route 175 does not extend to this driveway.

   Response: This comment should be forwarded to SEA Consultants, the final designer of Contract No. 88-H039, the Busway stations.

2. The width of the opening between the Busway drive and the Busway should be reduced so unauthorized vehicles are discouraged from entering the Busway.

   Response: The width of the Busway drive to/from the Busway cannot be reduced. The width shown, established using AutoTurn, is necessary to allow buses to enter the Busway in both directions as well as exit from both directions.

3. Will parked buses block the sightline for buses entering the Busway from the Busway driveway?

   Response: Sufficient space exists for a bus to move far enough forward, before turning onto the Busway, to see past southbound buses stopped at the platform.

4. Will allowance be made for a future CCSU Access Road under Route 175 (Cedar St.)?

   Response: The Department's proposal for replacing the Route 175 bridge over the abandoned railroad/proposed Busway does not allow for a future access road.

5. At the Cedar St. Station the pedestrian path across the parking area should be avoided. Can the pedestrian path be designed so pedestrians cross at the south side of the parking area?

   Response: This comment should be forwarded to SEA Consultants, the final designer of Contract No. 88-H039, the Busway stations.

6. Coordination with the bridge replacement project will be required.

   Response: Agreed. This should be coordinated during Final Design.

7. A two-foot wide concrete curb is shown separating directions of traffic on the Busway. At STA 120+80 and STA 154+30 this two foot area is being used as a pedestrian refuge island. This should be designed flush and meet AASHTO and MUTCD guidelines for island size and sign installation.

   Response: The two-foot wide island shown is not intended to provide pedestrian refuge. Rather, it is proposed to allow the installation of a fencing system and signage to channel pedestrians to cross the Busway at the crosswalk only. The two-foot wide islands are located within six-foot wide striped medians at both locations.

8. How will the Busway traffic be maintained when the future abutments for the proposed garage in the vicinity of STA 134+00 is constructed?

Response: This will only be an issue if the parking garage construction significantly lags behind the Busway construction. If this turns out to be the case, and as discussed at the Revised PD Review meeting held on July 17th, it is assumed that the footings for the parking garage piers will be constructed in the median during construction of the Busway itself. Busway traffic can be maintained on the Busway as shown while the outer "drop-off" lanes and remaining necessary parking garage footings and piers are constructed. Once complete, Busway traffic can be shifted onto the newly constructed "drop-off" lanes while the median piers are constructed. While this is a viable option, construction staging and maintenance and protection of traffic plans will be developed during Final Design.

Responses to comments received from Ravi Chandran, Constructability Unit, dated July 26, 2007:

General Comments

1. Please provide details with the retaining walls in the 30% design.

   Response: In May, Baker submitted a structure type study for the Retaining Walls Below Bridge No. 05358 – Route 9 Over Busway to the Department for review. This study included details for these walls. Details for all other walls were not shown on the plans as this is a Final Design task. (SL for D plans have been submitted to DOT for review)

2. It is reminded a comprehensive construction schedule is now required with the 60% Design submission.

   Response: To be included in Final Design. (Not included with the 60% Design)

3. What will be the treatment at the interface of the concrete pavement and asphalt at the station locations.

   Response: This will be investigated, and determined, during Final Design. (the pavement at the stations is totally concrete.)

4. Additional survey information is warranted on the plans. This office recommends a separate survey control plan.

   Response: If desired by the Department, and part of the Final Designer's scope of work, a Survey Control Plan can be included in future design submission.

5. All drainage structures should be shown on the cross sections along with the proposed invert elevations.

   Response: Only critical cross sections are shown on the PD plans. In addition, the drainage design is schematic in nature and, therefore, proposed invert elevations are not computed. Proposed invert elevations will be computed during the formal drainage design, which is a Final Design task Proposed drainage structures will be shown on the cross sections in subsequent Final Design submissions. (Drainage structures are included in the cross sections. Invert elevations are noted on the Drainage plans.)

6. Please provide details for the concrete pavement and the treatment at the bituminous concrete islands.

   Response: To be included in Final Design. (Not sure what details would be required. It's a cold joint with no special treatment.)

7. Additional cross sections are warranted, preferably every fifty (50') feet and every major structure location.

   Response: Only critical cross sections are required as part of Preliminary Design. Cross sections, at 50-foot intervals and at other locations as warranted, will be included in Final Design.

8. Will open cut construction be allowed for the installation of the culverts? Or will temporary earth stabilization be necessary?

   Response: The Rehabilitation Type Study for this culvert, submitted to the Department in May, briefly discussed construction activities. Specific construction methods will be included in Final Design. (Open cut construction is allowed)

9. Has an environmental review been performed for the project?

   Response: Wetland and watercourses have been identified and delineated on the project base mapping. All other environmental work is being performed by the Department and is on-going. (OEP has commented on the drainage & FF submission.)

10. All structures placed on spread footings should be placed on 1' of crushed stone on top of geotextile.

    Response: To be investigated, and included as necessary, during the structural phase of Final Design. (Soil reports indicate suggested treatment.)

11. Based on the limited review of the soil and rock reports, there are areas of the Busway roadway that would benefit from a geotextile application.

    Response: To be investigated, and incorporated as necessary, during the geotechnical phase of Final Design. (Soil recommendations have been incorporated.)

Plan Sheet No. 6 (HWY-01)

1. Lester Street cul-de-sac should be modified to accommodate the proposed roadway embankment.

   Response: The Lester Street cul-de-sac is shown as proposed by the City of New Britain. Coordination between the Department, the Final Designer and the City of New Britain will be required during Final Design concerning this issue. (the existing Cul-De-Sac is being modified to accomodate the busway Design)

2. It is recommended the noise barrier be completed on the adjacent project. This contract covers the costs of remove and reset during construction operations, if the adjacent has completed construction.

   Response: It is anticipated that both contracts will be under construction concurrently. As such, coordination between the two contracts will be necessary during Final Design. The Department may want to consider having the entire run of noise barrier installed under the New Britain (No. 88-H035) contract. (Design and Estimate of noise barrier should be carried under Contract 88-H035)

Plan Sheet No. 9 (HWY-02)

1. What is the CCSU schedule for their work at the station? It is recommended not to have two (2) contractors working in the same vicinity.

   Response: The exact schedule for CCSU's east campus development has not been determined. Coordination between the two contracts is required during Final Design.

A-1-8

2. Anticipated monitoring of settlement should be through out the life of the project, as well as the Route 9 abutments, not only during the construction phase.

   Response: It is recommended that further discussion with the Department concerning monitoring of settlement take place during the Final Design phase. Any monitoring requirements the Department chooses to have can then be incorporated into the contract.

Plan Sheet No. 14 (HWY-04)

1. The 36" CMP should be replaced.

   Response: This will be investigated during the formal drainage design, which is part of Final Design. (the 36" CMP is being replaced with a 36" RCP)

2. There are railroad ties and ballast that will need to be removed and disposed.

   Response: This will be investigated, and incorporated into the contract documents as necessary, during Final Design.

Plan Sheet No. 18 (HWY-06)

1. New structure should be monitored for settlement.

   Response: It is recommended that further discussion with the Department concerning monitoring of settlement take place during the Final Design phase. Any monitoring requirements the Department chooses to have can then be incorporated into the contract. (Soils reports indicate suggested treatment)

2. This office recommends the structure be placed on 1' of stone and geotextile to limit possible movement.

   Response: To be investigated, and included as necessary, during the structural phase of Final Design. (Soils reports indicate suggested treatment.)

Plan Sheet No. 27 (UTL-02)

1. Please show conduit runs for luminaries as well as the anticipated power distribution center.

   Response: This comment should be forwarded to SEA Consultants, the final designer of Contract No. 88-H039 (the Busway stations) which includes illumination.

2. Each luminary should have a designated fuse to limit string outages.

   Response: This comment should be forwarded to SEA Consultants, the final designer of Contract No. 88-H039 (the Busway stations) which includes illumination.

Items

1. Missing items – drainage items, remove and dispose of railroad ties and ballast, water handling.

   Response: The drainage design for the PD is schematic in nature. As such a SF unit cost (based on pavement area) was used to estimate the cost of the drainage items. The other items, if necessary will be included during future design submissions. It should be noted that the Revised PD cost estimate carried lump sum items for both "Minor Items" and "Contingencies", both of which should cover the cost of the items noted..

2. Unit cost recommendations – the following are unit cost recommendations for certain items based on review of current prices off of Site Manager Reporting System:

Earth Excavation	$ 16.11/CY
Formation of Subgrade	$ 1.45/SY
Processed Aggregate Base	$ 35.00/CY
All Asphalt Items	$ 69.91/Ton
Concrete Curbing	$ 25.60/LF
Concrete Transition Barrier	$350.00/LF
Protective Fence (6' High)	$101.00/LF

   Construction Staking should be increased to 5% of the total estimate as there will be additional monitoring of existing and new structures covered under this item.

   Response: Baker, in conjunction with the Department, has revised the unit costs for all contract items for the New Britain – Hartford Busway. This was done in July and new cost estimates submitted to the Department.

(see Semi-Final Cost Estimate for latest prices on individual items.)

Responses to comments received from Michael E. Masayda, Hydraulics and Drainage, dated August 2, 2007

	INC.	NOT INC.
1. Typical Section shown for Busway Mainline at Station Platforms (East and Cedar Street Station) – The Busway's typical section for the station platform does not provide a shoulder and limited width will be available to collect water in the gutter before it spreads into the travelway. If a shoulder cannot be provided, then gutter flow should be intercepted as much as possible prior to discharging towards the platform. *Response: The typical section shown for the Stations has been agreed to by the Department. Formal drainage design will be performed during Final Design, a goal of which should be interception of as much gutter flow as possible prior to the station platforms.*	✓	
2. Typical Section shown for Busway Mainline at Future CCSU Station – The cross slope shown for the single lane on the right side of the Busway section is directed to the proposed median, away from the offroad swale. Redirecting the cross slope toward the proposed swale may eliminate the need for a storm drainage system along the inside of the median. *Response: The CCSU station is located on a horizontal curve in the Busway alignment. As such, this section is superelevated as shown on the Revised PD plans.*		✓ SEE BELOW
3. Critical Section 120+50 – The proposed 6" deep ditch shown on the right side of the section is very close to the edge of the road and may be too shallow for the flow in the ditch. As the drainage design develops, the calculations may indicate that a deeper ditch is required to contain the flow. *Response: Agreed. This should be investigated, and adjusted as necessary, during the drainage design phase of Final Design.*	✓	
4. Busway STA 126+50 and CCSU Access Road STA 21+00 – The inlets are proposed at a low point and will be located in a sag condition, as described in Section 11.7 of the Drainage Manual. Drainage calculations should follow the guidelines discussed in this section of the Drainage Manual to ensure the allowable flooding limits are achieved for not only this location but similar sag conditions throughout the Busway design. *Response: The drainage design will meet all requirement of the CDOT Drainage Manual.*	✓	
5. Stream Channel Encroachment Lines (SCEL) are delineated on the preliminary design plans. Any work within the SCEL will require an SCEL permit. *Response: Agreed. A Stream Channel Encroachment Permit was previously identified as being anticipated (Section 16.0 of the Preliminary Design Report) for this contract.*	✓	
6. Critical Section STA 126+80 – The existing twin box culvert needs to be extended upstream should the roadway be widened for the CCSU access road. See comments from this office dated July 5, 2007 concerning the Rehabilitation Study Report, referenced as Site 2, Bridge No. 05357. *Response: To be included in Final Design.*		✓ SEE BELOW

#1-2 – NOT POSSIBLE, SAME ROAD IS IN SUPERELEVATION.
#6 – NOT A PART OF CCSU ACCESS ROAD PORTION OF NO. 11

APPENDIX A-3

RESPONSES TO SEMI-FINAL DESIGN COMMENTS

Unit	Date
1. Environmental Planning	June 15, 2009
2. Hydraulics and Drainage	May 26, 2009
3. Environmental Planning	May 15, 2009
4. Hydraulics and Drainage	April 20, 2009

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

subject: Semi - Final Design Review
88-H034
New Britain – Hartford Busway
Newington Section
Town of Newington

date: June 15, 2009

to
Brian Cunningham
Transportation Supervising Engineer
Consultant Design – Highway Design
Bureau of Engineering and Highway Operations

from
Paul Corrente
Transportation Supervising Planner
Environmental Planning
Bureau of Policy and Planning

ext.

Type of Review:

☐ Schematic Design ☐ Preliminary Design ☒ Semi-Final Design ☐ Final Design ☐ Permit ☐ Other:

My staff has reviewed the above mentioned project and the water resource compliance section of this office offers the following comments:

Comment #	Loc. or Sheet #	Comment	Inc.	Not Inc. (If not, WHY)
Semi – Final Design Report				
1	**Table 5**	• The wetland areas are numbered 3 through 11. Is there a wetland area No. 1 or No. 2?	wetland number assigned by Bake	
		• Be prepared to discuss temporary wetland impacts. As an example, wetland area No. 3 indicates no permanent wetland impacts for retaining wall (RW) 105. Yet, there will be temporary impacts as a result of providing a cofferdam for the construction of RW 105.	✓ temporary Impact is accounted for in wetland impa	
		• Not sure where the wetland impacts are for wetland area No. 11 located at Sta. 187+00 LT. Plans show the wetland limits far LT. Please clarify.	STA 194+00 Rt	
		• The wetlands located under Route 175 are not accounted for. It is not known who is taking responsibility for the impact, as there are two designs being done concurrently at this location. The other design is being done by State Bridge. Please forward findings to this office as soon as possible.	✓ Included under Busway project	
		• General Comment. Similar to Table 5 and Table 6, a table regarding floodplain impacts should be developed.	✓	
		The following three impacts listed below were not accounted for within the table, but are clear impacts based on the design plans.		
		◦ At Sta. 171+65 RT, the placement of a riprap splash pad in the wetland is permanent impact.	✓	
		• At Sta. 175+00 LT, the swale discharge in the wetland is permanent impact.	✓	
		• At Sta. 194+00 RT, the placement of a scour hole in the wetland is permanent impact.	✓	
Semi – Final Design Submission				
2	**TYP**	• Along the Multi-Use Trail where a Legend G or I is needed, provide process aggregate. Revise graphics and provide a Legend T symbol at these locations.	✓	

		• Legend Table T. The thickness should be 4-inches and not 2-inches as labeled. Please clarify.	✓	
3	MDS-13	• The Scour Hole Data Table, at Sta. 174+65 RT, indicates a type 1 modified riprap and the plans call for intermediate. Please clarify.	✓	
4	PLN	• Please remove all drainage notes. i.e....swales, channel information, as the information is provided within the drainage sheets.	✓	
5	General	• Do the soil conditions support a slotted RCP design? • Throughout the project limits, there are a number of impacted areas between the RCP and communications conduit. Could the communications conduit be relocated under the trail where there will be less impact, as it appears that the depth of the drainage in some areas was a result of the conduit being in the way? • It is important to provide structural plans as soon as possible, as these impacts will require water-handling, containment, dewatering and staging plans for review and consideration and important for the permitting process. • The wetland and SCEL limits are not clearly visible. Please enhance graphics and provide callouts.	Slotted pipe to be removed and replaced by regular pipe and underdrain Conduit location by DOT ✓ ✓	
6	Water Quality Basins (WQB)	• The designer should be commended for their approach to enhancing stormwater treatment, but most of the basins are simply not warranted. See comments below and revise design as needed.	✓	
7	DRG-01	• Typically, WQB's are not to be placed within a floodplain. Please relocate out of the floodplain. • RW 105 will require a cofferdam during the installation. • Re-word Gravel Road to Access Road, as permanent access will be required for maintenance. • Why is the drainage system outletting at Sta. 123+30 RT so deep? Is it because of the drainage system from Project 88-H035? The transition outlet structure should not determine the depth for the entire drainage system when minimal cover is more than sufficient. Please investigate. • Will the East Street Station (Project 88-H039) discharge into WQB No. 1 as is recommended? If so, is the WQB designed accordingly? • If the East Street Station is to make use of WQB No. 1, then primary treatment and or the use of HDS for that project would not be needed.	✓ not possible for basin #1 ✓ ✓ Access Road has been eliminated depth required to pick up station drainage yes ✓ correct	
8	DRG-02 & 03	• Why is the drainage system between Sta. 135+50 to 138+50 so deep? The transition outlet structure should not determine the depth for the entire drainage system when minimal cover is more than sufficient. Please investigate.	✓ system raised	
9	DRG-03	• WQB No. 2 is not needed. A grass lined channel would be sufficient for the entire length. • The grass lined channel, as shown on MDS-16, should be pulled upslope to the wetland limit and not encroach into it. This is an avoidable wetland impact. • Why couldn't the two drainage discharge points be combined into one as it is recommended? Please investigate. • Move 'C-L' CB at Sta. 145+25 LT to Sta.145+64 LT, as a means to avoid an impact with the RW and connect to the CB located at Sta. 145+64 RT.	✓ WQB #2 has been eliminated cannot be pulled up slope due to profile this would lower system and increase wetland impact this is a low point and cannot be moved	
10	DRG-04	• Why is the drainage system between Sta. 153+00 to 155+80 so deep? The transition outlet structure should not determine the depth for the entire drainage system when minimal cover is more than sufficient. Please investigate. • As a stand alone busway drainage design, WQB No. 3 and	system will be raised ✓	

