CALUMET AREA
HYDROLOGIC MASTER PLAN

VOLUME II

WATERSHED ATLAS &
STAGE-DISCHARGE RATING CURVES

CALUMET AREA
CITY OF CHICAGO, COOK COUNTY, ILLINOIS

PREPARED FOR:

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- *Michael Miller* *Illinois State Geologic Survey (ISGS)*
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1.0 EXECUTIVE SUMMARY

This report specifically addresses two portions of the Calumet Area Hydrologic Master Plan (HMP): the development of a Watershed Boundary Atlas, and the development of stage-discharge relationships for the onsite stormwater outlet control structures. These tasks are known as Task 102 and Task 202, respectively.

The Watershed Boundary Atlas was developed following extensive research of the topography of the Calumet Area. V3 reviewed previous surveys from the DOE, drainage reports by the Illinois Department of Transportation, and sewer atlases from the Chicago Department of Water Management. In addition, the V3 team conducted field surveys in 2004 and 2005 to verify watershed boundaries, as well as to obtain specific details regarding the configuration of the onsite basin outlet control structures and overflow routes.

Stage–discharge relationships were developed for the onsite basin control structures. As stated above, V3 and its design team performed extensive field surveys in 2004 and 2005 to obtain details regarding the configuration of the control structures and overflow routes. This information was used by V3 engineers to analyze the unique hydraulic situation for each structure. Rating curves were then established based on a range of possible tailwater scenarios for use in the planning of future improvements to the site hydrology.

Significant concerns have been raised regarding the culvert connecting Indian Ridge Marsh North and Indian Ridge Marsh South under 122nd Street. The culvert is a corrugated metal pipe that dates to the 1920's and has had historical blockage issues. If the culvert were to fail, Indian Ridge Marsh North would overflow onto Torrance Avenue, a major thoroughfare through the Calumet Area.

Heron Pond and Indian Ridge Marsh South do not have functional control structures, but are regulated by outlet channels. Adjustable control structures would be beneficial for these areas to allow additional control of the normal pool elevations, especially for the heron population at Heron Pond.

Disclaimer: Due to ongoing activities within the study area, the information contained within this report may become obsolete after modifications by others. The information contained in this report is accurate as of August 2006.

2.0 INTRODUCTION

This report specifically addresses two portions of the Calumet Area Hydrologic Master Plan (HMP): the development of a Watershed Boundary Atlas, and the development of stage-discharge relationships for the onsite stormwater control structures. These tasks are known as Task 102 and Task 202, respectively. All site specific aerial photographs used within Volume II are dated 2004. The legend provided below refers to all site specific aerial maps that are used throughout this volume.

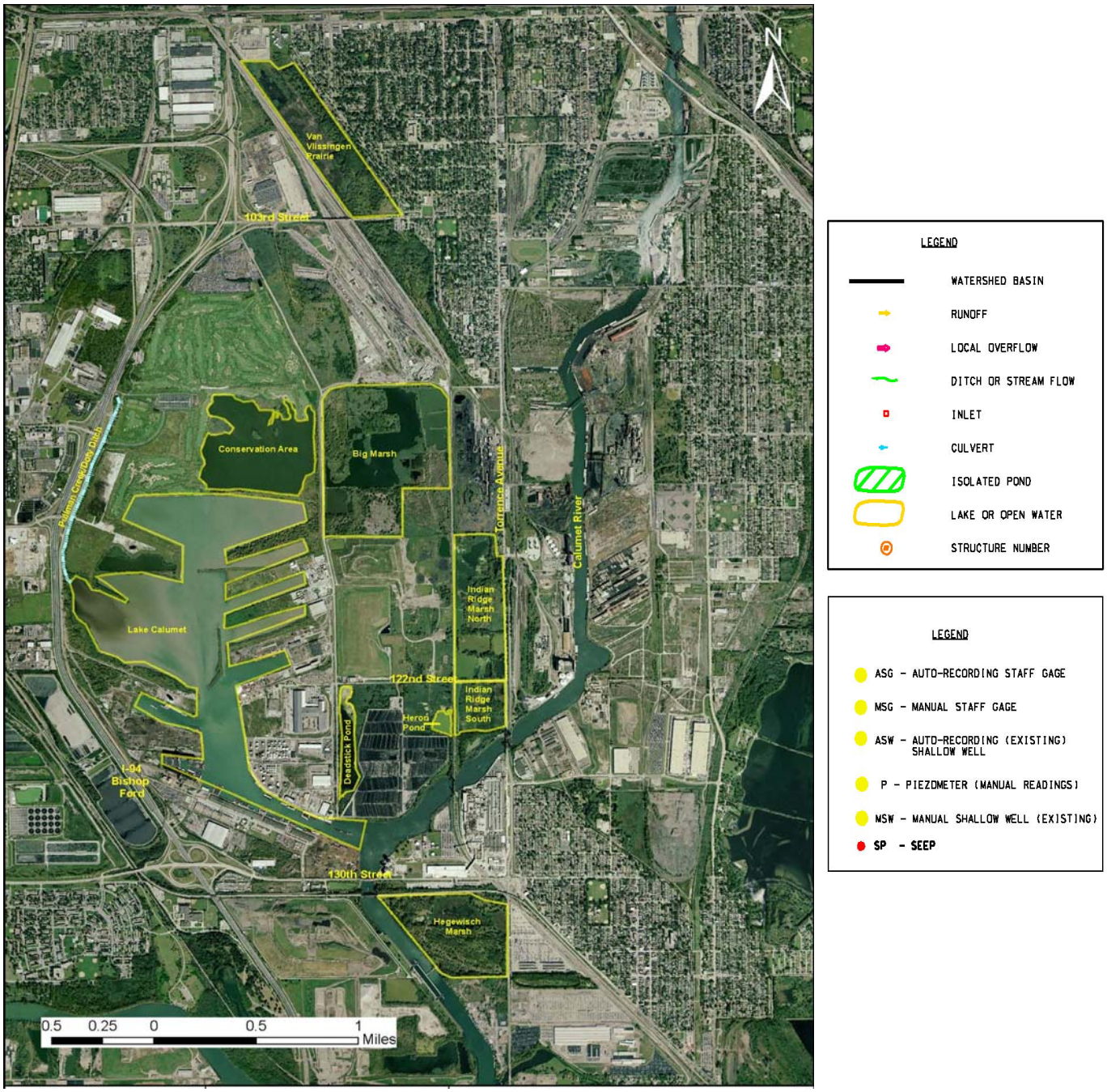


Figure 1: Lake Calumet Location Map.

3.0 WATERSHED BOUNDARY ATLAS

As part of the Hydrologic Master Plan, V3 has completed a watershed boundary delineation for the Calumet Area. Watershed boundaries were delineated based upon topographic and watercourse divides as determined from V3 field survey, DOE topographic survey base mapping, Illinois Department of Transportation (IDOT) drainage studies, USGS topographic quadrangle mapping, and Chicago Department of Water Management (DWM) sewer atlases.

The Watershed Boundary Atlas is presented in two exhibits. The first exhibit presents the overall Calumet vicinity with outlines of each of the major onsite hydrologic basins. Offsite basins tributary to the site are also shown. Approximate drainage areas are given for each of the major basins.

The second exhibit presents the Calumet Area in greater detail. This exhibit presents the major onsite basin boundaries, as well as the location and identification of basin outlet control structures and overflow routes, the total drainage area tributary to each control structure, and the overflow elevation for each of the basin overflow points.

The Watershed Boundary Atlas Exhibits are included in Appendix Section 1.

4.0 OUTLET CONTROL STRUCTURE STAGE-DISCHARGE RELATIONSHIPS

In order to assist in the planning of future improvements to the site, V3 has prepared stage-discharge rating curves for each of the onsite major hydrologic basin control structures. Details for each of the existing control structures were obtained by field survey conducted by the V3 team in 2004 and 2005. The structures were then evaluated for hydraulic performance under a range of expected tailwater conditions. Table 1 presents the list of major basin control structures, the connecting upstream and downstream hydrologic units, as well as the total drainage area tributary to the structure.

The stage-discharge relationships developed in this report are subject to the following limitations:

- Structures are assumed to be maintained. The effects of sediment and debris buildup were not considered (Standard Practice).
- The relationships indicate overflows local to the control structure. A lower overflow elevation between the two connected hydrologic units may exist a distance away from the control structure. Refer to Exhibit 2.

Structures were assumed to function independently. Interactions between hydrologic unit control structures may skew rating curves due to constantly varying tailwater conditions. This situation will be resolved internally by the computational modeling in Volume IV (Tasks 301 and 302).

Structure Identifier	Upstream Unit	Downstream Unit	Tributary Area
Structure #1	Deadstick Pond	Calumet River	90 Ac
Structure #2	Heron Pond	Calumet River	105 Ac
Structure #3	Indian Ridge Marsh North	Indian Ridge Marsh South	185 Ac
Structure #4	Cluster Sites	Lake Calumet	19 Ac
Structure #5	Big Marsh	Lake Calumet	626 Ac
Structure #6	Cluster Sites	Indian Ridge Marsh North	116 Ac
Structure #7	Coke Plant	Indian Ridge Marsh North	62 Ac[1]
Structure #8	Norfolk Southern RR Marsh	Big Marsh	250 Ac
Structure #9	Pullman Creek	Pullman Creek	852 Ac
Structure #10	Pullman Creek	Pullman Creek	813 Ac
Structure #11	State ROW	Pullman Creek	N/A
Structure #12	State ROW	Pullman Creek	N/A
Structure #13	Pullman Creek	Pullman Creek	319 Ac[2]
Structure #14	Coke Plant	Big Marsh	62 Ac[1]
Structure #15	Conservation Area	Lake Calumet	250 Ac
Structure #16	Pullman Creek	Pullman Creek	319 Ac[2]
Structure #17	Indian Ridge Marsh South	Calumet River	232 Ac

Table 1: Major Basin Control Structures.

4.1 Structure #1 – Deadstick Pond to Calumet River

Structure #1 regulates the discharge from Deadstick Pond to the Calumet River. The structure consists of a rectangular concrete box structure, roughly 34" x 42" in plan. The structure has an opening with adjustable stop logs on the north wall facing the pond. The opening is approximately 34" wide, and the existing top of the stop logs is approximately 75.5" below the top of the structure. The stop logs function as a weir to hold water in the pond at elevations below the crest of the stop logs. A rectangular metal grate is located on the roof (rim) of the structure to collect flow during extreme events. Once flow enters the structure, it is conveyed to the river through an 18" corrugated metal pipe (CMP). By inspection of the structure, it appears that the stop logs are utilized to set the normal water level of Deadstick Pond. Above the crest of the stop planks, the planks will provide minimal restriction to the flow of water into the structure. Under this condition, the pond elevation is then controlled by the capacity of the outlet pipe and the tailwater condition at the pipe outfall.

Stage-discharge relationships were developed for this structure based upon the surveyed geometry. Tailwater for the Calumet River was considered up to 583.0, the approximate high water level for Lake

[1] 124 Acres for the Coke Plant is split between Structures 7 and 14. Portions of the Coke Plant may actually be collected in a storm sewer and drained along Torrence Avenue. Assuming runoff from this area is tributary to the study area is conservative.
[2] 319 Acres is split between Structures 13 and 16. Exact division not determined.

Calumet and the Calumet River as regulated by the Thomas J. O'Brien Lock and Dam and the level of Lake Michigan[3].

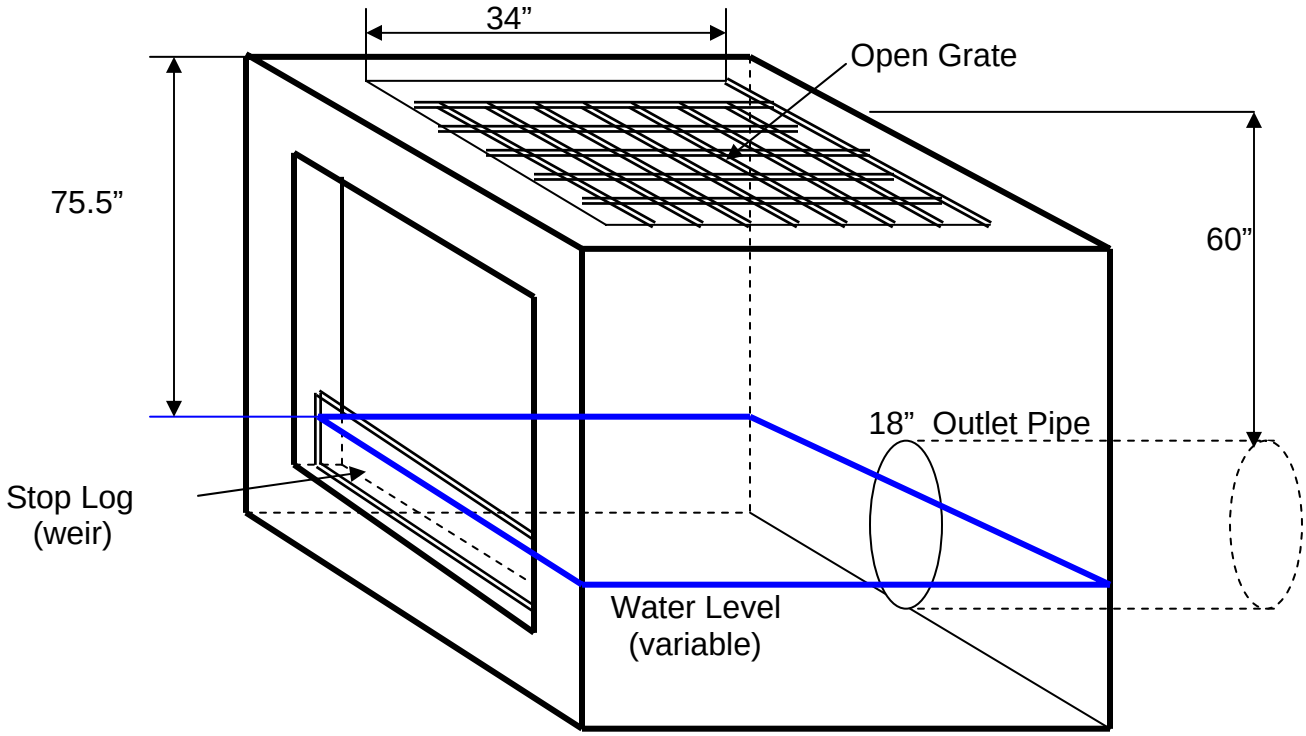


Figure 2: Structure #1 Hydraulic Geometry.

[3] Roadcap, et.al. "An Assessment of the Hydrology and Water Quality of Indian Ridge Marsh and the Potential Effects of Wetland Rehabilitation on the Diversity of Wetland Plant Communities", 1999, p. 8, 47.

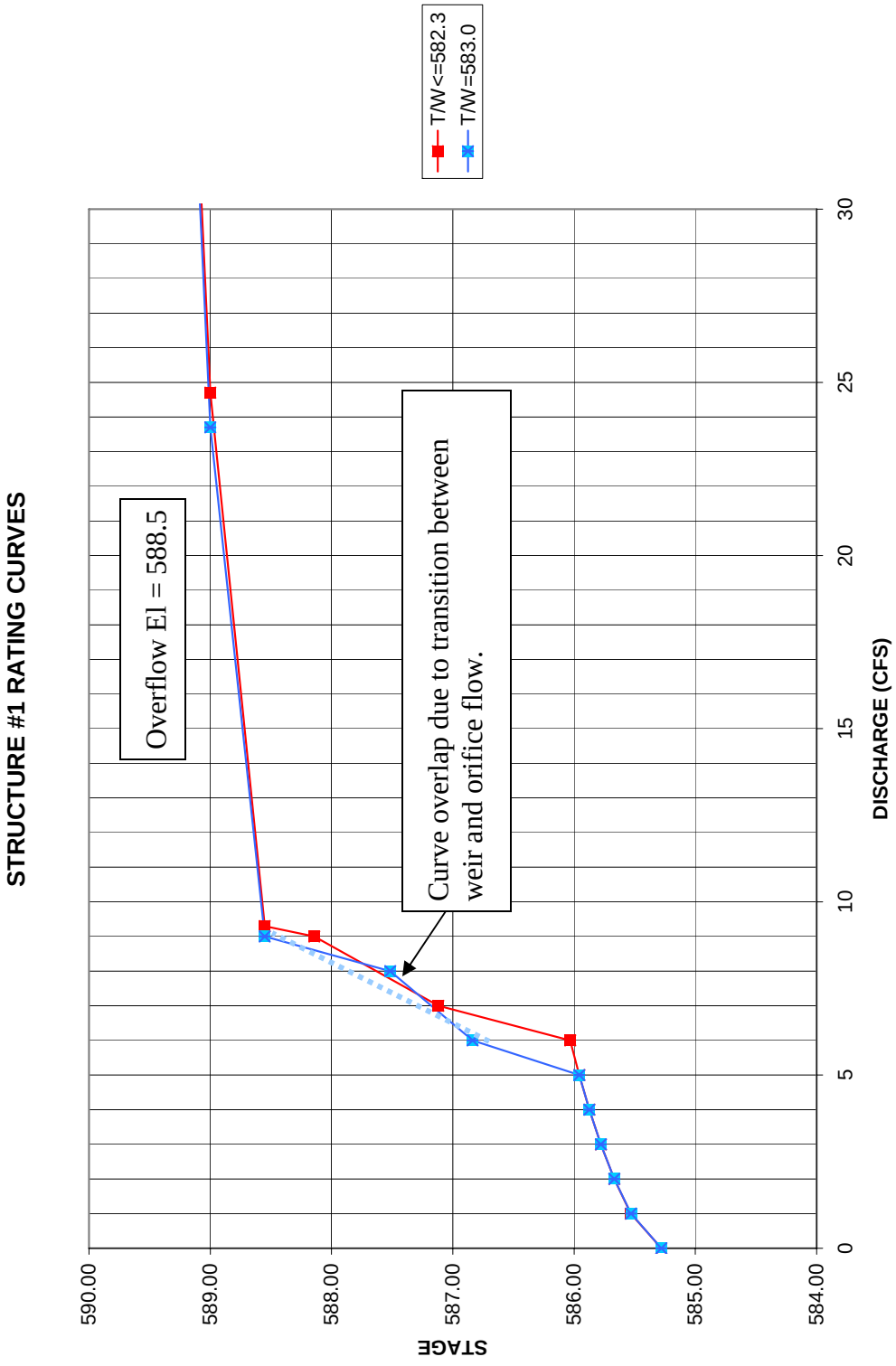


Figure 3: Structure #1 Rating Curves.

Figure 4: Structure #1 - Looking East.

Figure 5: Structure #1 - Approach Channel.

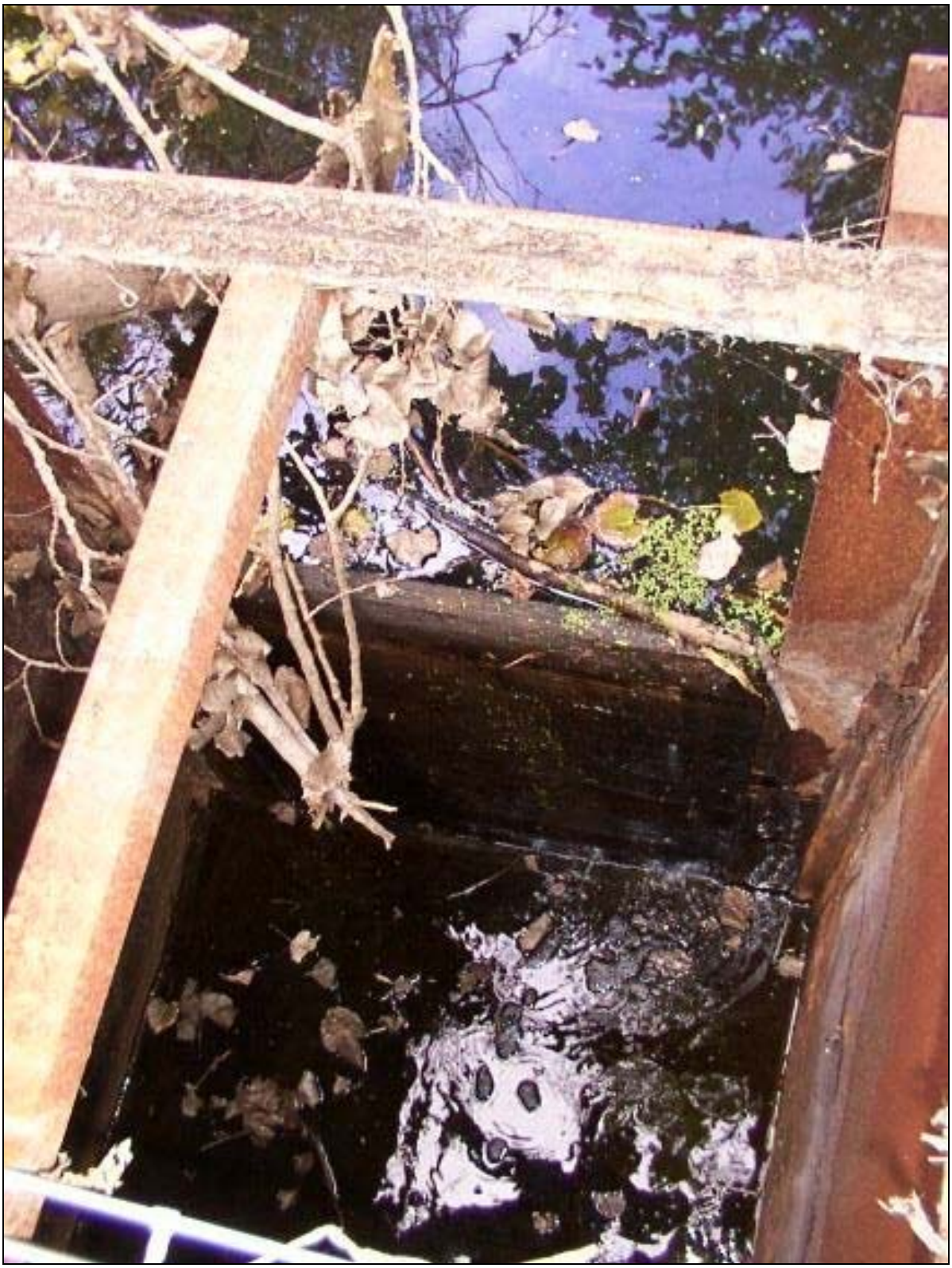


Figure 6: Structure #1 - Inside View.

Figure 7: Structure #1 - Outlet Pipe and Channel.

4.2 Structure #2 – Heron Pond to Calumet River

This control structure consists of a rudimentary man-made weir and open channel connecting Heron Pond to the Calumet River. The weir is approximately 5 feet wide and is made of grass clippings and debris approximately 12 inches deep. It appears that the clippings were placed in order to elevate the normal water level of the pond. Above the weir crest, the grass clippings and debris will not significantly restrict the rate of discharge exiting the pond. In this situation, the pond elevation is controlled by the discharge rate and capacity of the open channel connecting the weir to the Calumet River.

Stage-discharge relationships were developed for this structure based upon the surveyed geometry of the open channel as shown on Figure 8. Tailwater for the Calumet River was considered up to 583.0, the approximate high water level for Lake Calumet and the Calumet River as regulated by the Thomas J. O'Brien Lock and Dam and the level of Lake Michigan[4].

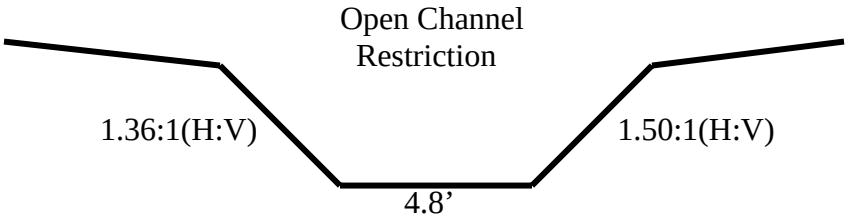


Figure 8: Structure #2 Hydraulic Geometry.

[4] Roadcap, 1999.

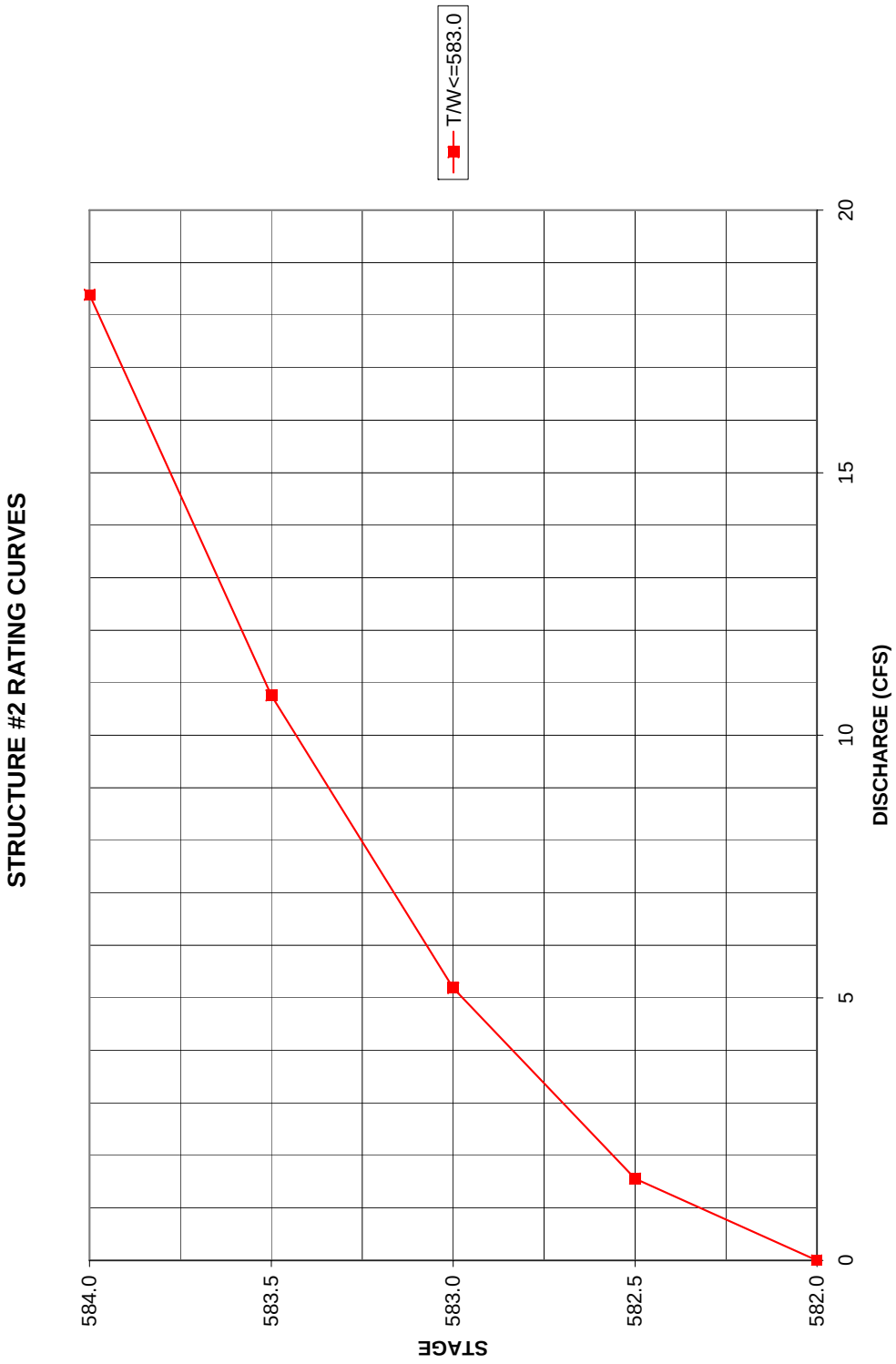


Figure 9: Structure #2 Rating Curves.

Figure 10: Structure #2 – Weir Constructed of Grass and Debris.

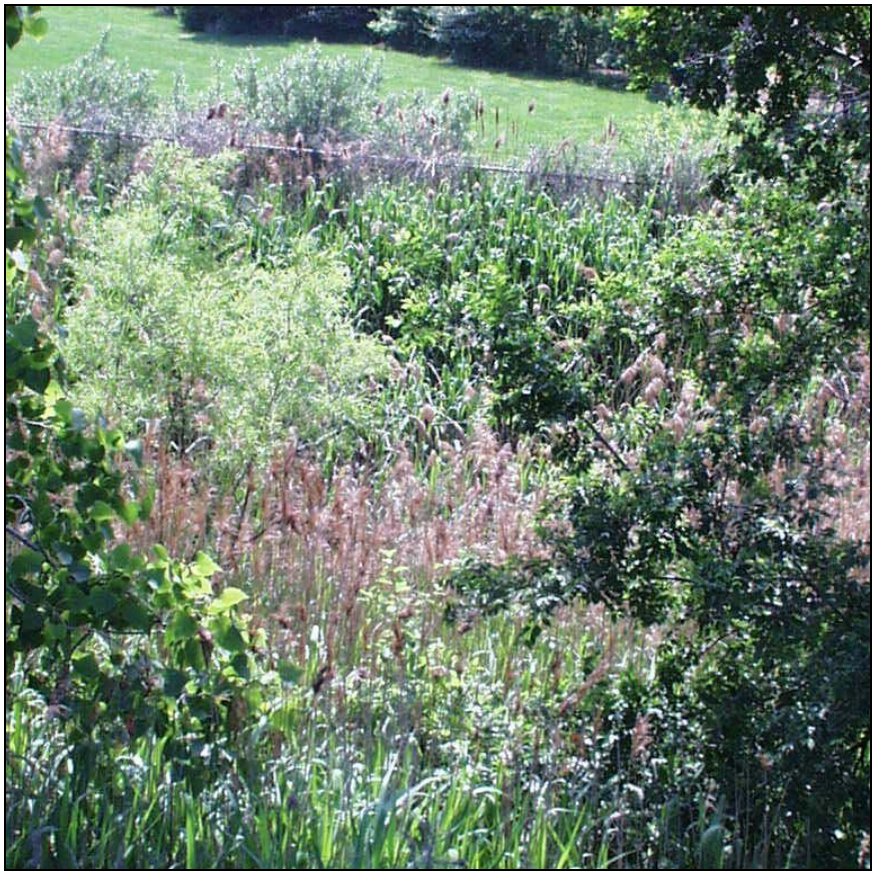
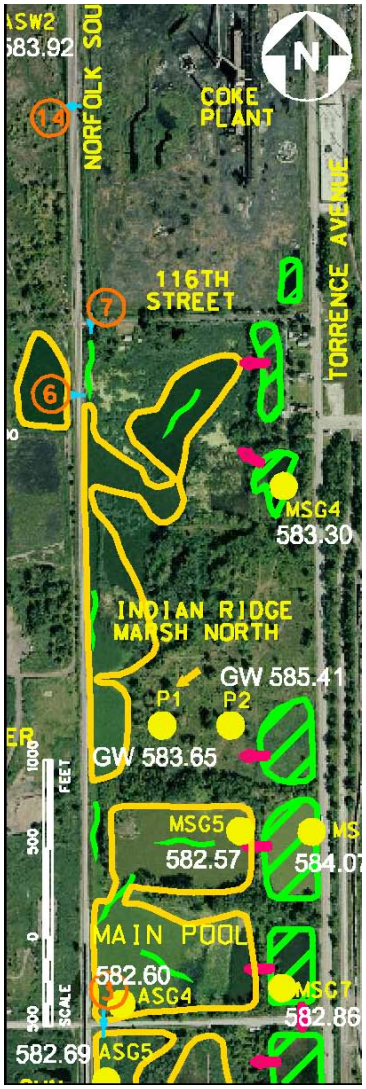


Figure 11: Structure #2 – Outlet Channel (Overgrown Condition).

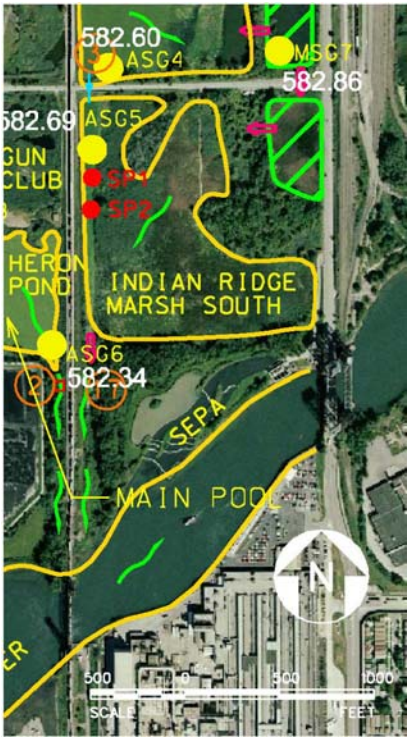
4.3 Structure #3 – Indian Ridge Marsh North to Indian Ridge Marsh South

Structure #3 consists of an inlet box and attached culvert connecting Indian Ridge Marsh North and Indian Ridge Marsh South under 122nd Street. The inlet consists of a concrete manhole with a 4' diameter open grate. The rim elevation of the grate is the lowest point of entry into the structure, and therefore sets the normal water level for North Indian Ridge Marsh. The outlet pipe consists of a single 24" corrugated metal pipe (CMP). Under most events, the water level in Indian Ridge Marsh North appears to be controlled by the open grate through either weir or orifice flow conditions, depending on the water depth above the grate. Under high water conditions, either in Indian Ridge Marsh North or by high tailwater conditions in Indian Ridge Marsh South where the outlet CMP is submerged, the outlet pipe will operate under pressure flow and will impact the stage-discharge relationship for the structure.



Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 12. Tailwater for Indian Ridge Marsh South was considered up to 588.0 to cover the range of expected water surface elevations in South Indian Ridge Marsh.

Significant concerns have been raised regarding the culvert connecting Indian Ridge Marsh North and Indian Ridge Marsh South under 122nd Street. The culvert is a corrugated



metal pipe that dates to the 1920's and has had historical blockage issues. If the culvert were to fail, Indian Ridge Marsh North would overflow onto Torrance Avenue, a major thoroughfare through the Calumet Area.

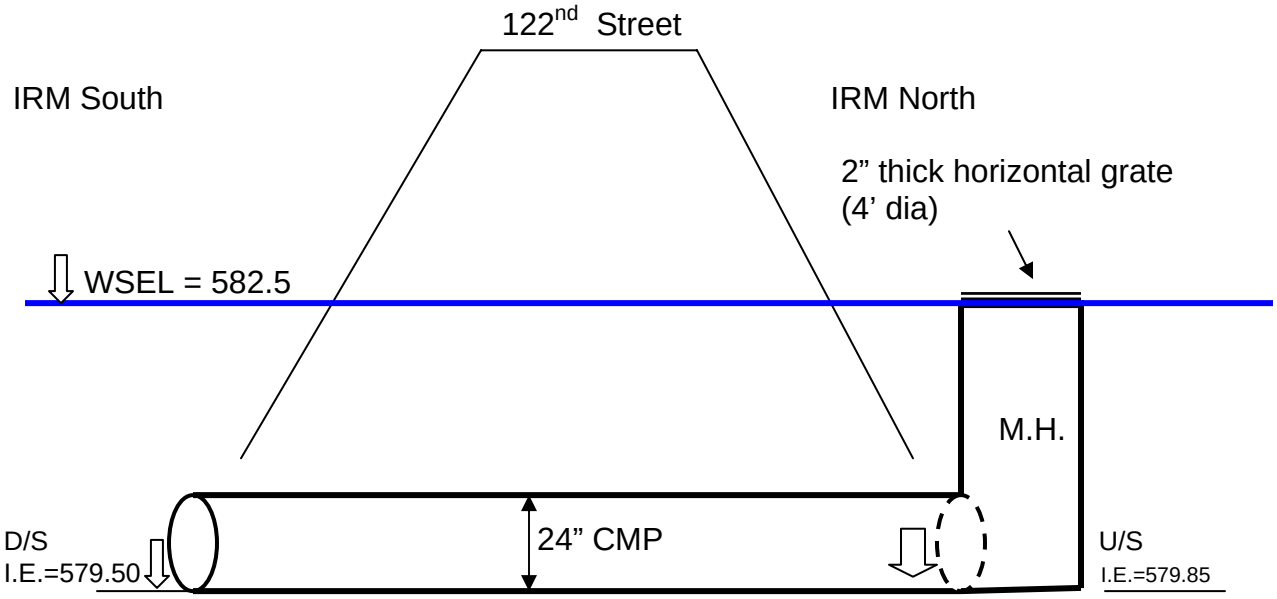


Figure 12: Structure #3 Hydraulic Geometry.

