Cleveland Innerbelt Bridge
E. 9th Street Roadway Package

DRAINAGE DESIGN REPORT

March 10, 2011
(Revised April 18, 2011)
(Revised May 27, 2011)
(Revised June 30, 2011)
(Revised July 11, 2011)
(Revised July 26, 2011)
(Revised August 11, 2011)
(Revised September 24, 2014)
(Revised June 26, 2015)

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REVISION HISTORY		
Revision	**Date**	**Comments**
--	March 10, 2011	Initial Report included with Interim E. 9th Street Roadway Submittal to HDR.
1	April 18, 2011	Report included with Final E. 9th Street Roadway Submittal to ODOT.
2	May 27, 2011	Report included with Final E. 9th Street Roadway Submittal to HDR.
3	June 30, 2011	Report included with Final E. 9th Street Roadway Submittal to HDR.
4	July 11, 2011	Report included with Final E. 9th Street Roadway Submittal to ODOT.
5	July 26, 2011	Report included with AFC E. 9th Street Roadway Submittal to ODOT.
6	August 11, 2011	Report included with AFC E. 9th Street Roadway Submittal to ODOT.
7	September 24, 2014	RFI 00479 East 9th Street Extension Ditch Modifications
8	June 26, 2015	CDSS calculations updated to reflect As-Built conditions. Non-Performed work has been hatched on drainage area maps. ODOT requested CDSS calculations be updated to reflect As-Built conditions.

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Checked By: Erica Johnson 6/26/2015

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DRAINAGE DESIGN REPORT

Introduction

The purpose for this report is to describe and document the design criteria and procedures used to complete the final design of the drainage and stormwater management facilities for the E. 9th Street portion of the Innerbelt Bridge Project. Anticipated maintenance requirements are provided for drainage and stormwater treatment facilities. Design calculations are provided in the Appendices to this report.

Project Area

The project area of the Innerbelt Bridge extends over a distance of approximately 1.7 miles, with about 1.0 mile on the east bank of the Cuyahoga River, and the remaining 0.7 miles on the west bank of the river. The area within the project limits, about 80 acres, lies entirely within the City of Cleveland's combined sewer area. More specifically, the project area lies within five different sewersheds (CSO-80, CSO-90, CSO-94, CSO 95 and CSO-235). The northernmost portion of the project area, on the east bank of the Cuyahoga River, drains to Combined Sewer Overflows (CSO's) 94 and 95, which discharge to Lake Erie. The remainder of the project area on the east bank of the river, and the entire project area on the west bank of the river, drain to CSO's 80, 90 and 235, which discharge to the Cuyahoga River. The east bank project area is shown in Figure 1.

Roadway construction documents for the Innerbelt Bridge Project were prepared in three parts: the E. 9th Street Construction Package which covered the new streets proposed for the Commercial region of the east bank project area; the Gateway Construction Package which covered the mainline portion of the east bank project area; and the Tremont Construction Package which covered the entire west bank project area. The E. 9th Street portion of the project area consists primarily of one major drainage area, or "outfall", and numerous locations of pavement reconstruction.

Drainage and Stormwater Management Requirements

Both stormwater quantity and quality control requirements were established for the Innerbelt Bridge Project. Regarding stormwater quantity control, areas within the project limits could remain connected to the combined sewer system. However, peak flows and runoff volumes to the combined sewer system from major outfalls were limited according to requirements of ODOT and the Northeast Ohio Regional Sewer District (NEORSD).

For this project, ODOT required that the post-construction 5-, 10- and 25-year peak flow rates at any point in the existing combined sewer system be limited to pre-construction rates. The sewer district required that there be no increase in stormwater runoff volume discharged to any individual combined sewer overflow (CSO) area during their control storm event. To control stormwater quality for the project, post-construction Best Management Practices (BMPs) were required for all proposed storm-only sewer systems to which the project drains. It was also required that installation of new storm-only drainage systems be implemented to the greatest extent possible.

In general, the design criteria contained in Volume 2 of the ODOT L&D Manual were used for the drainage and stormwater management facilities. City of Cleveland standards were used to design the storm sewers for the local streets in the Tremont area and Commercial region. ODOT Form LD-35, which contains specific drainage design criteria, was completed for the Innerbelt Bridge Project and is included in this report as Appendix A. All drainage and stormwater management facilities constructed under the E. 9th Street Construction Package will be owned and maintained by the City of Cleveland after construction.

Commercial Separate Storm Sewer System

The Commercial Outfall is at the east bank of the Cuyahoga River at approximately Canal Road extended, and lies within CSO-235. Under the preliminary design, a separate storm sewer system was proposed with a low-flow diversion structure to the combined sewer system for water quality control.

During final design, three additional options for the Commercial Outfall were evaluated. Option A consisted of the preliminary design with the addition of detention storage to limit the discharge to CSO-235 during the 6-month design storm. Option B consisted of complete connection of the new Commercial separate storm sewer system to CSO-235 with even greater detention storage necessary to limit discharges to CSO-235. Option C consisted of construction of a new sanitary sewer to serve existing businesses in the area and conversion of the existing combined sewer overflow pipe to a separate storm sewer outfall.

A review and analysis of the original low-flow diversion concept and three options was conducted by the Northeast Ohio Regional Sewer District to evaluate the impacts of each alternative on the CSO-235 system. As a result, the District was unable to conclude there would be no adverse impact on the CSO-235 system from the original low-flow diversion concept or from Options A and B. Although flow rates of stormwater runoff would be limited from these three alternatives, there would still be an increase in the volume of runoff discharged to the CSO-235 system. Regarding Option C, it was concluded that there would be no adverse impact to CSO-235. However, this alternative was determined to not be feasible due to cost and schedule constraints.

Based on the findings of the District, it was decided to completely separate the new Commercial Outfall to prevent any potential adverse impact to the CSO-235 system. This plan included a new separate drainage system with its outfall to the Cuyahoga River. Stormwater quality control will be provided by two manufactured treatment devices located on the new E. 9th Street just north of Canal Road.

As shown on Figure 1, the new storm sewer system begins at a low point in E. 14th Street and drains a total of 16 acres. The trunk storm sewer was designed to receive unrestricted runoff from five acres of land outside the future right-of-way. As noted above, water quality control for this new separate storm sewer system will be provided by two Unistorm Chambers, a ODOT Type 2 and Type 4. The Type 2 unit treats Commercial Rd and four inlets on E9th Street. This unit has a WQf=1.6 cfs (WQf=CIA=0.67*0.65*3.78). Located just downstream of the end of the ditch, the second unit is a Type 4 and drains the remainder of

the Commercial Outfall. This unit has a WQf=5.9 cfs (WQf=0.74*0.65*12.28). Appendix E contains detailed calculations for these two manufactured treatment devices.

The Commercial Outfall drainage area boundary under proposed conditions is shown in Figure 2. Drainage design calculations for the Commercial Outfall are provided in Appendices B through F. Drainage boundaries, areas and runoff coefficients used in the calculations are shown on the map attached as Appendix H. By the request of the City of Cleveland, the Approved CSX Rail Way Permit plan and profile, part of a previous submittal, is included in Appendix I. Design of this new separate storm sewer system was based on the project criteria found in Appendix A.

Spread calculations were also completed for the new bridge, Bridge 13, on E. 9th Street that crosses the GCRTA railroad tracks. The proposed bridge has three, 15-foot travel lanes, with 7- foot shoulders, a 2.0% longitudinal slope and a 0.22 ft/ft cross slope. A proposed inlet at Sta 25+92 will be constructed to keep the spread within the left 7-foot shoulder until the next proposed inlet down grade at Sta 23+45. The right gutter flow will also stay within the 7-foot shoulder until the next proposed inlet down grade at Sta 23+45. As a result, no scuppers were needed on this new bridge. Spread calculations for Bridge 13 are included in Appendix B and Appendix F.

As indicated above, City of Cleveland CB-1 and CB-3 inlets were used for pavement drainage. However, due to the cross section and slope of the new private drive along the north side of new E. 9th Street, a trench drain with two ODOT CB-6 inlets was selected for the intersection to limit bypass of pavement drainage onto new E. 9th Street.

Anticipated maintenance requirements for the drainage and stormwater management system for the Commercial Outfall are summarized below and detailed in Appendix E (includes a letter to the City of Cleveland):

1. Routine inspection and cleaning of storm sewer system.
2. Mowing of terrace area between E. 9th Street and swale.

3. Routine inspection of grass swale and removal of woody vegetation.
4. Inspection and cleaning of Unistorm Chambers (See Maintenance Manual Appendix E)

Commercial Combined Sewer System

The south end of new E. 9th Street and will be drained by a system of inlets leading to the combined sewer system. However, as shown in Figures 3 and 4, this proposed drainage area, 3.28 acres, is smaller than the existing drainage area of 6.57 acres at the connection point. To assess the impact of this reduced drainage area, existing and proposed flow rates were computed at the proposed connection point. As shown in Table 2, both the drainage area and peak flow rates were reduced at the connection point. The drainage calculations for these areas of pavement reconstruction are shown in Appendix G. Drainage boundaries, areas and runoff coefficients use in the calculations are shown on the map attached as Appendix H

Locations of Pavement Reconstruction

In addition to the proposed drainage system for the Commercial Outfall, there are 19 relatively small areas of pavement reconstruction, as shown in Figures 5 and 6. To assess the impact of pavement reconstruction, existing and proposed flow rates were computed at each of the 19 locations. As shown in Table 2, both the sum of the drainage areas and peak flow rates were reduced to the combined sewer system. The results of this analysis are shown in Table 2. The drainage calculations for these areas of pavement reconstruction are shown in Appendix G. Drainage boundaries, areas and runoff coefficients use in the calculations are shown on the map attached as Appendix H.

Table 1

Spread Requirements for Streets in the Commercial Region

Street Name	No. of Lanes	Lane Width (feet)	Shoulder Width (feet)	Allowable Spread on Traveled Lane (feet)	Total Allowable Spread (feet)	Design Storm	ADT
E. 9th Street							
Sta 11+56-12+50	2	12	3RT/1LT	6	9RT/7LT	2-year	
Sta 12+50-23+50	2	12	1	6	7	2-year	
Sta 23+50-25+50	2	12	3.75	6	9.75	2-year	
Sta 25+50-26+50	2	12	1	6	7	2-year	3,400
Commercial Road	2	12	4	6	10	2-year	1,000[1]
Broadway Avenue							
Sta 9+00-15+50	4	12	1	8	9	5-year	
Sta 15+50-17+75	4	12	1RT/5LT	8	9RT/13LT	5-year	
Sta 17+75-25+00	4	12	1	8	9	5-year	10,600
E. 14th Street							
STA 10+00-15+50	4	12	1	8	9	5-year	22,800
STA 15+50-16+50	5	12	1	12	13	5-year	22,800
Orange Ave							
12+75-23+00	6	12	1	8	9	5-year	37,700
23+00-23+90 LT	7	12	1	12	13	5-year	37,700
23+00-23+90 RT	6	12	1	8	9	5-year	37,700

[1] Estimate made by comparing to similar nearby roadways and considering the traffic that feeds the roadway.

Table 2

Peak Discharge Rates to the Combined Sewer System

Drainage Area ID*	Existing Drainage Area (acres)	Proposed Drainage Area (acres)	Existing Coef. of Runoff, C	Prop. Coef. of Runoff, C	Inc. in C	Exist. Time of Conc. (min)	Prop. Time of Conc. (min)	Intensity, I, (in/hr)						Peak Flow, Q (cfs)						Receiving Pipe**	
								Existing			Proposed			Existing			Proposed				
								5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	Size	Cap.
ODB-01	0.44	0.38	0.85	0.90	.05	5.34	4.51	5.44	6.20	7.09	5.64	6.44	7.36	2.05	2.33	2.67	1.93	2.20	2.52	--	--
ODB-02	1.31	1.24	0.57	0.58	.01	3.64	3.64	5.85	6.70	7.65	5.85	6.70	7.65	4.39	5.03	5.75	4.20	4.81	5.49	--	--
ODB-03	0.66	0.70	0.66	0.74	.08	3.31	3.51	5.94	6.80	7.76	5.89	6.74	7.69	2.59	2.97	3.39	3.05	3.49	3.98	12"	3.03
ODB-04	0.08	0.08	0.90	0.90	0	2.57	2.57	6.01	6.89	7.86	6.01	6.89	7.86	0.42	0.49	0.55	0.42	0.49	0.55	--	--
ODB-05	0.42	0.50	0.70	0.75	.05	9.59	8.22	4.39	4.95	5.69	4.73	5.35	6.14	1.29	1.46	1.67	1.76	2.00	2.29	12"	7.63
ODB-06	0.63	0.56	0.73	0.67	-.06	10.43	9.98	4.22	4.76	5.46	4.29	4.84	5.56	1.95	2.20	2.53	1.61	1.82	2.09	--	--
ODB-07	0.57	0.48	0.76	0.50	-.26	14.53	15.09	3.59	4.06	4.63	3.51	3.97	4.53	1.55	1.75	2.00	0.85	0.96	1.09	--	--
ODB-08	0.23	0.19	0.85	0.50	-.35	3.41	19.12	5.91	6.77	7.72	3.07	3.48	3.99	1.14	1.30	1.49	0.29	0.33	0.38	--	--
ODB-09	1.07	1.00	0.61	0.63	.02	8.04	8.04	4.77	5.41	6.20	4.77	5.41	6.20	3.11	3.53	4.05	2.98	3.38	3.87	--	--
ODB-10	0.28	0.36	0.80	0.86	.06	6.41	8.25	5.17	5.89	6.73	4.72	5.34	6.13	1.15	1.31	1.50	1.45	1.64	1.89	12"	4.21
ODB-11	0.43	0.43	0.63	0.69	.06	5.69	5.90	5.35	6.10	6.97	5.30	6.04	6.90	1.46	1.67	1.91	1.58	1.80	2.06	12"	4.60
ODB-12	0.68	0.68	0.74	0.74	0	5.22	5.22	5.47	6.24	7.13	5.47	6.24	7.13	2.74	3.12	3.57	2.74	3.12	3.57	--	--

Table 2 (continued)

Peak Discharge Rates to the Combined Sewer System

Drainage Area ID*	Existing Drainage Area (acres)	Proposed Drainage Area (acres)	Existing Coef. of Runoff, C	Prop. Coef. of Runoff, C	Inc. in C	Exist. Time of Conc. (min)	Prop. Time of Conc. (min)	Intensity, I, (in/hr)						Peak Flow, Q (cfs)						Receiving Pipe**	
								Existing			Proposed			Existing			Proposed				
								5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	Size	Cap.
ODB-13	0.75	0.74	0.72	0.73	.01	13.69	13.69	3.72	4.20	4.80	3.72	4.20	4.80	1.99	2.25	2.57	2.01	2.27	2.60	36"	112.38
ODB-14	0.42	0.36	0.74	0.71	-.03	7.94	7.94	4.80	5.44	6.23	4.80	5.44	6.23	1.49	1.68	1.93	1.23	1.39	1.59	--	--
ODB-15	0.46	0.43	0.72	0.78	.06	6.12	4.64	5.24	5.97	6.83	5.61	6.41	7.32	1.73	1.97	2.26	1.88	2.15	2.45	12"	3.09
ODB-16	0.23	0	0.86	0	-.86	1.43	0	6.01	6.89	7.86	0	0	0	1.20	1.38	1.57	0	0	0	--	--
ODB-17	0.60	0	0.84	0	-.84	5.19	0	5.47	6.24	7.14	0	0	0	2.75	3.14	3.60	0	0	0	--	--
ODB-18	0.34	0	0.85	0	-.85	2.91	0	6.01	6.89	7.86	0	0	0	1.72	1.97	2.25	0	0	0	--	--
ODB-19	0.33	0.33	0.67	0.50	-.17	11.52	12.37	4.06	4.57	5.24	3.93	4.43	5.07	0.91	1.02	1.17	0.66	0.74	0.85	--	--
Total Area to CSO 94	9.93	8.46	--	--	--	--	--	--	--	--	Total Flow to CSO 94			35.62	40.54	46.41	28.56	32.48	37.17	--	--
Commercial Combined Sewer System	6.57	3.28	0.77	0.79	.02	3.68	3.68	5.84	6.69	7.64	5.84	6.69	7.64	29.37	33.66	38.42	15.22	17.45	19.90	--	--

*See Figure 5 for locations of ODB drainage areas.
**The computed peak flow rates shown are based on the actual time of concentration (Tc). The proposed 10-year design flow rate for this drainage area is based on a minimum Tc of 10 minutes, which results in a flow rate less than the capacity of the receiving pipe.

Figure 1 - East Bank Innerbelt Bridge Project Area

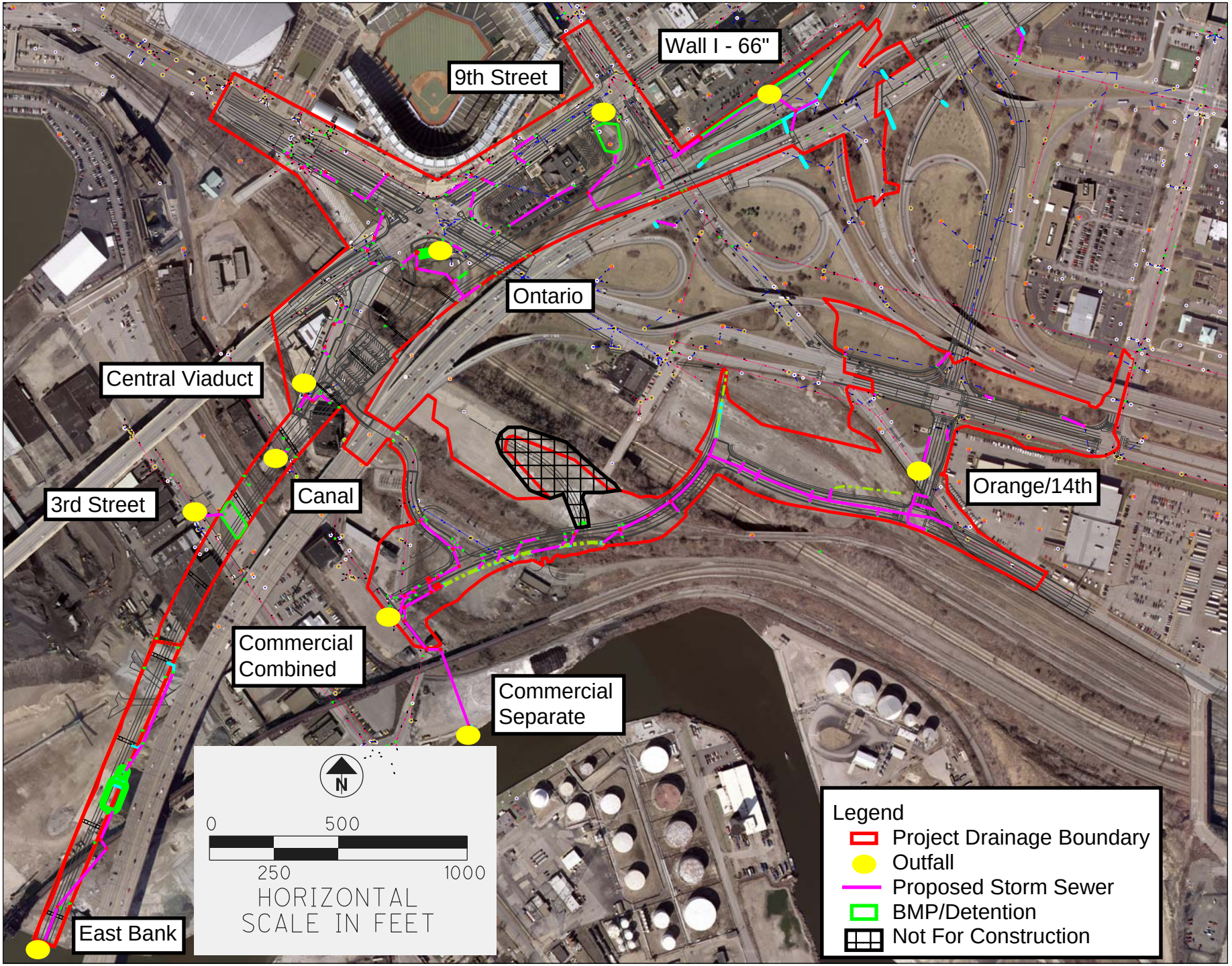


Figure 2 - Commercial Separate Sewer System

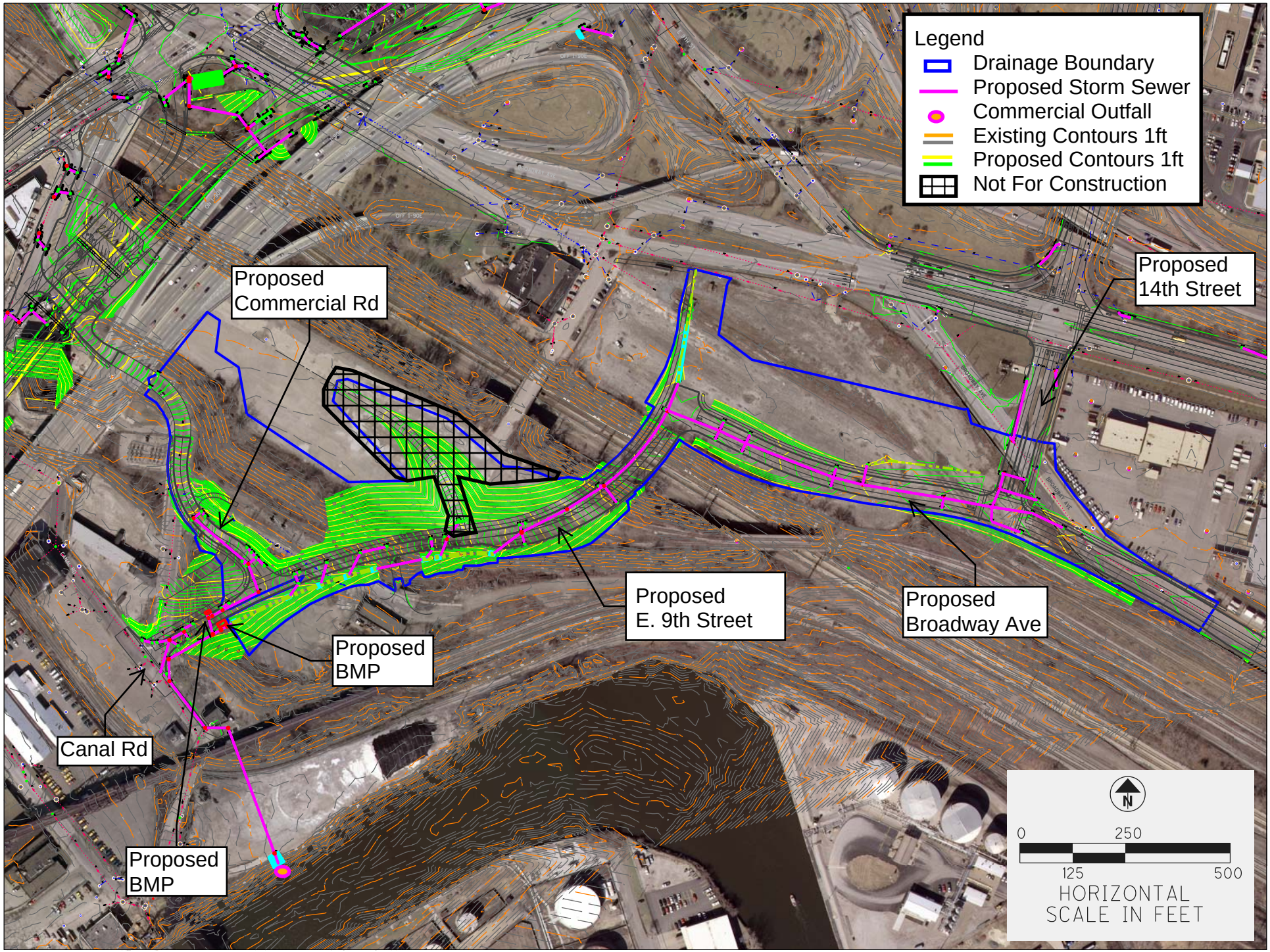


Figure 3 - Commercial Combined Sewer System - Existing Conditions

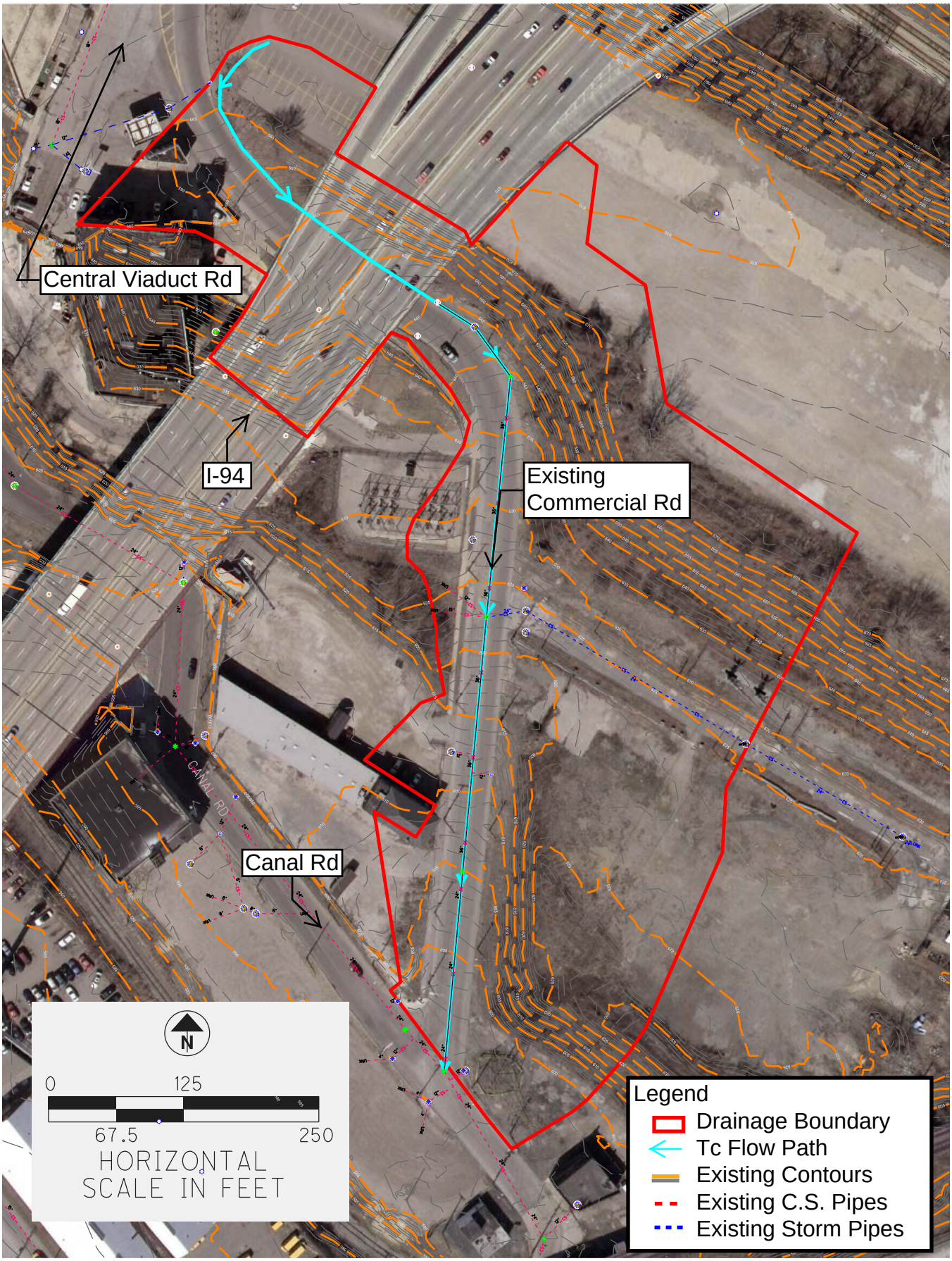


Figure 4 - Commercial Combined Sewer System - Proposed Conditions

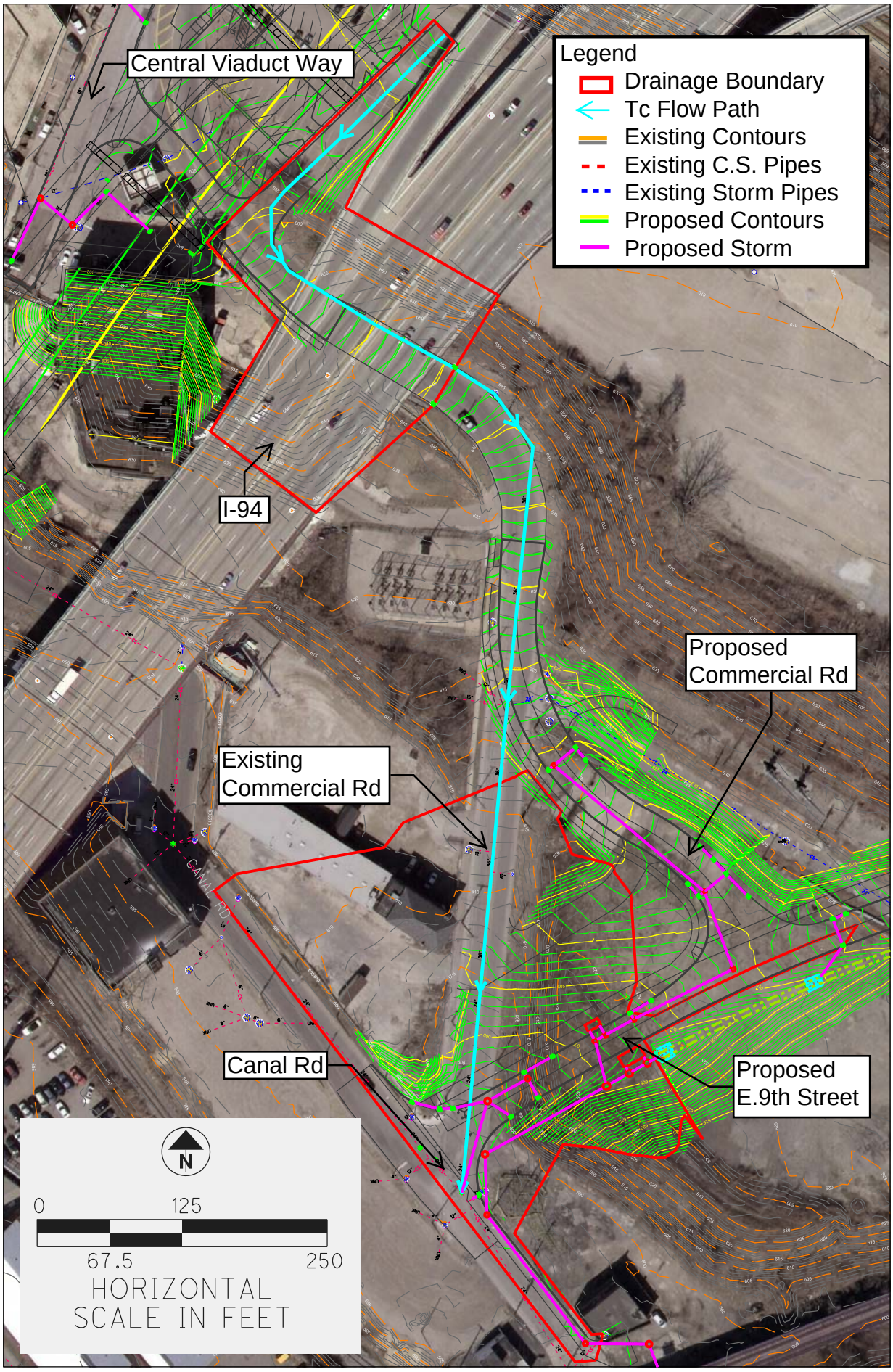


Figure 5 - Locations of Pavement Reconstruction - Existing Conditions

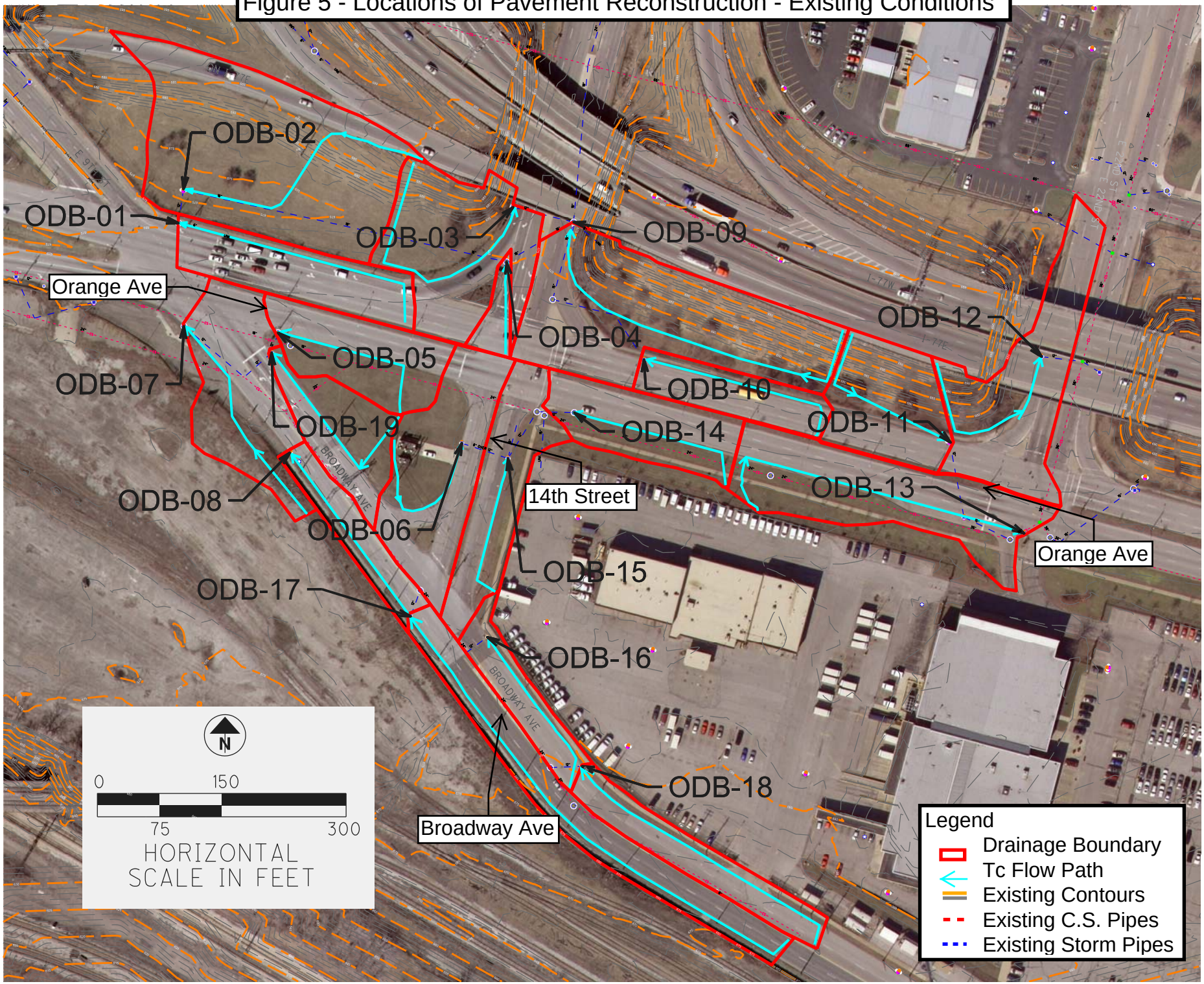
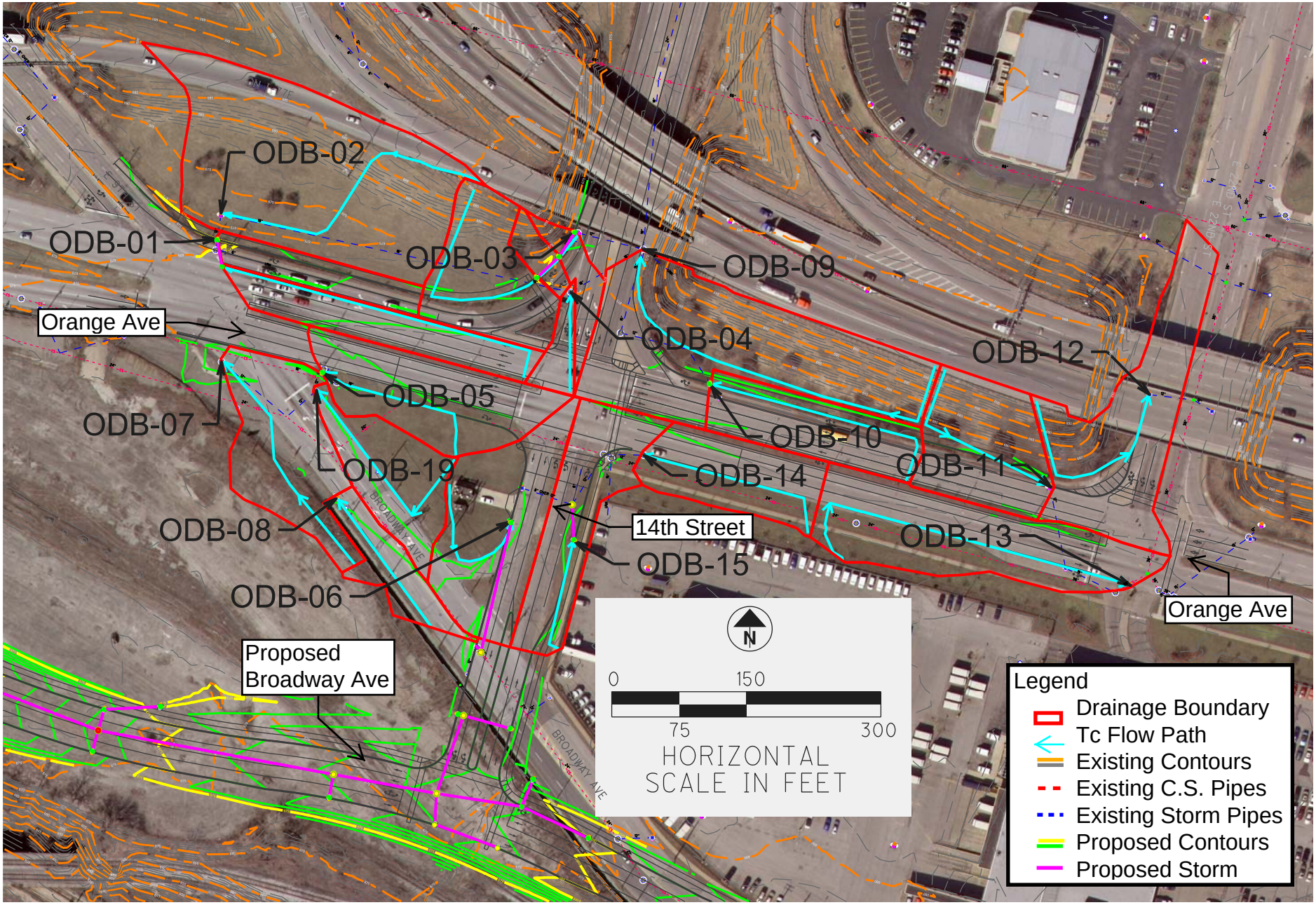


Figure 6 - Locations of Pavement Reconstruction - Proposed Conditions



APPENDIX A

Form LD-35
Revised January 2006

GENERAL PROJECT INFORMATION

CUY	90	14.90
County	Route	Section

Attach Typical Section)

AFFECTED ROADWAYS:	Route	Average Daily Traffic	Rural / Urban
INTERSTATE OR OTHER L/A FACILITIES	I-90 Innerbelt Bridge	71,000	Urban Interstate
ARTERIALS AND COLLECTORS	Orange Ave	23,300	Urban Arterial
	Fairfield Ave	1,500	Urban Collector
	Abbey Ave	1,200	Urban Collector
	Canal Rd	--	Urban Collector
	Ontario St	33,200	Urban Arterial
	Carnegie Ave	24,000	Urban Arterial
	E. 9th St	32,300/3,600	Urban Arterial Under I-90, Future Urban Collector (extension)
	Broadway	12,400	Urban Arterial
	E. 14th St	19,100	Urban Arterial, Future Urban Collector (extension)
	W. 14th St	3,600	Urban Collector (extension)
	W. 13th St	8,700	Urban Collector
LOCALS	Starkweather Ave	2,000[1]	Urban Local
	Kenilworth Ave	2,000[1]	Urban Local
	Central Viaduct Way	1,000[1]	Urban Local
	Commercial Rd	1,000[1]	Urban Collector, Future Urban Local (realigned portion)
CLEAR ZONE	See L&D Manual, Vol. 1, Section 600.2		

[1] Estimate made by comparing to similar nearby roadways and considering the traffic that feeds the roadway.

All Units are English:

PIPE POLICY:

The Pipe Policy of ODOT and the City of Cleveland will be used for this project. (See Section 1002 for additional information)

If a policy other than ODOT's is being used, the following material types are permitted:

For drainage conduit owned and maintained by the city of Cleveland:

1. Use Vitrified Clay Pipe (VCP), Extra Strength (ES), C-700, with premium joints, ODOT item 706.08 for all proposed main sewer pipe 18" and smaller.

2. Use Reinforced Concrete Pipe (RCP) with premium joints, ODOT Item 706.02 for all proposed main sewer pipe 21" and larger.

3. Ductile Iron Pipe (DIP) may be used if approved by the WPC engineer.

(Please attach a copy of the written pipe policy. In lieu of a written policy, documentation of locally funded construction practices may be provided)
See Attachment A.

POST CONSTRUCTION BMP POLICY:

The Post Construction BMP Policy of ODOT will be used for this project.

If a policy other than ODOT's is being used, the following BMP's are permitted:

_____

_____

_____

PROJECT SPECIFIC INFORMATION AFFECTING DRAINAGE:

See Attachment B - Project Scope, Central Viaduct, CUY-90-14.90, Innerbelt Bridge, Section 13, Drainage

Section A. Roadway Culverts (Type A Conduits)

1. DESIGN STORM FREQUENCY (1004.2):

   a. Mainline 50- Year

   b. Crossroads 10- Year

2. BANKFULL DESIGN Yes No (Circle yes if at least one culvert has bankfull design) *attach a list of culverts with bankfull designs* Culvert across driveway entrance on south side of proposed E. 9th Street extension.

3. FLOOD PLAIN CULVERT(S) NEEDED? Yes No (Circle yes if at least one culvert has flood plain culverts) *attach a list of culverts with flood plain culverts*

4. DURABILITY SERVICE LIFE _____50_____ Year *attach a list of culverts with their durability service life if multiple culverts have different frequencies.*

5. ABRASIVE SITE? Yes No (Circle yes if at least one culvert has an abrasive site) *attach a list of culverts with their abrasive site assumptions if multiple culverts are different*

6. MAXIMUM ALLOWABLE HEADWATER FOR DESIGN STORM (1006.2):

   a. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.

   b. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat to rolling terrain.

   c. 4 feet above the inlet crown of a culvert in a deep ravine.

   d. 1 foot below the near edge of pavement for bicycle pathways.

7. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1003):

a. For rural streams, use USGS Water Resources Investigations Report 89-4126 "Techniques for Estimating Flood-Peak Discharges of Rural Unregulated Streams in Ohio".

b. For urban streams, use USGS Open File Report 93-135 "Estimation of Peak-Frequency Relations, Flood Hydrographs, and Volume–Duration–Frequency Relations of Ungaged Small Urban Streams in Ohio".

8. SCALE OF TOPOGRAPHIC MAPPING USED TO DELINEATE DRAINAGE AREAS (1101.1):

a. >100 acres: 1" = 2000'

b. < 100 acres: 1" = 50 to 800'

9. MANNING'S "n" USED FOR (1105.6.5):

a. Smooth pipe 0.012

b. Corrugated pipe:

2-$^{2}/_{3}$" x $^{1}/_{2}$":	Full flow	0.0225-0.0250
3" x 1":	Full flow	0.0260-0.0281
6" x 2":	Full flow	~~0.0300-0.0332~~

Section A. Roadway Culverts - Continued

10. ENTRANCE LOSS COEFFICIENT (k_e) (1105.6.6, table 1105-1):

a.	Corrugated pipe:	HW-4 Headwall 0.90	Full Headwall 0.25*
b.	Smooth Concrete pipe	HW-4 Headwall 0.20	Full Headwall 0.20
d.	Box Shape	Full Headwall _____	*with beveled entrance

11. MINIMUM COVER (top of pipe to subgrade) FOR (1008):

a. Rigid pipe 9"

b. Flexible pipe 12"

12. MAXIMUM COVER FOR (1008):

a. Rigid pipe See Figures 1008-10 to 1008-14, L&D Vol.2

b. Flexible pipe Thermoplastic - 20'; Corrugated Steel – See Figures 1008-1 - 1008-9 and 1008-15 – 1008-21

13. MAXIMUM ALLOWABLE CULVERT OUTLET VELOCITY (1002.2.2) :

a. Bare earth channel 5 fps

b. Rock channel protection 20 fps

c. Use energy dissipator for velocities in excess of 20 f.p.s.