		No. 4 are not needed. A standard outlet protection structure is more than sufficient. Revise the cut or fill slopes accordingly. • Will the Cedar Street Station (Project 88-H039) make use of WQB No. 3 as is recommended? This would make better use of WQB No. 3. Please investigate. • If it is deemed necessary to make use of WQB No. 3, in conjunction with the Cedar Street Station, the outlet should always discharge in the direction of the basin. • If the Cedar Street Station is to make use of WQB No. 3, then primary treatment and or the use of a HDS for that project will not be necessary. • The need for containment, dewatering and water-handling at Sta. 158+25 cross culvert will be required. • The drainage at Sta. 159+85 is too deep. Please investigate and provide a standard outlet protection structure.	✓ Basins eliminated ✓ Basin No 3 has been eliminated ✓ Basin No 3 has been eliminated this is an intermitt Stream can be bypassed during dry weather ✓
11	DRG-05	• At Sta. 165+00 RT, shorten the pipe to the extent possible. • The RW will require cofferdam and dewatering. • The HDS is not warranted. Please remove from the project.	✓ it is as short as possible ✓ ✓
12	DRG-06	• The proposed 6x6 box culvert will required water-handling, etc... • At Sta. 179+50 RT, a 4-foot sump is not needed. Please provide a standard cb. • WBQ No. 5 is not needed. Standard outlet protection is more than sufficient. Revise the cut or fill slopes accordingly. • The swale discharge at Sta. 175+00 LT is a permanent impact. Please revise as the impact is avoidable.	✓ ✓ ✓ ✓ swale was pulled back
13	DRG-07	• WQB No. 6 and No. 7 is not needed. Standard outlet protection is more than sufficient. Revise the cut or fill slopes accordingly. • At Sta. 186+00 RT, a 4-foot sump is not needed. Please provide a standard CB. • At Sta. 194+00 RT, the scour hole is permanent impact and should be accounted for. • At the outlet structure at Sta. 196+50 RT, the note indicates a Type A riprap apron and the XSC sheet indicates a Type B. Please clarify. • At Sta. 196+99, a 4-foot sump is not needed. Please provide a standard CB. • The outlets at Sta. 196+50 and Sta. 196+99 should be combined. Please investigate.	✓ ✓ ✓ ✓ ✓ ✓

If you have any questions regarding these comments, please contact Mr. Paul Corrente at 860-594-2932.

Andrew Piraneo/ap

cc: Colleen Kissane – Paul Corrente
Mark Alexander – Kim Lesay – Amanda Freitas
Dave Mancini – Dave Cutler
Bob Reilly – Laurie LaRocca
Chung Lung Chow – Yolanda Antoniak
Dennis Guyette
Jacob Argiro (See station comments)

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

subject: Project No. 88-H034 (171-305)
New Britain – Hartford Busway
Newington Section
Semi-Final Design Review

FROM THE DESK OF
RICHARD B. ARMSTRONG
NAME. | F.Y.I. | PLS. SEE ME

memorandum

date: April 20, 2009

APR 21 2009

B.T. CUNNINGHAM	
B.J. NATWICK	
A.A. FESENMEYER	
L.I. LaROCCA	

to: Mr. Richard B. Armstrong
Trans. Principal Engineer
Consultant Design
Bureau of Engineering
and Construction

from: Michael E. Masayda
Trans. Principal Engineer
Hydraulics and Drainage
Bureau of Engineering
and Construction

Michael E Masayda

No.	Comment	Inc.	Not Inc.
1	The responses to our previous preliminary design comments, dated August 2, 2007 and drainage review comments, dated January 29, 2009 seem reasonable; however the comments concerning revisions to the storm drainage calculations cannot be verified until the supporting drainage calculations are submitted for review.	✓ Revised comps submitted on 4/14/2009	
2	Seven water quality basins are proposed within the project limits, which seems excessive since no curbing is proposed on the right side of the entire busway pavement and runoff will sheet flow off the pavement onto pervious surfaces. These water quality basins are proposed outside the busway's footprint and will require additional ROW acquisition and routine maintenance. Supporting calculations for the water quality volumes (WQV) and flows (WQF) should be provided to demonstrate that these basins are the most appropriate stormwater treatment measure. We recommend that the Office of Environmental Planning review the supporting stormwater treatment calculations for concurrence and to ensure that the proposed measures are practicable and appropriate. For example: Sta. 139 +00 Left – It is not clear why a water quality basin is proposed on the left side of the road since stormwater is being treated by the proposed grass lined channel and only one catch basin is discharging to this channel. Sta. 179 + 00 Right – The purpose of the proposed "Water Quality basin 5" is not clear. Only one curbline (Type "C" catch basin) is proposed and the other two basins are Type "C-L" structures.	All WQB's except #1 have been eliminated per discussions with H&D and OEP.	
3	The semi-final drainage report lists the property owners impacted by this portion of the busway project but the drainage rights and easements are not included on the plans. This information is required and should be shown on the semi-final (60%) design plans to evaluate the proposed property impacts and prepare the ROW acquisition process. The Drainage Design checklist indicates the drainage rights and easements will be submitted within a week of the semi-final submission.	✓ ROW impacts have been included	

No.	Comment	Inc.	Not Inc.
4	The drainage report should include a section documenting the storm water treatment measures that were considered for this project with a brief explanation why some of these measures were implemented while others were not. For example, since much of the stormwater treatment measures are proposed because of the proposed curbline between the busway and the multiuse trail, the drainage report should explain why the busway's shoulder slope cannot be graded away from the curb or why the curbing cannot be eliminated between the busway and the multi-use trail. This documentation would also be useful in preparing the DEP permit package.	✓ X-sections as determined by Department	
5	The cross sections should be extended as necessary to ensure that the proposed outlet elevations will match in with the existing ground elevations (including locations where pipes are proposed at different stations from the cross section's reference station). For example, invert elevations for outlet pipes at Station 160 +00 Right and 165 +00 Right are shown below the existing ground elevations. The location where the proposed elevation matches into the existing ground is uncertain.	✓	
6	Sta. 171 + 50 Right – A gross particle separator is proposed to intercept the discharge from a single catch basin along the pavement curbline. The purpose and need for a stormwater treatment structure at this location is questionable. Note that the terminology for this type of secondary storm water treatment structure has been changed to hydrodynamic separator. See hydrodynamic separators referenced in both the 2004 DEP Connecticut Stormwater Water Quality Manual (2004) and the DOT Drainage Manual.	✓ gross particle separator has been eliminated ✓	
7	Sta. 193 + 35 Right – A proposed 18" pipe will discharge drainage from an existing development that is located on the north side of the busway and discharge it to the south side of the busway without pretreatment. Are stormwater treatment measures required at this location? We recommend coordination with the Office of Environmental Planning and documenting this information in the drainage report.	✓ private drainage has been separated from Busway drainage and not treated as per discussion with DEP and HE	

No.	Comment	Inc.	Not Inc.
8	Proposed outlet at Sta. 196 +50 Right – The cross sections show that the proposed ground elevations at the drainage outlet will drain toward the splash pad rather than away from it. Review and revise accordingly.	✓	
9	Item 17 of the Drainage Design Checklist, which concerns the consideration of alternate pipe material was checked off as included but this documentation was not found in this submission and should be provided in the drainage report.	✓	

Yolanda Antoniak/ya:sd
cc: Joseph J. Obara
Cynthia S. Holden – Paul Corrente – Mark Alexander
Chong Lung Chow
088-H034D

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

m e m o r a n d u m

subject: Project No. 88-H034 (171-305 P.E.)
Semi-Final Drainage Submission Review
New Britain-Hartford Busway
Newington Section

date: May 26, 2009

to: Mr. Richard B. Armstrong
Trans. Principal Engineer
Consultant Design
Bureau of Engineering
and Construction

from: Michael E. Masayda
Trans. Principal Engineer
Hydraulics and Drainage
Bureau of Engineering
and Construction

Michael Masayda

We have reviewed the Drainage Design Report (rev. April 10, 2009) together with the responses to our previous comments dated January 29, 2009. The comments dated January 29, 2009 have been adequately addressed with the exception of comment nos. 5 and 8 which are reiterated in this memo. The comments dated April 20, 2009 have not yet been incorporated and should be addressed accordingly.

No.	Comment	Inc.	Not Inc.
	General		
1	The computations for the water quality basins (WQB) include the required volumes but not the dimensions and depths that are proposed on the miscellaneous detail sheets. This information should be included in the calculations to verify the size of the fore bay and basin.	✓	
2	The detail located in the drainage report shows the Special Type "C" catch basin is without a throat. A clogging factor should be imposed for these special catch basins that are proposed at low points. See Section 11.9.6 of the Drainage Manual, entitled *Grate Inlets in a Sag* for clogging factor guidelines.	✓	
3	No flow arrows are shown beyond the drainage outlet at Sta. 150 + 09. Check all outlets to ensure flow arrows are shown.	✓	
4	A channel lining detail should be included with the plans.	✓	
5	Water Handling plans should be provided in the subsequent submission.	✓	
6	Drainage rights and easements were not identified on the drainage plans. The impact of outletting busway drainage at the proposed locations cannot be adequately evaluated until the DOT ROW limits together with the existing and proposed drainage rights and easement are depicted on the plans. *(See previous comment no. 5 dated January 29, 2009.)*	✓	

No.	Comment	Inc.	Not Inc.
7	Identify the hydraulic control (i.e. house sill elevation, roadway elevation, etc.) and tailwater assumptions used to design and evaluate the cross culverts so that the proposed culvert dimensions and allowable freeboard requirements can be adequately reviewed and verified. *(See previous comment no. 8 dated January 29, 2009.)* Site 3: parking lot upstream, pipes B-00K 50 e w 30yr backwater Site 2B: No upstream control, it will flow at critical depth	✓ ✓ ✓	
8	Soils information should be investigated in locations where water quality basins will be constructed to ensure that the soil conditions are conducive for these storm water treatment systems.		
9	Sta. 144 + 50 Right to Sta. 145 + 64 Right Two drainage outlets are proposed within 120 feet of each other with the intention of separating clean water from the pavement runoff. The outlet at Sta. 144 + 50 will require approximately 120 feet of channel excavation to outlet at a proper elevation and involves additional property acquisition. It is not clear why this outlet is required when drainage can be connected to the proposed outlet located 100 feet away at Sta. 145+ 64 Right. (The runoff from the single catch basin at Sta. 145+ 64 Right intercepts a drainage area less than one acre and does not warrant additional stormwater treatment measures.) This would reduce the channel excavation limits and minimize ROW impacts.	This would lower The system and increase wetland impacts	
10	Sta. 156 + 00 Far Right (Water Quality Basin 3) a. The outlet is proposed perpendicular to the relatively narrow water quality basin and will require the discharge to take a 90 degree turn in order to flow through the WQB. There is concern that the basin's side slope will be subjected to direct discharge and prone to erosion. Reconfigure the position of the outlet relative to the WQB to avoid future erosion at the basin's bank slope. See other locations with similar outlet configurations and revise as necessary.	WQB #3 has been eliminated	
	b. The cross sections and grading plan show that the pipe will outlet at the bottom of the WQB but the construction plans show the outlet in the middle of the basin's 2:1 side slope. An outlet and splash pad along the basin's embankment slope is undesirable and will require revetment protection as outlined in Chapter 7 of the Drainage Manual. Review and revise to ensure consistency between the various plan sheets.	WQB #3 has been eliminated	

No.	Comment	Inc.	Not Inc.
11	Sta. 159 + 85 (Water Quality Basin 4) A single (Type "C") catch basin collects 0.28 acres of drainage area that is all pavement runoff before the drainage is directed to the water quality basin.		
	a. The water quality basin is not required since the drainage area is less than an acre and the water will flow overland for approximately 100 feet before reaching a regulated watercourse.	✓ WQB Area has been eliminated	
	b. The drainage calculations show that there is additional runoff created by the right side of the busway but this area is not curbed and the Type "C-L" catch basin on the right side of the road will not collect runoff during rainfall events but rather intercept snowmelt during winter conditions. The calculation should be revised to reflect the actual drainage that discharges through the proposed storm drainage system. Check the accuracy of other locations with similar design treatment.	✓	
12	Sta. 159 + 20 Left to Sta. 160 + 15 Left The left bank of the grass lined ditch is a 1.5:1 side slope with crushed stone proposed for slope protection. The riprap treatment should be designed as revetment rather than slope protection and keyed into the bottom of the ditch as outlined in Chapter 7 of the Drainage Manual.	✓	
13	Sta. 165 + 20 Right The inlet of the cross culvert is designed as a Type "C-L" catch basin and collects stormwater from ditches proposed on both sides of the catch basin. The 15" diameter RCP and riprap apron are sized using a 2.88 cfs flow rate and do not include the overland flow contributing from these ditches. Review and revise accordingly.	✓	
14	Sta. 171 + 65 (Concrete Gross Particle Separator) A hydrodynamic separator (referred as a gross particle separator on the plans) is proposed for a single basin that collects 0.57 acres of drainage area. It is not warranted since the drainage area is less than one acre.	✓ HDS has been eliminated	

No.	Comment	Inc.	Not Inc.
15	Sta. 179 + 50 (Water Quality Basin 5) One catch basin will intercept roadway drainage from a drainage area of 0.36 acres. The drainage area discharging to the busway is separated from the overland runoff that does not require pretreatment. The two other receiving catch basins are ancillary "C-L" catch basins.		
	a. It is not clear why a water quality basin is necessary at this location. The discharge point is located approximately 140 feet from the delineated wetland limits and runoff can travel overland for 140 feet before reaching the delineated wetland limit.	WQB has been removed	
	b. Reevaluate the need for the 4' deep sump at the last ancillary basins proposed at Sta. 179 + 50 Right.	✓2 sump provided	
	c. See similar condition and comment at Sta. 186 + 00 Right (Water Quality Basin 6) and Sta. 197 + 00 Right (Water Quality Basin 7).	WQB's 6 & 7 have been removed	
16	Sta. 194 + 00 a. Since the pipe is designed to convey surface runoff from one side of the road to the other, it is considered a cross culvert and should be evaluated based on the guidelines outlined in Section 8.3.11 of the Drainage Manual. Check the 25 year rainfall event to determine the impacts at the crossing. Apply this assessment at other locations that have similar cross culvert conditions.	The pipe is designed as a cross-culvert SI 4A with a 50yr storm design	
	b. The inlet for the cross culvert is a double Type "C-L" catch basin that is designed to intercept drainage from swales entering from both sides of the catch basin inlet. The calculations include cross culvert calculations based on 12.2 cfs but do not provide calculations demonstrating the inlet capacity at the catch basin.	SEE SITE 4A cross-culvert Design	
	Evaluate the inlet capacity of the Type "C-L" catch basin to ensure that the ponding depth at the catch basin does not exceed the depth of the proposed grass lined channel. Apply a clogging factor to the grate as defined in Section 11.9.6 of the Drainage Manual, entitled *Grate Inlets in a Sag*. Check the inlet capacity at other similar infield locations.	✓	

No.	Comment	Inc.	Not Inc.
16 cont.	c. The calculations indicate that *Swale 11* coming from the right side of the Type "C-L" catch basin, begins at Sta. 199 + 87 and carries the runoff to the inlet at Sta. 194+00. But the drainage plans and delineated drainage area show the beginning of the swale at Sta. 195 + 00, (487 feet less). Review and revise the calculations as necessary to ensure that the drainage areas and resulting discharge are correct.	✓	
	d. The design discharge applied in the culvert calculations is larger than that used to design the swales. Review and revise as necessary.	✓	

ya Yolanda Antoniak/ya:sd
cc: Joseph J. Obara
Cynthia Holden-Paul Corrente-Mark Alexander
Leo Fontaine – See comment no. 8
Chong Lung Chow
088-H034E