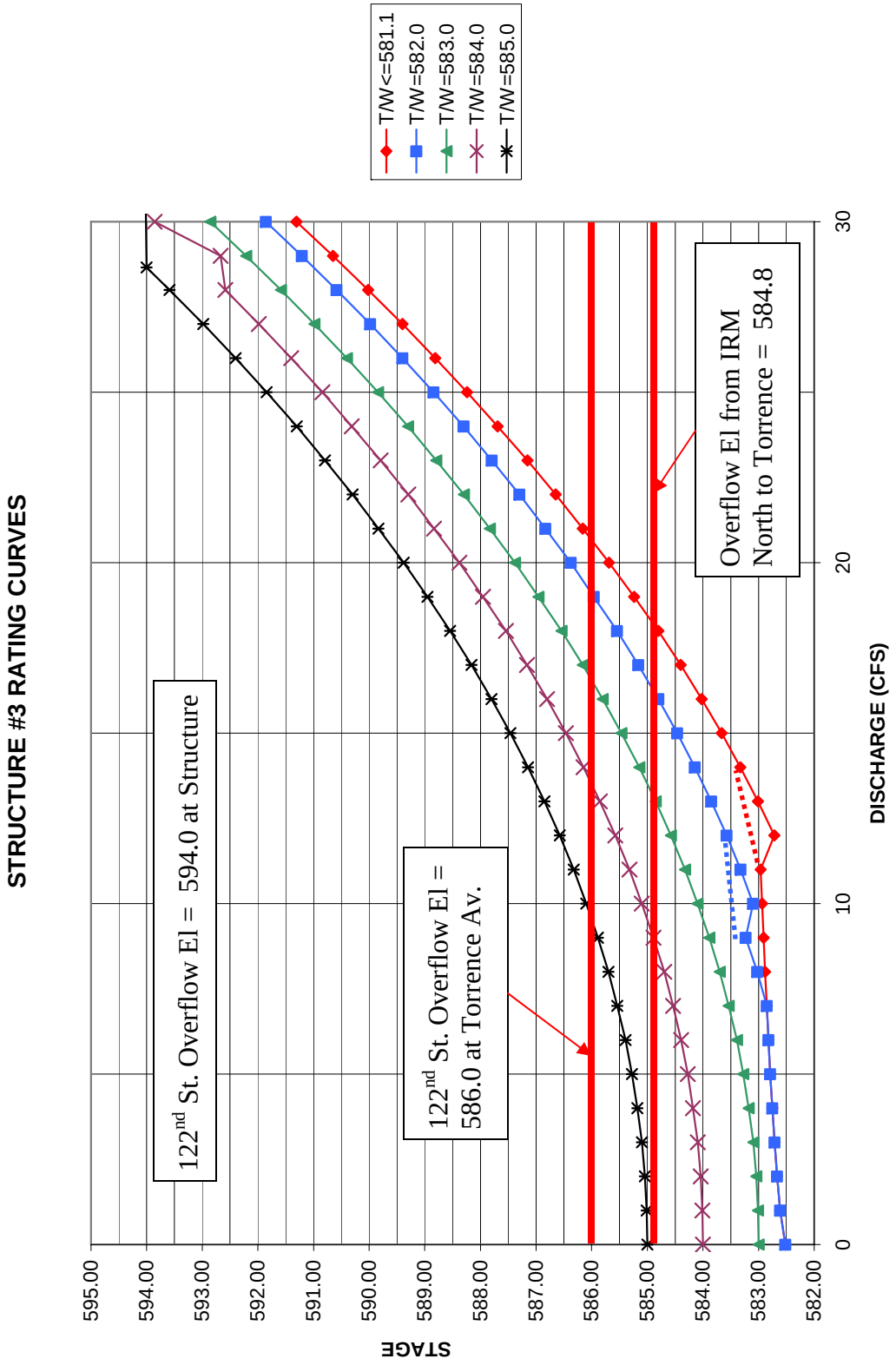


Figure 13: Structure #3 Rating Curves.

Figure 14 – Structure #3 Looking North.

Figure 15 – Structure #3 Obstructed Grate.

4.4 Structure #4 – Cluster Sites to Lake Calumet

This control structure was identified by Ross (1988) as a storm sewer serving Stony Island Avenue and the Cluster Sites, ultimately releasing into Lake Calumet. V3 has attempted to field locate this outlet on multiple occasions without success. If the area served by this outlet is not subject to proposed hydrologic modification by the DOE, no further effort to locate this outlet is recommended.

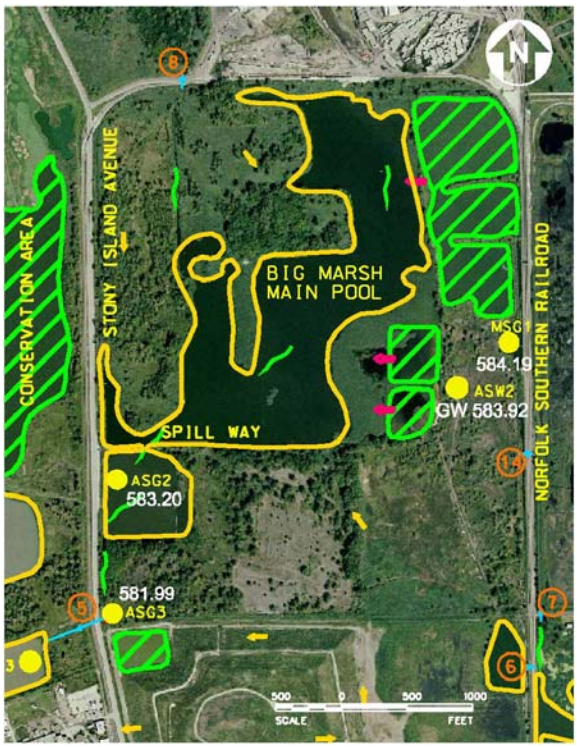
4.5 Structure #5 – Big Marsh to Lake Calumet

Structure #5 consists of a rectangular concrete drop inlet with twin 30" diameter outlet pipes connecting Big Marsh to Lake Calumet. The structure is approximately 5'x7' measured in plan. The northeast wall facing Big Marsh has an opening with an adjustable stop plank to control the normal water elevation in Big Marsh (similar to Structure #1). The opening is approximately 1'-10" wide by 12" tall with the stop plank blocking the lower 3" of the opening. Inside the structure there is a 6" thick concrete wall to wall deck with a 2' diameter orifice. Twin 30" diameter outlet pipes leading to Lake Calumet connect to the structure approximately 4'-6" below the orifice and concrete deck.

When the water level in Big Marsh is above the stop plank crest, the wall opening will provide minimal restriction to incoming flow until the structure is submerged. Under low flow conditions, flow control is provided by the wall opening and the concrete deck orifice. Under high flow or high tailwater conditions in Lake Calumet, the wall opening, the concrete deck orifice, and the outlet pipes will each impact the stage-discharge relationship for the structure.

A 2' diameter grate is located on the roof of the structure for access and overflow collection.

Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 16. Tailwater for the Calumet River was considered up to 583.0, the approximate high water level for Lake Calumet and the Calumet River as regulated by the Thomas J. O'Brien Lock and Dam and the level of Lake Michigan[5].



[5] Roadcap, 1999.

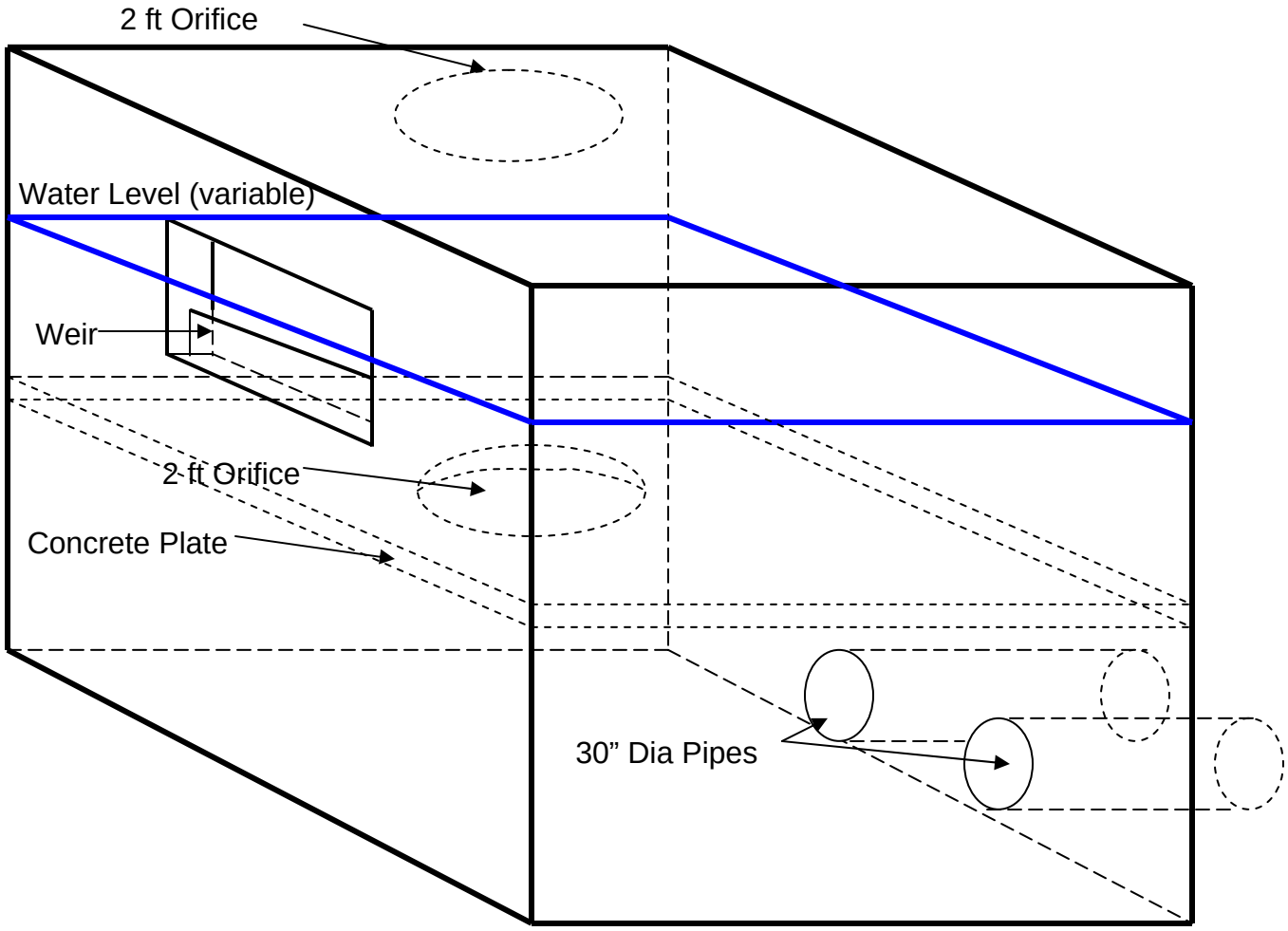


Figure 16 – Structure #5 Hydraulic Geometry.

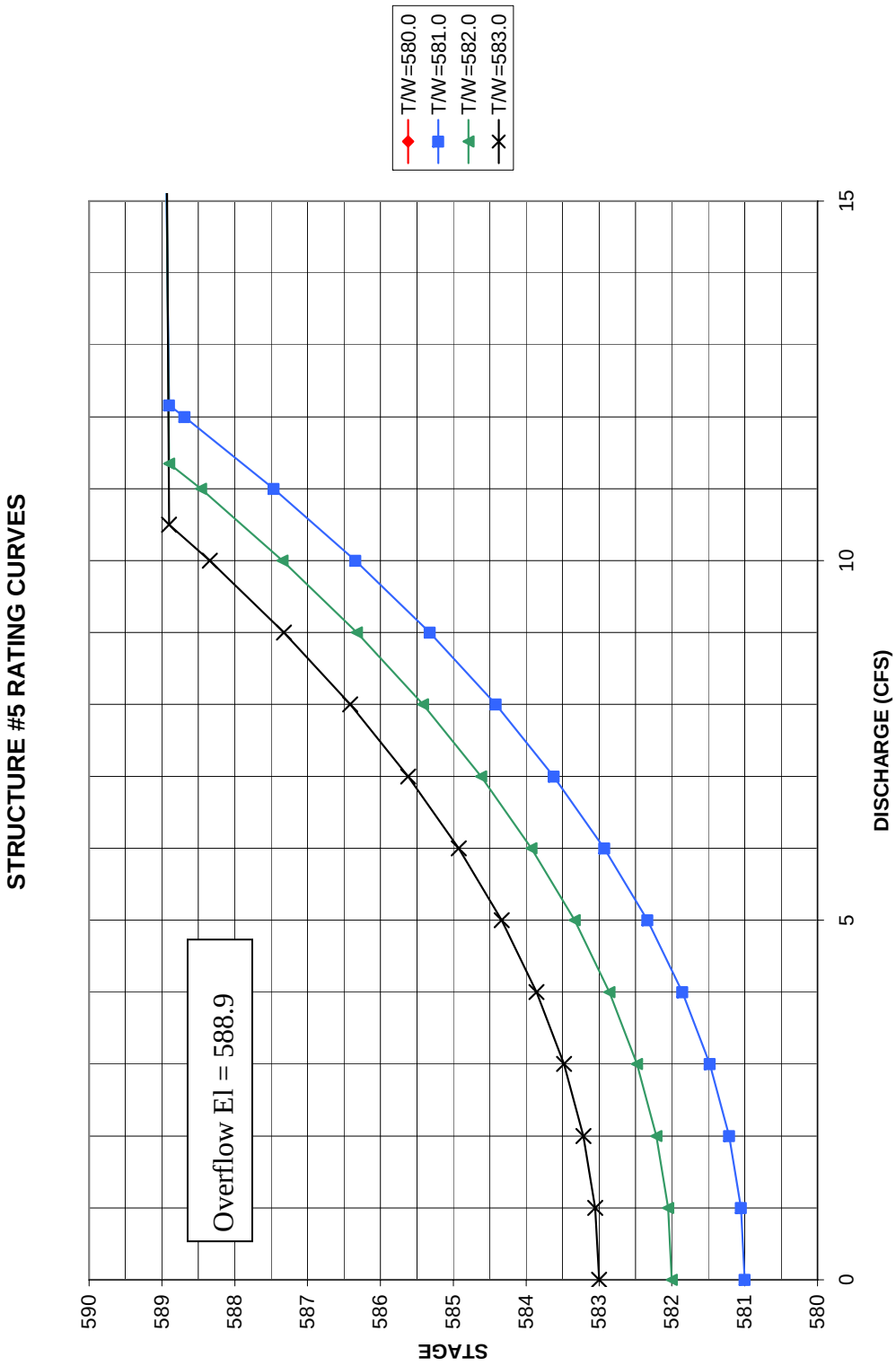


Figure 17: Structure #5 Rating Curves.

Figure 18: Structure # 5 – Looking Northeast.

Figure 19: Structure #5 – Looking Southeast.

4.6 Structure #6 – Cluster Sites to Indian Ridge Marsh North

This control structure was identified by Roadcap[6] and consists of multiple culverts connecting the Cluster Sites to Indian Ridge Marsh North under the Norfolk Southern Railroad. V3 understands that flow once discharged to Indian Ridge Marsh North from the Cluster Sites, in particular landfills Paxton #1 and #2, but the culverts have been abandoned and flow has been redirected to the west and now discharges ultimately to Lake Calumet. This information was confirmed by Patrick Engineering on January 5, 2006.

4.7 Structure #7 – Coke Plant to Indian Ridge Marsh North

Structure #7 consists of a single 36" diameter CMP culvert connecting the Coke Plant to Indian Ridge Marsh North. Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 20.

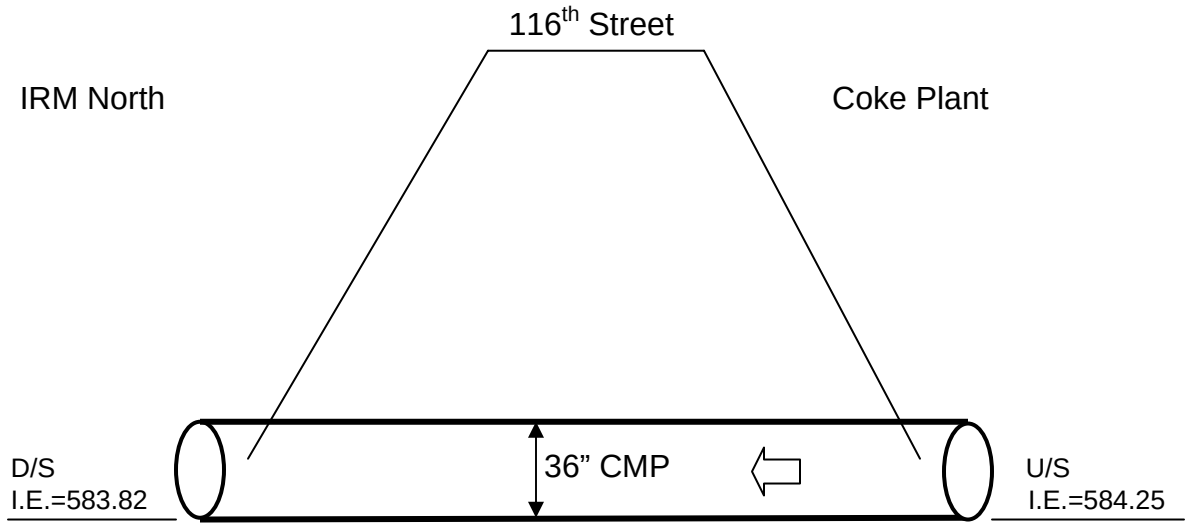


Figure 20: Structure #7 Hydraulic Geometry.

[6] Roadcap, 1999.

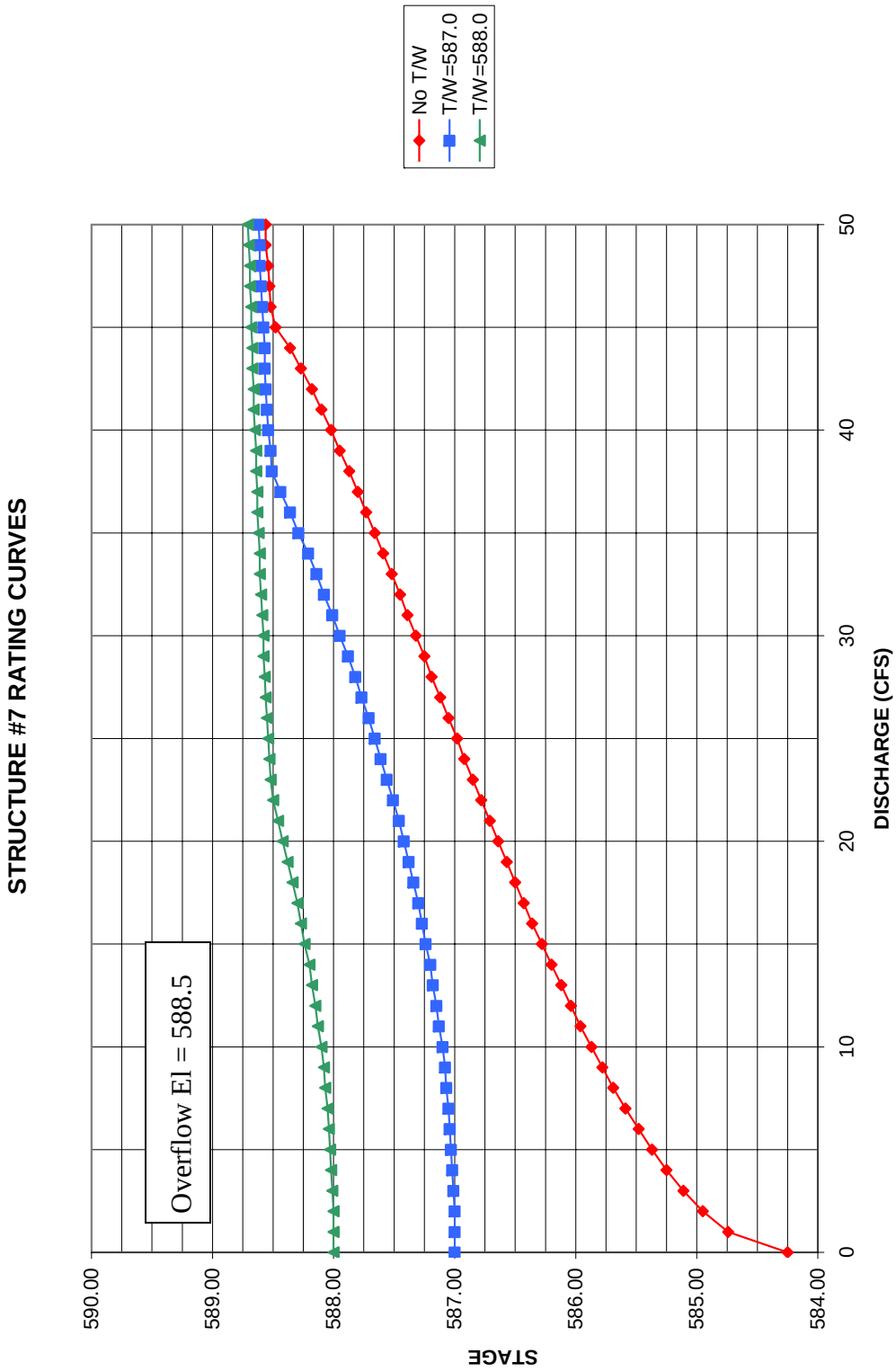


Figure 21: Structure #7 Rating Curves.

4.8 Structure #8 – Norfolk Southern Railroad Marsh to Big Marsh

Structure #8 consists of a single 24” diameter culvert connecting the Norfolk Southern Railroad Marsh to Big Marsh. Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 22.

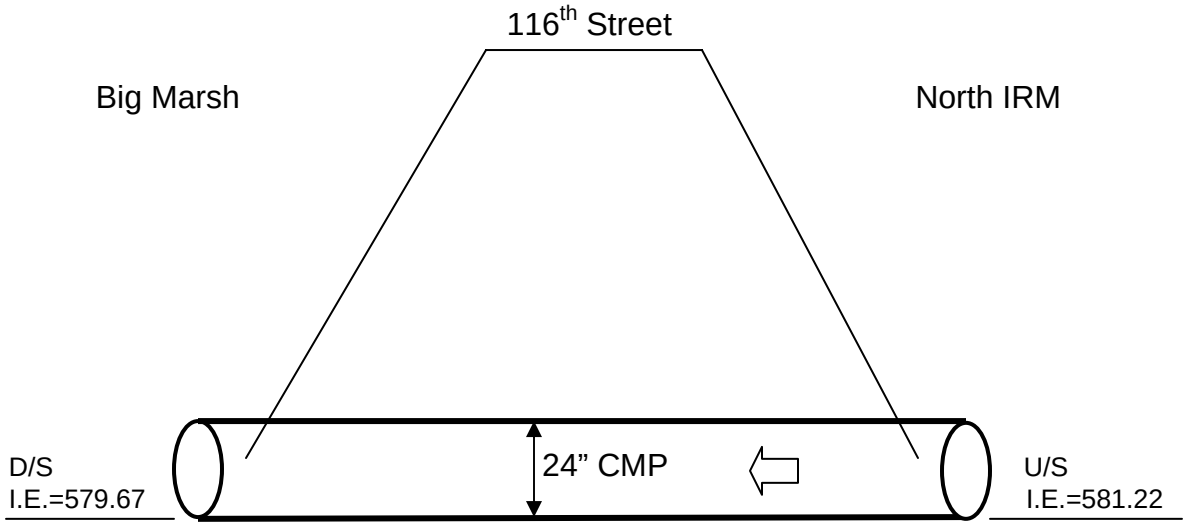


Figure 22: Structure #8 Hydraulic Geometry.

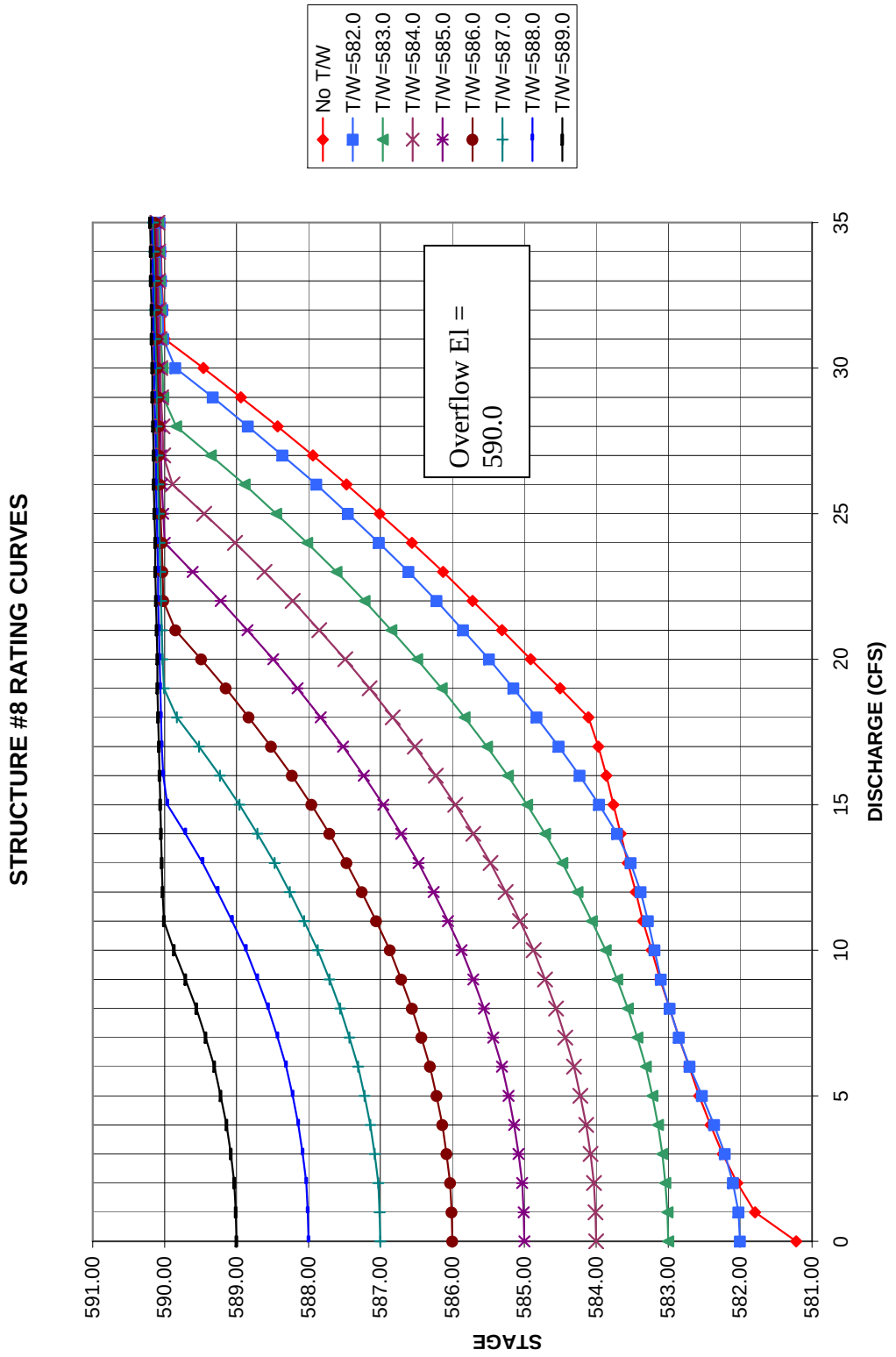


Figure 23: Structure #8 Rating Curves.

4.9 Structures #9-13 and #16 – Pullman Creek Culverts

These structures consist of a series of culverts that convey flow from the Illinois Department of Transportation right of way (I-57, I-94, and Stony Island Avenue) to Lake Calumet via Pullman Creek. These culverts are documented in the IDOT Hydraulic Report for Pumping Station 27 (2001). A hydraulic model developed in HEC-RAS has been established by IDOT for Pullman Creek, thus any proposed modifications to the culverts should be made in consultation with IDOT and using the existing hydraulic model. Accordingly, stage-discharge relationships for the individual culverts were not created as part of this report. Additional information regarding these culverts can be found in Volume III of the Calumet Area Hydrologic Master Plan.

Figure 24: Structure #9 – Pullman Creek Double Arch CMP Culverts Under Illinois International Port District Driveway at 116th Street.

Figure 25: Structure #10 – Pullman Creek Double Arch CMP Culverts Under Harborside International Golf Course Driveway at 111th Street.

Figure 26: Structure #11 – Box Culvert Under Doty Avenue at 110th Street.

4.10 Structure #14 – Coke Plant to Big Marsh

Structure #14 consists of a single 12” diameter culvert that regulates discharge from the Coke Plant to Big Marsh. Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 30.

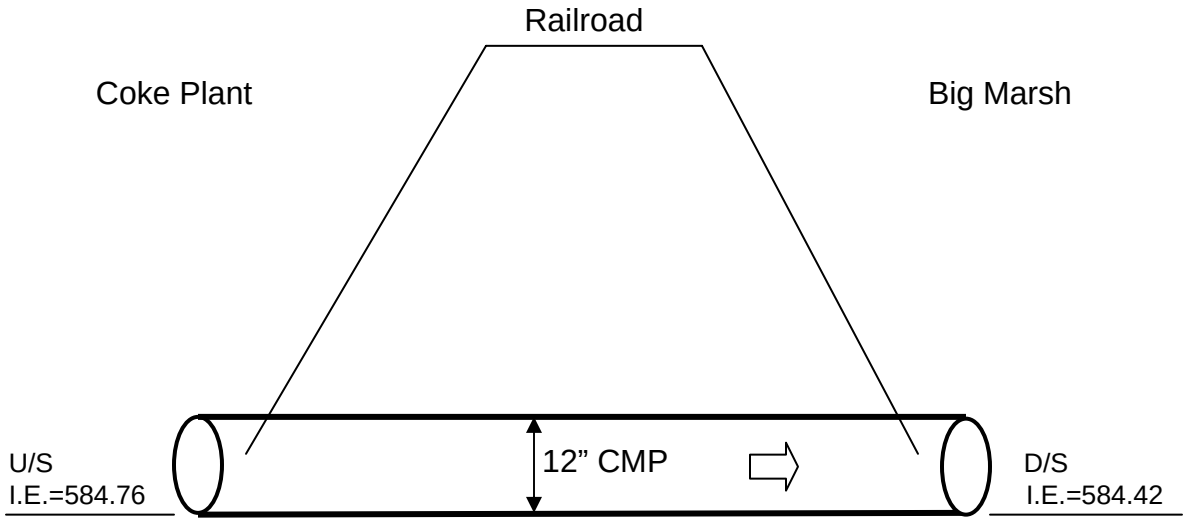


Figure 27: Structure #14 Hydraulic Geometry.

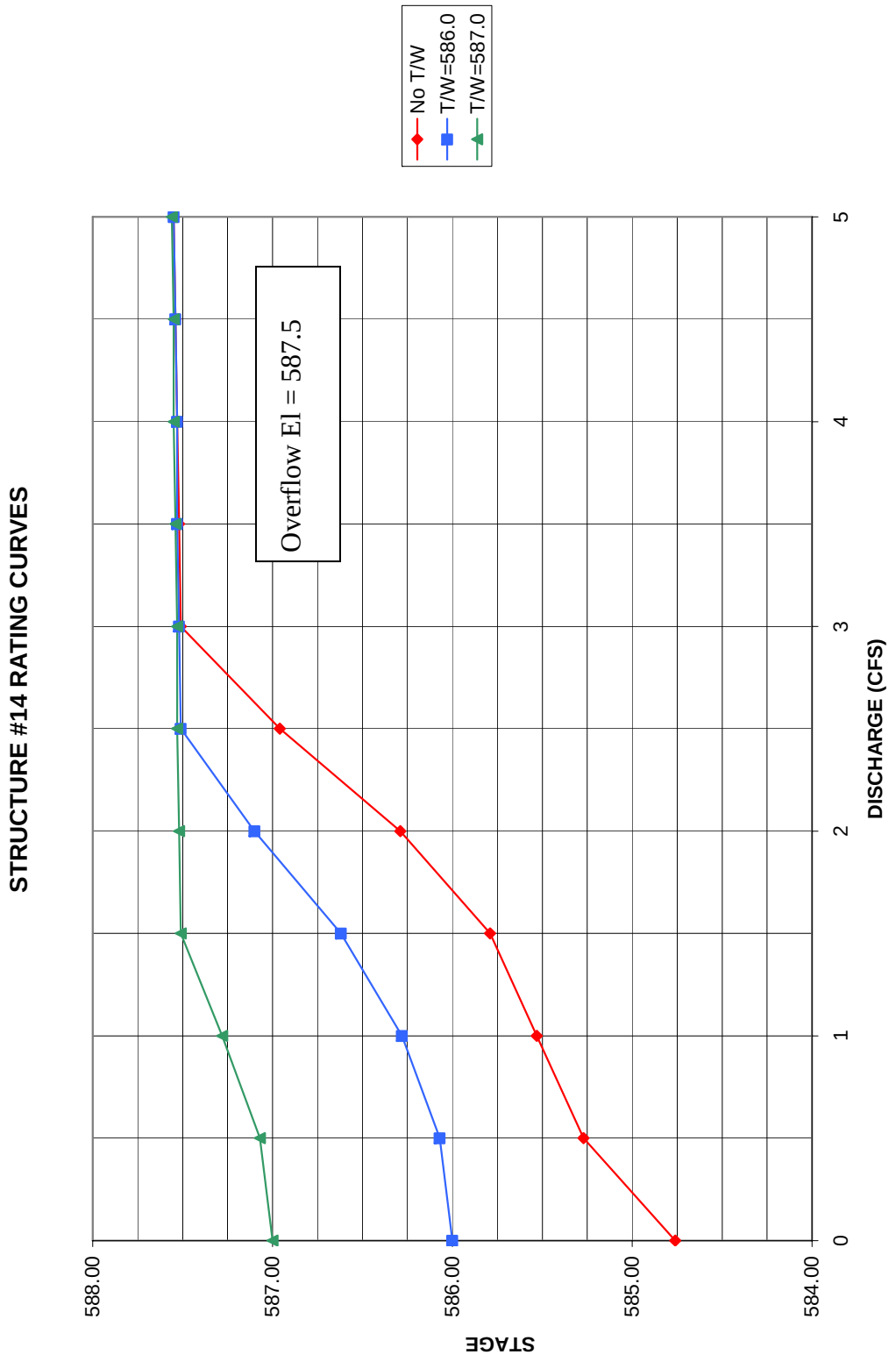
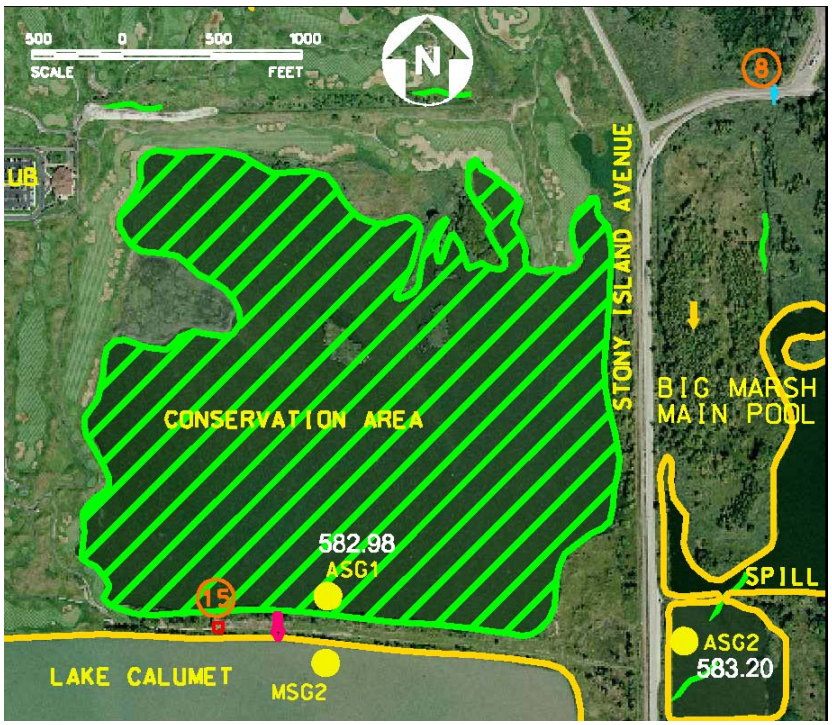


Figure 28: Structure #14 Rating Curves.