14. HEADWALL TYPE (1106.2):

a. Half-Height Headwall – Std Dwg HW-2.1 and 2.2

b. Full-Height Headwall – Std Dwg HW-1.1

c. Concrete Apron – provide special detail drawing

15. CONTACT WILL BE MADE WITH COUNTY ENGINEER TO ESTABLISH:

a. Contact shall be made with the County Engineer at the beginning of the design process to ascertain ditch cleanout grades and watersheds, and the design shall be based on that information.

b. Form LD-33 (available in the L&D, Vol 2, Appendix) shall be used to document approval.

16. MINIMUM PIPE SIZE (1002.3.1, Figure 1002-1) :

a. Freeway or limited access facility 24”

b. Other highways 15”

Section B. Storm Sewers (Type B & C Conduits)

1. DESIGN FREQUENCY (Just Full) (1104.4.1) - 10-year, ODOT and City

2. HYDRAULIC GRADIENT SHALL NOT EXCEED (1104.4.2):

a. 12 inches below edge of pavement for 25- year frequency storm (ODOT only).

b. Pavement catch basin grate or lip of inlet for 25- year frequency storm (ODOT only).

c. A point in a depressed pavement sag that would result in an impassible highway for a 50- year frequency storm (ODOT only).

d. Other: Storm sewers for all highways shall satisfy a 50-yr check to preclude flooding of buildings or extensive flooding of private property. One-directional lane of a multiple-lane highway or one-half of a lane on a two-lane highway shall be passable when the sewer system is discharging the 50-year storm.

e. The above is based on:

i. A pipe roughness “n” = 0.015 for pipe sizes 60" and under and 0.013 for larger sizes.

ii. _____

3. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1003):

a. Rational Method for pavement drainage, storm sewer and ditches.

i. Use ODOT rainfall data for design of pavement drainage and storm sewers.

ii. Use NEORSD rainfall data to compute discharge rates to the existing combined sewer system (Attachment C).

b. TR-55 for detention analysis.

i. Use ODOT rainfall data for detention facilities discharging to surface waters.

ii. Use NEORSD rainfall data for detention facilities discharging to the combined sewer system.

4. COEFFICIENT OF RUNOFF "C" FOR (1101.2.3):

   a. Pavement and paved shoulders 0.9

   b. Berms and slopes (4:1 and flatter) 0.5

   c. Berms and slopes (steeper than 4:1) 0.7

   d. Contributing areas:

   Residential 0.3 – 0.5 (single family), 0.4-0.7(multi-family) Woods 0.3 Cultivated 0.3 – 0.6
   Grassed Terrace (adjacent to sidewalks) 0.30

5. METHOD USED TO DETERMINE TIME TO FIRST CATCH BASIN OR PAVEMENT INLET (1101.2):

   a. The summation of the time of overland flow, the time of shallow concentrated flow and the time of pipe or open channel flow.

6. MINIMUM TIME TO (1104.4.4):

   a. Ditch catch basin 15 minutes

   b. Pavement inlet or catch basin 10 minutes

   c. When connecting to combined sewer, actual Tc calculated for pre/post flow analysis.

Section B. Storm Sewers (Type B & C Conduits) - Continued

7. MINIMUM COVER OVER SEWERS (1104.2.1): (see Attachment B)

   a. Rigid pipe:

      i. Type B conduit (under pavement or paved shoulder) 9" (top of pipe to subgrade). In no installation shall the distance from the top of pipe to pavement surface be <15".

      ii. Type C conduit (beyond pavement or paved shoulder) 18" (top of pipe to finish grade)

   b. Flexible pipe:

      i. Type B conduit (under pavement or paved shoulder) 12" (top of pipe to subgrade). In no installation shall the distance from the top of pipe to pavement surface be <24".

      ii. Type C conduit (beyond pavement or paved shoulder) 24" (top of pipe to finish grade)

   c. City requirement: 3 feet for all main sewers

8. DESIRABLE MINIMUM VELOCITY FOR DESIGN FLOW 3 f.p.s (1104.2.1). City sewers 3 f.p.s.

9. MAXIMUM LENGTH BETWEEN MANHOLES OR SUITABLE CLEANOUT POINTS (1104.2.2) :

   a. ODOT: Under 36"diameter – 300' City: Under 42" diameter - 300'

   b. ODOT: 36" - 60" diameter - 500' City: 42" diameter and larger – 500'

   c. ODOT: Over 60" diameter - 750-1000'

10. MINIMUM PIPE SIZE UNDER PAVEMENT (1104.4.6):

a. Freeway or limited access facility 15 inches

d. Other highways 12 inches

e. City storm sewer pipe: 12 inches

11. PROCEDURE TO FOLLOW WHEN EXISTING PRIVATE DRAINS ARE CUT BY PROPOSED SEWERS OR DITCHES: Connect through the curb or into a drainage structure as per general note in construction plans.

Section C. Roadway Ditches

1. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1003):

a. Rational Method

b.

2. DESIGN FREQUENCY TO DETERMINE (1102.3.1 or 1102.4):

ADT >2000:

a. Depth of flow determination 10- year

b. Shear Stress determination (for protection and width of protection) 5- year

ADT <2000:

c. Depth of flow determination 5- year

d. Shear Stress determination (for protection and width of protection) 2- year

3. METHOD USED TO DETERMINE TIME OF FLOW TO DITCH (1101.2):

The summation of the time of overland flow, the time of shallow concentrated flow and the time of pipe or open channel flow.

4. ALLOWABLE SHEAR STRESS FOR DITCH LINING (1102.3):

Permanent Ditch Protection:

a. Seed lining 0.40 psf.

b. Sod or other temporary ditch protection 1.0 psf.

c. Turf Reinforcing Mat (SS836), Type 1 2.00 psf.

d. Turf Reinforcing Mat (SS836), Type 2 3.00 psf.

e. Turf Reinforcing Mat (SS836), Type 3 5.00 psf.

f. RCP, Type B 6 psf.

g. RCP, Type C 4 psf.

h. RCP, Type D 2 psf.

Temporary Ditch Protection (Item 670):

a. Mat, Type A 1.25 psf.

b. Mat, Type B 1.50 psf.

c. Mat, Type C 2.00 psf.

d. Mat, Type E 2.25 psf.

e. Mat, Type F 0.45 psf.

Section C. Roadway Ditches - Continued

f. Mat, Type G 1.75 psf.

Tied Concrete Block Mat (Item 601)

a. Type 1 3 psf.

b. Type 2 5 psf.

c. Type3 7 psf.

5. MANNING'S "n" USED FOR (1102.3):

a. Seed lining 0.03

b. Sod, jute, or other temporary linings 0.04

c. Turf reinforcing mats 0.04

d. Tied Concrete Block Matting 0.03

e. Rock channel protection 0.06 for ditches, 0.04 for large channels

6. DITCH CONFIGURATION (1102.2):

a. Std roadside ditch radius for roadway, with 12- inch minimum depth

b. Trapezoidal for toe of embankment, with 12- inch minimum depth

6. TYPE OF DITCH CATCH BASIN (1102.3.4):

a. ODOT Std No.2-2A and B, No.2-3, No.2-4, No.2-5, No.2-6, No.4, No.5, No.8 and side ditch inlets

8. MINIMUM LONGITUDINAL SLOPE OF DITCHES IN CUT SECTIONS (1102.1):

a. 0.50% desirable minimum

b. 0.25% absolute minimum

9. METHOD USED TO LOCATE EXISTING FARM TILE CROSSED BY HIGHWAYS?

a. Contact the appropriate County Engineer's office for assistance in locating existing farm tile.

b. Through field observations.

Section C. Roadway Ditches – Continued

10. MINIMUM WIDTH OF DITCH LININGS (1102.3.1) :

a. Sod 7.5 ft.

b. Temporary linings 7.5 ft.

c. Turf reinforcing mats 7.5 ft.

11. DESIGN FREQUENCY DEPTH SHALL NOT EXCEED (1102.3.1):

a. An elevation 1 foot below edge of pavement for the design discharge.

b. The depth of flow in toe of slope ditches shall be limited such that the design year discharge does not overtop the ditch bank.

Section D. Median Ditches NA

1. DITCH CONFIGURATIONS (1102.3):

a. Depressed _____

b. Type of barrier _____

2. WIDTH BETWEEN PAVEMENT EDGES _____ ft.

3. ALLOWABLE SHEAR STRESS FOR DITCH LINING (1102.3):

Permanent Ditch Protection:

a. Seed lining _____ psf.

i. Sod or other temporary ditch protection _____ psf.

j. Turf Reinforcing Mat (SS836), Type 1 _____ psf.

k. Turf Reinforcing Mat (SS836), Type 2 _____ psf.

l. Turf Reinforcing Mat (SS836), Type 3 _____ psf.

Temporary Ditch Protection (Item 670):

d. Mat, Type A _____ psf.

e. Mat, Type B _____ psf.

f. Mat, Type C _____ psf.

g. Mat, Type E _____ psf.

h. Mat, Type F _____ psf.

i. Mat, Type G _____ psf.

Tied Concrete Block Mat (Item 601)

a. Type 1 _____ psf.

b. Type 2 _____ psf.

c. Type 3 _____ psf.

4. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1101.2):
a.

b.

5. CATCH BASIN SPACING WILL BE DETERMINED BY HYDRAULIC ANALYSIS USING (1102.3.4):

a. _____ year frequency and "n" = _____ for velocity

b. _____ year frequency and "n" = _____ for depth

c. Controls:
i. Design frequency depth shall not exceed:

(1)

(2)

d. Catch basin spacing, depressed median, fill section:

Median Width	84'	60'	40'
i. Desirable maximum			
ii. Absolute maximum			

5. TYPE OF MEDIAN CATCH BASIN OR INLET (1102.3.4):

a.

7. MINIMUM LONGITUDINAL SLOPE OF DEPRESSED EARTH MEDIAN:

Section E. Drainage for Curbed Pavements

1. CONTROLS FOR THE DETERMINATION OF INLET OR CATCH BASIN SPACING (1103):

a. Design storm frequency: 10- year ODOT, 5-year ADT Urban >9000, other 2-year

b. Check storm frequency: 50- year for freeways, high volume highways and high volume City streets; 25- year for other multi-lane highways and City streets (for underpasses or depressed roadways where the storm sewer is the only outlet)

c. METHOD USED TO DETERMINE TIME TO FIRST CATCH BASIN OR PAVEMENT INLET:

i. The summation of the time of overland flow, the time of shallow concentrated flow and the time of pipe or open channel flow.

ii. Absolute minimum time of concentration of 10 minutes

d. Maximum spread of flow into traveled lane (use ODOT L&D Manual Table 1103-1 and ADT):

i. Freeways 0 ft

ii. 2-lane City Streets 6 ft

iii. 4-lane City Streets 8 ft

Outside lane width greater than 12 feet 0 ft. (freeways)

Total allowable spread on pavement shoulder width ft. (freeways, see Table 1103-1 for other highway types)

e. Maximum depth of flow at curb 1 in below top of curb for the design discharge, 5 in max. depth. 6- in max. along barrier wall ODOT.

f. Manning's "n" for:

i. Reinforced concrete pavement 0.015

ii. Asphaltic concrete pavement 0.015

iii. Paved shoulders 0.015

2. TYPE OF INLET OR CATCH BASIN PROPOSED FOR (1103):

a. Continuous grades ODOT Std 6' pavement inlet or CB No.3A. City CB-1 on city streets.

c. Sags ODOT Std CB No.3. For drives, Std No.6 with flanking No.3A catch basins - see 1103.7. City sags use a CB-3(single CB-1 adjacent a IB-1)

3. INLET LIP OF CURB OPENING INLET WILL BE DEPRESSED 2.0 INCHES BELOW NORMAL GUTTER.

a. A local depression of 0.5 inches will be used to determine spacing of combination grate and curb opening catch basins for a curb pavement section.

b. A local depression of 0.0 inches will be used to determine spacing of combination grate and curb opening catch basins for a combination curb and gutter section.

4. BRIDGE DECK DRAINAGE

a. The design frequency of bridge deck drainage in the Scope of Work (14.2.4) and the L&D was intended to be the 10-year event for the Interim and Future condition and a 2-year event for the Bi-Directional Condition. Due to the poor condition of the deck on several existing bridges, these bridge decks or bridge superstructures will be replaced now. When Innerbelt Contract CCG-3 is constructed these bridges will be completely replaced or will no longer be needed. In an attempt to reduce the number of scuppers on bridges in accordance with ODOT's L&D Section 1103.1, it was agreed to use the 2-year storm for the design frequency for the re-decked bridges. That requirement is to confine the 2-year design storm to the Interim Condition shoulder width, and limit the extent to which the 10-year storm spread exceeds the shoulder width.

Attachment A – City of Cleveland Standards

CITY OF CLEVELAND

DIVISION OF WATER POLLUTION CONTROL (WPC)

STANDARDS FOR PREPARATION OF PLANS FOR NEW SEWERS

A plan of existing and/or proposed sewers shall be submitted for all projects involving new sewer systems or substantial additions to existing sewer systems. When preparing the sewer plan, the following are to be taken into consideration:

General information

1. The sewer plans should be legible and clear, otherwise the plan review cannot proceed.
2. Use 24"x36" size
3. North arrow
4. Legend for utilities
5. Label the existing and/or proposed streets and indicate their status: public, private, dedicated, vacated, existing public or private sewer easement, etc.
6. Show the sewer or utility easement if it exists and provide copies of the easement records. Show the owner of the easement.
7. Show the location and width of all existing or proposed utility easements.
8. Label the right of way (in bold type), curb, underground utilities and property lines.
9. Show the addresses and names of the existing and/or proposed properties if available.
10. Show on the plan and profile views the location and type of all utility lines.
11. Show the elevation of the finished floor and/or basement floor on the property in relation to the existing and/or proposed sewer.
12. It is highly recommended to check the availability of sewer records for the plan and profile views and location of sewer connections during the design stage.
13. Include a list of all file numbers and sewer records that have been provided by WPC on the plans.
14. Plans should be prepared with 1:20 horizontal scale and 1:5 vertical (elevations) scale.
15. The sewer plans should show the plan view with its respective profile view on the same sheet. Also, cross section views are required for the proposed catch basins.

Sewer Bulkheads

If a sewer bulkhead is required, show the location on the plans. Indicate that a masonry bulkhead should be constructed, by the contractor, for all existing sewers to be cut and abandoned.

Sewer Abandoned

If sewer pipes are to be abandoned, show the location and size of the pipes. Indicate if the pipes will be sandfilled or grouted in place, or removed.

Main Sewer

The following are required when preparing plans for proposed main sewers located in the City right of way or public easement:

1. Show all existing and proposed underground utilities on both plan and profile views.

2. A minimum horizontal clearance of 8 ft is required between the main sewer and any underground utility line.

3. Show the actual width of the existing and proposed main sewers.

4. Show the new main sewers in bold type.
5. Storm and sanitary main sewers are required in proposed public roadways. In addition to WPC approval, approval of the new sewers should be granted by the Ohio EPA and the Northeast Ohio Regional Sewer District (NEORSD). Approved copies of the plans and/or correspondence should be submitted to WPC. The NEORSD phone number is (216) 881-6600.

6. If the main sewer is not owned by the City, show its ownership.

7. If the proposed main sewer is private, an encroachment permit approved by the City Council is required.

8. All new main sewers and manholes should be located within the public roadway.

9. All proposed main sewers should flow by gravity.

10. Show the length, size, material type and slope of the proposed main sewer. Also indicate if the sewer is combined, sanitary or storm.

11. The minimum depth of a proposed main sewer is 9 ft. It can be shallower if it is intended for street drainage only.

12. A minimum cover of 3 ft is required for all proposed main sewers.

13. Use a minimum size of 12” for proposed storm and/or sanitary main sewers.

14. Use a minimum size of 15” for proposed combined main sewers.

15. Use Vitrified Clay Pipe (VCP), Extra Strength (ES), C-700, with premium joints, ODOT item 706.08 for all proposed main sewer pipe 18” and smaller.

16. Use Reinforced Concrete Pipe (RCP) with premium joints, ODOT Item 706.02 for all proposed main sewer pipe 21” and larger.

17. Ductile Iron Pipe (DIP) may be used if approved by the WPC engineer.

18. No horizontal bends are allowed in the main sewers.

19. Use a minimum slope of 0.50% for all proposed main sewers.

20. Submit sewer calculations for any proposed main sewer. For the design of sewers, the velocity of water cannot exceed 15 ft/s but not less than 3 ft/s.

21. If a sewer easement is required for the proposed main sewer, it should be labeled on the plans along with its width. Generally, the sewer easement should not be less than 50 ft and it should be accessible at all times.

22. Show locations of all special sewers such as inverted siphons, concrete encasements, culverts, etc.

23. Include the EPA requirements for sewer testing.

24. If a storm sewer is discharging to a body of water (i.e. river, creek or lake) the plans should be approved by the authorizing agency (i.e. Ohio EPA, Ohio Department of Natural Resources (ODNR), US Army Corps of Engineers)

25. The following notes should be included in the plans when a public sewer is built:

    a. The contractor should notify the Division of Water Pollution Control (WPC) prior to start of construction. Call the engineering office at (216) 664-2756 or (216) 664-2787 to coordinate the sewer work.

    b. The contractor is required to submit sewer shop drawings to WPC prior to sewer installation. The drawings should include the sewer pipes, manholes, catch basins and other sewer appurtenances.

    c. WPC will inspect the City sewer installation. The cost of the full time inspection shall be paid by the contractor. An inspection deposit shall be submitted to WPC prior to the start of construction.

    d. The proposed sewers should be constructed in accordance to the plans and specifications approved by WPC. Any deviations from the approved plans or specifications require a new plan submittal reflecting the changes. Upon review of the revised items, WPC will re-issue a new approval. It is strictly prohibited to construct any sewers unless they are approved by WPC.

    e. Upon completion of the sewer installation, the contractor is required to submit a hard copy and an electronic copy of as-built plans, and a CCTV copy of the new City sewers. WPC reserves the right not to approve any sewer that does not meet the City requirements.

    f. The contractor is responsible for the plan review fees of the new City main sewers.
    g. The contractor is required to obtain permits for all proposed or existing sewer connections that will service any property.

Sewer Connection (or Lateral)

The following are required for all proposed sewer connections located in the City right of way.

1. All proposed sewer connections should flow by gravity in the City right of way.

2. Show on the plan view the station of each proposed sewer connection.

3. Use a minimum size of 6” for all proposed sewer connections.

4. In general, use a 6” pipe for new house sewer connections.

5. Use a minimum slope of 1% for proposed 6” and 8” sewer connections.

6. The size and the slope of a proposed sewer connection should be based on its capacity.

7. If the proposed sewer connection will damage the structural integrity of a main sewer, a new manhole is needed. This requires special approval from WPC.

8. A minimum cover of 3 ft is required for all proposed sewer connections.

9. Label the sewer connections as “combined”, “storm” or “sanitary”.

10. If the proposed sewer connection is private, an encroachment permit approved by the City Council is required.

11. Use Vitrified Clay Pipe (VCP), ASTM C-700 ES, with premium joints, (ODOT item 706.08) for all proposed sewer connections 18” and smaller.

12. Use Reinforced Concrete Pipe (RCP) with premium joints, (ODOT Item 706.0) for all sewer connections 21” and larger.

13. Ductile Iron Pipe (DIP) may be used if approved by the WPC engineer.

14. Per the City standards, a test tee is required for each proposed sanitary and storm connection. Two test tees are required for a proposed combined sewer connection. The test tee should be located inside the property at 1 to 2 ft from the right of way. In commercial projects, a test tee can be replaced with a manhole.

15. It is preferred to tie the sewer connection to a manhole in the street. If this is not possible, the size of the sewer connection must be reviewed and approved by WPC to avoid structural damage of the main line.

16. No horizontal bends are allowed for sewer connections.

17. It is strictly prohibited to tie a sanitary sewer connection to a storm main sewer and vice versa.

18. Use a VCP Wye or Tee for sewer connections that tie to a VCP main sewer.

19. Use a saddle for sewer connections that tie to a brick or RCP main sewer.

20. Protrusion

Manhole

The following are required for all proposed sewer manholes located in the City right of way or public easement:

1. Show the type of material (brick or concrete), station, actual size, rim and invert elevations of existing and proposed manholes, including invert elevations of all pipes connecting to the manholes.

2. Indicate the station of the manhole on both plan and profile views.

3. Indicate the rim elevation of the manhole and the invert elevation of each sewer pipe that ties to the manhole with its respective direction and type (storm, sanitary or combined).

4. Indicate if the manhole is storm, sanitary, combined, regulator, chamber, dual, etc.

5. Indicate the type and size of the special manhole when it is required (i.e. large manhole, drop manhole, baffle manhole, junction chamber, etc.).

6. The difference of invert elevations between a manhole and a sanitary or combined sewer pipe that ties to this manhole should not exceed 2 ft. Special approval is required for a drop manhole.

7. The difference of invert elevations between a manhole and a storm sewer pipe that ties to this manhole should not exceed 10 ft. Special approval is required for a drop storm manhole.

8. It is prohibited to propose a drop pipe inside the manhole.

9. For the manhole cover and casting, use EJIW 1700 **with vented holes**, or approved equal.

10. All proposed manholes should be accessible for maintenance purposes.

11. For main sewers 36" in diameter and less, manholes should be spaced at a maximum of 300 ft.

12. For main sewers 42" in diameter and larger, manholes should be spaced at a maximum of 500 ft.

Catch Basin

The following are required for all proposed catch basins that are located in the City right of way.

1. Show the station, rim and invert elevations of existing and proposed catch basins, including invert elevations of all pipes connecting to the catch basins.

2. All proposed catch basins should be located in the public roadway.

3. It is preferred to tie a proposed catch basin to a manhole.

4. Use 12" VCP Extra Strength (ES), C-700, with premium joints, ODOT item 706.08, for all catch basin connections.

5. Use 1% minimum slope for all proposed catch basin connections.

6. It is prohibited to tie a service sewer connection to the City catch basin.

7. Use the City of Cleveland standard rectangular catch basin detail CB-1 for all proposed catch basins in the roadway unless another detail is required by a WPC engineer. This detail requires a trap and 24" minimum sump. For the trap use EJIW 5964-12 or approved equal. For the casting and grate, use EJIW 7350 or approved equal.

8. In a special project, WPC may require a 36" minimum sump.

9. It is prohibited to propose a catch basin within the limits of an ADA ramp.

10. It is prohibited to propose a catch basin within the limits of a driveway apron.

11. No more than two catch basins can be tied in series.

Water Pollution Control Address and Contacts:

Address:
Division of Water Pollution Control
12302 Kirby Avenue
Cleveland, Ohio 44108

Engineering Office:	Customer Service:
(216) 664-2787	
(216) 664-3638	(216) 664-2513
(216) 664-3783	
(216) 664-2052	
(216) 664-2756	

Fax Number:
(216) 664-3477

Plan Review Process:

It is highly recommended that the consultant contact WPC Engineering office prior to the start of the sewer design to receive every available sewer record and guidelines.

Estimated review of each plan submittal is approximately three (3) weeks. WPC Engineering office will issue all comments in writing.

Addressee's response to WPC comments must be in writing and included with the revised plan submittal.

Additional Reference Information:

- WPC Standard Details for Sewer Appurtenances (see attached)
- Cuyahoga County Book of Uniform Standard Sewer Details
  To receive a copy contact Cuyahoga County Engineer's Office at (216) 348-3800
- Cuyahoga County Book of Uniform Standards for Sewerage Improvements
  To receive a copy contact Cuyahoga County Engineer's Office at (216) 348-3800
- ODOT Book of Construction and Material Specifications
- To receive an electronic copy of the WPC Standards for Preparation of Plans for New Sewers contact WPC Engineering Office

Attachment B – Project Scope

Revision Date: July 28, 2010

CUY-90-14.90

PID 77332/85531

PROJECT SCOPE

State of Ohio
Department of Transportation
Jolene M. Molitoris, Director

Innerbelt Bridge
Construction Contract Group 1 (CCG1)

Approved _____
Date _____ District Deputy Director

Approved _____
Date _____ Director, Department of Transportation

Drainage Scope Only

1.17 GOVERNING REGULATIONS

It is the responsibility of the DBT to acquire and utilize the necessary manuals that apply to the design and construction work required to complete this Project.

The Standard Specifications of the State of Ohio, Department of Transportation (Construction and Materials Specifications [C&MS]), and Supplemental Specifications shall govern this Project.

(See Section 2.6.8 for modifications of the approval requirements of the governing regulations listed in this section.)

The DBT shall design and construct Interstate and NHS elements of the construction Project in conformance with the standards, policies, and standard specification cited in 23 CFR 625.4, and use the latest edition of each enumerated provision.

The following listing of governing regulations is alphabetical. Utility and railroad work shall comply with appropriate governing regulation. ODOT Standards and Manuals take precedence over others listed unless noted otherwise in the Project scope. The current edition, including updates released on or before May 15, 2010, of the following shall be met or exceeded in the performance of the design and construction work required to complete this Project: (except as noted below)

A. American Association of State Highway and Transportation Officials (AASHTO) Publications:
    a. A Policy on Design Standards - Interstate System
    b. A Policy on Geometric Design of Highways and Streets
    c. Bridge Welding Code
    d. Guide Design Specifications for Bridge Temporary Works
    e. Guide for the Development of Bicycle Facilities
    f. Guide Specifications for Design and Construction of Segmental Concrete Bridges
    g. Guide Specifications for Thermal Effects in Concrete Bridge Superstructures
    h. Laboratory Specifications
    i. LRFD Bridge Construction Specifications
    j. LRFD Bridge Design Specifications
    k. Manual for Bridge Evaluation
    l. Manual on Subsurface Investigations
    m. Roadside Design Guide
    n. Roadway Lighting Design Guide
    o. Standard Specifications, 17th Edition (for existing structures only)
B. ADA Accessibility Guideline US Access Board
C. American Traffic Safety Services Association (ATSSA) Portable Changeable Message Sign (PCMS) Handbook
D. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering
E. CEB/fip Model Code for Concrete Structures, Appendix E, Time Dependent Behavior of Concrete, Creep and Shrinkage
F. City of Cleveland Publications:
    a. Cleveland Water Standards at: (http://www.clevelandwater.com/system_overview/standard_details06.aspx)
    b. Standard Construction Drawings (including Drainage Design Standards) at: (http://www.city.cleveland.oh.us/CityofCleveland/Home/Government/CityAgencies/PublicService/Public%20Service%20Publications)
G. Cleveland Public Power (CPP) Street Light Standards and General Construction Notes
H. CSX Publications:
    a. Criteria for Overhead Bridges
    b. Design & Construction Standard Specifications
I. Federal Highway Administration (FHWA) Publications:
    a. HEC-21 Design of Bridge Deck Drainage
    b. HEC-22 Urban Drainage Design Manual

c. Manual of Uniform Traffic Control Devices (MUTCD)

J. Illuminating Engineering Society of North America (IESNA)
   a. Roadway Lighting RP-8-00 (Reaffirmed 2005)
   b. Lighting for Parking Facilities (Parking Lots)
   c. Recommended Practice for Tunnel Lighting (Underpass Lighting)

K. National Cooperative Highway Research Program (NCHRP) 350 Hardware Report

L. National Electric Code (NEC)

M. National Electric Safety Code (NESC)

N. Norfolk Southern's (NS) Guidelines for Design of Highway Separation Structures over Railroad (Overhead Grade Separation)

O. Ohio Department of Transportation (ODOT) Publications:
   a. Aesthetic Design Guidelines
   b. Bridge Design Manual (2007 edition for new structures and 2004 edition for existing structures) (BDM)
   c. CADD Engineering Standards Manual
   d. Construction Inspection Manual of Procedures
   e. Construction and Material Specifications
   f. Design Guidance for Independent Bicycle Facilities
   g. Design Guidance for Roadway-Based Bicycle Facilities
   h. Ecological Manual
   i. Ecological Resources and Permits - Technical Guidance Documents
   j. Environmental Services Handbooks and Guidelines
   k. Geotechnical Bulletins
      i. GB1-Plan Subgrades (Dated July 15, 2010)
      ii. GB1: Subgrade Analysis Spreadsheet (Dated July 15, 2010)
      iii. GB2-Special Benching and Sidehill Embankment Fills
      iv. GB4-Guidelines for the use of Geotechnical Instrumentation
      v. GB9-Geotechnical Software
   l. Geotechnical Engineering Checklists
   m. Location and Design Manuals
      i. Volume One - Roadway Design
      ii. Volume Two - Drainage Design
      iii. Volume Three - Plan Preparation
   n. Mapping Specifications – Office of Aerial Engineering
   o. Ohio Manual of Uniform Traffic Control Devices (OMUTCD)
   p. Pavement Design & Rehabilitation Manual
   q. Plan Insert Sheets
   r. Quality Standard for Temporary Traffic Control Devices
   s. Qualified Products List (QPL) (http://www.dot.state.oh.us/divisions/constructionmgt/materials/pages/qpl.aspx)
   t. Railroad Coordination Policy and Procedures Manual
   u. Real Estate Policies and Procedures Manuals
   v. Roadway Safety Landscaping Guidelines
   w. Sign Design Manual (SDM)
   x. Specifications for Geotechnical Explorations (SGE)
   y. Standard Construction Drawings – All Series (SCD)
      i. The following SCD shall use the 7/16/2010 revision: TC-16.21, TC-81.21, TC-82.10
   z. State Highway Access Management Manual
   aa. Survey Manual
   bb. Traffic Engineering Manual (TEM)
   cc. Quality Standards for Temporary Traffic Control Devices
   dd. Utility Manual "Procedure for Utility Relocations, Adjustments and Reimbursement"
   ee. Wireless Communication Tower Manual

ff. Waterway Permit Manual

P. Transportation Research Board (TRB)
   a. Highway Capacity Manual

Q. United States Coast Guard (USCG)
   a. Bridge Permit Application Guide
   b. Bridge Lighting and Other Signals

1.18 SUPPLEMENTAL SPECIFICATIONS

The DBT is directed to perform work as applicable in accordance with the supplemental specifications listed below. Supplemental Specifications modified specifically for this contract have been included in Appendices. Other supplemental specifications govern depending on DBT design and construction. (See Section 2.6.8 for modifications of the approval requirements.)

A. SS800 – Revisions to the C&MS
B. Modified SS832 Temporary Sediment And Erosion Control
C. SS835 - Exfiltration Trench
D. SS836 - Seeding and Erosion Control with Turf Reinforcing Mat
E. SS837 - Liner Pipe
F. SS839 - Trench Drain System
G. Modified SS840 - Mechanically Stabilized Earth Wall
H. SS850 - Cement Treated Free Draining Base (for exfiltration trench applications only)
I. Modified SS878 – Inspection and Compaction Testing of Unbound Materials
J. Modified SS879 – QC/QA Embankment
K. SS895 - Manufactured Water Quality Structure
L. Modified SS898 - QC/QA Concrete for Structures
M. SS902 - Conduit Inspection Equipment
N. SS937 - Polyethylene Liner Pipe
O. SS939 - Precast Trench Drain
P. SS995 - Precast Water Quality Structure

1.9 DESIGN DESIGNATIONS and MAINTAINING AGENCIES

Table 0-1 below indicates the functional classification, design speeds, legal speeds and maintaining agencies of roadways and trails that are designed and constructed as part of this contract or will be crossed by a new bridge or other structure as part of this contract. Available traffic information is depicted in the Innerbelt Interchange Justification Study in Appendix TC-03. Additional traffic information required will be obtained by the DBT and certified as necessary.

The design speed for the Future Condition and Interim Condition of I-90 shall be as listed in Table 1-1. The design speed for the Bi-Directional Condition of I-90 will vary from the value listed in the table for the tie-ins as indicated in Section 12.3.

The existing legal speed for I-90 in the Project limits is 50 mph. The Bi-Directional Condition and Interim Condition will be posted for 50 mph. The Future Condition will be posted for 55 mph at the completion of all Innerbelt Construction Contract Groups.

The streets along the Ontario-Broadway-Orange corridor will be renamed as part of the Project. Currently Ontario terminates at Carnegie and becomes Broadway. Upon the realignment of Broadway, Ontario will extend south to a new E.9th Street intersection and Orange will extend north to the same new E.9th Street intersection. As such, the following intersections will be renamed: Carnegie/Ontario-Broadway will become Carnegie/Ontario, and E.9th Street/Broadway-Orange will become E.9th Street/Ontario-Orange.

Table 0-1: Design Designations and Maintaining Agencies

Roadway	Functional Classification	Other Designation	Design Speed (MPH)	Legal Speed (MPH)	Maintaining Agency
I-90	Urban Interstate	STRAHNET, NHS High Priority	60	50[1]	Ohio Department of Transportation (ODOT)
I-71	Urban Interstate	STRAHNET, NHS High Priority	60	50[1]	ODOT
E.14th Street Ramp to I-90 westbound (A3)	Diamond Ramp		30 (Minimum)	-	ODOT
E.9th Street Ramp to I-90 westbound (A4)	Diamond Ramp		30 (Minimum)	-	ODOT
Ontario Avenue Ramp to I-90 westbound (A5)	Diamond Ramp		30 (Minimum)	-	ODOT
I-90 westbound Ramp to W. 14th Street Extension (A6)	Loop Ramp		25 (Minimum)	-	ODOT
W.14th Street Extension	Future Urban Collector	City Street	25	25	City of Cleveland
University Road	Urban Local	City Street	30	25	City of Cleveland
E.9th Street (Between Canal and Broadway)	Future Urban Collector	City Street, Future NHS Intermodal Connector	30	25	City of Cleveland
E.14th Street	Urban Arterial	Future SR 14 and Future SR 43 between Orange and Broadway	30	25	City of Cleveland

[1] The existing speed zone will remain in place until the completion of all of the Innerbelt construction contract groups. Upon completion of final build out the existing speed zone will be revised and I-90 posted for 55 MPH. The speed zone revision is not part of this contract.

Roadway	Functional Classification	Other Designation	Design Speed (MPH)	Legal Speed (MPH)	Maintaining Agency
Broadway	Urban Arterial	SR 14 and SR 43	30	30	City of Cleveland
Commercial Road	Urban Collector, Future Urban Local	City Street, Existing NHS Intermodal Connector Pending E.9th Street	25	25	City of Cleveland
Central Viaduct Way	Urban Local	City Street	25	25	City of Cleveland
E.9th Street (under I-90)	Urban Arterial	City Street, Other NHS and NHS Intermodal Connector	30	30	City of Cleveland
Carnegie Avenue	Urban Arterial	SR 10 and NHS Intermodal Connector	30	30	City of Cleveland
Orange Avenue	Urban Arterial	SR 87, US 422, SR 8, NHS Intermodal Connector, Future SR 14,	30	30	City of Cleveland
Ontario Street	Urban Arterial	SR 87, US 422, SR 8, SR 14, SR43 and NHS Intermodal Connector	30	30	City of Cleveland
Canal Road	Urban Collector	NHS Intermodal Connector	30	25	City of Cleveland
West 3rd Street	Urban Collector	NHS Intermodal Connector	30	25	City of Cleveland
W.14th Street	Urban Collector	City Street	30	25	City of Cleveland
Abbey Avenue	Urban Collector	City Street	30	25	City of Cleveland
Fairfield Avenue	Urban Collector	City Street	30	25	City of Cleveland
Kenilworth Avenue	Urban Local	City Street	30	25	City of Cleveland
Starkweather Avenue	Urban Local	City Street	30	25	City of Cleveland

Roadway	Functional Classification	Other Designation	Design Speed (MPH)	Legal Speed (MPH)	Maintaining Agency
Towpath Trail	Shared Use Path	Independent Facility	20	-	Multi-Party Agreement[2]

5. ENVIRONMENTAL COMMITMENTS

PERMITTING PROJECT REQUIREMENTS

The DBT must ensure that the Project is constructed and maintained in accordance with all conditions of the environmental commitments and each applicable permit required for the Project. This includes the permits described in the scope and any additional permits needed that are not specifically identified in the scope.
If not already obtained by the Department, the DBT shall obtain all necessary permits and pay all charges, fees and taxes associated with these permits. The DBT shall be responsible for any fines levied by environmental regulatory agencies as a result of their construction activities or non-compliance with any permit special or general conditions.

Waterway Permits

It is required that the DBT be aware of Section 404/401 Permits/Certifications and U.S. Coast Guard (USCG) Section 9 Permit requirements for the Project.
The Office of Environmental Services (OES) will obtain the required waterway permits from the U.S. Army Corps of Engineers (USACE) and the Ohio Environmental Protection Agency (OEPA) based on assumptions established by the Department or other agents for the Department regarding the amount and location of fills. The DBT shall comply with the requirements and conditions of the approved waterway permits.
The Department will submit a draft USCG Section 9 Bridge Permit Application based on the 30% plan submission included with the Technical Proposal as discussed in Section 14.3.10. Excluding other applicable permit requirements, the DBT shall not construct viaduct foundations adjacent to the navigable channel until the USCG Section 9 Permit is obtained. The DBT shall be responsible for completing the final USCG Section 9 Bridge Permit Application. The Section 9 Bridge Permit application shall be prepared according to the ODOT Waterway Permits Manual. The Section 9 application shall be submitted by OES to the USCG for review and comment. The DBT shall address all the comments and submit the final Section 9 application with a list of the disposition of all comments to OES for coordination with the USCG. The DBT shall comply with the requirements and conditions of the approved permit. USCG Coordination information is provided in Appendix EC-08.
USCG Contact information:

Scot M. Striffler
Bridge Program Manager, Ninth Coast Guard District Bridge Program
U.S. Coast Guard
1240 E.9th Street
Cleveland, OH 44199
(216) 902-6087
Scot.M.Striffler@uscg.mil

OES coordinates any issues regarding USCG Section 9 Permits, USACE Section 404 Permits and OEPA 401 Water Quality Certification. At no time will the DBT coordinate waterway permit issues directly with the permitting agencies unless directed to do so by OES.
OES Permits Contact information:

William R. Cody
Assistant Environmental Administrator
Office of Environmental Services
Ohio Department of Transportation
1980 W. Broad Street

[2] City of Cleveland, Cleveland Metroparks, ODOT and Cuyahoga County

Columbus, OH 43223
(614) 466-5198
bill.cody@dot.state.oh.us

The Corps of Engineers issued Nationwide Permits #3 & #7 for the project on April 14, 2010. All design and construction shall be in accordance with the Nationwide Permits and the Special Conditions of the permit. The Nationwide Permits are in Appendix EC-22. The permits are valid until March 18, 2012. The DB Team shall prepare a re-evaluation application, in order to obtain a permit extension. The DB Team shall submit the re-evaluation application to ODOT by November 1, 2011.

If the DBT proposes any temporary and/or permanent fill(s) that have not been permitted through the 404/401 or Section 9 permit processes, permit modification(s) are required. The DBT shall coordinate the request for the permit(s) modification with the Project Engineer and OES. The Department makes no guarantee to granting the permit modification(s) request. The permit modification(s) shall be coordinated by OES with the USCG, USACE and OEPA where applicable. Supply the Project Engineer/OES with the following information:

A. A plan and profile drawing showing the temporary and/or permanent fill(s) with the Ordinary High Water Mark (OHWM) elevation. The OHWM elevation of the main navigation channel of the Cuyahoga River is 575.00 feet within the project limits.
B. Volume of temporary and/or permanent fill below the OHWM.
C. The surface area of temporary and/or permanent fill below the OHWM.
D. A restoration plan for the area affected by the causeway and access fill.
E. Time frames for placement and removal of the temporary and/or permanent fill.
F. A minimum of 60 days shall be allowed for OES to coordinate any proposed permit modification with the USCG, USACE and/or OEPA.

National Pollutant Discharge Elimination System (NPDES) Permit

ODOT obtains the Notice of Intent (NOI) from OEPA for the Project. The DBT and the IQF shall be co-permittees. All temporary sediment and erosion control is the responsibility of the DBT. Refer to Appendix EC-03: Modified SS832 for developing the Storm Water Pollution Prevention Plan (SWPPP) and locating, furnishing, installing, and maintaining temporary sediment and erosion control.
Earth disturbing activity is not permitted prior to the OEPA issuance of a Facility Permit Number and fully executed co-permittee Form. The SWPPP must be in place prior to the initiation of any earth disturbing activity. The DBT shall describe the effects of construction sequencing with respect to temporary sediment and erosion control in the SWPPP. In addition, the DBT shall describe the approach to temporary sediment and erosion control for the overall project and the implementation of temporary erosion and sediment practices or facilities to be employed during each operation of the construction sequence.
All temporary sediment and erosion control work and the SWPPP shall be according to Modified SS832. (For information about OEPA's NPDES permit requirements see http://www.epa.state.oh.us/dsw/permits/permits.aspx.)

Harbormaster Permit

The DBT shall be responsible for obtaining permits and paying any fees related to the permit for the City Harbormaster in accordance with Section 573 of the City Ordinances for the City of Cleveland.
Harbormaster contact information is:

Sandra Ambris
Harbor Master
1501 N. Marginal Rd.
Cleveland, Ohio 44114
(216) 664-5020
sambris@clevelandairport.com

The DBT shall forward a copy of any correspondence with the City Harbormaster to the OES Permits Contact.

Floodplain Impacts

Prior to construction of any and all drainage structures in a floodplain, the DBT shall be responsible for submitting a letter identifying any temporary or permanent impacts to the floodplain to the ODOT District 12 Environmental Coordinator for review and comment. The District will coordinate with the local flood plain coordinator for agreement.
Any additional impacts identified subsequent to the agreement from the floodplain coordinator require coordination by ODOT District 12. Allow 15 days for this further coordination.

Removal of Temporary Erosion Control Items

The DBT shall remove all temporary erosion control items before the Project is accepted. Removed temporary erosion control items become the property of the DBT. The DBT shall dispose of removed temporary erosion control items in accordance with the appropriate C&MS specifications.

Typical U.S. Coast Guard Conditions

The following is a list of typical conditions placed in Section 9 Bridge Permits by the USCG for the DBT's consideration. The final Section 9 Permit will contain specific conditions for the Cleveland Viaduct Project. The DBT shall comply with the final requirements and conditions of the approved permit. OES coordinates any issues regarding USCG Section 9 Permits. At no time will the DBT coordinate waterway permit issues directly with the permitting agencies unless directed to do so by OES.

A. Maintain free navigation of the waterway and navigable depths.
B. Two weeks prior to the scheduled demolition work on the bulkhead, notify the USCG office of the demolition schedule. Complete the Project Information Record and return it to the USCG office.
C. One week prior to demolition, schedule a pre-demolition meeting with the USCG and all involved parties to ensure that all equipment, manpower and materials are in place for the impending demolition.
D. Prior to commencing operations, furnish the Commander, Ninth Coast Guard District, evidence of a good and sufficient bond to insure compliance with USCG requirements.
E. Prevent the dropping of spark-producing, lighted and other objects on tows or vessels. Cease use of all flame-cutting, welding, and similar spark-producing operations over the channel when vessels are passing beneath the bridge.
F. Promptly remove any object dropped into the river which may constitute a hazard to navigation.
G. Where explosives or blasting is permitted and planned for use, immediately prior to the denotation of any underwater explosives, explode two or three blasting caps to frighten fish away from the demolition site.
H. If any objects causing an obstruction to navigation are placed or accidentally dropped into the river, mark such objects with one or more lighted buoys. Use buoys that are horizontally striped orange and white with the top stripe orange; align the buoys cross-river at intervals of about 25 feet or as close as practicable to the obstruction in the river. Light each buoy at night with a quick flashing white light (60 flashes per minute). If steel is extending above water, orange flags by day and quick flashing white lights by night may be displayed on the steel in lieu of any buoy.
I. Notify the Commander (dwb), Ninth Coast Guard District, at least 15 days in advance of any action that may impede navigation. Allow 15 days for issuance of revised notices caused by any revision of work schedule. Update notification by telephone if necessary to assure that navigation interests are aware of impending events that may affect the movement of river traffic.
J. The DBT agrees to be responsible for damages to persons or properties resulting from the work and save and hold harmless the United States from any claim for damages resulting from this operation.
K. Maintain the present navigation lighting on the bridge until all work is completed, and the navigation lights to be prescribed at a future time are installed and placed into operation. If work activities obscure the existing lights on the bridge from the river, the DBT shall relocate the existing lighting or install temporary navigation lights that meet USCG approval.
L. When using barges and other watercraft in demolition activities, use lights and signals for the barges and watercraft as required by the "Inland Navigational Rules of 1980."
M. Where explosives or blasting is permitted and planned for use, use flagmen to warn river traffic before blasting. Station flagmen in a radio-equipped boat approximately one-half mile upstream and downstream of the bridge not less than one hour prior to and during the detonation of explosives to warn approaching river traffic of the impending action and obstructions in the river. Provide such warning devices as may be necessary to keep boats out of the immediate danger area.
N. Any temporary fills, rubble, or similar material deposited in the river must be approved by the Commander, U.S. Army Engineer District 9, and Buffalo District pursuant to Section 404 of Public Law 95-217.
O. Coordinate and submit plans for any temporary causeways, work bridges or other falsework to be placed in the river to the Commander (dwb), Ninth Coast Guard District for approval.
P. Spoil all rubble in upland, non-wetland areas above ordinary high water. Obtain approval for disposal sites from the Commander, U.S. Army Engineer District, and Buffalo District.