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

COM-09A REV. 2/91 Printer on Recycled or Reclaimed Paper

subject: **Subject Drainage Design**
Project 88-H034
Hartford-New Britain
Busway - Newington

date: May 15, 2009

to
Brian Cunningham
Supervising Transportation Engineer
Bureau of Engineering & Highway Operations

from
Mark Alexander *Mark Alexander* *ext.*
Supervising Transportation Planner
Environmental Planning
Bureau of Policy and Planning

☐ Schematic Design ☐ Preliminary Design ☒ Semi-Final Design ☐ Final Design ☐ Other

My staff has reviewed the submission for the above mentioned project and offers the following comments:

Comment #	Loc. or Sheet #	Comment	Inc.	Not Inc. (If not, WHY)
1	**General - wetlands**	- Numerous wetland lines and intermittent watercourse designations throughout the project appear in need of clarification. It is the understanding of this office that FHI is currently working on this task and that updated information will be incorporated into the ground files	✓	
2	**Retaining wall #105**	- Access for this retaining wall must be considered for permitting purposes as it is adjacent to a regulated wetland. If a temporary haul road is needed, it must be incorporated into the plans.	Access from Busway is sufficient - no haul road needed	
3	**Structure at 174 +90**	The proposed structure replacement in this vicinity will raise some specific questions during the permitting process. There should be an attempt to meet certain culvert crossing requirements as follows: - Pre-application coordination with DEP Fisheries is needed. - The culvert should meet the ACOE openness ratio. - The culvert should be buried one foot to allow natural streambed material to cover the bottom of the structure - The drainage area to the structure needs to be provided. - The riprap at the outfall, if truly needed, should also be buried one foot and top dressed with natural streambed material - Native plantings should be considered at the inlet and outlet - Access during construction needs to be considered and depicted on plans - A water handling plan needs to be developed and included in the plans, including dewatering as necessary for culvert placement. → Some of this information is depicted on sheet 215, but needs to be worked into overall plan views.	✓ ✓ not met ✓ ✓ Native soil would wash away in scour hole Planting by others along busway corridor ✓ ✓	
4	**PLN-07** →	The grading in the vicinity of Station 198+00 Right should be investigated and moved out of the SCEL if possible.	✓	

5	MDS 14 - 18	These detail sheets were provided for the proposed basins. These sheets do not depict the wetland or floodplain limits. Basins should not impact regulated areas. Placement may be further discussed with DEP IWRD, especially if impact is minor, however, please take the possible high groundwater table into consideration when planning basins in these areas.	✓all basins except # 1 have been removed	

If you have any questions regarding these comments please contact Kim Lesay, Transportation Planner 2 of my staff at 594-2933.

Kimberly Lesay/kl
cc: Cynthia Holden - Mark Alexander
Paul Corrente - Andrew Piraneo
Laurie LaRocca
Dennis Guyette
Mike Masayda - Lenny Chow - Yolanda Antoniak

APPENDIX A-4

RESPONSES TO FINAL 90% DESIGN COMMENTS

Unit	Date
1. Hydraulics and Drainage	January 15 & February 2, 2010
2. Environmental Planning	December 16, 2009
3. Environmental Planning	January 8, 2010

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

subject: Project No. 88-H034 (171-305 P.E.)
Final Plans for Review
New Britain-Hartford Busway
Newington

date: January 15, 2010

to: Ms. Julie F. Georges
Trans. Principal Engineer
Consultant Design – Structures
Bureau of Engineering
and Construction

from: Michael E. Masayda
Trans. Principal Engineer
Hydraulics and Drainage
Bureau of Engineering
and Construction

We have reviewed the final plans for the five retaining walls and one box culvert together with the special provisions and offer the following:

No.	Comment	Inc.	Not Inc.
	Structure Plan Review (See Highway Plans, Sheet Nos. 166 to 189/ Drawing Nos. S-01 to S-26)		
1	Retaining Wall (Site 2) Sta. 141 + 55 to Sta. 145 + 68 The cross sections and structure plans show that the retaining wall footing at Sta. 145 + 25 Far Left is at the same elevation as the proposed 24" RCP lateral pipe. The conflict should be resolved. The footing elevation is determined by the Proprietary Wall Designer	X	
2	Retaining Wall (Site 3) Sta. 168 + 00 to Sta. 176 + 75 No comments.	X	
3	Retaining Wall (Site 4) Sta. 123 + 35 to Sta. 126 + 70 Retaining Wall (Site 5) Sta. 126 + 55 to Sta. 127 + 12 Sta. 126 + 70 – The bottom of footings for retaining walls at Site 4 and Site 5 are 6 feet and 10 feet, respectively, above the existing box culvert that will convey Bass Brook under the proposed busway. We recommend that the Department's Soils and Foundations Section review this condition to ensure that the new loads imposed on the box culverts will not adversely affect the structural integrity of the crossing.	X	
4	Proposed Box Culvert Sta. 174 + 55		
	a. Include the Temporary Hydraulic Data table for the proposed box culvert as typified in Table 3.3 of the Drainage Manual.	X	
	b. Include the elevations for the cofferdams that are shown on the Water Handling Plan.	X	
	c. The invert elevation of the temporary 48" pipe will be one foot higher than the invert of the existing stone box. It is not clear how the watercourse will be redirected from the existing stone box to the temporary 48" diameter pipe. A construction sequence of the water handling operation should be developed and included on the Water Handling Plan.	X	

No.	Comment	Inc.	Not Inc.
4 cont.	d. Drawing Nos. S-21 and S-22 call for a "Drainage Easement Line" at the downstream portion of the crossing but Drawing No. ROW-06 the Right of Way plans, call for a "Drainage Right of Way". Coordinate with the Department's Rights of Way Division to ensure that the proposed acquisition is correctly labeled on the drawings. Revise accordingly.	X	
	c. A "Temporary Drainage Right of Way Line" is noted on the Water Handling Plan for only the downstream portion of the proposed crossing. Similar temporary rights/ easements may also be required at the upstream side of the crossing and should be confirmed with the Department's Rights of Way Division. Ensure that the proper terminology is presented on the plan as discussed in the comment above. The temporary pipe layout has been revised to fall within the upstream easement.	X	

yy Yolanda Antoniak/ya:sd

cc: Joseph J. Obara
Leo Fontaine – See comment No. 3
Richard B. Armstrong
Paul Corrente – Andrew Piraneo
Mark Alexander – Kim Lesay
Chong Lung Chow
088-H034G

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Subject: **Final Plans for Review**
PE Project No. 171-305
Project No. 88-H034
New Britain-Hartford Busway
Newington Section

MEMORANDUM

Date: February 2, 2010

To: Mr. Richard B. Armstrong
Principle Engineer – Consultant Design
Bureau of Engineering and Construction

From: Michael E. Masayda
Principle Engineer – Hydraulics & Drainage
Bureau of Engineering and Construction

We have reviewed the final plan submission, which included both the Highway and Structure Plans, and offer the following comments. Review comments for the retaining walls and box culvert, as depicted on Drawing Nos. S-01 to S-26, were sent to the CE Bridge Section under separate cover dated 1/15/10. Our previous comments dated April 20, 2009 and May 26, 2009 have been adequately addressed based on the current submittal and designer's responses to those comments.

	INCL.	NOT INCL.
1. It is unclear from the plans what drainage work will be done under the subject contract (Proj. 88-H034), the Station Contract to the west, (Project 88-H039) and the adjacent busway mainline project to the south. (Project 88-H035) The proposed activities at the interface between the three projects should be better differentiated on the plan to avoid misunderstandings during construction.		
For example:		
• Sta. 118 + 00 Left – The catchbasin is shown as a proposed catchbasin in this busway project but is labeled as "Under Project No. 88-H035." Under which project will the catchbasin be installed?	✓	
RESPONSE: THE CB WILL BE INSTALLED UNDER CONTRACT NO. 88-H035.		
• Sta. 121 +00 Left – A proposed manhole is shown outside the busway footprint but is labeled as "Manhole (Station) See Contract No. 88-H039". Under which project will this manhole be installed? If it will be constructed under the Station contract then it should not be depicted as a proposed structure on this contract.	✓	
RESPONSE: THE MH WILL BE CONSTRUCTED UNDER CONTRACT NO. 88-H039. MH WILL BE SHOWN FOR INFO REFERENCE ONLY.		
2. Sta. 122 + 00 to Sta. 123 + 00		
a.) The catchbasins at Sta. 122 + 25 are located in a depressed sag condition, created by the proposed precast concrete barriers on both sides of the busway. A 25 year frequency rainfall should be imposed on the storm drainage system to ensure that the road will be passable during the higher frequency storm. See Section 11.7 and Table 11-2 of the Drainage Manual.	✓	
RESPONSE: ANALYSIS SHOWS THE CATCH BASINS MEET THE CRITERIA. DRAINAGE REPORT HAS BEEN REVISED ACCORDINGLY.		
b.) The catchbasin at Sta. 122 + 25 Right is labeled as a 6' diameter precast concrete structure. It is unclear why a 6' diameter manhole is necessary to carry the storm drainage system since the outlet pipe is 30" diameter, which will fit inside a standard catchbasin. (See also Sta. 123 + 10 Right)		✓
RESPONSE: 6' DIA. STRUCTURE IS REQUIRED DUE TO THE ANGLE BETWEEN THE CONNECTING PIPES.		
c.) The cross sections between Sta. 122 + 00 to Sta. 123 + 00 show that the inlets are proposed in the shoulder, several feet away from the edge of the barrier curb. Shift the catchbasins grates to the precast concrete barrier curb to improve their interception capacity and avoid ponding. Impose a clogging factor since the catchbasins don't have a throat.	✓	
RESPONSE: THE CB'S ARE AT THE GUTTERLINE AND THE CLOGGING FACTOR WAS ADDED CATCH BASIN AT THE LOW POINT. NO THROAT IS PROPOSED FOR THIS CB.		

	INCL.	NOT INCL.

3. Include a detail for the Special Type "C" catchbasins that are proposed at the precast concrete barrier. The detail is included in the Drainage report but omitted from the plans sheets. Coordinate with the Conn DOT project engineer to ensure that the same "Special" catchbasin detail is applied at similar locations within the limits of the busway project. ✓

4. Section 14 in the 90% design report, entitled Stream Channel Encroachment, indicates that no fills are proposed within the Stream Channel Encroachment lines (SCEL) but the cross sections show several feet of fill between Sta. 125 + 00 to Sta. 129+00, where the busway will be under the existing Route 9 bridge. These SCEL impacts should be noted in the Design Report and addressed in the environmental permit package accordingly. ✓
RESPONSE: THE SCEL IMPACT TABLE HAS BEEN REVISED TO INCLUDE THIS AREA.

5. Cross Section Sta. 133 + 00 Far Left
A low spot is being created with no provision for an inlet. All cross sections should be checked to ensure that off road areas are graded to drain properly and avoid unnecessary ponding conditions. See also Cross Section at Sta. 196 + 00 alongside private property. ✓
RESPONSE: THE CROSS SECTIONS HAVE BEEN REVISED TO DRAIN PROPERLY.

6. Details should be included for the swales, ditches and channels being proposed on the project. ✓

7. The number of catchbasins that are proposed between Highpoint (HP) Sta. 128 + 33 to HP Sta. 150 +07 is questionable (too low) based on the drainage area contributing to the lowpoint at CB Sta. 145 + 64 Left. Review the gutterflow analysis and design parameters presented for Drainage systems 2 and 3 of the drainage report to verify that the allowable design spread width will be achieved. Additional catchbasin inlets or a double great catchbasin may be required. ✓

   For example:

   a.) The width of flow computation for the two on grade catchbasins that are proposed at Sta. 135 + 50 Left and Sta. 138 + 50 Left assume that the catchbasin are at a lowpoint and do not account for the Q bypass that contributes to the next down gradient catchbasin. The gutterflow calculations should be adjusted to provide an accurate runoff contributing to the lowpoint. ✓

   b.) The shoulder cross slope used in the calculations for the Lowpoint catchbasin at Sta. 145 + 64 Left is 0.05'/' which is steeper than the 0.04'/' cross slope depicted on the typical sections and cross sections. Revise the gutterflow calculations accordingly. ✓

8. Item 17 of the *Drainage Design Checklist* indicates that the report includes documentation that alternate drainage pipe material were considered in the project but this information was not found in the drainage report. ✓

	INCL.	NOT INCL
9. The proposed ground elevations depicted on the cross sections that begin at Sta. 146 + 50 Right, in vicinity of the Cedar St. Bridge, do not match into the existing terrain. If the busway's proposed ground elevations are intended to match into those that reflect the new Bridge grading then it should be depicted more clearly on the cross sections.	✓	
10. The Type H erosion control matting should be labeled "Permanent" on the design plans as discussed in Section 7.6.8 of the Drainage Manual entitled Erosion Control Matting. (i.e Erosion Control Matting - Type H (Permanent)).	✓	
11. The 2-year return period is typically used to design temporary linings for roadside channels. This design measure should be applied for future projects where temporary lining warranted. See Section 7.6.7 in the Drainage Manual entitled *Design Parameters.*	✓	
12. <u>Sta. 152 + 00 Left to Sta. Sta. 157 + 00 Left (Busway in front of Cedar Street Station)</u>		
a.) A Type "C-L" catchbasin is proposed in the middle of the Cedar St. Station driveway and will capture very little flow. Consider shifting the catchbasin to the curbline to be more effective in capturing the pavement runoff. RESPONSE: THE CB HAS BEEN RELOCATED TO CURB SECTION AS REQUIRED	✓	
b.) The final plans for the Cedar St. station have not yet been submitted for review. The Busway mainline designer should coordinate with the Station designer accordingly to ensure that the interface between the stations <u>both at Cedar Street and East Main Street</u> is accurately represented on plans and cross sections. RESPONSE: DESIGN COORDINATION IS ON GOING.	✓	
<u>For example:</u> The cross sections in front of the Cedar St. Station do not show the proposed grading at Cedar Station. Although it is uncertain which contract will be built first, this information should be shown for the Final submission either as a future or proposed condition.		
13. A slope protection detail should be included in the project drawings.	✓	
14. The cross section in vicinity of the cross culvert at Sta. 174 + 80 shows that the invert elevation for the new 6' x 6' box culvert (elev. 65.2) is shown several feet higher than that on the plans and in the calculations (flow line elev. 63.7/ invert elev. of 62.7). Review and revise accordingly. RESPONSE: THE CULVERT AND SECTION HAVE REVISED AS REQUIRED	✓	

Yolanda Antoniak/gmp
cc: Joseph J. Obara
Paul N. Corrente – Andrew Piraneo
Mark W. Alexander – Kim C. Lesay
Chong L. Chow
Dave Mancini

Cory Garro

From:	Lesay, Kimberly C [Kimberly.Lesay@ct.gov]
Sent:	Wednesday, December 16, 2009 2:01 PM
To:	Mancini, David M.; Cunningham, Brian T
Cc:	Natwick, Brian J.; Piraneo, Andrew; Alexander, Mark W; LaRocca, Laurie I.
Subject:	88-H034 Final Plan review

I have reviewed the final plans provided, dated November 12, along with responses to comments and offer the following:

Follow up on previous comments dated May 15, 2009:

- **Comment #2 requests that access be depicted if necessary for construction of the retaining walls. The response states that access from the busway is sufficient. Please clarify how this work will be done entirely from above. Is the wall prefabricated? and how will it be set? how will the bedding for it be prepared from above?** (see below)
- **Comment #3 - If natural streambed material is being provided within the culvert, then why would it wash away at the scour hole?** CJM WAS DIRECTED BY CONNDOT TO PLACE ONE FOOT DEEP LAYER OF NATIVE SOIL INSIDE THE CULVERT. ONCE CULVERT IS IN OPERATION, NO ONE CAN GUARANTEE THE SOIL WON'T WASH OUT.
- **Sheet 57 - at station 144+50 Right, is grading truly required past the wetland line? If so, this grading must be counted as impact** *
- **Sheet S-22 - the temporary dewatering basin appears to slightly impact wetlands beyond the impact footprint. please move this basin upslope and out of the regulated area.** - The basin has been revised.