4.11 Structure #15 – Conservation Area to Lake Calumet

Structure #15 consists of two ductile iron pipe culverts 24" and 18" in diameter, which control discharge from the Conservation Area to Lake Calumet. Stop logs are provided on both pipes for control of upstream water surface elevations.

Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 32. Tailwater for the Calumet River was considered up to 583.0, the approximate high water level for Lake Calumet and the Calumet River as regulated by the Thomas J. O'Brien Lock and Dam and the level of Lake Michigan[7].



[7] Roadcap, 1999.

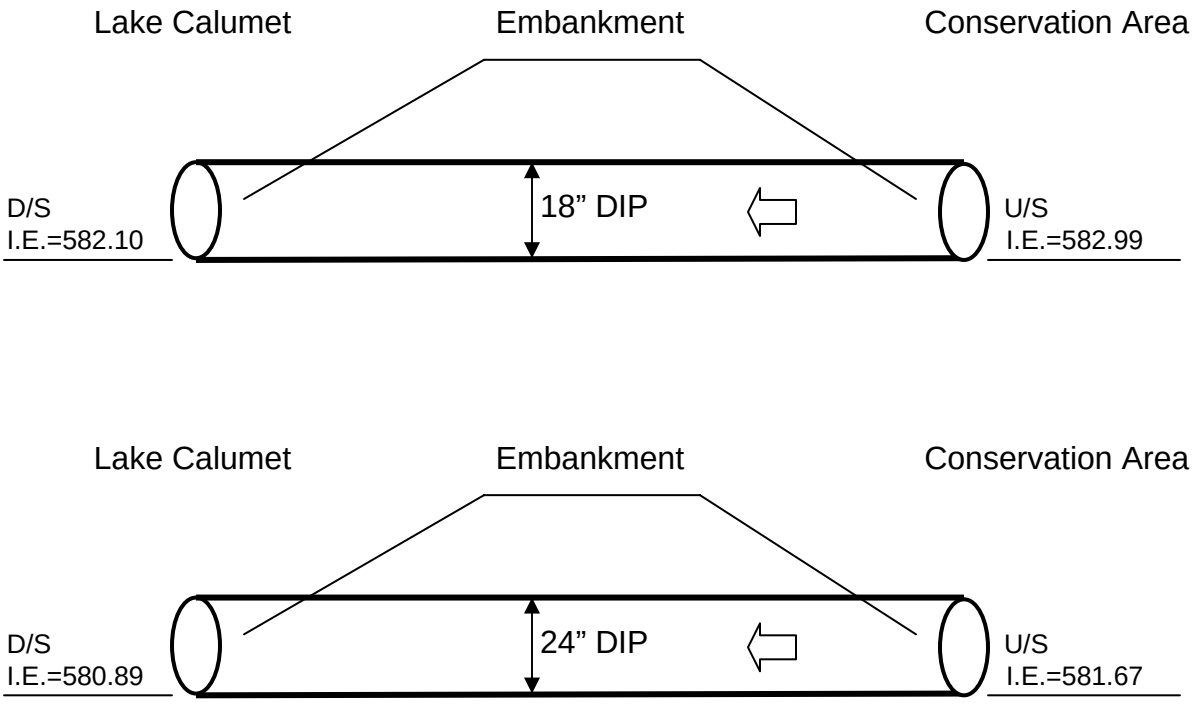


Figure 29: Structure #15 Hydraulic Geometry.

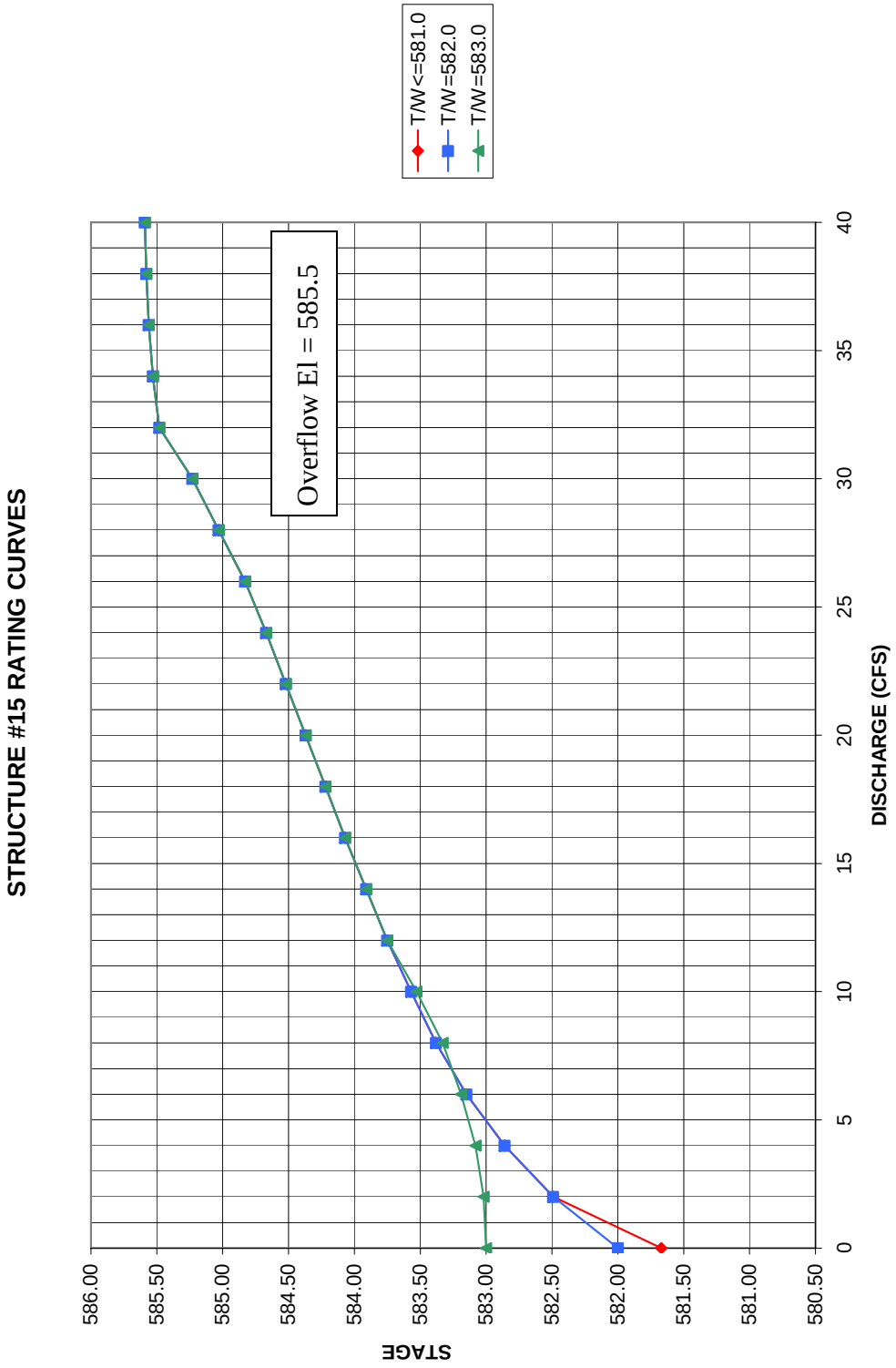


Figure 30: Structure #15 Rating Curves.

Figure 31: Structure #15 - Looking North.

Figure 32: Structure #15 - Looking South.

Figure 33: Structure #15.

4.12 Structure #17 – Indian Ridge Marsh South to Calumet River

Structure #17 consists of an open channel connecting Indian Ridge Marsh South to the Calumet River.

Stage-discharge relationships were developed for this structure based upon the surveyed geometry shown in Figure 34. Tailwater for the Calumet River was considered up to 583.0, the approximate high water level for Lake Calumet and the Calumet River as regulated by the Thomas J. O'Brien Lock and Dam and the level of Lake Michigan[8].

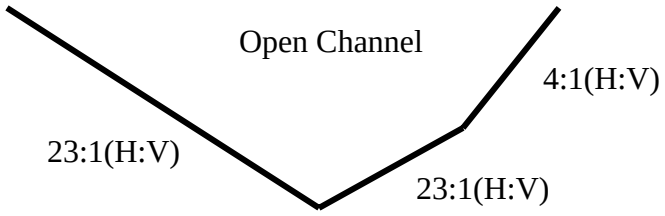


Figure 34: Structure #17 Hydraulic Geometry.

[8] Roadcap, 1999.

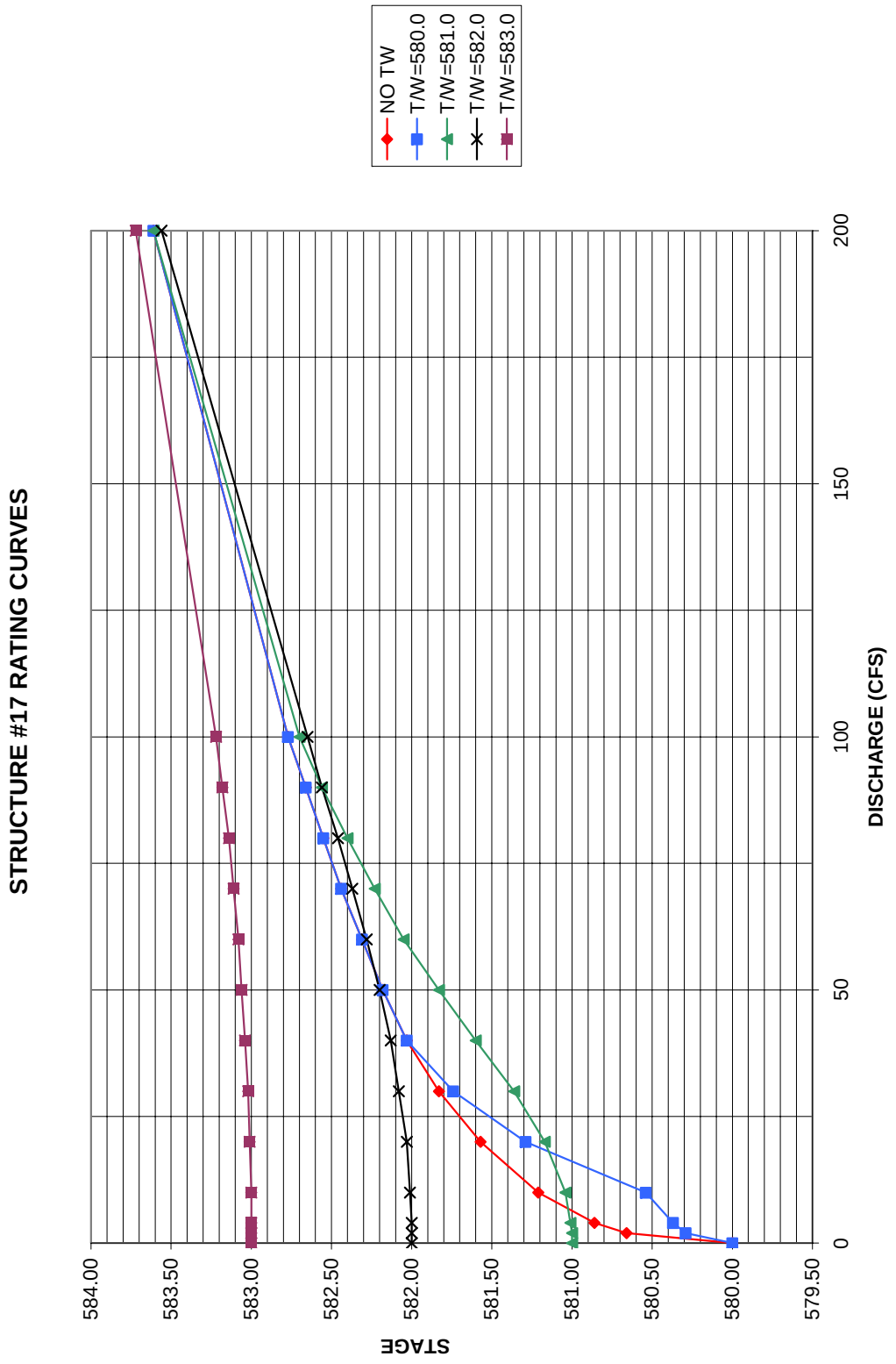


Figure 35: Structure #17 Rating Curves.

Figure 36: Structure #17 - Downstream End Looking North.

Figure 37: Structure #17 - Looking South From 122nd Street.

GLOSSARY

Automatic Staff Gage (ASG) : Apparatus installed to collect sufrace water elevations of water bodies at 15 minute intervals.

Anoxic : Water that contains little to no dissolved oxygen.

Conveyance Capacity : The maximum amount of water that can be transported downstream by a pipe or channel.

Discharge : The rate of water flowing out of a site.

Dredging : Process of removing sediment accumulation from lake and river bottoms.

Equality Formation : Tongues of glacial lake deposits that consist of silts, clays and sands.

Evapotranspiration : Proportion of waterbudget that is returned to the air through evaporation and transpiration (plant uptake).

Glacio-fluvial : Sediment or lithified sequence deposited from meltwater streams flowing from or within glaciers.

Glacio-lacustrine : Sediment or lithified sequence deposited within a glacial lake.

Gradient : Slope of a surface, generally pertaining to groundwater surfaces in these texts.

Headwater : The depth of water at the upstream end of a control structure or pipe.

HEC-RAS : Hydraulic Engineering Center – River Analysis System. A computation program widely used for developing water surface profiles for streams and ditches.

Hummock : Micro-topographic mounds that usually form from soil consolidation and poor surface water drainage.

Hydraulics : The determination of water surface elevations through relationships of flow and physical geography.

Hydrology : The determination of stormwater runoff rates and volumes for a study area based on rainfall data and physical geography.

Hydroperiod : A simulated or measured time duration of water elevations.

Infiltration : The downward movement of water through pores or small openings in soil or rock.

Inudation : Standing surface water.

Manual Staff Gage (MSG) : Apparatus installed within surface water body to visually observe surface water elevations (observations conducted once per month).

*All words are not necessarily referred to in text.

Mottles : Soil discolorations usually caused by chemical interactions between water and chemicals/minerals within the soil.

Orifice : A control structure ; a small opening, usually in a metal plate or wall, used to restrict the amount of water discharging from a site.

Permeability : The capacity of rock or sediment for transmitting fluid flow under unequal pressure.

Piezometer : A well installed into the ground that penetrates an underground water bearing unit – in which the groundwater elevation can be monitored along with its associated head.

Reduction : The removal of oxygen from soil or water.

Slag : Iron and steel manufacturing by-product. Waste material resulting from the impurities of mineral ore and ash from coke.

Stage-Discharge Rating Curve : A curve illustrating discharge rates for water leaving a site at given stages or elevations.

Seep : A location where groundwater discharges to the surface.

Stop Logs : Removable planks used to block water from leaving a site. The top stop log will set the normal pool level for a basin.

Stormwater Control Structure : A device, usually an orifice or a weir, used to regulate water discharge from a site.

Stratigraphy : The arrangement of rock and or soil types in chronologic order of sequence.

Submerged : Located entirely underwater.

Tailwater : The depth of water at the downstream end of a control structure or pipe.

Watershed : The area the drains to a similar point location or water body.

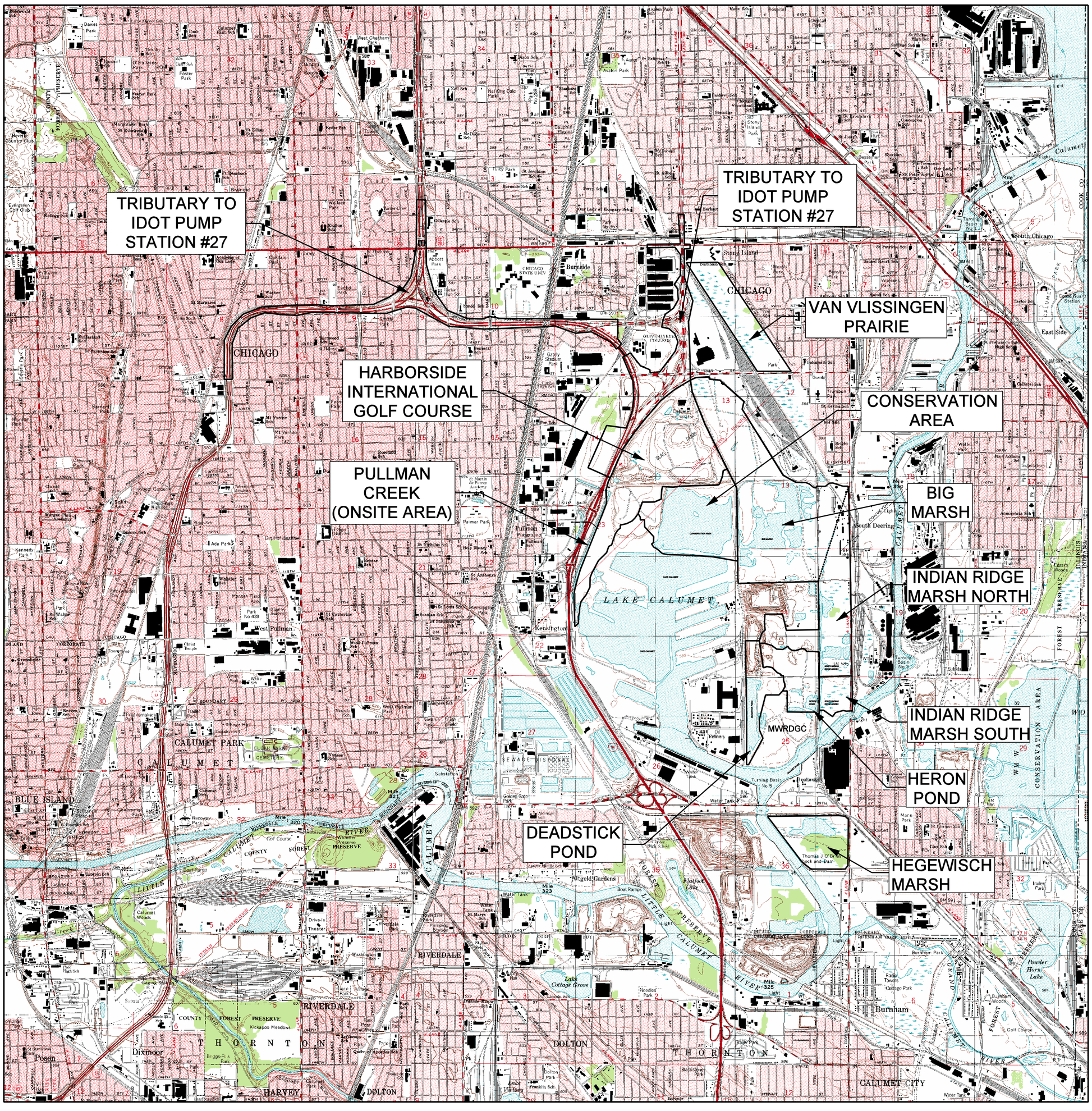
Weir : A control structure that prevents discharge from a site until the headwater exceeds the overflow elevation.

*All words are not necessarily referred to in text.

SECTION 1

CALUMET AREA HYDROLOGIC MASTER PLAN

WATERSHED BOUNDARY ATLAS



Produced by the United States Geological Survey
Control by USGS, NOS/NOAA and City of Chicago
Topography by photogrammetric methods from aerial photographs taken 1964 and planetable surveys 1927. Revised from aerial photographs taken 1988. Field checked 1991. Map edited 1991
Selected hydrographic data compiled from NOS chart 14905 (1986)
This information is not intended for navigational purposes
Projection: Illinois coordinate system, east zone (Transverse Mercator)
10,000-foot grid ticks: Illinois coordinate system, east zone and Indiana coordinate system, west zone
1000-meter Universal Transverse Mercator grid, zone 16
1927 North American Datum
The difference between 1927 North American Datum and North American Datum of 1983 (NAD 83) for 7.5 minute intersections is given in USGS Bulletin 1875. The NAD 83 is shown by dashed corner ticks
There may be private inholdings within the boundaries of the National or State reservations shown on this map
Red tint indicates areas in which only landmark buildings are shown

UTM GRID AND 1991 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET
REFERENCE LEVEL 578.8 FEET, APPROXIMATE MEAN GREAT LAKES DATUM
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE

COMPLIES WITH U.S. GEOLOGICAL SURVEY STANDARDS FOR SPATIAL ACCURACY - CLASS 2
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
ILLINOIS GEOLOGICAL SURVEY, CHAMPAIGN, ILLINOIS 61820
AND INDIANA DEPARTMENT OF NATURAL RESOURCES, INDIANAPOLIS, INDIANA 46204
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION
Primary highway, hard surface
Secondary highway, hard surface
Light duty road, hard or improved surface
Unimproved road
Interstate Route
U. S. Route
State Route

ESTIMATED WATERSHED BASIN TRIBUTARY AREA SCHEDULE

BASIN NAME	BASIN AREA
BIG MARSH	626 AC
CONSERVATION AREA	250 AC
DEADSTICK POND	90 AC
HERON POND	105 AC
INDIAN RIDGE MARSH NORTH	185 AC
PULLMAN CREEK (ONSITE AREA)	414 AC
IDOT PUMP STATION #27	457 AC
INDIAN RIDGE MARSH SOUTH	232 AC

WATERSHED BASIN DELINEATIONS ARE BASED UPON THE FOLLOWING RESOURCES:

1. V3 FIELD SURVEY (2004).
2. CITY OF CHICAGO TOPOGRAPHIC BASE MAPPING.
3. ILLINOIS DEPARTMENT OF TRANSPORTATION PULLMAN CREEK PUMP STATION REPORT. (HYDRAULIC REPORT, PUMPING STATION NO. 27, 2001)
4. CHICAGO DEPARTMENT OF WATER MANAGEMENT SEWER ATLASES.

2000 0 2000 4000
1" = 2000'
SCALE FEET

DRAWING NO. 1 OF 2

WATERSHED BOUNDARY ATLAS

CALUMET AREA HYDROLOGIC MASTER PLAN

CHICAGO IL

PROJECT NO.: 98216.HMP	DESIGNED BY:
FILE NAME: 1-COVERSHT	DRAWN BY: SWA
DATE: 03/31/06	CHECKED BY: DGD
SCALE: 1"=2000'	PROJECT MANAGER: KRO

SEAL:

REVISIONS

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

Visio, Vertere, Virtute... *The Vision to Transform with Excellence*

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...\Mstn\E202A\1-coversht-R.dgn 8/21/2006 3:02:52 PM

CALUMET AREA HYDROLOGIC MASTER PLAN

WATERSHED BOUNDARY ATLAS

LEGEND

- WATERSHED BASIN
- RUNOFF
- LOCAL OVERFLOW
- DITCH OR STREAM FLOW
- INLET
- CULVERT
- ISOLATED POND
- LAKE OR OPEN WATER
- (#) STRUCTURE NUMBER

STRUCTURE NOTES

1. DROP INLET DRAINS DEADSTICK POND TO CALUMET RIVER.
2. ABANDONED WEIR STRUCTURE IN HERON POND'S OUTFALL DITCH.
3. 24" CMP CULVERT UNDER 122ND STREET.
4. STORM SEWER OUTFALL IDENTIFIED BY ROSS (1988) (HAS NOT BEEN VERIFIED IN THE FIELD).
5. DROP INLET DRAINS BIG MARSH TO LAKE CALUMET.
6. ABANDONED CULVERTS UNDER RAILROAD.
7. CMP CULVERT UNDER 116TH STREET.
8. CULVERT UNDER RAILROAD.
9. DOUBLE CORRUGATED METAL PIPE ARCH CULVERT IN PULLMAN CREEK.
10. DOUBLE CORRUGATED METAL PIPE ARCH CULVERT IN PULLMAN CREEK.
11. BOX CULVERT UNDER DOTY AVENUE.
12. BOX CULVERT UNDER I-94.
13. CMP CULVERT UNDER ACCESS ROAD TO GOLF CLUB HOUSE.
14. CULVERT 12" CMP FROM COKE PLANT TO BIG MARSH.
15. DROP INLET DRAINS CONSERVATION AREAS TO LAKE CALUMET.
16. 42" STORM SEWER FROM HARBORSIDE INTERNATIONAL GOLF COURSE.
17. OUTLET CHANNEL FROM INDIAN RIDGE MARSH SOUTH TO CALUMET RIVER.

STRUCTURE TRIBUTARY AREA SCHEDULE	
STRUCTURE IDENTIFIER	TRIBUTARY AREA
1	90 AC
2	105 AC
3	185 AC
4	19 AC
5	626 AC
6	116 AC
7	62 AC
8	250 AC
9	852 AC
10	813 AC
11	N/A
12	N/A
13+16	319 AC
14	62 AC
15	250 AC
17	232 AC

BASIN OVERFLOW ELEVATION SCHEDULE	
OVERFLOW LOCATION	OVERFLOW ELEVATION
122ND STREET TO HERON POND	589.0
INDIAN RIDGE MARSH NORTH TO INDIAN RIDGE MARSH SOUTH	586.0
INDIAN RIDGE MARSH NORTH TO TORRENCE AVENUE	584.8
CONSERVATION AREA TO LAKE CALUMET	585.5
STRUCTURE 1	588.5
STRUCTURE 2	N/A
STRUCTURE 3	594.0
STRUCTURE 5	588.9
STRUCTURE 7	588.5
STRUCTURE 8	590.0
STRUCTURE 14	587.5
STRUCTURE 15	585.5
STRUCTURE 17	N/A

N W E S

600 0 600 1200
1"=600'
SCALE FEET

NOTE: AERIAL PHOTOGRAPHY YEAR 2000.

DRAWING NO. 2 OF 2

WATERSHED BOUNDARY ATLAS

CALUMET AREA HYDROLOGIC MASTER PLAN

CHICAGO IL

PROJECT NO.: 98216.HMP	DESIGNED BY:
FILE NAME: 2-AERIAL	DRAWN BY: SWA
DATE: 03/31/06	CHECKED BY: GVW
SCALE: 1"=600'	PROJECT MANAGER: KRO

SEAL:

REVISIONS

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

Visio, Vertere, Virtute... *"The Vision to Transform with Excellence"*

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SECTION 2

LAKE CALUMET HMP
STRUCTURE RATING CURVES

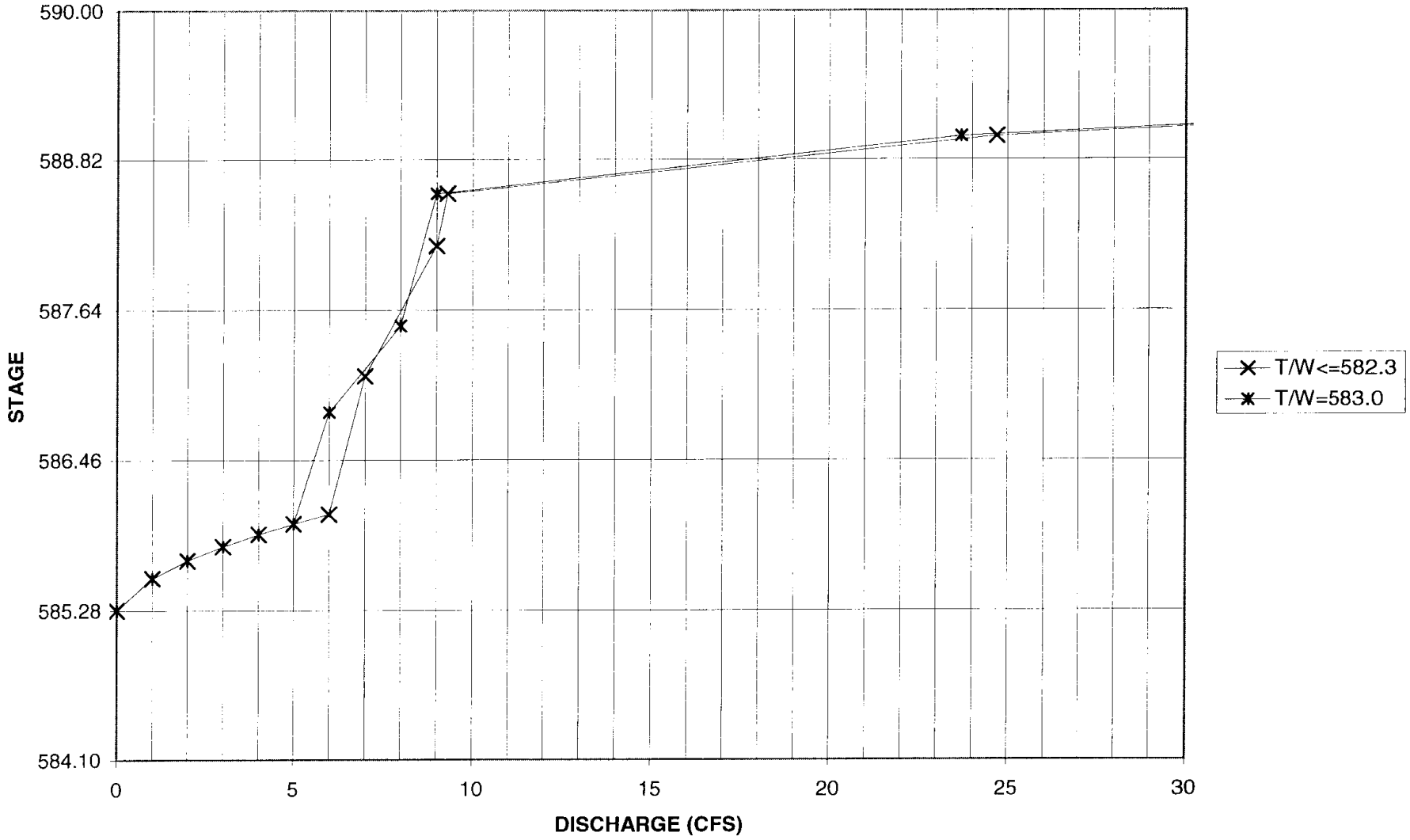
STRUCTURE NO: 1 - DEADSTICK POND
ENGINEER: SWA
DATE: 11-7-05

CHECKED BY: DGD
DATE: 11-7-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS	
	TAILWATER	
	<=582.3	583
0	585.28	585.28
1	585.53	585.53
2	585.67	585.67
3	585.78	585.78
4	585.87	585.87
5	585.96	585.96
6	586.03	586.84
7	587.12	
8		587.51
9	588.14	588.55
9.3	588.55	
24.7	589.00	
99.8	590.00	
23.7		589.00
98.8		590.00

STRUCTURE #1 RATING CURVES



LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	1		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-7-05	DATE:	11-7-05

PIPE FLOW FROM STRUCTURE TO OUTLET

U/S I.E.	581.8	h	1.00 FT
D/S I.E.	581.10	U/S CROWN EL	583.3
TAILWATER ELEVATION	582.3	D/S CROWN EL	582.6
n	0.024	Qf	4.01 CFS
D	18.00 IN	Vf	2.27 FPS
L	201.00 FT	A	1.77 SF
		R	0.38

Culvert Designer/Analyzer Report
Deadstick Structure #1

Analysis Component			
Storm Event	Design	Discharge	10.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	10.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	582.30 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	10.00 cfs	589.42 ft	6.50 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Deadstick Structure #1

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.42 ft	Discharge	10.00 cfs
Inlet Control HW Elev	584.05 ft	Tailwater Elevation	582.30 ft
Outlet Control HW Elev	589.42 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.08		

Grades			
Upstream Invert	581.80 ft	Downstream Invert	581.10 ft
Length	201.00 ft	Constructed Slope	0.003483 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	1.22 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.22 ft
Velocity Downstream	6.50 ft/s	Critical Slope	0.031377 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.42 ft	Upstream Velocity Head	0.50 ft
Ke	0.50	Entrance Loss	0.25 ft

Inlet Control Properties			
Inlet Control HW Elev	584.05 ft	Flow Control	Submerged
Inlet Type	Headwall	Area Full	1.8 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
Deadstick Structure #1

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	10.00	0.10 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.80
0.10	582.30
0.20	582.31
0.30	582.33
0.40	582.35
0.50	582.37
0.60	582.39
0.70	582.42
0.80	582.44
0.90	582.47
1.00	582.50
1.10	582.52
1.20	582.55
1.30	582.58
1.40	582.60
1.50	582.63
1.60	582.66
1.70	582.68
1.80	582.71
1.90	582.74
2.00	582.76
2.10	582.79
2.20	582.82
2.30	582.84
2.40	582.87
2.50	582.90
2.60	582.92
2.70	582.95
2.80	582.97
2.90	583.00
3.00	583.03
3.10	583.06
3.20	583.09
3.30	583.11
3.40	583.14
3.50	583.18
3.60	583.21
3.70	583.24
3.80	583.28
3.90	583.31
4.00	583.35
4.10	583.40
4.20	583.48
4.30	583.55
4.40	583.62
4.50	583.68
4.60	583.75
4.70	583.82

Rating Table Report
Deadstick Structure #1

Discharge (cfs)	HW Elev (ft)
4.80	583.89
4.90	583.97
5.00	584.04
5.10	584.11
5.20	584.19
5.30	584.26
5.40	584.34
5.50	584.42
5.60	584.50
5.70	584.58
5.80	584.67
5.90	584.75
6.00	584.84
6.10	584.92
6.20	585.01
6.30	585.10
6.40	585.19
6.50	585.29
6.60	585.38
6.70	585.48
6.80	585.57
6.90	585.67
7.00	585.77
7.10	585.87
7.20	585.97
7.30	586.08
7.40	586.18
7.50	586.29
7.60	586.40
7.70	586.51
7.80	586.62
7.90	586.73
8.00	586.84
8.10	586.96
8.20	587.08
8.30	587.19
8.40	587.31
8.50	587.44
8.60	587.56
8.70	587.68
8.80	587.81
8.90	587.93
9.00	588.06
9.10	588.19
9.20	588.32
9.30	588.45
9.40	588.59
9.50	588.72
9.60	588.86
9.70	589.00
9.80	589.14
9.90	589.28
10.00	589.42

WEIR / ORIFICE DATA

WEIR 1

L	2.83 FT
CREST EL	585.28
WEIR TOP	587.55

WEIR SUBMERGENCE

INVERT	585.28 FT
CENTER	586.42 FT
AREA	6.43 SF
C	0.61

WEIR/ORIFICE HYDRAULICS (INLET CONTROL)

		WEIR 1 (INLET CONTROL)				
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)	CONTROL
1	582.50	2.8	0.25	WEIR	585.53	WEIR
2	582.76	2.92	0.39	WEIR	585.67	WEIR
3	583.03	3	0.50	WEIR	585.78	WEIR
4	583.35	3.08	0.59	WEIR	585.87	WEIR
5	584.04	3.17	0.68	WEIR	585.96	WEIR
6	584.84	3.25	0.75	WEIR	586.03	WEIR
7	585.77	3.32	SUBMERGED WEIR			S WEIR
8	586.84	3.32	SUBMERGED WEIR			S WEIR
9	588.06	3.32	ORIFICE	0.08	588.14	ORIFICE

WEIR FLOW: Q=CL*h^(3/2)
SUBMERGED WEIR FLOW: Q=Qf*[1-(H2/H1)^1.5]^.385, Qf=C(H1)^1.5
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
L	2.83 FT	TYPE	0
CREST EL	585.28	WIDTH 1	0.00 FT
WEIR TOP	587.55	WIDTH 2	0.00 FT
		C	0
WEIR SUBMERGENCE		GRATE	0
INVERT	585.28 FT	INVERT	0
CENTER	586.42 FT	AREA	0.00 SF
AREA	6.43 SF		
C	0.61		

WEIR/ORIFICE HYDRAULICS (OUTLET CONTROL-PT1)

		WEIR 1 (SUBMERGED WEIR)						
Q (CFS)	D/S WSL (FT)	C	TAILWATER HEAD (H2) (FT)	H1 TRIAL (FT)	Q1 (CFS)	H1 (FT)	U/S WSL (FT)	CONTROL
1	582.50	2.8	INLET	INLET	INLET	INLET	585.53	WEIR
2	582.76	2.92	INLET	INLET	INLET	INLET	585.67	WEIR
3	583.03	2.92	INLET	INLET	INLET	INLET	585.78	WEIR
4	583.35	3.08	INLET	INLET	INLET	INLET	585.87	WEIR
5	584.04	3.08	INLET	INLET	INLET	INLET	585.96	WEIR
6	584.84	3.3	INLET	INLET	INLET	INLET	586.03	WEIR
7	585.77	3.3	0.49	1.84	8.24	1.84	587.12	S WEIR
8	586.84	3.3	1.56	2.53	13.28	2.52		TRANS
9	588.06	3.32	ORIFICE	ORIFICE	ORIFICE	ORIFICE	588.14	ORIFICE

WEIR FLOW: Q=CL*h^(3/2)
SUBMERGED WEIR FLOW: Q=Qf*[1-(H2/H1)^1.5]^.385, Qf=C(H1)^1.5
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

OVERFLOW DATA

AT Q = 9 CFS, HEAD ON OUTLET PIPE IS APPROACHING STRUCTURE RIM.
AS WEIR PROVIDES MINIMAL RESTRICTION, WSL REACHES TOP OF
STRUCTURE OUTSIDE OF CONTROL STRUCTURE AND INSIDE OF CONTROL
STRUCTURE NEAR SIMULTANEOUSLY. EFFECTIVE GRATE CAPACITY = 0.