Q. Submit requests to temporarily block the river and stop river traffic, in writing, for approval to the Commander (dwb), Ninth Coast Guard District.

R. Where explosives or blasting is permitted and planned for use, if, in the opinion of the person in charge of the explosive detonation, the use of radiotelephone or other electronic equipment in the area should be prohibited, at any time, advise the Coast Guard well in advance so that timely notices can be published.

S. Where explosives or blasting is permitted and planned for use, if explosives are to be transported by water, obtain permits in accordance with Title 49, Code of Federal Regulations. Submit applications to the USCG Marine Safety Office, 9th District.

T. When the Commander, Ninth Coast Guard District determines that hazardous conditions exist, provide a towboat (tug) to assist vessels through the bridge on demand. Provide a vessel of adequate capacity and design to assist tows through the work area. Make the towboat (tug) available 24 hours a day, seven days a week. The boat may also be used as the DBT's work tug, provided that the assistance of commercial tows through the area takes priority over the DBT's normal usage.

Typical Nationwide Permit Conditions

The following is a list of typical conditions placed on Nationwide Permits for the DBT's consideration. The final Nationwide Permit will contain specific conditions for the Cleveland Viaduct Project. The DBT shall comply with the final requirements and conditions of the approved permit. OES coordinates any issues regarding USACE Section 404 Permits and OEPA 401 Water Quality Certification. At no time will the DBT coordinate waterway permit issues directly with the permitting agencies unless directed to do so by OES.

A. Waterway Permit Time Restrictions: Complete all work in streams and wetlands depicted in the final approved permit by the date provided in the Permit.

For work on streams and wetlands, the Department will consider the Contractor's submission of an extension to the waterway permit end date based on project constraints. In order to be considered, the Contractor must submit a justification to the Engineer at least two months prior to the waterway permit end date.

The Engineer will submit the request for a time extension to the ODOT OES Waterway Permits Unit (614-466-7100) for consideration and coordination with the USACE and/or Ohio EPA.

B. Deviations from Permitted Construction Activities: Make no deviations from the requirements for work in streams and wetlands depicted in the plans and/or Final Permit unless a modification has been submitted to ODOT and approved by the appropriate agencies (i.e., USACE, OEPA, USCG, Ohio Department of Natural Resources [ODNR], U.S. Fish and Wildlife Service [USFWS]).

For emergency situations resulting in unanticipated impacts to streams or wetlands, provide notification (verbal or written) to the Engineer as soon as possible following discovery of the situation. Written notification to the Engineer and notification to the ODOT OES Waterway Permits Unit must be made within 24 hours.

For non-emergency situations, notify the Engineer in writing for submission to the ODOT OES Waterway Permits Unit (614-466-7100) for consideration and coordination with the appropriate agencies. Notification must be made at least two months prior to the planned non-permitted activities. Consideration of the requested deviation is at the discretion of the Director and must be coordinated with the appropriate regulatory agencies.

C. Bank Protection and Temporary/Permanent Fill Materials: For bank protection and temporary and permanent fills in or adjacent to streams and wetlands on the Project, use materials free from toxic contaminants in other than trace quantities. Broken asphalt is specifically excluded.

Do not use cadmium, chromium, arsenate (CCA), creosote, and other pressure treated lumber in structures that are placed in wetlands and streams.

D. Cultural Resources: If archeological sites or human remains are discovered, cease all work in the immediate area and notify the Engineer who shall immediately contact OES. OES Cultural Resource Contact information:

Paul Graham
Assistant Environmental Administrator
Office of Environmental Services
Ohio Department of Transportation
1980 W. Broad Street
Columbus, OH 43223
(614) 466-5099

paul.graham@dot.state.oh.us

In the event of human remains are discovered, the Engineer shall also contact the Cuyahoga County Sherriff's Office.

E. Water Resource Demarcation: Prior to site disturbance, demarcate all streams, wetlands, lakes, and ponds indicated on the plans in the field as per modified Supplemental Specification 832. Maintain demarcation fence throughout the construction process. Remove the demarcation fence and posts following the completion of the Project.

F. Blasting: Notify the ODNR if blasting is required within or near stream channels according to ORC 1533.58 and ODOT C&MS 107.07.
Notify the Engineer, in writing, for submission to the ODOT OES Waterway Permits Unit (614-466-7100) for coordination with the ODNR.

G. Waterway Permits: Maintain a copy of the waterway permits (e.g., USACE 404, USCG Section 9 Bridge Permit and the OEPA WQC and/or Isolated Wetland Permit) at the work site at all times and make it available to all contractors and subcontractors.

H. Birds and Bats: Prior to the removal of bridge structures, examine the underside of the bridge for the presence of birds and bats. Should any birds or bats be found roosting on the underside of the bridge, notify the Engineer for coordination with ODOT OES (614-466-7100).

I. Construction Completion Certification: Upon Completion of the work, notify the Engineer. Complete the USACE Construction Completion Certification and obtain the signature of the Engineer. Forward this information to:

U.S. Corps of Engineers
DSCC
Building 10, Section 10
3990 East Broad Street
Columbus, Ohio 43218

The DBT shall forward a copy of the certification to the ODOT OES Permits Contact.

OTHER ENVIRONMENTAL COMMITMENTS

Noise Walls

(See Section 15 - Noise Analysis and Noise Barriers.)

Vibration Analysis

(See Section 9.3.4 - Vibration Monitoring and Control Requirements.)

Section 106/Historic Sites

The DBT shall comply with all provisions of the Programmatic Agreement (PA) among the Federal Highway Administration (FHWA), The Ohio State Historic Preservation Office, and ODOT regarding the Federal-Aid Highway Improvement of Interstate Routes 71, 77, and 90 in The City of Cleveland, Cuyahoga County, Ohio CUY-90 Innerbelt: PID 77510, Agreement Number 15498.
In accordance with the PA, FHWA and ODOT propose the following treatment plans to resolve the adverse effect on the three impacted historic properties:

A. Broadway Mills – Level II documentation as specified by the Historic American Building Survey (HABS) will be prepared. A commemorative display will be located at or near the existing mill site.

B. Marathon Gas station – Level II documentation as specified by the Historic American Building Survey (HABS)

C. Distribution Terminal Warehouse – a historic context will be prepared documenting the significance of the resource in relation to the City of Cleveland's food distribution industrial history.

The Level II documentation and historic context will be prepared by the Department and will be included in Appendix EC-07. The DBT is not permitted to begin demolition activities until the Level II documentation has been completed. A schedule indicating when the property is released for demolition/construction is included in Appendix RW-01.

The DBT shall ensure that the above mitigation/enhancement activities are included in the design of the Project. The six 30-inch diameter (approximate) medallions on the north face of the Broadway Mills Building shall be

salvaged prior to demolition. The 10 architectural sandstone center pieces above each half circle window on the top floor shall also be salvaged prior to demolition. These salvaged materials shall be incorporated into the design of a commemorative display to showcase the historic value of the Broadway Mills Building to this area of Cleveland. The commemorative display will be located on the existing Broadway Mills site within the new overlook area. Other pieces of the Broadway Mills Building, (e.g. sandstone window sills, exterior bricks, cornices, etc.) may also be salvaged for reuse in the commemorative display and in the overall design of the overlook areas under the new bridge.

The DBT shall design three commemorative displays of the Broadway Mills Building. The DBT designer shall have Historic/Architecture Investigations prequalification.

See Section 16 – Aesthetics and Enhancements for additional requirements.

Asbestos on Bridges

Asbestos surveys were conducted on the bridges within the project limits by a certified asbestos hazard evaluation specialist. The surveys identified the asbestos containing materials (ACM) on the bridges. See Appendix EC-10, EC-21 and EC-28 for the inspection reports.
The removal and disposal of any ACM during the construction must comply with the Ohio Administrative Code, Occupational Safety and Health Administration (OSHA) regulations, and the National Emission Standard for Hazardous Air Pollutants (NESHAP) Standards for Asbestos.

The DBT shall complete the OEPA Notification of Demolition and Renovation forms and submit the completed form to the Local Air Authority at least ten (10) days prior to demolition of the bridges. The Contractor shall provide a copy of the completed forms to the Department. The Local Air Authority is:

City of Cleveland
Department of Health & Welfare
Division of the Environment
1925 St. Clair Avenue
Cleveland, Ohio 44114

The DBT shall provide an individual trained in the provisions of NESHAP that will be on-site during removal of the ACM. In addition to the ACM identified in the Asbestos Survey Report, any additional non-visible asbestos encountered within the project work limits shall also be monitored by this individual.
If unknown contamination is discovered during construction, the DBT shall notify ODOT immediately and shall follow the Spill Prevention Control and Countermeasure (SPCC) Plan as well as all appropriate regulations.
The DBT shall furnish all labor, equipment, and materials necessary to complete, submit, and comply with the OEPA Notification form and to remove, transport, and dispose of the materials containing asbestos from within the project work limits. The cost for this work shall be included in the overall lump sum price and is not to be compensated through force account as described in Section 0.

Materials Management

Before building demolition operations begin, the Department will conduct regulated materials inspections of all buildings subject to renovation or demolition. The findings of these inspections will be made available to the DBT. A list of property acquisitions is available in Appendix RW-01. The table in the appendix shows the status of individual parcels and buildings and the status of asbestos inspection.
Regulated materials can include but are not limited to: asbestos, mercury switches, fluorescent light bulbs, underground storage tanks (UST), and oil pits.
The DBT is responsible for abatement activities required for the buildings determined to contain regulated materials from the Department's inspections. All buildings, where the DBT is granted access to AND is in receipt the Department's regulated materials inspection findings prior to the bid submission are considered Known Abatements. The cost for these Known Abatements shall be included in the overall lump sum price and is not be compensated through force account.
It is expected that the Department will not have acquired or will not have provided an inspection report for some properties. The regulated material inspections on these properties will not be available to the DBT prior to bid. These are considered Unknown Abatements. Items used to implement the DBT's regulated material removal activities for Unknown Abatements shall be paid from the encumbered amount included in the proposal as Regulated Materials Removal and Disposal. The fixed amount represents the Department's estimate of the total cost of the Unknown Abatement activities for these buildings. Payment for the removal and disposal of regulated materials for Unknown Abatements shall be based on C&MS 109.05 - Force Account and is considered an excusable, non-compensable delay as per Item 108.06.B.7.
At least 10 Business Days before operations begin, the DBT shall complete an OEPA 'Notification of Demolition

and Renovation' form and submit this to the local air pollution control division, if delegated, or OEPA.
The DBT shall ensure that all suspect materials shall be removed and properly disposed of by a certified Asbestos Removal Professional in accordance with OAC 3745-20. An individual trained in the provisions of NESHAPS (40 CFR Part 61, subpart M) will be on site during the demolition or renovation of any structure with ACM and evidence that the required training has been accomplished by this person will be available during normal business hours.
If the DBT encounters an unknown or known UST within the right-of-way, the DBT shall decommission and remove the UST. This effort will be paid under C&MS 109.05 - Force Account and is considered an excusable, non-compensable delay as per Item 108.06.B.7. If a UST is encountered, ODOT and the DBT shall follow all applicable rules and regulations associated with UST removal activities.
The DBT shall meet all regulatory conditions imposed at properties with regulated materials associated with construction. These conditions could include ensuring that the surrounding properties and populations are not exposed to the regulated materials on the site. The DBT shall ensure that the site is properly contained during construction so that regulated materials do not migrate off site; and so that the health and safety of all on-site personnel are protected during work at the site, the DBT shall prepare an Spill Prevention Control and Countermeasures (SPCC) plan that provides specific guidance for managing regulated materials that may be encountered within the right-of-way.
If unknown regulated materials are discovered during construction, the DBT shall notify ODOT immediately and shall follow the SPCC Plan as well as all appropriate regulations.
The DBT shall dispose of construction waste material such as concrete or other harmful materials at approved sites in accordance with all appropriate regulations.
The DBTs shall review the environmental documentation for the project, including the Environmental Site Assessments completed by the Department. DBTs shall utilize this information to manage excavated materials on the project. DBTs shall use innovative and sustainable methods to reuse as much of the excavated materials as allowed by applicable regulations. Excess excavated materials that are regulated shall be appropriately managed by the DBT. This management may include transporting and paying for disposal at appropriate disposal facilities.
During the geotechnical investigation for the East 9th Street/Commercial Road realignment, off-colored and odd smelling soils were encountered in field samples. Based on these indications, soils were sampled and tested. The Phase II ESA analytical test results did not shows levels of compounds that would characterize excavated materials from this site as a hazardous waste. The test results along with the sample borings logs show that the soils contain weathered slag. The Phase II ESA Reports are available in Appendix EC-11.
Based on the Phase II ESA reports for the Norfolk Southern property (Parcel 632), the DBT can incorporate the excavated material into project. If the excavated material is not incorporated into the project, it shall be disposed of in a solid waste landfill.

13 DRAINAGE

The DBT shall design and construct drainage and storm water management facilities and systems including, but not limited to, catch basins, inlets, manholes, pipes, culverts, underdrains, outfalls, storm water Best Management Practices (BMPs) and associated items for the Project Drainage Area as defined in Section 13.2.5. Additional drainage requirements for structures can be found in Section 14.

GOVERNING REGULATIONS

The governing regulations for ODOT and local facilities are indicated in Section **Error! Reference source not found.** and 13.1.2. Table 13-1 indicates changes to Location and Design, Volume 2 that govern this Project.

Table 0-1: Location and Design, Volume 2 Revisions

Section	Subject	Revised Language
1002.3.1	Type A Conduits	Where durability requires increased thicknesses of the corrugated steel alternate, the 1-inch corrugation profile ~~should~~ ***shall*** be specified for pipe diameters over 48 inches.
1006.2.2.C	Culvert Allowable Headwater - Check Storm Controls	A replacement structure ~~should~~ ***shall*** be sized to prevent overtopping by the 100-year flood where such overtopping would not occur with the existing structure.

Section	Subject	Revised Language
1006.2.2.D	Culvert Allowable Headwater - Check Storm Controls	A replacement structure ~~should~~ ***shall*** be sized such that flooding of upstream productive land is not increased for the 100-year flood when compared to the existing structure.
1006.2.4	Culvert Allowable Headwater – Limitations	Where large structures (greater than or equal to 10 feet in span) are involved, the structure ~~should~~ ***shall*** be sized to pass the design storm while maintaining a free water surface through the structure.
1006.2.4	Culvert Allowable Headwater – Limitations	Where the overtopping point on the roadway is outside the watershed break, the ditch break overflow elevation ~~should~~ ***shall*** be utilized as a headwater control in lieu of 1006.2.1 A.
1007.1	Pipe Removal Policy	Use the following guidelines to determine whether an existing pipe, regardless of type, being taken out of service ~~should~~ ***shall*** be abandoned or removed.
1007.1	Pipe Removal Policy	Pipes 8 inches in diameter or rise, or less, regardless of depth or height of fill, ~~may~~ ***shall*** be abandoned in place.
1007.1	Pipe Removal Policy	Pipes 10 inches through 24 inches in diameter or rise with less than 3 feet of final cover ~~should~~ ***shall*** be removed or filled; with more than 3 feet of final cover they may be abandoned in place.
1007.1	Pipe Removal Policy	Pipes over 24 inches in diameter or rise ~~should~~ ***shall*** ~~generally~~ be removed.
1008.1.2	Corrugated and Spiral Rib Steel and Aluminum Pipes, and Corrugated Steel and Aluminum Pipe Arches	The thickness ~~should~~ ***shall*** be determined for the maximum height of cover and it shall be used for the full length of the structure.
1008.1.2	Corrugated and Spiral Rib Steel and Aluminum Pipes, and Corrugated Steel and Aluminum Pipe Arches	However, where a short length of conduit requiring a higher strength pipe is contiguous with a long run of pipe, then only that short length ~~should~~ ***shall*** be specified as requiring the higher strength pipe.
1008.1.3	Cambered Flow Line	Where soil conditions at the site indicate that appreciable settlement may be expected, a cambered flow line ~~should~~ ***shall*** be provided.
1008.2	Rigid Pipe	Where soil conditions at the site indicate that appreciable settlement may be expected, a cambered flow line ~~should~~ ***shall*** be provided.
1008.2.3.B	Rigid Pipe – Structural Design Criteria	The concrete pipe alternate ~~should~~ ***shall*** be specified as 706.02 with special design.

Section	Subject	Revised Language
1008.2.3.D	Rigid Pipe – Structural Design Criteria	The required pipe strength ~~should~~ ***shall*** be determined for the maximum height of cover and it shall be used for the full length of the pipe. However, where a short length of conduit requiring a higher strength pipe is contiguous with a long run of pipe, then only that short length ~~should~~ ***shall*** be specified as requiring the higher strength pipe.
1009.2.1	Pipe Underdrains	The depth of the rock cut underdrain ~~should~~ ***shall*** be 6 inches below the cut surface of the rock (Figure 1009-10).
1009.2.1	Pipe Underdrains	Underdrains which outlet to a slope ~~should~~ ***shall*** be provided with an outlet per SCD DM-1.1.
1009.2.1	Pipe Underdrains	A fabric filter wrap ~~should~~ ***shall*** be used when existing soils consist of a sandy or sandy-silt composition.
1009.2.4	Aggregate Drains	Aggregate drains ~~should~~ ***shall*** be located at 50 foot intervals on each side of the pavement and staggered so that each drain is 25 feet longitudinally apart from the adjacent drain on the opposite side.
1009.2.4	Aggregate Drains	For superelevated pavements, the drains ~~should~~ ***shall*** be located on the low side only, at each transverse joint in rigid pavement and at 25 foot intervals for other pavement.
Figures 1008-1 through 1008-9	General Notes	Before a pipe is used under a cover exceeding 100 feet, the structural maximum allowable height of cover and the required bearing pressure ~~should~~ ***shall*** be calculated and an investigation of the bearing capacity of the foundation material performed.
Figures 1008-10 through 1008-14	General Notes	Before a pipe is used under a cover exceeding 100 feet, the structural maximum allowable height of cover and the required bearing pressure ~~should~~ ***shall*** be calculated and an investigation of the bearing capacity of the foundation material performed.
Figures 1008-15 through 1008-21	General Notes	Before a pipe is used under a cover exceeding 100 feet, the structural maximum allowable height of cover and the required bearing pressure ~~should~~ ***shall*** be calculated and an investigation of the bearing capacity of the foundation material performed.
1102.3.4.D	Catch Basin Types	The basin ~~should~~ ***shall*** also be located outside the design clear zone or behind guardrail where the protruding feature of the basin is not objectionable.
1103.5	Drainage; Miscellaneous	Inlets or catch basins ~~should~~ ***shall*** ~~arbitrarily~~ be placed upstream of all intersections, bridges and pedestrian ramps.
1103.5	Flanking Inlets	The above is prevalent in long flat sag vertical curves, where a flanking inlet (or catch basin) ~~should~~ ***shall*** ~~arbitrarily~~ be provided on both sides of the low point in a pavement sag.
1103.6.2	Grate or Combination Grate and Curb Opening Inlet	The curb opening of a combination catch basin on a continuous grade will admit some flow, particularly if there is a partial clogging of the grate; however, the additional capacity ~~should~~ ***shall*** be considered as a factor of safety only.
1103.7	Grate Catch Basins and Curb Opening Inlets In Pavement Sags	The spread in the sag ~~should~~ ***shall*** be determined from the depth of flow at the edge of grate using Figure 1103-3 and ~~should~~ ***shall*** include the total flow (contributions from each side of the sag vertical curve) reaching the inlet or catch basin.

Section	Subject	Revised Language
1104.2.2	Storm Sewer Access	Small sewers (under 36 inches in diameter) located under or near the edge of pavement, ~~should~~ ***shall*** be accessible at intervals not to exceed 300 feet. For sewers sized 36 to 60 inches manholes ~~should~~ ***shall*** be spaced every 500 feet maximum. Manholes should be provided every 750 to 1000 feet maximum for larger sewers.
1104.4.2	Hydraulic Grade Line	Starting at the storm sewer system outlet and working upstream, the elevation of the hydraulic grade line at the upper end of each sewer run ~~should~~ ***shall*** be determined using a 25-year frequency.
1104.4.2	Hydraulic Grade Line	One directional lane of a multiple lane highway or one-half of a lane on a 2-lane highway ~~should~~ ***shall*** be passable when the sewer system is discharging the 50-year storm.
1106.1	End Treatments	Headwalls ~~should~~ ***shall*** also be provided for Type D conduits greater than 24 inches in diameter or rise.
1107.2	Rock Channel Protection	A filter ~~should~~ ***shall*** always be specified to prevent soil piping through the rock.
1107.2	Rock Channel Protection	An aggregate filter ~~should~~ ***shall*** be used when the RCP is under water.
1117.2	Manufactured Systems	As shown in the figure above, manufactured systems ~~should~~ ***shall*** not be provided on sewers that are carrying a water quality flow greater than 6 cfs.

ODOT Facilities

All plans and design for ODOT facilities are to be prepared in accordance with the latest standards provided in Section 0. ODOT drainage and post-construction storm water BMP facilities are considered to be those items that ODOT owns and maintains after construction. This is based on maintenance responsibility for the respective roadway. A list of roadways and their respective maintaining agencies is available in Section 1.8. Required supplemental specifications controlling drainage related work are listed in Section 0.

In the event of a conflict among the standards listed related to drainage, the Department's standards shall take precedence. For drainage components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice can be used as agreed to by the Department.

For post-construction storm water BMP components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice and meet the requirements of the Ohio EPA NPDES General Permit for Storm Water Discharge from Small and Large Construction Activities (OEPA Permit #OHC000003) can be used as agreed to by the Department.

Local Facilities

All plans and design for local facilities are to be prepared in accordance with the latest standards provided in Section 0. Local drainage and post-construction storm water BMP facilities are considered to be those items that the local public agency owns and maintains after construction. This is based on maintenance responsibility for the respective roadway. A list of roadways and their respective maintaining agencies is available in Section 0. Required supplemental specifications controlling drainage related work are listed in Section 0.

In the event of a conflict among the standards listed related to drainage, use this document (Project Scope) to determine the appropriate criteria. For drainage components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice can be used as agreed to by the Department.

For post-construction storm water BMP components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice and meet the requirements of the Ohio EPA NPDES General Permit for Storm Water Discharge from Small and Large Construction Activities (OEPA Permit #OHC000003) can be used as agreed to by the Department.

REQUIREMENTS

General Drainage Requirements

A. Use City of Cleveland Standards for drainage conduit and drainage structures owned and maintained by the City of Cleveland. For conduit sizes 18 inches and larger, use reinforced concrete pipe according to ODOT

C&MS 706.02. For conduit sizes smaller than 18 inches, use vitrified clay pipe according to ODOT C&MS 706.08. VCP must be Extra Strength. (See City of Cleveland drainage standards in Appendix DR-10.)

B. All drainage conduit crossing under any railroad, including any drainage conduit crossing under an elevated railroad shall be in accordance with railroad governing regulations. (See Section 1.17 and Section 7)
C. Adjusting rings are not permitted for casting adjustments in pavement. The DBT shall adjust the height of supporting walls per the C&MS.
D. Existing conduit to be abandoned shall be filled and plugged per L&D Vol. 2 note D103. Prior to filling and plugging, conduit shall be videotaped to ensure that unknown connections are not impacted.
E. The DBT shall remove sediment and debris from the existing drainage conduits and drainage structures to provide a functioning drainage system. All materials removed shall be disposed of as per C&MS 105.16 and 105.17. All sewers shall be cleaned out to the satisfaction of the engineer.
F. The DBT shall provide no less than five (5) feet of cover from the lower of existing or proposed ground on drainage conduit in the region bound by proposed westbound I-90, existing I-90, W.14th Street Extension, and Abbey Avenue. The purpose is to accommodate future parking construction.
G. Premium (water-tight) joints are required for submerged outfalls from outlet to nearest upstream drainage structure.
H. The DBT shall be responsible for appropriately designed pipe end treatments for all river outfalls.
I. Provide all final drainage calculations to the Department. Include both PDF and source files.
J. All underdrains shall have fabric wrap and shall be minimum 6 inch diameter.
K. The DBT shall design the parking lot drainage system such that ponding is limited to the landscaped areas for rainfall events up to and including the 5-year rainfall event. The maximum depth of ponding shall be 6 inches.

West Slope Drainage Requirements

All proposed storm sewer system facilities between Abbey Avenue and the Cuyahoga River shall meet the following requirements:

A. Minimum pipe cover shall be 5 feet for any pipe under a 4:1 or steeper slope.
B. Use mechanical connectors or flanged joints on 4:1 or steeper slope.
C. All proposed drainage structures shall have premium, water tight joints.
D. Maximum pipe velocity shall be 15 fps except for any pipe immediately prior to a ring chamber.

In order to introduce turbulence and improve oxygen levels of the West Bank storm water runoff, the DBT shall provide ring chambers in accordance with ODOT Plan Insert Sheets RC-2 and RS-2 (http://www.dot.state.oh.us/Divisions/HighwayOps/Structures/Hydraulic/Pages/Downloads.aspx) at the end of all West Bank storm sewer systems that outlet to the Cuyahoga River. In the case of a submerged outlet, the ring chamber section should be provided immediately prior to the section below elevation of 570 feet.

A drainage structure shall be provided to transition from the standard conduit to the ring chamber portion of the storm sewer. The DBT shall match the top of crown for the conduits entering and exiting the drainage structure.

The conduit type for the ring chamber portion shall be reinforced concrete pipe (C&MS 706.02 with premium joints per 706.11). The reinforced concrete conduit strength shall be based on the height of fill (L&D Volume 2, Figure 1008-10). The diameter of the conduit with ring chambers shall be a minimum of 36 inches, but shall be properly sized to meet the requirements of the FHWA/OH-84/007 Internal Energy Dissipaters for Culverts (included in Appendix DR-11) , and the length of ring chamber section shall correspond to Plan Insert Sheet RC-2. Additional design details for the ring chambers and corresponding conduit shall be in accordance with Plan Insert Sheets RC-2 and RS-2. The reinforced concrete pipe material shall be provided from the end of the ring chamber to the ultimate pipe outfall at the river.

E.9th Street (Commercial Road Hill Area) Storm Sewer

The proposed storm sewer outfall for the E. 9th Street system, from the CSX tracks to the Cuyahoga River, shall have the following requirements:

A. Provide a pipe design that considers all site conditions including, but not limited to, the following:

a. Maximum 110 feet height of cover over the pipe with an assumed material density of 140 lbs/cu. ft.
b. The proposed pipe will be subjected to varying pile heights/loads due to the temporary stockpiling of materials at this site.
c. Soil foundation, including pipe backfill and bedding.
d. Any needed dewatering during installation.

B. DBT shall provide design calculations with two (2) independent PE stamps from individuals qualified in structural design (double stamp does not remove requirement for IQF to verify design submission).

One underground or one above ground aerial sewer crossing across the GCRTA alignment is permissible in the region of the E.9th Street Bridge over GCRTA. The drainage system design shall consider ease of maintenance (vehicle accessibility, manholes on each side of crossing, etc.). In addition, the DBT shall refer to the railroad agreements in Appendix RR-01. If an aerial crossing is used see Appendix DR-12 – Aerial Crossing Requirements.

Structure Drainage

All of the drainage from all of the bridge decks is to be collected and conducted to the storm sewer system. The bridge deck drainage design shall conform to the following:

Bi-Directional Condition spread design

A. Two (2) year storm design frequency.
B. Spread is allowed into one-third (1/3) of the outside traveled lane.

Interim and Future Condition spread design

A. Ten (10) year storm design frequency per §1103.2 of ODOT L&D Volume 2.
B. Allowable spread of zero (0) feet into traveled lane per §1103.2 of ODOT L&D Volume 2.

Structure drainage requirements

Structure drainage requirements for the I-90 Viaduct and other structures may be found in Section 14 - Structures.

Storm Sewer

The existing drainage within the Project area is primarily conveyed through various combined sewer systems. The NEORSD relocation of their facilities will include temporary drainage connections to the relocated combined sewers. These temporary connections shall be removed by the DBT and the drainage directed into existing or new storm only systems.
Coordination with NEORSD's Walworth Run Interceptor Realignment project. The DBT shall be responsible for the design and construction of permanent storm sewer outfalls to pick up storm flows which previously entered the NEORSD Interceptor sewer system. The contributing drainage areas for these sewers include the area bounded by Fairfield, W13th, W15th and the Cuyahoga River. See the Sewer Abandonment plans in UT-03. These storm sewer systems shall include water quality BMPs as required in Section 13.2.6.

No net increase in peak flows (in the 5-, 10-, or 25-year design storm) shall occur to any point on the existing combined sewer system as a result of this Project. This does not preclude the DBT from removing upstream flow and adding an equivalent amount of downstream flow as this would pose no net increase to any point of the existing drainage system. This requirement has been established with Cleveland Water Pollution Control and North East Ohio Regional Sewer District.
Potential storm water outfall locations are shown in Appendix DR-02. Modifications to the planned outfall locations are allowable provided that they meet permit requirements. (See Section 0 - Environmental Commitments for further information.)
The DBT shall adjust or reconstruct catch basins, inlets, manholes and other castings as necessary to accommodate resurfacing.
The minimum Project Drainage Area is defined as follows:

A. All area within the construction limits or draining to the construction limits of the Project as finalized by the DBT. This includes areas within the construction limits but outside of existing or proposed ODOT right-of-way, including local streets.
B. All existing I-90 mainline and ramp pavement and bridge area between Starkweather Avenue and the east bank of the Cuyahoga River. This includes areas of I-90 (mainline and ramp) that previously drained into the combined sewer network but have experienced a severed connection to the combined sewer due to the NEORSD Walworth Run relocation project.

The installation of proposed storm-only drainage systems shall be implemented to the greatest extent possible.

Storm Water Best Management Practices (BMP)

General BMP Requirements

Post-construction storm water BMP treatment options are provided in Appendix DR-02. With respect to post-construction storm water BMPs, the Project is considered a "new construction" project as described in Section 1115.6 of Location and Design Manual, Volume 2.

The DBT shall provide post-construction storm water BMPs according to L&D Volume 2 and the Ohio EPA NPDES General Permit (OHC000003) for Storm Water Discharge from Small and Large Construction Activities to meet the storm water treatment requirements established in the NPDES Permit. Unless site conditions or safety issues preclude their use, use detention-based BMPs sized to treat the water quality volume as indicated in Appendix DR-02. The BMPs and storm sewer layouts proposed in Appendix DR-02 are for information purposes only and do not represent a prescriptive drainage design.

The DBT shall prepare slope stability analyses on pond side slopes and berms, and settlement analyses on berms. The DBT shall prepare geotechnical recommendations for infiltration zones. The DBT shall perform all detention pond and infiltration zone analyses.

Additional requirements:

A. For drainage areas tributary to the storm only systems, BMPs shall be sized based on the entire contributing drainage area (offsite and onsite) to the BMP. The treatment approach for BMP design shall be to provide 100% treatment for 100% of the project. If right-of-way, geotechnical, or structural issues do not allow 100% treatment, the DBT shall provide treatment to the maximum extent practicable. The treatment requirement shall not be reduced below the criteria established in the Section 1115.6.2 of Location and Design Manual, Volume 2. See Section **Error! Reference source not found.** for minimum Project Drainage Area.
B. Runoff from the Project Drainage Area directed to the combined sewer network is not required to be treated with a post-construction BMP.
C. Furnish a 6-inch layer of C&MS 601 Detention Basin Aggregate on the bottom of all detention basins.
D. If a bioretention cell is proposed, the bioretention cell storage area shall include the area above the planting soil and within the planting soil. Assume a porosity of 0.4.
E. If an extended detention pond is proposed, the pond shall have a sediment forebay and a length to width ratio of 3:1.
F. Prepare calculations and drainage area mapping for post-construction BMPs.
G. Provide vehicular access to accommodate equipment necessary for periodic maintenance of detention-based BMPs and manufactured systems. This shall include providing locking gates in fencing as necessary.
H. At the conclusion of construction activities when the site is stabilized, the DBT shall inspect and perform maintenance activities on any installed BMPs to allow the system to properly function to its full extent.
I. BMPs shall be located within right-of-way limits as indicated in the Final Right-of-Way Plans in Appendix RW-03 unless a maintenance agreement is in place with the property owner.
J. The DBT shall provide the following information regarding constructed BMP facilities:
    a. For Exfiltration Trenches, provide station (downstream edge of box structure), offset, RT/LT, length, and Type (A, B, or C).
    b. For Manufactured Systems, provide station (mainline manhole location), offset, RT/LT, and Type (1, 2, 3 or 4).
    c. For Vegetated Biofilter, provide station (begin and end station of VBF), offset, RT/LT, bottom width, and protective lining (selected according to L&D Volume 2, Section 1102). Protective linings include seed (CMS 659), sodding (CMS 660), ditch erosion protection mat (Type A, B, C, D, E, F, or G), and turf reinforcing mat (Type 1, 2, or 3).
    d. For Extended Detention, provide station (outlet structure), offset, RT/LT, and Type (A – above ground, or B – below ground).
    e. For Bioretention Cell, Infiltration Basin, or Constructed Wetland, provide station (outlet structure or downstream edge of bank), offset, and RT/LT.
    f. For Infiltration Trench, provide station (downstream edge of bank), offset, RT/LT, length, depth, and top width.

Prohibited BMP Systems

Retention Basins (permanent wet pond) are prohibited from being used as post-construction storm water BMP on this Project.

Detention-based BMPs and infiltration BMPs are not permitted in west slope between Abbey Avenue and the Cuyahoga River.

Permitted BMP Systems –Locally Maintained Facilities

Any BMP meeting the requirements of Section 13.2.6.1 and Section 13.2.6.2 is considered an acceptable storm water BMP for proposed E.9th Street and any proposed city street drainage facilities within the Project Drainage Area.

Permitted BMP Systems – West Bank

Any BMP meeting the requirements of Section 13.2.6.1 and Section 13.2.6.2 is considered an acceptable storm water BMP for the West Bank (all Project Drainage Area west/south of the Cuyahoga River). One or more extended detention ponds or bio-retention cell BMPs shall be used to treat the water quality volume associated with at least seven (7) acres of the West Bank.

Permitted BMP Systems – East Bank

Bioretention cells or extended detention basins designed to ODOT L&D Vol. 2 standards are the only acceptable storm water BMP's for any proposed storm-only drainage system receiving runoff from the mainline or ramps (non-local streets) on the East Bank (all Project Drainage Area east/north of the Cuyahoga River).

14.3.8 Drainage System

In addition to the requirements of Section 13 - Drainage, the bridge deck surface drainage design shall conform to the following:

A. Deck drainage shall be collected at the gutter lines (toe of parapet) by scuppers. Over-the-side drainage is not permitted.
B. Transverse deck drains are not permitted.
C. Welding of scuppers, downspouts, or drainage supports shall not be allowed in tension areas of main steel members.
D. The drainage system shall consist of closed conduit from the deck elevation to the point of discharge into the ground drainage system. Dropping drainage directly from the deck elevation to the ground elevation is not permitted.
E. Conduit enclosed within box type superstructures is not permitted.
F. Conduit enclosed in substructures is not permitted.
G. The conduit shall be polyvinyl chloride (PVC) plastic pipe per ODOT material specification 707.45.
H. The minimum conduit diameter is 15 inches.
I. The conduit shall have sufficient slope to maintain a minimum velocity of three (3) feet per second. Provide slopes as steep as can be practically incorporated with the geometry of the structure. The slope of horizontal conductors shall not be less than 15 percent.
J. Vertical conduit runs to the ground drainage system shall only be located at piers.
K. All bridge drainage inlets/scuppers shall be located within 20 feet of a substructure unit.
L. Vertical conduit runs to the ground drainage system shall consist of closed conduit except for a free fall of two (2) feet above the ground. The drainage shall be controlled at the point of discharge (i.e. bottom of the vertical conduit) by permanent features that completely contain the discharge and prevent erosion to the adjacent ground while discharging up to the 25-year design storm.
M. The maximum conduit bend angle is 45 degrees.
N. Cleanouts shall be provided immediately upstream of each bend, on vertical downspouts accessible from the ground, and at the end of each horizontal segment.

Attachment C – NEORSD Rainfall Data

Attachment C

Northeast Ohio
Regional Sewer District

Request for Connection Approval to Combined Sewer System

Submittal Guidelines for Review and Approval

Northeast Ohio Regional Sewer District
Protecting Your Health and Environment

December 6, 2010

Revised:

1.0 Purpose

The Title IV Combined Sewer Code of the Northeast Ohio Regional Sewer District (NEORSD) provides the NEORSD with the authority to control combined sewer overflows (CSOs) from the combined sewer system and control peak flows from local combined sewer systems at the point of connection into sewers owned by the NEORSD or member community. Therefore, the NEORSD has the authority to review all requests for connection approval to the combined sewer system.

The purpose of this document is to provide guidance to landowner, developers, and design engineers interested in developing land in the combined sewer service area and provide a uniform process for submitting construction plans to the NEORSD for review and approval. Design standards and criteria are also provided for use in developing stormwater management systems for sites where a connection is requested to be made to an existing combined sewer or CSO pipe.

2.0 Procedures for Submittal and Review

Requests for connection approval are required for all new development and redevelopment projects within the NEORSD service area seeking to connect to a combined sewer, CSO pipe, or separated storm sewer tributary to a combined sewer or CSO pipe. This section outlines the procedures that should be followed to ensure a complete submittal package is provided for review.

2.1 General Information

- Landowners, developers, and design engineers on behalf of the owner/developer may request approval to connect by submitting a set of construction plans with associated calculations supporting the stormwater management plan. For the sake of simplicity, the term "Designer" will be used throughout this document to refer to the landowner, developer and/or design engineer working on behalf of the owner/developer.

- Connection requests shall be made prior to the start of any work requiring approval from NEORSD. Work should only start after approval has been granted.

- As stated in the Title IV Combined Sewer Code of the NEORSD, the NEORSD has 15 business days upon receipt of a complete submittal package to review a connection request. The NEORSD will attempt to review these request in the shortest possible time. The Designer is encouraged to contact the NEORSD early in the design process to avoid delays in the project schedule. A definition of a complete submittal package is provided in section 2.2.

- Minimum design standards and criteria accepted by the NEORSD are provided in this document for designing stormwater management plans for sites within its service area. Depending on the location of the development site within the service area, there may be cases where a more restrictive design criterion is required due to downstream capacity issues. The Designer is encouraged to contact the NEORSD early in the design phase to determine whether the site is located in a critical area of the combined sewer system and subject to stricter design criteria.

- Construction plans showing the layout of the area intended to be developed shall be submitted to the NEORSD by the Designer. The plans shall be prepared under the direction of and sealed by a registered professional engineer.

- The NEORSD will review the plans for adequacy of stormwater management design to ensure that the proposed stormwater drainage system has the capacity to handle all contributing flow without diminution of the existing level of service in the combined sewer system.

2.2 Submittal Requirements

A complete submittal package should include and clearly state, at minimum, the following:

1. Stormwater criteria and design standards used if other than the NEORSD Title IV Code of Regulation.
2. Site map(s) of showing project site location, total drainage area, land use/cover, amount of impervious area and longest flow paths for existing and proposed conditions.
3. Detailed topographical map showing existing topography and proposed grades of the entire area, as well as the topography of all adjacent property to the extent that off-site contributing flow can be determined. All off-site contributing flow must be accommodated. All existing watercourses, lakes, wetlands and floodplain (if applicable) should also be included on the map. Please specify the horizontal and vertical national datum used.
4. Location, size, and type of all existing storm sewers, channels, and/or structures located upstream and downstream of project area.
5. Location, size, and type of proposed storm sewers, channels, and/or structures to be built as part of the site's stormwater management design.
6. Plans, cross-section views and details of all SCMs. If an existing SCM on or off-site will be used then as-built information must be provided. Please identify drainage area unique to each SCM on plans.
7. Plans and details of the soil erosion and sedimentation control measures. Indicate which measures are temporary or permanent and the party responsible for maintaining the control measures.
8. Predominant soil type from USDA soil surveys or soil borings found at site.
9. Drainage breakup sheet indicating the number of acres and percent imperviousness contributing to each specific drainage structure or SCM.
10. Design data and criteria used for sizing all drainage structures, channels, and SCMs.
11. Hydrologic and hydraulic calculations, assumptions, and parameters used for quantifying peak flows for existing and post-development conditions. Longest flow paths used in quantifying time of concentration for each should be shown on a site map.
12. A plan and a proposed schedule for the perpetual maintenance of the complete storm drainage system. Indicate who will be responsible (i.e. municipality, landowner, or homeowners' association) for the maintenance. If the homeowners' association will be responsible for the system, the subdivision deed restrictions must have a section indicating such responsibility and a copy must be submitted to the NEORSD. If there is a maintenance agreement with the City, Village or Township, a copy of the agreement must be submitted to the NEORSD. The maintenance plan must be submitted prior to plan approval.

3.0 Design Criteria and Engineering Standards

The design criteria and engineering standards set forth herein are intended to guide designers to develop a stormwater management system that controls the quantity and quality of the stormwater discharge for a development site. The internal drainage for a site as well as the downstream conditions will be reviewed. Every site is part of an overall watershed and the system should be designed with this in mind. The system should conform to natural drainage patterns both on and off-site. These standards are the minimum requirements of the NEORSD and should not be construed as all-inclusive. The design engineer should consider many factors when planning the stormwater management system. In particular, Federal, State, and Local standards may be more strict than these standards. In the case where conflicting standards arise, the more stringent requirement will govern. Exceptions will be considered when conforming to a local community stormwater criteria or standard is required.

3.1 Title IV Design Criteria

The design criteria specified in the Title IV Combined Sewer Code of the NEORSD are outlined below based on the type of sewer that will be connected to (i.e., combined sewer or CSO pipe):

1. For connections to the combined sewer system, storage volume shall be provided based on the 5-year event using a maximum release rate as defined in section 3.4. For larger, less frequent design events greater than the 5-year event, the maximum release rate shall be defined as the existing conditions peak discharge of the corresponding storm frequency evaluated for post-development conditions.

2. For connections to a CSO pipe, directly or via a separated storm sewer, treatment of stormwater runoff shall be handled in accordance with Part III.G.2.e of the Ohio EPA's General Construction Permit OHC000003. It should be noted, however, that the NEORSD will only accept stormwater management designs that provide water quality treatment for 100% of the project area whether the project is considered a redevelopment project or not. Post-development peak flows shall not exceed existing conditions peak flows up to the 25-year design event.

The criteria are the minimum design standard accepted by the NEORSD. In addition to the Title IV criteria herein, the Designer must also abide by the rules, standards, specifications and master plan of the municipality where the site is located. In the case where conflicting standards arise, the more stringent requirements will govern.

3.2 Rainfall Intensity-Duration-Frequency

Rainfall intensity-duration-frequency (IDF) estimates provided in Appendix A shall be used to the design of the stormwater management plans. Other sources of rainfall IDF estimates may be used if required by another Federal, State, or local standard applicable to the development site. If a different rainfall IDF source is used to support the stormwater design as dictated by another Federal, State or local authority, it should be clearly documented in the submittal package for review.

3.3 Peak Stormwater Flows

There are no NEORSD restrictions on the type of engineering methodology or software that the designer may use to quantify stormwater runoff from the site at this time. It is the responsibility of the designer to select an appropriate methodology suitable for the nature of the site. Supporting documentation, clearly stating the methodology, assumptions, parameters, and computations must be submitted for review and approval. In addition, the basis for selecting critical parameters, i.e., runoff coefficients, curve number, time of concentration, etc., should also be documented and provided for review.

3.4 Maximum Release Rate

Typically the maximum release rate is defined as the existing conditions 6-month, 24-hour peak flow. There may be cases where a more restrictive allowable discharge rate is required due to downstream capacity issues. In this situation, the designer will be required to incorporate a more restrictive release rate criterion into the stormwater management design to protect existing connections by avoiding the increase risks in basement flooding and/or increase in CSO volume. The designer is encouraged to contact the NEORSD to determine whether the development site is located in a critical area of the combined sewer system that is subject to stricter release rate limits.

NOTE: Stormwater Design Discussion Group intends to replace the 6-month, 24-hour criteria with a figure/map that would show release rates based on CSO tributary areas.

3.5 Stormwater Storage Requirements

There are no NEORSD restrictions on the type of engineering methodology or software that the designer may use to quantify required storage volume at this time. It is the responsibility of the designer to select an appropriate methodology for site design. Supporting documentation, clearly stating the methodology, assumptions, parameters, and computations must be submitted for review and approval. Documentation

with supporting calculation on the maximum allowable discharge used to determine the required storage volume must be clearly stated and provided for review and approval.

3.6 Stormwater Conveyance

There are no NEORSD restrictions on the type of engineering methodology or software that the designer may use to size the stormwater conveyance system at this time. It is the responsibility of the designer to select an appropriate methodology for site design. Supporting documentation, clearly stating the methodology, assumptions, parameters, and computations must be submitted for review and approval.

3.7 Physical Connection

The following general conditions are required by the NEORSD regarding the physical connection to one of its facilities pending approval of all connection requests.