Report and plans have been forwarded to Paul Corrente's crew for further comment. Thanks, Kim

Kimberly Lesay
Environmental Planning Division
Department of Transportation
2800 Berlin Turnpike
PO Box 317546
Newington, CT 06131-7546
phone (860) 594-2933
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Kimberly.Lesay@ct.gov

"Today's problems cannot be solved if we still think the way we thought when we created them."- Albert Einstein

* GRADING IS REQUIRED TO DISCHARGE STORM SEWER SYSTEM.

Comment #2 : The work can be done from above using cranes to set the prefabricated wall. The slope can be benched as needed to prepare the bedding. A temporary earth retention system will be used to avoid the wetlands.

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

memorandum

subject: Final Plan Design Review
88-H034
New Britain – Hartford Busway
Newington Section
Town of Newington

date: January 8, 2010

to
Brian Cunningham
Transportation Supervising Engineer
Consultant Design – Highway Design
Bureau of Engineering and Construction

from
Paul Corrente
Transportation Supervising Planner
Environmental Planning
Bureau of Policy and Planning

ext.

Type of Review:

☐ Schematic Design ☐ Preliminary Design ☐ Semi-Final Design ☒ Final Design ☐ Permit ☐ Other:

My staff has reviewed the above mentioned project and the water resource compliance section of this office offers the following comments:

Comment #	Loc. or Sheet #	Comment	Inc.	Not Inc. (If not, WHY)	
1	TYP	Not all of the Typical Sections have incorporated the Legend T or have been graphically updated in areas under the Legend G and I. Please clarify.	✓		
2	MDS-01	• The riprap apron at Sta. 138+80 LT is not shown. Please clarify. • Is the riprap apron at Sta. 156+00 RT really 157+00 RT? Please clarify.	✓		PLANS WILL BE REVISED AS REQUIRED
3	PLN	Is there a reason for a 5-foot high chain link fence on the south side for the entire length of the project? Access will be required at all outlets for routine inspections and maintenance. Also, please review the placement of the fence in areas adjacent to swales, ditches, etc... and within cut and fill limits.		✓	CONNDOT IS INVESTIGATING ISSUE. CJM WILL INCL AS REQ'D
4	DRG	• The XSC's show a 6-inch underdrain and the DRG sheets callout a 4-inch underdrain. Please clarify.	✓		4" UNDERDRAIN
		• For SB-3, the XSC shows a type C CB versus "Special" as called out on the plan sheet. Please clarify.	✓		CROSS SECTION THAT WILL BE USED
		• The XSC from Sta. 129+50 to 130+50 shows no curbing. Please clarify if the intent is to have sheet flow from the busway runoff over the trail.		✓	IMPACT ATTENUATOR REQUIRES NO CURBING
		• This office is recommending that the MH's located within the trail be relocated onto the busway, as visual inspections and routine maintenance will be easier from the busway.		✓	MH'S CAN BE ACCESSED FROM M-7 TRAIL.
		• On the DRG-04, the XSC's continue to slotted pipe. Please clarify.	✓		SLOTTED PIPE IS NOT USED
		• For SB-16, the XSC shows Type C CB versus a Type C-L on the plan sheet. Please clarify.	✓		CB WILL BE RELOCATED TO CURB SECTION
		• For Site 2B, a water-handling plan will be required for the proposed 36-inch cross culvert.		✓	DRY STREAM NOT REQ'D
5	PRO	The profile sheets continue to show slotted pipe. Please clarify.	✓		NO SLOTTED PIPE
6	STR	For retaining wall (RW) 3 and 4, which is adjacent to and in wetlands, this office concurs with Ms. Kim Lesay's comment that more is needed to be shown and or explained regarding access			

		and constructability. It is generally understood that the temporary earth retaining system and proprietary walls will be constructed from existing grade upward. However, if the temporary earth retaining system is to be left in place, as suggested, it will need to be cut a minimum of 3-feet below grade and not left exposed, especially in a wetland area. If the wetland systems are in areas which are subject to flooding, then the temporary earth retaining system would have to be designed at a minimum elevation to withstand a significant storm event. The following questions need to addressed: 1. Once the wall is in place, how will the Contractor gain access to cut the sheets 3-feet below grade? 2. How will the Contractor back fill the open excavation within the wetland after the wall is in place? 3. Do the retaining systems need to be at a minimum elevation to keep potential flows out of the work area? NO. 4. Dewatering will likely be required to keep groundwater and or back flows from entering the work site. How will this operation occur? Where will the setting basin be located and discharge? Pump to BASINS outside wetland (AOBE). 5. Keep in mind that the wording "temporary" is no longer valid when proposing to leave them in place, as the permanent placement is now considered a permanent wetland impact and should be accounted for. (see below). 6. Any potential temporary access will need to be accounted for and shown on the plan sheets and permit plates. 7. All above said work within the wetland systems need to permitted and shown on the plans and permit plates. 8. How will the disturbed wetland areas be restored after construction? 9. Where will the 6-inch underdrain discharge?	X X X X X X X X X	
7	STR	The water-handling plan for the 6x6 box culvert is incomplete. Full containment will be required on the downstream end to construct the cast in place retaining walls and flared wingwalls. It also appears that the earth retaining system upstream needs to offset further. The following information is required: 1. Detailed staging plans. 2. A sequence of construction. This should include work associated with the RW 3. 3. Cofferdam and dewatering. 4. What is the two-year elevation? 5. The permit will require all of the above information.	X X X X X	

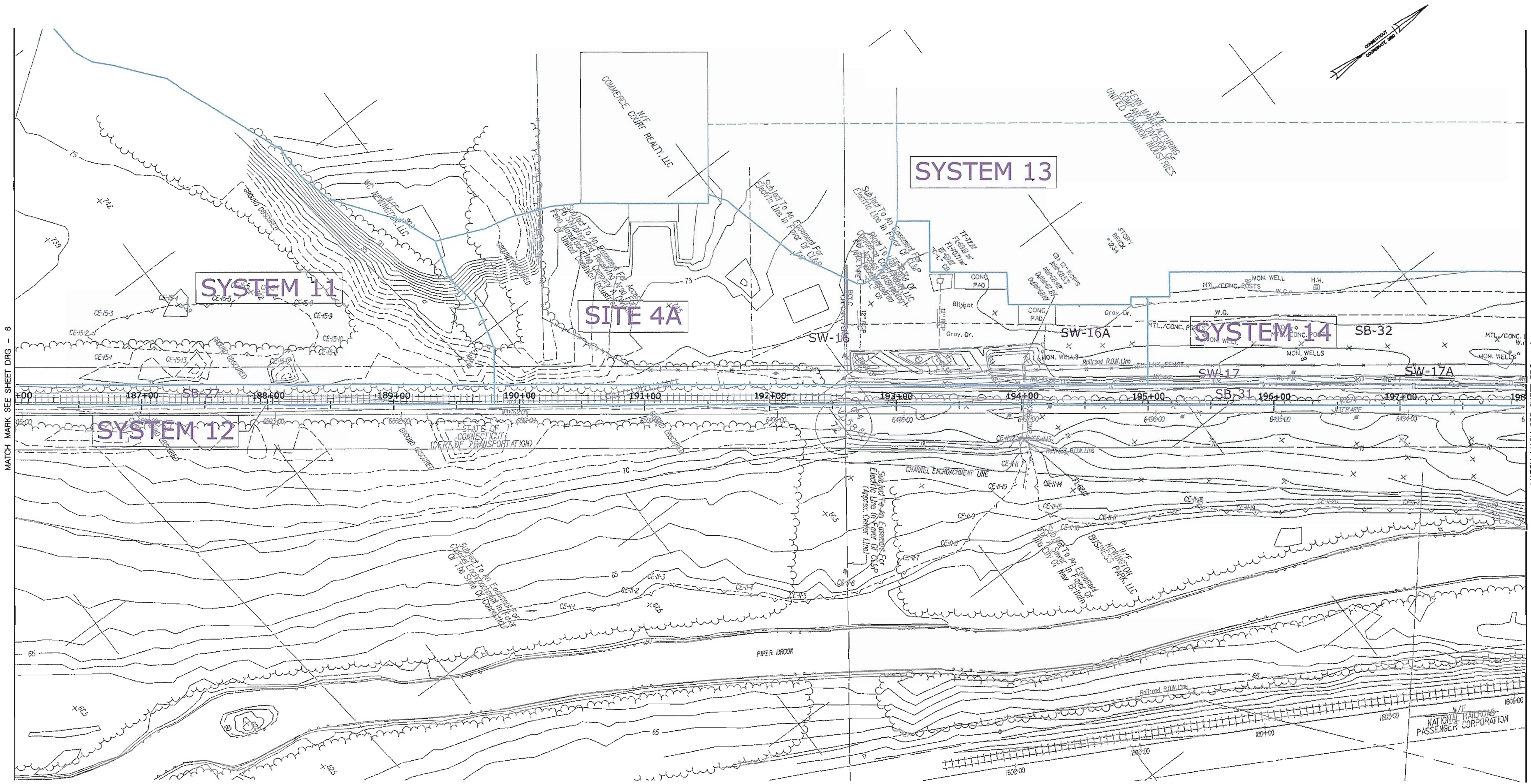
If you have any questions regarding these comments, please contact Mr. Paul Corrente at 860-594-2932.

Andrew Piraneo/ap

cc: Colleen Kissane – Paul Corrente – Andrew Piraneo
Mark Alexander – Kim Lesay – Amanda Freitas
Tim Wilson – Richard Armstrong
Dave Mancini – Bob Reilly – Kevin Mahoney - Laurie LaRocca
Chung Lung Chow – Yolanda Antoniak
Jacob Argiro

Comment 6 The earth retaining system has been revised from stay-in-place, to a temporary system. The back fill can be placed concurrent with the wall construction without encroaching beyond the earth retaining system by using an excavator, positioned within the work area. Access will be from the busway work area. Wetland soils will be used to restore the disturbed areas. The underdrain details will be provided by the proprietary Wall designer in accordance with the specifications

APPENDIX B
EXISTING WATERSHED MAPS



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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.

Plotted: 10/22/2009

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET 0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

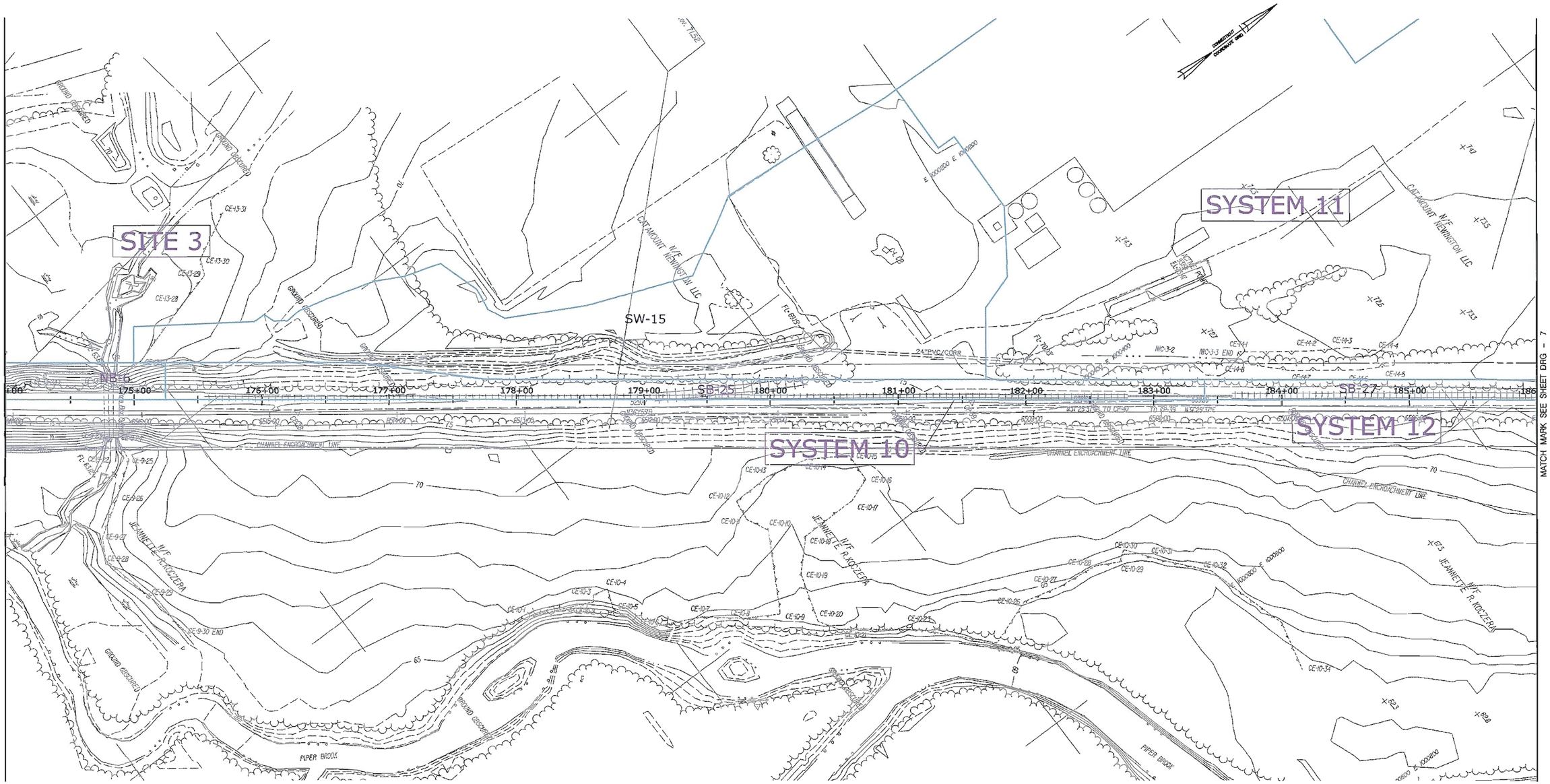
Filename: $FILE$

SIGNATURE/BLOCK: OFFICE OF ENGINEERING
APPROVED BY: -
DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305
DRAWING NO. B-07
SHEET NO.



REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 10/22/2009

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

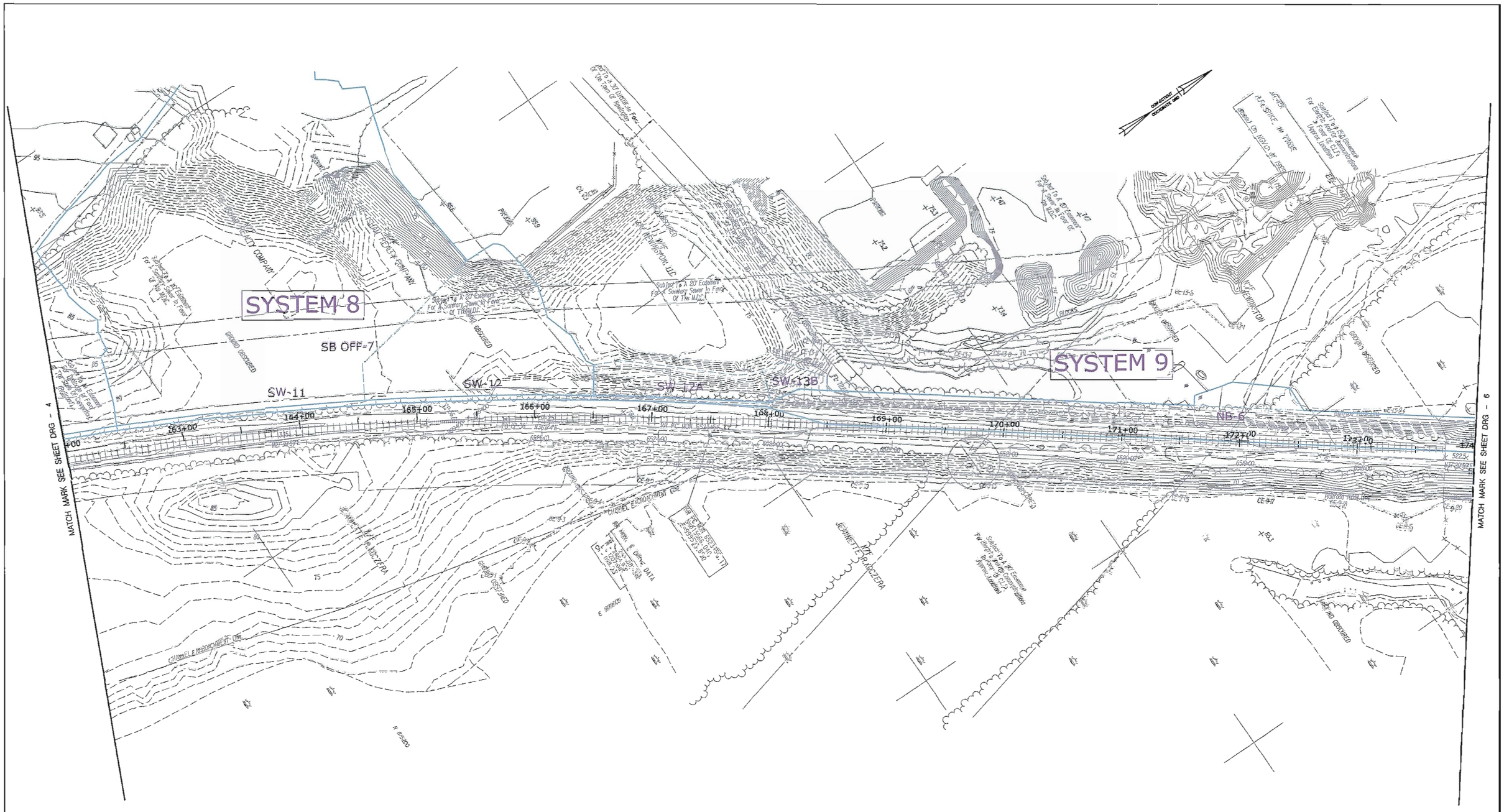
Filename: $FILE$

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305
DRAWING NO. B-06
SHEET NO.



REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 10/22/2009

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILE$

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305
DRAWING NO. B-05
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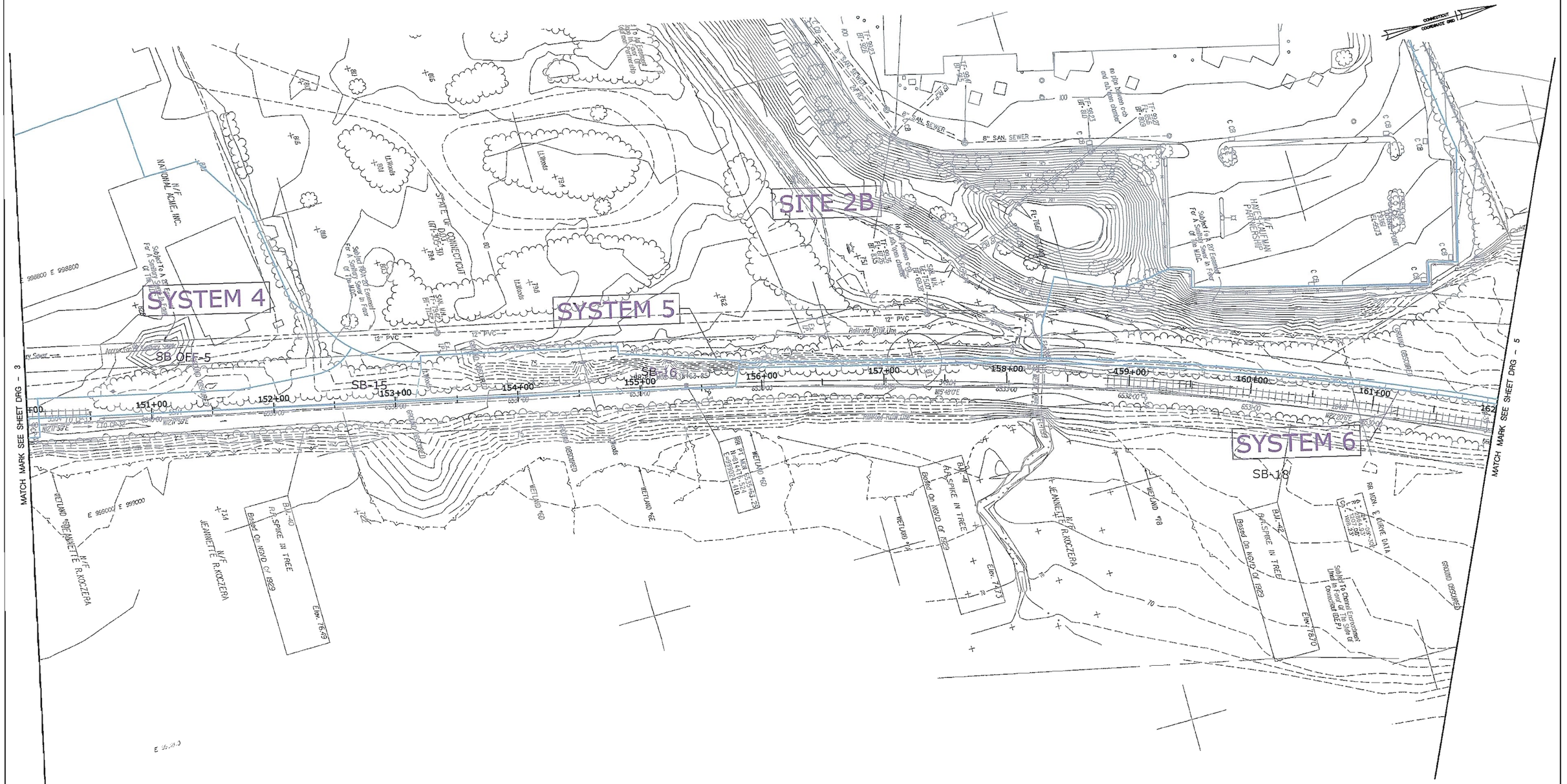

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Plotted: 10/22/2009

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SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

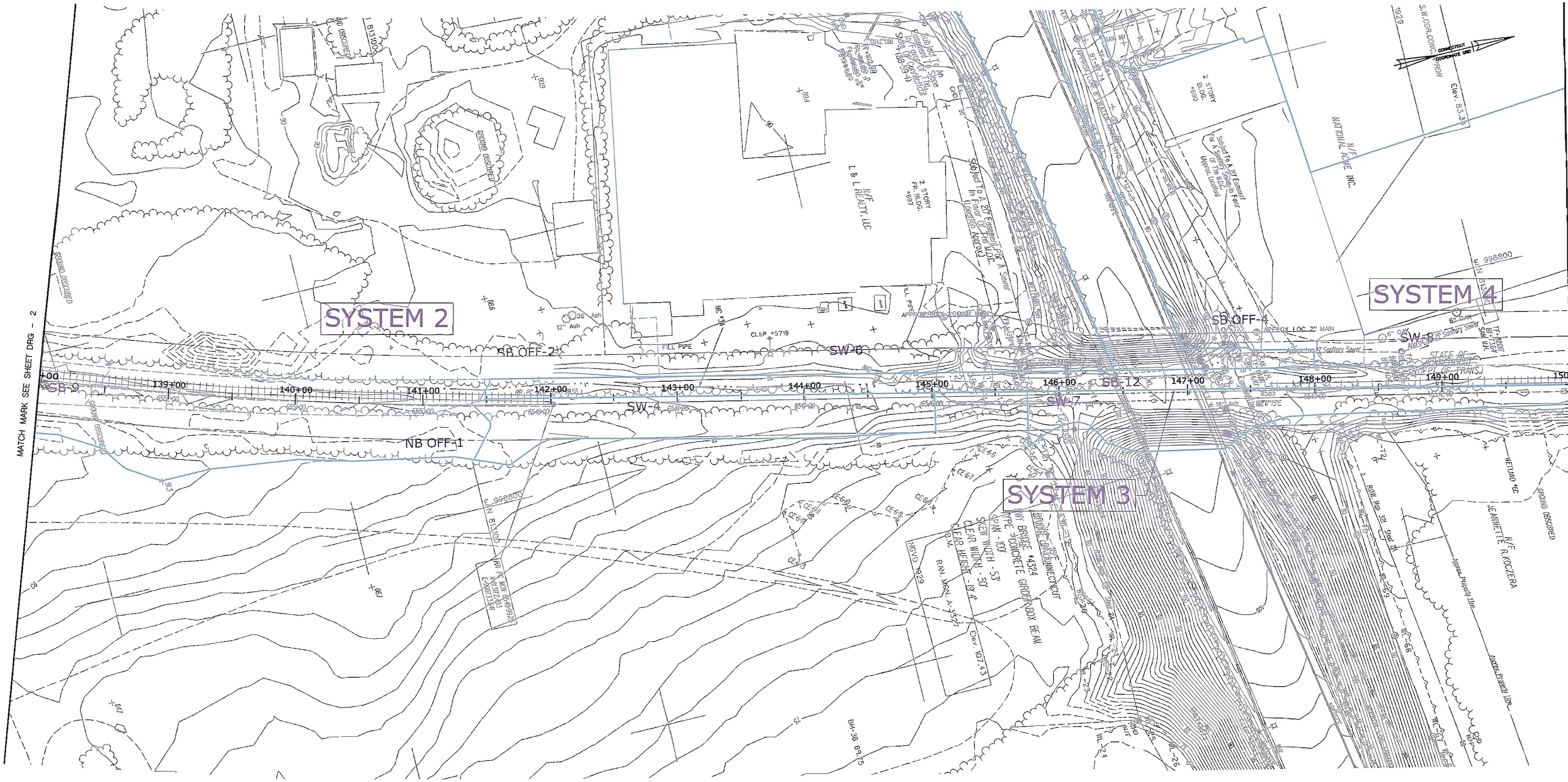
Filename: $FILE$

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305
DRAWING NO. B-04
SHEET NO.



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Plotted: 10/22/2009

DESIGNER/DRAFTER: AB/JF

CHECKED BY: CG

SCALE IN FEET 0 40 80

SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILE$

SIGNATURE/BLOCK: OFFICE OF ENGINEERING

APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

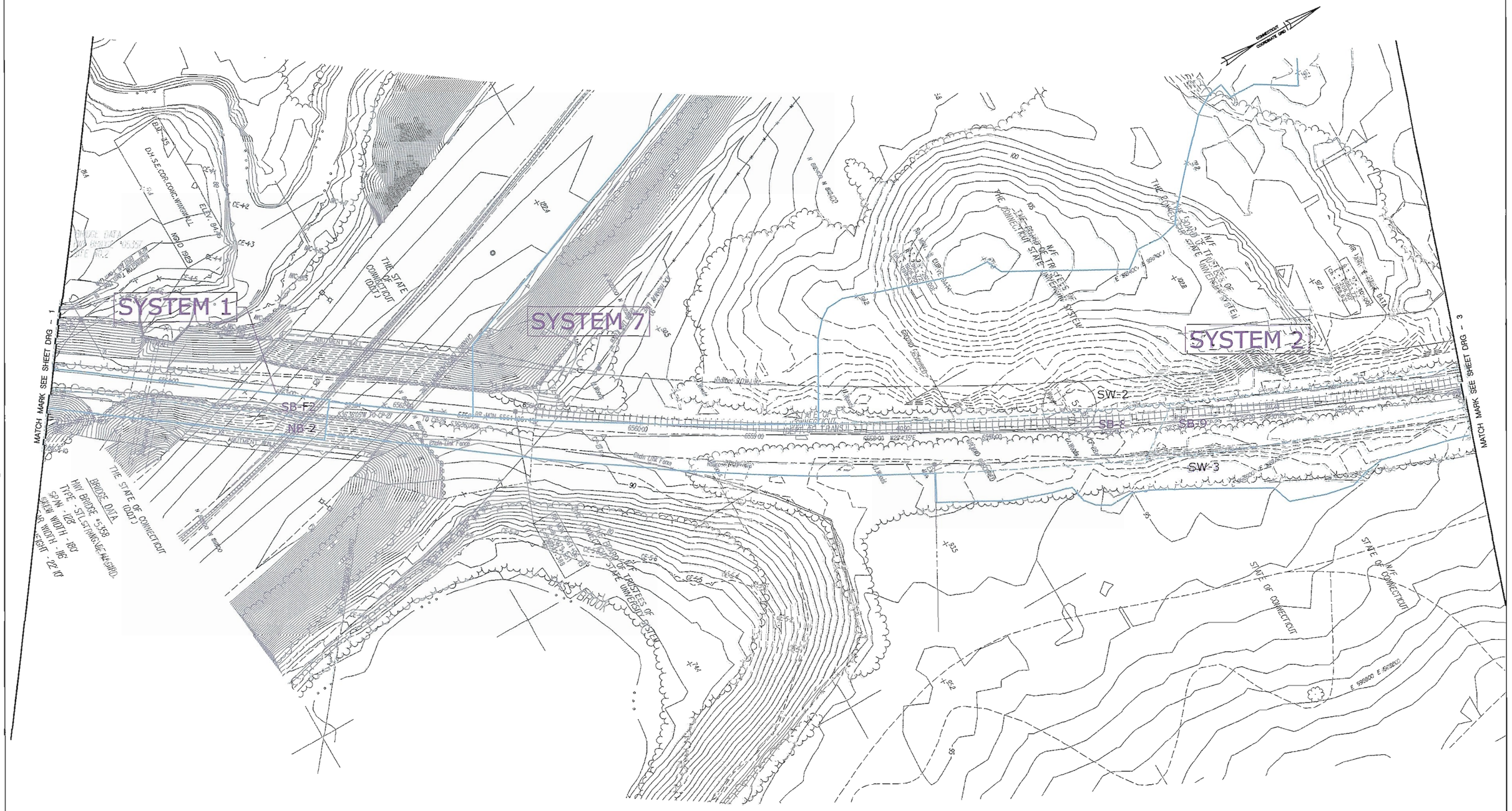
TOWN: NEWINGTON

DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305

DRAWING NO. B-03

SHEET NO.



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Plotted: 10/22/2009

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

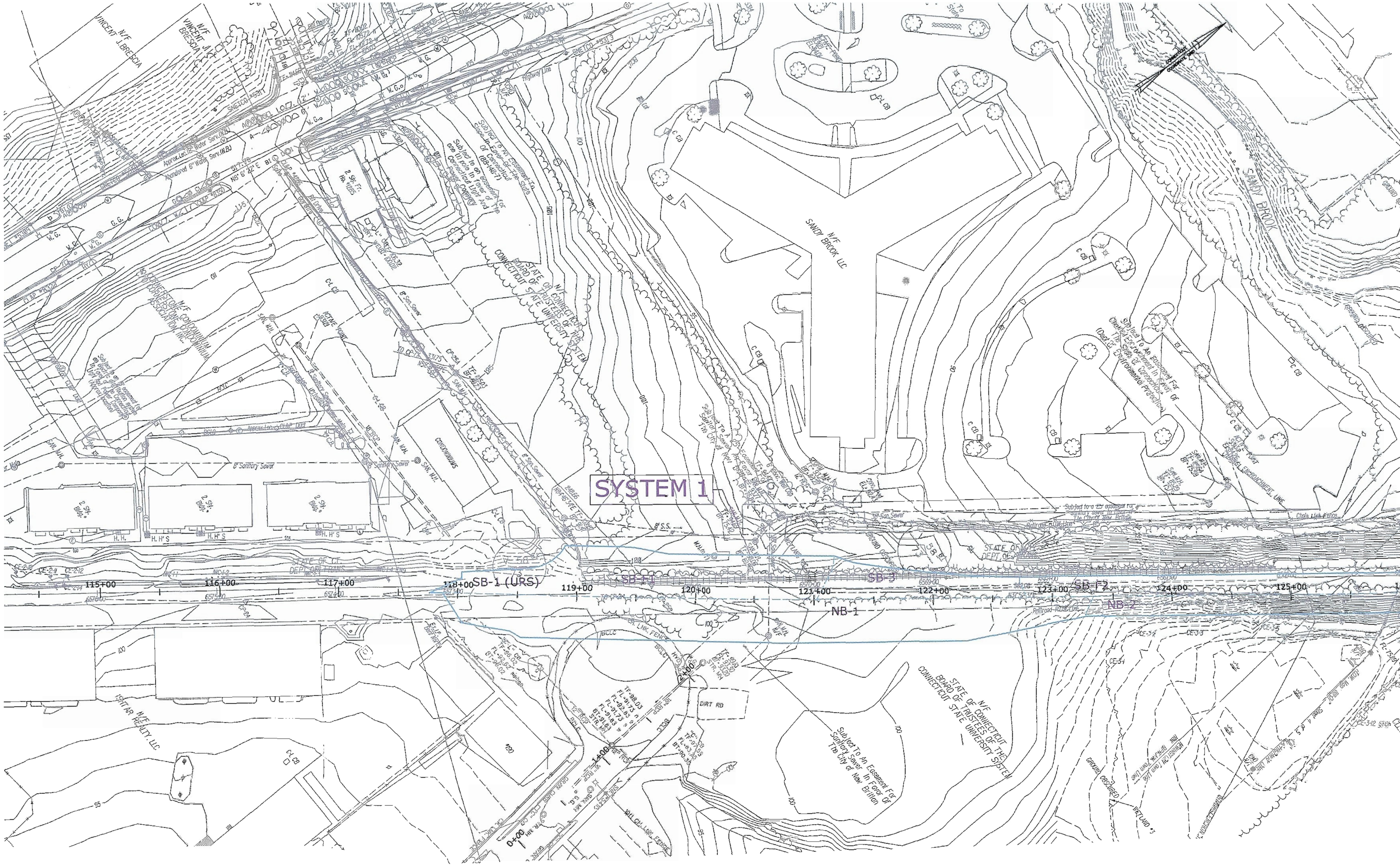
Filename: $FILE$

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305
DRAWING NO. B-02
SHEET NO.