STRUCTURE OVERFLOW
ASSUME 20' WIDE OVERFLOW PATH
RIM = 588.55 C=2.6

ELEVATION	HEAD	OVERFLOW Q	PIPE Q	TOTAL Q
FT	FT	CFS	CFS	CFS
590	1.45	90.8	9	99.8
589	0.45	15.7	9	24.7

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	1		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-7-05	DATE:	11-7-05

PIPE FLOW FROM STRUCTURE TO OUTLET

U/S I.E.	581.8	h	0.30 FT
D/S I.E.	581.10	U/S CROWN EL	583.3
TAILWATER ELEVATION	583	D/S CROWN EL	582.6
n	0.024	Qf	2.20 CFS
D	18.00 IN	Vf	1.24 FPS
L	201.00 FT	A	1.77 SF
		R	0.38

Culvert Designer/Analyzer Report
Deadstick Structure #1

Analysis Component			
Storm Event	Design	Discharge	10.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	10.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	583.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-18 inch Circular	10.00 cfs	589.96 ft	5.66 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Deadstick Structure #1

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.96 ft	Discharge	10.00 cfs
Inlet Control HW Elev	584.05 ft	Tailwater Elevation	583.00 ft
Outlet Control HW Elev	589.96 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.44		

Grades			
Upstream Invert	581.80 ft	Downstream Invert	581.10 ft
Length	201.00 ft	Constructed Slope	0.003483 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	1.90 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.22 ft
Velocity Downstream	5.66 ft/s	Critical Slope	0.031377 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.96 ft	Upstream Velocity Head	0.50 ft
Ke	0.50	Entrance Loss	0.25 ft

Inlet Control Properties			
Inlet Control HW Elev	584.05 ft	Flow Control	Submerged
Inlet Type	Headwall	Area Full	1.8 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

SDI Consultants Ltd
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Rating Table Report
Deadstick Structure #1

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	10.00	0.10 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.80
0.10	583.00
0.20	583.00
0.30	583.01
0.40	583.01
0.50	583.02
0.60	583.03
0.70	583.03
0.80	583.04
0.90	583.06
1.00	583.07
1.10	583.08
1.20	583.10
1.30	583.12
1.40	583.13
1.50	583.15
1.60	583.17
1.70	583.20
1.80	583.22
1.90	583.25
2.00	583.28
2.10	583.31
2.20	583.34
2.30	583.37
2.40	583.40
2.50	583.43
2.60	583.47
2.70	583.51
2.80	583.55
2.90	583.58
3.00	583.63
3.10	583.67
3.20	583.71
3.30	583.76
3.40	583.80
3.50	583.85
3.60	583.90
3.70	583.95
3.80	584.00
3.90	584.06
4.00	584.11
4.10	584.17
4.20	584.23
4.30	584.29
4.40	584.35
4.50	584.41
4.60	584.47
4.70	584.54

Rating Table Report
Deadstick Structure #1

Discharge (cfs)	HW Elev (ft)
4.80	584.60
4.90	584.67
5.00	584.74
5.10	584.81
5.20	584.88
5.30	584.95
5.40	585.03
5.50	585.10
5.60	585.18
5.70	585.26
5.80	585.34
5.90	585.42
6.00	585.50
6.10	585.59
6.20	585.67
6.30	585.76
6.40	585.85
6.50	585.94
6.60	586.03
6.70	586.12
6.80	586.22
6.90	586.31
7.00	586.41
7.10	586.51
7.20	586.61
7.30	586.71
7.40	586.81
7.50	586.91
7.60	587.02
7.70	587.12
7.80	587.23
7.90	587.34
8.00	587.45
8.10	587.56
8.20	587.68
8.30	587.79
8.40	587.91
8.50	588.03
8.60	588.14
8.70	588.26
8.80	588.39
8.90	588.51
9.00	588.63
9.10	588.76
9.20	588.89
9.30	589.02
9.40	589.15
9.50	589.28
9.60	589.41
9.70	589.54
9.80	589.68
9.90	589.82
10.00	589.96

WEIR / ORIFICE DATA

WEIR 1

L	2.83 FT
CREST EL	585.28
WEIR TOP	587.55

WEIR SUBMERGENCE

INVERT	585.28 FT
CENTER	586.42 FT
AREA	6.43 SF
C	0.61

WEIR/ORIFICE HYDRAULICS (INLET CONTROL)

		WEIR 1 (INLET CONTROL)				
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)	CONTROL
1	583.07	2.83	0.25	WEIR	585.53	WEIR
2	583.28	2.92	0.39	WEIR	585.67	WEIR
3	583.63	3	0.50	WEIR	585.78	WEIR
4	584.11	3.08	0.59	WEIR	585.87	WEIR
5	584.74	3.17	0.68	WEIR	585.96	WEIR
6	585.50	3.25	SUBMERGED WEIR			S WEIR
7	586.41	3.32	SUBMERGED WEIR			S WEIR
8	587.45	3.32	ORIFICE	0.06	587.51	ORIFICE

WEIR FLOW: Q=CL*h^(3/2)
SUBMERGED WEIR FLOW: Q=Qf*[1-(H2/H1)^1.5]^.385, Qf=C(H1)^1.5
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

WEIR / ORIFICE DATA

WEIR 1

L	2.83	FT
CREST EL	585.28	
WEIR TOP	587.55	

WEIR SUBMERGENCE

INVERT	585.28	FT
CENTER	586.42	FT
AREA	6.43	SF
C	0.61	

WEIR/ORIFICE HYDRAULICS (OUTLET CONTROL-PT1)

		WEIR 1 (SUBMERGED WEIR)						
Q	D/S WSL	C	TAILWATER	H1 TRIAL	Q1	H1	U/S WSL	CONTROL
(CFS)	(FT)		HEAD (H2) (FT)	(FT)	(CFS)	(FT)	(FT)	
1	583.07	2.8	INLET	INLET	INLET	INLET	585.53	WEIR
2	583.28	2.92	INLET	INLET	INLET	INLET	585.67	WEIR
3	583.63	3	INLET	INLET	INLET	INLET	585.78	WEIR
4	584.11	3.08	INLET	INLET	INLET	INLET	585.87	WEIR
5	584.74	3.17	INLET	INLET	INLET	INLET	585.96	WEIR
6	585.50	3.32	0.22	1.57	6.50	1.56	586.84	S WEIR
7	586.41	3.32	1.13	2.14	10.39	2.14		TRANS
8	587.45	3.32	ORIFICE	ORIFICE	ORIFICE	ORIFICE	587.51	ORIFICE

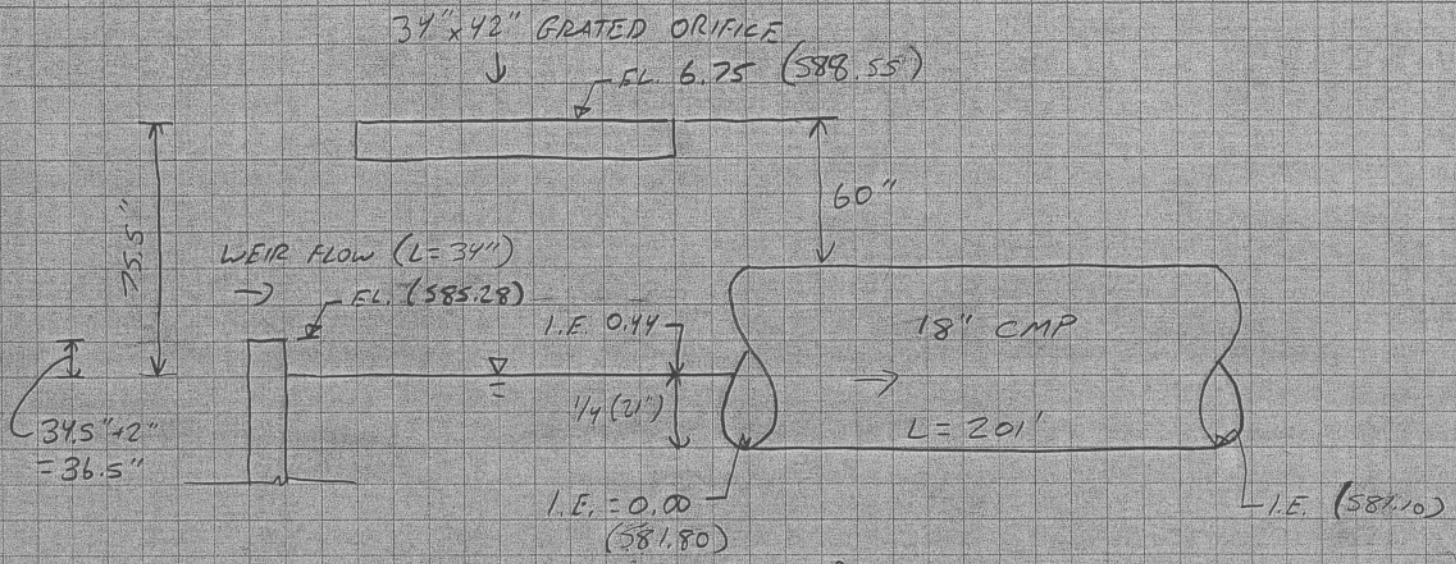
WEIR FLOW: Q=CL*h^(3/2)
SUBMERGED WEIR FLOW: Q=Qf*[1-(H2/H1)^1.5]^.385, Qf=C(H1)^1.5
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

OVERFLOW DATA

AT Q = 9 CFS, HEAD ON OUTLET PIPE IS APPROACHING STRUCTURE RIM. AS WEIR PROVIDES MINIMAL RESTRICTION, WSL REACHES TOP OF STRUCTURE OUTSIDE OF CONTROL STRUCTURE AND INSIDE OF CONTROL STRUCTURE NEAR SIMULTANEOUSLY. EFFECTIVE GRATE CAPACITY = 0.

STRUCTURE OVERFLOW
ASSUME 20' WIDE OVERFLOW PATH
RIM = 588.55 C=2.6

ELEVATION	HEAD	OVERFLOW Q	PIPE Q	TOTAL Q
FT	FT	CFS	CFS	CFS
590	1.45	90.8	8	98.8
589	0.45	15.7	8	23.7



PIPE LENGTH ESTIMATED FROM EDI SURVEY AND DOE MAPPING.

T/W

CALUMET RIVER NWL = 576.00 +/-
HWL = ?

DATUM DETERMINED BY COMPARISON OF FIELD MEASUREMENTS WITH EDI SURVEY AND BASE MAPPING FROM DOE.

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 11-7-05		SUBJECT: STRUCTURE #1
CHECKED: DGD	ENGINEERING CALCULATIONS	SHEET NO:
DATE: 11-7-05		

DEVELOP RATING CURVES FOR STRUCTURE WITH VARIABLE TAILWATER CONDITIONS.

1. T/W < 581.10 + 0.8D = FREE OUTFALL
   581.10 + 0.8(18/12)
   582.30

A. DEVELOP RATING CURVE FOR PIPE WITH T/W = 582.30

$\emptyset$ = 18"
n = 0.024 [CMP]
L = 201'
h = 581.80 + 1.5 - 582.30 = 1.00'

EXIT LOSS: $H_o = 1.0\left(\frac{V_o^2}{2g} - \frac{V_d^2}{2g}\right)$ HEC-22 (7-4)

V_o = PIPE VELOCITY
V_d = CHANNEL VELOCITY DOWNSTREAM

FOR CHANNEL FLOW IN SAME DIRECTION AS OUTLET, $V_o \sim V_d$, THEREFORE $H_o = 0$. (FHWA HEC-22 7.1.6.2)

ENTRANCE LOSS: $H_{AH} = K_{AH}\left(\frac{V_o^2}{2g}\right) = H_i$ HEC-22 (7-9)

K_{AH} = 0.5 FOR INLET WITH STRAIGHT PIPE RUN. HEC-22 (T7-5A)
V_o = PIPE VELOCITY

FRICTION LOSS: $H_f = L\left(\frac{Qn}{1.486 A R^{2/3}}\right)^2$ PRESSURE FLOW

H_f = REFER TO HYDRAULIC GRAVITY FLOW ELEMENTS CHART

U/S WSL = T/W + H_o + H_f + H_i

USE U/S WSL AS D/S WSL FOR WEIR/ORIFICE CALCULATIONS

COMPUTED: SWA	CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 11-7-05		SUBJECT: STRUCTURE #1
CHECKED: DGD	ENGINEERING CALCULATIONS	SHEET NO:
DATE: 11-7-05		

B. CALCULATE HEAD ON WEIR

1. FOR D/S WSL < WEIR CREST, ANALYZE AS WEIR

$Q = C L H^{3/2}$ U/S WSL = H + WEIR CREST

$H = \left(\frac{Q}{CL}\right)^{2/3}$

Q = FLOW (CFS)
C = COEFFICIENT (SEE ATTACHED TABLE)
L = WEIR LENGTH (FT)
H = HEAD (FT)

IF HEAD EXCEEDS WEIR CROWN, ANALYZE AS ORIFICE

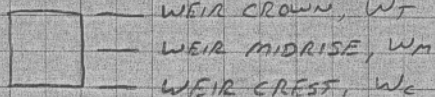
2. FOR D/S WSL > WEIR CREST, ANALYZE AS SUBMERGED WEIR

$Q_f = Q_1\left[1-(H_2/H_1)^{1.5}\right]^{.385}$ $Q_1 = CH_1^{1.5}$ HEC-22

3. FOR HEAD > WEIR CROWN, ANALYZE AS SIDE ORIFICE

$Q = CA\sqrt{2gh}$

$H = \left(\frac{Q}{CA}\right)^2\left(\frac{1}{2g}\right)$



$W_m = \frac{(W_T - W_c)}{2} + W_c$

Q = FLOW (CFS)
C = 0.61
A = ORIFICE AREA (SF)
g = 32.2 (FT/S²)
H = HEAD

U/S WSL = H + MAX (D/S WSL, W_m)

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 11-7-05		SUBJECT: STRUCTURE #1
CHECKED: DGD		
DATE: 11-7-05	ENGINEERING CALCULATIONS	SHEET NO:

Table 8-1. SI Units - Broad-Crested Weir Coefficient C Values as a Function of Weir Crest.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest Breadth and Head (coefficient has units of $m^{0.5}$/sec).[1]															
Head[2] (m)	Breadth of Crest of Weir (m)														
	0.15	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.25	1.50	2.00	3.00	4.00
0.10	1.59	1.56	1.50	1.47	1.45	1.43	1.42	1.41	1.40	1.39	1.37	1.35	1.36	1.40	1.45
0.15	1.65	1.60	1.51	1.48	1.45	1.44	1.44	1.44	1.45	1.45	1.44	1.43	1.44	1.45	1.47
0.20	1.73	1.66	1.54	1.49	1.46	1.44	1.44	1.45	1.47	1.48	1.48	1.49	1.49	1.49	1.48
0.30	1.83	1.77	1.64	1.56	1.50	1.47	1.46	1.46	1.46	1.47	1.47	1.48	1.48	1.48	1.46
0.40	1.83	1.80	1.74	1.65	1.57	1.52	1.49	1.47	1.46	1.46	1.47	1.47	1.47	1.48	1.47
0.50	1.83	1.82	1.81	1.74	1.67	1.60	1.55	1.51	1.48	1.48	1.47	1.46	1.46	1.46	1.45
0.60	1.83	1.83	1.82	1.73	1.65	1.58	1.54	1.46	1.31	1.34	1.48	1.46	1.46	1.46	1.45
0.70	1.83	1.83	1.83	1.78	1.72	1.65	1.60	1.53	1.44	1.45	1.49	1.47	1.47	1.46	1.45
0.80	1.83	1.83	1.83	1.82	1.79	1.72	1.66	1.60	1.57	1.55	1.50	1.47	1.47	1.46	1.45
0.90	1.83	1.83	1.83	1.83	1.81	1.76	1.71	1.66	1.61	1.58	1.50	1.47	1.47	1.46	1.45
1.00	1.83	1.83	1.83	1.83	1.82	1.81	1.76	1.70	1.64	1.60	1.51	1.48	1.47	1.46	1.45
1.10	1.83	1.83	1.83	1.83	1.83	1.83	1.80	1.75	1.66	1.62	1.52	1.49	1.47	1.46	1.45
1.20	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.79	1.70	1.65	1.53	1.49	1.48	1.46	1.45
1.30	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.82	1.77	1.71	1.56	1.51	1.49	1.46	1.45
1.40	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.77	1.60	1.52	1.50	1.46	1.45
1.50	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.79	1.66	1.55	1.51	1.46	1.45
1.60	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.81	1.74	1.58	1.53	1.46	1.45

(1) Modified from reference 49 (2) Measured at le a st 2.5 H_c upstream of the weir

Table 8-1. English Units - Broad-Crested Weir Coefficient C Values as a Function of Weir Crest.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest Breadth and Head (coefficient has units of $ft^{0.5}$/sec).[1]											
Head[2] (ft)	Breadth of Crest of Weir (ft)										
	0.50	0.75	1.00	1.5	2.0	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

(1) Table is taken from reference 49.

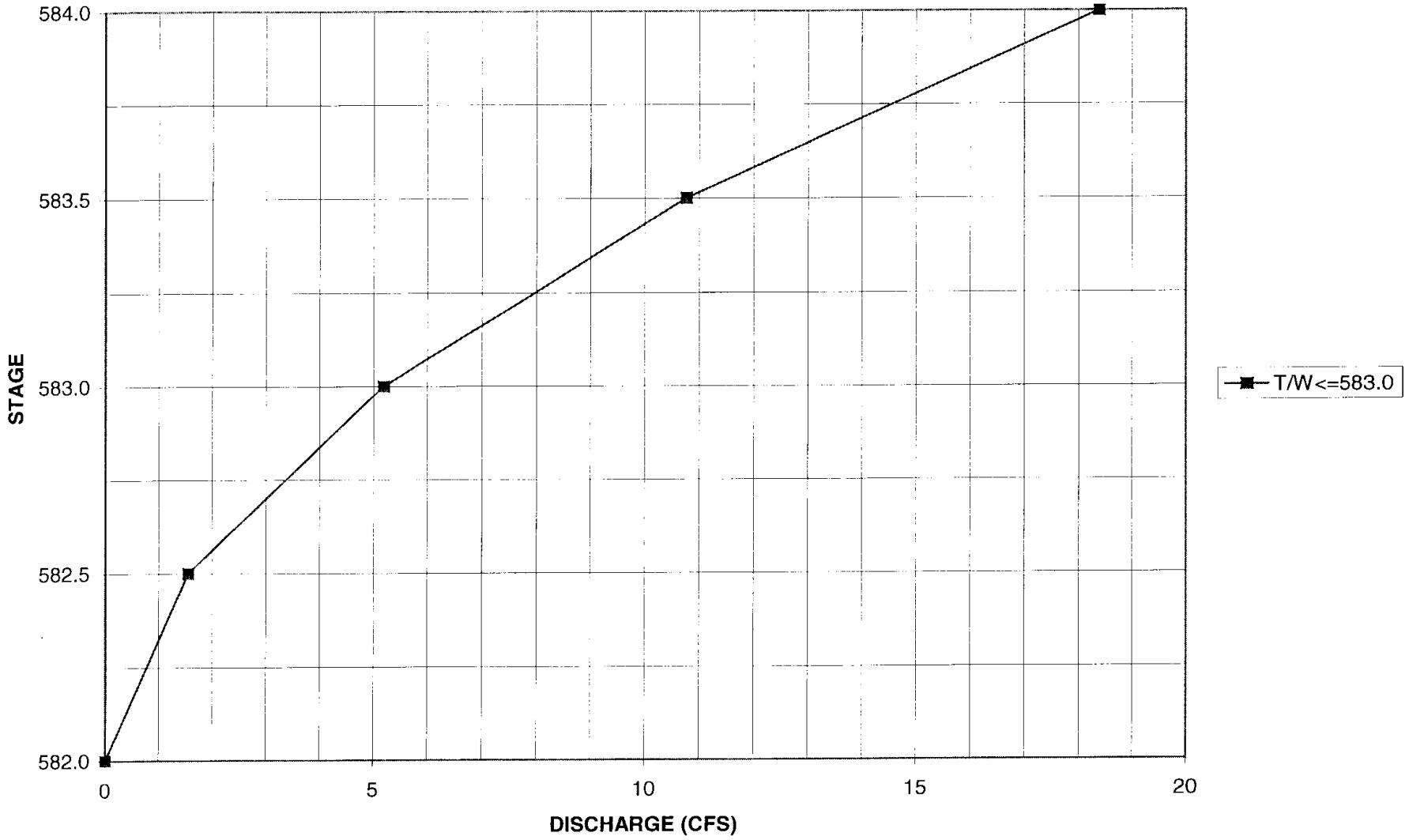
LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO: 2 - HERON POND OUTLET
ENGINEER: SWA CHECKED BY: DGD
DATE: 11-8-05 DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS
	TAILWATER
	<=583
0	582.0
1.56	582.5
5.19	583.0
10.76	583.5
18.39	584.0

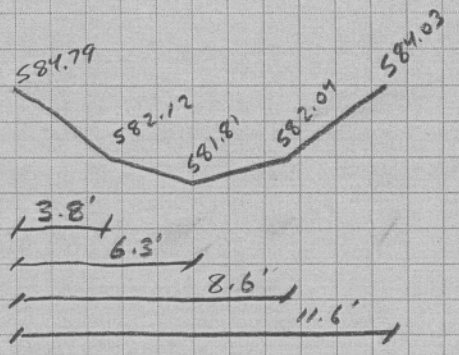
STRUCTURE #2 RATING CURVES



Structure #2 - Heron Pond Outlet Structure

The Heron Pond Outlet consists of an open channel connecting Heron Pond to the Calumet River. A restriction in the channel is located at the Heron Pond outlet.

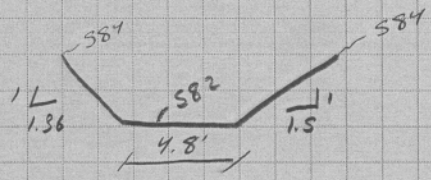
Geometry of channel at Heron Pond outlet from field survey



Channel slope: $\frac{5'}{1075'} = 0.0046\ 1/1'$

$n = 0.10$ Heavy vegetation

Model as trapezoidal channel



Solve for stage discharge relationship.

Tailwater up to 583.0 should not have a significant impact on the rating curve due to elevation of the control point.

COMPUTED: SWA		PROJECT: 98216 HMP
DATE: 11-8-05		LAKE CALUMET HMP
CHECKED: DGD		SUBJECT: HERON POND OUTLET
DATE: 11-8-05	ENGINEERING CALCULATIONS	SHEET NO:

Trapezoidal Channel Analysis & Design

Open Channel - Uniform flow

Worksheet Name: Structure 2 Heron Po

Description: Heron Pond Outlet

Solve For Discharge

Given Constant Data;

Bottom Width.....	4.80
Z-Left.....	1.36
Z-Right.....	1.50
Mannings 'n'.....	0.100
Channel Slope.....	0.0046

Variable Input Data	Minimum	Maximum	Increment By
Channel Depth	0.00	2.00	0.50

Bottom Width ft	Z-Left (H:V)	Z-Right (H:V)	Mannings 'n'	Channel Slope ft/ft	VARIABLE Channel Depth ft	COMPUTED Channel Discharge cfs	COMPUTED Velocity fps
Unable to compute this instance.							
4.80	1.36	1.50	0.100	0.0046	0.50	1.56	0.57
4.80	1.36	1.50	0.100	0.0046	1.00	5.19	0.83
4.80	1.36	1.50	0.100	0.0046	1.50	10.76	1.03
4.80	1.36	1.50	0.100	0.0046	2.00	18.39	1.20

LAKE CALUMET HMP
STRUCTURE RATING CURVES

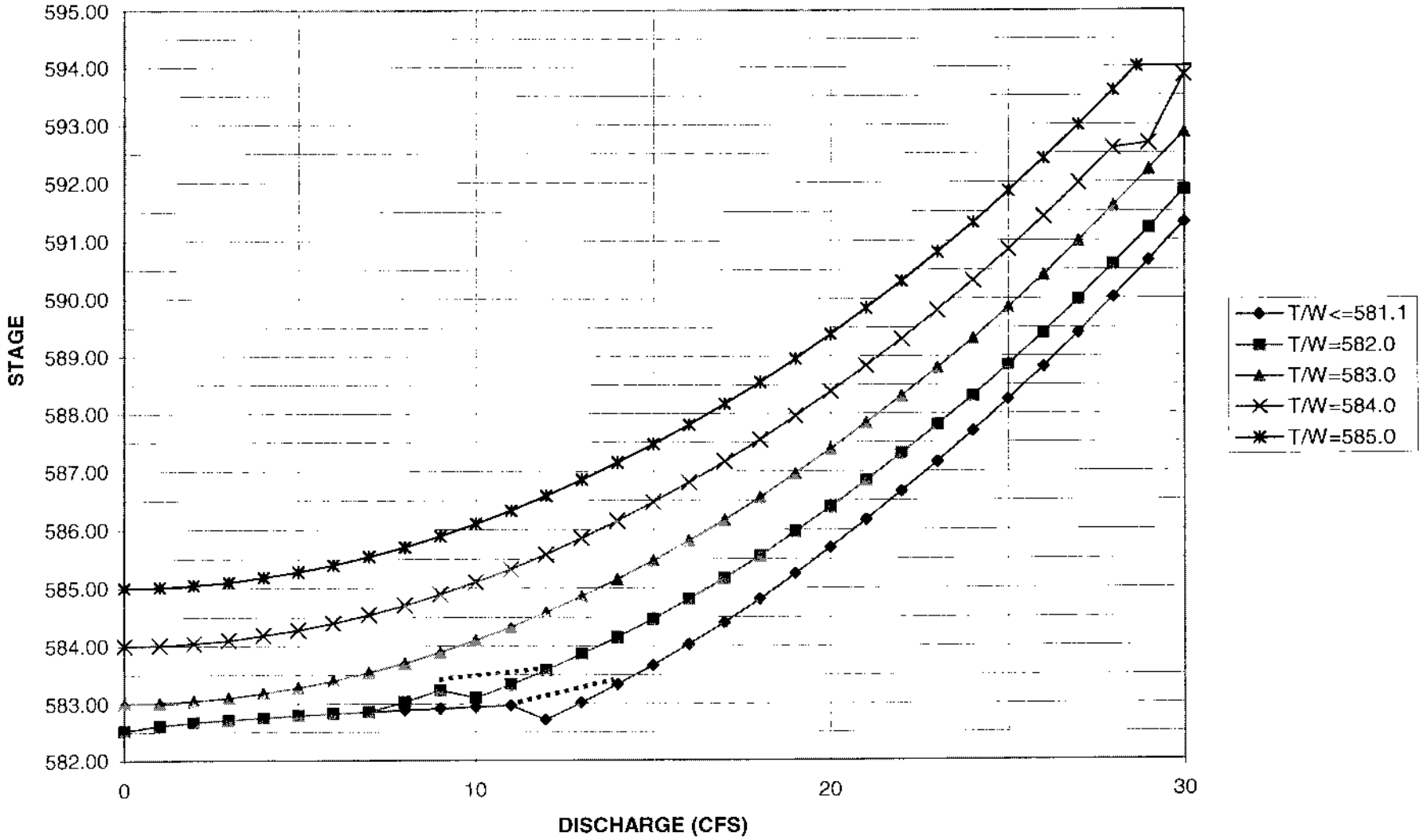
STRUCTURE NO: 3
ENGINEER: SWA
DATE: 11-8-05

CHECKED BY: DGD
DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS				
	TAILWATER				
	<=581.1	582	583	584	585
0	582.52	582.52	583.00	584.00	585.00
1	582.61	582.61	583.01	584.01	585.01
2	582.67	582.67	583.04	584.04	585.04
3	582.71	582.71	583.10	584.10	585.10
4	582.75	582.75	583.18	584.18	585.18
5	582.79	582.79	583.27	584.27	585.27
6	582.82	582.82	583.39	584.39	585.39
7	582.85	582.85	583.54	584.54	585.54
8	582.88	583.02	583.70	584.70	585.70
9	582.91	583.23	583.89	584.89	585.89
10	582.94	583.10	584.10	585.10	586.10
11	582.96	583.32	584.32	585.32	586.32
12	582.72	583.58	584.58	585.58	586.58
13	583.01	583.85	584.85	585.85	586.85
14	583.33	584.15	585.15	586.15	587.15
15	583.66	584.46	585.46	586.46	587.46
16	584.02	584.80	585.80	586.80	587.80
17	584.40	585.16	586.16	587.16	588.16
18	584.80	585.54	586.54	587.54	588.54
19	585.23	585.96	586.95	587.95	588.95
20	585.69	586.38	587.38	588.38	589.38
21	586.16	586.83	587.83	588.83	589.83
22	586.65	587.30	588.30	589.30	590.30
23	587.15	587.79	588.79	589.79	590.79
24	587.69	588.30	589.30	590.31	591.30
25	588.24	588.84	589.84	590.84	591.84
26	588.81	589.40	590.40	591.40	592.40
27	589.40	589.98	590.98	591.98	592.98
28	590.02	590.59	591.59	592.59	593.59
28.66					594.00
29	590.65	591.21	592.21	592.67	
30	591.31	591.86	592.86	593.86	
54.03					594.21
235.60					594.86

STRUCTURE #3 RATING CURVES



Culvert Designer/Analyzer Report
122nd Street Structure #3

Analysis Component			
Storm Event	Design	Discharge	30.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	30.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	581.10 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	30.00 cfs	590.77 ft	9.84 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
122nd Street Structure #3

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	590.77	ft	Discharge	30.00	cfs
Inlet Control HW Elev	584.68	ft	Tailwater Elevation	581.10	ft
Outlet Control HW Elev	590.77	ft	Control Type	Outlet Control	
Headwater Depth/ Height	5.46				

Grades					
Upstream Invert	579.85	ft	Downstream Invert	579.50	ft
Length	120.00	ft	Constructed Slope	0.002917	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.86	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.86	ft
Velocity Downstream	9.84	ft/s	Critical Slope	0.051839	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	590.77	ft	Upstream Velocity Head	1.42	ft
Ke	0.50		Entrance Loss	0.71	ft

Inlet Control Properties					
Inlet Control HW Elev	584.68	ft	Flow Control	Submerged	
Inlet Type	Headwall		Area Full	3.1	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Rating Table Report
122nd Street Structure #3

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	30.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	579.85
1.00	581.12
2.00	581.16
3.00	581.23
4.00	581.31
5.00	581.42
6.00	581.53
7.00	581.65
8.00	581.79
9.00	581.94
10.00	582.13
11.00	582.37
12.00	582.63
13.00	582.91
14.00	583.21
15.00	583.53
16.00	583.87
17.00	584.23
18.00	584.61
19.00	585.02
20.00	585.45
21.00	585.90
22.00	586.36
23.00	586.84
24.00	587.35
25.00	587.87
26.00	588.41
27.00	588.97
28.00	589.55
29.00	590.15
30.00	590.77

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	3		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	579.85	h	0.35 FT
D/S I.E.	579.50	U/S CROWN EL	581.85
TAILWATER ELEVATION	581.1	D/S CROWN EL	581.5
n	0.024	Qf	6.62 CFS
D	24.00 IN	Vf	2.11 FPS
L	120.00 FT	A	3.14 SF
# BARRELS	1	R	0.50

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	4.00 FT	TYPE	BOTTOM
RIM	582.52	C	0.61
L	12.57 FT	AREA	12.57 SF

OVERFLOW DATA		ASSUME GRATE BLOCKS	
OVERFLOW EL	594	1/3 OF OPENING	
LENGTH	100 FT		
C	2.6	FREE AREA	8.38 SF

WEIR/ORIFICE HYDRAULICS

		STRUCTURE						
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)	OVERFLOW Y/N	OVERFLOW Q (CFS)	TOTAL Q (CFS)
1	581.12	2.8	0.09	0.00	582.61	N	0.00	1.00
2	581.16	2.8	0.15	0.00	582.67	N	0.00	2.00
3	581.23	2.8	0.19	0.01	582.71	N	0.00	3.00
4	581.31	2.82	0.23	0.01	582.75	N	0.00	4.00
5	581.42	2.84	0.27	0.01	582.79	N	0.00	5.00
6	581.53	2.86	0.30	0.02	582.82	N	0.00	6.00
7	581.65	2.88	0.33	0.03	582.85	N	0.00	7.00
8	581.79	2.9	0.36	0.04	582.88	N	0.00	8.00
9	581.94	2.92	0.39	0.05	582.91	N	0.00	9.00
10	582.13	2.94	0.42	0.06	582.94	N	0.00	10.00
11	582.37	2.96	0.44	0.07	582.96	N	0.00	11.00
12	582.63	2.98	SUB	0.09	582.72	N	0.00	12.00
13	582.91	3	SUB	0.10	583.01	N	0.00	13.00
14	583.21	3	SUB	0.12	583.33	N	0.00	14.00
15	583.53	3.02	SUB	0.13	583.66	N	0.00	15.00
16	583.87	3.04	SUB	0.15	584.02	N	0.00	16.00
17	584.23	3.06	SUB	0.17	584.40	N	0.00	17.00
18	584.61	3.08	SUB	0.19	584.80	N	0.00	18.00
19	585.02	3.1	SUB	0.21	585.23	N	0.00	19.00
20	585.45	3.12	SUB	0.24	585.69	N	0.00	20.00
21	585.90	3.16	SUB	0.26	586.16	N	0.00	21.00
22	586.36	3.18	SUB	0.29	586.65	N	0.00	22.00
23	586.84	3.19	SUB	0.31	587.15	N	0.00	23.00
24	587.35	3.19	SUB	0.34	587.69	N	0.00	24.00
25	587.87	3.22	SUB	0.37	588.24	N	0.00	25.00
26	588.41	3.23	SUB	0.40	588.81	N	0.00	26.00
27	588.97	3.26	SUB	0.43	589.40	N	0.00	27.00
28	589.55	3.27	SUB	0.47	590.02	N	0.00	28.00
29	590.15	3.29	SUB	0.50	590.65	N	0.00	29.00
30	590.77	3.3	SUB	0.54	591.31	N	0.00	30.00