Connections to existing laterals

- The existing laterals to be used shall be instated by video camera, and a copy of the video shall be submitted to the NEORSD for review and approval prior to the connections being made. Upon review of the videotape by the NEORSD, if the existing lateral(s) needs to be cleaned and or repaired the work shall be performed at no cost to the NEORSD prior to the connections being made.
- The laterals shall be re-inspected after the cleaning and/or repair and a copy of the video shall be submitted to the NEORSD for review and approval prior to the connection being made. All laterals not approved for use shall be abandoned.
- The contractor shall provide a watertight connection to the existing lateral and encase the connection in concrete.

If an existing lateral cannot be used, a new lateral shall be installed and the contractor shall meet the following conditions. (lay permit)

- Provide pre-construction and post-construction video inspection of the interceptor showing footage measurement from either the upstream or the downstream manhole and extending a minimum of 20 feet past the connection point. The former shall be submitted to the NEORSD for approval prior to the commencement of work.
- The connection shall be made through a properly sized cored hole. If the connection is to a reinforced concrete or vitrified clay pipe, then the lateral shall be concreted to the sewer using a manufactured boot that makes a watertight connection. If the connection is to a brick sewer, then the lateral shall be connected by wrapping a waterstop material such as Volclay RX101 or equal around the lateralwith two (2) wraps minimum in accordance with the attached detail. If waterstop material is used, the annular space between the sewer wall and lateral shall be filled with hydraulic cement. Either type of connection shall then be encased in concrete. The owner shall warrant that the connection will be watertight for a period of one year.

The following conditions apply to either the use of an existing lateral or the construction of a new lateral.

- The owner shall warrant that the connection will be watertight for a period of one year.
- The contractor is responsible for any and all damage to the interceptor as determined by the NEORSD.
- The contractor shall prevent any debris from entering the sewer. Any debris entering the sewer shall be removed by the contractor.

- The contractor is responsible for obtaining any and all permits required for the work.
- A 72-hour notice shall be provided to Mr. Lyle Plummer or Mr. Brian Stapleton (216-641-6000) to schedule a NEORSD inspector for the connection.

APPENDIX A

Table A-1. Rainfall Depth-Duration.

Tc (min)	Rainfall Depth (in)											
	2-Month	3-Month	4-Month	6-Month	9-Month	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
5	**0.13**	**0.15**	**0.17**	**0.19**	**0.22**	**0.32**	**0.39**	**0.46**	**0.53**	**0.60**	**0.67**	**0.73**
10	**0.24**	**0.28**	**0.30**	**0.35**	**0.40**	**0.50**	**0.60**	**0.72**	**0.81**	**0.93**	**1.01**	**1.10**
15	**0.30**	**0.35**	**0.38**	**0.45**	**0.51**	**0.61**	**0.74**	**0.88**	**1.00**	**1.14**	**1.25**	**1.36**
20	0.34	0.39	0.43	0.50	0.57	0.68	0.82	0.99	1.12	1.29	1.42	1.56
25	0.37	0.44	0.47	0.56	0.63	0.74	0.90	1.10	1.25	1.45	1.60	1.76
30	**0.41**	**0.48**	**0.52**	**0.61**	**0.69**	**0.81**	**0.98**	**1.21**	**1.38**	**1.61**	**1.78**	**1.96**
35	0.43	0.50	0.55	0.64	0.72	0.84	1.01	1.26	1.44	1.69	1.87	2.07
40	0.45	0.52	0.57	0.67	0.75	0.87	1.05	1.31	1.51	1.77	1.97	2.18
45	0.47	0.55	0.60	0.70	0.79	0.90	1.09	1.36	1.57	1.85	2.06	2.29
50	0.49	0.57	0.62	0.72	0.82	0.93	1.13	1.41	1.63	1.93	2.16	2.40
55	0.51	0.59	0.65	0.75	0.85	0.96	1.17	1.46	1.69	2.01	2.25	2.51
60	**0.53**	**0.61**	**0.67**	**0.78**	**0.88**	**0.99**	**1.21**	**1.51**	**1.76**	**2.09**	**2.35**	**2.62**
65	0.54	0.62	0.68	0.80	0.90	1.00	1.22	1.53	1.78	2.12	2.39	2.67
70	0.55	0.64	0.70	0.81	0.92	1.01	1.24	1.55	1.81	2.15	2.43	2.72
75	0.56	0.65	0.71	0.83	0.93	1.03	1.25	1.57	1.83	2.18	2.47	2.76
80	0.57	0.66	0.72	0.84	0.95	1.04	1.27	1.59	1.86	2.22	2.51	2.81
85	0.58	0.67	0.74	0.86	0.97	1.05	1.28	1.61	1.88	2.25	2.55	2.86
90	0.59	0.69	0.75	0.87	0.99	1.07	1.30	1.64	1.91	2.28	2.59	2.91
95	0.60	0.70	0.76	0.89	1.00	1.08	1.31	1.66	1.93	2.31	2.63	2.95
100	0.61	0.71	0.78	0.90	1.02	1.09	1.33	1.68	1.96	2.35	2.67	3.00
105	0.62	0.72	0.79	0.92	1.04	1.11	1.34	1.70	1.98	2.38	2.71	3.05
110	0.63	0.74	0.80	0.93	1.06	1.12	1.36	1.72	2.01	2.41	2.75	3.10
115	0.64	0.75	0.82	0.95	1.07	1.13	1.37	1.74	2.03	2.44	2.79	3.14
120	**0.65**	**0.76**	**0.83**	**0.96**	**1.09**	**1.15**	**1.39**	**1.76**	**2.06**	**2.48**	**2.83**	**3.19**
180	**0.72**	**0.84**	**0.92**	**1.06**	**1.21**	**1.23**	**1.49**	**1.89**	**2.21**	**2.68**	**3.06**	**3.48**
360	**0.84**	**0.98**	**1.07**	**1.24**	**1.41**	**1.45**	**1.75**	**2.21**	**2.61**	**3.20**	**3.70**	**4.25**
720	**0.97**	**1.13**	**1.24**	**1.43**	**1.63**	**1.67**	**2.01**	**2.52**	**2.96**	**3.61**	**4.17**	**4.79**
1440	**1.12**	**1.31**	**1.43**	**1.65**	**1.88**	**1.95**	**2.33**	**2.92**	**3.40**	**4.09**	**4.66**	**5.28**

Bolded numbers indicate values taken directly from rainfall atlas references. Rainfall estimates for 2-month through 9-month frequencies were taken from the Illinois State Water Survey's *Rainfall Frequency Atlas of the Midwest (Bulletin 71)* by Huff and Angel dated 1992. Rainfall estimates for the 1-year through 100-year frequencies are based on average estimates obtained from the NOAA Atlas 14 website (http://hdsc.nws.noaa.gov/hdsc/pfds/orb/oh_pfds.html). Two observation sites (Cleveland WSO AP 33-1657 and Cleveland Easterly 33-1651) were used to develop the average estimates shown in the table above. Non-bolded numbers were derived by means of linear interpretation between the two rainfall atlas references for estimates.

Table A-2. Rainfall Intensity-Duration.

Tc (min)	Rainfall Intensity (in/hr)											
	2-Month	3-Month	4-Month	6-Month	9-Month	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
5	1.56	1.80	2.04	2.28	2.64	3.84	4.62	5.52	6.30	7.20	7.98	8.70
10	1.44	1.68	1.80	2.10	2.40	3.00	3.60	4.29	4.83	5.55	6.03	6.57
15	1.20	1.40	1.52	1.80	2.04	2.44	2.94	3.52	3.98	4.54	4.98	5.44
20	1.01	1.18	1.28	1.51	1.71	2.03	2.45	2.97	3.37	3.88	4.27	4.68
25	0.90	1.05	1.14	1.34	1.51	1.78	2.15	2.63	3.00	3.48	3.84	4.22
30	0.82	0.96	1.04	1.22	1.38	1.61	1.95	2.41	2.76	3.21	3.56	3.92
35	0.74	0.86	0.93	1.09	1.24	1.43	1.74	2.15	2.47	2.89	3.21	3.55
40	0.68	0.79	0.86	1.00	1.13	1.30	1.58	1.96	2.26	2.65	2.95	3.27
45	0.63	0.73	0.79	0.93	1.05	1.19	1.45	1.81	2.09	2.46	2.75	3.05
50	0.59	0.68	0.74	0.87	0.98	1.11	1.35	1.69	1.96	2.31	2.59	2.88
55	0.56	0.64	0.70	0.82	0.93	1.04	1.27	1.59	1.85	2.19	2.46	2.74
60	0.53	0.61	0.67	0.78	0.88	0.99	1.21	1.51	1.76	2.09	2.35	2.62
65	0.50	0.57	0.63	0.73	0.83	0.92	1.13	1.41	1.64	1.95	2.20	2.46
70	0.47	0.54	0.60	0.69	0.78	0.87	1.06	1.33	1.55	1.84	2.08	2.33
75	0.45	0.52	0.57	0.66	0.75	0.82	1.00	1.26	1.46	1.75	1.97	2.21
80	0.43	0.50	0.54	0.63	0.71	0.78	0.95	1.20	1.39	1.66	1.88	2.11
85	0.41	0.47	0.52	0.60	0.68	0.74	0.91	1.14	1.33	1.59	1.80	2.02
90	0.39	0.46	0.50	0.58	0.66	0.71	0.87	1.09	1.27	1.52	1.72	1.94
95	0.38	0.44	0.48	0.56	0.63	0.68	0.83	1.05	1.22	1.46	1.66	1.86
100	0.37	0.43	0.47	0.54	0.61	0.66	0.80	1.01	1.17	1.41	1.60	1.80
105	0.35	0.41	0.45	0.52	0.59	0.63	0.77	0.97	1.13	1.36	1.55	1.74
110	0.34	0.40	0.44	0.51	0.58	0.61	0.74	0.94	1.09	1.31	1.50	1.69
115	0.33	0.39	0.43	0.49	0.56	0.59	0.72	0.91	1.06	1.27	1.45	1.64
120	0.33	0.38	0.42	0.48	0.55	0.57	0.70	0.88	1.03	1.24	1.41	1.60
180	0.24	0.28	0.31	0.35	0.40	0.41	0.50	0.63	0.74	0.89	1.02	1.16
360	0.14	0.16	0.18	0.21	0.24	0.24	0.29	0.37	0.43	0.53	0.62	0.71
720	0.08	0.09	0.10	0.12	0.14	0.14	0.17	0.21	0.25	0.30	0.35	0.40
1440	0.05	0.05	0.06	0.07	0.08	0.08	0.10	0.12	0.14	0.17	0.19	0.22

APPENDIX B

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 24+41 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 13.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
22+08	Begin																	
24+41	CB-3A	233.00	0.82	0.38	1.00	2.22	10.00	0.0115	0.0160	0.0160	0.00	0.0417	4.30	0.69	0.65	1.34	0.141	8.79

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 24+41 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 13.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
22+08	Begin																	
24+41	CB-3A	233.00	0.82	0.38	1.00	1.89	10.00	0.0115	0.0160	0.0160	0.00	0.0417	6.79	0.93	1.18	2.12	0.167	10.44

INLET SPACING DESIGN

PID : 49633 **Date :** 04/18/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 24+30 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
20+50	Begin																	
24+41	CB-3A	391.00	0.82	0.38	1.00	3.80	10.00	0.0115	0.0160	0.0160	0.00	0.0417	4.30	0.69	0.65	1.34	0.141	8.79

INLET SPACING DESIGN

PID : 49633 **Date :** 04/18/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 24+30 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
20+50	Begin																	
24+41	CB-3A	391.00	0.82	0.38	1.00	3.27	10.00	0.0115	0.0160	0.0160	0.00	0.0417	6.79	0.93	1.18	2.12	0.167	10.44

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - LT side (spread - 7 ft from rt turn only lane + 8 ft thru lane) **Designer :** ELJ/AKL

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 15.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
20+25	Begin																	
22+95	CB-3A	270.00	0.75	0.50	1.00	3.80	10.00	0.0038	0.0160	0.0160	0.00	0.0417	4.30	0.76	0.84	1.61	0.185	11.59

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - LT side (spread - 7 ft from rt turn only lane + 8 ft thru lane) **Designer :** ELJ/AKL

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 15.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
20+25	Begin																	
22+95	CB-3A	270.00	0.75	0.50	1.00	3.27	10.00	0.0038	0.0160	0.0160	0.00	0.0417	6.79	1.03	1.51	2.54	0.220	13.76

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 18+73 RT **Designer :** ELJ/AKL

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 13.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
16+28	Begin																	
18+46	CB-3A	218.00	0.86	0.30	1.00	4.98	10.00	0.0014	0.0160	0.0160	0.00	0.0417	4.30	0.61	0.48	1.09	0.193	12.08
18+73	CB-3A	27.00	0.86	0.04	1.00	0.72	10.00	0.0014	0.0160	0.0160	0.00	0.0417	4.30	0.41	0.20	0.62	0.156	9.75

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 18+73 RT **Designer :** ELJ/AKL

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 13.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
16+28	Begin																	
18+46	CB-3A	218.00	0.86	0.30	1.00	4.32	10.00	0.0014	0.0160	0.0160	0.00	0.0417	6.79	0.82	0.90	1.72	0.229	14.34
18+73	CB-3A	27.00	0.86	0.04	1.00	0.62	10.00	0.0014	0.0160	0.0160	0.00	0.0417	6.79	0.61	0.50	1.11	0.195	12.17

INLET SPACING DESIGN

PID : 49633 **Date :** 06/28/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Left Side 15+91 to 16+51 LT **Designer :** AKL

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 15.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
14+74	Begin																	
15+91	CB-3A	130.00	0.74	0.53	1.00	1.04	10.00	0.0208	0.0100	0.0100	0.00	0.0417	4.30	0.65	1.03	1.69	0.115	11.51
16+51	CB-3A	93.00	0.74	0.18	1.00	0.81	10.00	0.0141	0.0160	0.0160	0.00	0.0417	4.30	0.78	0.82	1.60	0.145	9.05

INLET SPACING DESIGN

PID : 49633 **Date :** 06/28/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Left Side 15+91 to 16+51 LT **Designer :** AKL

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 15.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
14+74	Begin																	
15+91	CB-3A	130.00	0.74	0.53	1.00	0.88	10.00	0.0208	0.0100	0.0100	0.00	0.0417	6.79	0.88	1.79	2.66	0.137	13.66
16+51	CB-3A	93.00	0.74	0.18	1.00	0.70	10.00	0.0141	0.0160	0.0160	0.00	0.0417	6.79	1.10	1.59	2.69	0.176	10.99

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 15+73 RT D41 **Designer :** ELJ/AKL

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 13.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
15+27	Begin																		
15+73	CB-3	46.00	0.69	0.15	1.00	0.94	10.00	0.0030	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.45	0.120	7.48	Sag
16+28	Begin																		
15+73	CB-3	55.00	0.69	0.18	1.00	0.89	10.00	0.0050	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.53	0.116	7.28	End

SUMP DATA

Total Flow (cfs) : 0.98 **Ponded Depth (ft.) :** 0.086 **Spread on Pavement (ft.) :** 4.16

INLET SPACING DESIGN

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** Orange Avenue

Description : Orange Avenue - Right side 15+73 RT D41 **Designer :** ELJ/AKL

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 13.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
15+27	Begin																		
15+73	CB-3	46.00	0.69	0.15	1.00	0.79	10.00	0.0030	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.70	0.142	8.88	Sag
16+28	Begin																		
15+73	CB-3	55.00	0.69	0.18	1.00	0.75	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.84	0.138	8.64	End

SUMP DATA

Total Flow (cfs) : 1.55 **Ponded Depth (ft.) :** 0.130 **Spread on Pavement (ft.) :** 6.92

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Left Side Sta. 13+20 LT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+80	Begin																		
13+21	CB-3	141.00	0.67	0.30	1.00	1.88	10.00	0.0062	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.86	0.134	8.38	Sag
14+74	Begin																		
13+21	CB-3	91.00	0.67	0.26	1.00	1.50	10.00	0.0038	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.75	0.140	8.73	End

SUMP DATA

Total Flow (cfs) : 1.62 **Ponded Depth (ft.) :** 0.135 **Spread on Pavement (ft.) :** 7.24

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Left Side Sta. 13+20 LT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+80	Begin																		
13+21	CB-3	141.00	0.67	0.30	1.00	1.60	10.00	0.0062	0.0160	0.0160	0.00	0.0417	6.79	******	******	1.37	0.159	9.94	Sag
14+74	Begin																		
13+21	CB-3	91.00	0.67	0.26	1.00	1.27	10.00	0.0038	0.0160	0.0160	0.00	0.0417	6.79	******	******	1.19	0.166	10.36	End

SUMP DATA

Total Flow (cfs) : 2.56 **Ponded Depth (ft.) :** 0.196 **Spread on Pavement (ft.) :** 11.05

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Right Side Sta. 13+20 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+80	Begin																		
13+21	CB-3	141.00	0.78	0.20	1.00	2.01	10.00	0.0062	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.67	0.122	7.62	Sag
14+74	Begin																		
13+21	CB-3	140.00	0.78	0.23	1.00	2.32	10.00	0.0038	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.77	0.141	8.81	End

SUMP DATA

Total Flow (cfs) : 1.45 **Ponded Depth (ft.) :** 0.123 **Spread on Pavement (ft.) :** 6.46

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Right Side Sta. 13+20 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+80	Begin																		
13+21	CB-3	141.00	0.78	0.20	1.00	1.71	10.00	0.0062	0.0160	0.0160	0.00	0.0417	6.79	******	******	1.06	0.145	9.04	Sag
14+74	Begin																		
13+21	CB-3	140.00	0.78	0.23	1.00	1.98	10.00	0.0038	0.0160	0.0160	0.00	0.0417	6.79	******	******	1.22	0.167	10.46	End

SUMP DATA

Total Flow (cfs) : 2.28 **Ponded Depth (ft.) :** 0.179 **Spread on Pavement (ft.) :** 10.00

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Left 10+98 **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
10+00	Begin																		
10+98	CB-3	65.00	0.68	0.21	1.00	1.02	10.00	0.0050	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.61	0.122	7.64	Sag
11+85	Begin																		
10+98	CB-3	87.00	0.68	0.13	1.00	1.54	10.00	0.0050	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.38	0.103	6.41	End

SUMP DATA

Total Flow (cfs) : 0.99 **Ponded Depth (ft.) :** 0.087 **Spread on Pavement (ft.) :** 4.20

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Left 10+98 **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
10+00	Begin																		
10+98	CB-3	65.00	0.68	0.21	1.00	0.86	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.96	0.145	9.08	Sag
11+85	Begin																		
10+98	CB-3	87.00	0.68	0.13	1.00	1.30	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.60	0.122	7.61	End

SUMP DATA

Total Flow (cfs) : 1.56 **Ponded Depth (ft.) :** 0.131 **Spread on Pavement (ft.) :** 6.99

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Right Side Sta. 11+20 RT (Broadway) to 11+85 RT (East 14th) **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+20	Begin																		
15+40	CB-3A	420.00	0.82	0.37	1.00	4.37	10.00	0.0099	0.0160	0.0160	0.00	0.0417	4.30	0.67	0.63	1.31	0.143	8.96	
16+20	CB-3A	80.00	0.79	0.07	1.00	0.94	10.00	0.0099	0.0160	0.0160	0.00	0.0417	4.30	0.51	0.36	0.87	0.123	7.71	
10+98	CB-3	96.00	0.77	0.12	1.00	1.48	10.00	0.0050	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.76	0.133	8.30	Sag
11+85	Begin																		
10+98	CB-3	87.00	0.77	0.09	1.00	1.65	10.00	0.0050	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.29	0.092	5.78	End

SUMP DATA

Total Flow (cfs) : 1.05 **Ponded Depth (ft.) :** 0.091 **Spread on Pavement (ft.) :** 4.51

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - Right Side Sta. 11+20 RT (Broadway) to 11+85 RT (East 14th) **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+20	Begin																		
15+40	CB-3A	420.00	0.82	0.37	1.00	3.78	10.00	0.0099	0.0160	0.0160	0.00	0.0417	6.79	0.91	1.15	2.07	0.170	10.64	
16+20	CB-3A	80.00	0.79	0.07	1.00	0.80	10.00	0.0099	0.0160	0.0160	0.00	0.0417	6.79	0.75	0.78	1.53	0.152	9.51	
10+98	CB-3	96.00	0.77	0.12	1.00	1.24	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.79	******	******	1.41	0.168	10.48	Sag
11+85	Begin																		
10+98	CB-3	87.00	0.77	0.09	1.00	1.40	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.46	0.110	6.86	End

SUMP DATA

Total Flow (cfs) : 1.87 **Ponded Depth (ft.) :** 0.152 **Spread on Pavement (ft.) :** 8.31

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** Broadway Avenue

Description : Broadway Avenue - Left Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+20	Begin																		
16+27	CB-3A	507.00	0.70	0.44	1.00	5.32	10.00	0.0099	0.0160	0.0160	0.00	0.0417	4.30	0.68	0.64	1.32	0.144	8.99	
17+05	CB-3A	78.00	0.71	0.07	1.00	0.93	10.00	0.0099	0.0160	0.0160	0.00	0.0417	4.30	0.50	0.34	0.84	0.121	7.59	
18+30	CB-3A	125.00	0.75	0.13	1.00	1.50	10.00	0.0099	0.0160	0.0160	0.00	0.0417	4.30	0.46	0.28	0.75	0.116	7.26	
20+97	CB-3A	267.00	0.69	0.26	1.00	2.05	10.00	0.0254	0.0160	0.0160	0.00	0.0417	4.30	0.60	0.44	1.04	0.110	6.90	
23+21	CB-3A	224.00	0.70	0.32	1.00	1.83	10.00	0.0177	0.0160	0.0160	0.00	0.0417	4.30	0.72	0.67	1.39	0.132	8.22	
23+90	CB-3	69.00	0.71	0.11	1.00	0.70	10.00	0.0132	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.99	0.123	7.66	Sag
24+50	Begin																		
23+90	CB-3	60.00	0.71	0.11	1.00	1.08	10.00	0.0053	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.32	0.096	5.98	End

SUMP DATA

Total Flow (cfs) : 1.32 **Ponded Depth (ft.) :** 0.113 **Spread on Pavement (ft.) :** 5.86

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** Broadway Avenue

Description : Broadway Avenue - Left Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
11+20	Begin																		
16+27	CB-3A	507.00	0.70	0.44	1.00	4.62	10.00	0.0099	0.0160	0.0160	0.00	0.0417	6.79	0.92	1.16	2.08	0.171	10.67	
17+05	CB-3A	78.00	0.71	0.07	1.00	0.79	10.00	0.0099	0.0160	0.0160	0.00	0.0417	6.79	0.73	0.75	1.48	0.150	9.38	
18+30	CB-3A	125.00	0.75	0.13	1.00	1.25	10.00	0.0099	0.0160	0.0160	0.00	0.0417	6.79	0.70	0.69	1.39	0.147	9.16	
20+97	CB-3A	267.00	0.69	0.26	1.00	1.72	10.00	0.0254	0.0160	0.0160	0.00	0.0417	6.79	0.90	0.98	1.88	0.138	8.61	
23+21	CB-3A	224.00	0.70	0.32	1.00	1.54	10.00	0.0177	0.0160	0.0160	0.00	0.0417	6.79	1.06	1.42	2.48	0.164	10.22	
23+90	CB-3	69.00	0.71	0.11	1.00	0.58	10.00	0.0132	0.0160	0.0160	0.00	0.0417	6.79	******	******	1.93	0.157	9.84	Sag
24+50	Begin																		
23+90	CB-3	60.00	0.71	0.11	1.00	0.91	10.00	0.0053	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.51	0.114	7.10	End

SUMP DATA

Total Flow (cfs) : 2.45 **Ponded Depth (ft.) :** 0.189 **Spread on Pavement (ft.) :** 10.63

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** Broadway Avenue

Description : Broadway Avenue - Right Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 5 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
17+25	Begin																		
20+97	CB-3A	372.00	0.79	0.34	1.00	2.75	10.00	0.0254	0.0160	0.0160	0.00	0.0417	4.30	0.65	0.52	1.17	0.115	7.20	
23+21	CB-3A	224.00	0.75	0.33	1.00	1.77	10.00	0.0177	0.0160	0.0160	0.00	0.0417	4.30	0.79	0.80	1.59	0.138	8.65	
23+90	CB-3	69.00	0.75	0.13	1.00	0.67	10.00	0.0132	0.0160	0.0160	0.00	0.0417	4.30	******	******	1.21	0.132	8.24	Sag
24+50	Begin																		
23+90	CB-3	60.00	0.75	0.19	1.00	0.92	10.00	0.0053	0.0160	0.0160	0.00	0.0417	4.30	******	******	0.61	0.121	7.59	End

SUMP DATA

Total Flow (cfs) : 1.82 **Ponded Depth (ft.) :** 0.149 **Spread on Pavement (ft.) :** 8.10

INLET SPACING DESIGN

PID : 49633 **Date :** 04/08/2011 **Project :** CUY-90-14.90 **Location :** Broadway Avenue

Description : Broadway Avenue - Right Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 9.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
17+25	Begin																		
20+97	CB-3A	372.00	0.79	0.34	1.00	2.35	10.00	0.0254	0.0160	0.0160	0.00	0.0417	6.79	0.89	0.96	1.85	0.137	8.55	
23+21	CB-3A	224.00	0.75	0.33	1.00	1.51	10.00	0.0177	0.0160	0.0160	0.00	0.0417	6.79	1.11	1.55	2.65	0.168	10.48	
23+90	CB-3	69.00	0.75	0.13	1.00	0.56	10.00	0.0132	0.0160	0.0160	0.00	0.0417	6.79	******	******	2.18	0.165	10.29	Sag
24+50	Begin																		
23+90	CB-3	60.00	0.75	0.19	1.00	0.77	10.00	0.0053	0.0160	0.0160	0.00	0.0417	6.79	******	******	0.97	0.144	9.01	End

SUMP DATA

Total Flow (cfs) : 3.15 **Ponded Depth (ft.) :** 0.231 **Spread on Pavement (ft.) :** 13.21

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street between Canal Road and Broadway Avenue - Right Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 7.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
25+49	Begin																		
23+46	CB-3A	203.00	0.90	0.22	1.00	1.27	10.00	0.0484	0.0160	0.0160	0.00	0.0417	3.60	0.48	0.23	0.71	0.085	5.29	
21+16	CB-3A	230.00	0.78	0.42	1.00	1.14	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.78	0.61	1.40	0.105	6.55	
19+00	CB-3A	216.00	0.90	0.11	1.00	1.23	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.61	0.36	0.97	0.091	5.71	
15+67	CB-3A	333.00	0.82	0.21	1.00	1.86	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.61	0.37	0.98	0.092	5.73	
12+72	CB-3A	295.00	0.77	0.27	1.00	2.06	10.00	0.0300	0.0160	0.0160	0.00	0.0417	3.60	0.64	0.48	1.12	0.110	6.86	
12+44	CB-3A	28.00	0.76	0.03	1.00	0.24	10.00	0.0300	0.0160	0.0160	0.00	0.0417	3.60	0.40	0.17	0.57	0.085	5.33	
34+60	CB-3	220.00	0.64	0.12	1.00	3.86	10.00	0.0050	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.46	0.110	6.86	Sag
36+20	Begin																		
34+60	CB-3	160.00	0.64	0.05	1.00	3.87	10.00	0.0050	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.12	0.066	4.10	End

SUMP DATA

Total Flow (cfs) : 0.57 **Ponded Depth (ft.) :** 0.047 **Spread on Pavement (ft.) :** 1.84

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street between Canal Road and Broadway Avenue - Right Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 7.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
25+49	Begin																		
23+46	CB-3A	203.00	0.90	0.22	1.00	1.12	10.00	0.0484	0.0160	0.0160	0.00	0.0417	6.21	0.70	0.52	1.22	0.104	6.49	
21+16	CB-3A	230.00	0.78	0.42	1.00	0.99	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	1.17	1.36	2.53	0.131	8.19	
19+00	CB-3A	216.00	0.90	0.11	1.00	1.04	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	0.99	0.98	1.97	0.119	7.46	
15+67	CB-3A	333.00	0.82	0.21	1.00	1.57	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	1.01	1.02	2.04	0.121	7.55	
12+72	CB-3A	295.00	0.77	0.27	1.00	1.74	10.00	0.0300	0.0160	0.0160	0.00	0.0417	6.21	1.05	1.27	2.31	0.144	9.02	
12+44	CB-3A	28.00	0.76	0.03	1.00	0.19	10.00	0.0300	0.0160	0.0160	0.00	0.0417	6.21	0.76	0.67	1.43	0.120	7.53	
34+60	CB-3	220.00	0.64	0.12	1.00	3.09	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.21	******	******	1.16	0.156	9.74	Sag
36+20	Begin																		
34+60	CB-3	160.00	0.64	0.05	1.00	3.37	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.20	0.080	5.03	End

SUMP DATA

Total Flow (cfs) : 1.36 **Ponded Depth (ft.) :** 0.116 **Spread on Pavement (ft.) :** 6.06

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** Commercial Road

Description : Commercial Road - Left Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
17+13	Begin																	
16+06	CB-3A	107.00	0.80	0.06	1.00	0.83	10.00	0.0721	0.0160	0.0160	0.00	0.0417	3.60	0.16	0.01	0.16	0.045	2.82
12+51	CB-3A	355.00	0.77	0.25	1.00	2.02	10.00	0.0652	0.0160	0.0160	0.00	0.0417	3.60	0.49	0.22	0.71	0.080	5.00
10+96	CB-3A	155.00	0.77	0.13	1.00	1.17	10.00	0.0367	0.0160	0.0160	0.00	0.0417	3.60	0.41	0.18	0.59	0.083	5.21
10+81	CB-3A	15.00	0.66	0.01	1.00	0.15	10.00	0.0316	0.0206	0.0206	0.00	0.0417	3.60	0.20	0.01	0.21	0.064	3.10

INLET SPACING DESIGN

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** Commercial Road

Description : Commercial Road - Left Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
17+13	Begin																	
16+06	CB-3A	107.00	0.80	0.06	1.00	0.73	10.00	0.0721	0.0160	0.0160	0.00	0.0417	6.21	0.24	0.04	0.28	0.055	3.46
12+51	CB-3A	355.00	0.77	0.25	1.00	1.76	10.00	0.0652	0.0160	0.0160	0.00	0.0417	6.21	0.73	0.52	1.25	0.099	6.19
10+96	CB-3A	155.00	0.77	0.13	1.00	1.00	10.00	0.0367	0.0160	0.0160	0.00	0.0417	6.21	0.66	0.50	1.16	0.107	6.70
10+81	CB-3A	15.00	0.66	0.01	1.00	0.12	10.00	0.0316	0.0206	0.0206	0.00	0.0417	6.21	0.43	0.12	0.55	0.092	4.45

INLET SPACING DESIGN

PID : 49633 **Date :** 04/18/2011 **Project :** CUY-90-14.90 **Location :** Commercial Road

Description : Commercial Road - Right Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
16+25	Begin																	
16+06	CB-3A	19.00	0.76	0.30	1.00	0.10	10.00	0.0721	0.0160	0.0160	0.00	0.0417	3.60	0.55	0.28	0.83	0.083	5.20
12+52	CB-3A	354.00	0.65	1.48	1.00	1.32	10.00	0.0652	0.0160	0.0160	0.00	0.0417	3.60	1.56	2.17	3.73	0.149	9.32
12+37	CB-3A	15.00	0.66	0.08	1.00	0.07	10.00	0.0652	0.0160	0.0160	0.00	0.0417	3.60	1.13	1.22	2.35	0.125	7.84
11+11	CB-3A	126.00	0.65	0.73	1.00	0.64	10.00	0.0364	0.0160	0.0160	0.00	0.0417	3.60	1.24	1.69	2.94	0.152	9.51
10+96	CB-3A	15.00	0.63	0.12	1.00	0.09	10.00	0.0364	0.0160	0.0160	0.00	0.0417	3.60	0.95	1.02	1.97	0.131	8.19
10+80	CB-3	16.00	0.64	0.10	1.00	0.11	10.00	0.0316	0.0160	0.0160	0.00	0.0417	3.60	0.82	0.44	1.26	0.114	7.11

INLET SPACING DESIGN

PID : 49633 **Date :** 04/18/2011 **Project :** CUY-90-14.90 **Location :** Commercial Road

Description : Commercial Road - Right Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
16+25	Begin																	
16+06	CB-3A	19.00	0.76	0.30	1.00	0.09	10.00	0.0721	0.0160	0.0160	0.00	0.0417	6.21	0.81	0.62	1.43	0.102	6.38
12+52	CB-3A	354.00	0.65	1.48	1.00	1.16	10.00	0.0652	0.0160	0.0160	0.00	0.0417	6.21	2.39	4.19	6.57	0.184	11.53
12+37	CB-3A	15.00	0.66	0.08	1.00	0.06	10.00	0.0652	0.0160	0.0160	0.00	0.0417	6.21	1.79	2.70	4.49	0.160	10.00
11+11	CB-3A	126.00	0.65	0.73	1.00	0.55	10.00	0.0364	0.0160	0.0160	0.00	0.0417	6.21	1.98	3.67	5.66	0.195	12.16
10+96	CB-3A	15.00	0.63	0.12	1.00	0.07	10.00	0.0364	0.0160	0.0160	0.00	0.0417	6.21	1.57	2.58	4.15	0.173	10.83
10+80	CB-3	16.00	0.64	0.10	1.00	0.09	10.00	0.0316	0.0160	0.0160	0.00	0.0417	6.21	1.47	1.53	3.00	0.157	9.84

INLET SPACING DESIGN

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street between Canal Road and Broadway Avenue - Left Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 7.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
26+60	Begin																	
25+92	CB-3A	68.00	0.75	0.12	1.00	0.72	10.00	0.0200	0.0160	0.0160	0.00	0.0417	3.60	0.25	0.06	0.31	0.073	4.58
23+35	CB-3A	257.00	0.90	0.28	1.00	1.51	10.00	0.0484	0.0160	0.0160	0.00	0.0417	3.60	0.59	0.37	0.96	0.095	5.93
21+29	CB-3A	206.00	0.72	0.39	1.00	1.03	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.78	0.61	1.39	0.105	6.54
21+14	CB-3A	15.00	0.66	0.04	1.00	0.09	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.49	0.22	0.71	0.081	5.08
19+33	CB-3A	181.00	0.66	1.81	1.00	0.65	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	1.78	2.74	4.52	0.163	10.18
19+00	CB-3A	33.00	0.70	0.08	1.00	0.15	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	1.30	1.65	2.95	0.139	8.68
17+94	CB-3A	106.00	0.70	0.46	1.00	0.46	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	1.26	1.55	2.81	0.136	8.51
17+30	CB-3A	64.00	0.71	0.21	1.00	0.30	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	1.03	1.06	2.09	0.122	7.62
16+48	CB-3A	82.00	0.71	0.34	1.00	0.39	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.97	0.94	1.92	0.118	7.38
15+80	CB-3A	68.00	0.71	0.15	1.00	0.36	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.75	0.57	1.32	0.103	6.42
15+67	CB-3A	13.00	0.65	0.05	1.00	0.08	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.47	0.21	0.67	0.080	4.99
13+97	CB-3A	170.00	0.00	0.00	0.00	0.00	0.00	0.0600	0.0160	0.0160	0.00	0.0417	0.00	0.90	0.81	1.72	0.113	7.08
13+77	CB-3A	20.00	0.58	0.05	1.00	0.12	10.00	0.0600	0.0160	0.0160	0.00	0.0417	3.60	0.58	0.33	0.91	0.089	5.58
13+00	CB-3A	77.00	0.61	0.17	1.00	0.50	10.00	0.0480	0.0160	0.0160	0.00	0.0417	3.60	0.48	0.23	0.71	0.085	5.30
12+72	CB-3A	28.00	0.59	0.46	1.00	0.16	10.00	0.0420	0.0160	0.0160	0.00	0.0417	3.60	0.69	0.52	1.20	0.106	6.62

INLET SPACING DESIGN

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
12+04	CB-3A	68.00	0.54	0.30	1.00	0.47	10.00	0.0300	0.0160	0.0160	0.00	0.0417	3.60	0.63	0.47	1.10	0.109	6.82	
11+90	CB-3A	15.00	0.65	0.13	1.00	0.15	10.00	0.0140	0.0160	0.0160	7.00	0.0417	3.60	0.48	0.29	0.77	0.110	6.89	
11+80	CB-3	10.00	0.58	0.20	1.00	0.10	10.00	0.0140	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.71	0.107	6.69	Sag
33+15	Begin																		
11+80	CB-3	47.00	0.58	0.36	1.00	0.59	10.00	0.0070	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.75	0.124	7.77	End

SUMP DATA

Total Flow (cfs) : 1.46

Ponded Depth (ft.) : 0.124

Spread on Pavement (ft.) : 6.54

INLET SPACING DESIGN

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street between Canal Road and Broadway Avenue - Left Side **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 7.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
26+60	Begin																	
25+92	CB-3A	68.00	0.75	0.12	1.00	0.64	10.00	0.0200	0.0160	0.0160	0.00	0.0417	6.21	0.37	0.16	0.54	0.090	5.62
23+35	CB-3A	257.00	0.90	0.28	1.00	1.32	10.00	0.0484	0.0160	0.0160	0.00	0.0417	6.21	0.89	0.83	1.72	0.118	7.38
21+29	CB-3A	206.00	0.72	0.39	1.00	0.89	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	1.19	1.40	2.59	0.132	8.26
21+14	CB-3A	15.00	0.66	0.04	1.00	0.08	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	0.85	0.72	1.57	0.110	6.85
19+33	CB-3A	181.00	0.66	1.81	1.00	0.57	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	2.78	5.36	8.14	0.203	12.69
19+00	CB-3A	33.00	0.70	0.08	1.00	0.13	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	2.13	3.60	5.73	0.178	11.12
17+94	CB-3A	106.00	0.70	0.46	1.00	0.39	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	2.09	3.50	5.59	0.176	11.02
17+30	CB-3A	64.00	0.71	0.21	1.00	0.25	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	1.75	2.68	4.43	0.162	10.10
16+48	CB-3A	82.00	0.71	0.34	1.00	0.32	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	1.67	2.49	4.16	0.158	9.87
15+80	CB-3A	68.00	0.71	0.15	1.00	0.29	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	1.36	1.78	3.14	0.142	8.88
15+67	CB-3A	13.00	0.65	0.05	1.00	0.06	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	0.99	0.98	1.97	0.119	7.45
13+97	CB-3A	170.00	0.00	0.00	0.00	0.00	0.00	0.0600	0.0160	0.0160	0.00	0.0417	0.00	1.16	1.32	2.49	0.130	8.13
13+77	CB-3A	20.00	0.58	0.05	1.00	0.11	10.00	0.0600	0.0160	0.0160	0.00	0.0417	6.21	0.82	0.67	1.49	0.107	6.71
13+00	CB-3A	77.00	0.61	0.17	1.00	0.43	10.00	0.0480	0.0160	0.0160	0.00	0.0417	6.21	0.74	0.58	1.33	0.107	6.70
12+72	CB-3A	28.00	0.59	0.46	1.00	0.14	10.00	0.0420	0.0160	0.0160	0.00	0.0417	6.21	1.06	1.20	2.26	0.134	8.39

INLET SPACING DESIGN

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
12+04	CB-3A	68.00	0.54	0.30	1.00	0.40	10.00	0.0300	0.0160	0.0160	0.00	0.0417	6.21	1.01	1.19	2.21	0.142	8.86	
11+90	CB-3A	15.00	0.65	0.13	1.00	0.13	10.00	0.0140	0.0160	0.0160	7.00	0.0417	6.21	0.82	0.90	1.72	0.149	9.30	
11+80	CB-3	10.00	0.58	0.20	1.00	0.09	10.00	0.0140	0.0160	0.0160	0.00	0.0417	6.21	******	******	1.62	0.146	9.10	Sag
33+15	Begin																		
11+80	CB-3	47.00	0.58	0.36	1.00	0.52	10.00	0.0070	0.0160	0.0160	0.00	0.0417	6.21	******	******	1.30	0.153	9.53	End

SUMP DATA

Total Flow (cfs) : 2.91

Ponded Depth (ft.) : 0.217

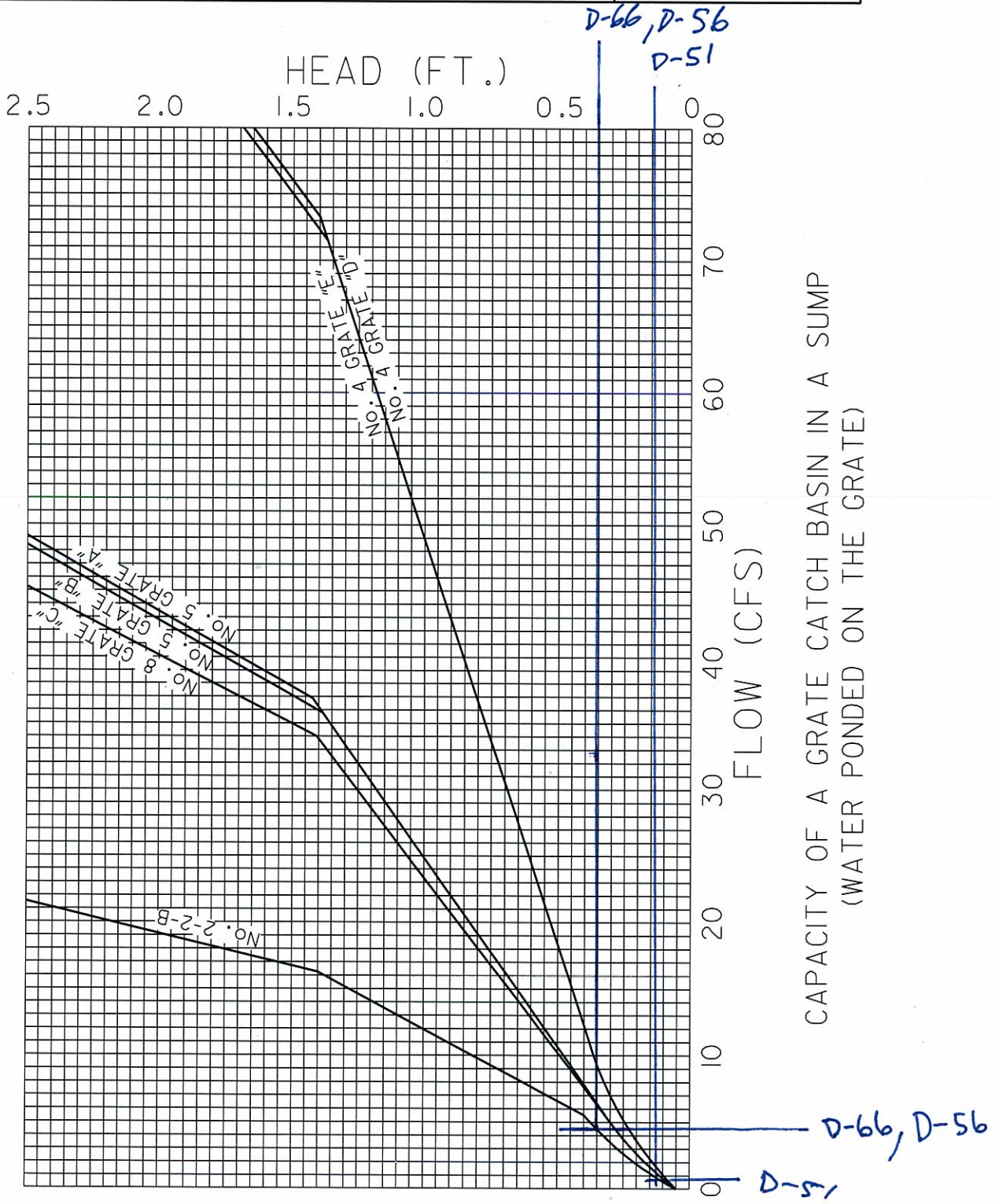
Spread on Pavement (ft.) : 12.37

10yr checks

CAPACITY OF A GRATE CATCH BASIN IN A SUMP

1102-1

REFERENCE SECTION
1102.3.5



APPENDIX C

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - 11+71 LT to 13+20 LT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 672.38

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
0DB0	D40B	13+22	0.56	0.38	10.00	5.10	6.07	1.9	2.3	12	150.1	0.0128	672.90	4.56	3.76	0.0055	673.49	676.80	3.31	2.90	CB 3
begin		11+71	0.56	0.38									670.98				672.38	677.53			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - 13+20 RT to 13+57 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 672.70

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
ODB1	D41B	13+21		0.43	0.34	10.00	5.10	6.17	1.7	2.1	12	38.1	0.0163	672.48	4.83	4.24	0.0045	672.99	676.78	3.79	3.30	CB 3
begin		13+56		0.43	0.34									671.86				672.73	677.24			0.015
D41B	CS	13+56		0.00	0.00	10.13	5.07	6.17	1.7	2.1	12	6.0	0.0267	671.86	5.78	5.42	0.0045	672.73	677.24	4.51	4.38	MH 3
final		13+60		0.43	0.34									671.70				672.70	677.23			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 06/28/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : East 14th Street - 15+91 LT to 16+51 LT **Designer :** AKL