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Plotted: 10/22/2009

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET 0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

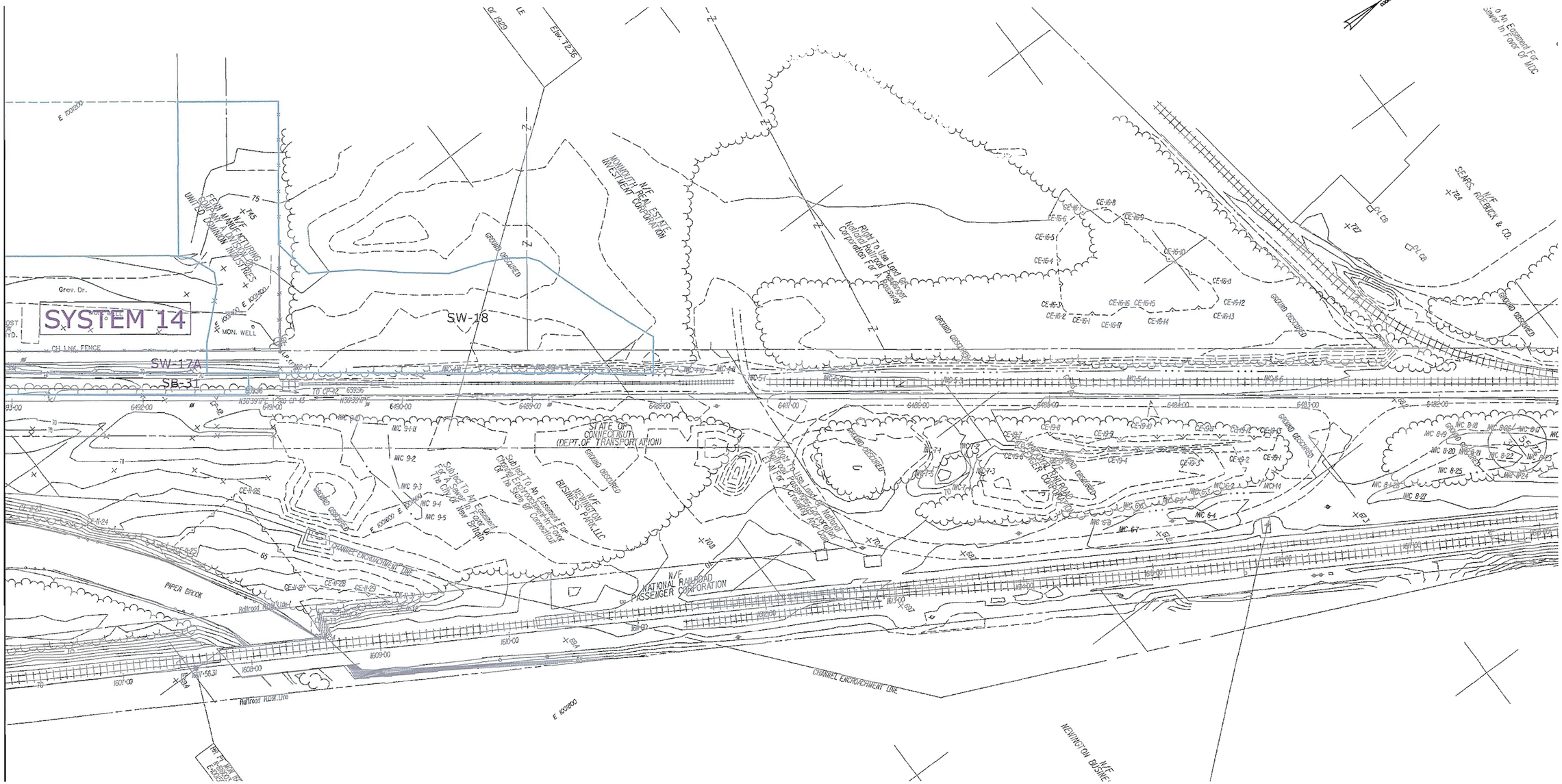
Filename: $FILE$

SIGNATURE/BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: EXISTING DRAINAGE MAP

PROJECT NO. 171-305
DRAWING NO. B-01
SHEET NO.



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Plotted: 10/22/2009

DESIGNER/DRAFTER: **AB/JF**

CHECKED BY: **CG**

SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW_MSH_088_H034_EXIST_B-08.dgn

SIGNATURE/ BLOCK:
OFFICE OF ENGINEERING

APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY

TOWN:
NEWINGTON

DRAWING TITLE:
EXISTING DRAINAGE MAP

PROJECT NO.
171-305

DRAWING NO.
B-08

SHEET NO.

MATCH MARK SEE SHEET DRG - 6

MATCH MARK SEE SHEET DRG - 8

SYSTEM 13

SEDIMENTATION CONTROL SYSTEM (TYPICAL)

WETLAND 11

670'-4" UNDERDRAIN

560'-4" UNDERDRAIN

SYSTEM 12

NB-8
TYPE 'C-L' CB
STA. 186+00, 16' RT.
T.F. =74.77
F.L. =70.90

100 YEAR FLOOD LIMIT (TYP)

58'-12" RCP

4'-12" RCP

FMH-1
MANHOLE
STA. 192+70, 58' LT.
T.F. = 73.25
F.L. = 69.69

SW-16
GRASS LINED CHANNEL
(B=4', D=2', Z=2)
W/ 8' WIDE E.C.M. TYPE "G"

OUTLET FOR UNDERDRAIN

COMMUNICATIONS CONDUIT

OUTLET FOR UNDERDRAIN

CHANNEL ENCROACHMENT LINE

18" RCCE
F.L.=67.00

TYPE-I SCOUR HOLE
(MODIFIED RIPRAP)

4'-12" RCP

FMH-2
MANHOLE
STA. 193+35, 58' LT.
T.F. = 73.25
F.L. = 69.38 (12"W)
F.L. = 69.11 (12"S)
F.L. = 68.00 (18")

84'-18" RCP

SB-34
TYPE 'C-L' CB
DOUBLE GRATE TYPE II
W/ PAVED APRON
STA. 194+00, 42' LT.
T.F. = 71.50
F.L. = 68.20

24'-15" RCP

SB-30
TYPE 'C' CB
STA. 194+00, 16' LT.
T.F. =74.43
F.L.=68.06

SW-16A
GRASS LINED DITCH
(B=2', D=2', Z=2)
W/ 4' WIDE E.C.M. TYPE "G"

42'-15" RCP

EXISTING CULVERT TO BE REMOVED

15" RCCE
F.L. = 67.80

TYPE-I SCOUR HOLE
(MODIFIED RIPRAP)

CROSS CULVERT
SITE 4A

IWC 4-1 TO 4-11

SW-17
GRASS SWALE
W/8' WIDE E.C.M.
TYPE "G"

SB-32
TYPE 'C-L' CB
W/ PAVED APRON
STA. 196+99, 42' LT.
T.F. = 71.50
F.L. = 69.36

28'-12" RCP

SW-17A
GRASS SWALE
W/8' WIDE E.C.M.
TYPE "G"

WETLAND 7E

SB-31
TYPE 'C' CB
STA. 196+99, 16' LT.
T.F. =73.03
F.L.=69.21

26'-12" RCP

NB-9
TYPE 'C-L' CB
STA. 196+99, 16' RT.
T.F. = 73.08
F.L. = 68.92

14'-12" RCP

12" RCCE
F.L.=68.50

TYPE 2 SCOUR HOLE
(MODIFIED RIPRAP)

SYSTEM 14

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 5/12/2010

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DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILE$

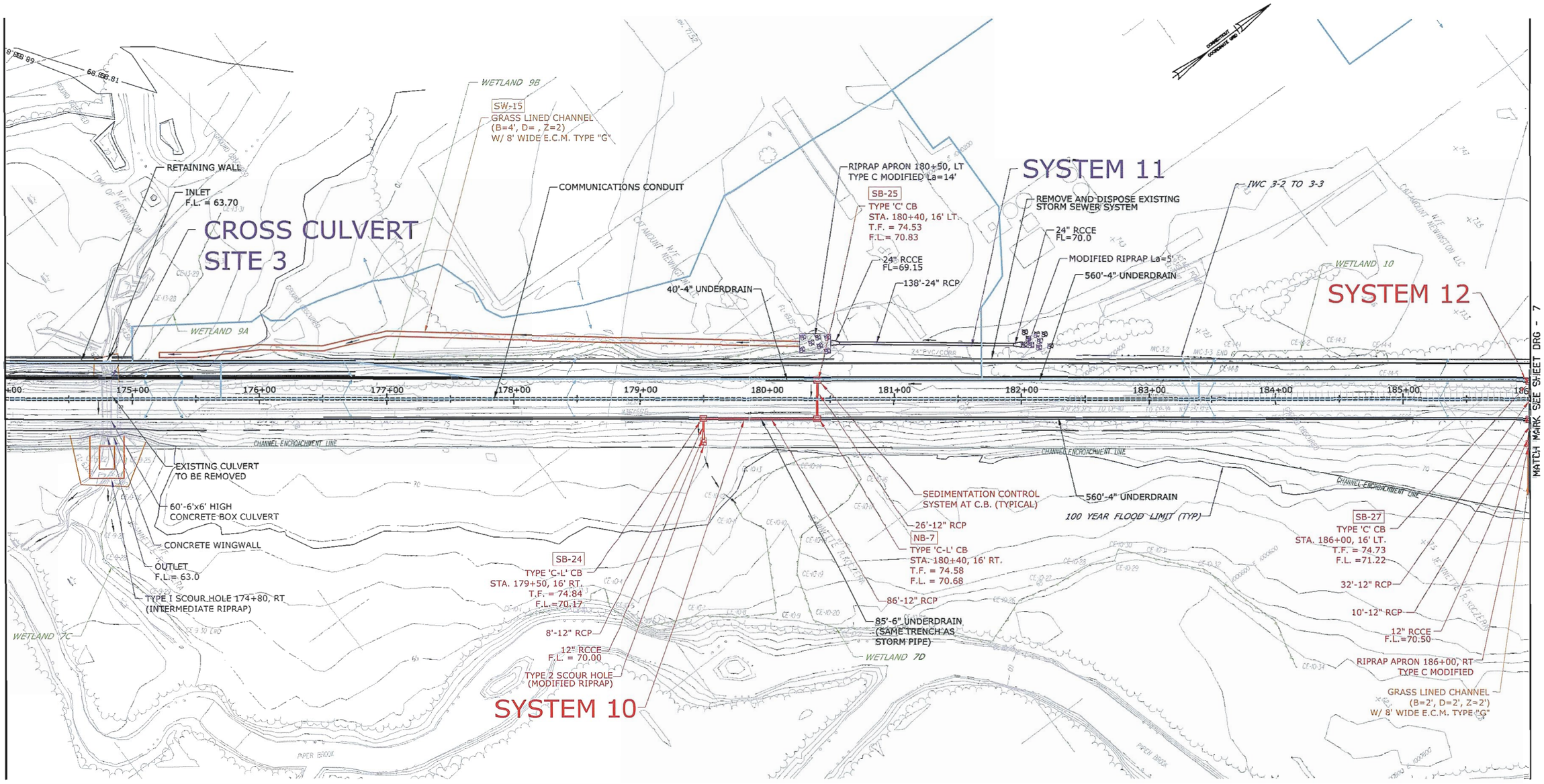
SIGNATURE/BLOCK: OFFICE OF ENGINEERING
APPROVED BY: -
DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON

DRAWING TITLE: DRAINAGE PLAN

PROJECT NO. 171-305
DRAWING NO. C-07
SHEET NO.



REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 5/12/2010

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET 0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: sFILE5

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: DRAINAGE PLAN

PROJECT NO. 171-305
DRAWING NO. C-06
SHEET NO.

MATCH MARK SEE SHEET DRG - 4

MATCH MARK SEE SHEET DRG - 6

SB OFF-7
TYPE 'C-L' CB W/ PAVED APRON
STA. 164+50, 46' LT.
T.F. = 75.75
F.L. = 73.45

SYSTEM 8

SEDIMENTATION CONTROL SYSTEM AT C.B. (TYPICAL)

SW-11
GRASS LINED DITCH
(B=2', D=2, Z=2)
W/ 12' WIDE E.C.M. TYPE "G"

4" UNDERDRAIN

SW-12
GRASS LINED DITCH
(B=2', D=1, Z=2)
W/ 4' WIDE E.C.M. TYPE 'G'

SW-13A
GRASS LINED DITCH
(B=1', D=2', Z=2)
W/ 4' WIDE E.C.M. TYPE "G"

SW-13B
GRASS LINED DITCH
(B=2', D=1', Z=2)
W/ 4' WIDE E.C.M. TYPE "H"
(PERMANENT)

RETAINING WALL NO.103

WETLAND 9A

100 YEAR FLOOD LIMIT (TYP)

COMMUNICATIONS CONDUIT

SB-22
TYPE 'C' CB
STA. 171+65, 16' LT.
T.F. = 74.84
F.L. = 71.00

H.P.

163+00 164+00 165+00 166+00 167+00 168+00 169+00 170+00 171+00 172+00 173+00

68.61 19.89

CHANNEL ENCROACHMENT LINE

4" UNDERDRAIN

128'-15" RCP

15" RCCE
F.L. = 72.50

OUTLET FOR UNDERDRAIN

RIPRAP APRON 165+20, RT.
TYPE A MODIFIED La=10'

100 YEAR FLOOD LIMIT (TYP)

WETLAND 7C

SYSTEM 9

26'-12" RCP

NB-6
TYPE 'C-L' CB
STA. 171+65, 16' RT.
T.F. = 74.88
F.L. = 70.00 (12"W)
F.L. = 68.20 (12"E)

16'-12" RCP

12" RCCE
F.L. = 66.00

SCOUR HOLE 171+65, RT
TYPE I MODIFIED RIPRAP

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 5/12/2010

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DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET 0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILE$

SIGNATURE/ BLOCK:
OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY

TOWN:
NEWINGTON

DRAWING TITLE:
DRAINAGE PLAN

PROJECT NO. 171-305
DRAWING NO. C-05
SHEET NO.