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

Culvert Designer/Analyzer Report
122nd Street Structure #3

Analysis Component			
Storm Event	Design	Discharge	30.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	30.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	582.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	30.00 cfs	591.32 ft	9.55 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
122nd Street Structure #3

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	591.32	ft	Discharge	30.00	cfs
Inlet Control HW Elev	584.68	ft	Tailwater Elevation	582.00	ft
Outlet Control HW Elev	591.32	ft	Control Type	Outlet Control	
Headwater Depth/ Height	5.73				

Grades					
Upstream Invert	579.85	ft	Downstream Invert	579.50	ft
Length	120.00	ft	Constructed Slope	0.002917	ft/ft

Hydraulic Profile					
Profile	Pressure		Depth, Downstream	2.50	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.86	ft
Velocity Downstream	9.55	ft/s	Critical Slope	0.051839	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	591.32	ft	Upstream Velocity Head	1.42	ft
Ke	0.50		Entrance Loss	0.71	ft

Inlet Control Properties					
Inlet Control HW Elev	584.68	ft	Flow Control	Submerged	
Inlet Type	Headwall		Area Full	3.1	ft^2
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

SDI Consultants Ltd
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Rating Table Report
122nd Street Structure #3

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	30.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	579.85
1.00	582.01
2.00	582.04
3.00	582.09
4.00	582.17
5.00	582.26
6.00	582.37
7.00	582.51
8.00	582.66
9.00	582.84
10.00	583.04
11.00	583.25
12.00	583.49
13.00	583.75
14.00	584.03
15.00	584.33
16.00	584.65
17.00	584.99
18.00	585.35
19.00	585.74
20.00	586.14
21.00	586.57
22.00	587.01
23.00	587.48
24.00	587.96
25.00	588.47
26.00	589.00
27.00	589.55
28.00	590.12
29.00	590.71
30.00	591.32

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	3		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	579.85	h	0.35 FT
D/S I.E.	579.50	U/S CROWN EL	581.85
TAILWATER ELEVATION	582	D/S CROWN EL	581.5
n	0.024	Qf	6.62 CFS
D	24.00 IN	Vf	2.11 FPS
L	120.00 FT	A	3.14 SF
# BARRELS	1	R	0.50

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	4.00 FT	TYPE	BOTTOM
RIM	582.52	C	0.61
L	12.57 FT	AREA	12.57 SF
OVERFLOW DATA		ASSUME GRATE BLOCKS	
OVERFLOW EL	594	1/3 OF OPENING	
LENGTH	100 FT		
C	2.6	FREE AREA	8.38 SF

WEIR/ORIFICE HYDRAULICS

		STRUCTURE						
Q	D/S WSL	C	WEIR HEAD	ORIFICE HEAD	U/S WSL	OVERFLOW	OVERFLOW	TOTAL
(CFS)	(FT)		(FT)	(FT)	(FT)	Y/N	Q (CFS)	Q (CFS)
1	582.02	2.8	0.09	0.00	582.61	N	0.00	1.00
2	582.04	2.8	0.15	0.00	582.67	N	0.00	2.00
3	582.09	2.8	0.19	0.01	582.71	N	0.00	3.00
4	582.17	2.82	0.23	0.01	582.75	N	0.00	4.00
5	582.26	2.84	0.27	0.01	582.79	N	0.00	5.00
6	582.37	2.86	0.30	0.02	582.82	N	0.00	6.00
7	582.51	2.88	0.33	0.03	582.85	N	0.00	7.00
8	582.66	2.9	0.36	0.04	583.02	N	0.00	8.00
9	582.84	2.92	0.39	0.05	583.23	N	0.00	9.00
10	583.04		SUB	0.06	583.10	N	0.00	10.00
11	583.25		SUB	0.07	583.32	N	0.00	11.00
12	583.49		SUB	0.09	583.58	N	0.00	12.00
13	583.75		SUB	0.10	583.85	N	0.00	13.00
14	584.03		SUB	0.12	584.15	N	0.00	14.00
15	584.33		SUB	0.13	584.46	N	0.00	15.00
16	584.65		SUB	0.15	584.80	N	0.00	16.00
17	584.99		SUB	0.17	585.16	N	0.00	17.00
18	585.35		SUB	0.19	585.54	N	0.00	18.00
19	585.75		SUB	0.21	585.96	N	0.00	19.00
20	586.14		SUB	0.24	586.38	N	0.00	20.00
21	586.57		SUB	0.26	586.83	N	0.00	21.00
22	587.01		SUB	0.29	587.30	N	0.00	22.00
23	587.48		SUB	0.31	587.79	N	0.00	23.00
24	587.96		SUB	0.34	588.30	N	0.00	24.00
25	588.47		SUB	0.37	588.84	N	0.00	25.00
26	589.00		SUB	0.40	589.40	N	0.00	26.00
27	589.55		SUB	0.43	589.98	N	0.00	27.00
28	590.12		SUB	0.47	590.59	N	0.00	28.00
29	590.71		SUB	0.50	591.21	N	0.00	29.00
30	591.32		SUB	0.54	591.86	N	0.00	30.00

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

Culvert Designer/Analyzer Report
122nd Street Structure #3

Analysis Component			
Storm Event	Design	Discharge	30.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	30.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	583.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	30.00 cfs	592.32 ft	9.55 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Designer/Analyzer Report
122nd Street Structure #3

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	592.32 ft	Discharge	30.00 cfs
Inlet Control HW Elev	584.68 ft	Tailwater Elevation	583.00 ft
Outlet Control HW Elev	592.32 ft	Control Type	Outlet Control
Headwater Depth/ Height	6.23		

Grades			
Upstream Invert	579.85 ft	Downstream Invert	579.50 ft
Length	120.00 ft	Constructed Slope	0.002917 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	3.50 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.86 ft
Velocity Downstream	9.55 ft/s	Critical Slope	0.051839 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	592.32 ft	Upstream Velocity Head	1.42 ft
Ke	0.50	Entrance Loss	0.71 ft

Inlet Control Properties			
Inlet Control HW Elev	584.68 ft	Flow Control	Submerged
Inlet Type	Headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
122nd Street Structure #3

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	30.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	579.85
1.00	583.01
2.00	583.04
3.00	583.09
4.00	583.17
5.00	583.26
6.00	583.37
7.00	583.51
8.00	583.66
9.00	583.84
10.00	584.04
11.00	584.25
12.00	584.49
13.00	584.75
14.00	585.03
15.00	585.33
16.00	585.65
17.00	585.99
18.00	586.35
19.00	586.74
20.00	587.14
21.00	587.57
22.00	588.01
23.00	588.48
24.00	588.96
25.00	589.47
26.00	590.00
27.00	590.55
28.00	591.12
29.00	591.71
30.00	592.32

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	3		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	579.85	h	0.35 FT
D/S I.E.	579.50	U/S CROWN EL	581.85
TAILWATER ELEVATION	583	D/S CROWN EL	581.5
n	0.024	Qf	6.62 CFS
D	24.00 IN	Vf	2.11 FPS
L	120.00 FT	A	3.14 SF
# BARRELS	1	R	0.50

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	4.00 FT	TYPE	BOTTOM
RIM	582.52	C	0.61
L	12.57 FT	AREA	12.57 SF

OVERFLOW DATA		ASSUME GRATE BLOCKS	
OVERFLOW EL	594	1/3 OF OPENING	
LENGTH	100 FT		
C	2.6	FREE AREA	8.38 SF

WEIR/ORIFICE HYDRAULICS

		STRUCTURE						
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)	OVERFLOW Y/N	OVERFLOW Q (CFS)	TOTAL Q (CFS)
1	583.01		SUB	0.00	583.01	N	0.00	1.00
2	583.04		SUB	0.00	583.04	N	0.00	2.00
3	583.09		SUB	0.01	583.10	N	0.00	3.00
4	583.17		SUB	0.01	583.18	N	0.00	4.00
5	583.26		SUB	0.01	583.27	N	0.00	5.00
6	583.37		SUB	0.02	583.39	N	0.00	6.00
7	583.51		SUB	0.03	583.54	N	0.00	7.00
8	583.66		SUB	0.04	583.70	N	0.00	8.00
9	583.84		SUB	0.05	583.89	N	0.00	9.00
10	584.04		SUB	0.06	584.10	N	0.00	10.00
11	584.25		SUB	0.07	584.32	N	0.00	11.00
12	584.49		SUB	0.09	584.58	N	0.00	12.00
13	584.75		SUB	0.10	584.85	N	0.00	13.00
14	585.03		SUB	0.12	585.15	N	0.00	14.00
15	585.33		SUB	0.13	585.46	N	0.00	15.00
16	585.65		SUB	0.15	585.80	N	0.00	16.00
17	585.99		SUB	0.17	586.16	N	0.00	17.00
18	586.35		SUB	0.19	586.54	N	0.00	18.00
19	586.74		SUB	0.21	586.95	N	0.00	19.00
20	587.14		SUB	0.24	587.38	N	0.00	20.00
21	587.57		SUB	0.26	587.83	N	0.00	21.00
22	588.01		SUB	0.29	588.30	N	0.00	22.00
23	588.48		SUB	0.31	588.79	N	0.00	23.00
24	588.96		SUB	0.34	589.30	N	0.00	24.00
25	589.47		SUB	0.37	589.84	N	0.00	25.00
26	590.00		SUB	0.40	590.40	N	0.00	26.00
27	590.55		SUB	0.43	590.98	N	0.00	27.00
28	591.12		SUB	0.47	591.59	N	0.00	28.00
29	591.71		SUB	0.50	592.21	N	0.00	29.00
30	592.32		SUB	0.54	592.86	N	0.00	30.00

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

Culvert Designer/Analyzer Report
122nd Street Structure #3

Analysis Component			
Storm Event	Design	Discharge	30.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	30.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	584.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	30.00 cfs	593.32 ft	9.55 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
122nd Street Structure #3

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	593.32 ft	Discharge	30.00 cfs
Inlet Control HW Elev	584.68 ft	Tailwater Elevation	584.00 ft
Outlet Control HW Elev	593.32 ft	Control Type	Outlet Control
Headwater Depth/ Height	6.73		

Grades			
Upstream Invert	579.85 ft	Downstream Invert	579.50 ft
Length	120.00 ft	Constructed Slope	0.002917 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	4.50 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.86 ft
Velocity Downstream	9.55 ft/s	Critical Slope	0.051839 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	593.32 ft	Upstream Velocity Head	1.42 ft
Ke	0.50	Entrance Loss	0.71 ft

Inlet Control Properties			
Inlet Control HW Elev	584.68 ft	Flow Control	Submerged
Inlet Type	Headwall	Area Full	3.1 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

SDI Consultants Ltd
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Rating Table Report
122nd Street Structure #3

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	30.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	579.85
1.00	584.01
2.00	584.04
3.00	584.09
4.00	584.17
5.00	584.26
6.00	584.37
7.00	584.51
8.00	584.66
9.00	584.84
10.00	585.04
11.00	585.25
12.00	585.49
13.00	585.75
14.00	586.03
15.00	586.33
16.00	586.65
17.00	586.99
18.00	587.35
19.00	587.74
20.00	588.14
21.00	588.57
22.00	589.01
23.00	589.48
24.00	589.96
25.00	590.47
26.00	591.00
27.00	591.55
28.00	592.12
29.00	592.71
30.00	593.32

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	3		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	579.85	h	0.35 FT
D/S I.E.	579.50	U/S CROWN EL	581.85
TAILWATER ELEVATION	584	D/S CROWN EL	581.5
n	0.024	Qf	6.62 CFS
D	24.00 IN	Vf	2.11 FPS
L	120.00 FT	A	3.14 SF
# BARRELS	1	R	0.50

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	4.00 FT	TYPE	BOTTOM
RIM	582.52	C	0.61
L	12.57 FT	AREA	12.57 SF

OVERFLOW DATA		ASSUME GRATE BLOCKS	
OVERFLOW EL	594	1/3 OF OPENING	
LENGTH	100 FT		
C	2.6	FREE AREA	8.38 SF

WEIR/ORIFICE HYDRAULICS

		STRUCTURE						
Q	D/S WSL	C	WEIR HEAD	ORIFICE HEAD	U/S WSL	OVERFLOW	OVERFLOW	TOTAL
(CFS)	(FT)		(FT)	(FT)	(FT)	Y/N	Q (CFS)	Q (CFS)
1	584.01		SUB	0.00	584.01	N	0.00	1.00
2	584.04		SUB	0.00	584.04	N	0.00	2.00
3	584.09		SUB	0.01	584.10	N	0.00	3.00
4	584.17		SUB	0.01	584.18	N	0.00	4.00
5	584.26		SUB	0.01	584.27	N	0.00	5.00
6	584.37		SUB	0.02	584.39	N	0.00	6.00
7	584.51		SUB	0.03	584.54	N	0.00	7.00
8	584.66		SUB	0.04	584.70	N	0.00	8.00
9	584.84		SUB	0.05	584.89	N	0.00	9.00
10	585.04		SUB	0.06	585.10	N	0.00	10.00
11	585.25		SUB	0.07	585.32	N	0.00	11.00
12	585.49		SUB	0.09	585.58	N	0.00	12.00
13	585.75		SUB	0.10	585.85	N	0.00	13.00
14	586.03		SUB	0.12	586.15	N	0.00	14.00
15	586.33		SUB	0.13	586.46	N	0.00	15.00
16	586.65		SUB	0.15	586.80	N	0.00	16.00
17	586.99		SUB	0.17	587.16	N	0.00	17.00
18	587.35		SUB	0.19	587.54	N	0.00	18.00
19	587.74		SUB	0.21	587.95	N	0.00	19.00
20	588.14		SUB	0.24	588.38	N	0.00	20.00
21	588.57		SUB	0.26	588.83	N	0.00	21.00
22	589.01		SUB	0.29	589.30	N	0.00	22.00
23	589.48		SUB	0.31	589.79	N	0.00	23.00
24	589.97		SUB	0.34	590.31	N	0.00	24.00
25	590.47		SUB	0.37	590.84	N	0.00	25.00
26	591.00		SUB	0.40	591.40	N	0.00	26.00
27	591.55		SUB	0.43	591.98	N	0.00	27.00
28	592.12		SUB	0.47	592.59	N	0.00	28.00
29	592.17		SUB	0.50	592.67	N	0.00	29.00
30	593.32		SUB	0.54	593.86	N	0.00	30.00

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

Culvert Designer/Analyzer Report
122nd Street Structure #3

Analysis Component			
Storm Event	Design	Discharge	30.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	30.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	585.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	30.00 cfs	594.32 ft	9.55 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
122nd Street Structure #3

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	594.32 ft	Discharge	30.00 cfs
Inlet Control HW Elev	585.00 ft	Tailwater Elevation	585.00 ft
Outlet Control HW Elev	594.32 ft	Control Type	Outlet Control
Headwater Depth/ Height	7.23		

Grades			
Upstream Invert	579.85 ft	Downstream Invert	579.50 ft
Length	120.00 ft	Constructed Slope	0.002917 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	5.50 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.86 ft
Velocity Downstream	9.55 ft/s	Critical Slope	0.051839 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	594.32 ft	Upstream Velocity Head	1.42 ft
Ke	0.50	Entrance Loss	0.71 ft

Inlet Control Properties			
Inlet Control HW Elev	585.00 ft	Flow Control	Submerged
Inlet Type	Headwall	Area Full	3.1 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
122nd Street Structure #3

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	30.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	579.85
1.00	585.01
2.00	585.04
3.00	585.09
4.00	585.17
5.00	585.26
6.00	585.37
7.00	585.51
8.00	585.66
9.00	585.84
10.00	586.04
11.00	586.25
12.00	586.49
13.00	586.75
14.00	587.03
15.00	587.33
16.00	587.65
17.00	587.99
18.00	588.35
19.00	588.74
20.00	589.14
21.00	589.57
22.00	590.01
23.00	590.48
24.00	590.96
25.00	591.47
26.00	592.00
27.00	592.55
28.00	593.12
29.00	593.71
30.00	594.32

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	3		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	579.85	h	0.35 FT
D/S I.E.	579.50	U/S CROWN EL	581.85
TAILWATER ELEVATION	585	D/S CROWN EL	581.5
n	0.024	Qf	6.62 CFS
D	24.00 IN	Vf	2.11 FPS
L	120.00 FT	A	3.14 SF
# BARRELS	1	R	0.50

WEIR / ORIFICE DATA

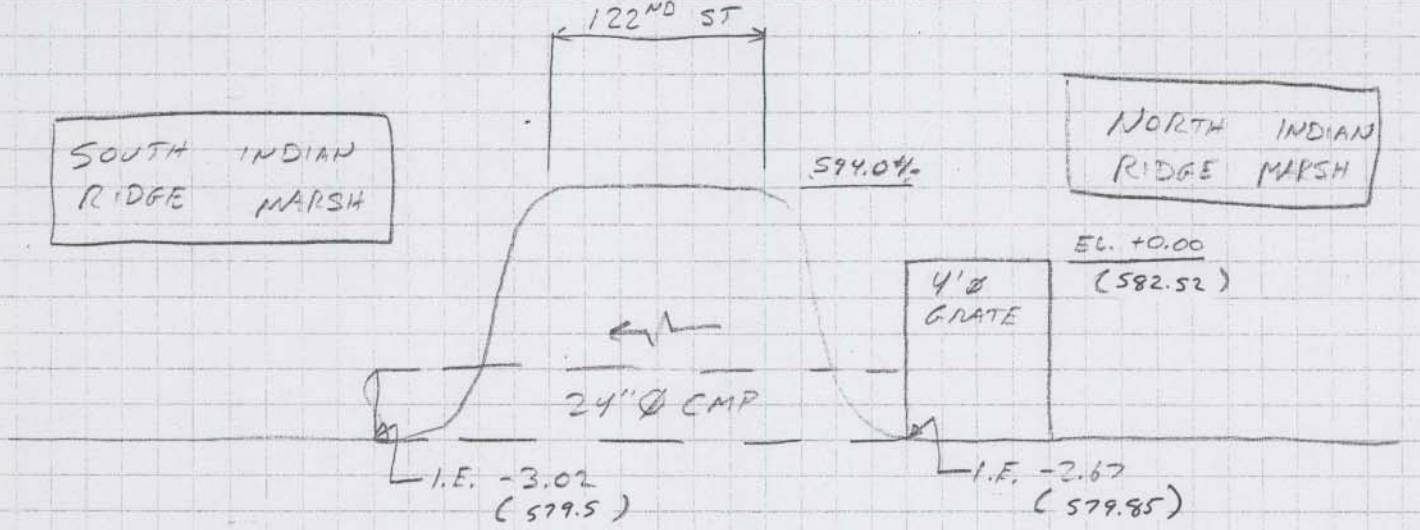
WEIR 1		ORIFICE 1	
D	4.00 FT	TYPE	BOTTOM
RIM	582.52	C	0.61
L	12.57 FT	AREA	12.57 SF
OVERFLOW DATA		ASSUME GRATE BLOCKS	
OVERFLOW EL	594	1/3 OF OPENING	
LENGTH	100 FT		
C	2.6	FREE AREA	8.38 SF

WEIR/ORIFICE HYDRAULICS

		STRUCTURE						
Q	D/S WSL	C	WEIR HEAD	ORIFICE HEAD	U/S WSL	OVERFLOW	OVERFLOW	TOTAL
(CFS)	(FT)		(FT)	(FT)	(FT)	Y/N	Q (CFS)	Q (CFS)
1	585.01		SUB	0.00	585.01	N	0.00	1.00
2	585.04		SUB	0.00	585.04	N	0.00	2.00
3	585.09		SUB	0.01	585.10	N	0.00	3.00
4	585.17		SUB	0.01	585.18	N	0.00	4.00
5	585.26		SUB	0.01	585.27	N	0.00	5.00
6	585.37		SUB	0.02	585.39	N	0.00	6.00
7	585.51		SUB	0.03	585.54	N	0.00	7.00
8	585.66		SUB	0.04	585.70	N	0.00	8.00
9	585.84		SUB	0.05	585.89	N	0.00	9.00
10	586.04		SUB	0.06	586.10	N	0.00	10.00
11	586.25		SUB	0.07	586.32	N	0.00	11.00
12	586.49		SUB	0.09	586.58	N	0.00	12.00
13	586.75		SUB	0.10	586.85	N	0.00	13.00
14	587.03		SUB	0.12	587.15	N	0.00	14.00
15	587.33		SUB	0.13	587.46	N	0.00	15.00
16	587.65		SUB	0.15	587.80	N	0.00	16.00
17	587.99		SUB	0.17	588.16	N	0.00	17.00
18	588.35		SUB	0.19	588.54	N	0.00	18.00
19	588.74		SUB	0.21	588.95	N	0.00	19.00
20	589.14		SUB	0.24	589.38	N	0.00	20.00
21	589.57		SUB	0.26	589.83	N	0.00	21.00
22	590.01		SUB	0.29	590.30	N	0.00	22.00
23	590.48		SUB	0.31	590.79	N	0.00	23.00
24	590.96		SUB	0.34	591.30	N	0.00	24.00
25	591.47		SUB	0.37	591.84	N	0.00	25.00
26	592.00		SUB	0.40	592.40	N	0.00	26.00
27	592.55		SUB	0.43	592.98	N	0.00	27.00
28	593.12		SUB	0.47	593.59	N	0.00	28.00
29	593.71		SUB	0.50	594.21	Y	25.03	54.03
30	594.32		SUB	0.54	594.86	Y	205.60	235.60

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

LAKE CALUMET STRUCTURE RATING CURVES
STRUCTURE #3



FROM DOE MAPPING AND FIELD SURVEY

TOP OF STRUCTURE = 582.52
TOP OF EMBANKMENT = 594.0+/-
PIPE LENGTH = 120 LF

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE #3
CHECKED: DED		SHEET NO:
DATE: 11-8-05	ENGINEERING CALCULATIONS	

DEVELOP RATING CURVES FOR STRUCTURE WITH VARIABLE TAILWATER CONDITIONS

1. EVALUATE FOR T/W FROM 0.8D TO CALUMET RIVER HIGH WSL

$0.8D = 579.5' + 0.8(24"/12"/1') = 581.1$
$HWL = 583.0'+/-$

A. DEVELOP U/S WSL FOR CULVERTS WITH VARYING T/W

$\varnothing = 24"$
$n = 0.024$ (CMP)
$L = 170'$

BARRELS = 1

EXIT LOSS: $H_o = 1.0\left(\frac{V_o^2}{2g} - \frac{V_d^2}{2g}\right)$ HEC-22 (7-4)

V_o = PIPE VELOCITY
V_d = DOWNSTREAM VELOCITY = 0 FOR POND

$H_o = V_o^2/2g$

ENTRANCE LOSS: $H_i = V\left(\frac{V_o^2}{2g}\right)$ HEC-22 (7-9)

V_o = PIPE VELOCITY
V = 0.5 FOR INLET WITH STRAIGHT PIPE RUN HEC-22 (T 7-5A)

FRICTION LOSS: $H_f = L\left(\frac{Q_n}{1.486\,A\,R^{2/3}}\right)^2$ PRESSURE FLOW

H_f = REFER TO HYDRAULIC GRAVITY FLOW ELEMENT CHART

U/S WSL = T/W + H_o + H_f + H_i

COMPUTED: DWH	CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE #3
CHECKED: DGD	ENGINEERING CALCULATIONS	SHEET NO:
DATE: 11-8-05		

B. CALCULATE U/S WSL FOR FLOW THROUGH GRATE

1. SET PIPE U/S WSL AS D/S WSL FOR GRATE

2. ANALYZE GRATE AS WEIR AND ORIFICE, USE LESSER FLOW VALUE.

WEIR FLOW

$Q = C L H^{3/2}$ U/S WSL = H + WEIR CREST

Q = FLOW (CFS)
C = COEFFICIENT (SEE ATTACHED TABLE)
L = WEIR LENGTH (FT)
H = HEAD (FT) $H = \left(\frac{Q}{CL}\right)^{2/3}$

ORIFICE FLOW

$Q = CA\sqrt{2gH}$ U/S WSL = H + TOP OF GRATE

Q = FLOW (CFS)
C = 0.61
A = ORIFICE AREA (SF) $H = \left(\frac{Q}{CA}\right)^2 \left(\frac{1}{2g}\right)$
g = 32.2 (FT/S^2)
H = HEAD (FT)

ASSUME GRATE REDUCES "A" BY 1/3.

3. FOR U/S WSL > 594.0, ADD FLOW OVER ROADWAY

ANALYZE AS WEIR

$Q = C L H^{3/2}$

Q = ADDITIONAL FLOW (CFS)
C = 2.6
L = 100 FT
H = HEAD (FT)

H = U/S WSL - 594.0

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE #3
CHECKED: DFD	ENGINEERING CALCULATIONS	SHEET NO:
DATE: 11-8-05		

Table 8-1. SI Units - Broad-Crested Weir Coefficient C Values as a Function of Weir Crest.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest Breadth and Head (coefficient has units of $m^{0.5}$/sec).[1]															
Head[2] (m)	Breadth of Crest of Weir (m)														
	0.15	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.25	1.50	2.00	3.00	4.00
0.10	1.59	1.56	1.50	1.47	1.45	1.43	1.42	1.41	1.40	1.39	1.37	1.35	1.36	1.40	1.45
0.15	1.65	1.60	1.51	1.48	1.45	1.44	1.44	1.44	1.45	1.45	1.44	1.43	1.44	1.45	1.47
0.20	1.73	1.66	1.54	1.49	1.46	1.44	1.44	1.45	1.47	1.48	1.48	1.49	1.49	1.49	1.48
0.30	1.83	1.77	1.64	1.56	1.50	1.47	1.46	1.46	1.46	1.47	1.47	1.48	1.48	1.48	1.46
0.40	1.83	1.80	1.74	1.65	1.57	1.52	1.49	1.47	1.46	1.46	1.47	1.47	1.47	1.48	1.47
0.50	1.83	1.82	1.81	1.74	1.67	1.60	1.55	1.51	1.48	1.48	1.47	1.46	1.46	1.46	1.45
0.60	1.83	1.83	1.82	1.73	1.65	1.58	1.54	1.46	1.31	1.34	1.48	1.46	1.46	1.46	1.45
0.70	1.83	1.83	1.83	1.78	1.72	1.65	1.60	1.53	1.44	1.45	1.49	1.47	1.47	1.46	1.45
0.80	1.83	1.83	1.83	1.82	1.79	1.72	1.66	1.60	1.57	1.55	1.50	1.47	1.47	1.46	1.45
0.90	1.83	1.83	1.83	1.83	1.81	1.76	1.71	1.66	1.61	1.58	1.50	1.47	1.47	1.46	1.45
1.00	1.83	1.83	1.83	1.83	1.82	1.81	1.76	1.70	1.64	1.60	1.51	1.48	1.47	1.46	1.45
1.10	1.83	1.83	1.83	1.83	1.83	1.83	1.80	1.75	1.66	1.62	1.52	1.49	1.47	1.46	1.45
1.20	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.79	1.70	1.65	1.53	1.49	1.48	1.46	1.45
1.30	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.82	1.77	1.71	1.56	1.51	1.49	1.46	1.45
1.40	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.77	1.60	1.52	1.50	1.46	1.45
1.50	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.79	1.66	1.55	1.51	1.46	1.45
1.60	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.81	1.74	1.58	1.53	1.46	1.46

(1) Modified from reference 49 (2) Measured at le a st 2.5 H_c upstream of the weir

Table 8-1. English Units - Broad-Crested Weir Coefficient C Values as a Function of Weir Crest.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest Breadth and Head (coefficient has units of $ft^{0.5}$/sec).[1]											
Head[2] (ft)	Breadth of Crest of Weir (ft)										
	0.50	0.75	1.00	1.5	2.0	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3 32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

(1) Table is taken from reference 49.

LAKE CALUMET HMP
STRUCTURE RATING CURVES

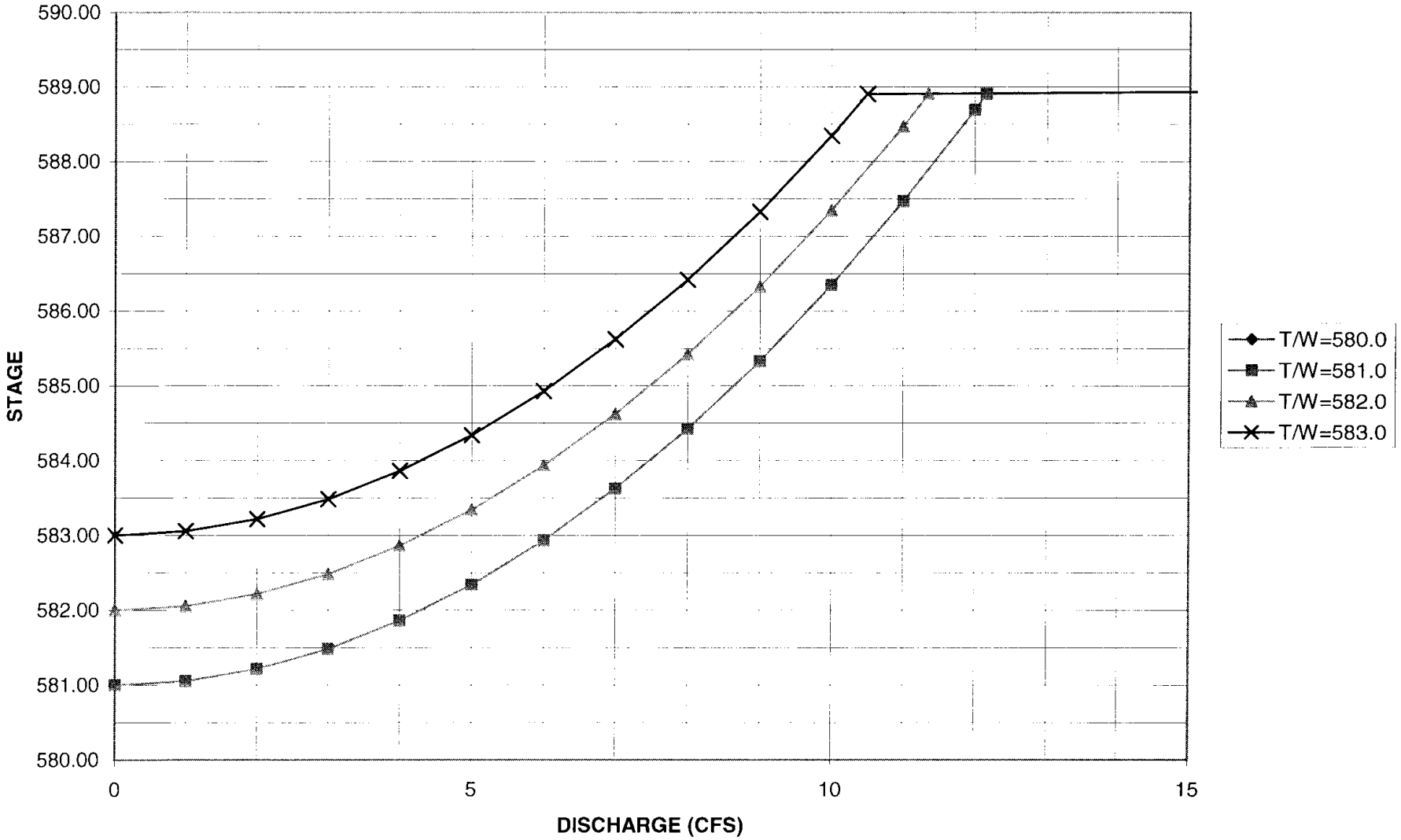
STRUCTURE NO: 5
ENGINEER: SWA
DATE: 11-8-05

CHECKED BY: DGD
DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS			
	TAILWATER			
	580	581	582	583
0	580.70	581.00	582.00	583.00
1.00	581.03	581.05	582.05	583.05
2.00	581.16	581.21	582.21	583.21
3.00	581.39	581.48	582.48	583.48
4.00	581.72	581.86	582.86	583.86
5.00	582.14	582.34	583.34	584.34
6.00	582.66	582.93	583.93	584.93
7.00	583.30	583.62	584.62	585.62
8.00	584.04	584.42	585.42	586.42
9.00	584.88	585.32	586.32	587.32
10.00	585.81	586.34	587.34	588.34
10.50				588.90
11.00	586.83	587.47	588.47	
11.35			588.90	
12.00	587.94	588.69		
12.16		588.90		
12.80	588.90			
44.20	589.14			
121.46				589.47
194.19			589.69	
323.15		590.02		
536.61	590.49			
634.10				590.69
818.28			591.02	
1086.90		591.47		
1449.73	591.07			

STRUCTURE #5 RATING CURVES



LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	5		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	575.99		h	FT
D/S I.E.	unknown		U/S CROWN EL	578.49
TAILWATER ELEVATION	580.0		D/S CROWN EL	
n	0.024		Qf	CFS
D	30.00	IN	Vf	FPS
L	425.00	FT	A	4.91 SF
# BARRELS	2		R	0.63

Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Analysis Component			
Storm Event	Design	Discharge	15.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	15.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	580.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-30 inch Circular	15.00 cfs	580.54 ft	1.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	580.54 ft	Discharge	15.00 cfs
Inlet Control HW Elev	580.00 ft	Tailwater Elevation	580.00 ft
Outlet Control HW Elev	580.54 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.82		

Grades			
Upstream Invert	575.99 ft	Downstream Invert	575.00 ft
Length	425.00 ft	Constructed Slope	0.002329 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	5.00 ft
Slope Type	N/A	Normal Depth	1.54 ft
Flow Regime	N/A	Critical Depth	0.91 ft
Velocity Downstream	1.53 ft/s	Critical Slope	0.014244 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	580.54 ft	Upstream Velocity Head	0.04 ft
Ke	0.50	Entrance Loss	0.02 ft

Inlet Control Properties			
Inlet Control HW Elev	580.00 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	9.8 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
Big Marsh Outlet Structure #5

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	15.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	575.99
0.50	580.00
1.00	580.00
1.50	580.01
2.00	580.01
2.50	580.01
3.00	580.02
3.50	580.03
4.00	580.04
4.50	580.05
5.00	580.06
5.50	580.07
6.00	580.09
6.50	580.10
7.00	580.12
7.50	580.13
8.00	580.15
8.50	580.17
9.00	580.19
9.50	580.22
10.00	580.24
10.50	580.26
11.00	580.29
11.50	580.32
12.00	580.34
12.50	580.37
13.00	580.40
13.50	580.44
14.00	580.47
14.50	580.50
15.00	580.54

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WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	2.00 FT	TYPE	BOTTOM
RIM	580.49	C	0.61
L	6.28 FT	AREA	3.14 SF