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 669.56

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DBO3	DB03	15+91		0.53	0.39	10.00	5.10	6.16	2.0	2.4	12	66.0	0.0318	670.71	6.44	5.93	0.0061	671.17	674.72	3.55	3.01	CB 3A
begin		16+51		0.53	0.39									668.61				669.63	673.48			0.015
DB03	CS	16+51		0.18	0.13	10.17	5.06	6.16	2.7	3.2	12	6.0	0.0083	668.61	4.08	3.03	0.0110	669.63	673.48	3.85	3.87	CB 3A
final		16+51		0.71	0.53									668.56				669.56	673.48			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 06/28/2011 **Project :** CUY-90-14.90 **Location :** ORANGE AVENUE

Description : STORM SEWER - ORANGE AVENUE - 22+95 LT **Designer :** ELJ/AKL

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 673.80

JUNCTION From	JUNCTION To	STATION From	STATION To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DODB EXCB		22+95		0.50	0.38	10.00	5.10	6.21	1.9	2.3	12	6.0	0.0683	673.21	8.42	8.68	0.0057	673.83	676.31	2.48	2.10	CB 3A
begin		22+95		0.50	0.38									672.80				673.80	677.14			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/19/2011 **Project :** CUY-90-14.90 **Location :** ORANGE AVENUE

Description :STORM SEWER - ORANGE AVENUE - 15+73 TO 14+77 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 674.46

JUNCTION From	To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D41	EXCB	15+73	0.28	0.19	10.00	5.10	6.07	1.0	1.2	12	96.0	0.0070	674.13	3.06	2.77	0.0014	674.60	677.28	2.68	2.15	CB 3
begin		14+77	0.28	0.19									673.46				674.46	677.21			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/19/2011 **Project :** CUY-90-14.90 **Location :** ORANGE AVENUE

Description :STORM SEWER - ORANGE AVENUE - 18+46 TO 18+73 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 675.22

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DB10	DB10	18+46		0.30	0.26	10.00	5.10	6.16	1.3	1.6	12	27.0	0.0060	674.48	3.12	2.57	0.0026	675.32	677.23	1.91	1.75	CB 3A
begin		18+73		0.30	0.26									674.32				675.24	677.20			0.015
DB10	EX	18+73		0.04	0.03	10.14	5.06	6.16	1.5	1.8	12	7.0	0.0143	674.32	4.44	3.97	0.0034	675.24	677.20	1.96	1.88	CB 3A
final		18+78		0.34	0.29									674.22				675.22	677.93			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 06/15/2011 **Project :** CUY-90-14.90 **Location :** East 14th Street

Description : Orange - 24+30 RT to 24+41 RT **Designer :** ELJ/AKL

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 671.84

JUNCTION From	To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
DB01	EX	24+41	0.38	0.31	10.00	5.10	6.20	1.6	1.9	12	6.0	0.0050	670.87	3.04	2.35	0.0039	671.86	674.63	2.77	2.76	CB 3A
begin		24+41	0.38	0.31									670.84				671.84	674.63			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/14/2011 **Project :** CUY-90-14.90 **Location :** Broadway Avenue/East 9th Street

Description : Broadway (16+20 RT) to East 9th Street (20+46 LT) **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 642.12

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D51	D53C	16+20		0.40	0.14	15.00	4.20	4.63	0.6	0.6	12	96.1	0.0127	673.41	3.29	3.74	0.0004	673.70	677.47	3.77	3.06	CB 2-2B
begin		10+53		0.40	0.14									672.19				673.55	677.39			0.015
D53B	D53	15+42		0.37	0.30	10.00	5.10	6.12	1.6	1.9	12	79.7	0.0085	675.67	3.70	3.07	0.0036	676.26	679.57	3.31	2.90	CB 3A
begin		16+20		0.77	0.44									674.99				675.78	678.74			0.015
D50	D50B	10+92		0.34	0.23	10.00	5.10	4.63	1.2	1.1	12	7.1	0.0070	672.34	3.21	2.79	0.0012	673.69	677.00	3.31	3.66	CB 3
begin		10+91		1.10	0.67									672.29				673.68	677.27			0.015
D52	D50B	10+88		0.21	0.16	10.00	5.10	4.63	0.8	0.7	12	54.8	0.0093	672.80	3.23	3.20	0.0006	673.71	677.13	3.42	3.33	CB 3
begin		10+91		1.31	0.83									672.29				673.68	677.27			0.015
D50B	D53C	10+91		0.00	0.00	10.28	5.03	4.63	2.0	1.8	12	37.9	0.0026	672.29	2.49	1.71	0.0034	673.68	677.27	3.59	3.98	MH 3
		10+53		1.31	0.83						**Warning**			672.19				673.55	677.39			0.015
D53C	D55B	10+53		0.00	0.00	15.49	4.13	4.63	2.2	2.4	12	46.3	0.0110	672.09	4.43	3.49	0.0063	673.55	677.39	3.84	4.30	MH 3
		17+14		1.31	0.83									671.58				673.26	678.25			0.015
D53	D55B	16+20		0.07	0.06	10.36	5.02	4.63	1.8	1.7	12	97.6	0.0314	674.86	6.26	5.88	0.0029	675.24	678.74	3.50	2.88	CB 3A
		17+14		1.38	0.89									671.80				673.26	678.25			0.015
D54B	D54	16+27		0.44	0.31	10.00	5.10	6.09	1.6	1.9	12	74.9	0.0039	674.53	2.73	2.07	0.0037	675.33	678.53	3.20	3.00	CB 3A
begin		17+05		1.82	1.19									674.24				675.03	677.74			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D54	D55B	17+05		0.07	0.05	10.46	5.00	6.05	1.8	2.1	12	34.9	0.0072	674.02	3.58	2.81	0.0048	674.75	677.74	2.99	2.72	CB 3A
		17+14		1.89	1.24									673.77				674.58	678.25			0.015
D55B	D57	17+14		0.00	0.00	15.66	4.11	4.63	5.1	5.7	18	116.5	0.0047	671.45	3.94	6.73	0.0040	673.26	678.25	4.99	5.30	MH 3
		18+30		1.89	1.24									670.90				672.80	677.25			0.015
D177	D57	18+29		0.13	0.09	10.00	5.10	4.63	0.5	0.4	12	28.3	0.0473	672.59	4.98	7.23	0.0002	672.80	676.59	3.79	3.00	CB 3A
begin		18+30		2.01	1.34									671.25				672.80	677.25			0.015
D57	D60B	18+30		0.00	0.00	16.15	4.04	4.63	5.4	6.2	18	196.7	0.0077	670.90	4.86	8.61	0.0046	672.80	677.25	4.45	4.85	MH 3
		20+26		2.01	1.34									669.38				671.89	675.03			0.015
D56	D60B	20+25		1.44	1.27	15.00	4.20	4.63	5.3	5.9	12	51.2	0.0197	671.04	6.78	4.67	0.0361	673.74	674.40	0.66	2.36	CB 2-2B
begin		20+26		3.45	2.60						**Warning**			670.03				671.89	675.03			0.015
D60B	D60	20+26		0.00	0.00	16.83	3.95	4.63	10.3	12.1	18	70.1	0.0147	669.30	7.10	11.87	0.0175	671.89	675.03	3.14	4.23	MH 3
		20+97		3.45	2.60									668.27				670.66	673.52			0.015
D58	D60	20+97		0.34	0.27	10.00	5.10	4.63	1.4	1.3	12	26.3	0.0099	669.13	3.80	3.30	0.0017	670.71	673.01	2.30	2.88	CB 3A
begin		20+97		3.80	2.87									668.87				670.66	673.52			0.015
D59	D60	20+97		0.26	0.18	10.00	5.10	4.63	0.9	0.8	12	23.6	0.0110	669.13	3.52	3.49	0.0007	670.68	672.96	2.28	2.83	CB 3A
begin		20+97		4.05	3.05									668.87				670.66	673.52			0.015
D60	D65B	20+97		0.00	0.00	16.99	3.93	4.63	12.0	14.1	18	223.9	0.0208	668.27	8.43	14.13	0.0241	670.66	673.52	2.86	3.75	MH 3
		23+20		4.05	3.05									663.61				665.27	667.96			0.015
D61	D65B	23+21		0.33	0.25	10.00	5.10	4.63	1.3	1.2	12	26.0	0.0112	664.15	3.89	3.51	0.0014	665.31	667.35	2.04	2.20	CB 3A
begin		23+21		4.38	3.30									663.86				665.27	667.96			0.015
D63	D65B	23+21		0.32	0.22	10.00	5.10	4.63	1.1	1.0	12	24.0	0.0000	663.91	1.43	0.02	0.0011	665.30	667.36	2.06	2.45	CB 3A
begin		23+21		4.70	3.52						**Warning**			663.91				665.27	667.96			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D65B	D65	23+21		0.00	0.00	17.44	3.87	4.63	13.6	16.3	24	68.9	0.0035	663.26	4.34	12.45	0.0069	665.27	667.96	2.69	2.70	MH 3
		23+90		4.70	3.52						Warning			663.02				664.80	667.32			0.015
D62	D65	23+90		0.32	0.24	10.00	5.10	4.63	1.2	1.1	12	23.8	0.0117	663.42	3.91	3.60	0.0013	664.83	666.77	1.94	2.35	CB 3
begin		23+90		5.02	3.76									663.14				664.80	667.32			0.015
D64	D65	23+91		0.21	0.15	10.00	5.10	4.63	0.8	0.7	12	26.2	0.0412	663.85	5.44	6.74	0.0005	664.81	666.81	2.00	1.96	CB 3
begin		23+90		5.23	3.91									662.77				664.80	667.32			0.015
D65	D68	23+90		0.00	0.00	17.70	3.84	4.63	15.0	18.1	30	133.7	0.0049	663.13	5.29	26.66	0.0026	664.80	667.32	2.52	1.69	MH 3
		25+92		5.23	3.91									662.48				664.45	668.02			0.015
D66	D68	26+70		1.52	1.32	15.00	4.20	5.09	5.6	6.7	18	73.7	0.0106	663.56	5.52	10.07	0.0055	664.50	667.26	2.76	2.20	CB 8
begin		25+92		6.75	5.23									662.78				664.03	668.02			0.015
D67	D68	25+92		0.12	0.09	10.00	5.10	6.19	0.4	0.5	12	8.6	0.0070	663.52	2.46	2.77	0.0003	664.11	667.77	3.66	3.25	CB 3A
begin		25+92		6.86	5.32									663.46				664.11	668.02			0.015
D68	D69	25+92		0.00	0.00	18.12	3.79	4.58	20.2	24.4	24	236.1	0.0297	662.48	11.23	36.36	0.0154	663.74	668.02	4.28	3.54	MH 3
		23+46		6.86	5.32						Warning			655.46				657.33	660.91			0.015
D69B	D69	23+31		0.28	0.25	10.00	5.10	6.19	1.3	1.6	12	16.6	0.0253	656.83	5.25	5.28	0.0025	657.22	660.03	2.81	2.20	CB 3A
begin		23+46		7.14	5.57									656.41				657.17	660.91			0.015
D69C	D69	23+46		0.22	0.20	10.00	5.10	6.17	1.0	1.2	12	46.1	0.0369	657.16	5.63	6.38	0.0016	657.47	660.50	3.03	2.34	CB 3A
begin		23+46		7.36	5.76									655.46				656.19	660.91			0.015
D69	D70	23+46		0.00	0.00	18.47	3.75	4.57	21.6	26.3	24	105.2	0.0491	652.51	13.82	46.75	0.0180	653.63	660.91	7.28	6.40	MH 3
		22+37		7.36	5.76									647.34				649.24	654.47			0.015
D70	D74	22+37		0.00	0.00	18.60	3.74	4.52	21.5	26.1	24	121.5	0.0495	647.17	13.84	46.91	0.0177	648.28	654.47	6.19	5.30	MH 3
		21+14		7.36	5.76									641.16				643.90	647.36			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D72B	D72	21+29		0.39	0.28	10.00	5.10	4.52	1.4	1.3	12	13.9	0.0662	643.49	7.72	8.55	0.0017	643.96	647.80	3.84	3.31	CB 3A
begin		21+15		7.75	6.05									642.57				643.94	647.01			0.015
D72	D74	21+15		0.04	0.03	10.03	5.09	4.52	1.6	1.4	12	18.3	0.0224	642.57	5.34	4.97	0.0021	643.94	647.01	3.07	3.44	CB 3A
		21+14		7.80	6.08									642.16				643.90	647.36			0.015
D73	D74	21+16		0.42	0.32	10.00	5.10	4.52	1.6	1.5	12	31.1	0.0283	643.04	5.86	5.59	0.0022	643.97	646.94	2.97	2.90	CB 3A
begin		21+14		8.21	6.40									642.16				643.90	647.36			0.015
D74	CH13	21+14		0.00	0.00	18.74	3.72	4.52	23.8	28.9	24	80.3	0.0116	641.16	7.58	22.70	0.0218	643.90	647.36	3.46	4.20	MH 3
final		20+46		8.21	6.40						**Warning**			640.23				642.15	642.23			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street - 19+18 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 633.44

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D76B	D179	19+33		0.62	0.43	10.00	5.10	6.16	2.2	2.7	12	9.4	0.0128	632.48	4.70	3.75	0.0075	633.55	636.16	2.61	2.68	CB 3A
begin		19+38		0.62	0.43									632.36				633.48	636.79			0.015
D179	HW	19+38		0.00	0.00	10.03	5.09	6.16	2.2	2.7	18	42.1	0.0124	631.81	4.59	10.88	0.0009	633.48	636.79	3.31	3.48	MH 3
final		19+18		0.62	0.43									631.29				633.44	632.79			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street - 18+83 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 631.45

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D76	D78	19+00	0.12	0.08	10.00	5.10	6.15	0.4	0.5	12	25.9	0.0510	630.33	4.95	7.50	0.0003	631.49	634.23	2.74	2.90	CB 3A
begin		19+00	0.12	0.08									629.01				631.48	634.21			0.015
D78	HW	19+00	0.11	0.10	10.09	5.08	6.15	0.9	1.1	12	24.0	0.0046	629.01	2.59	2.25	0.0013	631.48	634.21	2.73	4.20	CB 3A
final		18+83	0.23	0.18									628.90				631.45	629.90			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street - 16+91 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 620.97

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D79B	D79	17+94		0.51	0.36	10.00	5.10	6.13	1.8	2.2	12	64.3	0.0600	623.52	7.93	8.14	0.0050	623.89	627.85	3.96	3.33	CB 3A
begin		17+30		0.51	0.36									619.66				621.56	624.01			0.015
D79	HW	17+30		0.21	0.15	10.14	5.07	6.13	2.6	3.1	12	58.5	0.0183	619.66	5.60	4.49	0.0101	621.56	624.01	2.45	3.35	CB 3A
final		16+91		0.72	0.51									618.59				620.97	619.59			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street - 16+20 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 616.32

JUNCTION From	To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D81B	HW	16+47	0.34	0.24	10.00	5.10	6.13	1.2	1.5	12	50.5	0.0053	615.09	2.94	2.43	0.0023	616.43	619.03	2.60	2.94	CB 3A
begin		16+19	0.34	0.24									614.82				616.32	615.82			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street - 15+38 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 611.48

JUNCTION From	To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D82	HW	15+68	0.21	0.19	10.00	5.10	6.09	1.0	1.2	12	34.0	0.0003	609.55	1.23	0.57	0.0014	611.53	614.20	2.67	3.65	CB 3A
begin		15+38	0.21	0.19						Warning			609.54				611.48	610.54			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/19/2011 **Project :** CUY-90-14.90 **Location :** E9th and Canal

Description :STORM SEWER - E9th Low point E9th 11+92 60 RT **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 592.14

JUNCTION From	To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D109	CS	34+53	0.23	0.16	10.00	5.10	6.21	0.8	1.0	12	6.0	0.1767	593.20	9.22	13.96	0.0010	593.39	595.20	1.81	1.00	CB 3
begin		34+47	0.23	0.16									592.14				592.85	595.26			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/16/2011 **Project :** CUY-90-14.90 **Location :** East 9th/Canal

Description : East 9th to Canal Combined Sewer **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 586.76

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D94	D95	13+00		0.17	0.11	10.00	5.10	6.19	0.5	0.7	12	25.5	0.0655	593.68	5.74	8.50	0.0004	593.87	598.68	4.81	4.00	CB 3A
begin		12+74		0.17	0.11									592.01				593.04	597.60			0.015
D95	D97	12+74		0.46	0.27	10.07	5.08	6.19	1.9	2.3	12	5.5	0.0273	592.33	6.03	5.49	0.0056	593.04	597.60	4.56	4.27	CB 3A
		12+74		0.63	0.38									592.18				593.01	597.84			0.015
D43	D97	12+72		0.27	0.21	10.00	5.10	6.20	1.1	1.3	12	20.5	0.0610	593.43	6.86	8.20	0.0017	593.71	597.45	3.74	3.02	CB 3A
begin		12+74		0.90	0.58									592.18				592.92	597.84			0.015
D97	D100	12+74		0.00	0.00	10.09	5.08	6.16	3.0	3.6	18	40.3	0.0241	591.79	6.31	15.19	0.0016	592.31	597.84	5.53	4.55	MH 3
		12+34		0.90	0.58									590.82				591.93	596.60			0.015
D96	D100	12+44		0.03	0.03	10.00	5.10	6.17	0.1	0.2	12	25.4	0.0457	593.91	3.29	7.10	0.0000	594.02	596.51	2.49	1.60	CB 3A
begin		12+34		0.93	0.61									592.75				593.33	596.60			0.015
D98B	D98	11+76		0.08	0.05	10.00	5.10	6.16	0.3	0.3	12	23.3	0.0073	590.50	2.13	2.84	0.0001	590.95	595.16	4.21	3.66	CB 3
begin		11+93		1.01	0.66									590.33				590.94	595.37			0.015
D98	D99	11+93		0.22	0.14	10.18	5.06	6.11	0.9	1.1	12	12.0	0.0417	590.33	5.73	6.78	0.0013	590.62	595.37	4.75	4.04	CB 3A
		12+04		1.23	0.79									589.83				590.61	595.61			0.015
D99	D100	12+04		0.30	0.16	10.22	5.05	6.11	1.7	2.1	12	30.7	0.0059	589.83	3.30	2.54	0.0047	590.61	595.61	5.00	4.78	CB 3A
		12+34		1.53	0.96									589.65				590.46	596.60			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D100	CS	12+34		0.00	0.00	10.37	5.01	6.07	4.8	5.8	18	81.7	0.0439	588.85	9.00	20.52	0.0041	589.42	596.60	7.18	6.25	MH 3
final		34+48		1.53	0.96									585.26				586.76	595.73			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/31/2011 **Project :** CUY-90-14.90 **Location :** Commercial Parking Lot Combined Sewer

Description : Scupper drainage to proposed system to Commercial CS **Designer :** BHess

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 639.75

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D748	D749	19+40	0.02	0.02	10.00	5.10	6.18	0.1	0.1	15	16.9	0.0409	660.86	2.78	12.18	0.0000	660.95	664.11	3.16	2.00	CB 3A
begin		19+40	0.02	0.02									660.17				660.86	666.01			0.015
D750	D749	19+51	0.12	0.11	10.00	5.10	6.19	0.6	0.7	15	15.3	0.0301	662.52	4.28	10.45	0.0001	662.85	666.07	3.22	2.30	CB 6
begin		19+40	0.14	0.13									662.06				662.84	666.01			0.015
D749	D751	19+41	0.00	0.00	10.10	5.07	6.05	0.6	0.8	15	129.0	0.0267	660.17	4.28	9.83	0.0002	660.41	666.01	5.60	4.59	MH 3
		18+57	0.14	0.13									656.73				657.53	661.53			0.015
D751	D753	18+57	0.01	0.01	10.60	4.97	6.03	0.7	0.8	15	31.0	0.0610	656.73	5.81	14.87	0.0002	656.94	661.53	4.59	3.55	CB 3A
		18+17	0.15	0.14									654.84				655.64	659.94			0.015
D753	D754	18+17	0.24	0.20	10.69	4.95	5.96	1.6	2.0	15	118.3	0.0540	654.84	7.24	13.99	0.0013	655.17	659.94	4.77	3.85	CB 3A
		16+83	0.39	0.33									648.45				649.36	652.05			0.015
D754	D755	16+83	0.00	0.00	10.96	4.89	5.91	1.6	2.0	15	115.1	0.0720	648.45	8.02	16.16	0.0012	648.76	652.05	3.29	2.35	MH 3
		15+76	0.39	0.33									640.17				641.07	645.87			0.015
D755	755A	15+76	0.00	0.00	11.20	4.84	5.87	1.6	2.0	15	57.0	0.0837	640.07	8.42	17.42	0.0012	640.36	645.87	5.51	4.55	MH 3
		15+70	0.39	0.33									635.30				639.77	643.00			0.015
755A	18020	15+76	0.00	0.00	11.32	4.82	5.87	1.6	2.0	15	16.0	0.0356	632.50	6.23	11.37	0.0012	639.77	643.00	3.23	9.25	MH 3
final		15+70	0.39	0.33									631.93				639.75	639.40			0.015

NOTE: See BU 1010-Roadway Gateway for Storm Sewer Profiles.

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/31/2011 **Project :** CUY-90-14.90 **Location :** Commercial Parking Lot Combined Sewer

Description : Scupper drainage to proposed system to Commercial CS **Designer :** BHess

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 100 **Hydraulic Gradient Frequency (yrs.) :** 100

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 639.75

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (100 / 100)	DISCHARGE (cfs.) (100 / 100)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D748	D749	19+40	0.02	0.02	10.00	7.71	7.68	0.1	0.1	15	16.9	0.0409	660.86	3.16	12.18	0.0000	660.96	664.11	3.15	2.00	CB 3A
begin		19+40	0.02	0.02									660.17				660.87	666.01			0.015
D750	D749	19+51	0.12	0.11	10.00	7.71	7.69	0.8	0.8	15	15.3	0.0301	662.52	4.85	10.45	0.0002	662.87	666.07	3.20	2.30	CB 6
begin		19+40	0.14	0.13									662.06				662.86	666.01			0.015
D749	D751	19+41	0.00	0.00	10.09	7.68	7.53	1.0	0.9	15	129.0	0.0267	660.17	4.83	9.83	0.0003	660.44	666.01	5.57	4.59	MH 3
		18+57	0.14	0.13									656.73				657.55	661.53			0.015
D751	D753	18+57	0.01	0.01	10.53	7.53	7.50	1.0	1.0	15	31.0	0.0610	656.73	6.60	14.87	0.0003	656.96	661.53	4.57	3.55	CB 3A
		18+17	0.15	0.14									654.84				655.66	659.94			0.015
D753	D754	18+17	0.24	0.20	10.61	7.50	7.42	2.5	2.5	15	118.3	0.0540	654.84	8.17	13.99	0.0019	655.21	659.94	4.73	3.85	CB 3A
		16+83	0.39	0.33									648.45				649.39	652.05			0.015
D754	D755	16+83	0.00	0.00	10.85	7.42	7.35	2.5	2.4	15	115.1	0.0720	648.45	9.06	16.16	0.0019	648.79	652.05	3.26	2.35	MH 3
		15+76	0.39	0.33									640.17				641.11	645.87			0.015
D755	755A	15+76	0.00	0.00	11.07	7.35	7.31	2.4	2.4	15	57.0	0.0837	640.07	9.49	17.42	0.0019	640.40	645.87	5.47	4.55	MH 3
		15+70	0.39	0.33									635.30				639.78	643.00			0.015
755A	18020	15+76	0.00	0.00	11.17	7.32	7.31	2.4	2.4	15	16.0	0.0356	632.50	7.00	11.37	0.0019	639.78	643.00	3.22	9.25	MH 3
final		15+70	0.39	0.33									631.93				639.75	639.40			0.015

NOTE: See BU 1010-Roadway Gateway for Storm Sewer Profiles.

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/16/2011 **Project :** CUY-90-14.90 **Location :** Commercial

Description : Commercial to E9th Ditch Headwall To River Outfall **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 575.00

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D87B	D87	12+37	0.08	0.05	10.00	5.10	6.19	0.3	0.3	12	13.1	0.1015	615.07	5.34	10.58	0.0001	615.19	618.06	2.87	1.99	CB 3A
begin		12+51	0.07	0.05									613.74				614.42	618.94			0.015
D87	D89	12+51	1.48	0.96	10.04	5.09	6.19	5.1	6.2	15	25.4	0.0382	613.74	8.76	11.77	0.0124	614.42	618.94	4.52	3.95	CB 3A
		12+52	1.55	1.01									612.77				613.90	619.31			0.015
D88	D89	12+51	0.25	0.20	10.00	5.10	6.20	1.0	1.2	12	6.5	0.0354	613.39	5.53	6.25	0.0015	613.90	618.91	5.01	4.52	CB 3A
begin		12+52	1.80	1.20									613.16				613.89	619.31			0.015
D89	D92	12+52	0.00	0.00	10.09	5.08	6.11	6.1	7.4	15	170.7	0.0389	612.61	9.23	11.88	0.0172	613.36	619.31	5.95	5.45	MH 3
		10+81	1.80	1.20									605.97				607.14	611.32			0.015
D178	D178	11+11	0.73	0.48	10.00	5.10	6.20	2.4	2.9	12	16.5	0.0360	608.00	7.11	6.30	0.0091	608.50	612.02	3.52	3.02	CB 3A
begin		10+96	2.54	1.68									607.41				608.27	611.63			0.015
D178	D90	10+96	0.12	0.08	10.04	5.09	6.19	2.8	3.4	12	14.4	0.0403	607.41	7.68	6.67	0.0123	607.94	611.63	3.69	3.22	CB 3A
		10+82	2.66	1.76									606.83				607.73	611.33			0.015
D90	D92	10+82	0.10	0.07	10.07	5.08	6.17	3.1	3.8	15	24.3	0.0103	606.58	4.75	6.11	0.0047	607.46	611.40	3.94	3.57	CB 3A
		10+81	2.76	1.82									606.33				607.35	611.32			0.015
D91B	D91	10+96	0.13	0.10	10.00	5.10	6.20	0.5	0.6	12	11.9	0.0798	607.21	6.09	9.38	0.0004	607.39	611.56	4.17	3.35	CB 3A
begin		10+81	2.90	1.93									606.26				606.93	611.06			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D91	D92	10+81	10+81	0.01 2.91	0.01 1.94	10.03	5.09	6.06	0.6	0.7	12	7.5	0.0333	606.27 606.02	4.58	6.06	0.0005	606.90 606.90	611.07 611.32	4.17	3.80	I 3A 0.015
D92	D92B	10+81	72+10	0.00 2.91	0.00 1.94	10.40	5.01	6.06	9.7	11.7	18	72.2	0.0169	605.52 604.30	7.47	12.73	0.0166	606.90 605.70	611.32 608.80	4.42	4.30	MH 3 0.015
D81C begin	D81	15+80	15+69	0.15 3.06	0.11 2.05	10.00	5.10	6.19	0.6	0.7	12	11.0	0.0136	609.82 609.67	3.32	3.88	0.0005	610.35 610.34	614.99 614.32	4.64	4.17	CB 3A 0.015
D81	D92B	15+69	14+72	0.05 3.11	0.03 2.08	10.06	5.08	6.12	0.7	0.9	12	97.7	0.0479	609.67 604.99	5.62	7.27	0.0008	609.91 605.68	614.32 608.80	4.41	3.65	CB 3A 0.015
D92B	D110	14+72	13+77	0.00 3.11	0.00 2.08	10.56	4.98	6.03	10.3	12.5	18	95.9	0.0571	603.49 598.02	12.15	23.39	0.0189	604.31 599.44	608.80 603.11	4.49	3.81	MH 3 0.015
D94C begin	D94B	13+87	13+77	0.62 3.73	0.42 2.49	10.00	5.10	6.20	2.1	2.6	12	20.8	0.0471	599.53 598.55	7.57	7.21	0.0070	599.96 599.40	603.93 602.77	3.97	3.40	CB 3A 0.015
D94B	D110	13+77	13+77	0.05 3.78	0.03 2.52	10.05	5.09	6.19	2.3	2.8	12	6.3	0.0335	598.47 598.26	6.80	6.08	0.0081	599.17 599.12	602.77 603.11	3.60	3.30	CB 3A 0.015
D110	D114	13+77	13+48	0.00 3.78	0.00 2.52	10.69	4.95	6.02	12.5	15.2	18	28.1	0.0722	598.02 595.99	13.91	26.32	0.0278	598.87 597.46	603.11 601.44	4.24	3.59	MH 3 0.015
D114	D113	13+48	13+38	0.00 3.78	0.00 2.52	10.72	4.94	6.02	12.5	15.2	18	10.0	0.0260	595.99 595.73	9.33	15.79	0.0278	597.46 597.18	601.44 600.83	3.98	3.95	MH 3 0.015
D113	D107	13+38	13+29	0.00 3.78	0.00 2.52	10.74	4.94	4.25	12.5	10.7	18	40.1	0.0382	595.73 594.20	10.89	19.13	0.0139	596.93 596.37	600.83 603.80	3.90	3.60	MH 3 0.015
HW begin	D106	13+79	13+68	12.28 16.06	9.09 11.61	20.34	3.55	4.33	32.3	39.4	30 *	11.0	0.0291	598.84 598.52 **	12.54	65.19	0.0123	601.30 601.17	600.84 603.82	-0.46	-0.50	HW Full He 0.015

* This is a 38"x24" elliptical pipe. Used the circular equivalent of 30" for CDSS calculations.

** The invert elevation based on As-built survey is 599.32, but this would result in a negative pipe slope.

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D106	D112	13+68	13+50	0.00 16.06	0.00 11.61	20.35	3.55	4.33	32.2	39.4	30	18.0	0.0267	599.12 598.64	12.14	62.44	0.0123	601.17 600.95	603.82 603.74	2.65	2.20	MH 3 0.015
D112	D107	13+50	13+29	0.00 16.06	0.00 11.61	20.38	3.55	4.25	32.2	38.7	30	22.6	0.0394	594.74 593.85	14.05	75.88	0.0118	596.64 596.37	603.74 603.80	7.10	6.50	MH 3 0.015
D107	D101	13+29	12+08	0.00 16.06	0.00 11.61	20.41	3.54	4.25	41.1	49.4	30	120.0	0.0224	593.85 591.16	11.97	57.24	0.0193	596.37 594.06	603.80 596.29	7.43	7.45	MH 3 0.015
D101	D101	12+08	34+69	0.00 16.06	0.00 11.61	20.57	3.53	4.25	40.9	49.4	30	47.0	0.0245	590.67 589.52	12.39	59.82	0.0193	594.06 593.15	596.29 595.63	2.23	3.12	MH 3 0.015
D101	D102	34+69	36+16	0.00 16.06	0.00 11.61	20.64	3.52	4.25	40.9	49.4	30 Warning	147.0	0.0078	588.88 587.73	8.33	33.82	0.0193	593.15 590.31	595.63 597.22	2.48	4.25	MH 3 0.015
D102	D103	36+16	36+56	0.00 16.06	0.00 11.61	20.93	3.49	4.25	40.5	49.4	30	58.0	0.0151	587.68 586.80	10.12	47.05	0.0193	590.31 589.20	597.22 598.04	6.91	7.04	MH 3 0.015
D103	D108	11+56	11+56	0.00 16.06	0.00 11.61	21.03	3.48	4.18	40.4	48.5	36	175.0	0.0219	574.02 570.18	11.94	92.11	0.0070	576.74 575.51	598.04 582.34	21.30	21.02	MH 3 0.015
D108	D104	11+56	11+56	0.00 16.06	0.00 11.61	21.27	3.46	4.18	40.2	48.5	42	138.0	0.0049	570.18 569.51	6.75	65.36	0.0031	575.51 575.08	582.34 583.26	6.83	8.66	MH 3 0.015
D104	DW final	11+56	11+56	0.00 16.06	0.00 11.61	21.61	3.43	4.18	39.8	48.5	42	26.0	0.0050	569.51 569.38	6.81	66.32	0.0031	575.08 575.00	583.26 574.39	8.18	10.25	MH 3 0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 04/16/2011 **Project :** CUY-90-14.90 **Location :** Commercial

Description : Commercial to E9th Ditch Headwall To River Outfall **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 100 **Hydraulic Gradient Frequency (yrs.) :** 100

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 575.00

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (100	(100	DISCHARGE (cfs.) (100	(100	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D87B	D87	12+37	0.08	0.05	10.00	7.71	7.69	0.4	0.4	12	13.1	0.1015	615.07	6.10	10.58	0.0002	615.20	618.06	2.86	1.99	CB 3A
begin		12+51	0.07	0.05									613.74				614.52	618.94			0.015
D87	D89	12+51	1.48	0.96	10.04	7.70	7.69	7.8	7.7	15	25.4	0.0382	613.74	9.67	11.77	0.0191	614.52	618.94	4.42	3.95	CB 3A
		12+52	1.55	1.01									612.77				613.95	619.31			0.015
D88	D89	12+51	0.25	0.20	10.00	7.71	7.71	1.5	1.5	12	6.5	0.0354	613.39	6.19	6.25	0.0024	613.94	618.91	4.97	4.52	CB 3A
begin		12+52	1.80	1.20									613.16				613.92	619.31			0.015
D89	D92	12+52	0.00	0.00	10.08	7.69	7.54	9.3	9.1	15	170.7	0.0389	612.61	10.07	11.88	0.0262	613.47	619.31	5.84	5.45	MH 3
		10+81	1.80	1.20									605.97				607.60	611.32			0.015
D178	D178	11+11	0.73	0.48	10.00	7.71	7.70	3.7	3.7	12	16.5	0.0360	608.00	7.88	6.30	0.0141	608.57	612.02	3.45	3.02	CB 3A
begin		10+96	2.54	1.68									607.41				608.31	611.63			0.015
D178	D90	10+96	0.12	0.08	10.03	7.70	7.54	4.3	4.2	12	14.4	0.0403	607.41	8.52	6.67	0.0182	608.03	611.63	3.60	3.22	CB 3A
		10+82	2.66	1.76									606.83				607.77	611.33			0.015
D90	D92	10+82	0.10	0.07	10.06	7.69	7.54	4.8	4.7	15	24.3	0.0103	606.58	5.18	6.11	0.0070	607.77	611.40	3.63	3.57	CB 3A
		10+81	2.76	1.82									606.33				607.60	611.32			0.015
D91B	D91	10+96	0.13	0.10	10.00	7.71	7.54	0.8	0.8	12	11.9	0.0798	607.21	6.91	9.38	0.0006	607.61	611.56	3.95	3.35	CB 3A
begin		10+81	2.90	1.93									606.26				607.61	611.06			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (100	(100	DISCHARGE (cfs.) (100	(100	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D91	D92	10+81	10+81	0.01 2.91	0.01 1.94	10.03	7.70	7.54	0.9	0.8	12	7.5	0.0333	606.27 606.02	5.19	6.06	0.0007	607.61 607.60	611.07 611.32	3.46	3.80	I 3A 0.015
D92	D92B	10+81	72+10	0.00 2.91	0.00 1.94	10.36	7.59	7.54	14.7	14.6	18 Warning	72.2	0.0169	605.52 604.30	8.31	12.73	0.0257	607.60 605.75	611.32 608.80	3.72	4.30	MH 3 0.015
D81C begin	D81	15+80	15+69	0.15 3.06	0.11 2.05	10.00	7.71	7.70	0.8	0.8	12	11.0	0.0136	609.82 609.67	3.75	3.88	0.0007	610.37 610.36	614.99 614.32	4.62	4.17	CB 3A 0.015
D81	D92B	15+69	14+72	0.05 3.11	0.03 2.08	10.05	7.70	7.61	1.1	1.1	12	97.7	0.0479	609.67 604.99	6.32	7.27	0.0012	609.94 605.71	614.32 608.80	4.38	3.65	CB 3A 0.015
D92B	D110	14+72	13+77	0.00 3.11	0.00 2.08	10.51	7.54	5.20	15.6	10.8	18	95.9	0.0571	603.49 598.02	13.40	23.39	0.0140	604.24 601.57	608.80 603.11	4.56	3.81	MH 3 0.015
D94C begin	D94B	13+87	13+77	0.62 3.73	0.42 2.49	10.00	7.71	5.20	3.2	2.2	12	20.8	0.0471	599.53 598.55	8.45	7.21	0.0049	601.71 601.61	603.93 602.77	2.22	3.40	CB 3A 0.015
D94B	D110	13+77	13+77	0.05 3.78	0.03 2.52	10.04	7.70	5.20	3.5	2.3	12	6.3	0.0335	598.47 598.26	7.57	6.08	0.0057	601.61 601.57	602.77 603.11	1.16	3.30	CB 3A 0.015
D110	D114	13+77	13+48	0.00 3.78	0.00 2.52	10.63	7.50	5.20	18.9	13.1	18	28.1	0.0722	598.02 595.99	15.30	26.32	0.0207	601.57 600.99	603.11 601.44	1.54	3.59	MH 3 0.015
D114	D113	13+48	13+38	0.00 3.78	0.00 2.52	10.66	7.49	5.20	18.9	13.1	18 Warning	10.0	0.0260	595.99 595.73	10.69	15.79	0.0207	600.99 600.78	601.44 600.83	0.45	3.95	MH 3 0.015
D113	D107	13+38	13+29	0.00 3.78	0.00 2.52	10.67	7.48	5.20	18.9	13.1	18	40.1	0.0382	595.73 594.20	11.34	19.13	0.0207	600.78 599.95	600.83 603.80	0.05	3.60	MH 3 0.015
HW begin	D106	13+79	13+68	12.28 16.06	9.09 11.61	20.34	5.28	5.28	48.0	48.0	30	11.0	0.0291	598.84 598.52	13.69	65.19	0.0182	601.55 601.35	600.84 603.82	-0.71	-0.50	HW Full He 0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (100	(100	DISCHARGE (cfs.) (100	(100	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D106	D112	13+68		0.00	0.00	20.35	5.28	5.28	48.0	48.0	30	18.0	0.0267	599.12	13.22	62.44	0.0182	601.35	603.82	2.47	2.20	MH 3
		13+50		16.06	11.61									598.64				601.03	603.74			0.015
D112	D107	13+50		0.00	0.00	20.38	5.28	5.20	48.0	47.2	30	22.6	0.0394	594.74	15.45	75.88	0.0176	600.35	603.74	3.39	6.50	MH 3
		13+29		16.06	11.61									593.85				599.95	603.80			0.015
D107	D101	13+29		0.00	0.00	20.40	5.27	5.20	61.2	60.3	30	120.0	0.0224	593.85	12.47	57.24	0.0288	599.95	603.80	3.85	7.45	MH 3
		12+08		16.06	11.61						Warning			591.16				596.50	596.29			0.015
D101	D101	12+08		0.00	0.00	20.56	5.25	5.20	60.9	60.3	30	47.0	0.0245	590.67	12.41	59.82	0.0288	596.50	596.29	-0.21	3.12	MH 3
		34+69		16.06	11.61						Warning			589.52				595.15	595.63			0.015
D101	D102	34+69		0.00	0.00	20.62	5.24	5.20	60.8	60.3	30	147.0	0.0078	588.88	12.39	33.82	0.0288	595.15	595.63	0.48	4.25	MH 3
		36+16		16.06	11.61						Warning			587.73				590.92	597.22			0.015
D102	D103	36+16		0.00	0.00	20.82	5.21	5.20	60.5	60.3	30	58.0	0.0151	587.68	12.32	47.05	0.0288	590.92	597.22	6.30	7.04	MH 3
		36+56		16.06	11.61						Warning			586.80				589.25	598.04			0.015
D103	D108	11+56		0.00	0.00	20.90	5.20	5.11	60.3	59.3	36	175.0	0.0219	574.02	13.12	92.11	0.0105	577.60	598.04	20.44	21.02	MH 3
		11+56		16.06	11.61									570.18				575.76	582.34			0.015
D108	D104	11+56		0.00	0.00	21.12	5.16	5.11	60.0	59.3	42	138.0	0.0049	570.18	7.20	65.36	0.0046	575.76	582.34	6.58	8.66	MH 3
		11+56		16.06	11.61									569.51				575.12	583.26			0.015
D104	DW	11+56		0.00	0.00	21.44	5.12	5.11	59.4	59.3	42	26.0	0.0050	569.51	7.30	66.32	0.0046	575.12	583.26	8.14	10.25	MH 3
final		11+56		16.06	11.61									569.38				575.00	574.39			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 01/13/2016 **Project :** CUY-90-14.90 **Location :** Existing Commercial Rd

Description :NW of E. 9th St and Canal Rd. **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 582.93

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D99A	EX95	12+55	0.17	0.12	10.00	5.10	6.18	0.6	0.7	12	25.0	0.0132	599.33	3.37	3.82	0.0005	599.69	603.10	3.41	2.77	CB 3A
begin		12+80	0.17	0.12									599.00				599.68	604.91			0.015

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-20+46 RT to 18+70 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
20+46	Concent							8.21		0.78	6.40					18.79					
20+46	19+18	R	128.00	0.00	2.56	4.35	0.0616	0.26	8.47	0.70	6.59	Seed	3.20	5	0.030	19.09	7.14	3.55	21.09	0.92	6.39
												Jute Mat	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Temp. Mat	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 1	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 2	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 3	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 3	3.66	10	0.060	19.27	4.39	4.85	24.12	1.26	8.71
19+18	Concent							1.81		0.66	7.78					10.14					
19+18	18+83	R	35.00	5.00	4.29	5.36	0.0760	0.00	10.28	0.00	7.78	Seed	3.18	5	0.030	19.37	6.96	2.30	24.71	0.48	9.67
												Jute Mat	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Temp. Mat	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Perm, Type 1	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Perm, Type 3	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Perm, Type 3	3.65	10	0.060	19.41	4.41	3.54	28.38	0.75	12.21
18+83	Concent							0.19		0.84	7.94					10.12					
18+83	18+70	R	13.00	5.00	4.29	5.36	0.0999	0.00	10.47	0.00	7.94	Seed	3.17	5	0.030	19.46	7.70	2.83	25.16	0.45	9.38
												Jute Mat	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Temp. Mat	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 1	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 2	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 3	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 3	3.64	10	0.060	19.45	4.90	4.39	28.93	0.70	11.79

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-17+59 to 13+80 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
17+59	Concent							10.47		0.75	7.85					19.45					
17+59	16+91	R	68.00	5.00	2.80	2.29	0.0539	0.05	10.52	0.70	7.89	Seed	3.15	5	0.030	19.62	6.78	1.92	24.88	0.57	7.90
												Jute Mat	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Temp. Mat	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Perm, Type 1	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Perm, Type 2	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Perm, Type 2	3.62	10	0.060	19.71	4.36	3.02	28.52	0.90	9.57
16+91	Concent							0.67		0.70	8.36					10.14					
16+91	16+20	R	71.00	5.00	3.68	3.71	0.0553	0.21	11.40	0.60	8.48	Seed	3.13	5	0.030	19.90	6.63	1.95	26.55	0.56	9.18
												Jute Mat	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02
												Temp. Mat	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02
												Perm, Type 1	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02
												Perm, Type 2	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.59	10	0.060	19.99	4.22	3.02	30.42	0.88	11.47
16+20	Concent							0.34		0.71	8.72					10.00					
16+20	15+38	R	82.00	5.00	2.61	3.28	0.0667	0.00	11.74	0.00	8.72	Seed	3.10	5	0.030	20.20	7.35	2.31	27.08	0.56	8.27
												Jute Mat	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Temp. Mat	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 1	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 2	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 3	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 3	3.56	10	0.060	20.28	4.71	3.63	31.03	0.87	10.13
15+38	Concent							0.21		0.90	8.91					10.17					
15+38	14+50	R	88.00	5.00	2.61	3.28	0.0510	0.33	12.28	0.64	9.12	Seed	3.08	5	0.030	20.53	6.77	1.94	28.07	0.61	8.59
												Jute Mat	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Temp. Mat	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Perm, Type 1	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Perm, Type 2	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Perm, Type 2	3.52	10	0.060	20.62	4.32	3.03	32.14	0.95	10.61
14+50	13+80	R	70.00	5.00	3.09	2.78	0.0822	0.00	12.28	0.00	9.12	Seed	3.05	5	0.030	20.81	7.97	2.73	27.85	0.53	8.12
												Jute Mat	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Temp. Mat	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Perm, Type 1	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Perm, Type 3	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Perm, Type 3	3.50	10	0.060	20.84	5.12	4.29	31.93	0.84	9.91