CROSS CULVERT SITE 2B

MATCH MARK SEE SHEET DRG - 3

MATCH MARK SEE SHEET DRG - 5

SW-8
GRASS LINED DITCH
(B=2', D=1.5', Z=2)
W/ 6' WIDE E.C.M. TYPE "G"

SB OFF-5
TYPE 'C-L' CB W/ PAVED APRON
STA. 150+09, 41' LT.
T.F. = 80.00
F.L. = 75.85

SEDIMENTATION CONTROL SYSTEM AT C.B. (TYPICAL)

20'-18" RCP

MH-S51
MANHOLE
T.F.=84.67
F.L.=76.00(15")
F.L.=75.75(18")
F.L.=75.25(24")

4" UNDERDRAIN

SW-9
GRASS LINED SWALE
W/ 8' WIDE E.C.M. TYPE "G"

CEDAR STREET STATION
SEE CONTRACT NO. 88-H039

SYSTEM 5

SB-15
TYPE 'C' CB
STA. 153+00, 31' LT.
T.F. = 82.71
F.L. = 78.90

8'-12" RCP

174'-12" RCP

MANHOLE
STA. 154+90, 24' LT.
T.F.=82.08
F.L.=77.98

6'-12" RCP

TYPE 'C' CB
STA. 155+00, 27' LT.
T.F. = 81.89
F.L.=77.95 (12")
F.L.=77.70 (15")

64'-15" RCP

SB-16
TYPE 'C-L' CB
STA. 155+65, 35' LT.
T.F. = 81.90
F.L.=77.25

112'-15" RCP

50'-15" RCP

36" RCCE
F.L.=72.81

TYPE 'C-L' CB
STA. 156+80, 16' LT.
T.F. = 81.90
F.L.=76.47

SPECIAL RIPRAP SLOPE PROTECTION

SB-18
TYPE 'C' CB
STA. 159+85, 16' LT.
T.F. = 80.71
F.L.=77.00

460'-4" UNDERDRAIN

SW-10
GRASS LINED DITCH
(B=2', D=1.5', Z=2)
W/ 8' WIDE SYNTHETIC MAT TYPE "H"

SYSTEM 6

475'-4" UNDERDRAIN

28'-12" RCP

NB-5
TYPE 'C-L' CB
STA. 159+85, 16' RT.
T.F. = 79.93
F.L. = 76.86 (12")
F.L. = 74.13 (15")

26'-15" RCP

15" RCCE
F.L.=74.00

RIPRAP APRON 159+70, RT
TYPE A MODIFIED La=10'

68'-36" RCP
F.L.=71.81

SCOUR HOLE
158+25, RT
TYPE I MODIFIED

MANHOLE
STA. 153+10, 24' LT.
T.F. = 82.88
F.L. = 78.86

COMMUNICATIONS CONDUIT

SEDIMENTATION CONTROL SYSTEM (TYPICAL)

50'-24" RCP

24" RCCE
F.L.=77.00

RIPRAP APRON 150+09, RT
TYPE A MODIFIED La=16'

SYSTEM 4

MH-4
MANHOLE
STA. 156+55, 30' RT
T.F.=81.00
F.L.=75.97(W)
F.L.=72.60(E)

34'-15" RCP

15" RCCE
F.L.=72.40

RIPRAP APRON 157+00 RT
TYPE A MODIFIED La=10'

100 YEAR FLOOD LIMIT (TYP)

WETLAND 6D
WETLAND 6E
WETLAND 7A
WETLAND 7B
WETLAND 8C

151+00 152+00 153+00 154+00 155+00 156+00 157+00 158+00 159+00 160+00 161+00

70.81

Based On NGVD Of 1929

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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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.

Plotted: 5/12/2010

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET 0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

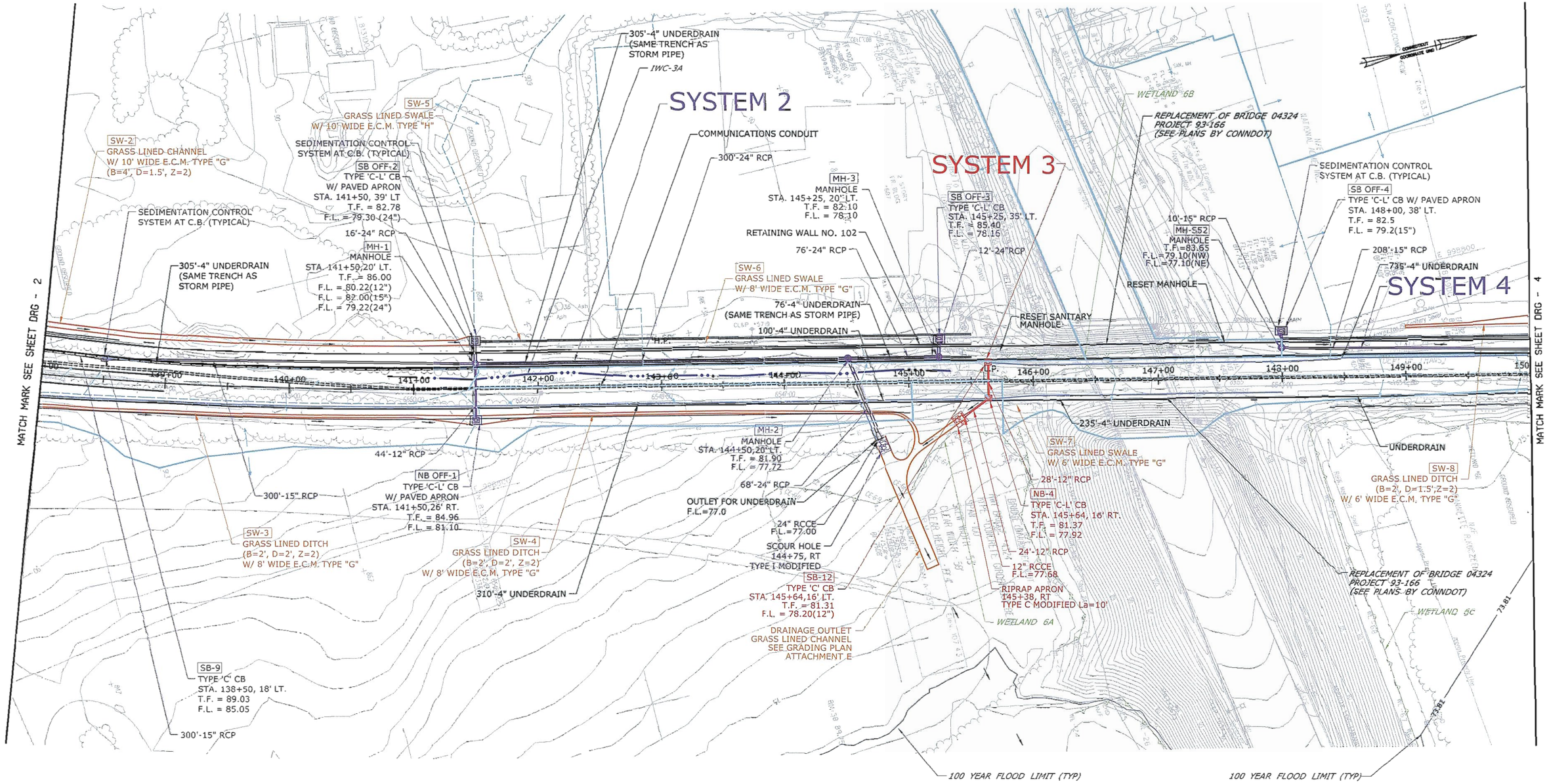
Filename: $FILE$

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: DRAINAGE PLAN

PROJECT NO. 171-305
DRAWING NO. C-04
SHEET NO.



REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 5/12/2010

DESIGNER/DRAFTER: AB/JF

CHECKED BY: CG

SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILE$

SIGNATURE/BLOCK: OFFICE OF ENGINEERING

APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

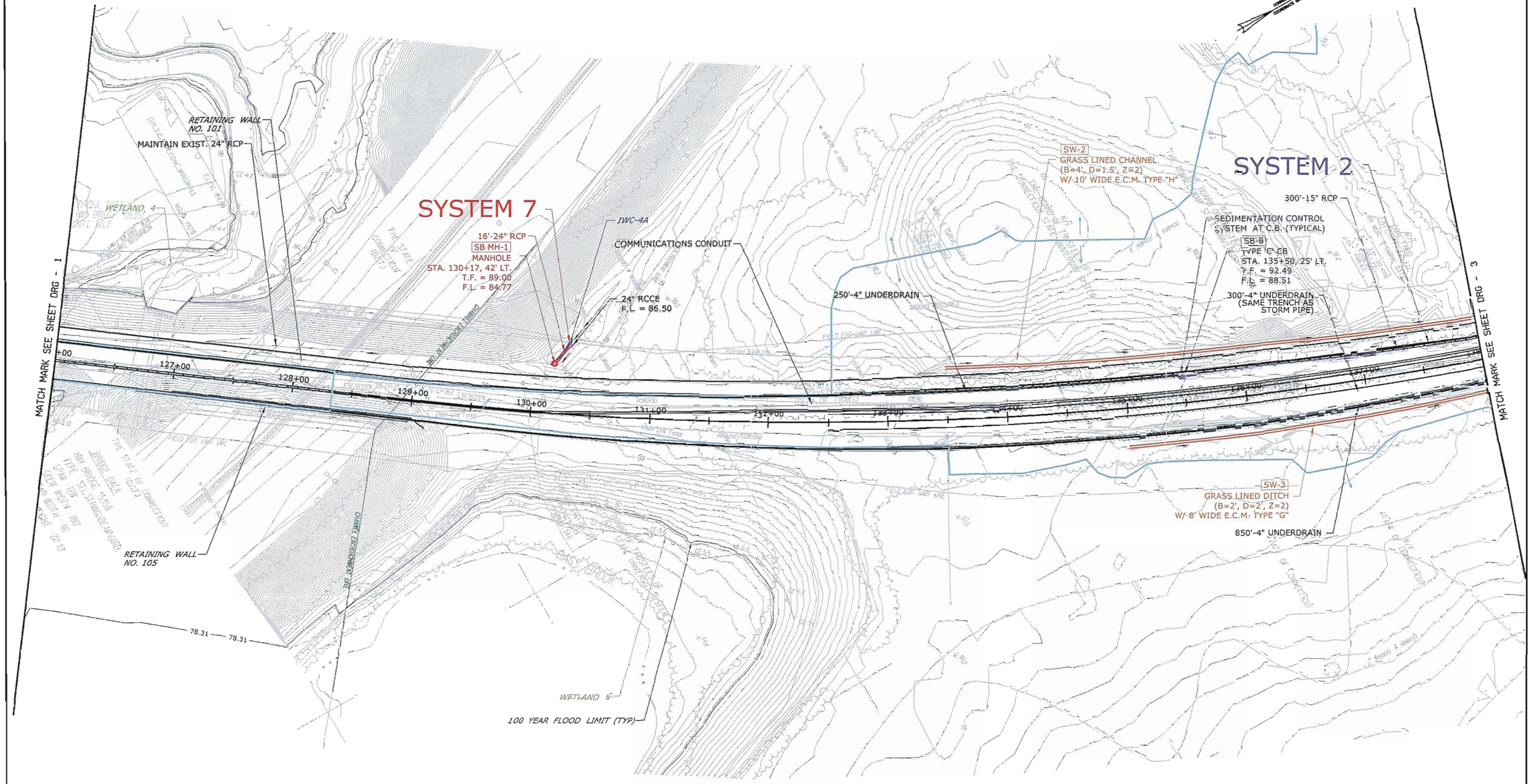
TOWN: NEWINGTON

DRAWING TITLE: DRAINAGE PLAN

PROJECT NO. 171-305

DRAWING NO. C-03

SHEET NO.



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Plotted: 5/12/2010

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DESIGNER/DRAFTER: AB/JF

CHECKED BY: CG

SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILES

SIGNATURE/ BLOCK:
OFFICE OF ENGINEERING

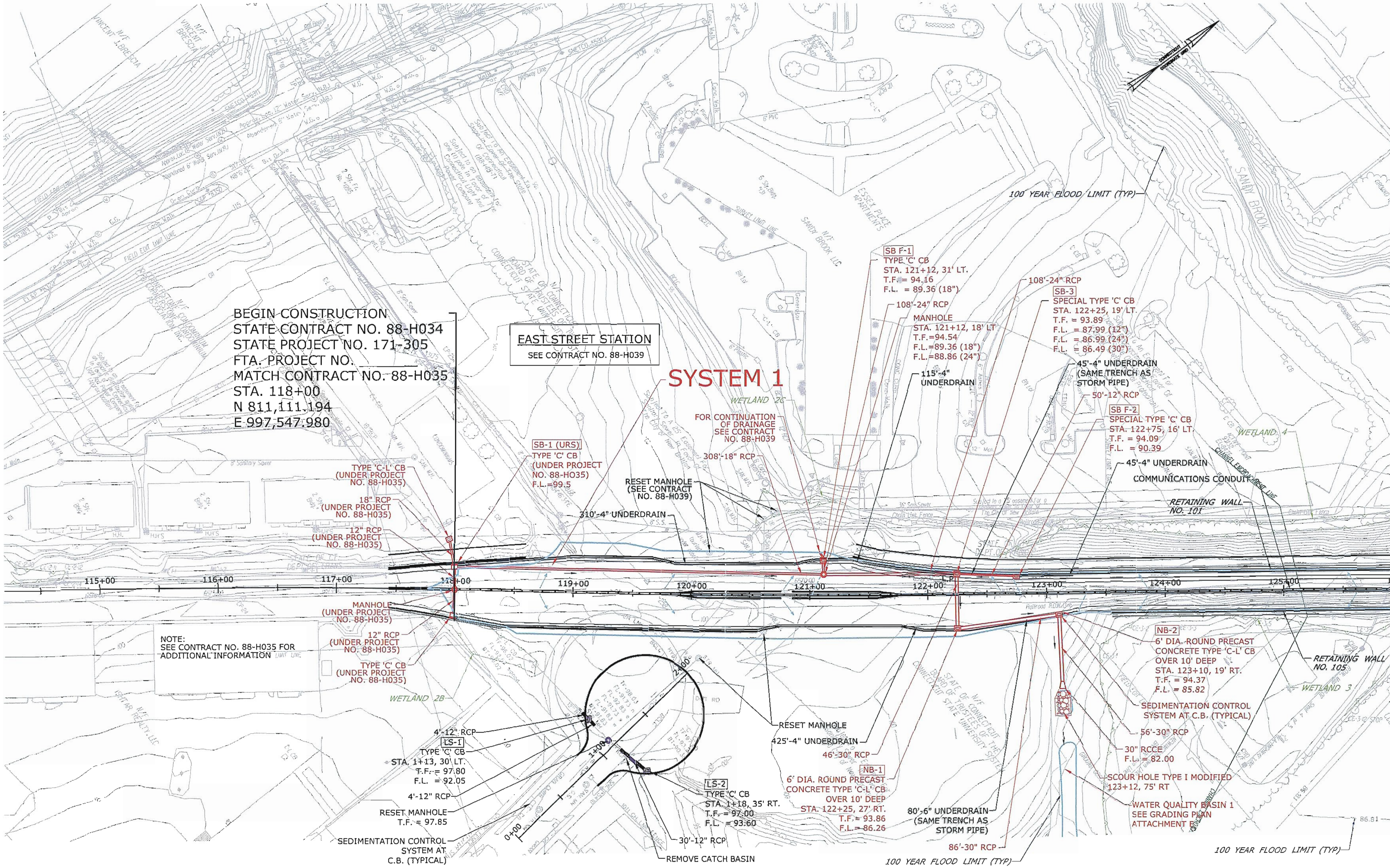
APPROVED BY: -
DATE: -

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY

TOWN:
NEWINGTON

DRAWING TITLE:
DRAINAGE PLAN

PROJECT NO. 171-305
DRAWING NO. C-02
SHEET NO.



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Plotted: 5/12/2010

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET 0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: $FILE$

SIGNATURE/BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON
DRAWING TITLE: DRAINAGE PLAN

PROJECT NO. 171-305
DRAWING NO. C-01
SHEET NO.