WEIR/ORIFICE HYDRAULICS

		2' DIA. BOTTOM ORIFICE			
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)
1	580.00	2.8	0.15	0.00	580.64
2	580.01	2.82	0.23	0.02	580.72
3	580.02	2.86	0.30	0.04	580.79
4	580.04	2.89	0.36	0.07	580.85
5	580.06	2.94	0.42	0.11	580.91
6	580.09	2.98	0.47	0.15	580.96
7	580.12	3.01	0.52	0.21	581.01
8	580.15	3.05	0.56	0.27	581.05
9	580.19	3.08	0.60	0.34	581.09
10	580.24	3.12	0.64	0.42	581.13
11	580.29	3.16	0.67	0.51	581.16
12	580.34	3.2	0.71	0.61	581.20
13	580.40	3.23	0.74	0.71	581.23
14	580.47	3.27	0.77	0.83	581.32
15	580.54		SUB	0.95	581.49

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1		ROOF ORIFICE	
L	1.83 FT	TYPE	SIDE	TYPE	BOTTOM
CREST	580.70	C	0.61	C	0.61
CROWN	581.24	AREA	0.99 SF	AREA	3.14 SF
		CENTER	580.97	CENTER	582.32

OVERFLOW DATA

OVERFLOW EL	588.9
C	2.6
L	100 FT

WEIR/ORIFICE HYDRAULICS

		SIDE OPENING				ROOF ORIFICE		OVERFLOW		
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)	OVERFLOW Y/N	OVERFLOW Q (CFS)	TOTAL Q (CFS)
1	580.64	2.88	0.33	WEIR	581.03	0.00	581.03	N	0.00	1.00
2	580.72		SUB	0.17	581.14	0.00	581.16	N	0.00	2.00
3	580.79		SUB	0.38	581.35	0.00	581.39	N	0.00	3.00
4	580.85		SUB	0.68	581.65	0.00	581.72	N	0.00	4.00
5	580.91		SUB	1.06	582.03	0.00	582.14	N	0.00	5.00
6	580.96		SUB	1.53	582.50	0.18	582.66	N	0.00	6.00
7	581.01		SUB	2.09	583.09	0.77	583.30	N	0.00	7.00
8	581.05		SUB	2.72	583.77	1.45	584.04	N	0.00	8.00
9	581.09		SUB	3.45	584.54	2.22	584.88	N	0.00	9.00
10	581.13		SUB	4.26	585.39	3.07	585.81	N	0.00	10.00
11	581.16		SUB	5.15	586.32	4.00	586.83	N	0.00	11.00
12	581.20		SUB	6.13	587.33	5.01	587.94	N	0.00	12.00
13	581.23		SUB	7.20	588.43	6.11	589.14	Y	31.20	44.20
14	581.32		SUB	8.35	589.66	7.34	590.49	Y	522.61	536.61
15	581.49		SUB	9.58	591.07	8.75	592.02	Y	1434.73	1449.73

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	5		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	575.99		h		FT
D/S I.E.	unknown		U/S CROWN EL	578.49	
TAILWATER ELEVATION	581.0		D/S CROWN EL		
n	0.024		Qf		CFS
D	30.00	IN	Vf		FPS
L	425.00	FT	A	4.91	SF
# BARRELS	2		R	0.63	

Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Analysis Component			
Storm Event	Design	Discharge	15.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	15.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	581.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-30 inch Circular	15.00 cfs	581.54 ft	1.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	581.54 ft	Discharge	15.00 cfs
Inlet Control HW Elev	581.00 ft	Tailwater Elevation	581.00 ft
Outlet Control HW Elev	581.54 ft	Control Type	Outlet Control
Headwater Depth/ Height	2.22		

Grades			
Upstream Invert	575.99 ft	Downstream Invert	575.00 ft
Length	425.00 ft	Constructed Slope	0.002329 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	6.00 ft
Slope Type	N/A	Normal Depth	1.54 ft
Flow Regime	N/A	Critical Depth	0.91 ft
Velocity Downstream	1.53 ft/s	Critical Slope	0.014244 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	581.54 ft	Upstream Velocity Head	0.04 ft
Ke	0.50	Entrance Loss	0.02 ft

Inlet Control Properties			
Inlet Control HW Elev	581.00 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	9.8 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
Big Marsh Outlet Structure #5

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	15.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	575.99
0.50	581.00
1.00	581.00
1.50	581.01
2.00	581.01
2.50	581.01
3.00	581.02
3.50	581.03
4.00	581.04
4.50	581.05
5.00	581.06
5.50	581.07
6.00	581.09
6.50	581.10
7.00	581.12
7.50	581.13
8.00	581.15
8.50	581.17
9.00	581.19
9.50	581.22
10.00	581.24
10.50	581.26
11.00	581.29
11.50	581.32
12.00	581.34
12.50	581.37
13.00	581.40
13.50	581.44
14.00	581.47
14.50	581.50
15.00	581.54

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	2.00 FT	TYPE	BOTTOM
RIM	580.49	C	0.61
L	6.28 FT	AREA	3.14 SF

WEIR/ORIFICE HYDRAULICS

		2' DIA. BOTTOM ORIFICE			
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)
1	581.00		SUB	0.00	581.00
2	581.01		SUB	0.02	581.03
3	581.02		SUB	0.04	581.06
4	581.04		SUB	0.07	581.11
5	581.06		SUB	0.11	581.17
6	581.09		SUB	0.15	581.24
7	581.12		SUB	0.21	581.33
8	581.15		SUB	0.27	581.42
9	581.19		SUB	0.34	581.53
10	581.24		SUB	0.42	581.66
11	581.29		SUB	0.51	581.80
12	581.34		SUB	0.61	581.95
13	581.40		SUB	0.71	582.11
14	581.47		SUB	0.83	582.30
15	581.54		SUB	0.95	582.49

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1		ROOF ORIFICE	
L	1.83 FT	TYPE	SIDE	TYPE	BOTTOM
CREST	580.70	C	0.61	C	0.61
CROWN	581.24	AREA	0.99 SF	AREA	3.14 SF
		CENTER	580.97	CENTER	582.32

OVERFLOW DATA

OVERFLOW EL	588.9
C	2.6
L	100 FT

WEIR/ORIFICE HYDRAULICS

		SIDE OPENING				ROOF ORIFICE		OVERFLOW		
Q	D/S WSL	C	WEIR HEAD	ORIFICE HEAD	U/S WSL	ORIFICE HEAD	U/S WSL	OVERFLOW	OVERFLOW	TOTAL
(CFS)	(FT)		(FT)	(FT)	(FT)	(FT)	(FT)	Y/N	Q (CFS)	Q (CFS)
1	581.00		SUB	0.04	581.05	0.00	581.05	N	0.00	1.00
2	581.03		SUB	0.17	581.20	0.00	581.21	N	0.00	2.00
3	581.06		SUB	0.38	581.44	0.00	581.48	N	0.00	3.00
4	581.11		SUB	0.68	581.79	0.00	581.86	N	0.00	4.00
5	581.17		SUB	1.06	582.23	0.00	582.34	N	0.00	5.00
6	581.24		SUB	1.53	582.78	0.46	582.93	N	0.00	6.00
7	581.33		SUB	2.09	583.41	1.09	583.62	N	0.00	7.00
8	581.42		SUB	2.72	584.15	1.83	584.42	N	0.00	8.00
9	581.53		SUB	3.45	584.98	2.66	585.32	N	0.00	9.00
10	581.66		SUB	4.26	585.92	3.60	586.34	N	0.00	10.00
11	581.80		SUB	5.15	586.95	4.63	587.47	N	0.00	11.00
12	581.95		SUB	6.13	588.08	5.76	588.69	N	0.00	12.00
13	582.11		SUB	7.20	589.31	6.99	590.02	Y	310.15	323.15
14	582.30		SUB	8.35	590.64	8.32	591.47	Y	1072.90	1086.90
15	582.49		SUB	9.58	592.07	9.75	593.02	Y	2176.44	2191.44

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	5		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	575.99		h		FT
D/S I.E.	unknown		U/S CROWN EL	578.49	
TAILWATER ELEVATION	581.0		D/S CROWN EL		
n	0.024		Qf		CFS
D	30.00	IN	Vf		FPS
L	425.00	FT	A	4.91	SF
# BARRELS	2		R	0.63	

Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Analysis Component			
Storm Event	Design	Discharge	15.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	15.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	582.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-30 inch Circular	15.00 cfs	582.54 ft	1.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

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Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	582.54 ft	Discharge	15.00 cfs
Inlet Control HW Elev	582.00 ft	Tailwater Elevation	582.00 ft
Outlet Control HW Elev	582.54 ft	Control Type	Outlet Control
Headwater Depth/ Height	2.62		

Grades			
Upstream Invert	575.99 ft	Downstream Invert	575.00 ft
Length	425.00 ft	Constructed Slope	0.002329 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	7.00 ft
Slope Type	N/A	Normal Depth	1.54 ft
Flow Regime	N/A	Critical Depth	0.91 ft
Velocity Downstream	1.53 ft/s	Critical Slope	0.014244 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	582.54 ft	Upstream Velocity Head	0.04 ft
Ke	0.50	Entrance Loss	0.02 ft

Inlet Control Properties			
Inlet Control HW Elev	582.00 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	9.8 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
Big Marsh Outlet Structure #5

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	15.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	575.99
0.50	582.00
1.00	582.00
1.50	582.01
2.00	582.01
2.50	582.01
3.00	582.02
3.50	582.03
4.00	582.04
4.50	582.05
5.00	582.06
5.50	582.07
6.00	582.09
6.50	582.10
7.00	582.12
7.50	582.13
8.00	582.15
8.50	582.17
9.00	582.19
9.50	582.22
10.00	582.24
10.50	582.26
11.00	582.29
11.50	582.32
12.00	582.34
12.50	582.37
13.00	582.40
13.50	582.44
14.00	582.47
14.50	582.50
15.00	582.54

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	2.00 FT	TYPE	BOTTOM
RIM	580.49	C	0.61
L	6.28 FT	AREA	3.14 SF

WEIR/ORIFICE HYDRAULICS

		2' DIA. BOTTOM ORIFICE			
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)
1	582.00		SUB	0.00	582.00
2	582.01		SUB	0.02	582.03
3	582.02		SUB	0.04	582.06
4	582.04		SUB	0.07	582.11
5	582.06		SUB	0.11	582.17
6	582.09		SUB	0.15	582.24
7	582.12		SUB	0.21	582.33
8	582.15		SUB	0.27	582.42
9	582.19		SUB	0.34	582.53
10	582.24		SUB	0.42	582.66
11	582.29		SUB	0.51	582.80
12	582.34		SUB	0.61	582.95
13	582.40		SUB	0.71	583.11
14	582.47		SUB	0.83	583.30
15	582.54		SUB	0.95	583.49

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1		ROOF ORIFICE	
L	1.83 FT	TYPE	SIDE	TYPE	BOTTOM
CREST	580.70	C	0.61	C	0.61
CROWN	581.24	AREA	0.99 SF	AREA	3.14 SF
		CENTER	580.97	CENTER	582.32

OVERFLOW DATA

OVERFLOW EL	588.9
C	2.6
L	100 FT

WEIR/ORIFICE HYDRAULICS

		SIDE OPENING				ROOF ORIFICE		OVERFLOW		
Q	D/S WSL	C	WEIR HEAD	ORIFICE HEAD	U/S WSL	ORIFICE HEAD	U/S WSL	OVERFLOW	OVERFLOW	TOTAL
(CFS)	(FT)		(FT)	(FT)	(FT)	(FT)	(FT)	Y/N	Q (CFS)	Q (CFS)
1	582.00		SUB	0.04	582.05	0.00	582.05	N	0.00	1.00
2	582.03		SUB	0.17	582.20	0.00	582.21	N	0.00	2.00
3	582.06		SUB	0.38	582.44	0.12	582.48	N	0.00	3.00
4	582.11		SUB	0.68	582.79	0.47	582.86	N	0.00	4.00
5	582.17		SUB	1.06	583.23	0.91	583.34	N	0.00	5.00
6	582.24		SUB	1.53	583.78	1.46	583.93	N	0.00	6.00
7	582.33		SUB	2.09	584.41	2.09	584.62	N	0.00	7.00
8	582.42		SUB	2.72	585.15	2.83	585.42	N	0.00	8.00
9	582.53		SUB	3.45	585.98	3.66	586.32	N	0.00	9.00
10	582.66		SUB	4.26	586.92	4.60	587.34	N	0.00	10.00
11	582.80		SUB	5.15	587.95	5.63	588.47	N	0.00	11.00
12	582.95		SUB	6.13	589.08	6.76	589.69	Y	182.19	194.19
13	583.11		SUB	7.20	590.31	7.99	591.02	Y	805.28	818.28
14	583.30		SUB	8.35	591.64	9.32	592.47	Y	1755.78	1769.78
15	583.49		SUB	9.58	593.07	10.75	594.02	Y	3014.55	3029.55

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO:	5		
ENGINEER:	SWA	CHECKED BY:	DGD
DATE:	11-8-05	DATE:	11-8-05

PIPE FLOW FROM STRUCTURE TO OUTLET (PER PIPE)

U/S I.E.	575.99		h	FT
D/S I.E.	unknown		U/S CROWN EL	578.49
TAILWATER ELEVATION	581.0		D/S CROWN EL	
n	0.024		Qf	CFS
D	30.00	IN	Vf	FPS
L	425.00	FT	A	4.91 SF
# BARRELS	2		R	0.63

Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Analysis Component			
Storm Event	Design	Discharge	15.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	15.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	583.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-30 inch Circular	15.00 cfs	583.54 ft	1.53 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Big Marsh Outlet Structure #5

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	583.54 ft	Discharge	15.00 cfs
Inlet Control HW Elev	583.00 ft	Tailwater Elevation	583.00 ft
Outlet Control HW Elev	583.54 ft	Control Type	Outlet Control
Headwater Depth/ Height	3.02		

Grades			
Upstream Invert	575.99 ft	Downstream Invert	575.00 ft
Length	425.00 ft	Constructed Slope	0.002329 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	8.00 ft
Slope Type	N/A	Normal Depth	1.54 ft
Flow Regime	N/A	Critical Depth	0.91 ft
Velocity Downstream	1.53 ft/s	Critical Slope	0.014244 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	583.54 ft	Upstream Velocity Head	0.04 ft
Ke	0.50	Entrance Loss	0.02 ft

Inlet Control Properties			
Inlet Control HW Elev	583.00 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	9.8 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

SDI Consultants Ltd
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Rating Table Report
Big Marsh Outlet Structure #5

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	15.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	575.99
0.50	583.00
1.00	583.00
1.50	583.01
2.00	583.01
2.50	583.01
3.00	583.02
3.50	583.03
4.00	583.04
4.50	583.05
5.00	583.06
5.50	583.07
6.00	583.09
6.50	583.10
7.00	583.12
7.50	583.13
8.00	583.15
8.50	583.17
9.00	583.19
9.50	583.22
10.00	583.24
10.50	583.26
11.00	583.29
11.50	583.32
12.00	583.34
12.50	583.37
13.00	583.40
13.50	583.44
14.00	583.47
14.50	583.50
15.00	583.54

SDI Consultants Ltd
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1	
D	2.00 FT	TYPE	BOTTOM
RIM	580.49	C	0.61
L	6.28 FT	AREA	3.14 SF

WEIR/ORIFICE HYDRAULICS

		2' DIA. BOTTOM ORIFICE			
Q (CFS)	D/S WSL (FT)	C	WEIR HEAD (FT)	ORIFICE HEAD (FT)	U/S WSL (FT)
1	583.00		SUB	0.00	583.00
2	583.01		SUB	0.02	583.03
3	583.02		SUB	0.04	583.06
4	583.04		SUB	0.07	583.11
5	583.06		SUB	0.11	583.17
6	583.09		SUB	0.15	583.24
7	583.12		SUB	0.21	583.33
8	583.15		SUB	0.27	583.42
9	583.19		SUB	0.34	583.53
10	583.24		SUB	0.42	583.66
11	583.29		SUB	0.51	583.80
12	583.34		SUB	0.61	583.95
13	583.40		SUB	0.71	584.11
14	583.47		SUB	0.83	584.30
15	583.54		SUB	0.95	584.49

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

WEIR / ORIFICE DATA

WEIR 1		ORIFICE 1		ROOF ORIFICE	
L	1.83 FT	TYPE	SIDE	TYPE	BOTTOM
CREST	580.70	C	0.61	C	0.61
CROWN	581.24	AREA	0.99 SF	AREA	3.14 SF
		CENTER	580.97	CENTER	582.32

OVERFLOW DATA

OVERFLOW EL	588.9
C	2.6
L	100 FT

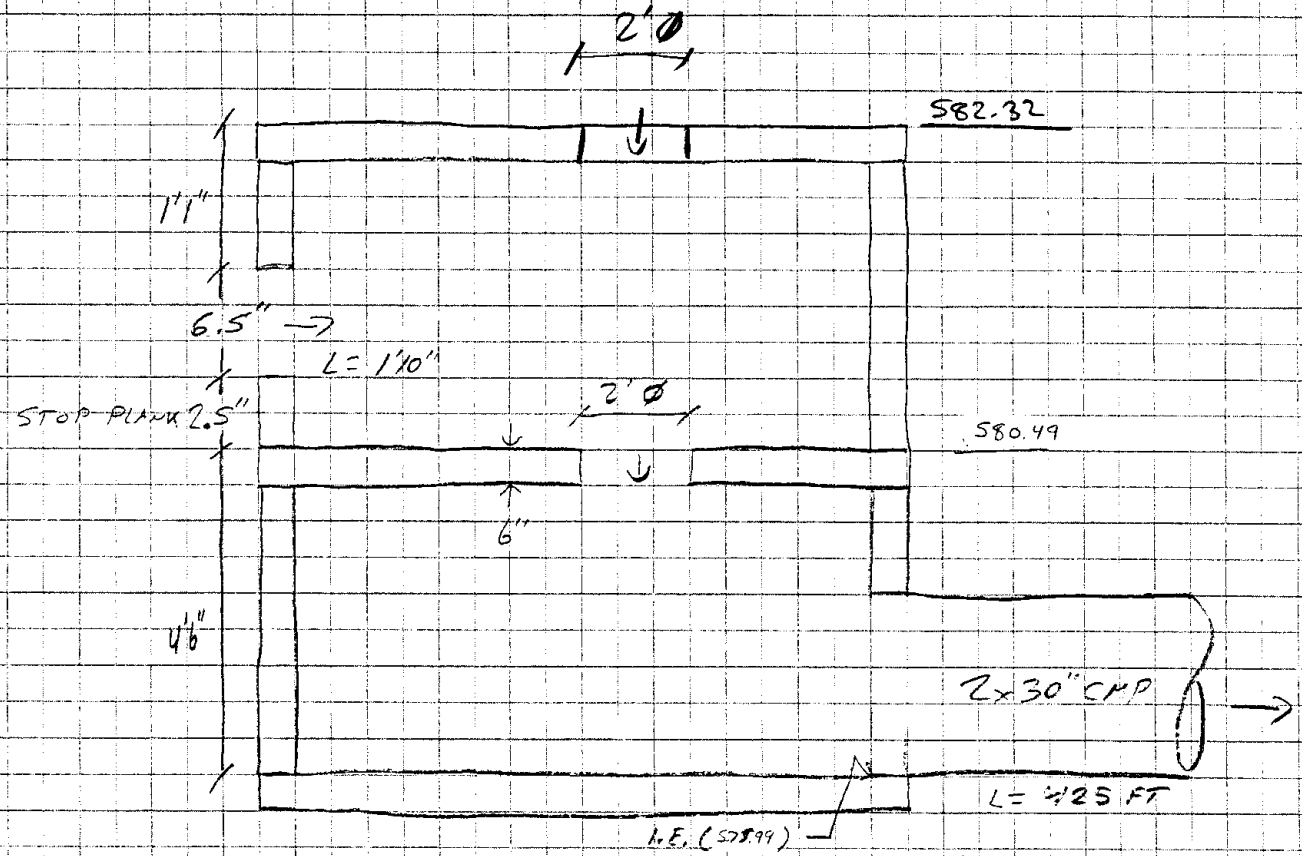
WEIR/ORIFICE HYDRAULICS

		SIDE OPENING				ROOF ORIFICE		OVERFLOW		
Q	D/S WSL	C	WEIR HEAD	ORIFICE HEAD	U/S WSL	ORIFICE HEAD	U/S WSL	OVERFLOW	OVERFLOW	TOTAL
(CFS)	(FT)		(FT)	(FT)	(FT)	(FT)	(FT)	Y/N	Q (CFS)	Q (CFS)
1	583.00		SUB	0.04	583.05	0.73	583.05	N	0.00	1.00
2	583.03		SUB	0.17	583.20	0.88	583.21	N	0.00	2.00
3	583.06		SUB	0.38	583.44	1.12	583.48	N	0.00	3.00
4	583.11		SUB	0.68	583.79	1.47	583.86	N	0.00	4.00
5	583.17		SUB	1.06	584.23	1.91	584.34	N	0.00	5.00
6	583.24		SUB	1.53	584.78	2.46	584.93	N	0.00	6.00
7	583.33		SUB	2.09	585.41	3.09	585.62	N	0.00	7.00
8	583.42		SUB	2.72	586.15	3.83	586.42	N	0.00	8.00
9	583.53		SUB	3.45	586.98	4.66	587.32	N	0.00	9.00
10	583.66		SUB	4.26	587.92	5.60	588.34	N	0.00	10.00
11	583.80		SUB	5.15	588.95	6.63	589.47	Y	110.46	121.46
12	583.95		SUB	6.13	590.08	7.76	590.69	Y	622.10	634.10
13	584.11		SUB	7.20	591.31	8.99	592.02	Y	1436.16	1449.16
14	584.30		SUB	8.35	592.64	10.32	593.47	Y	2542.34	2556.34
15	584.49		SUB	9.58	594.07	11.75	595.02	Y	3939.02	3954.02

WEIR FLOW: Q=CL*h^(3/2)
ORIFICE FLOW: Q=CA*(2gh)^(1/2)

LAKE CALUMET HYDROLOGIC MASTER PLAN - DEVELOP RATING CURVES FOR CONTROL STRUCTURES

STRUCTURE #5: DROP INLET DRAINS BIG MARSH TO LAKE CALUMET



PIPE LENGTH ESTIMATED FROM DOE MAPPING

COMPUTED: SWF	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 6-[illegible]-05		SUBJECT: STRUCTURE #5
CHECKED:		
DATE:	ENGINEERING CALCULATIONS	SHEET NO:

A. DEVELOP RATING CURVE FOR PIPE WITH T/W

$\emptyset$ = 30" # BARRELS = 2

n = 0.024

L = 425 LF

EXIT LOSS = $H_o = 1.0 \left(\frac{V_o^2}{2g} - \frac{V_d^2}{2g} \right)$ HEC-22 (T-4)

V_o = PIPE VELOCITY

V_d = CHANNEL VELOCITY DOWNSTREAM = 0 FOR LAKE HEC-22 (2.1.6.2)

$H_o = \frac{V_o^2}{2g}$

ENTRANCE LOSS = $H_i = K_i \left(\frac{V_o^2}{2g} \right)$ HEC-22 (T-9)

K_i = 0.5 FOR INLET WITH STRAIGHT PIPE RUN HEC-22 (T7-5A)

V_o = PIPE VELOCITY

FRICTION LOSS

$H_f = L \left(\frac{Q_n}{1.486 A R^{2/3}} \right)^2$ PRESSURE FLOW

U/S WSL = T/W + H_o + H_f + H_i

USE U/S WSL AS D/S WSL FOR 2'$\emptyset$ WEIR/ORIFICE CALCULATIONS

COMPUTED: CWF	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 6-10-02		SUBJECT: STRUCTURE #5
CHECKED:		
DATE:	ENGINEERING CALCULATIONS	SHEET NO:

B. CALCULATE HEAD ON 2'Ø ORIFICE

SET D/S WSL AS PIPE U/S WSL.

ORIFICE U/S WSL WILL BE LARGER OF HEAD REQ'D TO PASS FLOW BY EITHER WEIR OR ORIFICE ANALYSIS.

WEIR ANALYSIS

$Q = CLH^{3/2}$

$H = \left(\frac{Q}{CL}\right)^{2/3}$

Q = FLOW (CFS)
C = COEFFICIENT (SEE ATTACHED TABLE)
L = WEIR LENGTH (FT) = πD
H = HEAD ON WEIR (FT)

U/S WSL = H + MAX (WEIR CREST, D/S WSL)

ORIFICE ANALYSIS

$Q = CA\sqrt{2gH}$

$H = \left(\frac{Q}{CA}\right)^2 \left(\frac{1}{2g}\right)$

Q = FLOW (CFS)
C = 0.61
A = ORIFICE AREA (SF)
g = 32.2 FT/S^2
H = HEAD ON ORIFICE (FT)

U/S WSL = H + MAX (ORIFICE INV., D/S WSL)

USE U/S WSL AS D/S WSL FOR WEIR/ORIFICE CALCULATIONS FOR OPENING IN SIDE WALL OF STRUCTURE.

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 6-10-04		SUBJECT: STRUCTURE #5
CHECKED:		
DATE:	ENGINEERING CALCULATIONS	SHEET NO:

Table 8-1. SI Units - Broad-Crested Weir Coefficient C Values as a Function of Weir Crest.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest Breadth and Head (coefficient has units of $m^{0.5}/sec$).[1]															
Head[2] (m)	Breadth of Crest of Weir (m)														
	0.15	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.25	1.50	2.00	3.00	4.00
0.10	1.59	1.56	1.50	1.47	1.45	1.43	1.42	1.41	1.40	1.39	1.37	1.35	1.36	1.40	1.45
0.15	1.65	1.60	1.51	1.48	1.45	1.44	1.44	1.44	1.45	1.45	1.44	1.43	1.44	1.45	1.47
0.20	1.73	1.66	1.54	1.49	1.46	1.44	1.44	1.45	1.47	1.48	1.48	1.49	1.49	1.49	1.48
0.30	1.83	1.77	1.64	1.56	1.50	1.47	1.46	1.46	1.46	1.47	1.47	1.48	1.48	1.48	1.46
0.40	1.83	1.80	1.74	1.65	1.57	1.52	1.49	1.47	1.46	1.46	1.47	1.47	1.47	1.48	1.47
0.50	1.83	1.82	1.81	1.74	1.67	1.60	1.55	1.51	1.48	1.48	1.47	1.46	1.46	1.46	1.45
0.60	1.83	1.83	1.82	1.73	1.65	1.58	1.54	1.46	1.31	1.34	1.48	1.46	1.46	1.46	1.45
0.70	1.83	1.83	1.83	1.78	1.72	1.65	1.60	1.53	1.44	1.45	1.49	1.47	1.47	1.46	1.45
0.80	1.83	1.83	1.83	1.82	1.79	1.72	1.66	1.60	1.57	1.55	1.50	1.47	1.47	1.46	1.45
0.90	1.83	1.83	1.83	1.83	1.81	1.76	1.71	1.66	1.61	1.58	1.50	1.47	1.47	1.46	1.45
1.00	1.83	1.83	1.83	1.83	1.82	1.81	1.76	1.70	1.64	1.60	1.51	1.48	1.47	1.46	1.45
1.10	1.83	1.83	1.83	1.83	1.83	1.83	1.80	1.75	1.66	1.62	1.52	1.49	1.47	1.46	1.45
1.20	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.79	1.70	1.65	1.53	1.49	1.48	1.46	1.45
1.30	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.82	1.77	1.71	1.56	1.51	1.49	1.46	1.45
1.40	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.77	1.60	1.52	1.50	1.46	1.45
1.50	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.79	1.66	1.55	1.51	1.46	1.45
1.60	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.81	1.74	1.58	1.53	1.46	1.45

(1) Modified from reference 49 (2) Measured at le a st 2.5 H_c upstream of the weir

Table 8-1. English Units - Broad-Crested Weir Coefficient C Values as a Function of Weir Crest.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest Breadth and Head (coefficient has units of $ft^{0.5}/sec$).[1]											
Head[2] (ft)	Breadth of Crest of Weir (ft)										
	0.50	0.75	1.00	1.5	2.0	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

(1) Table is taken from reference 49.

C. CALCULATE HEAD ON SIDE OPENING

SET D/S WSL AS U/S WSL FROM 2D WEIR/ORIFICE CALCULATIONS

WEIR ANALYSIS

$$Q = CLH^{3/2}$$

$$H = \left(\frac{Q}{CL}\right)^{2/3}$$

Q = FLOW (CFS)
C = COEFFICIENT (SEE ATTACHED TABLE)
L = WEIR LENGTH (FT)
H = HEAD ON WEIR (FT)

U/S WSL = H + MAX (WEIR CREST, D/S WSL) UNTIL U/S WSL EXCEEDS WEIR CROWN, THEN PROCEED TO ORIFICE ANALYSIS

ORIFICE ANALYSIS

$$Q = CA\sqrt{2gH}$$

$$H = \left(\frac{Q}{CA}\right)^2 \left(\frac{1}{2g}\right)$$

Q = FLOW (CFS)
C = 0.61
A = ORIFICE AREA (SF)
g = 32.2 FT/S^2
H = HEAD ON ORIFICE (FT) (MEASURED TO CENTER OF OPENING)

U/S WSL = H + MAX (OPENING CENTER, D/S WSL)

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 6-10-04		SUBJECT: STRUCTURE #5
CHECKED:		
DATE:	ENGINEERING CALCULATIONS	SHEET NO:

D. ACCOUNT FOR OVERFLOW BYPASSING STRUCTURE.

RUNOFF WILL OVERFLOW STONY ISLAND AVE. AT EL. = 588.9 (PER DOE MAPPING).

ACCOUNT FOR OVERFLOW AS A WEIR.

$Q = C L H^{3/2}$

Q = FLOW (CFS)
C = 2.6
L = 100'
H = HEAD (FT) = U/S WSL − OVERFLOW EL.

COMPUTED: SWA	V3 CONSULTANTS	PROJECT: LAKE CALUMET HMP
DATE: 6-10-04		SUBJECT: STRUCTURE #5
CHECKED:	ENGINEERING CALCULATIONS	SHEET NO:
DATE:		

LAKE CALUMET HMP
STRUCTURE RATING CURVES

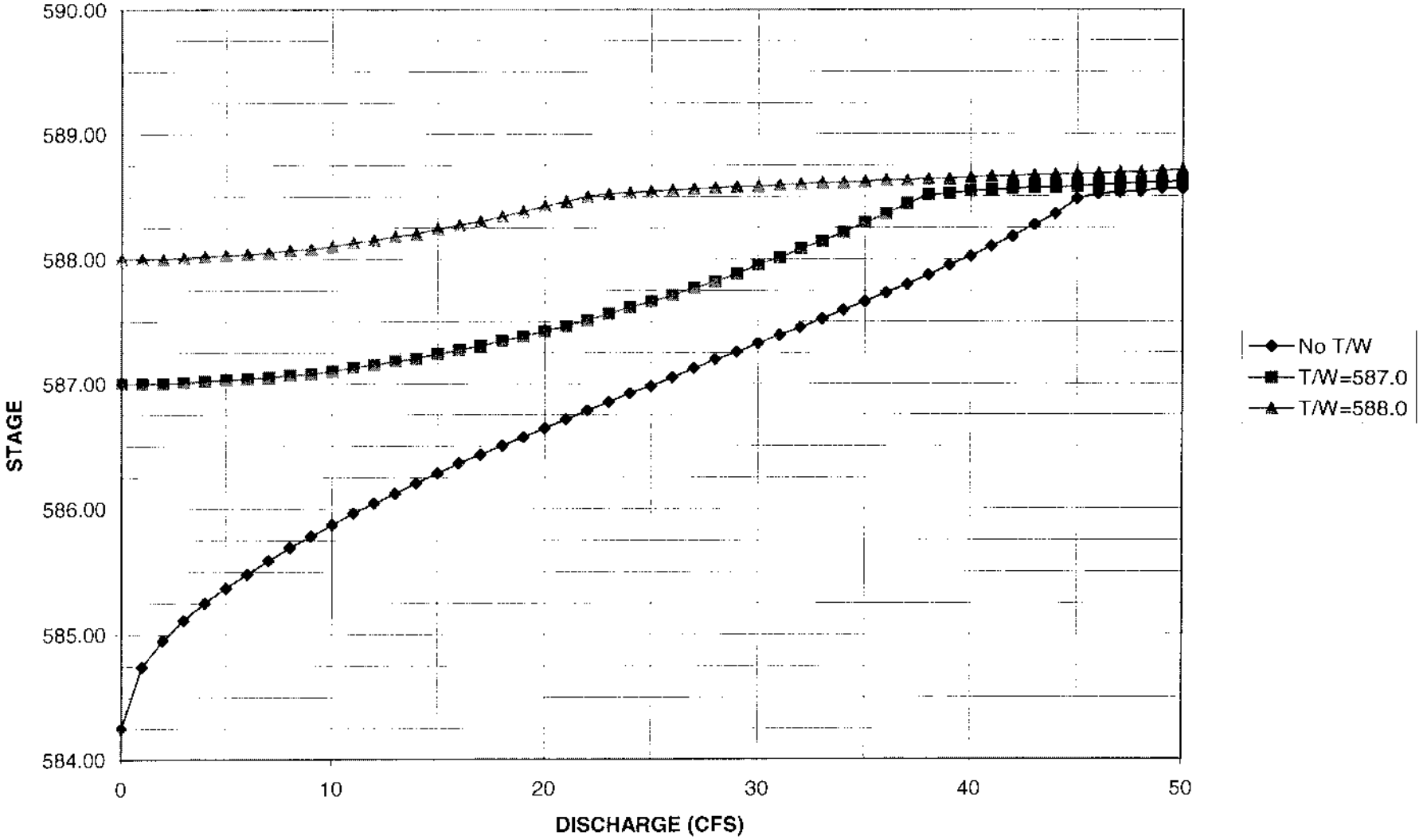
STRUCTURE NO: 7
ENGINEER: SWA
DATE: 11-8-05

CHECKED BY: DGD
DATE: 11-8-05

SUMMARY CHART

FLOW	STAGE AT VARYING TAILWATER CONDITIONS		
(CFS)	TAILWATER		
	0	587	588
0	584.25	587.00	588.00
1	584.74	587.00	588.00
2	584.95	587.00	588.00
3	585.11	587.01	588.01
4	585.25	587.02	588.02
5	585.37	587.03	588.03
6	585.48	587.04	588.04
7	585.59	587.05	588.05
8	585.69	587.07	588.07
9	585.78	587.08	588.08
10	585.87	587.10	588.10
11	585.96	587.13	588.13
12	586.04	587.15	588.15
13	586.12	587.18	588.18
14	586.20	587.20	588.20
15	586.28	587.24	588.24
16	586.36	587.27	588.27
17	586.43	587.30	588.30
18	586.50	587.34	588.34
19	586.57	587.38	588.38
20	586.64	587.42	588.42
21	586.71	587.46	588.46
22	586.78	587.51	588.50
23	586.85	587.56	588.52
24	586.92	587.61	588.53
25	586.98	587.66	588.54
26	587.05	587.71	588.55
27	587.12	587.77	588.56
28	587.19	587.82	588.57
29	587.25	587.88	588.58
30	587.32	587.95	588.58
31	587.39	588.01	588.59
32	587.45	588.08	588.60
33	587.52	588.14	588.61
34	587.59	588.21	588.61
35	587.66	588.29	588.62
36	587.73	588.36	588.63
37	587.80	588.44	588.63
38	587.87	588.51	588.64
39	587.95	588.52	588.64
40	588.02	588.54	588.65
41	588.10	588.55	588.66
42	588.18	588.56	588.66
43	588.27	588.57	588.67
44	588.36	588.57	588.67
45	588.48	588.58	588.68
46	588.52	588.59	588.68
47	588.53	588.60	588.69
48	588.54	588.61	588.69
49	588.56	588.61	588.70
50	588.56	588.62	588.71

STRUCTURE #7 RATING CURVES



Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-36 inch Circular	56.77 cfs	589.93 ft	9.21 ft/s
Weir	Broad Crested	443.21 cfs	589.93 ft	N/A
Total	----------	499.97 cfs	589.93 ft	N/A