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-17+59 to 13+80 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
17+59	Concent							10.47		0.75	7.85					19.42					
17+59	16+91	R	68.00	5.00	2.80	2.29	0.0539	0.05	10.52	0.70	7.89	Seed	4.44	25	0.030	19.57	7.53	2.32	34.99	0.69	8.50
												Jute Mat	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Temp. Mat	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 1	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 2	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 3	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 3	5.39	100	0.060	19.65	4.89	3.74	42.53	1.11	10.65
16+91	Concent							0.67		0.70	8.36					10.14					
16+91	16+20	R	71.00	5.00	3.68	3.71	0.0553	0.21	11.40	0.60	8.48	Seed	4.40	25	0.030	19.83	7.33	2.34	37.35	0.68	10.01
												Jute Mat	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Temp. Mat	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Perm, Type 1	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Perm, Type 3	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Perm, Type 3	5.35	100	0.060	19.90	4.71	3.70	45.40	1.07	12.94
16+20	Concent							0.34		0.71	8.72					10.00					
16+20	15+38	R	82.00	5.00	2.61	3.28	0.0667	0.00	11.74	0.00	8.72	Seed	4.37	25	0.030	20.10	8.16	2.79	38.11	0.67	8.94
												Jute Mat	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Temp. Mat	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 1	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 2	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 3	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 3	5.31	100	0.060	20.16	5.28	4.47	46.33	1.07	11.33
15+38	Concent							0.21		0.90	8.91					10.17					
15+38	14+50	R	88.00	5.00	2.61	3.28	0.0510	0.33	12.28	0.64	9.12	Seed	4.33	25	0.030	20.40	7.51	2.34	39.52	0.73	9.33
												Jute Mat	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Temp. Mat	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 1	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 2	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 3	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 3	5.26	100	0.060	20.46	4.84	3.73	48.03	1.17	11.91
14+50	13+80	R	70.00	5.00	3.09	2.78	0.0822	0.00	12.28	0.00	9.12	Seed	4.30	25	0.030	20.65	8.86	3.30	39.23	0.64	8.77

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Jute Mat	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Temp. Mat	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 1	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 2	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 3	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 3	5.23	100	0.060	20.66	5.75	5.30	47.74	1.03	11.07

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-20+46 RT to 18+70 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
20+46	Concent							8.21		0.78	6.40					18.79					
20+46	19+18	R	128.00	0.00	2.56	4.35	0.0616	0.26	8.47	0.70	6.59	Seed	4.50	25	0.030	19.06	7.78	4.04	29.65	1.05	7.26
												Jute Mat	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Temp. Mat	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Perm, Type 1	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Perm, Type 2	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Perm, Type 3	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												RCP, Type B	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												RCP, Type B	5.46	100	0.060	19.23	4.85	5.63	35.97	1.46	10.12
19+18	Concent							1.81		0.66	7.78					10.14					
19+18	18+83	R	35.00	5.00	4.29	5.36	0.0760	0.00	10.28	0.00	7.78	Seed	4.47	25	0.030	19.33	7.68	2.75	34.76	0.58	10.60
												Jute Mat	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Temp. Mat	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 1	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Perm, Type 2	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Perm, Type 3	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Perm, Type 3	5.44	100	0.060	19.35	4.93	4.33	42.34	0.91	13.81
18+83	Concent							0.19		0.84	7.94					10.12					
18+83	18+70	R	13.00	5.00	4.29	5.36	0.0999	0.00	10.47	0.00	7.94	Seed	4.46	25	0.030	19.40	8.51	3.40	35.40	0.54	10.26
												Jute Mat	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Temp. Mat	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 1	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 2	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 3	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 3	5.44	100	0.060	19.39	5.47	5.37	43.16	0.86	13.31

DITCH ANALYSIS

PID : 46933 **Date :** 04/17/2011 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street - 29+30 LT to 26+66 LT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
29+30	28+02	R	128.48	4.00	3.00	3.00	0.0192	0.30	0.30	0.80	0.24	Seed	3.47	5	0.030	16.33	1.58	0.14	0.83	0.12	4.73
												Seed	3.99	10	0.040	16.52	1.38	0.19	0.96	0.16	4.93
28+02	27+20	L	82.00	4.00	3.00	3.00	0.0257	0.15	0.45	0.80	0.36	Seed	3.40	5	0.030	17.01	2.00	0.22	1.22	0.14	4.83
												Seed	3.89	10	0.040	17.30	1.74	0.28	1.39	0.18	5.06
27+20	26+69	L	51.00	4.00	3.00	3.00	0.0592	1.00	1.45	0.86	1.22	Seed	3.38	5	0.030	17.22	4.00	0.82	4.12	0.22	5.33
												Jute Mat	3.38	5	0.040	17.27	3.30	0.96	4.11	0.26	5.56
												Temp. Mat	3.38	5	0.040	17.27	3.30	0.96	4.11	0.26	5.56
												Temp. Mat	3.86	10	0.040	17.55	3.45	1.04	4.70	0.28	5.69

DITCH ANALYSIS

PID : 46933 **Date :** 04/17/2011 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street/Broadway Ditch - 24+37 (Broadway Align.) to 26+69 LT (E9th Alig) **Designer :** PNS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
24+37	24+54	R	18.00	2.00	3.00	3.00	0.4000 *	0.03	0.03	0.87	0.03	Seed	3.60	5	0.030	15.13	2.27	0.50	0.09	0.02	2.12
												Jute Mat	3.60	5	0.040	15.16	1.88	0.60	0.09	0.02	2.15
												Temp. Mat	3.60	5	0.040	15.16	1.88	0.60	0.09	0.02	2.15
												Temp. Mat	4.18	10	0.040	15.15	1.95	0.67	0.11	0.03	2.16
24+54	26+69	R	74.00	2.00	3.00	3.00	0.0050	0.05	0.08	0.90	0.07	Seed	3.44	5	0.030	16.64	0.79	0.04	0.24	0.13	2.77
												Seed	3.93	10	0.040	16.95	0.70	0.05	0.28	0.16	2.97

DITCH ANALYSIS

PID : 46933 **Date :** 04/17/2011 **Project :** CUY-90-14.90 **Location :** Broadway

Description : Broadway - Sta. 18+63.48 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
17+50	19+00	R	150.00	0.00	16.00	17.00	0.0100	1.43	1.43	0.87	1.24	Seed	3.46	5	0.030	16.48	1.68	0.25	4.30	0.39	13.01
												Seed	3.96	10	0.040	16.76	1.40	0.29	4.92	0.46	15.24
19+00	20+35	R	135.00	0.00	15.00	10.00	0.0025	0.01	1.44	0.87	1.25	Seed	3.25	5	0.030	18.58	1.05	0.09	4.07	0.56	13.90
												Seed	3.66	10	0.040	19.29	0.87	0.10	4.59	0.65	16.20

For	Commercial Outfall Rip rap	Job no.	49633	Sheet no.	1/2
Made by	PNS	Checked by	BAHess	Backchecked by	PNSheding 7-24-11
Date	7-15-2011	Date	7/24/11	Date	PNSheding 8-10-11

HNTB

HEC-15 ✓

$$n = \frac{\alpha d_a^{1/6}}{2.25 + 5.23 \log\left(\frac{d_a}{D_{50}}\right)} \qquad (6.1)$$

$$\tau_p = F_x(\gamma_s - \gamma)D_{50} \qquad (6.7)$$

$$D_{50} \geq \frac{SF\, d\, S_0}{F_x(SG-1)} \qquad (6.8)$$

$$Re = \frac{V_x D_{50}}{\nu} \qquad (6.9)$$

$$V_x = \sqrt{g d S} \qquad (6.10)$$

HEC-RAS model Input/Results

→ depth @ riprap = 566
MAX DEPTH = 575.23 − 566.00 = 9.23 ft

$g = 32.2$ ft/s

$d = 575.23 - 543.00 = 32.23$ ft

$S = 0.0071$ ft/ft @ Bulkhead; $= 0.0049$ ft/ft @ Commercial outfall

$V_x = \sqrt{(32.2)(32.23)(0.0071)} = 2.714$ ft/s

$\sqrt{(32.2)(9.23)(0.0049)} = 1.206$ ft/s

$D_{50} = 12$ inch $\rightarrow Re = \frac{(2.714)(1)}{(1.217\times10^{-5})} = 2.23\times10^5$

$\frac{(1.206)(1)}{(1.217\times10^{-5})} = 1.04\times10^5$

Table 6.1 w/ Re → $F_x = 0.15$

$SF = 1.5$

$$D_{50} \geq \frac{1.5(32.23)(0.0071)}{(0.15)(2.64-1)} = 1.4 \text{ ft} \quad (1.395')$$

$$\frac{1.5(9.23)(0.0049)}{(0.15)(2.64-1)} = 0.97$$

ME101-1204

For		Job no.		Sheet no. 2/3	HNTB
Made by	PNStanley 7-15-11	Checked by BAHess	7/24/11	Backchecked by PNStanley 7-24-11	
Date		Date		Date	

preceding 8-10-11

Side slopes

$\gamma_s = K_1 \gamma_d$

$D_{50,s} = \frac{K_1}{K_2} D_{50,b}$ (6-15)

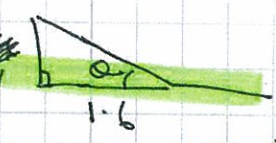
$K_2 = \sqrt{1 - \left(\frac{\sin\theta}{\sin\phi}\right)^2}$

$= \sqrt{1 - \left(\frac{\sin(58°32')}{\sin(40°)}\right)^2}$ 42.5

$K_2 = 0.57$ 0.62

$z = 1.6$

$K_1 = 0.06C(1.6) + 0.67 = 0.77$ 0.78

$\theta \Rightarrow$ 

$\theta = \arctan\left(\frac{1.6}{1}\right) = 58°32'$

ϕ = angle of repose = 40° 42.5° (see attached chart)

$D_{50,s} = \frac{K_1}{K_2} D_{50,b} = \frac{0.77}{0.57}(1.395\,1) = 1.88$ ft 0.97 1.20

∴ Use Type A STONE to add add'l protection vs Type B.

Check E_f 6-11 (steep slopes)

$P_{50} \geq \frac{SF\, dS\Delta}{F_x(SG-1)}$ (6-11)

$\Delta = \frac{K_1(1+\sin(\alpha+\beta))\tan\phi}{2(\cos\theta\tan\phi - SF\sin\theta\cos\beta)}$

$\phi = 40$ 42.5°

$\theta = 32°$

$\alpha = 0.41°$ 0.28°

$\beta = \operatorname{arctan}\left(\frac{\frac{\cos\alpha}{2\sin\theta} + \sin\alpha}{\eta\tan\phi}\right)$

$\eta = \frac{\gamma_s}{F_x(\gamma_s - \gamma)D_{50}} = \frac{K_1\gamma_s h S}{F_x(\gamma_s-\gamma)D_{50}}$

$= \frac{(0.77)(62.4)}{0.15(165-62.4)(1.395)}$ 0.78

$= \frac{(165)(32.23)(0.0071)}{0.15(165-62.4)(1.395)}$ 9.23 0.0049 = 0.07

0.51 ✓ 0.36 ✓ 2.0 ✓

ME101-1204

For		Job no.		Sheet no. 3/3	HNTB
Made by	PN Shelley	Checked by	BAllen	Backchecked by	PN Shelley
Date	7-15-11	Date	7/24/11	Date	7-24-11

PN Shelley 8-10-11

Calculate S.F. $\beta = \arctan\left(\frac{\cos(0.41)}{2\sin(32) + \sin(0.41)}\right) = \arctan(0.40) = 21.8° = 3.43°$

$0.28 \quad 0.07 \quad 0.51 \tan(40°) \quad 42.5 \quad 0.06$

$S.F. = \frac{\cos\theta \tan\phi}{\eta' \tan\phi + \sin\theta \cos\beta}$ Eq. Appendix D.4

$\eta' = \eta \cdot \frac{1 + \sin(\alpha + \beta)}{2} = 0.51 \cdot \frac{1 + \sin(0.41 + 21.8)}{2}$ Eq. Appendix D.5

$0.28 \quad 3.43$

$= 0.35 \quad 0.04$

$S.F. = \frac{\cos(32)\tan(40)}{0.35\tan(40) + \sin(32)\cos(21.8)}$

$42.5° \quad 0.04 \quad 42.5° \quad 3.43$

$= 0.712 \quad 0.7$

0.786 — 0.86 — unstable

1.27 — stable

$= 1.3875 \approx 1.4$ stable ✓

100yr WSE = 575.23

500yr WSE = 576.86

Grout Riprap to 575.50 for 100yr protection. Above that Riprap will be stable for events less than or equal to 100yr. Grout to 576.86 For protection against the 500 yr event.

Use Type A Riprap @ outfall ✓

ME101-1204

7 "EROSION & SEDIMENTATION", JULIEN, CC 1998

Incipient motion

The threshold conditions between erosion and sedimentation of a single particle are usually referred to as incipient motion. The stability of granular material is first examined without flow in Section 7.1 and under flowing water in the following sections. In Section 7.2, simplified particle equilibrium conditions on nearly horizontal surfaces are discussed for uniform and nonuniform material. The equilibrium of particles under tridimensional moments of force is treated in Section 7.3. A simplified force analysis is presented in Section 7.4. Three examples of particle stability analysis and stable channel design are provided.

7.1 Angle of repose

The stability of a single particle on a plane horizontal surface is first considered in Figure 7.1a for simple two-dimensional particle shapes. The threshold condition is obtained when the particle center of mass is vertically above the point of contact. It is shown that the critical angle at

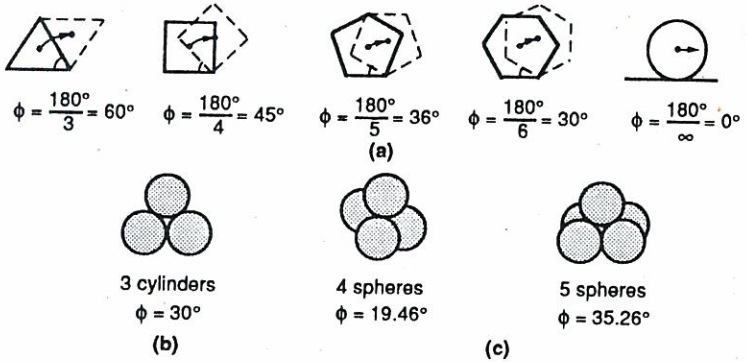


Figure 7.1. Angle of repose for simple shapes

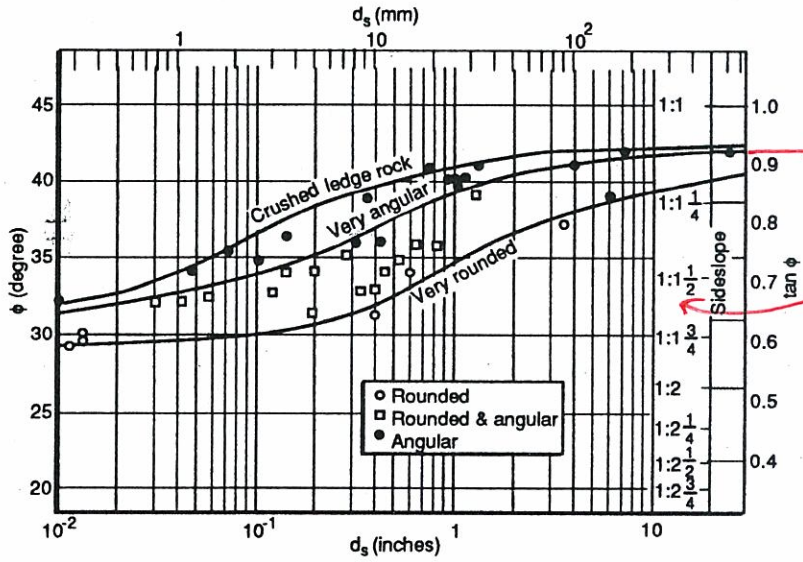


Figure 7.2. Angle of repose for granular material (from Simons, 1957)

which motion occurs, or angle of repose ϕ, equals 180° divided by the number of sides of the polygon. For instance, the angle of repose ϕ of an equilateral triangle is $\phi = 180°/3 = 60°$, that of a square is $\phi = 180°/4 = 45°$, and that of a sphere is $\phi = 180°/\infty = 0°$. One concludes that the angle of repose of particles on a flat surface increases with angularity.

Long cylinders standing on each other (Fig. 7.1b) rest at an angle of repose $\phi = 30°$. A sphere standing on spheres of equal diameter (Fig. 7.1c) reaches threshold of motion at $\phi = 19.5°$ for three points of contact, and at $\phi = 35.3°$ for four points of contact. For natural granular material, the angle of repose varies with grain size and angularity of the material, as shown in Figure 7.2.

In the case of material with different diameter particles, consider a sphere of diameter d_2 resting on top of four identical spheres of different diameter d_1, as sketched in Figure 7.3. Geometrically, the angle of repose is given by

$$\tan\phi = \frac{d_1}{\sqrt{(d_1+d_2)^2 - 2d_1^2}} = \sqrt{\frac{1}{(1+d_2/d_1)^2 - 2}} \qquad (7.1)$$

The angle of repose ϕ is 35.3° when $d_2 = d_1$; it decreases when $d_2 > d_1$ and increases for fine particles $d_2 < d_1$ until $d_2 = 0.41 d_1$.

For	Commercial Outfall	Job no.	49633	Sheet no.	1/1
Made by	PNshedivy	Checked by	BAHESS	Backchecked by	PNshedivy 8-9-11
Date	8-9-11	Date	8/10/11	Date	

HNTB

EM 1110-2-1601 Source USACE

$$D_{30} = S_f C_s C_v C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{1/2} \frac{V}{\sqrt{K_1 g d}} \right]^{2.5} \quad \text{(Eq 3-3)}$$

$S_f = 1.5$

$C_s = 0.30$

$C_v = 1.0$

$C_T = 1.0$

$d = 9.23$ FT

$\gamma_w = 62.4$ lb/ft^2

$\gamma_s = 165$ lb/ft^2

$g = 32.2$ ft/s^2

$V = 4.73$ ft/s (HEC-RAS)

$$K_1 = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\phi}} = \sqrt{1 - \frac{\sin^2(32)}{\sin^2(40)}} = 0.56 \quad \text{(Eq 3-4)}$$

0.566 ⇒ 0.57

$$D_{30} = 1.5 \times 0.30 \times 1.0 \times 1.0 \times 9.23 \times \left[\left(\frac{62.4}{165 - 62.4} \right)^{1/2} \frac{4.73}{\sqrt{(0.56)(32.2)(9.23)}} \right]^{2.5}$$

0.57

$D_{30} = 0.18$ FT ⟶ Table 3-1 $D_{30(min)} = 0.37$

↳ $D_{50(max)} = 11$ in

$D_{50(min)} = 7$ in

∴ use Type C Riprap

↳ No grout.

ME101-1204

Table 3-1
Gradations for Riprap Placement in the Dry, Low-Turbulence Zones

D_{100}(max) in.	Limits of Stone Weight, lb[1], for Percent Lighter by Weight: 100 Max	100 Min	50 Max[2]	50 Min	15 Max[2]	15 Min	D_{30}(min) ft	D_{90}(min) ft
Specific Weight = 155 pcf								
9	34	14	10	7	5	2	0.37	0.53
12	81	32	24	16	12	5	0.48	0.70
15	159	63	47	32	23	10	0.61	0.88
18	274	110	81	55	41	17	0.73	1.06
21	435	174	129	87	64	27	0.85	1.23
24	649	260	192	130	96	41	0.97	1.40
27	924	370	274	185	137	58	1.10	1.59
30	1,268	507	376	254	188	79	1.22	1.77
33	1,688	675	500	338	250	105	1.34	1.94
36	2,191	877	649	438	325	137	1.46	2.11
42	3,480	1,392	1,031	696	516	217	1.70	2.47
48	5,194	2,078	1,539	1,039	769	325	1.95	2.82
54	7,396	2,958	2,191	1,479	1,096	462	2.19	3.17
Specific Weight = 165 pcf								
9	36	15	11	7	5	2	0.37	0.53
12	86	35	26	17	13	5	0.48	0.70
15	169	67	50	34	25	11	0.61	0.88
18	292	117	86	58	43	18	0.73	1.06
21	463	185	137	93	69	29	0.85	1.23
24	691	276	205	138	102	43	0.97	1.40
27	984	394	292	197	146	62	1.10	1.59
30	1,350	540	400	270	200	84	1.22	1.77
33	1,797	719	532	359	266	112	1.34	1.96
36	2,331	933	691	467	346	146	1.46	2.11
42	3,704	1,482	1,098	741	549	232	1.70	2.47
48	5,529	2,212	1,638	1,106	819	346	1.95	2.82
54	7,873	3,149	2,335	1,575	1,168	492	2.19	3.17
Specific Weight = 175 pcf								
9	39	15	11	8	6	2	0.37	0.53
12	92	37	27	18	14	5	0.48	0.70
15	179	72	53	36	27	11	0.61	0.88
18	309	124	92	62	46	19	0.73	1.06
21	491	196	146	98	73	31	0.85	1.23
24	733	293	217	147	109	46	0.97	1.40
27	1,044	417	309	209	155	65	1.10	1.59
30	1,432	573	424	286	212	89	1.22	1.77
33	1,906	762	565	381	282	119	1.34	1.94
36	2,474	990	733	495	367	155	1.46	2.11
42	3,929	1,571	1,164	786	582	246	1.70	2.47
48	5,864	2,346	1,738	1,173	869	367	1.95	2.82
54	8,350	3,340	2,474	1,670	1,237	522	2.19	3.17

Notes:
1. Stone weight limit data from ETL 1110-2-120 (HQUSACE, 1971 (14 May), "Additional Guidance for Riprap Channel Protection, Ch 1," US Government Printing Office, Washington, DC). Relationship between diameter and weight is based on the shape of a sphere.
2. The maximum limits at the W_{50} and W_{15} sizes can be increased as in the Lower Mississippi Valley Division Standardized Gradations shown in Appendix F.

APPENDIX D

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-20+46 RT to 18+70 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
20+46	Concent							8.21		0.78	6.40					18.79					
20+46	19+18	R	128.00	0.00	2.56	4.35	0.0616	0.26	8.47	0.70	6.59	Seed	3.20	5	0.030	19.09	7.14	3.55	21.09	0.92	6.39
												Jute Mat	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Temp. Mat	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 1	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 2	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 3	3.18	5	0.060	19.29	4.24	4.60	20.97	1.20	8.27
												Perm, Type 3	3.66	10	0.060	19.27	4.39	4.85	24.12	1.26	8.71
19+18	Concent							1.81		0.66	7.78					10.14					
19+18	18+83	R	35.00	5.00	4.29	5.36	0.0760	0.00	10.28	0.00	7.78	Seed	3.18	5	0.030	19.37	6.96	2.30	24.71	0.48	9.67
												Jute Mat	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Temp. Mat	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Perm, Type 1	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Perm, Type 3	3.17	5	0.060	19.43	4.25	3.30	24.67	0.70	11.71
												Perm, Type 3	3.65	10	0.060	19.41	4.41	3.54	28.38	0.75	12.21
18+83	Concent							0.19		0.84	7.94					10.12					
18+83	18+70	R	13.00	5.00	4.29	5.36	0.0999	0.00	10.47	0.00	7.94	Seed	3.17	5	0.030	19.46	7.70	2.83	25.16	0.45	9.38
												Jute Mat	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Temp. Mat	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 1	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 2	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 3	3.17	5	0.060	19.47	4.71	4.08	25.15	0.65	11.32
												Perm, Type 3	3.64	10	0.060	19.45	4.90	4.39	28.93	0.70	11.79

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-17+59 to 13+80 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
17+59	Concent							10.47		0.75	7.85					19.45					
17+59	16+91	R	68.00	5.00	2.80	2.29	0.0539	0.05	10.52	0.70	7.89	Seed	3.15	5	0.030	19.62	6.78	1.92	24.88	0.57	7.90
												Jute Mat	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Temp. Mat	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Perm, Type 1	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Perm, Type 2	3.15	5	0.060	19.72	4.18	2.80	24.81	0.83	9.24
												Perm, Type 2	3.62	10	0.060	19.71	4.36	3.02	28.52	0.90	9.57
16+91	Concent							0.67		0.70	8.36					10.14					
16+91	16+20	R	71.00	5.00	3.68	3.71	0.0553	0.21	11.40	0.60	8.48	Seed	3.13	5	0.030	19.90	6.63	1.95	26.55	0.56	9.18
												Jute Mat	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02
												Temp. Mat	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02
												Perm, Type 1	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02
												Perm, Type 2	3.12	5	0.060	20.01	4.05	2.81	26.47	0.82	11.02

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.59	10	0.060	19.99	4.22	3.02	30.42	0.88	11.47
16+20	Concent							0.34		0.71	8.72					10.00					
16+20	15+38	R	82.00	5.00	2.61	3.28	0.0667	0.00	11.74	0.00	8.72	Seed	3.10	5	0.030	20.20	7.35	2.31	27.08	0.56	8.27
												Jute Mat	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Temp. Mat	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 1	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 2	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 3	3.09	5	0.060	20.31	4.52	3.37	27.00	0.81	9.76
												Perm, Type 3	3.56	10	0.060	20.28	4.71	3.63	31.03	0.87	10.13
15+38	Concent							0.21		0.90	8.91					10.17					
15+38	14+50	R	88.00	5.00	2.61	3.28	0.0510	0.33	12.28	0.64	9.12	Seed	3.08	5	0.030	20.53	6.77	1.94	28.07	0.61	8.59
												Jute Mat	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Temp. Mat	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Perm, Type 1	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Perm, Type 2	3.06	5	0.060	20.66	4.15	2.81	27.96	0.88	10.21
												Perm, Type 2	3.52	10	0.060	20.62	4.32	3.03	32.14	0.95	10.61
14+50	13+80	R	70.00	5.00	3.09	2.78	0.0822	0.00	12.28	0.00	9.12	Seed	3.05	5	0.030	20.81	7.97	2.73	27.85	0.53	8.12
												Jute Mat	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Temp. Mat	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Perm, Type 1	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Perm, Type 3	3.05	5	0.060	20.90	4.92	3.98	27.78	0.78	9.56
												Perm, Type 3	3.50	10	0.060	20.84	5.12	4.29	31.93	0.84	9.91

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-17+59 to 13+80 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

		Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
	Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
	RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
17+59	Concent							10.47		0.75	7.85					19.42					
17+59	16+91	R	68.00	5.00	2.80	2.29	0.0539	0.05	10.52	0.70	7.89	Seed	4.44	25	0.030	19.57	7.53	2.32	34.99	0.69	8.50
												Jute Mat	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Temp. Mat	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 1	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 2	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 3	4.42	25	0.060	19.66	4.62	3.37	34.89	1.00	10.09
												Perm, Type 3	5.39	100	0.060	19.65	4.89	3.74	42.53	1.11	10.65
16+91	Concent							0.67		0.70	8.36					10.14					
16+91	16+20	R	71.00	5.00	3.68	3.71	0.0553	0.21	11.40	0.60	8.48	Seed	4.40	25	0.030	19.83	7.33	2.34	37.35	0.68	10.01
												Jute Mat	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Temp. Mat	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Perm, Type 1	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Perm, Type 3	4.39	25	0.060	19.93	4.46	3.35	37.24	0.97	12.18
												Perm, Type 3	5.35	100	0.060	19.90	4.71	3.70	45.40	1.07	12.94
16+20	Concent							0.34		0.71	8.72					10.00					
16+20	15+38	R	82.00	5.00	2.61	3.28	0.0667	0.00	11.74	0.00	8.72	Seed	4.37	25	0.030	20.10	8.16	2.79	38.11	0.67	8.94
												Jute Mat	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Temp. Mat	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 1	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 2	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 3	4.36	25	0.060	20.20	4.99	4.03	37.99	0.97	10.71
												Perm, Type 3	5.31	100	0.060	20.16	5.28	4.47	46.33	1.07	11.33
15+38	Concent							0.21		0.90	8.91					10.17					
15+38	14+50	R	88.00	5.00	2.61	3.28	0.0510	0.33	12.28	0.64	9.12	Seed	4.33	25	0.030	20.40	7.51	2.34	39.52	0.73	9.33
												Jute Mat	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Temp. Mat	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 1	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 2	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 3	4.32	25	0.060	20.52	4.58	3.37	39.38	1.06	11.24
												Perm, Type 3	5.26	100	0.060	20.46	4.84	3.73	48.03	1.17	11.91
14+50	13+80	R	70.00	5.00	3.09	2.78	0.0822	0.00	12.28	0.00	9.12	Seed	4.30	25	0.030	20.65	8.86	3.30	39.23	0.64	8.77

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Jute Mat	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Temp. Mat	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 1	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 2	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 3	4.29	25	0.060	20.74	5.43	4.78	39.14	0.93	10.47
												Perm, Type 3	5.23	100	0.060	20.66	5.75	5.30	47.74	1.03	11.07

DITCH ANALYSIS

PID : 49633 **Date :** 09/16/2014 **Project :** CUY-90-14.90 **Location :** East 9th Street

Description : East 9th Street-20+46 RT to 18+70 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
20+46	Concent							8.21		0.78	6.40					18.79					
20+46	19+18	R	128.00	0.00	2.56	4.35	0.0616	0.26	8.47	0.70	6.59	Seed	4.50	25	0.030	19.06	7.78	4.04	29.65	1.05	7.26
												Jute Mat	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Temp. Mat	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Perm, Type 1	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Perm, Type 2	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												Perm, Type 3	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												RCP, Type B	4.48	25	0.060	19.25	4.62	5.23	29.49	1.36	9.39
												RCP, Type B	5.46	100	0.060	19.23	4.85	5.63	35.97	1.46	10.12
19+18	Concent							1.81		0.66	7.78					10.14					
19+18	18+83	R	35.00	5.00	4.29	5.36	0.0760	0.00	10.28	0.00	7.78	Seed	4.47	25	0.030	19.33	7.68	2.75	34.76	0.58	10.60
												Jute Mat	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Temp. Mat	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 1	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Perm, Type 2	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Perm, Type 3	4.46	25	0.060	19.38	4.67	3.92	34.71	0.83	12.98
												Perm, Type 3	5.44	100	0.060	19.35	4.93	4.33	42.34	0.91	13.81
18+83	Concent							0.19		0.84	7.94					10.12					
18+83	18+70	R	13.00	5.00	4.29	5.36	0.0999	0.00	10.47	0.00	7.94	Seed	4.46	25	0.030	19.40	8.51	3.40	35.40	0.54	10.26
												Jute Mat	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Temp. Mat	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 1	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 2	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 3	4.46	25	0.060	19.42	5.18	4.86	35.38	0.78	12.52
												Perm, Type 3	5.44	100	0.060	19.39	5.47	5.37	43.16	0.86	13.31

Culvert Designer/Analyzer Report
STA 1800 25 RT ON 9TH ST DRIVEWAY CULVERT

Analysis Component			
Storm Event	Design	Discharge	35.41 cfs

Peak Discharge Method: User-Specified			
Design Discharge	35.41 cfs	Check Discharge	43.19 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	623.95 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24x38 inch Horiz Ellipse	35.41 cfs	631.44 ft	14.94 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
STA 1800 25 RT ON 9TH ST DRIVEWAY CULVERT

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	631.44	ft	Discharge	35.41	cfs
Inlet Control HW Elev.	631.44	ft	Tailwater Elevation	623.95	ft
Outlet Control HW Elev.	631.31	ft	Control Type	Inlet Control	
Headwater Depth/Height	1.61				

Grades					
Upstream Invert	628.23	ft	Downstream Invert	623.01	ft
Length	108.30	ft	Constructed Slope	0.048199	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.97	ft
Slope Type	Steep		Normal Depth	0.96	ft
Flow Regime	Supercritical		Critical Depth	1.65	ft
Velocity Downstream	14.94	ft/s	Critical Slope	0.008459	ft/ft

Section					
Section Shape	Horizontal Ellipse		Mannings Coefficient	0.015	
Section Material	Concrete		Span	3.15	ft
Section Size	24x38 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	631.31	ft	Upstream Velocity Head	0.95	ft
Ke	0.50		Entrance Loss	0.48	ft

Inlet Control Properties					
Inlet Control HW Elev.	631.44	ft	Flow Control	Submerged	
Inlet Type	Square edge with headwall (horizontal ellipse)		Area Full	5.1	ft²
K	0.01000		HDS 5 Chart	29	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
STA 1800 25 RT ON 9TH ST DRIVEWAY CULVERT

Analysis Component			
Storm Event	Check	Discharge	43.19 cfs

Peak Discharge Method: User-Specified			
Design Discharge	35.41 cfs	Check Discharge	43.19 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	624.07 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24x38 inch Horiz Ellipse	43.19 cfs	632.38 ft	15.71 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
STA 1800 25 RT ON 9TH ST DRIVEWAY CULVERT

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	632.38 ft	Discharge	43.19 cfs
Inlet Control HW Elev.	632.38 ft	Tailwater Elevation	624.07 ft
Outlet Control HW Elev.	631.89 ft	Control Type	Inlet Control
Headwater Depth/Height	2.07		

Grades			
Upstream Invert	628.23 ft	Downstream Invert	623.01 ft
Length	108.30 ft	Constructed Slope	0.048199 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.04 ft
Slope Type	Steep	Normal Depth	1.01 ft
Flow Regime	Supercritical	Critical Depth	1.79 ft
Velocity Downstream	15.71 ft/s	Critical Slope	0.011680 ft/ft

Section			
Section Shape	Horizontal Ellipse	Mannings Coefficient	0.015
Section Material	Concrete	Span	3.15 ft
Section Size	24x38 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	631.89 ft	Upstream Velocity Head	1.25 ft
Ke	0.50	Entrance Loss	0.62 ft

Inlet Control Properties			
Inlet Control HW Elev.	632.38 ft	Flow Control	Submerged
Inlet Type	Square edge with headwall (horizontal ellipse)	Area Full	5.1 ft²
K	0.01000	HDS 5 Chart	29
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Designer/Analyzer Report
STA 1380 55 RT ON 9TH ST END OF DITCH

Analysis Component			
Storm Event	Design	Discharge	39.16 cfs

Peak Discharge Method: User-Specified			
Design Discharge	39.16 cfs	Check Discharge	47.78 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.89 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24x38 inch Horiz Ellipse	39.16 cfs	602.06 ft	10.09 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
STA 1380 55 RT ON 9TH ST END OF DITCH

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	602.06 ft	Discharge	39.16 cfs
Inlet Control HW Elev.	602.06 ft	Tailwater Elevation	0.89 ft
Outlet Control HW Elev.	601.86 ft	Control Type	Inlet Control
Headwater Depth/Height	1.61		

Grades			
Upstream Invert	598.84 ft	Downstream Invert	598.52 ft
Length	11.00 ft	Constructed Slope	0.029091 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.41 ft
Slope Type	Steep	Normal Depth	1.11 ft
Flow Regime	Supercritical	Critical Depth	1.73 ft
Velocity Downstream	10.09 ft/s	Critical Slope	0.009851 ft/ft

Section			
Section Shape	Horizontal Ellipse	Mannings Coefficient	0.015
Section Material	Concrete	Span	3.15 ft
Section Size	24x38 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	601.86 ft	Upstream Velocity Head	1.08 ft
Ke	0.20	Entrance Loss	0.22 ft

Inlet Control Properties			
Inlet Control HW Elev.	602.06 ft	Flow Control	Submerged
Inlet Type	Groove end projecting (horizontal ellipse)	Area Full	5.1 ft²
K	0.00450	HDS 5 Chart	29
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Designer/Analyzer Report
STA 1380 55 RT ON 9TH ST END OF DITCH

Analysis Component			
Storm Event	Check	Discharge	47.78 cfs

Peak Discharge Method: User-Specified			
Design Discharge	39.16 cfs	Check Discharge	47.78 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.89 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24x38 inch Horiz Ellipse	47.78 cfs	602.97 ft	11.00 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
STA 1380 55 RT ON 9TH ST END OF DITCH

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	602.97 ft	Discharge	47.78 cfs
Inlet Control HW Elev.	602.97 ft	Tailwater Elevation	0.89 ft
Outlet Control HW Elev.	602.44 ft	Control Type	Inlet Control
Headwater Depth/Height	2.07		

Grades			
Upstream Invert	598.84 ft	Downstream Invert	598.52 ft
Length	11.00 ft	Constructed Slope	0.029091 ft/ft

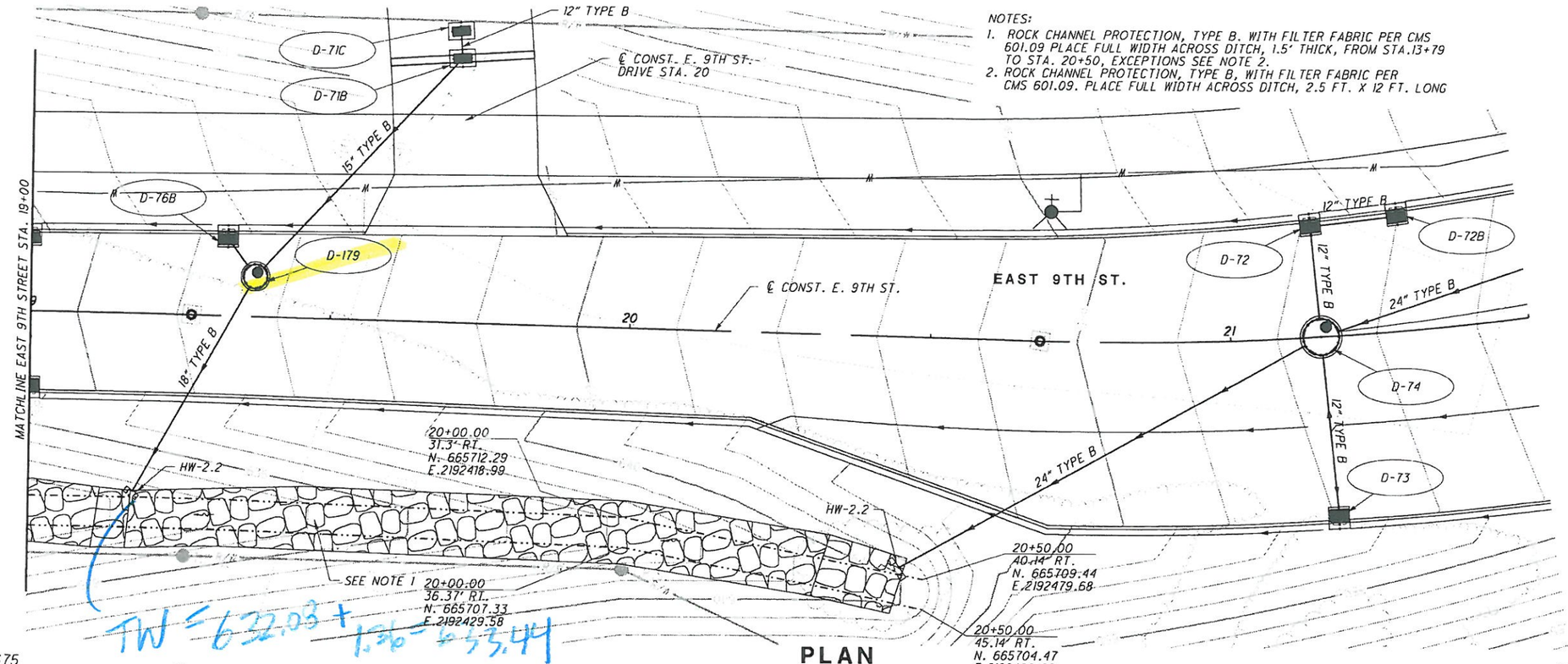
Hydraulic Profile			
Profile	S2	Depth, Downstream	1.58 ft
Slope Type	Steep	Normal Depth	1.25 ft
Flow Regime	Supercritical	Critical Depth	1.84 ft
Velocity Downstream	11.00 ft/s	Critical Slope	0.014176 ft/ft

Section			
Section Shape	Horizontal Ellipse	Mannings Coefficient	0.015
Section Material	Concrete	Span	3.15 ft
Section Size	24x38 inch	Rise	2.00 ft
Number Sections	1		

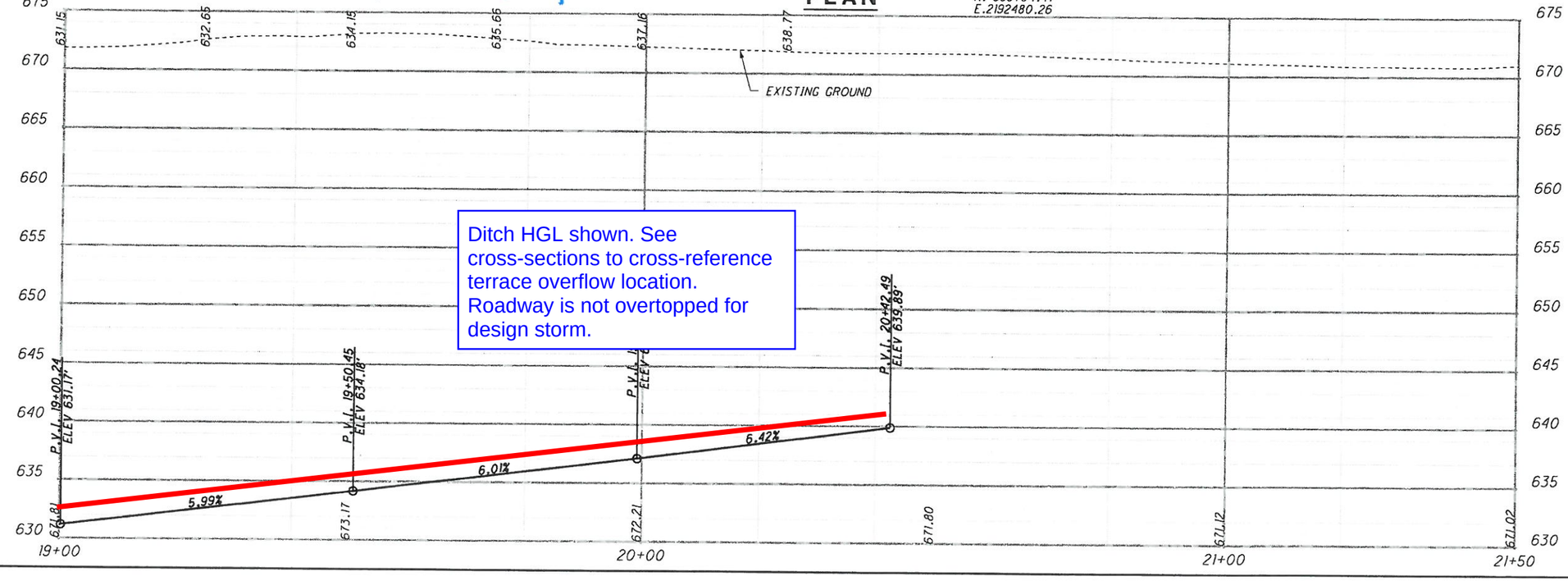
Outlet Control Properties			
Outlet Control HW Elev.	602.44 ft	Upstream Velocity Head	1.46 ft
Ke	0.20	Entrance Loss	0.29 ft

Inlet Control Properties			
Inlet Control HW Elev.	602.97 ft	Flow Control	Submerged
Inlet Type	Grate projecting (horizontal ellipse)	Area Full	5.1 ft²
K	0.00450	HDS 5 Chart	29
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

NOTES:
1. ROCK CHANNEL PROTECTION, TYPE B. WITH FILTER FABRIC PER CMS 601.09 PLACE FULL WIDTH ACROSS DITCH, 1.5' THICK, FROM STA.13+79 TO STA. 20+50, EXCEPTIONS SEE NOTE 2.
2. ROCK CHANNEL PROTECTION, TYPE B, WITH FILTER FABRIC PER CMS 601.09. PLACE FULL WIDTH ACROSS DITCH, 2.5 FT. X 12 FT. LONG



PLAN



Ditch HGL shown. See cross-sections to cross-reference terrace overflow location. Roadway is not overtopped for design storm.