END CONSTRUCTION
STATE CONTRACT NO. 88-H034
STATE PROJECT NO. 171-305
FTA. PROJECT NO. _____
STA. 203+00
N 818,414.719
E 1,001,641.759

MATCH CONTRACT NO. 93-H046

MATCH MARK SEE SHEET DRG - 7

IWC 4-1 TO 4-11

SW-18
GRASS LINED DITCH
(B=2', D=, Z=2)
W/-6' WIDE E.C.M. TYPE "G"

COMMUNICATIONS CONDUIT

100'-4" UNDERDRAIN
(TIE INTO UNDERDRAIN
UNDER PROJECT 93-H046)

IWC 5-1 TO 5-5

WETLAND 13

100'-4" UNDERDRAIN
(TIE INTO UNDERDRAIN
UNDER PROJECT 93-H046)

687681
CHANNEL ENCROACHMENT LINE

WETLAND 7E

PIPER BROOK

100 YEAR FLOOD LIMIT (TYP)

WETLAND 7F

WETLAND 7G

WETLAND 12

IWC 6-8 TO 6-2

IWC 8-28 TO 8-8

CHANNEL ENCROACHMENT LINE

199+00 200+00 201+00 202+00 203+00 204+00 205+00 206+00 207+00 208+00 209+00

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted: 5/12/2010

DESIGNER/DRAFTER: AB/JF
CHECKED BY: CG
SCALE IN FEET
0 40 80
SCALE 1"=40'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW_MSH_088_H034_DEP_C-08.dgn

SIGNATURE/ BLOCK: OFFICE OF ENGINEERING
APPROVED BY: - DATE: -

PROJECT TITLE: NEW BRITAIN - HARTFORD Bbusway

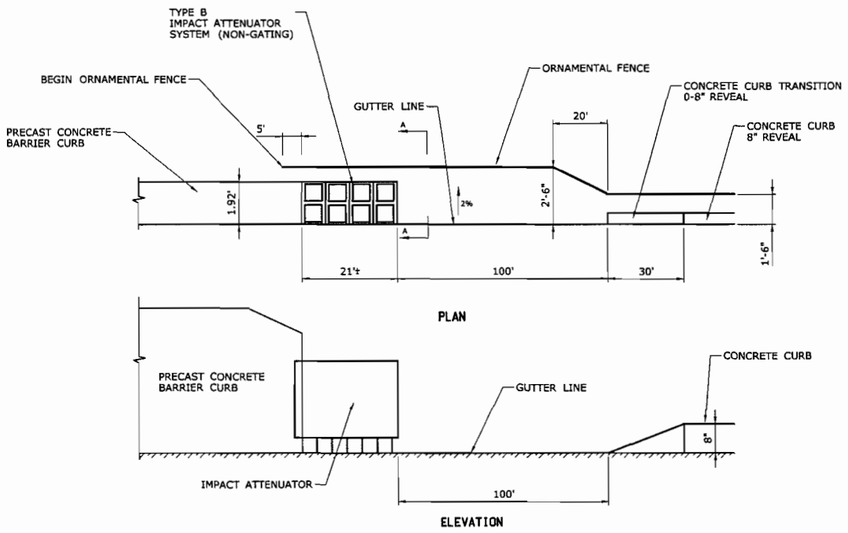
TOWN: NEWINGTON

DRAWING TITLE: DRAINAGE PLAN

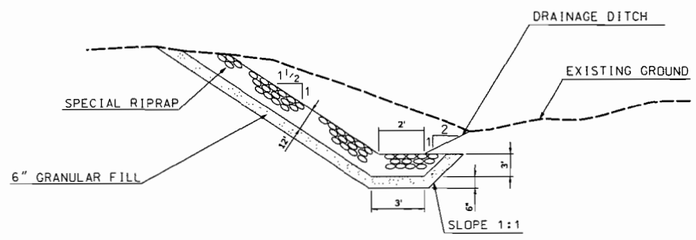
PROJECT NO. 171-305
DRAWING NO. C-08
SHEET NO.

APPENDIX C
PROPOSED WATERSHED MAPS

APPENDIX D
OUTLET PROTECTION DETAILS

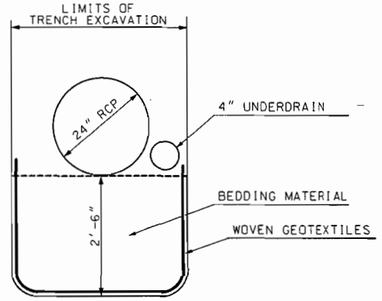


ELEVATION - IMPACT ATTENUATOR (STA. 129+40 LT.)

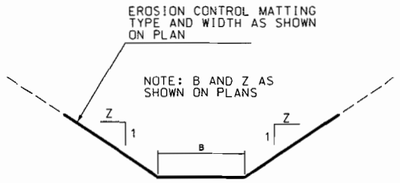


ELEVATION

SPECIAL RIPRAP FOR SLOPE PROTECTION DETAIL

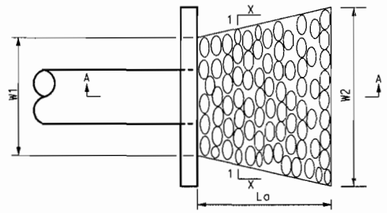


24" RCP TRENCH DETAIL STA. 141+50 TO OUTLET (STA. 144+75)

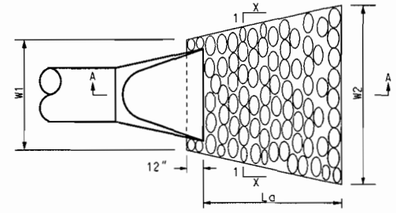


SECTION

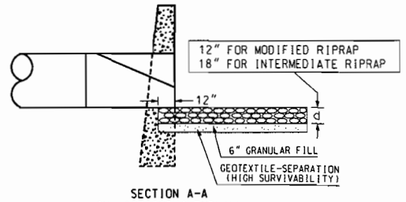
GRASS LINED SWALE DITCH, CHANNEL DETAIL



ENDWALL PLAN VIEW



CULVERT END PLAN VIEW

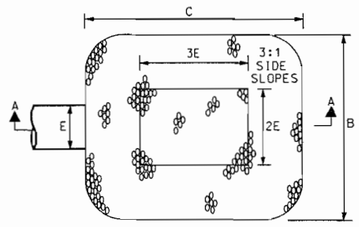


SECTION A-A
CULVERT END & ENDWALL

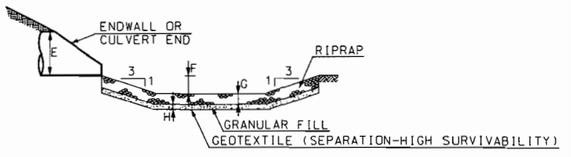
LOCATION	PAD DIMENSIONS (Lo.W1.W2.X) IN FEET	RIPRAP
NEW BRITAIN-HARTFORD BUSWAY		
STA. 145+38. RT.	(10.10.10.0)	MODIFIED
STA. 150+09. RT.	(16.6.18.3)	MODIFIED
STA. 157+00. RT.	(0.0.0.0)	MODIFIED
STA. 159+70. RT.	(10.4.14.3)	MODIFIED
STA. 165+20. RT.	(10.4.75.11.75.3)	MODIFIED
STA. 180+50. LT.	(14.15.15.0)	MODIFIED
STA. 182+10. LT.	(5.5.5.0)	12" THICK MODIFIED
STA. 186+00. RT.	(10.3.8.0)	MODIFIED

LOCATION, SIZE & TYPE OF RIPRAP APRON CHART

RIPRAP APRON DETAIL



PLAN



SECTION A-A

SCOUR HOLE

LOCATION, SIZE & TYPE OF SCOUR HOLE CHART

LOCATION	E	F	B	C	G	H	RIPRAP
STA. 123+12. RT	30"	15"	13'-0"	15'-0"	12"	6"	MODIFIED
STA. 144+75. RT	24"	12"	10'-0"	12'-0"	12"	6"	MODIFIED
STA. 158+25. RT	36"	18"	15'-0"	18'-0"	12"	6"	MODIFIED
STA. 171+65. RT	12"	6"	5'-0"	6'-0"	12"	6"	MODIFIED
STA. 174+80. RT	60"	30"	27'-0"	33'-0"	18"	6"	INTERMEDIATE
STA. 179+50. RT	12"	6"	5'-0"	6'-0"	12"	6"	MODIFIED
STA. 193+35. RT	18"	9"	8'-0"	9'-0"	12"	6"	MODIFIED
STA. 194+02. RT	24"	12"	10'-0"	12'-0"	12"	6"	MODIFIED
STA. 197+00. RT	12"	12"	8'-0"	9'-0"	12"	6"	MODIFIED

SCOUR HOLE DETAIL

FINAL DESIGN REVIEW

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STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

-

NEW BRITAIN-HARTFORD BUSWAY

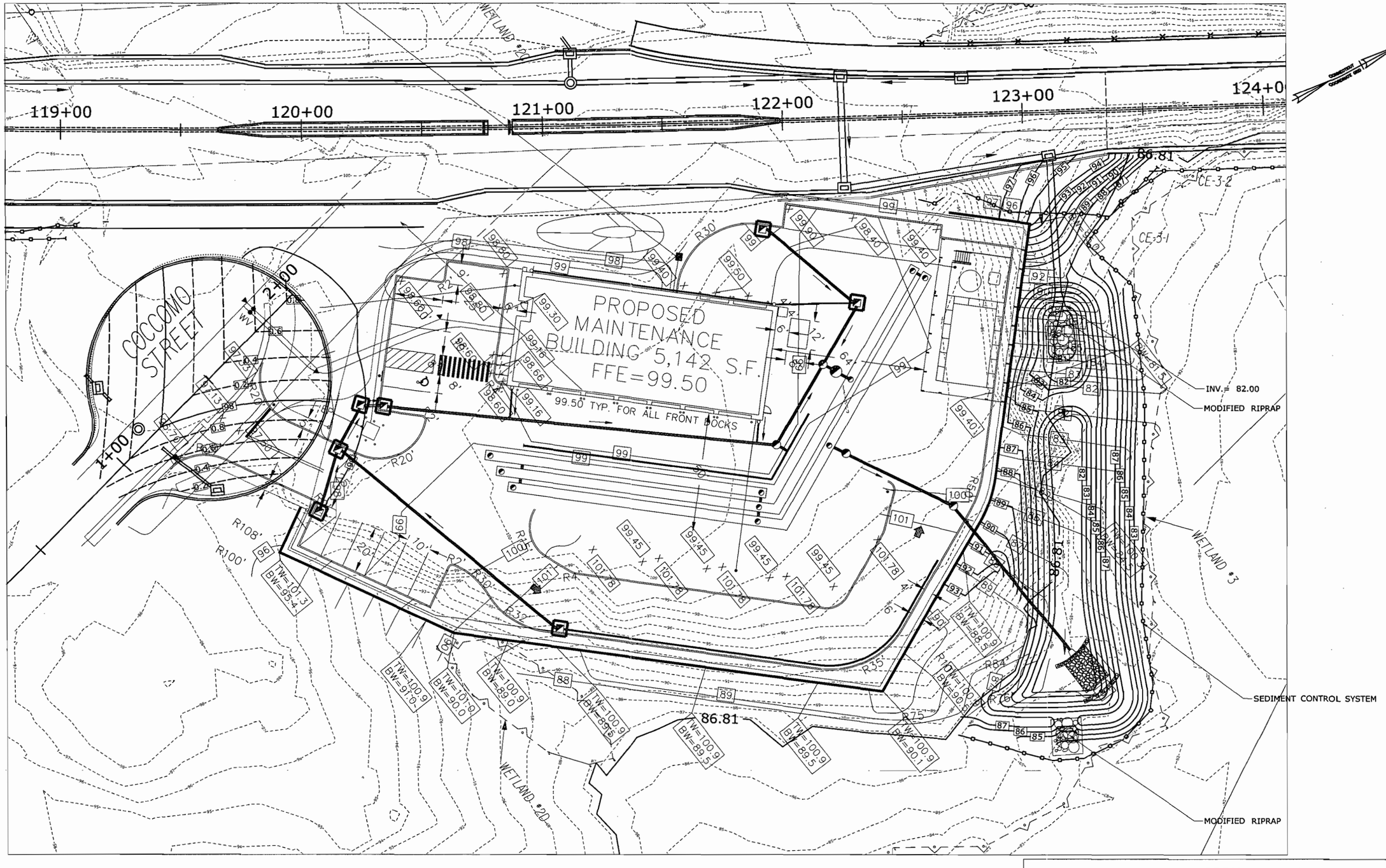
NEWINGTON

MISCELLANEOUS DETAILS

171-305

MDS-01

APPENDIX E
GRADING PLANS



FINAL DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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Plotted Date: 5/12/2010

DESIGNER/DRAFTER: RF/JF
CHECKED BY: CG
SCALE IN FEET 0 20 40
SCALE 1"=20'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW_MSH_0107_0288_MDS-02.dgn

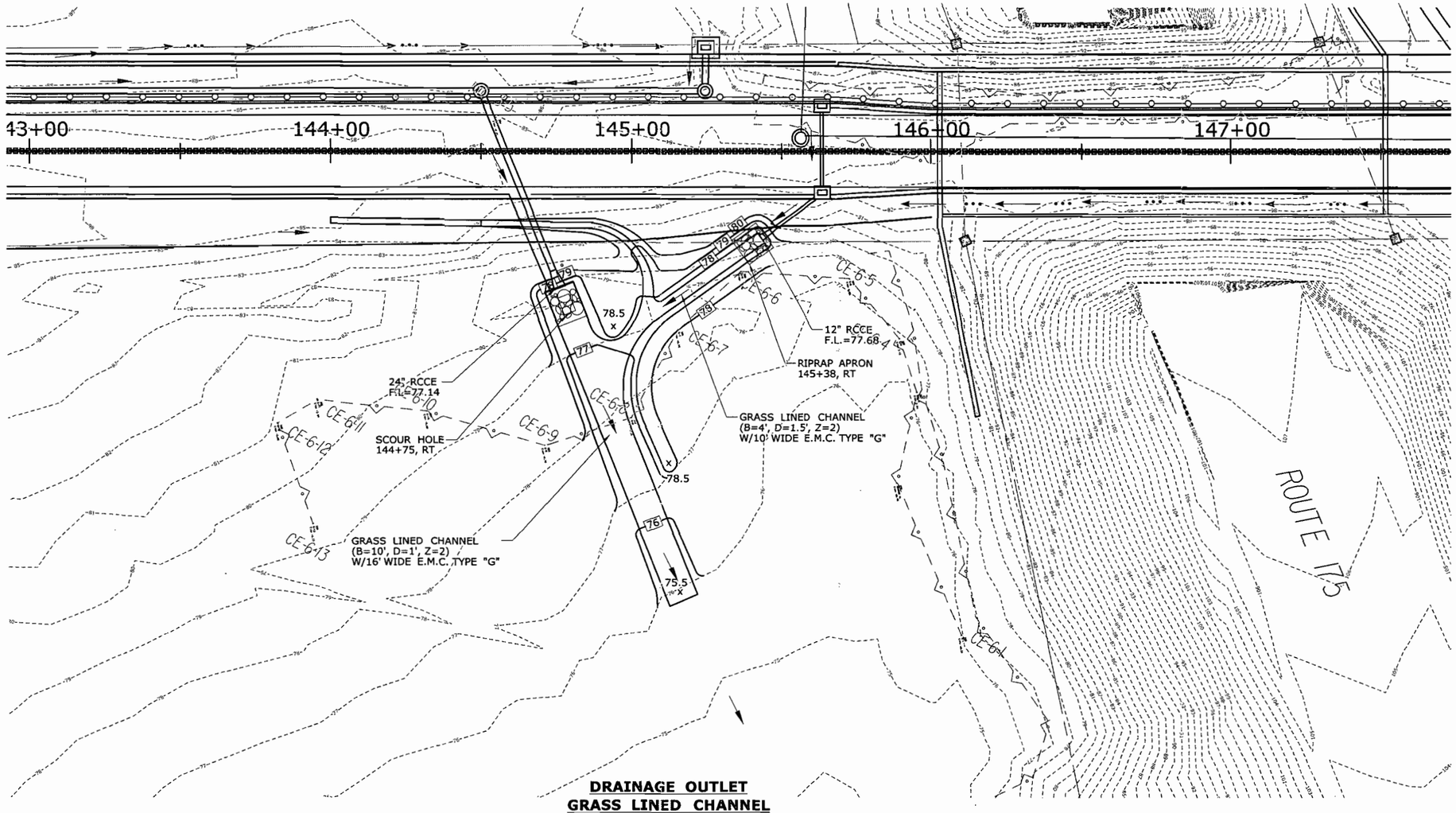
SIGNATURE/ BLOCK:

PROJECT TITLE:
NEW BRITAIN - HARTFORD BUSWAY

TOWN:
NEWINGTON

DRAWING TITLE:
WATER QUALITY BASIN 1
GRADING DETAIL

PROJECT NO. 171-305
DRAWING NO. MDS-02
SHEET NO.



DRAINAGE OUTLET
GRASS LINED CHANNEL

FINAL DESIGN REVIEW

REV.	DATE	REVISION DESCRIPTION	SHEET NO.
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DESIGNER/DRAFTER: RF/JF
CHECKED BY: CG
SCALE IN FEET
0 20 40
SCALE 1"=20'

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

Filename: ...\HW.MSH.0107.0288.MDS-03.dgn

SIGNATURE/ BLOCK:

PROJECT TITLE: NEW BRITAIN - HARTFORD BUSWAY

TOWN: NEWINGTON

DRAWING TITLE: DRAINAGE OUTLET GRADING DETAIL

PROJECT NO. 171-305

DRAWING NO. MDS-03

SHEET NO.