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.93 ft	Discharge	56.77 cfs
Inlet Control HW Elev	589.43 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev	589.93 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.89		

Grades			
Upstream Invert	584.25 ft	Downstream Invert	583.82 ft
Length	60.00 ft	Constructed Slope	0.007167 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	2.44 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	2.44 ft
Velocity Downstream	9.21 ft/s	Critical Slope	0.025007 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.93 ft	Upstream Velocity Head	1.00 ft
Ke	0.90	Entrance Loss	0.90 ft

Inlet Control Properties			
Inlet Control HW Elev	589.43 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	7.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	443.21 cfs	Allowable HW Elevation	589.93 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	588.50 ft	Headwater Elevation	589.93 ft

Rating Table Report
116th Street Culvert Structure #7

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	50.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	0.00
1.00	584.74
2.00	584.95
3.00	585.11
4.00	585.25
5.00	585.37
6.00	585.48
7.00	585.59
8.00	585.69
9.00	585.78
10.00	585.87
11.00	585.96
12.00	586.04
13.00	586.12
14.00	586.20
15.00	586.28
16.00	586.36
17.00	586.43
18.00	586.50
19.00	586.57
20.00	586.64
21.00	586.71
22.00	586.78
23.00	586.85
24.00	586.92
25.00	586.98
26.00	587.05
27.00	587.12
28.00	587.19
29.00	587.25
30.00	587.32
31.00	587.39
32.00	587.45
33.00	587.52
34.00	587.59
35.00	587.66
36.00	587.73
37.00	587.80
38.00	587.87
39.00	587.95
40.00	588.02
41.00	588.10
42.00	588.18
43.00	588.27
44.00	588.36
45.00	588.48
46.00	588.52
47.00	588.53

Rating Table Report
116th Street Culvert Structure #7

Discharge (cfs)	HW Elev (ft)
48.00	588.54
49.00	588.56
50.00	588.56

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	587.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-36 inch Circular	52.86 cfs	589.94 ft	7.48 ft/s
Weir	Broad Crested	447.14 cfs	589.94 ft	N/A
Total	----------	500.00 cfs	589.94 ft	N/A

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.94 ft	Discharge	52.86 cfs
Inlet Control HW Elev	588.95 ft	Tailwater Elevation	587.00 ft
Outlet Control HW Elev	589.94 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.90		

Grades			
Upstream Invert	584.25 ft	Downstream Invert	583.82 ft
Length	60.00 ft	Constructed Slope	0.007167 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	3.18 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.36 ft
Velocity Downstream	7.48 ft/s	Critical Slope	0.023114 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.94 ft	Upstream Velocity Head	0.87 ft
Ke	0.90	Entrance Loss	0.78 ft

Inlet Control Properties			
Inlet Control HW Elev	588.95 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	7.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	447.14 cfs	Allowable HW Elevation	589.94 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	588.50 ft	Headwater Elevation	589.94 ft

Rating Table Report
116th Street Culvert Structure #7

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	50.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	584.25
1.00	587.00
2.00	587.00
3.00	587.01
4.00	587.02
5.00	587.03
6.00	587.04
7.00	587.05
8.00	587.07
9.00	587.08
10.00	587.10
11.00	587.13
12.00	587.15
13.00	587.18
14.00	587.20
15.00	587.24
16.00	587.27
17.00	587.30
18.00	587.34
19.00	587.38
20.00	587.42
21.00	587.46
22.00	587.51
23.00	587.56
24.00	587.61
25.00	587.66
26.00	587.71
27.00	587.77
28.00	587.82
29.00	587.88
30.00	587.95
31.00	588.01
32.00	588.08
33.00	588.14
34.00	588.21
35.00	588.29
36.00	588.36
37.00	588.44
38.00	588.51
39.00	588.52
40.00	588.54
41.00	588.55
42.00	588.56
43.00	588.57
44.00	588.57
45.00	588.58
46.00	588.59
47.00	588.60

Rating Table Report
116th Street Culvert Structure #7

Discharge (cfs)	HW Elev (ft)
48.00	588.61
49.00	588.61
50.00	588.62

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	588.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-36 inch Circular	43.15 cfs	589.96 ft	6.10 ft/s
Weir	Broad Crested	456.85 cfs	589.96 ft	N/A
Total	----------	500.00 cfs	589.96 ft	N/A

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.96 ft	Discharge	43.15 cfs
Inlet Control HW Elev	588.05 ft	Tailwater Elevation	588.00 ft
Outlet Control HW Elev	589.96 ft	Control Type	Outlet Control
Headwater Depth/ Height	1.90		

Grades			
Upstream Invert	584.25 ft	Downstream Invert	583.82 ft
Length	60.00 ft	Constructed Slope	0.007167 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	4.18 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.14 ft
Velocity Downstream	6.10 ft/s	Critical Slope	0.019387 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.96 ft	Upstream Velocity Head	0.58 ft
Ke	0.90	Entrance Loss	0.52 ft

Inlet Control Properties			
Inlet Control HW Elev	588.05 ft	Flow Control	Transition
Inlet Type	Projecting	Area Full	7.1 ft^2
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
116th Street Culvert Structure #7

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	456.85 cfs	Allowable HW Elevation	589.96 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	588.50 ft	Headwater Elevation	589.96 ft

Rating Table Report
116th Street Culvert Structure #7

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	50.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	584.25
1.00	588.00
2.00	588.00
3.00	588.01
4.00	588.02
5.00	588.03
6.00	588.04
7.00	588.05
8.00	588.07
9.00	588.09
10.00	588.10
11.00	588.13
12.00	588.15
13.00	588.18
14.00	588.21
15.00	588.24
16.00	588.27
17.00	588.30
18.00	588.34
19.00	588.38
20.00	588.42
21.00	588.46
22.00	588.50
23.00	588.52
24.00	588.53
25.00	588.54
26.00	588.55
27.00	588.56
28.00	588.57
29.00	588.58
30.00	588.58
31.00	588.59
32.00	588.60
33.00	588.61
34.00	588.61
35.00	588.62
36.00	588.63
37.00	588.63
38.00	588.64
39.00	588.64
40.00	588.65
41.00	588.66
42.00	588.66
43.00	588.67
44.00	588.67
45.00	588.68
46.00	588.68
47.00	588.69

SDI Consultants Ltd
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Rating Table Report
116th Street Culvert Structure #7

Discharge (cfs)	HW Elev (ft)
48.00	588.69
49.00	588.70
50.00	588.71

STRUCTURE #7- 116TH STREET CULVERT

ANALYZE IN CULVERT MASTER

I.E. U/S = 584.25
D/S = 583.82

L = 60'
n = 0.024 CMP
Ø = 36"

OVERFLOW EL = 588.5 +/-
L = 100'
C = 2.6

TAILWATER RANGE

NO TAILWATER
TW = 587.0
TW = 588.0

COMPUTED: SWA		PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE #7
CHECKED: DGD	ENGINEERING CALCULATIONS	SHEET NO:
DATE: 11-8-05		

LAKE CALUMET HMP
STRUCTURE RATING CURVES

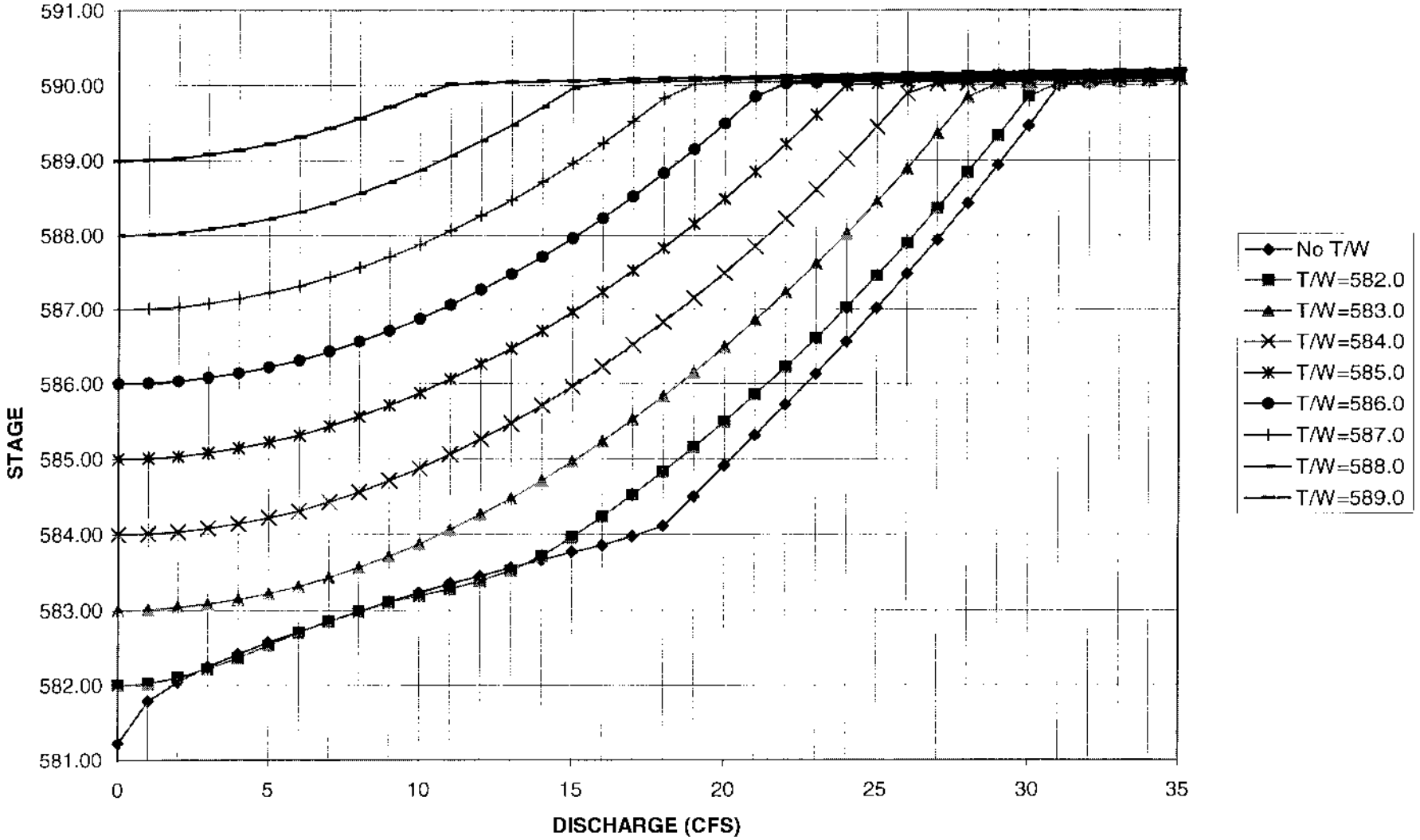
STRUCTURE NO: 8
ENGINEER: SWA
DATE: 11-8-05

CHECKED BY: DGD
DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS								
	TAILWATER								
	0	582	583	584	585	586	587	588	589
0	581.22	582.00	583.00	584.00	585.00	586.00	587.00	588.00	589.00
1	581.79	582.02	583.01	584.01	585.01	586.01	587.01	588.01	589.01
2	582.04	582.10	583.04	584.03	585.03	586.03	587.03	588.03	589.03
3	582.24	582.21	583.08	584.08	585.08	586.08	587.08	588.08	589.08
4	582.41	582.36	583.14	584.14	585.14	586.14	587.14	588.14	589.14
5	582.57	582.53	583.22	584.22	585.22	586.22	587.22	588.22	589.22
6	582.71	582.70	583.31	584.31	585.31	586.31	587.31	588.31	589.31
7	582.85	582.85	583.43	584.43	585.43	586.43	587.43	588.43	589.43
8	582.98	582.98	583.56	584.56	585.56	586.56	587.56	588.56	589.56
9	583.11	583.10	583.71	584.71	585.71	586.71	587.71	588.71	589.71
10	583.23	583.19	583.87	584.87	585.87	586.87	587.87	588.87	589.87
11	583.35	583.28	584.06	585.06	586.06	587.06	588.06	589.06	590.01
12	583.45	583.38	584.26	585.26	586.26	587.26	588.26	589.26	590.03
13	583.56	583.52	584.47	585.47	586.47	587.47	588.47	589.47	590.04
14	583.66	583.71	584.71	585.71	586.71	587.71	588.71	589.71	590.05
15	583.76	583.96	584.96	585.96	586.96	587.96	588.96	589.96	590.06
16	583.86	584.23	585.23	586.23	587.23	588.23	589.23	590.02	590.07
17	583.97	584.52	585.52	586.52	587.52	588.52	589.52	590.04	590.08
18	584.11	584.83	585.83	586.83	587.83	588.83	589.83	590.05	590.09
19	584.50	585.15	586.15	587.15	588.15	589.15	590.01	590.06	590.10
20	584.91	585.49	586.49	587.49	588.49	589.49	590.03	590.07	590.10
21	585.31	585.85	586.85	587.85	588.85	589.85	590.04	590.08	590.11
22	585.72	586.22	587.22	588.22	589.22	590.02	590.05	590.09	590.12
23	586.13	586.61	587.61	588.61	589.61	590.03	590.06	590.09	590.13
24	586.56	587.02	588.02	589.02	590.00	590.04	590.07	590.10	590.13
25	587.01	587.45	588.45	589.45	590.02	590.06	590.08	590.11	590.14
26	587.47	587.89	588.89	589.89	590.04	590.07	590.09	590.12	590.15
27	587.94	588.36	589.36	590.02	590.05	590.08	590.10	590.12	590.15
28	588.43	588.84	589.84	590.03	590.06	590.08	590.11	590.13	590.16
29	588.94	589.33	590.02	590.05	590.07	590.09	590.11	590.14	590.17
30	589.46	589.85	590.03	590.06	590.08	590.10	590.12	590.14	590.17
31	590.00	590.02	590.05	590.07	590.09	590.11	590.13	590.15	590.18
32	590.02	590.03	590.06	590.08	590.10	590.12	590.14	590.16	590.18
33	590.04	590.05	590.07	590.09	590.10	590.12	590.14	590.16	590.19
34	590.05	590.06	590.08	590.09	590.11	590.13	590.15	590.17	590.19
35	590.06	590.07	590.09	590.10	590.12	590.14	590.16	590.18	590.20

STRUCTURE #8 RATING CURVES



Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	33.59 cfs	591.48 ft	10.88 ft/s
Weir	Broad Crested	466.19 cfs	591.48 ft	N/A
Total	----------	499.79 cfs	591.48 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	591.48	ft	Discharge	33.59	cfs
Inlet Control HW Elev	588.61	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev	591.48	ft	Control Type	Outlet Control	
Headwater Depth/ Height	5.13				

Grades					
Upstream Invert	581.22	ft	Downstream Invert	579.67	ft
Length	86.00	ft	Constructed Slope	0.018023	ft/ft

Hydraulic Profile					
Profile	CompositeM2Pressure		Depth, Downstream	1.91	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.91	ft
Velocity Downstream	10.88	ft/s	Critical Slope	0.065216	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	591.48	ft	Upstream Velocity Head	1.78	ft
Ke	0.90		Entrance Loss	1.60	ft

Inlet Control Properties					
Inlet Control HW Elev	588.61	ft	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	3.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	466.19 cfs	Allowable HW Elevation	591.48 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.48 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	0.00
1.00	581.79
2.00	582.04
3.00	582.24
4.00	582.41
5.00	582.57
6.00	582.71
7.00	582.85
8.00	582.98
9.00	583.11
10.00	583.23
11.00	583.35
12.00	583.45
13.00	583.56
14.00	583.66
15.00	583.76
16.00	583.86
17.00	583.97
18.00	584.11
19.00	584.50
20.00	584.91
21.00	585.31
22.00	585.72
23.00	586.13
24.00	586.56
25.00	587.01
26.00	587.47
27.00	587.94
28.00	588.43
29.00	588.94
30.00	589.46
31.00	590.00
32.00	590.02
33.00	590.04
34.00	590.05
35.00	590.06
36.00	590.07
37.00	590.08
38.00	590.09
39.00	590.10
40.00	590.10

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	589.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	16.97 cfs	591.51 ft	5.40 ft/s
Weir	Broad Crested	482.89 cfs	591.51 ft	N/A
Total	----------	499.86 cfs	591.51 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.51 ft	Discharge	16.97 cfs
Inlet Control HW Elev	589.00 ft	Tailwater Elevation	589.00 ft
Outlet Control HW Elev	591.51 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.15		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	9.33 ft
Slope Type	N/A	Normal Depth	1.70 ft
Flow Regime	N/A	Critical Depth	1.49 ft
Velocity Downstream	5.40 ft/s	Critical Slope	0.023607 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.51 ft	Upstream Velocity Head	0.45 ft
Ke	0.90	Entrance Loss	0.41 ft

Inlet Control Properties			
Inlet Control HW Elev	589.00 ft	Flow Control	Transition
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested					
Discharge	482.89	cfs	Allowable HW Elevation	591.51	ft
Weir Coefficient	2.60	US	Length	100.00	ft
Crest Elevation	590.00	ft	Headwater Elevation	591.51	ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	589.01
2.00	589.03
3.00	589.08
4.00	589.14
5.00	589.22
6.00	589.31
7.00	589.43
8.00	589.56
9.00	589.71
10.00	589.87
11.00	590.01
12.00	590.03
13.00	590.04
14.00	590.05
15.00	590.06
16.00	590.07
17.00	590.08
18.00	590.09
19.00	590.10
20.00	590.10
21.00	590.11
22.00	590.12
23.00	590.13
24.00	590.13
25.00	590.14
26.00	590.15
27.00	590.15
28.00	590.16
29.00	590.17
30.00	590.17
31.00	590.18
32.00	590.18
33.00	590.19
34.00	590.19
35.00	590.20
36.00	590.21
37.00	590.21
38.00	590.22
39.00	590.22
40.00	590.23

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	582.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	32.97 cfs	591.48 ft	10.49 ft/s
Weir	Broad Crested	466.82 cfs	591.48 ft	N/A
Total	----------	499.79 cfs	591.48 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	591.48	ft	Discharge	32.97	cfs
Inlet Control HW Elev	588.37	ft	Tailwater Elevation	582.00	ft
Outlet Control HW Elev	591.48	ft	Control Type	Outlet Control	
Headwater Depth/ Height	5.13				

Grades					
Upstream Invert	581.22	ft	Downstream Invert	579.67	ft
Length	86.00	ft	Constructed Slope	0.018023	ft/ft

Hydraulic Profile					
Profile	Pressure		Depth, Downstream	2.33	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.90	ft
Velocity Downstream	10.49	ft/s	Critical Slope	0.062710	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	591.48	ft	Upstream Velocity Head	1.71	ft
Ke	0.90		Entrance Loss	1.54	ft

Inlet Control Properties					
Inlet Control HW Elev	588.37	ft	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	3.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	466.82 cfs	Allowable HW Elevation	591.48 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.48 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	582.02
2.00	582.10
3.00	582.21
4.00	582.36
5.00	582.53
6.00	582.70
7.00	582.85
8.00	582.98
9.00	583.10
10.00	583.19
11.00	583.28
12.00	583.38
13.00	583.52
14.00	583.71
15.00	583.96
16.00	584.23
17.00	584.52
18.00	584.83
19.00	585.15
20.00	585.49
21.00	585.85
22.00	586.22
23.00	586.61
24.00	587.02
25.00	587.45
26.00	587.89
27.00	588.36
28.00	588.84
29.00	589.33
30.00	589.85
31.00	590.02
32.00	590.03
33.00	590.05
34.00	590.06
35.00	590.07
36.00	590.08
37.00	590.09
38.00	590.09
39.00	590.10
40.00	590.11

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	583.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	31.19 cfs	591.48 ft	9.93 ft/s
Weir	Broad Crested	468.61 cfs	591.48 ft	N/A
Total	----------	499.79 cfs	591.48 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.48 ft	Discharge	31.19 cfs
Inlet Control HW Elev	587.73 ft	Tailwater Elevation	583.00 ft
Outlet Control HW Elev	591.48 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.13		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	3.33 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.88 ft
Velocity Downstream	9.93 ft/s	Critical Slope	0.055986 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.48 ft	Upstream Velocity Head	1.53 ft
Ke	0.90	Entrance Loss	1.38 ft

Inlet Control Properties			
Inlet Control HW Elev	587.73 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested					
Discharge	468.61	cfs	Allowable HW Elevation	591.48	ft
Weir Coefficient	2.60	US	Length	100.00	ft
Crest Elevation	590.00	ft	Headwater Elevation	591.48	ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	583.01
2.00	583.04
3.00	583.08
4.00	583.14
5.00	583.22
6.00	583.31
7.00	583.43
8.00	583.56
9.00	583.71
10.00	583.87
11.00	584.06
12.00	584.26
13.00	584.47
14.00	584.71
15.00	584.96
16.00	585.23
17.00	585.52
18.00	585.83
19.00	586.15
20.00	586.49
21.00	586.85
22.00	587.22
23.00	587.61
24.00	588.02
25.00	588.45
26.00	588.89
27.00	589.36
28.00	589.84
29.00	590.02
30.00	590.03
31.00	590.05
32.00	590.06
33.00	590.07
34.00	590.08
35.00	590.09
36.00	590.09
37.00	590.10
38.00	590.11
39.00	590.12
40.00	590.12

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	584.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	29.30 cfs	591.49 ft	9.33 ft/s
Weir	Broad Crested	470.50 cfs	591.49 ft	N/A
Total	----------	499.80 cfs	591.49 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.48 ft	Discharge	29.30 cfs
Inlet Control HW Elev	587.09 ft	Tailwater Elevation	584.00 ft
Outlet Control HW Elev	591.48 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.13		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	4.33 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.85 ft
Velocity Downstream	9.33 ft/s	Critical Slope	0.049517 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.48 ft	Upstream Velocity Head	1.35 ft
Ke	0.90	Entrance Loss	1.22 ft

Inlet Control Properties			
Inlet Control HW Elev	587.09 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft^2
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	470.50 cfs	Allowable HW Elevation	591.49 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.48 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	584.01
2.00	584.03
3.00	584.08
4.00	584.14
5.00	584.22
6.00	584.31
7.00	584.43
8.00	584.56
9.00	584.71
10.00	584.87
11.00	585.06
12.00	585.26
13.00	585.47
14.00	585.71
15.00	585.96
16.00	586.23
17.00	586.52
18.00	586.83
19.00	587.15
20.00	587.49
21.00	587.85
22.00	588.22
23.00	588.61
24.00	589.02
25.00	589.45
26.00	589.89
27.00	590.02
28.00	590.03
29.00	590.05
30.00	590.06
31.00	590.07
32.00	590.08
33.00	590.09
34.00	590.09
35.00	590.10
36.00	590.11
37.00	590.12
38.00	590.13
39.00	590.13
40.00	590.14

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	585.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	27.28 cfs	591.49 ft	8.68 ft/s
Weir	Broad Crested	472.53 cfs	591.49 ft	N/A
Total	----------	499.81 cfs	591.49 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.49 ft	Discharge	27.28 cfs
Inlet Control HW Elev	586.45 ft	Tailwater Elevation	585.00 ft
Outlet Control HW Elev	591.49 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.13		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	5.33 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.81 ft
Velocity Downstream	8.68 ft/s	Critical Slope	0.043377 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.49 ft	Upstream Velocity Head	1.17 ft
Ke	0.90	Entrance Loss	1.05 ft

Inlet Control Properties			
Inlet Control HW Elev	586.45 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	472.53 cfs	Allowable HW Elevation	591.49 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.49 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	585.01
2.00	585.03
3.00	585.08
4.00	585.14
5.00	585.22
6.00	585.31
7.00	585.43
8.00	585.56
9.00	585.71
10.00	585.87
11.00	586.06
12.00	586.26
13.00	586.47
14.00	586.71
15.00	586.96
16.00	587.23
17.00	587.52
18.00	587.83
19.00	588.15
20.00	588.49
21.00	588.85
22.00	589.22
23.00	589.61
24.00	590.00
25.00	590.02
26.00	590.04
27.00	590.05
28.00	590.06
29.00	590.07
30.00	590.08
31.00	590.09
32.00	590.10
33.00	590.10
34.00	590.11
35.00	590.12
36.00	590.13
37.00	590.13
38.00	590.14
39.00	590.15
40.00	590.15

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Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	586.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	25.10 cfs	591.49 ft	7.99 ft/s
Weir	Broad Crested	474.72 cfs	591.49 ft	N/A
Total	----------	499.82 cfs	591.49 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.49 ft	Discharge	25.10 cfs
Inlet Control HW Elev	586.00 ft	Tailwater Elevation	586.00 ft
Outlet Control HW Elev	591.49 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.14		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	6.33 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.76 ft
Velocity Downstream	7.99 ft/s	Critical Slope	0.037653 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.49 ft	Upstream Velocity Head	0.99 ft
Ke	0.90	Entrance Loss	0.89 ft

Inlet Control Properties			
Inlet Control HW Elev	586.00 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	474.72 cfs	Allowable HW Elevation	591.49 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.49 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	586.01
2.00	586.03
3.00	586.08
4.00	586.14
5.00	586.22
6.00	586.31
7.00	586.43
8.00	586.56
9.00	586.71
10.00	586.87
11.00	587.06
12.00	587.26
13.00	587.47
14.00	587.71
15.00	587.96
16.00	588.23
17.00	588.52
18.00	588.83
19.00	589.15
20.00	589.49
21.00	589.85
22.00	590.02
23.00	590.03
24.00	590.04
25.00	590.06
26.00	590.07
27.00	590.08
28.00	590.08
29.00	590.09
30.00	590.10
31.00	590.11
32.00	590.12
33.00	590.12
34.00	590.13
35.00	590.14
36.00	590.14
37.00	590.15
38.00	590.16
39.00	590.16
40.00	590.17

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Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	587.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	22.71 cfs	591.50 ft	7.23 ft/s
Weir	Broad Crested	477.12 cfs	591.50 ft	N/A
Total	----------	499.83 cfs	591.50 ft	N/A

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.50 ft	Discharge	22.71 cfs
Inlet Control HW Elev	587.00 ft	Tailwater Elevation	587.00 ft
Outlet Control HW Elev	591.50 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.14		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	7.33 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.70 ft
Velocity Downstream	7.23 ft/s	Critical Slope	0.032429 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.50 ft	Upstream Velocity Head	0.81 ft
Ke	0.90	Entrance Loss	0.73 ft

Inlet Control Properties			
Inlet Control HW Elev	587.00 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft^2
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	477.12 cfs	Allowable HW Elevation	591.50 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.50 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	587.01
2.00	587.03
3.00	587.08
4.00	587.14
5.00	587.22
6.00	587.31
7.00	587.43
8.00	587.56
9.00	587.71
10.00	587.87
11.00	588.06
12.00	588.26
13.00	588.47
14.00	588.71
15.00	588.96
16.00	589.23
17.00	589.52
18.00	589.83
19.00	590.01
20.00	590.03
21.00	590.04
22.00	590.05
23.00	590.06
24.00	590.07
25.00	590.08
26.00	590.09
27.00	590.10
28.00	590.11
29.00	590.11
30.00	590.12
31.00	590.13
32.00	590.14
33.00	590.14
34.00	590.15
35.00	590.16
36.00	590.16
37.00	590.17
38.00	590.17
39.00	590.18
40.00	590.19

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Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	588.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	20.05 cfs	591.50 ft	6.38 ft/s
Weir	Broad Crested	479.80 cfs	591.50 ft	N/A
Total	----------	499.84 cfs	591.50 ft	N/A

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Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	591.50 ft	Discharge	20.05 cfs
Inlet Control HW Elev	588.00 ft	Tailwater Elevation	588.00 ft
Outlet Control HW Elev	591.50 ft	Control Type	Outlet Control
Headwater Depth/ Height	5.14		

Grades			
Upstream Invert	581.22 ft	Downstream Invert	579.67 ft
Length	86.00 ft	Constructed Slope	0.018023 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	8.33 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	1.61 ft
Velocity Downstream	6.38 ft/s	Critical Slope	0.027747 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	591.50 ft	Upstream Velocity Head	0.63 ft
Ke	0.90	Entrance Loss	0.57 ft

Inlet Control Properties			
Inlet Control HW Elev	588.00 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft^2
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
RR Marsh to Big Marsh Structure #8

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	479.80 cfs	Allowable HW Elevation	591.50 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	590.00 ft	Headwater Elevation	591.50 ft

Rating Table Report
RR Marsh to Big Marsh Structure #8

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.22
1.00	588.01
2.00	588.03
3.00	588.08
4.00	588.14
5.00	588.22
6.00	588.31
7.00	588.43
8.00	588.56
9.00	588.71
10.00	588.87
11.00	589.06
12.00	589.26
13.00	589.47
14.00	589.71
15.00	589.96
16.00	590.02
17.00	590.04
18.00	590.05
19.00	590.06
20.00	590.07
21.00	590.08
22.00	590.09
23.00	590.09
24.00	590.10
25.00	590.11
26.00	590.12
27.00	590.12
28.00	590.13
29.00	590.14
30.00	590.14
31.00	590.15
32.00	590.16
33.00	590.16
34.00	590.17
35.00	590.18
36.00	590.18
37.00	590.19
38.00	590.19
39.00	590.20
40.00	590.20

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STRUCTURE #8 - CULVERT FROM RR MARSH TO BIG MARSH

ANALYZE IN CULVERT MASTER

I.E. U/S: 581.22
D/S: 579.67

L: 86'
n: 0.024 CMP
D: 24"

OVERFLOW EL: 590.0 +/-
L: 100'
C: 2.6

TAILWATER RANGE

NO TAILWATER
BIG MARSH OVERFLOW TW: 589.0 +/-
TW: 582
TW: 583
TW: 584
TW: 585
TW: 586
TW: 587
TW: 588

COMPUTED: NA
DATE: 1-8-05
CHECKED: DGD
DATE: 1-8-05

V3 ENGINEERING CALCULATIONS

PROJECT: LAKE CALHOUN HMP
SUBJECT: STRUCTURE #8
SHEET NO:

LAKE CALUMET HMP
STRUCTURE RATING CURVES

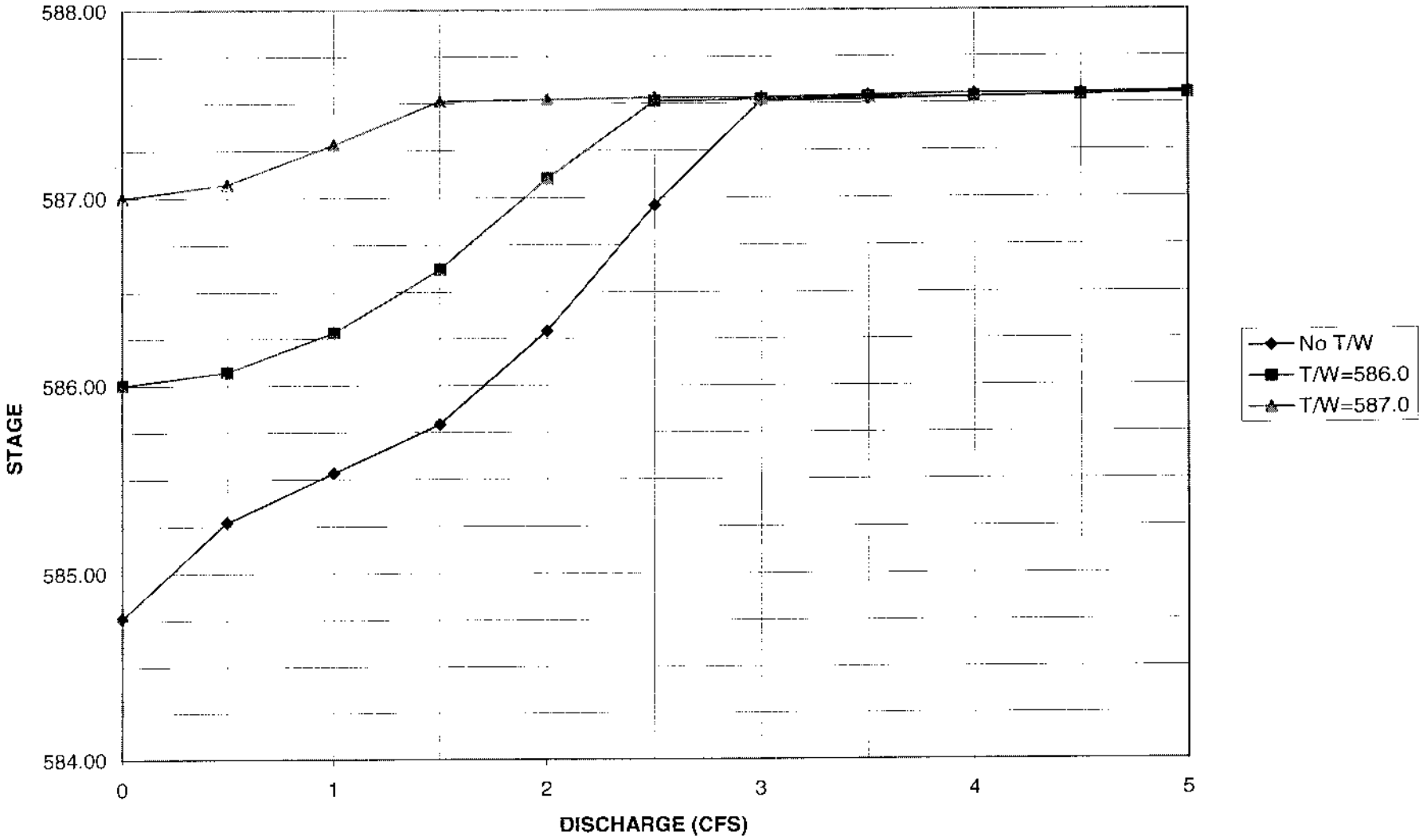
STRUCTURE NO: 14
ENGINEER: SWA
DATE: 11-8-05

CHECKED BY: DGD
DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS		
	TAILWATER		
	0	586	587
0	584.76	586.00	587.00
0.5	585.27	586.07	587.07
1	585.53	586.28	587.28
1.5	585.79	586.62	587.51
2	586.29	587.10	587.52
2.5	586.96	587.51	587.53
3	587.51	587.52	587.53
3.5	587.52	587.53	587.54
4	587.53	587.53	587.55
4.5	587.54	587.54	587.55
5	587.55	587.55	587.56

STRUCTURE #14 RATING CURVES



Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-12 inch Circular	3.66 cfs	589.04 ft	5.34 ft/s
Weir	Broad Crested	496.45 cfs	589.04 ft	N/A
Total	----------	500.11 cfs	589.04 ft	N/A

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Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.04 ft	Discharge	3.66 cfs
Inlet Control HW Elev	586.50 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev	589.04 ft	Control Type	Outlet Control
Headwater Depth/ Height	4.28		

Grades			
Upstream Invert	584.76 ft	Downstream Invert	584.42 ft
Length	85.00 ft	Constructed Slope	0.004000 ft/ft

Hydraulic Profile			
Profile	CompositeM2Pressure	Depth, Downstream	0.82 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	0.82 ft
Velocity Downstream	5.34 ft/s	Critical Slope	0.036344 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.00 ft
Section Size	12 inch	Rise	1.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.04 ft	Upstream Velocity Head	0.34 ft
Ke	0.90	Entrance Loss	0.30 ft

Inlet Control Properties			
Inlet Control HW Elev	586.50 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.8 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	496.45 cfs	Allowable HW Elevation	589.04 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	587.50 ft	Headwater Elevation	589.04 ft

Rating Table Report
Big Marsh to Core Plant Structure #14

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	10.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	0.00
0.50	585.27
1.00	585.53
1.50	585.79
2.00	586.29
2.50	586.96
3.00	587.51
3.50	587.52
4.00	587.53
4.50	587.53
5.00	587.54
5.50	587.55
6.00	587.55
6.50	587.56
7.00	587.56
7.50	587.57
8.00	587.57
8.50	587.58
9.00	587.58
9.50	587.59
10.00	587.59