NO.	REVISIONS	DATE
A	FINAL SUBMITTAL	03/30/2011
B	FINAL SUBMITTAL TO ODOT	04/19/2011
C	FINAL SUBMITTAL - RESUBMIT 1	05/25/2011
D	FINAL SUBMITTAL TO ODOT - RESUBMIT 1	07/01/2011
1	APPROVED FOR CONSTRUCTION	08/01/2011

STATE OF OHIO
ERICA L JOHNSON
70955
REGISTERED
PROFESSIONAL ENGINEER
11-4-13

DESIGN AGENCY
WALSH CONSTRUCTION
WALSH HNTB

CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

ROADWAY
E 9TH EXTENSION

DRAINAGE DETAILS
DITCH RT. OF E.9TH ST.
STA. 19+00 TO STA. 21+50

HORIZONTAL SCALE IN FEET
0 5 10 20

CUY-90-14.90

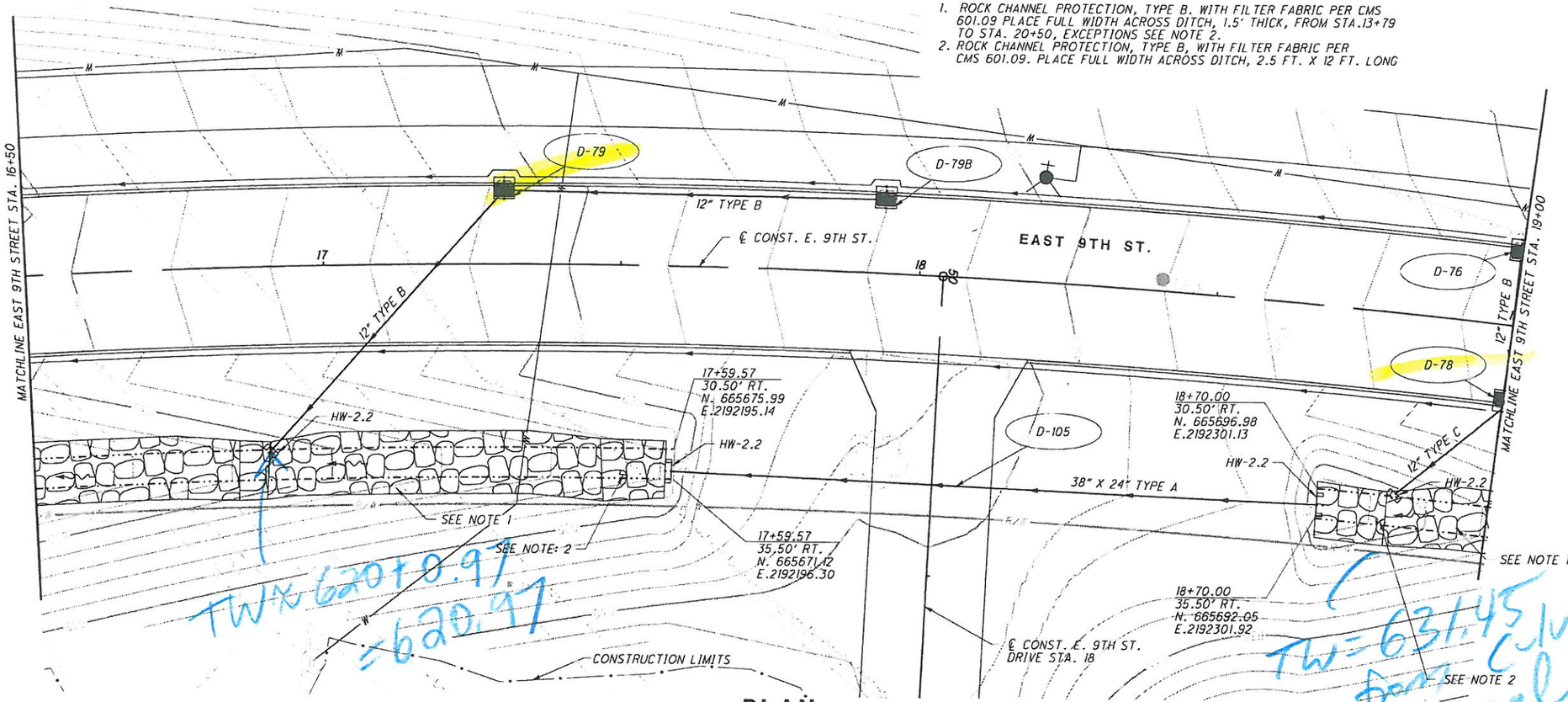
DWG. NO.
DR-049

DESIGNED PNS
CHECKED KAE

153
252

11/6/2013 8:29:07 AM
Model:Sheet3
File:496.33-S-RD-DR05.dgn

NOTES:
1. ROCK CHANNEL PROTECTION, TYPE B. WITH FILTER FABRIC PER CMS 601.09 PLACE FULL WIDTH ACROSS DITCH, 1.5' THICK, FROM STA.13+79 TO STA. 20+50, EXCEPTIONS SEE NOTE 2.
2. ROCK CHANNEL PROTECTION, TYPE B, WITH FILTER FABRIC PER CMS 601.09. PLACE FULL WIDTH ACROSS DITCH, 2.5 FT. X 12 FT. LONG



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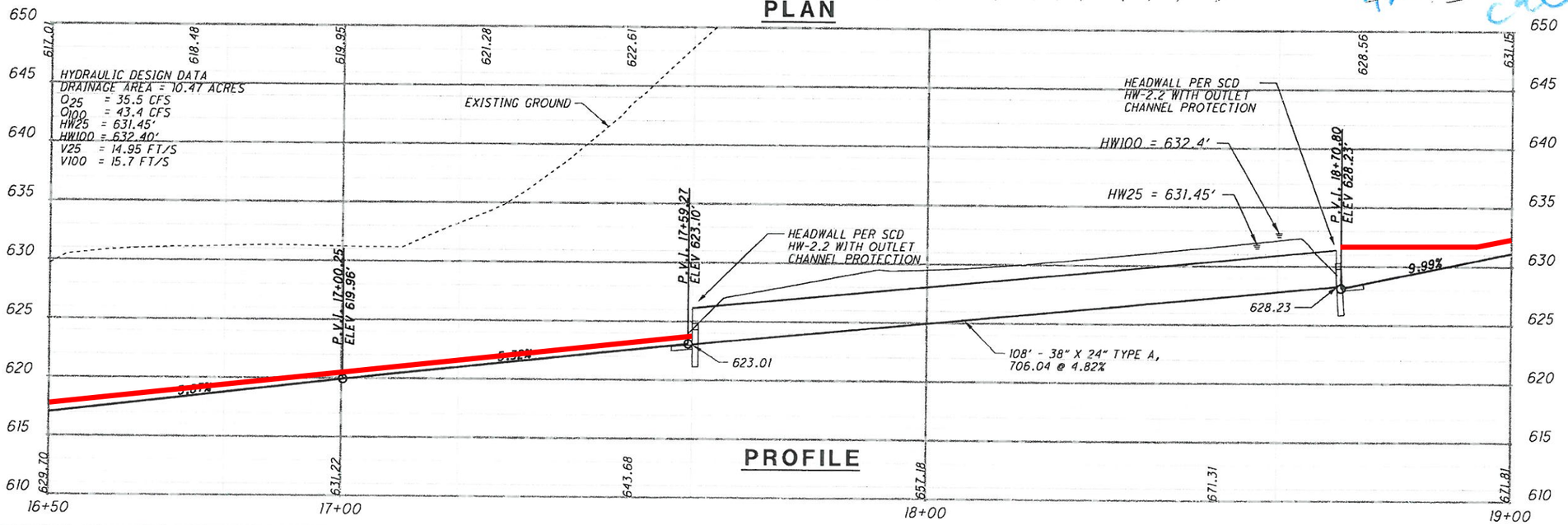


PROFILE

TW=620+0.97
=620.97

TW=631.45 Culvert
from
calc.

NO.	REVISIONS	DATE
A	FINAL SUBMITTAL	03/10/2011
B	FINAL SUBMITTAL TO ODOT	04/19/2011
C	FINAL SUBMITTAL - RESUBMIT 1	05/26/2011
D	FINAL SUBMITTAL TO ODOT - RESUBMIT 1	07/01/2011
1	APPROVED FOR CONSTRUCTION	09/01/2011

STATE OF OHIO
ERICA JOHNSON
70955
REGISTERED
PROFESSIONAL ENGINEER
11-6-13

DESIGN AGENCY
WALSH HNTB
WALSH CONSTRUCTION

CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

ROADWAY
E 9TH EXTENSION

DRAINAGE DETAILS
CULVERT / DITCH RT. OF E. 9TH ST.
STA. 16+50 TO STA. 19+00

CUY-90-14.90

HORIZONTAL SCALE IN FEET
0 5 10 20

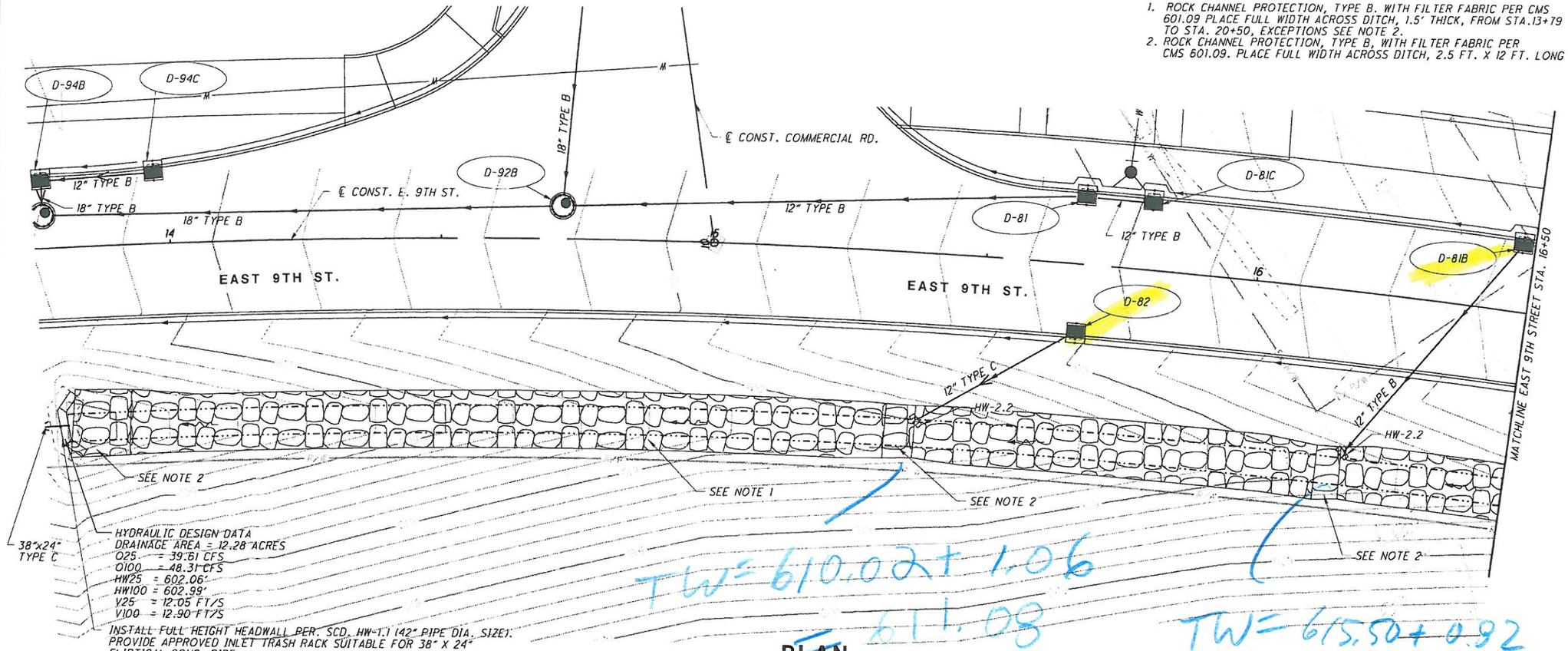
DWG. NO.
DR-048

DESIGNED PNS
CHECKED KAE

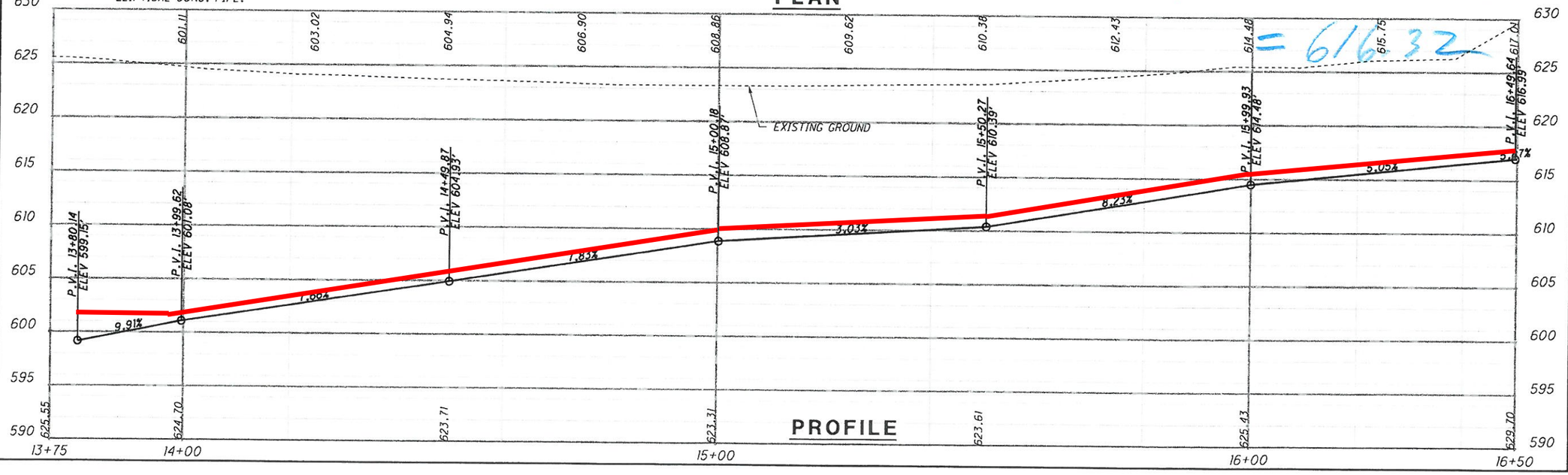
152
252

11/6/2013 8:29:03 AM
Model:Sheet2
File:496.33-S-RD-DR05.dgn

NOTES:
1. ROCK CHANNEL PROTECTION, TYPE B. WITH FILTER FABRIC PER CMS 601.09 PLACE FULL WIDTH ACROSS DITCH, 1.5' THICK, FROM STA.13+79 TO STA. 20+50, EXCEPTIONS SEE NOTE 2.
2. ROCK CHANNEL PROTECTION, TYPE B, WITH FILTER FABRIC PER CMS 601.09. PLACE FULL WIDTH ACROSS DITCH, 2.5 FT. X 12 FT. LONG



PLAN



PROFILE

NO.	REVISIONS	DATE
A	FINAL SUBMITTAL	03/01/2011
B	FINAL SUBMITTAL TO ODOT	04/19/2011
C	FINAL SUBMITTAL - RESUBMIT 1	05/25/2011
D	FINAL SUBMITTAL TO ODOT - RESUBMIT 1	07/01/2011
1	APPROVED FOR CONSTRUCTION	09/01/2011

STATE OF OHIO ERICA L JOHNSON 70955 REGISTERED PROFESSIONAL ENGINEER
11-6-13

DESIGN AGENCY: WILSH HNTB

CONSULTANT: VANVERBELT BRIDGE

ROADWAY
E 9TH EXTENSION

DRAINAGE DETAILS
DITCH RT. OF E.9TH ST.
STA.13+75 TO STA.16+50

HORIZONTAL SCALE IN FEET
0 5 10 20

CUY-90-14.90

DWG. NO. DR-047

DESIGNED PNS
CHECKED KAE

151
252

11/6/2013 8:28:59 AM
Model:Sheet1
File:196335-SHD-DR05.dgn

Allowable Shear Stress	
RCP Type	τ_a lbs/ft^2
B	6
C	4
D	2

Type C downstream of driveway and Type B upstream is sufficient. see CDSS calcs.

C. Type B or C RCP may be utilized for lining ditches on steep grades (slopes from 10%- 25%) that carry flow from the end of a cut section down to the valley floor. Use HEC-15 procedures with a safety factor of 1.5 for steep gradient channels (refer to HEC-15).
Contact OHE for further guidance of RCP usage for 5-year discharges greater than or equal to 50 cfs.

D. Tied concrete block mat protection (601) may be used for slopes and swales with 2:1 or flatter side slopes with profile grades at 25% or less. The matting may be used within the clear zone provided that the top of the blocks are flush with the finished grade. Install per the manufacturers recommendations. The allowable shear stress for each type is shown in table 1102-2.

Table 1102-2
Tied Concrete Block Mat Shear Stress

Type	Allowable Shear Stress (lbf/ft^2)
1	3
2	5
3	7

E. Articulating concrete block revetment system (601) may be used for slopes and channels with 2:1 or flatter side slopes. The revetment may be used within the clear zone provided that the top of the blocks are flush with the finished grade. Install per the manufacturers recommendations. The allowable shear stress for each type is shown in table 1102-3.

Table 1102-3
Articulating Concrete Block Revetment System Shear Stress

Type	Allowable Shear Stress (lbf/ft^2)
1	17
2	20
3	23

F. A concrete lining should be considered only as a last resort. Contact OHE, before using a concrete lining.

1102.3.3 Roughness

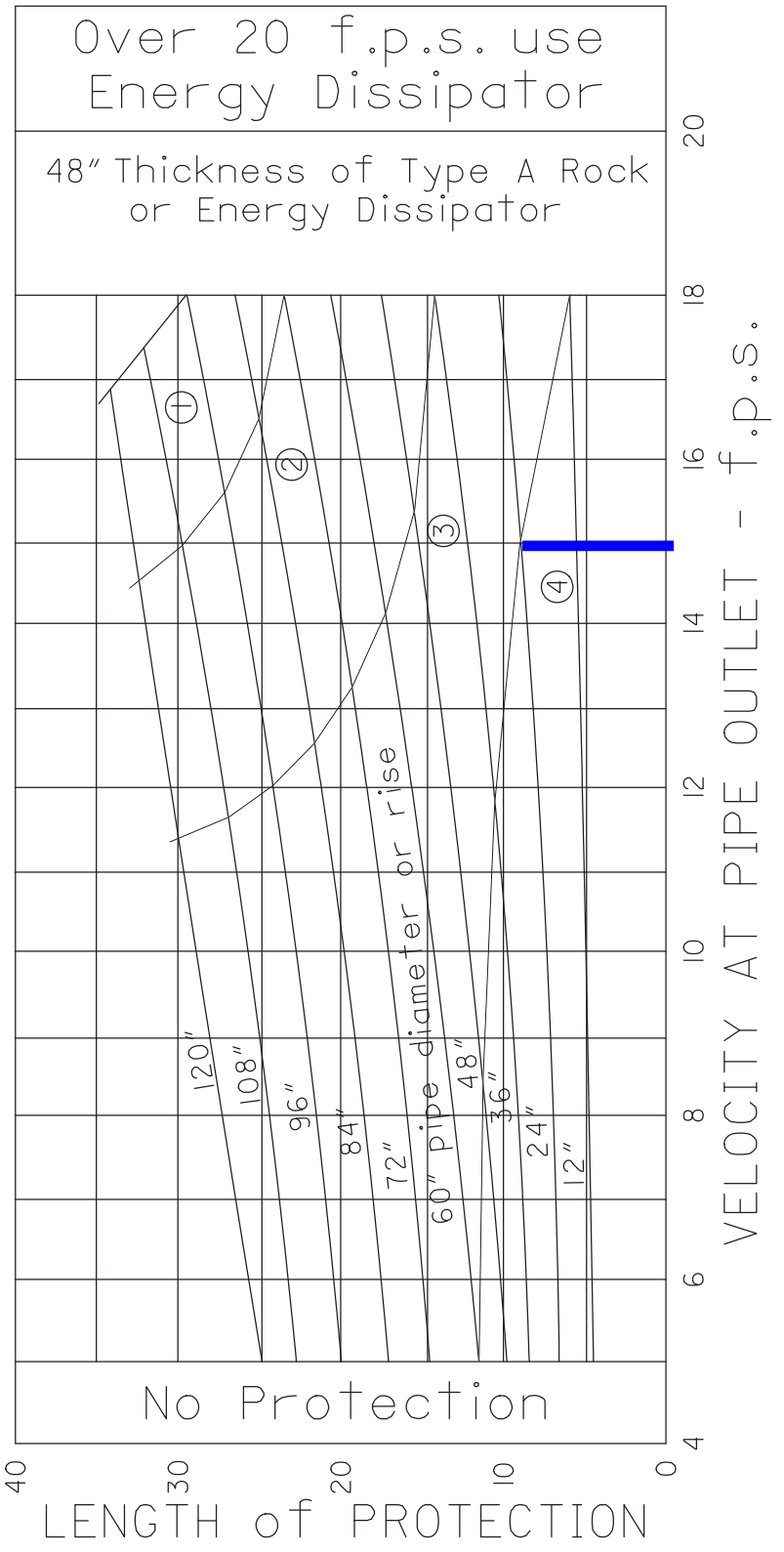
Suggested values for Manning's Roughness Coefficient "n" for the various types of open water carriers are listed in Table 1102-3.

Per the culvert analysis in the prior pages the culvert velocity along the E9th Right Ditch have a maximum of 15 ft/s. The length of protection is the entire ditch and meets the required length shown below for each culvert. The rock type placed in the field visually meets the D50 sizes for type B and C. The plans indicate the location of the Type B and Type C.

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1107-1

REFERENCE SECTION
1107.2



ROCK TYPE
LEGEND
①48" of 18" rock A
②36" of 18" rock A
③30" of 12" rock B
④18" of 6" rock C

NOTES

Rock size (6", 12", 18") indicates the square opening on which 85% of the material, by weight, will be retained.

The width of protection shall be the width of the headwall, with 4' being the minimum.

(Where a stream bed will withstand the calculated velocity without erosion, no rock channel protection will be required.)

APPENDIX E

June 23, 2011

Mr. Richard Switalski, P.E.
Administration Bureau Manager
Division of Engineering & Construction
601 Lakeside Ave, Room 518
Cleveland, OH 44114-1067

Re: CUY–90–14.90
Cleveland Innerbelt Bridge Project
Maintenance of Drainage Facilities

Dear Mr. Switalski:

We are writing to inform you of the drainage facilities to be constructed under the Innerbelt Bridge Project which the City will own and maintain. We also want to inform you of the maintenance activities necessary for these facilities as requested by Mr. Ben Stock of your Division staff.

One drainage facility is a 660-foot long vegetated swale along new E. 9th Street extended, between Canal Road and the GCRTA railway. This swale has a bottom width of five feet, a 3:1 back-slope, a 3:1 to 6:1 fore-slope, and a longitudinal slope of four to seven percent. The bottom of the swale will be lined with a permanent turf reinforcement mat (TRM). The swale bottom and side slopes will be restored in a low-growing native grass mixture. Neither the bottom nor side slopes of the swale should need mowing. However, the following maintenance activities should be carried out:

1. Annual inspections to detect and remove weeds and woody growth.
2. Frequent inspection to detect and remove trash from the swale and any trash that has accumulated on the trash rack at the downstream end.
3. Frequent inspection to observe and remedy the structural integrity of the trash rack and sewer inlet at the downstream end.
4. Frequent inspection to detect and remedy significant erosion that has occurred, and significant accumulation of sediment that has occurred.
5. Pesticides and fertilizer should be used in moderation, and only if needed to establish or maintain dense vegetation.
6. If mowing is necessary, remove cut vegetation to prevent clogging of the trash rack at the downstream end.

It is our understanding that the City must yet determine which division will be responsible for maintenance of the vegetated swale.

The other drainage facilities which the City will own and maintain are two manufactured stormwater treatment devices, Unistorm Vaults by Environment 21, located in the vicinity of E 9th St Extended and Canal Road. Maintenance activities recommended for these devices by the manufacturer consist of, in general, periodic inspection and cleaning. A copy of the

manufacturer's recommended maintenance plan for the Unistorm Vault is attached to this letter, and can be found on the manufacturer's website at www.env21.com.

It is our understanding that Division of Water Pollution Control will be responsible for maintenance of the two manufactured stormwater treatment devices, and the contact person in this division is Mr. Elie Ramy.

Please inform us of the division and contact person that will be responsible for maintenance of the E. 9th Street swale, so this information can be included on our Drainage Design Report for the E. 9th Street Roadway Package of the Project. Please call if you have any questions concerning this matter.

Sincerely,

Kenneth Fertal, PE, PS
Roadway Design Manager
Cleveland Innerbelt Bridge Project

Enclosure

Copy: Benjamin Stock - Division of Engineering & Construction
Elie Ramy, Division of Water Pollution Control

UNISTORM SYSTEM MAINTENANCE

1.0 UNISTORM DESCRIPTION

1.1 The UniStorm is a precast concrete structure. It is available in different configurations (e.g., with an at grade inlet grate, flow control, etc.) and with different attachments (e.g., flow control vanes, flow diffusers, etc.).

1.2 The UniStorm System consists of stages of treatment separated by a precast concrete baffle walls. The baffle walls are designed to meet site-specific flow requirements and provide four functions:

(a) Removes floatables and sediment in the inlet stage

(b) Provides a low head loss flow path between the first and second stages

(c) Provides for additional sediment removal in the second stage.

(d) Provides flow control either with vanes mounted on the upstream side of the baffle wall or through diversion baffles.

1.3 The UniStorm Systems are manufactured from standard precast concrete components. These components are designed to reduce the weight that needs to be handled during shipment and installation.

1.4 Normal water depth in the UniStorm System structure sump will be 3-6 ft dependent on the project requirements. This shallow sump reduces excavation costs and the depth to be accessed from a standard vacuum truck (13' lift).

1.5 Cast iron access frames vented covers, or hatches are provided in the UniStorm System roof to make the sediment pile readily accessible for measurement and cleaning in each stage of the structure.

1.6 Standing water tends to be an attraction for mosquitoes to use as a breeding ground, therefore Environment 21, LLC recommends using solid covers with gaskets or bio-safe mosquito tablets or a combination of both.

2.0 POLLUTANT STORAGE CAPACITY AND CLEANOUT FREQUENCY

2.1 The recommended maintenance practice for the UniStorm System is to plan on quarterly inspections and an annual pump-out based on the following general design guidelines:

2.1.1 Sediment Sump -- the rate at which sediment is accumulated will depend on land use and other pavement activities (e.g., heavy winter sanding will create extra sediment, while regular sweeping will reduce accumulation). The UniStorm System structure sump is designed to store an average sediment pile depth of up to 1.0 ft. Environment 21 recommends that the sediment should be removed when the first-stage sediment pile depth is 6"-12"

2.1.2 Floatables Chambers -- oil sheen and floating debris will be retained in the inlet stage of the UniStorm System. Annual accumulation of floatables is estimated at less than 0.50 inches but can vary depending on land use.

2.1.3 During the first one to two years of operation, Environment 21 recommends visual inspections in January, April, July, and October. This inspection schedule may be modified in subsequent years according to experience or to meet specific stormwater permit requirements.

2.1.4 Refer to the Environment 21 system specific design package for the estimated maintenance interval or call 1-800-809-2801.

3.0 SAFETY

3.1 Safety is a priority and the following are recommended guidelines while performing maintenance on UniStorm Systems. These guidelines are not all-inclusive and by no means are they meant to usurp any safety program already in place for the individuals performing the maintenance on the UniStorm System.

3.1.1 The UniStorm System is a confined space structure but entry into it is not required and is not recommended by

Environment 21, LLC. The design of the UniStorm System is such that all of the maintenance may be completed without entry. In the remote chance that entry into the UniStorm System structure is required only trained, qualified workers with the proper Personal Protective Equipment (PPE) should perform the entry.

3.1.2 The UniStorm System has cast iron access frames with covers which provide access to all stages of the UniStorm system. The openings are normally at ground level so the work area should be staged properly with safeguards to prevent anyone or anything from inadvertently falling through an opening in the UniStorm System structure. The access openings provided are usually sized at 24" or 30", dependent on the diameter of the structure, and conform to ASTM C478 specifications.

3.1.3 After maintenance has been completed on the UniStorm System, the area should be cleared of slip and trip hazards and the cast iron covers set securely in place.

4.0 FLOATABLES OBSERVATION AND MEASUREMENT

4.1 Maintain an inventory all tools and equipment used for completion of this procedure.

4.2 Obtain a flood light and a measuring rod (increments in inches marked on the rod). The measuring rod must be of a length that will reach the floor of the UniStorm System structure and still extend a minimum of 2' above the cast iron access frame. The rod should not bend.

4.3 Set up the work area using proper safety procedures, equipment (e.g., barricades) and PPE as required.

4.4 Carefully remove the cast iron covers using proper lifting and rigging equipment; set the covers off to the side in a safe area and safe configuration (e.g., not suspended).

4.5 Illuminate the water surface in the inlet stage of the UniStorm System with the flood light.

4.6 Gently stir the floatables to estimate the depth. Obtain a sample of the floatables, water, or sediment, if required, for waste disposal. The depth of the oil sheen and floating debris will typically be less than one inch and can be skimmed from the surface prior to the pump-out of the sediment. Organic debris that has become waterlogged and settled to the floor is expected to be present in relatively small quantities that will be removed during the pump out of the mineral sediment.

4.7 Inspect all surfaces, which can be seen, of the UniStorm System structure for wear (e.g., cracking, spalling, etc.). Report signs of degradation to the proper authorities (i.e., owner, municipality, etc.).

4.8 Repeat steps 4.6 and 4.7 for any other stages of the UniStorm System.

5.0 SEDIMENT PILE DEPTH MEASUREMENT

5.1 Complete section 4.0 of this procedure prior this section.

5.2 Lower the measuring rod (from step 4.2) into the inlet stage of the UniStorm System structure until a slight resistance to movement occurs; the rod is now at the top of the sediment pile. Obtain a sight measurement by sighting the rod measuring increments to a point on the cover frame.

5.3 Twist the measuring rod into the sediment pile until the measuring rod is on the floor (verify the expected level using project submittal drawings). Obtain a sight measurement by sighting the rod increments to the same point on the access frame as was used in step 5.2. Subtract the smaller number from the larger number as obtained in this step and step 5.2. For example, if the measurement in step 5.2 is 8' 0" and the measurement in step 5.3 is 8' 3" subtract the 8' 0" from the 8' 3". The resultant 3" is the sediment depth of the UniStorm Manhole.

5.4 Repeat steps 5.2 and 5.3 for any other stages of the UniStorm System.

5.5 If pump-out of the UniStorm System is required and will occur immediately go to Section 6.0 of this procedure; if not go to Section 7.0 of this procedure.

6.0 PUMP-OUT OF THE UNISTORM SYSTEM

6.1 Contact the following for approval and notification of the intent to pump out the UniStorm System:

6.1.1 Owner

6.1.1.1 Obtain permission from the Owner to pump out the contents of the UniStorm System.

6.1.2 Waste Disposal Facility

6.1.2.1 Facilities used by the local Highway Department may be acceptable, while, for industrial sites, the pumper truck contents should be delivered to a disposal site approved by the owner of the industrial site and disposed of in accordance with local requirements for disposal of pollutants.

6.1.2.2 Obtain permission to deliver the waste to the facility.

6.1.3 Government Agencies

6.1.3.1 Obtain permission, as required, from local, State and Federal Agencies.

6.2 Obtain a standard truck-mounted sewer and catch basin cleaner with positive displacement rotary lobe vacuum pumps or other acceptable pump-out equipment.

6.3 If the area was secured after the inspection and Section 7.0 was performed complete steps 4.2 and 4.3 of this procedure.

6.4 Using the truck-mounted sewer and catch basin cleaner, suction the floatables and hydrocarbons from the inlet stage. Segregate this waste from the sediment and water as required by the local regulations and the waste facility.

6.5 Using the truck-mounted sewer and catch basin cleaner, suction the standing water and sediment from the inlet stage. Segregate this waste from the hydrocarbons and floatables as required by the local regulations and the waste facility.

6.6 Using the water supply from the vacuum truck wash down the interior surface of the UniStorm system and suction any waste and water from the bottom of the structure.

6.7 Repeat steps 6.4 through 6.6 for any other stages of the UniStorm System.

6.8 Using a flood light inspect all surfaces, which can be seen, of the UniStorm System structure for wear (e.g., cracking, spalling, etc.). Report signs of degradation to the proper authorities (i.e., owner, municipality, etc.).

6.9 Refill the UniStorm System, with clean water, to the inlet/outlet pipe invert elevation.

6.10 Properly dispose of the waste removed from UniStorm System as pre-arranged

7.0 SECURING THE AREA

7.1 Verify that no personnel, tools or equipment are in the UniStorm System structure.

7.2 Inspect the cast iron access frames and covers for damage (e.g., cracks, excessive wear, etc.).

7.3 Clear the cast iron access frames of any extraneous material and carefully replace the cast iron covers using proper lifting and rigging equipment. Verify that the covers are properly seated.

7.4 Remove the site set-up (tools, equipment, etc.) and verify the work area has been returned to its pre-work condition.

7.5 Complete an inventory of all tools and equipment used for this work, accounting for lost, damaged, or stolen tools or equipment.

8.0 RECORD KEEPING

8.1 Maintenance is a very important aspect in keeping the UniStorm System performance up to par. The attached "UNISTORM SYSTEM MAINTENANCE DATA SHEET" is provided and should be used to document the maintenance performed on the UniStorm System.

8.2 Provide a copy of the "UNISTORM SYSTEM MAINTENANCE DATA SHEET" to the owner, required government agencies, and Environment 21, LLC (P.O. Box 55, East Pembroke, NY 14056-1055.

environment 21
Global Stormwater Solutions
P.O. Box 55 | East Pembroke | NY 14056
Phone: 1-800-605-2801 | Fax: 1-585-810-4701
www.env21.com | enveng@env21.com

Technology That Separates

UNISTORM SYSTEM MAINTENANCE DATA SHEET

STRUCTURE NO.:_____ **LOCATION:**_____

OWNER:_____ **UNISTORM MODEL**_____

DATE INSTALLED:_____ **MUNICIPALITY:**_____

DATE	SEDIMENT PILE DEPTH	OIL SHEEN YES/NO	FLOATABLE DEPTH	PUMPOUT REQ. YES/NO	SAMPLED YES/NO	SAMPLE RESULTS

PUMPOUT DATA (IF APPLICABLE)

DATE	SEDIMENT VOLUME REMOVED	FLOATABLES VOLUME REMOVED	SEDIMENT/FLOATABLE DISPOSAL INFORMATION:	
			WHERE DISPOSED	HOW DISPOSED

environment
Global Stormwater Solutions
P.O. Box 55 | East Pembroke | NY 14056
Phone: 1-800-673-2391 Fax: 1-585-815-4701
www.env21.com | enveng@env21.com

Technology That Separates

PRIOR TO START OF WORK

OWNER NOTIFIED AS REQUIRED. ☐

GOVERNMENT AGENCIES NOTIFIED AS REQUIRED. ☐

DISPOSAL SITE CONTACTED (IF PUMPOUT IS REQUIRED.) ☐

ALL REQUIRED PPE, TOOLS, AND EQUIPMENT ARE AVAILABLE AND IN GOOD WORKING ORDER. ☐

AFTER WORK COMPLETION

ANY SIGNS OF WEAR NOTED AND REPORTED IF NECESSARY ☐

UNISTORM SYSTEM HAS BEEN FILLED WITH CLEAN WATER ☐

ALL CAST IRON COVERS HAVE BEEN PROPERLY REPLACED. ☐

NO HAZARDOUS CONDITIONS EXIST AS A RESULT OF THE MAINTENANCE WORK. ☐

ALL PPE, TOOLS, AND EQUIPMENT HAVE BEEN INVENTORIED AND REMOVED FROM THE SITE. ☐

THE WORK AREA HAS BEEN RETURNED TO A SAFE PRE-WORK CONDITION. ☐

ALL NOTIFICATIONS HAVE BEEN MADE, AS REQUIRED, THAT THE WORK IS COMPLETED. ☐

DATE: _____ **SIGNATURE:** _____

APPENDIX F

Bridge Deck Drainage Calculations Summary

For Bridge - (BL-13)

BL-13

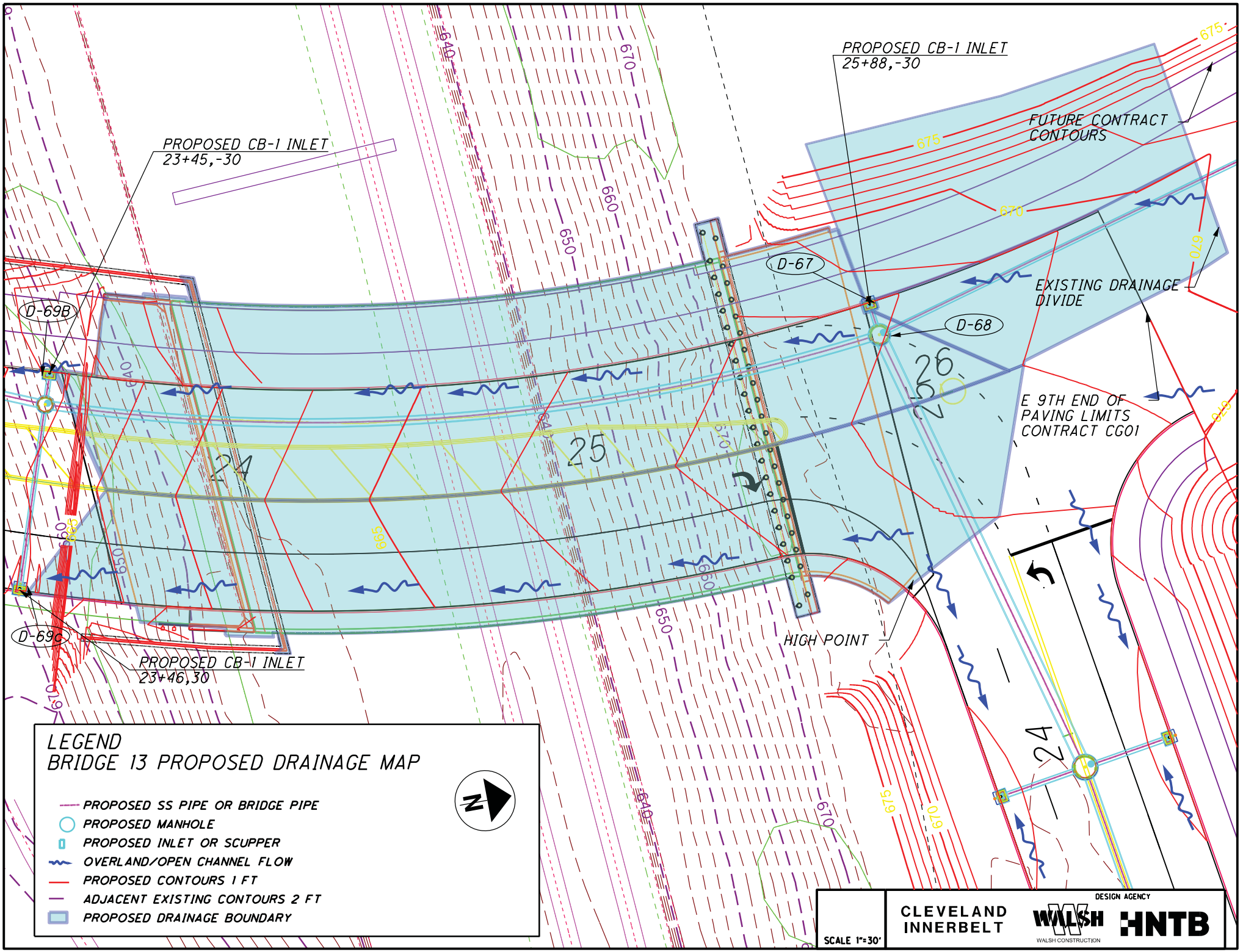
Bridge 13 is the proposed East 9th St bridge over the GCRTA from Sta. 23+98 to Sta. 25+50. This is new construction and there is no existing bridge.

The proposed bridge is 155 ft long, 94 ft wide, contains 2-12ft north bound lanes, 1-12ft southbound lane, and a variable painted median strip. Both directions contain a 3.75 ft shoulder. The bridge traveled way is 60 ft wide, has a 22.5 ft sidewalk terrace on the southbound side, and a 6 ft terrace on the northbound side. A crown is located at the midpoint of the traveled way. The bridge cross slope is a constant 1.6% slope crowned in the center of the traveled way, and a has variable longitudinal slope. At the forward abutment this slope is 2.0% and at the rear abutment is 4.1%.

No suppers are proposed for the bridged. An inlet is proposed upstream of the forward abutment approach slab located at Station 25+88, 29.75 LT. Beyond the rear abutment approach slab an inlet is proposed on each side of the traveled way, at Station 23+45, 29.75 LT and 30.50 RT. The cross slope of the upstream and both downstream inlets are 1.6%. Both downstream inlets have a longitudinal slope of 5.53% and the upstream inlet has a longitudal slope of 2.21%. Because of the variable longitudinal slope, a conservative approach of using the forward abutment slope of 2.0% was used on the downstream inlets. This actual slope of these inlets is 5.53%.

Spread was analyzed for the future condition (there is no interim condition) using the 2 yr ODOT design storm based on L&D Volume II Section 1103.2. Since the ADT is less than 9,000, the spread is not to exceed 6 ft into the first traveled lane. With a 3.75 ft shoulder along the bridge and 12 ft adjacent lanes, the allowable spread is 9.75 ft in each direction. Both upstream and downstream inlets contain a 1ft shoulder allowing a maximum spread of 7 ft. The bypass flow will travel down 9th to the next inlet.

Design calculations for the storm sewer system can be found in the East 9th Roadway package drainage report Appendices.