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Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	586.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-12 inch Circular	3.32 cfs	589.04 ft	4.22 ft/s
Weir	Broad Crested	496.80 cfs	589.04 ft	N/A
Total	----------	500.11 cfs	589.04 ft	N/A

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Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.04 ft	Discharge	3.32 cfs
Inlet Control HW Elev	586.28 ft	Tailwater Elevation	586.00 ft
Outlet Control HW Elev	589.04 ft	Control Type	Outlet Control
Headwater Depth/ Height	4.28		

Grades			
Upstream Invert	584.76 ft	Downstream Invert	584.42 ft
Length	85.00 ft	Constructed Slope	0.004000 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	1.58 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	0.78 ft
Velocity Downstream	4.22 ft/s	Critical Slope	0.032609 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.00 ft
Section Size	12 inch	Rise	1.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.04 ft	Upstream Velocity Head	0.28 ft
Ke	0.90	Entrance Loss	0.25 ft

Inlet Control Properties			
Inlet Control HW Elev	586.28 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.8 ft^2
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

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Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	496.80 cfs	Allowable HW Elevation	589.04 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	587.50 ft	Headwater Elevation	589.04 ft

Rating Table Report
Big Marsh to Core Plant Structure #14

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	10.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	584.76
0.50	586.07
1.00	586.28
1.50	586.62
2.00	587.10
2.50	587.51
3.00	587.52
3.50	587.53
4.00	587.53
4.50	587.54
5.00	587.55
5.50	587.55
6.00	587.56
6.50	587.56
7.00	587.57
7.50	587.57
8.00	587.58
8.50	587.58
9.00	587.59
9.50	587.59
10.00	587.59

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Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Analysis Component			
Storm Event	Design	Discharge	500.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	500.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	587.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-12 inch Circular	2.72 cfs	589.04 ft	3.46 ft/s
Weir	Broad Crested	497.40 cfs	589.04 ft	N/A
Total	----------	500.12 cfs	589.04 ft	N/A

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Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	589.04 ft	Discharge	2.72 cfs
Inlet Control HW Elev	587.00 ft	Tailwater Elevation	587.00 ft
Outlet Control HW Elev	589.04 ft	Control Type	Outlet Control
Headwater Depth/ Height	4.28		

Grades			
Upstream Invert	584.76 ft	Downstream Invert	584.42 ft
Length	85.00 ft	Constructed Slope	0.004000 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	2.58 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	0.71 ft
Velocity Downstream	3.46 ft/s	Critical Slope	0.027600 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.00 ft
Section Size	12 inch	Rise	1.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	589.04 ft	Upstream Velocity Head	0.19 ft
Ke	0.90	Entrance Loss	0.17 ft

Inlet Control Properties			
Inlet Control HW Elev	587.00 ft	Flow Control	Unsubmerged
Inlet Type	Projecting	Area Full	0.8 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Big Marsh to Core Plant Structure #14

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	497.40 cfs	Allowable HW Elevation	589.04 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	587.50 ft	Headwater Elevation	589.04 ft

Rating Table Report
Big Marsh to Core Plant Structure #14

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	10.00	0.50 cfs

Discharge (cfs)	HW Elev (ft)
0.00	584.76
0.50	587.07
1.00	587.28
1.50	587.51
2.00	587.52
2.50	587.53
3.00	587.53
3.50	587.54
4.00	587.55
4.50	587.55
5.00	587.56
5.50	587.56
6.00	587.57
6.50	587.57
7.00	587.58
7.50	587.58
8.00	587.59
8.50	587.59
9.00	587.59
9.50	587.60
10.00	587.60

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STRUCTURE #14 - CULVERT FROM BIG MARSH TO COKE PLANT

ANALYZE IN CULVERT MASTER

I.E. U/S 584.76
D/S 584.42

L: 85'
n: .024 CMP
D: 12"

OVERLAND FLOW EL. = 587.5 +/-
L = 100'
C = 2.6

TAILWATER RANGE
NO TW
TW = 586.0
TW = 587.0

COMPUTED: SWA	V3 ENGINEERING CALCULATIONS	PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE #14
CHECKED: DGD		SHEET NO:
DATE: 11-8-05		

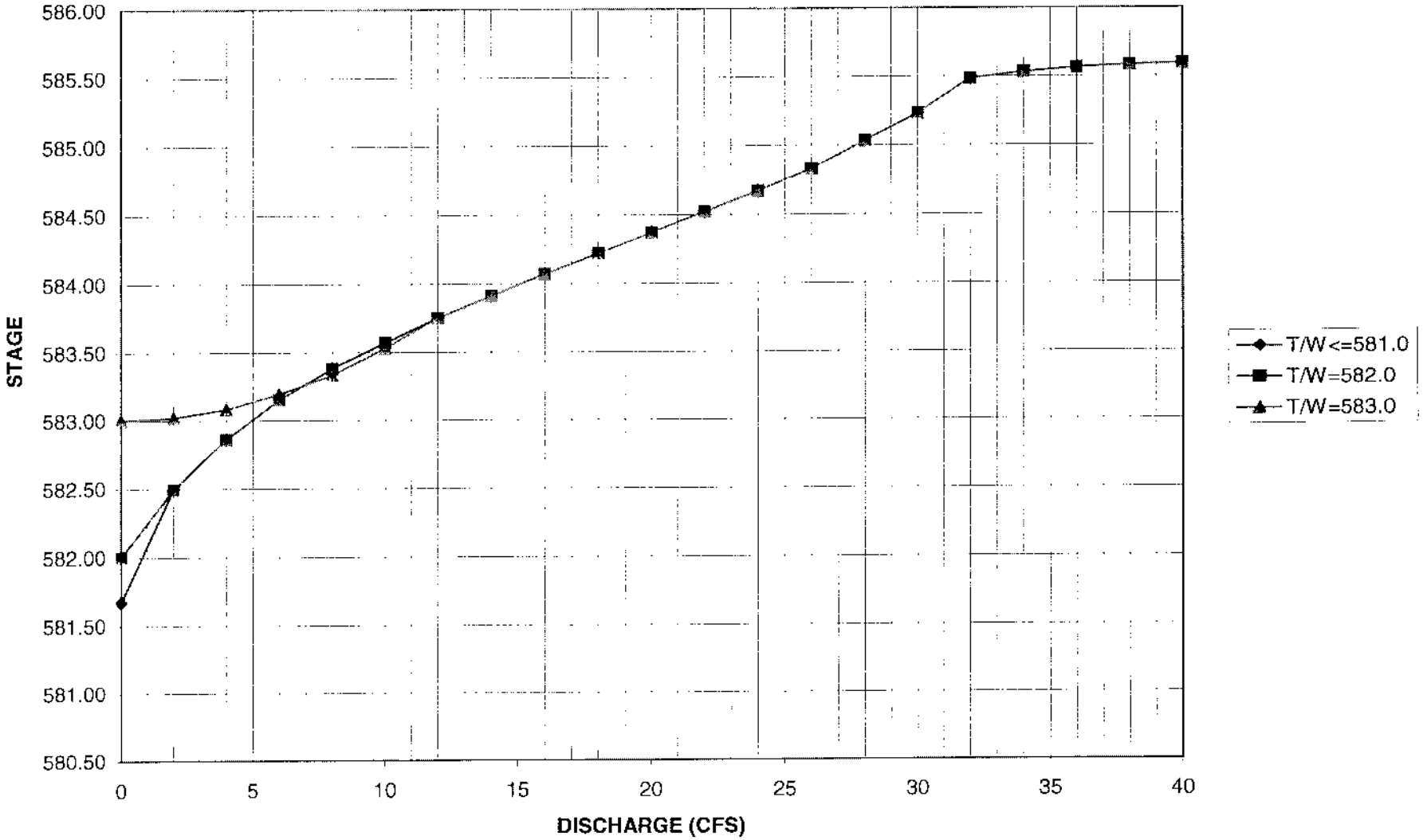
LAKE CALUMET HMP
STRUCTURE RATING CURVES

STRUCTURE NO: 15
ENGINEER: SWA CHECKED BY: DGD
DATE: 11-8-05 DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS		
	TAILWATER		
	<=581	582	583
0	581.67	582.00	583.00
2	582.49	582.49	583.02
4	582.86	582.86	583.08
6	583.15	583.15	583.19
8	583.38	583.38	583.33
10	583.57	583.57	583.53
12	583.75	583.75	583.75
14	583.91	583.91	583.91
16	584.07	584.07	584.07
18	584.22	584.22	584.22
20	584.37	584.37	584.37
22	584.52	584.52	584.52
24	584.67	584.67	584.67
26	584.83	584.83	584.83
28	585.03	585.03	585.03
30	585.23	585.23	585.23
32	585.48	585.48	585.48
34	585.53	585.53	585.53
36	585.56	585.56	585.56
38	585.58	585.58	585.58
40	585.59	585.59	585.59

STRUCTURE #15 RATING CURVES



Culvert Designer/Analyzer Report
Conservation Area Structure #15

Analysis Component			
Storm Event	Design	Discharge	40.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	40.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	581.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	22.61 cfs	585.59 ft	10.25 ft/s
Culvert-2	1-18 inch Circular	10.12 cfs	585.59 ft	9.43 ft/s
Weir	Broad Crested	7.32 cfs	585.59 ft	N/A
Total	----------	40.05 cfs	585.59 ft	N/A

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	585.59 ft	Discharge	22.61 cfs
Inlet Control HW Elev	585.59 ft	Tailwater Elevation	581.00 ft
Outlet Control HW Elev	585.24 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.96		

Grades			
Upstream Invert	581.67 ft	Downstream Invert	580.89 ft
Length	36.00 ft	Constructed Slope	0.021667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.32 ft
Slope Type	Steep	Normal Depth	1.21 ft
Flow Regime	Supercritical	Critical Depth	1.69 ft
Velocity Downstream	10.25 ft/s	Critical Slope	0.009454 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Steel	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	585.24 ft	Upstream Velocity Head	0.99 ft
Ke	0.90	Entrance Loss	0.89 ft

Inlet Control Properties			
Inlet Control HW Elev	585.59 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Culvert-2

Culvert Summary			
Computed Headwater Elevation	585.59 ft	Discharge	10.12 cfs
Inlet Control HW Elev	585.59 ft	Tailwater Elevation	581.00 ft
Outlet Control HW Elev	585.48 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.73		

Grades			
Upstream Invert	582.99 ft	Downstream Invert	582.10 ft
Length	30.00 ft	Constructed Slope	0.029667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.88 ft
Slope Type	Steep	Normal Depth	0.80 ft
Flow Regime	Supercritical	Critical Depth	1.23 ft
Velocity Downstream	9.43 ft/s	Critical Slope	0.009340 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Steel	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	585.48 ft	Upstream Velocity Head	0.67 ft
Ke	0.90	Entrance Loss	0.60 ft

Inlet Control Properties			
Inlet Control HW Elev	585.59 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	1.8 ft^2
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	7.32 cfs	Allowable HW Elevation	585.59 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	585.50 ft	Headwater Elevation	585.59 ft

Rating Table Report
Conservation Area Structure #15

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.00
1.00	582.24
2.00	582.49
3.00	582.69
4.00	582.86
5.00	583.02
6.00	583.15
7.00	583.27
8.00	583.38
9.00	583.48
10.00	583.57
11.00	583.66
12.00	583.75
13.00	583.83
14.00	583.91
15.00	583.99
16.00	584.07
17.00	584.15
18.00	584.22
19.00	584.30
20.00	584.37
21.00	584.45
22.00	584.52
23.00	584.59
24.00	584.67
25.00	584.74
26.00	584.83
27.00	584.93
28.00	585.03
29.00	585.13
30.00	585.23
31.00	585.34
32.00	585.48
33.00	585.52
34.00	585.53
35.00	585.55
36.00	585.56
37.00	585.57
38.00	585.58
39.00	585.58
40.00	585.59

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Analysis Component			
Storm Event	Design	Discharge	40.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	40.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	582.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	22.61 cfs	585.59 ft	10.25 ft/s
Culvert-2	1-18 inch Circular	10.12 cfs	585.59 ft	9.43 ft/s
Weir	Broad Crested	7.32 cfs	585.59 ft	N/A
Total	----------	40.05 cfs	585.59 ft	N/A

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	585.59 ft	Discharge	22.61 cfs
Inlet Control HW Elev	585.59 ft	Tailwater Elevation	582.00 ft
Outlet Control HW Elev	585.24 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.96		

Grades			
Upstream Invert	581.67 ft	Downstream Invert	580.89 ft
Length	36.00 ft	Constructed Slope	0.021667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.32 ft
Slope Type	Steep	Normal Depth	1.21 ft
Flow Regime	Supercritical	Critical Depth	1.69 ft
Velocity Downstream	10.25 ft/s	Critical Slope	0.009454 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Steel	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	585.24 ft	Upstream Velocity Head	0.99 ft
Ke	0.90	Entrance Loss	0.89 ft

Inlet Control Properties			
Inlet Control HW Elev	585.59 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Culvert-2

Culvert Summary			
Computed Headwater Elevation	585.59 ft	Discharge	10.12 cfs
Inlet Control HW Elev	585.59 ft	Tailwater Elevation	582.00 ft
Outlet Control HW Elev	585.48 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.73		

Grades			
Upstream Invert	582.99 ft	Downstream Invert	582.10 ft
Length	30.00 ft	Constructed Slope	0.029667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.88 ft
Slope Type	Steep	Normal Depth	0.80 ft
Flow Regime	Supercritical	Critical Depth	1.23 ft
Velocity Downstream	9.43 ft/s	Critical Slope	0.009340 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Steel	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	585.48 ft	Upstream Velocity Head	0.67 ft
Ke	0.90	Entrance Loss	0.60 ft

Inlet Control Properties			
Inlet Control HW Elev	585.59 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	1.8 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	7.32 cfs	Allowable HW Elevation	585.59 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	585.50 ft	Headwater Elevation	585.59 ft

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Rating Table Report
Conservation Area Structure #15

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.67
1.00	582.24
2.00	582.49
3.00	582.69
4.00	582.86
5.00	583.02
6.00	583.15
7.00	583.27
8.00	583.38
9.00	583.48
10.00	583.57
11.00	583.66
12.00	583.75
13.00	583.83
14.00	583.91
15.00	583.99
16.00	584.07
17.00	584.15
18.00	584.22
19.00	584.30
20.00	584.37
21.00	584.45
22.00	584.52
23.00	584.59
24.00	584.67
25.00	584.74
26.00	584.83
27.00	584.93
28.00	585.03
29.00	585.13
30.00	585.23
31.00	585.34
32.00	585.48
33.00	585.52
34.00	585.53
35.00	585.55
36.00	585.56
37.00	585.57
38.00	585.58
39.00	585.58
40.00	585.59

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Culvert Designer/Analyzer Report
Conservation Area Structure #15

Analysis Component			
Storm Event	Design	Discharge	40.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	40.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	583.00 ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	1-24 inch Circular	22.61 cfs	585.59 ft	10.25 ft/s
Culvert-2	1-18 inch Circular	10.12 cfs	585.59 ft	9.43 ft/s
Weir	Broad Crested	7.32 cfs	585.59 ft	N/A
Total	----------	40.05 cfs	585.59 ft	N/A

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Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	585.59 ft	Discharge	22.61 cfs
Inlet Control HW Elev	585.59 ft	Tailwater Elevation	583.00 ft
Outlet Control HW Elev	585.24 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.96		

Grades			
Upstream Invert	581.67 ft	Downstream Invert	580.89 ft
Length	36.00 ft	Constructed Slope	0.021667 ft/ft

Hydraulic Profile			
Profile	CompositePressureS1S2	Depth, Downstream	1.32 ft
Slope Type	N/A	Normal Depth	1.21 ft
Flow Regime	N/A	Critical Depth	1.69 ft
Velocity Downstream	10.25 ft/s	Critical Slope	0.009454 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Steel	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	585.24 ft	Upstream Velocity Head	0.99 ft
Ke	0.90	Entrance Loss	0.89 ft

Inlet Control Properties			
Inlet Control HW Elev	585.59 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Culvert-2

Culvert Summary			
Computed Headwater Elevation	585.59 ft	Discharge	10.12 cfs
Inlet Control HW Elev	585.59 ft	Tailwater Elevation	583.00 ft
Outlet Control HW Elev	585.48 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.73		

Grades			
Upstream Invert	582.99 ft	Downstream Invert	582.10 ft
Length	30.00 ft	Constructed Slope	0.029667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.88 ft
Slope Type	Steep	Normal Depth	0.80 ft
Flow Regime	Supercritical	Critical Depth	1.23 ft
Velocity Downstream	9.43 ft/s	Critical Slope	0.009340 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Steel	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	585.48 ft	Upstream Velocity Head	0.67 ft
Ke	0.90	Entrance Loss	0.60 ft

Inlet Control Properties			
Inlet Control HW Elev	585.59 ft	Flow Control	Submerged
Inlet Type	Projecting	Area Full	1.8 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Designer/Analyzer Report
Conservation Area Structure #15

Component:Weir

Hydraulic Component(s): Broad Crested			
Discharge	7.32 cfs	Allowable HW Elevation	585.59 ft
Weir Coefficient	2.60 US	Length	100.00 ft
Crest Elevation	585.50 ft	Headwater Elevation	585.59 ft

Rating Table Report
Conservation Area Structure #15

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	40.00	1.00 cfs

Discharge (cfs)	HW Elev (ft)
0.00	581.67
1.00	583.01
2.00	583.02
3.00	583.05
4.00	583.08
5.00	583.13
6.00	583.19
7.00	583.25
8.00	583.33
9.00	583.42
10.00	583.53
11.00	583.66
12.00	583.75
13.00	583.83
14.00	583.91
15.00	583.99
16.00	584.07
17.00	584.15
18.00	584.22
19.00	584.30
20.00	584.37
21.00	584.45
22.00	584.52
23.00	584.59
24.00	584.67
25.00	584.74
26.00	584.83
27.00	584.93
28.00	585.03
29.00	585.13
30.00	585.23
31.00	585.34
32.00	585.48
33.00	585.52
34.00	585.53
35.00	585.55
36.00	585.56
37.00	585.57
38.00	585.58
39.00	585.58
40.00	585.59

STRUCTURE #15 - CONSERVATION AREA OUTLET

ANALYZE USING CULVERT MASTER

#1 I.E. U/S 581.67
D/S 580.89

L 36'
n .015 DIP
ø 24"

#2 I.E. U/S 582.99
D/S 582.10

L 30'
n .015 DIP
ø 18"

OVERFLOW EL = 585.5 +/-
L = 100'
C = 2.6

TAIL WATER RANGE

TW = 583.0
TW < = 581.0
TW = 582.0

COMPUTED: SWA	V3 ENGINEERING CALCULATIONS	PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE #15
CHECKED: DCD		SHEET NO:
DATE: 11-8-05		

LAKE CALUMET HMP
STRUCTURE RATING CURVES

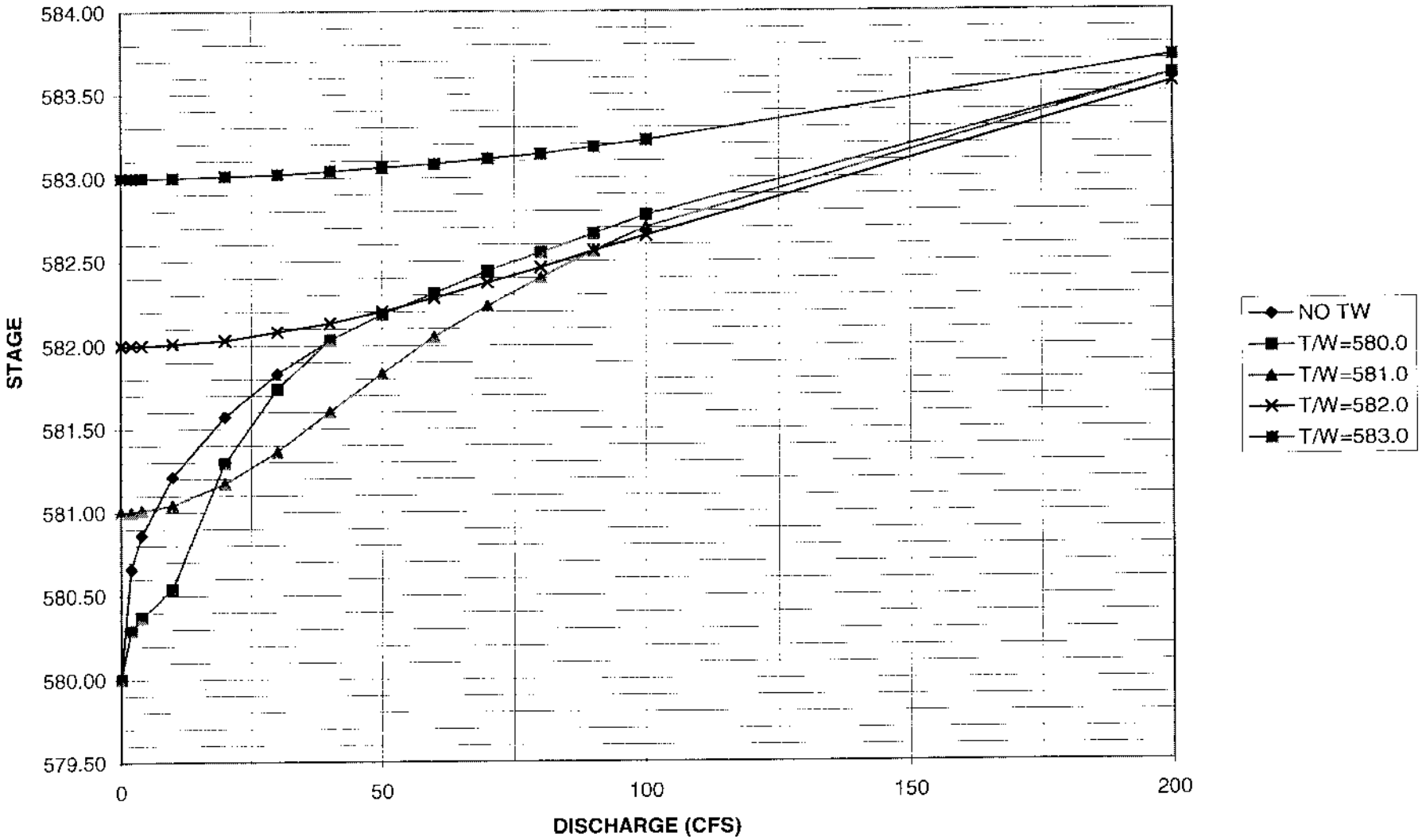
STRUCTURE NO: 17
ENGINEER: SWA
DATE: 11-8-05

CHECKED BY: DGD
DATE: 11-8-05

SUMMARY CHART

FLOW (CFS)	STAGE AT VARYING TAILWATER CONDITIONS				
	TAILWATER				
	NO TW	580	581	582	583
0	580.00	580.00	581.00	582.00	583.00
2	580.66	580.29	581.00	582.00	583.00
4	580.86	580.37	581.01	582.00	583.00
10	581.21	580.54	581.04	582.01	583.00
20	581.57	581.29	581.17	582.03	583.01
30	581.83	581.74	581.36	582.08	583.02
40	582.03	582.03	581.60	582.13	583.04
50	582.18	582.18	581.83	582.20	583.06
60	582.31	582.31	582.05	582.28	583.08
70	582.44	582.44	582.23	582.37	583.11
80	582.55	582.55	582.40	582.46	583.14
90	582.66	582.66	582.56	582.56	583.18
100	582.77	582.77	582.70	582.65	583.22
200	583.61	583.61	583.61	583.56	583.72

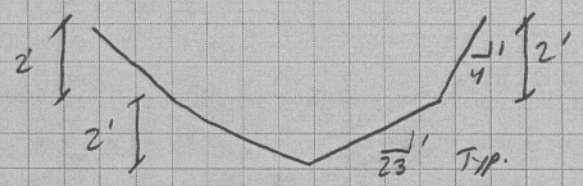
STRUCTURE #17 RATING CURVES



STRUCTURE #17 - SOUTH IRM OUTLET STRUCTURE

THE SOUTH IRM OUTLET CONSISTS OF AN OPEN CHANNEL CONNECTING SOUTH IRM TO THE CALUMET RIVER.

GEOMETRY OF CHANNEL



CHANNEL SLOPE = $\frac{2'}{650'}$ = 0.0031 ft/ft

U/S IE 580 +/-

D/S IE 578 +/-

n = 0.10 Heavy Vegetation

COMPUTED: SWA		PROJECT: LAKE CALUMET HMP
DATE: 11-8-05		SUBJECT: STRUCTURE 17
CHECKED: DGD	ENGINEERING CALCULATIONS	SHEET NO:
DATE: 11-8-05		

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	30.00	580.00	581.83		581.84	0.003116	0.78	38.48	42.07	0.14
Outlet	6.50	TW580	30.00	580.00	581.74		581.75	0.004032	0.86	34.94	40.09	0.16
Outlet	6.50	TW581	30.00	580.00	581.36		581.39	0.015014	1.41	21.34	31.33	0.30
Outlet	6.50	TW582	30.00	580.00	582.08		582.08	0.001516	0.61	49.54	47.03	0.10
Outlet	6.50	TW583	30.00	580.00	583.02		583.02	0.000175	0.31	100.01	59.79	0.04
Outlet	0.00	NO TW	30.00	578.00	579.84	578.84	579.85	0.003005	0.77	39.01	42.36	0.14
Outlet	0.00	TW580	30.00	578.00	580.00	578.84	580.01	0.001936	0.65	46.00	46.00	0.11
Outlet	0.00	TW581	30.00	578.00	581.00	578.84	581.00	0.000181	0.32	98.75	59.50	0.04
Outlet	0.00	TW582	30.00	578.00	582.00	578.84	582.00	0.000042	0.20	165.00	73.00	0.02
Outlet	0.00	TW583	30.00	578.00	583.00	578.84	583.00	0.000014	0.14	244.75	86.50	0.01

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	40.00	580.00	582.03		582.04	0.003124	0.84	47.36	46.40	0.15
Outlet	6.50	TW580	40.00	580.00	582.05		582.06	0.002893	0.83	48.48	46.72	0.14
Outlet	6.50	TW581	40.00	580.00	581.60		581.63	0.011457	1.37	29.30	36.71	0.27
Outlet	6.50	TW582	40.00	580.00	582.13		582.14	0.002271	0.77	52.22	47.79	0.13
Outlet	6.50	TW583	40.00	580.00	583.04		583.04	0.000302	0.41	100.99	60.01	0.05
Outlet	0.00	NO TW	40.00	578.00	580.04	578.94	580.05	0.003001	0.83	47.94	46.57	0.14
Outlet	0.00	TW580	40.00	578.00	580.00	578.94	580.01	0.003442	0.87	46.00	46.00	0.15
Outlet	0.00	TW581	40.00	578.00	581.00	578.94	581.00	0.000323	0.42	98.75	59.50	0.05
Outlet	0.00	TW582	40.00	578.00	582.00	578.94	582.00	0.000074	0.27	165.00	73.00	0.03
Outlet	0.00	TW583	40.00	578.00	583.00	578.94	583.00	0.000025	0.19	244.75	86.50	0.02

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	50.00	580.00	582.18		582.19	0.003119	0.92	54.36	48.39	0.15
Outlet	6.50	TW580	50.00	580.00	582.27		582.28	0.002440	0.86	58.72	49.59	0.13
Outlet	6.50	TW581	50.00	580.00	581.83		581.86	0.008544	1.29	38.67	42.18	0.24
Outlet	6.50	TW582	50.00	580.00	582.20		582.21	0.002908	0.90	55.56	48.72	0.15
Outlet	6.50	TW583	50.00	580.00	583.06		583.06	0.000455	0.51	102.23	60.28	0.06
Outlet	0.00	NO TW	50.00	578.00	580.19	579.03	580.20	0.003000	0.91	55.02	48.57	0.15
Outlet	0.00	TW580	50.00	578.00	580.00	579.03	580.02	0.005378	1.09	46.00	46.00	0.19
Outlet	0.00	TW581	50.00	578.00	581.00	579.03	581.00	0.000504	0.53	98.75	59.50	0.07
Outlet	0.00	TW582	50.00	578.00	582.00	579.03	582.00	0.000116	0.33	165.00	73.00	0.03
Outlet	0.00	TW583	50.00	578.00	583.00	579.03	583.00	0.000039	0.23	244.75	86.50	0.02

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	60.00	580.00	582.31		582.33	0.003114	0.99	61.02	50.21	0.15
Outlet	6.50	TW580	60.00	580.00	582.45		582.46	0.002205	0.89	68.20	52.11	0.13
Outlet	6.50	TW581	60.00	580.00	582.05		582.07	0.006563	1.24	48.36	46.69	0.21
Outlet	6.50	TW582	60.00	580.00	582.28		582.30	0.003384	1.02	59.43	49.78	0.16
Outlet	6.50	TW583	60.00	580.00	583.08		583.09	0.000628	0.61	103.73	60.62	0.07
Outlet	0.00	NO TW	60.00	578.00	580.33	579.10	580.34	0.003000	0.98	61.75	50.41	0.15
Outlet	0.00	TW580	60.00	578.00	580.00	579.10	580.03	0.007744	1.30	46.00	46.00	0.23
Outlet	0.00	TW581	60.00	578.00	581.00	579.10	581.01	0.000726	0.63	98.75	59.50	0.08
Outlet	0.00	TW582	60.00	578.00	582.00	579.10	582.00	0.000166	0.40	165.00	73.00	0.04
Outlet	0.00	TW583	60.00	578.00	583.00	579.10	583.00	0.000056	0.28	244.75	86.50	0.02

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	70.00	580.00	582.44		582.45	0.003111	1.05	67.41	51.90	0.15
Outlet	6.50	TW580	70.00	580.00	582.62		582.63	0.002081	0.93	76.90	54.32	0.13
Outlet	6.50	TW581	70.00	580.00	582.23		582.26	0.005214	1.23	57.14	49.16	0.20
Outlet	6.50	TW582	70.00	580.00	582.37		582.39	0.003689	1.11	63.80	50.96	0.17
Outlet	6.50	TW583	70.00	580.00	583.11		583.12	0.000814	0.70	105.49	61.01	0.08
Outlet	0.00	NO TW	70.00	578.00	580.45	579.18	580.47	0.003002	1.04	68.19	52.11	0.15
Outlet	0.00	TW580	70.00	578.00	580.00	579.18	580.04	0.010541	1.52	46.00	46.00	0.27
Outlet	0.00	TW581	70.00	578.00	581.00	579.18	581.01	0.000988	0.74	98.75	59.50	0.09
Outlet	0.00	TW582	70.00	578.00	582.00	579.18	582.00	0.000227	0.46	165.00	73.00	0.05
Outlet	0.00	TW583	70.00	578.00	583.00	579.18	583.00	0.000076	0.33	244.75	86.50	0.03

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	80.00	580.00	582.55		582.57	0.003108	1.11	73.58	53.48	0.16
Outlet	6.50	TW580	80.00	580.00	582.76		582.78	0.002006	0.97	85.09	56.31	0.13
Outlet	6.50	TW581	80.00	580.00	582.40		582.42	0.004447	1.24	65.47	51.40	0.18
Outlet	6.50	TW582	80.00	580.00	582.46		582.48	0.003857	1.18	68.56	52.20	0.17
Outlet	6.50	TW583	80.00	580.00	583.14		583.15	0.001007	0.78	107.48	61.45	0.09
Outlet	0.00	NO TW	80.00	578.00	580.57	579.24	580.59	0.003002	1.10	74.42	53.70	0.15
Outlet	0.00	TW580	80.00	578.00	580.00	579.24	580.05	0.013768	1.74	46.00	46.00	0.31
Outlet	0.00	TW581	80.00	578.00	581.00	579.24	581.01	0.001290	0.85	98.75	59.50	0.11
Outlet	0.00	TW582	80.00	578.00	582.00	579.24	582.00	0.000296	0.53	165.00	73.00	0.05
Outlet	0.00	TW583	80.00	578.00	583.00	579.24	583.00	0.000099	0.37	244.75	86.50	0.03

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	90.00	580.00	582.66		582.69	0.003106	1.16	79.55	54.97	0.16
Outlet	6.50	TW580	90.00	580.00	582.90		582.91	0.001961	1.01	92.81	58.14	0.13
Outlet	6.50	TW581	90.00	580.00	582.56		582.58	0.003899	1.24	73.79	53.54	0.18
Outlet	6.50	TW582	90.00	580.00	582.56		582.58	0.003926	1.25	73.62	53.50	0.18
Outlet	6.50	TW583	90.00	580.00	583.18		583.19	0.001201	0.86	109.70	61.94	0.10
Outlet	0.00	NO TW	90.00	578.00	580.68	579.30	580.70	0.003002	1.15	80.45	55.19	0.16
Outlet	0.00	TW580	90.00	578.00	580.00	579.30	580.06	0.017424	1.96	46.00	46.00	0.34
Outlet	0.00	TW581	90.00	578.00	581.00	579.30	581.01	0.001633	0.95	98.75	59.50	0.12
Outlet	0.00	TW582	90.00	578.00	582.00	579.30	582.01	0.000374	0.60	165.00	73.00	0.06
Outlet	0.00	TW583	90.00	578.00	583.00	579.30	583.00	0.000125	0.42	244.75	86.50	0.04

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	100.00	580.00	582.77		582.79	0.003104	1.21	85.36	56.38	0.16
Outlet	6.50	TW580	100.00	580.00	583.03		583.04	0.001920	1.04	100.41	59.88	0.13
Outlet	6.50	TW581	100.00	580.00	582.70		582.73	0.003553	1.26	81.59	55.47	0.17
Outlet	6.50	TW582	100.00	580.00	582.65		582.68	0.003930	1.30	78.90	54.81	0.18
Outlet	6.50	TW583	100.00	580.00	583.22		583.23	0.001391	0.94	112.15	62.47	0.11
Outlet	0.00	NO TW	100.00	578.00	580.79	579.35	580.81	0.003002	1.20	86.32	56.61	0.16
Outlet	0.00	TW580	100.00	578.00	580.00	579.35	580.07	0.021512	2.17	46.00	46.00	0.38
Outlet	0.00	TW581	100.00	578.00	581.00	579.35	581.02	0.002016	1.06	98.75	59.50	0.13
Outlet	0.00	TW582	100.00	578.00	582.00	579.35	582.01	0.000462	0.66	165.00	73.00	0.07
Outlet	0.00	TW583	100.00	578.00	583.00	579.35	583.00	0.000155	0.46	244.75	86.50	0.04

HEC-RAS Plan: Ex River: SIRM Reach: Outlet

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Outlet	6.50	NO TW	200.00	580.00	583.61		583.65	0.003091	1.56	137.61	67.75	0.17
Outlet	6.50	TW580	200.00	580.00	583.99		584.02	0.001872	1.33	164.30	72.87	0.14
Outlet	6.50	TW581	200.00	580.00	583.75		583.78	0.002545	1.47	147.34	69.66	0.16
Outlet	6.50	TW582	200.00	580.00	583.56		583.60	0.003304	1.60	134.42	67.11	0.18
Outlet	6.50	TW583	200.00	580.00	583.72		583.75	0.002657	1.49	145.12	69.23	0.16
Outlet	0.00	NO TW	200.00	578.00	581.63	579.79	581.67	0.003001	1.55	139.04	68.03	0.17
Outlet	0.00	TW580	200.00	578.00	580.00	579.79	580.29	0.086047	4.35	46.00	46.00	0.77
Outlet	0.00	TW581	200.00	578.00	581.00	579.79	581.07	0.008065	2.11	98.75	59.50	0.26
Outlet	0.00	TW582	200.00	578.00	582.00	579.79	582.03	0.001849	1.33	165.00	73.00	0.13
Outlet	0.00	TW583	200.00	578.00	583.00	579.79	583.01	0.000619	0.93	244.75	86.50	0.08