PROPOSED CB-1 INLET
23+45,-30
PROPOSED CB-1 INLET
25+88,-30
FUTURE CONTRACT CONTOURS
EXISTING DRAINAGE DIVIDE
D-69B
D-67
D-68
D-69C
PROPOSED CB-1 INLET
23+46,30
HIGH POINT
E 9TH END OF PAVING LIMITS CONTRACT CG01
24
25
26
LEGEND
BRIDGE 13 PROPOSED DRAINAGE MAP
PROPOSED SS PIPE OR BRIDGE PIPE
PROPOSED MANHOLE
PROPOSED INLET OR SCUPPER
OVERLAND/OPEN CHANNEL FLOW
PROPOSED CONTOURS 1 FT
ADJACENT EXISTING CONTOURS 2 FT
PROPOSED DRAINAGE BOUNDARY
N
SCALE 1"=30'
CLEVELAND INNERBELT
DESIGN AGENCY
WALSH CONSTRUCTION
HNTB

HNTB

	Made by: pns	Date: 5/27/2011	Use spread equation from 1986 FHWA Bridge Deck Drainage Guidelines.
	Checked by: bh	Date: 5/27/2011	Use E=1-(1-w/t)^2.67*Q per HEC 12 for determining inlet intercept flow.
			where w = scupper width (ft), and t = design spread (ft).
East 9th Street			n = 0.015 Allowable Spread is spread that is less than the shoulder width+6 ft

BRIDGE 13 DECK DRAINAGE CALCULATIONS (ODOT 2 YR RAINFALL)

LOCATION										GUTTER ANALYSIS										INLET ANALYSIS			
Station	offset (feet)	Side	Area (A) (acres)	Runoff Coeff (C)	CA	Total CA	T (min.)	I (in/hr)	Q (cfs)	L-Sl. (ft/ft)	X-Sl. (ft/ft)	By-Pass (cfs)	Total Q (cfs)	Y (ft)	Lane Width (ft)	Shoulder Width (ft)	Allowed Spread in traffic lane (ft) L&D V.II Table 1103-1	Total Allowable Spread (ft)	Spread (t) (ft)	Inlet Width (w) (ft)	Inlet Intercept Flow (E) (cfs)	By-Pass (cfs)	By-Pass %
25+88 proposed CB-1 inlet D-67	29.75	LT	0.09 0.06	0.7 0.9	0.063 0.054	0.117	10	3.6	0.421	0.0221	0.0160	0.000	0.421	0.081	12.000	1.000	6.000	7.00	5.06	1.50	0.257	0.165	39%
							Spread is less than allowable OK																
23+45 proposed CB-1 inlet D-69B	29.75	LT	0.28	0.9	0.252	0.252	10	3.6	0.907	0.0200	0.0160	0.165	1.072	0.117	12.000	3.000	6.000	9.00	7.31	1.50	0.491	0.580	54%
							Spread is less than allowable OK																
23+45 proposed CB-1 inlet D-69C	30.50	RT	0.22	0.9	0.198	0.198	10	3.6	0.713	0.0200	0.0160	0.000	0.713	0.100	12.000	1.000	6.000	9.75	6.27	1.50	0.369	0.344	48%
							Spread is less than allowable OK																

HNTB

	Made by: pns	Date: 5/27/2011	Use spread equation from 1986 FHWA Bridge Deck Drainage Guidelines.
	Checked by: bh	Date: 5/27/2011	Use E=1-(1-w/t)^2.67*Q per HEC 12 for determining inlet intercept flow.
			where w = scupper width (ft), and t = design spread (ft).
East 9th Street			n = 0.015 Allowable Spread is spread that is less than the shoulder width+6 ft

BRIDGE 13 DECK DRAINAGE CALCULATIONS (ODOT 10 YR RAINFALL CHECK)

LOCATION										GUTTER ANALYSIS										INLET ANALYSIS			
Station	offset (feet)	Side	Area (A) (acres)	Runoff Coeff (C)	CA	Total CA	T (min.)	I (in/hr)	Q (cfs)	L-Sl. (ft/ft)	X-Sl. (ft/ft)	By-Pass (cfs)	Total Q (cfs)	Y (ft)	Lane Width (ft)	Shoulder Width (ft)	Allowed Spread in traffic lane (ft) L&D V.II Table 1103-1	Total Allowable Spread (ft)	Spread (t) (ft)	Inlet Width (w) (ft)	Inlet Intercept Flow (E) (cfs)	By-Pass (cfs)	By-Pass %
25+88 proposed CB-1 inlet D-67	29.75	LT	0.09 0.06	0.7 0.9	0.063 0.054	0.117	10	5.1	0.597	0.0221	0.0160	0.000	0.597	0.092	12.000	1.000	6.000	7.00	5.76	1.50	0.330	0.267	45%
							Spread is less than allowable OK																
23+45 proposed CB-1 inlet D-69B	29.75	LT	0.28	0.9	0.252	0.252	10	5.1	1.285	0.0200	0.0160	0.267	1.552	0.134	12.000	3.000	6.000	9.00	8.40	1.50	0.634	0.918	59%
							Spread is less than allowable OK																
23+45 proposed CB-1 inlet D-69C	30.50	RT	0.22	0.9	0.198	0.198	10	5.1	1.01	0.0200	0.0160	0.000	1.010	0.114	12.000	1.000	6.000	9.75	7.15	1.50	0.471	0.538	53%
							Spread is less than allowable OK																

APPENDIX G

HNTB

Made by: BH Date: 5-27-11
Checked by: PS Date: 5-27-11

Job Number: 49633

Cleveland Innerbelt East Bank Pre and Post Drainage Areas and Runoff Coefficients

CN, Curve Number	88	77	98	98	74	94			
C, Rational Coefficient	0.7	0.50	0.9	0.9	0.3	0.8			
Outfall Terrain Description	Fair cond. ROW grass - steep slopes	Fair cond. ROW grass	Pavement	Parking Lot	Woods	Industrial/ Commercial	Area	CN	C
Commercial Combined Sewer Existing	4.43		2.14				6.57	91	0.77
Commercial Combined Sewer Proposed	1.80		1.48				3.28	93	0.79
ODB-01 Existing		0.05	0.39				0.44	96	0.85
ODB-01 Proposed (Composit of AD-ODB01 & ODB01B)			0.38				0.38	98	0.90
ODB-02 Existing		1.07	0.24				1.31	81	0.57
ODB-02 Proposed		0.99	0.25				1.24	81	0.58
ODB-03 Existing		0.40	0.26				0.66	85	0.66
ODB-03 Proposed (Composite of AD-ODB03, ODB03A & ODB03B-1)		0.28	0.42				0.70	90	0.74
ODB-04 Existing		0.00	0.08				0.08	98	0.90
ODB-04 Proposed		0.00	0.08				0.08	98	0.90
ODB-05 Existing		0.21	0.21				0.42	88	0.70
ODB-05 Proposed		0.19	0.31				0.50	90	0.75
ODB-06 Existing		0.26	0.37				0.63	89	0.73
ODB-06 Proposed		0.32	0.24				0.56	86	0.67
ODB-07 Existing		0.20	0.37				0.57	91	0.76
ODB-07 Proposed		0.48	0.00				0.48	77	0.50
ODB-08 Existing		0.03	0.20				0.23	95	0.85
ODB-08 Proposed		0.19	0.00				0.19	77	0.50
ODB-09 Existing		0.79	0.29				1.07	83	0.61
ODB-09 Proposed		0.68	0.32				1.00	84	0.63
ODB-10 Existing		0.07	0.21				0.28	93	0.80
ODB-10 Proposed (Composit of AD-ODB10A & ODB10B)		0.04	0.32				0.36	96	0.86
ODB-11 Existing		0.29	0.14				0.43	84	0.63
ODB-11 Proposed (Composit of AD-ODB11A & ODB11B)		0.23	0.20				0.43	87	0.69
ODB-12 Existing		0.28	0.40				0.68	89	0.74
ODB-12 Proposed		0.28	0.40				0.68	89	0.74
ODB-13 Existing		0.34	0.41				0.75	88	0.72
ODB-13 Proposed		0.32	0.42				0.74	89	0.73
ODB-14 Existing		0.17	0.25				0.42	90	0.74
ODB-14 Proposed		0.17	0.19				0.36	88	0.71
ODB-15 Existing		0.21	0.25				0.46	88	0.72
ODB-15 Proposed		0.13	0.30				0.43	92	0.78
ODB-16 Existing		0.02	0.21				0.23	96	0.86
ODB-16 Proposed - Area goes to proposed storm only sewer		0.00	0.00				0.00	0	0.00
ODB-17 Existing		0.09	0.51				0.60	95	0.84
ODB-17 Proposed - Area goes to proposed storm only sewer		0.00	0.00				0.00	0	0.00
ODB-18 Existing		0.05	0.29				0.34	95	0.85
ODB-18 Proposed - Area goes to proposed storm only sewer		0.00	0.00				0.00	0	0.00
ODB-19 Existing		0.19	0.14				0.33	86	0.67
ODB-19 Proposed		0.33	0.00				0.33	77	0.50

Note: Refer to Figures 5 & 6 for Outfall location

HNTB

Job Number: 49633 Made by: BH Date: 6/29/11
Checked by: PS Date: 6/29/11

Cleveland Innerbelt East Bank Pre and Post Drainage Areas and Runoff Coefficients: TC CALCULATION

Outfall Name	**CCSDB-EX**	**CCSDB-PR**	**ODB-01EX**	**ODB-01PR**	**ODB-02EX**	**ODB-02PR**	**ODB-03EX**	**ODB-03PR**	**ODB-04EX**	**ODB-04PR**	**ODB-05EX**	**ODB-05PR**	**ODB-06EX**	**ODB-06PR**	**ODB-07EX**	**ODB-07PR**	**ODB-08EX**	**ODB-08PR**	**ODB-09EX**
Sheetflow	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Grass	Grass	Grass	Grass	Grass	Grass		Grass	Grass
Runoff Coeffiecient	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.50	0.50	0.50	0.50	0.50	0.50		0.35	0.50
length, ft (<100)	90.00	90.00	50.00	65.00	100.00	100.00	58.00	66.00	100.00	100.00	65.00	49.00	80.00	80.00	100.00	100.00		100.00	100.00
dz, ft	4.25	4.25	0.93	1.20	3.00	3.00	0.97	1.71	2.75	2.75	0.90	0.80	1.00	1.00	0.58	0.58		0.50	20.51
slope	0.05	0.05	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.01		0.01	0.21
Tt, min	2.04	2.04	2.07	2.37	2.50	2.50	2.31	2.13	2.57	2.57	7.81	6.42	8.97	8.97	12.95	12.95		17.01	3.95
Shallow Concentrated	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Grass ROW	Grass ROW	Gutter Flow	Gutter Flow			Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Grass ROW	Gutter Flow	Grass ROW	Grass ROW
length, ft	275.00	275.00	288.00	230.00	240.00	240.00	165.00	197.00			149.00	150.00	120.00	55.00	177.00	177.00	237.00	115.00	364.00
dz, ft	21.00	21.00	1.50	1.78	13.00	13.00	3.00	2.71			0.70	0.70	0.54	0.20	1.50	1.50	0.77	0.42	3.55
slope %	7.64	7.64	0.52	0.77	5.42	5.42	1.82	1.38			0.47	0.47	0.45	0.36	0.85	0.85	0.32	0.37	0.98
Intercept Coefficient, k	0.62	0.62	0.62	0.62	0.46	0.46	0.62	0.62			0.62	0.62	0.62	0.46	0.62	0.46	0.62	0.46	0.46
avg velocity, ft/s	5.62	5.62	1.47	1.79	3.49	3.49	2.74	2.39			1.39	1.39	1.36	0.90	1.87	1.38	1.16	0.91	1.48
Tt, min	0.82	0.82	3.27	2.14	1.15	1.15	1.00	1.38			1.78	1.80	1.47	1.01	1.58	2.14	3.41	2.12	4.10
Pipe Flow																			
length, ft	742.00	742.00																	
dz, ft	59.00	59.00																	
slope %	7.95	7.95																	
Avg Pipe Size	24"	24"																	
avg velocity, ft/s	15.00	15.00																	
Tt, min	0.82	0.82																	
Total Tc, min (3 minute minimum)	3.68	3.68	5.34	4.51	3.64	3.64	3.31	3.51	2.57	2.57	9.59	8.22	10.43	9.98	14.53	15.09	3.41	19.12	8.04
Area, acres	6.57	3.28	0.44	0.38	1.31	1.24	0.66	0.70	0.08	0.08	0.42	0.50	0.63	0.56	0.57	0.48	0.23	0.19	1.07
C weighted	0.77	0.79	0.85	0.90	0.57	0.58	0.66	0.74	0.90	0.90	0.70	0.75	0.73	0.67	0.76	0.50	0.85	0.50	0.61
Intesities, in/hr																			
I 5	5.84	5.84	5.44	5.64	5.85	5.85	5.94	5.89	6.01	6.01	4.39	4.73	4.22	4.29	3.59	3.51	5.91	3.07	4.77
I 10	6.69	6.69	6.20	6.44	6.70	6.70	6.80	6.74	6.89	6.89	4.95	5.35	4.76	4.84	4.06	3.97	6.77	3.48	5.41
I 25	7.64	7.64	7.09	7.36	7.65	7.65	7.76	7.69	7.86	7.86	5.69	6.14	5.46	5.56	4.63	4.53	7.72	4.00	6.20
Flows, cfs																			
Q5	29.36	15.14	2.05	1.93	4.39	4.20	2.59	3.05	0.42	0.42	1.29	1.76	1.95	1.61	1.55	0.85	1.14	0.29	3.11
Q10	33.63	17.34	2.33	2.20	5.03	4.81	2.97	3.49	0.49	0.49	1.46	2.00	2.20	1.82	1.75	0.96	1.30	0.33	3.53
Q25	38.41	19.80	2.67	2.52	5.75	5.49	3.39	3.98	0.55	0.55	1.67	2.29	2.53	2.09	1.99	1.09	1.49	0.38	4.05

HNTB

Made by: BH Date: 6/29/11

Job Number: 49633 Checked by: PS Date: 6/29/11

Cleveland Innerbelt East Bank Pre and Post Drainage Areas and Runoff Coefficients: TC CALCULATION

Outfall Name	**ODB-09PR**	**ODB-10EX**	**ODB-10PR**	**ODB-11EX**	**ODB-11PR**	**ODB-12EX**	**ODB-12PR**	**ODB-13EX**	**ODB-13PR**	**ODB-14EX**	**ODB-14PR**	**ODB-15EX**	**ODB-15PR**	**ODB-16EX**	**ODB-17EX**	**ODB-18EX**	**ODB-19EX**	**ODB-19PR**
Sheetflow	Grass	Pavement	Pavement	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass				Grass	Grass
Runoff Coeffiecient	0.50	0.90	0.90	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50				0.50	0.50
length, ft (<100)	100.00	40.00	53.00	100.00	87.00	100.00	100.00	74.00	74.00	45.00	45.00	25.00	15.00				84.00	84.00
dz, ft	20.51	0.29	0.50	20.33	20.69	20.41	20.41	1.48	1.48	1.10	1.10	0.40	0.30				1.07	1.07
slope	0.21	0.01	0.01	0.20	0.24	0.20	0.20	0.02	0.02	0.02	0.02	0.02	0.02				0.01	0.01
Tt, min	3.95	2.53	2.67	3.96	3.50	3.95	3.95	7.37	7.37	5.38	5.38	4.62	3.32				9.13	9.13
Shallow Concentrated	Grass ROW	Gutter Flow	Gutter Flow	Grass ROW	Gutter Flow	Grass ROW	Grass ROW	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Gutter Flow	Grass ROW
length, ft	364.00	235.00	243.00	121.00	147.00	82.00	82.00	345.00	345.00	190.00	190.00	150.00	125.00	190.00	614.00	350.00	174.00	174.00
dz, ft	3.55	0.58	0.31	0.73	0.37	2.09	2.09	0.69	0.69	0.70	0.70	1.00	0.75	2.25	5.77	3.40	0.62	0.62
slope %	0.98	0.25	0.13	0.60	0.25	2.55	2.55	0.20	0.20	0.37	0.37	0.67	0.60	1.18	0.94	0.97	0.36	0.36
Intercept Coefficient, k	0.46	0.62	0.62	0.46	0.62	0.46	0.46	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.46
avg velocity, ft/s	1.48	1.01	0.73	1.16	1.02	2.39	2.39	0.91	0.91	1.23	1.23	1.66	1.58	2.21	1.97	2.00	1.21	0.90
Tt, min	4.10	3.88	5.57	1.73	2.40	0.57	0.57	6.32	6.32	2.56	2.56	1.51	1.32	1.43	5.19	2.91	2.39	3.24
Shallow Concentrated						Gutter Flow	Gutter Flow											
length, ft						68.00	68.00											
dz, ft						0.43	0.43											
slope %						0.63	0.63											
Intercept Coefficient, k						0.62	0.62											
avg velocity, ft/s						1.62	1.62											
Tt, min						0.70	0.70											
Total Tc, min (3 minute minimum)	8.04	6.41	8.25	5.69	5.90	5.22	5.22	13.69	13.69	7.94	7.94	6.12	4.64	1.43	5.19	2.91	11.52	12.37
Area, acres	1.00	0.28	0.36	0.43	0.43	0.68	0.68	0.75	0.74	0.42	0.36	0.46	0.43	0.23	0.60	0.34	0.33	0.33
C weighted	0.63	0.80	0.86	0.63	0.69	0.74	0.74	0.72	0.73	0.74	0.71	0.72	0.78	0.86	0.84	0.85	0.67	0.50
Intesities, in/hr																		
I 5	4.77	5.17	4.72	5.35	5.30	5.47	5.47	3.72	3.72	4.80	4.80	5.24	5.61	6.01	5.47	6.01	4.06	3.93
I 10	5.41	5.89	5.34	6.10	6.04	6.24	6.24	4.20	4.20	5.44	5.44	5.97	6.41	6.89	6.24	6.89	4.57	4.43
I 25	6.20	6.73	6.13	6.97	6.90	7.13	7.13	4.80	4.80	6.23	6.23	6.83	7.32	7.86	7.14	7.86	5.24	5.07
Flows, cfs																		
Q5	2.98	1.15	1.45	1.46	1.58	2.74	2.74	1.99	2.01	1.49	1.23	1.73	1.88	1.20	2.75	1.72	0.91	0.66
Q10	3.38	1.31	1.64	1.67	1.80	3.12	3.12	2.25	2.27	1.69	1.39	1.97	2.15	1.38	3.14	1.97	1.02	0.74
Q25	3.87	1.50	1.89	1.91	2.06	3.57	3.57	2.57	2.60	1.93	1.59	2.26	2.45	1.57	3.60	2.25	1.17	0.85

SCS CN Volume Detailed Report: Existing Commercial Combined Sewer Annual Year Design Storm

Element Details			
ID	64	Notes	
Label	Existing Commercial Combined Sewer Annual Year Design Storm		

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Existing Pavement	98.000	2.140	100.0	0.0	98.000
Existing Grass (C=0.7)	88.000	4.430	0.0	0.0	88.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	6.570	(N/A)	(N/A)	91.257

COMPUTE RUNOFF VOLUME USING CN
(Cumulative Volume from CN-Areas)

Frequency	1.00 years	Depth	2.40 in

Soil/Surface Description	Adjusted CN	Runoff (in)	Area (acres)	Volume (ac-ft)
Existing Pavement	98.000	2.17	2.140	0.387
Existing Grass (C=0.7)	88.000	1.30	4.430	0.479
TOTAL RUNOFF VOLUME --->	(N/A)	(N/A)	(N/A)	0.866

COMPUTE RUNOFF VOLUME USING CN
(From Composite Weighted CN)

Frequency	1.00 years	Depth	2.40 in

Soil/Surface Description	Adjusted CN	Area (acres)	Runoff (in)	Volume (ac-ft)
Existing Pavement	98.000	2.140	(N/A)	(N/A)
Existing Grass (C=0.7)	88.000	4.430	(N/A)	(N/A)
COMPOSITE RUNOFF VOLUME --->	91.257	6.570	1.52	0.832

SCS CN Volume Detailed Report: Proposed Commercial Combined Sewer Annual Year Design Storm

Element Details			
ID	66	Notes	
Label	Proposed Commercial Combined Sewer Annual Year Design Storm		

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Proposed Pavement	98.000	1.480	100.0	0.0	98.000
Proposed Grass	88.000	1.800	0.0	0.0	88.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	3.280	(N/A)	(N/A)	92.512

COMPUTE RUNOFF VOLUME USING CN
(Cumulative Volume from CN-Areas)

Frequency	1.00 years	Depth	2.40 in

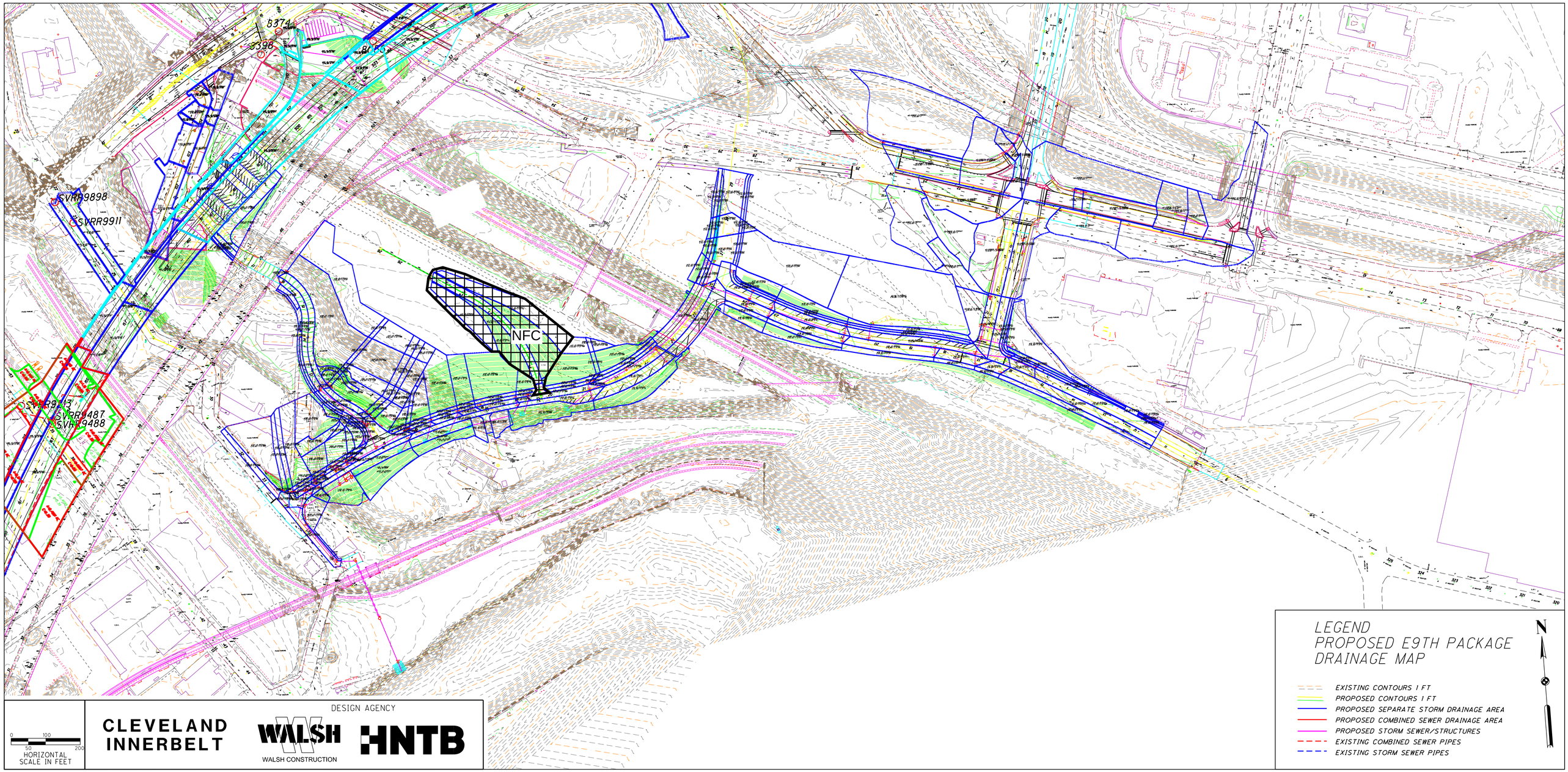
Soil/Surface Description	Adjusted CN	Runoff (in)	Area (acres)	Volume (ac-ft)
Proposed Pavement	98.000	2.17	1.480	0.268
Proposed Grass	88.000	1.30	1.800	0.194
TOTAL RUNOFF VOLUME --->	(N/A)	(N/A)	(N/A)	0.462

COMPUTE RUNOFF VOLUME USING CN
(From Composite Weighted CN)

Frequency	1.00 years	Depth	2.40 in

Soil/Surface Description	Adjusted CN	Area (acres)	Runoff (in)	Volume (ac-ft)
Proposed Pavement	98.000	1.480	(N/A)	(N/A)
Proposed Grass	88.000	1.800	(N/A)	(N/A)
COMPOSITE RUNOFF VOLUME --->	92.512	3.280	1.69	0.461

APPENDIX H



LEGEND
PROPOSED E9TH PACKAGE DRAINAGE MAP

- EXISTING CONTOURS 1 FT
- PROPOSED CONTOURS 1 FT
- PROPOSED SEPARATE STORM DRAINAGE AREA
- PROPOSED COMBINED SEWER DRAINAGE AREA
- PROPOSED STORM SEWER/STRUCTURES
- EXISTING COMBINED SEWER PIPES
- EXISTING STORM SEWER PIPES

N

0 100
50 200
HORIZONTAL SCALE IN FEET

CLEVELAND INNERBELT

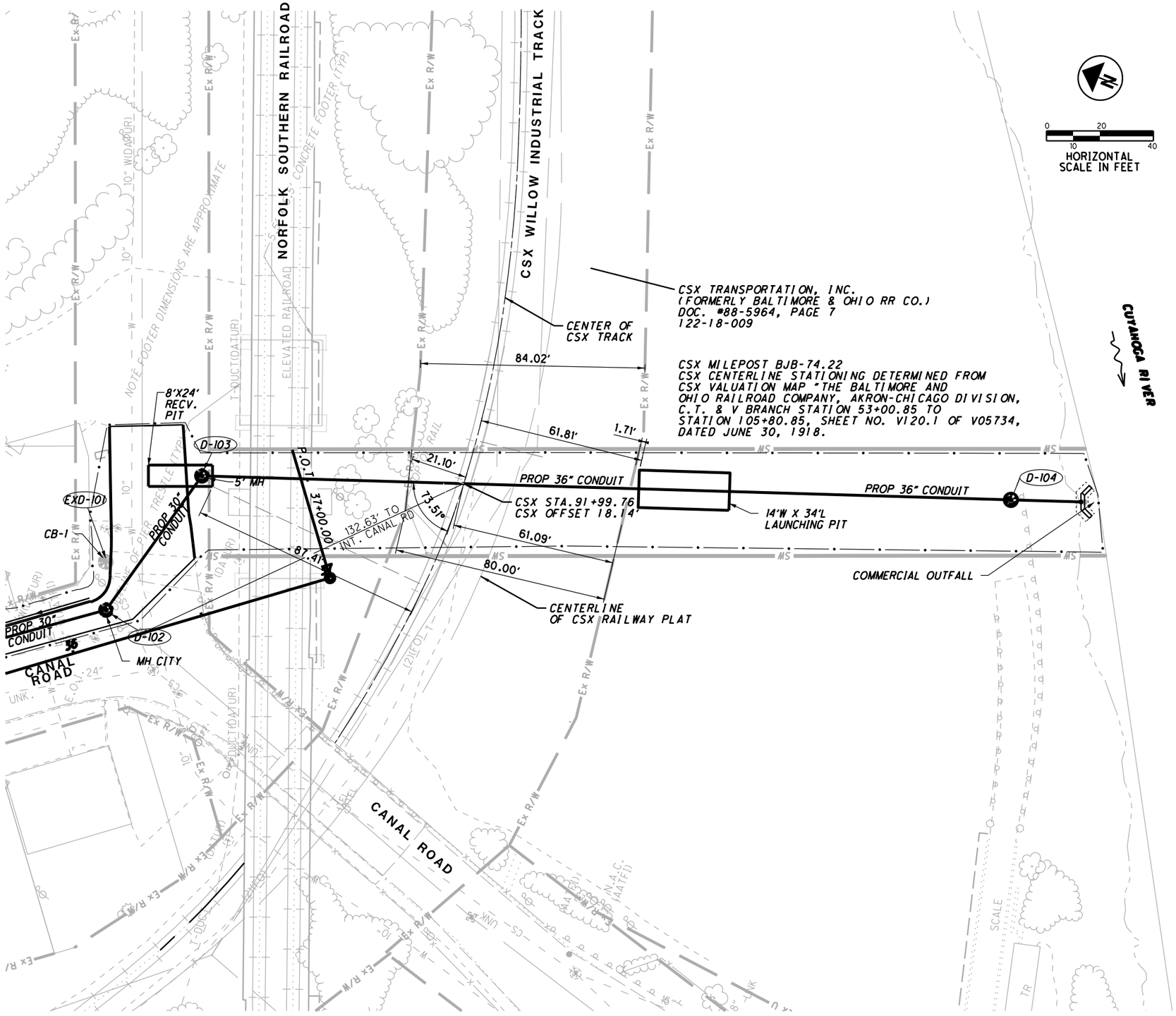
DESIGN AGENCY

WALSH CONSTRUCTION

HNTB

APPENDIX I

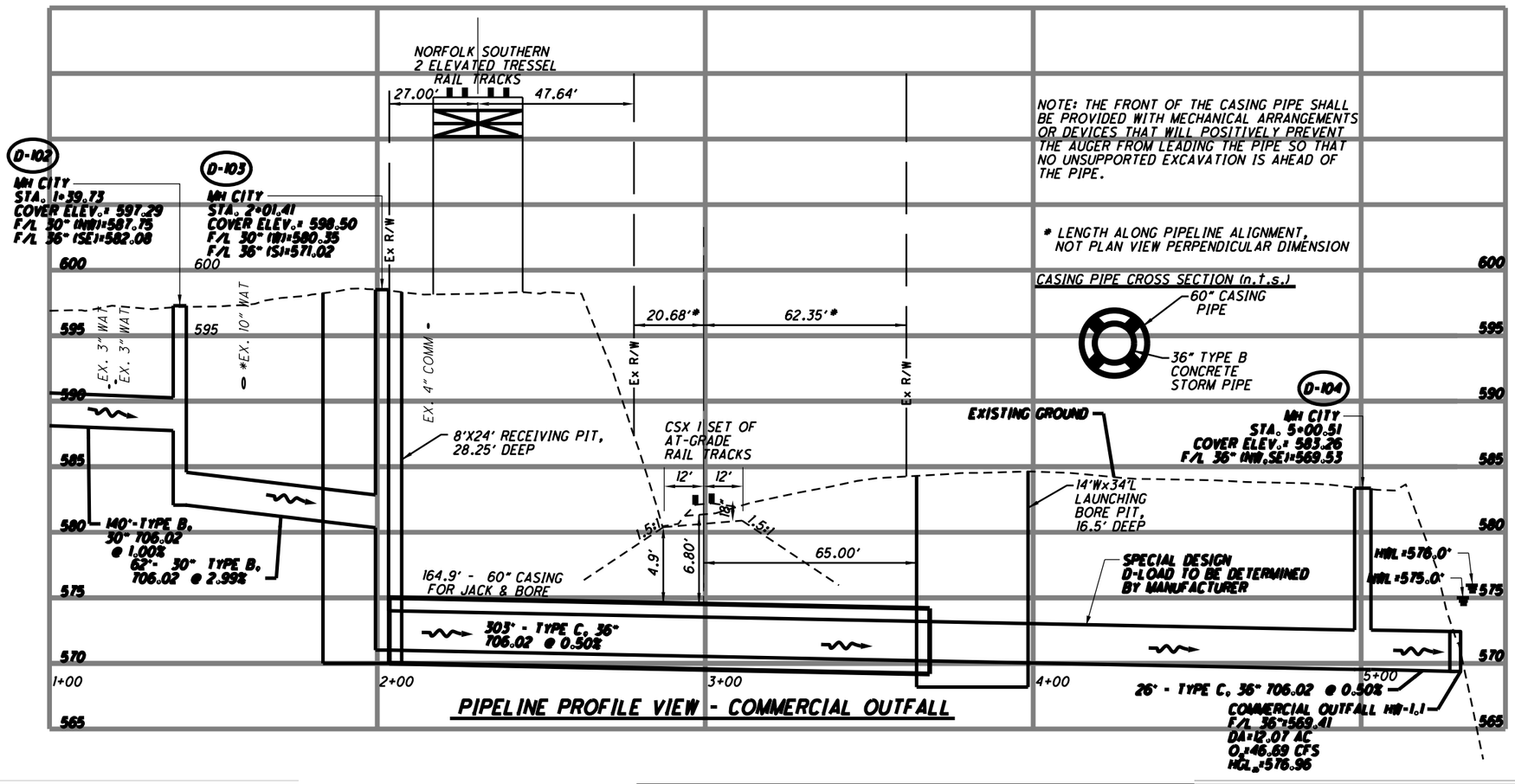
CSX PROPOSED STORM PLAN
COMMERCIAL OUTFALL
E. 9TH STREET TO CUYAHOGA RIVER



NOTES:

The Walsh Group

Location:	**Canal Road Crossing, Cleveland, OH**
Latitude:	**41 Degrees 29.4 Minutes N**
Longitude:	**81 Degrees 41.1 Minutes W**
Drawing No.:	**CSX001** Sheet **1** of **1**
Drawing Date:	**02/09/2011** Last Revised: **02/09/2011**
Drawing Scale:	**1** Inches = **40** Feet



PIPELINE PROFILE VIEW - COMMERCIAL OUTFALL

NOTE: THE FRONT OF THE CASING PIPE SHALL BE PROVIDED WITH MECHANICAL ARRANGEMENTS OR DEVICES THAT WILL POSITIVELY PREVENT THE AUGER FROM LEADING THE PIPE SO THAT NO UNSUPPORTED EXCAVATION IS AHEAD OF THE PIPE.

* LENGTH ALONG PIPELINE ALIGNMENT, NOT PLAN VIEW PERPENDICULAR DIMENSION

CASING PIPE CROSS SECTION (n.t.s.)

NOTES:

THE FRONT OF THE CASING PIPE SHALL BE PROVIDED WITH MECHANICAL ARRANGEMENTS OR DEVICES THAT WILL POSITIVELY PREVENT THE AUGER FROM LEADING THE PIPE SO THAT NO UNSUPPORTED EXCAVATION IS AHEAD OF THE PIPE.
CSXT PIPELINE SPECS. PAGE 23, A), ii) (c)

CASING PIPE ENDS WILL BE SEALED.IN ACCORDANCE WITH CSXT SPECS.
CSXT PIPELINE SPECS. PAGE 19, E)

Additional Notes/Information:

PIPELINE CONTENT DETAILS

CSXT Pipeline Spec. Reference			
	Commodity Description:	**Storm Water runoff**	
	Maximum Operating Pressure:	**N/A**	
	Is Commodity Flammable:	☐ Yes ☑ No	
	CARRIER/CASING PIPE DETAILS		
		Carrier Pipe	Casing Pipe
Page 13, C); & 17, D)	Pipe Material:	**Reinforced Concrete**	**Steel**
Page 13, C); & 17, D)	Material Specifications & Grade:	**ASTM C76 Class V**	**A252 Grade 2**
Page 13, C); & 17, D)	Specified Minimum Yield Strength:		**35 ksi**
	Nominal Size Outside Diameter (Inches):	**52**	**60**
Page 14, ii), (d)	Wall Thickness (Inches):	**4**	**0.844**
Page 13, C); & 17, D)	Type of Seam:	**N/A**	**Welded**
Page 13, C); & 17, D)	Type of Joints:	**Bell**	**Welded**
Page 16, v)	Tunnel Liner Plates Required:	☑ No ☐ Yes	
	Cathodic Protection:	☑ No ☐ Yes Type:	
	Protective Coating:	☑ No ☐ Yes Type:	
	Temp. Track Support or Rip-Rap Req.:	☑ No ☐ Yes Must Describe & Show on Drawing	

The Walsh Group

Location: **Canal Road Crossing, Cleveland, OH**

Latitude: **41 Degrees 29.4 Minutes N**

Longitude: **81 Degrees 41.1 Minutes W**

Drawing No.: **CSX 002** Sheet **1** of **1**

Drawing Date: **02/09/2011** Last Revised: **02/09/2011**

Drawing Scale: V **1** Inches = **10** Feet

Drawing Scale: H **1** Inches = **40** Feet

APPENDIX J

For Cleveland Innerbelt	Job No. 49633	Sheet No. 1
Made by JOL	Checked by	Backchecked by
Date 6/23/11	Date	Date

HNTB

42

30" ϕ Pipe "Splice"

Per AKL, 1 - 8' section could be unsupported

Design splice to resist cantilever effects.
twall = 4 1/2"

$A_{pipe} = \pi \left(\frac{25.5}{2}^2 - \frac{21}{2}^2\right)$
$= 502.6 \text{ in}^2$ (657.04)
$= 3.49 \text{ ft}^2$ (4.56)

$wt = (3.49)(150)$
$= 524$ lb/ft = DC (686)

$A_{water} = \pi \times \frac{21}{2}^2$ (assume full flow) (1385.4)
$= 1017.9 \text{ in}^2$
$= 7.07 \text{ ft}^2$ (9.62)

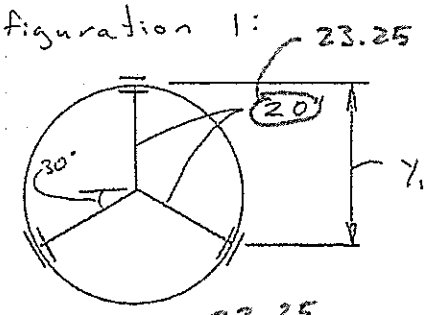
$wt = (7.07)(62.4)$
$= 441$ lb/ft = WA (600)

$M = [(1.25)(524)(8)(4) + (441)(8)(4)]/1000$ (686, 600)
$= 35.1$ k·ft (46.6)

Rev. JOL 7/11/11
Chkd. NJ. 7/11/11

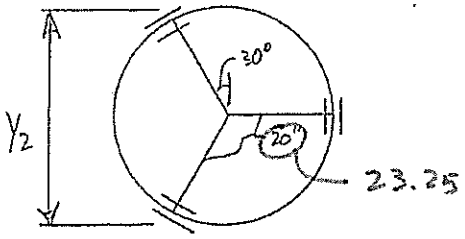
Assume all load carried by splices - no bearing between pipe sections.

Configuration 1:



$Y_1 = 20 + 20 \times \sin 30$ (23.25)
$= 30$ (34.875)

Configuration 2:



$Y_2 = 2 \times 20 \cos 30$ (23.25)
$= 34.6"$ (40.3)

use min y = 30" (34.875) = 2.5' (2.91)

force to splice
$= 35.1 / 2.5$ (46.8, 2.91)
$= 14$ K (16)

For	Cleveland Innerbelt	Job No.	49633	Sheet No.	2
Made by	JOL	Checked by		Backchecked by	JOL
Date	6/23/11	Date		Date	6/28/11

HNTB

Rev. JOL 7/11/11
Chkd. NJ 7/11/11

Check manhole detail -

bolt slip resistance:
(AASHTO 6.13, 2.8-1)
$\phi R = (.8)(1)(.33)(2)(51)$
$= 26.9$ K/bolt

$(26.9)(2) = 53.8$ K >> 14 (16) OK

tension in plate:
(6.8.2.1)

$P_{r1} = \phi_y F_y A_g$
$= (.95)(36)(8 \times 1/2)$
$= 136.8$ K

$P_{r2} = \phi_u F_u A_n R_p U$
$A_n = (8 \times 1/2) - (1\,1/16 + 1/16)(.5)$
$= 3.44$ in^2
$P_{r2} = (.8)(58)(3.44)(.9)(1)$
$= 143.6$ K

use $P_r = 136.8$ >> 14 (16) OK

(assumes A36 steel)

bearing of bolt on pipe:
(5.7.5)

assume 4000 psi concrete

$P_r = \phi .85 f'_c A_1 m$ (4.5)
$= (.7)(.85)(4.0)(4 \times 1)(1)$
$= 9.5$ (10.7) K > 14 (16)/2 = 7 (8) OK

Rev. JOL 7/11/11
Chkd. NJ 7/11/11

tear-out on pipe:
(ACI App. D, D-24)

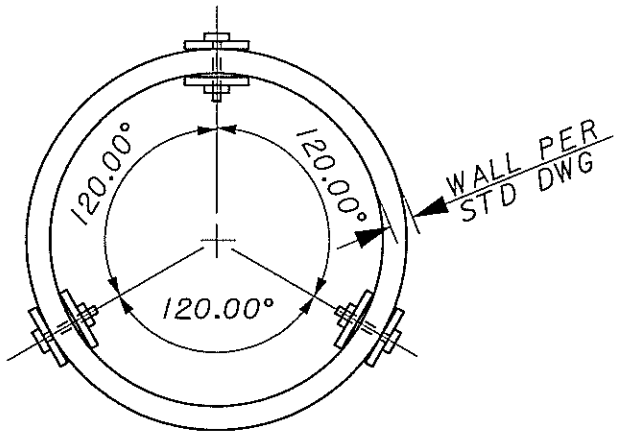
$V_b = 7\left(\frac{\ell_e}{d_o}\right)^{0.2} \sqrt{d_o} \sqrt{f'_c} (c_{a1})^{1.5}$
$\ell = 4$ (4.5)
$d_o = 1$
$f'_c = 4000$ psi
$c_{a1} = 12$"
$V_b = (7)\left(\frac{4}{4.5}\right)^{.2} \sqrt{1} \sqrt{4000} (12)^{1.5}/1000$
$= 24.28$ (24.86) K
$\phi V_b = (.85)(24.28)$
$= 20.6$ (21.1) K > 14 (16) OK

∴ use manhole detail

bearing of plate on pipe:

$P_r = (.7)(.85)(4.0)(8 \times 24)(1)$
$= 457$ K
> $(2)(51) = 102$ K OK
↑ bolt pretension

ME101-1204



603
ITEM ~~604 MANHOLE NO 3~~, AS PER PLAN

IN ADDITION TO THE ITEMS SHOWN ON THE PLAN AND THE APPLICABLE STANDARD CONSTRUCTION DRAWING, THIS ITEM SHALL INCLUDE THE FOLLOWING AT ~~EACH~~ The Joint Adjacent To The Bank ~~MANHOLE CONSTRUCTION JOINT~~:

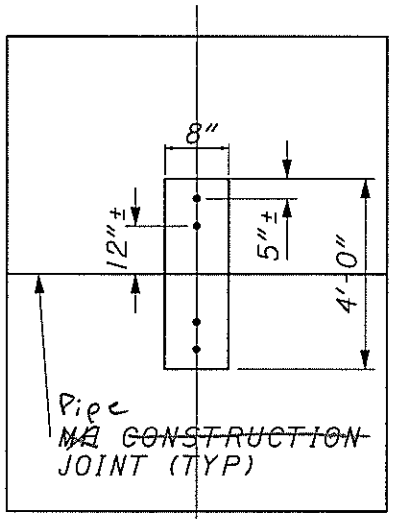
SIX (6) 8" x 48" x 1/2" STEEL PLATES — F_y = 36 ksi min

TWELVE (12) 1" DIAMETER A325 HIGH STRENGTH BOLTS (LENGTH DETERMINE BY THICKNESS OF MANHOLE WALLS AND 1" MIN/2" MAX THREAD STICKOUT.)

TWELVE (12) HOLES STD. DRILLED COMPLETELY AND CLEANLY THROUGH THE MANHOLE WALLS TO ACCEPT THE 1" DIAMETER BOLTS

ALL HARDWARE INCLUDING BOLTS, NUTS, PLATES, WASHERS, ETC. SHALL BE GALVANIZED PER 711.02 AND MEET THE REQUIREMENTS OF 513.15.

ALL OF THE LABOR, MATERIAL, AND EQUIPMENT REQUIRED TO PROVIDE THE ABOVE NOTED ITEMS SHALL BE INCLUDED IN THE UNIT PRICE BID FOR ITEM ~~604~~ 603 ~~MANHOLE NO. 3,~~ AS PER PLAN.



Pipe Splice

~~MH~~ DETAIL

TO SCALE

Calculations For Joint Deflection Check 42" Special	Job No. 49633	Sheet No. 1/2	HNTB
Made by ER Johnson	Date 8/16/11		
Checked by M. Simon	Date 8/16/11		
Backchecked by K. Fental	Date 8/18/11		

42 inch Special Pipe Information

- Length = 138 feet
- Slope = 0.50 %
- 8 foot pipe sections being installed per Rinker Shop Drawing
- 5 ½ inch deep equipment joint with rubber o-ring
- normal deflection at joint = 0.2984° (½" at joint) per Rinker
- Allowable (Max) deflection at joint = 0.4476° (3/4" at joint)

Determine Settlement of Salt Pipe Curvature does not exceed allowable joint deflection ∴

per Sheet 25 of 57 of GC-058 Rev 1 - Salt pile Settlement Memo. The maximum settlement at center of pile is 2.3 inches. The circle represents the radius of the salt pipe (48 feet). The pipe is longer than the radius of the salt pile. To analyse the pipe joint deflection the center of the pile was also considered the center of the pipe. Therefore, the settlement for the pipe occurs 69 feet from the center of the pile. The total settlement at this point on figure is 0.3 inches.

Joint Deflection at pt. 69 feet from center

= 2.3" − 0.3" = 2.0" over 69 feet ⇒ 0.1384°

= * for reverse curvature = 2 * 0.1384° = 0.2768°

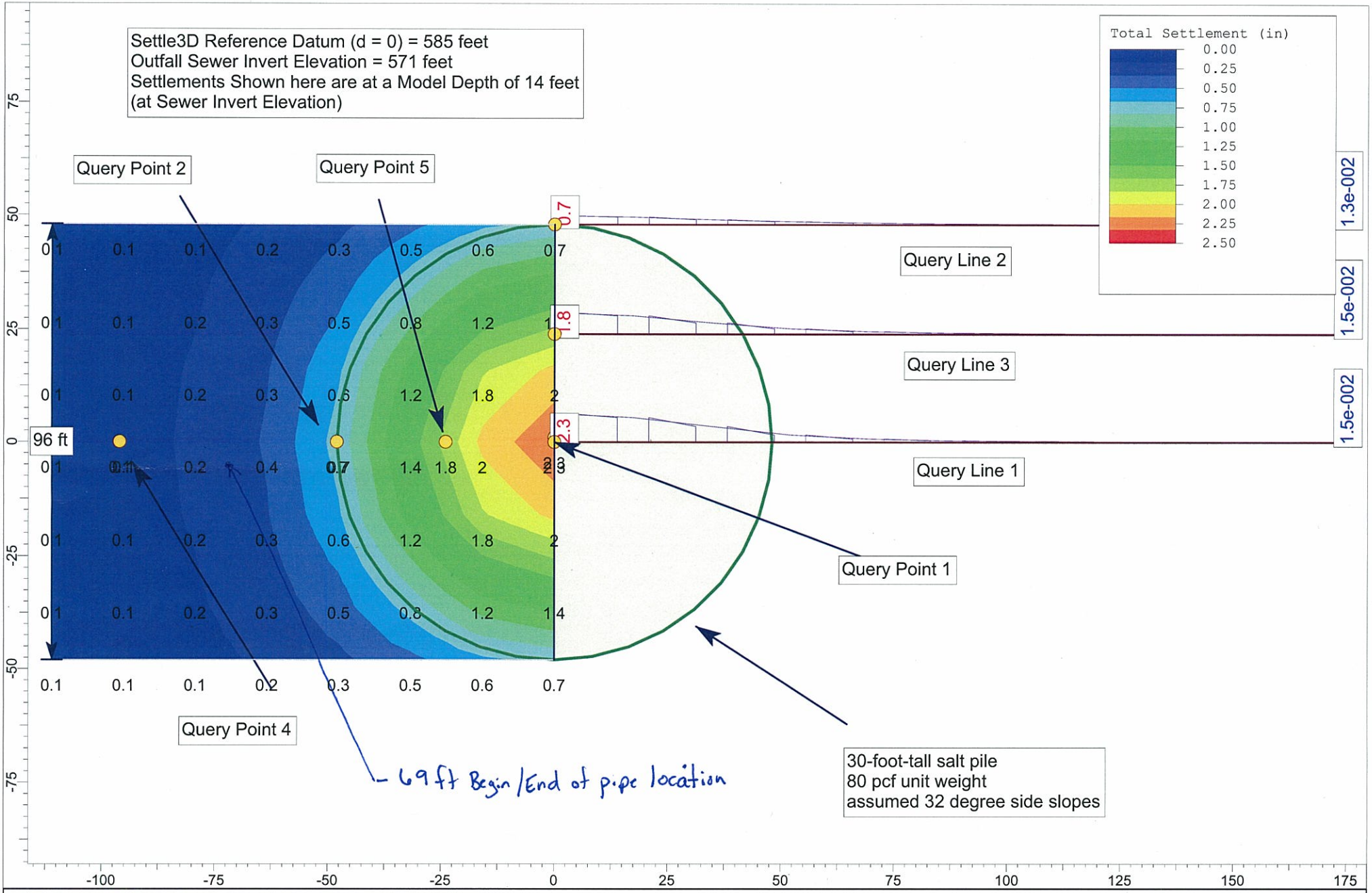
0.2768° < 0.2984° normal deflection.

0.2768° < 0.4476° Maximum Allowable deflection

* note reverse curvature is in a constant bowl shape under salt pipe. Greatest curvature is at center of pile.

Salt Pile Settlement_rev4_yhc.s3z (Recovered)

S & W 6/15/2011



Stage 20 = 600 mon

Data Type: Total Settlement