NTH Consultants, Ltd.

Infrastructure Engineering
and Environmental Services

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Northville, MI 48168
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248.324.5179 Fax

Mr. Christopher Scieszka
DTE Electric Company
One Energy Plaza
Detroit, Michigan 48226

October 14, 2021
NTH Project No. 62-210081-03

**RE: Inflow Design Flood Control System Plan 5-Year Periodic Assessment
Belle River Power Plant Bottom Ash Basins
East China Township, Michigan**

Dear Mr. Scieszka:

NTH Consultants, Ltd. (NTH) has completed a periodic update to the initial inflow design flood control (IDFC) system plan for the bottom ash basins at Belle River Power Plan (BRPP) in accordance with the Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals (CCR) from Electric Utilities 40 CFR Part 257.82. Specifically, this IDFC system plan constitutes the 5-year periodic assessment of the initial plan (dated October 14, 2016) for these impoundments, as required by 40 CFR Part 257.82(c)(4). NTH performed this assessment using information provided by personnel from DTE Electric Company (DTE), observations we made during a site visit by our personnel, and an updated topographic survey. In general, the analysis methods and development of information are presented in the initial inflow design flood control system plan and are not reiterated herein. This letter identifies changes to the conditions documented in the initial plan and stipulates any new information made available to NTH as part of the periodic assessment that may alter or re-affirm the findings from the initial 2016 evaluation, which is attached to the end of this report for reference.

BACKGROUND

The BRPP bottom ash basins are physical sedimentation basins and receive bottom ash and other process flow effluent pumped from the power plant. Discharge water from each basin flows over an outlet weir and gravity flows to a site storm water conveyance network of ditches and pipes, eventually discharging in accordance with a National Pollution Discharge Elimination System (NPDES) permit. The basins are not incised CCR surface impoundments, per the definition in 40 CFR 257.53 and therefore, a 100-year storm event was used for the assessment.

NTH prepared an IDFC system plan in 2016 to document and demonstrate the hydrologic and hydraulic capacity and performance conditions of the CCR surface impoundments, including the basins, intake structures, and downstream hydraulic structures in accordance with 40 CFR 257.82. We previously determined that the existing downstream conveyance system experienced deficiencies when modeled at the 100-year storm event, but the deficiencies were independent of the hydraulic performance of the bottom ash basins and outfall structures themselves and does not impact the overall hydraulic performance of the basins. In addition, the discharge from the basins meets the regulatory NPDES permit requirements for total suspended solids (TSS) and fats, oils, and grease (FOG), so the impoundment discharge water flooding downstream of the conveyance structures would not be considered a release of CCR or regulated wastewater and would therefore be an operational item, but not a regulatory consideration.

ASSESSMENT

For this periodic evaluation, NTH performed the following to analyze the condition of the bottom ash basins and verify the information presented in the initial IDFC report:

- Performed a site visit on July 29, 2021, to meet DTE personnel, learn about any changes to the DTE assets, and observe the current system conditions. A photo log from our site visit is included as an attachment to this letter;
- Reviewed the initial report;
- Procured supplemental topographic and bathymetric survey of the conveyance ditches and bottom ash basins. The supplemental survey was performed on May 17, 2021 by BMJ Engineers & Surveyors, Inc. to update previous bathymetric information from 2016 and to facilitate accurate capacity calculations for the system. The supplemental survey information is included as an attachment to this letter;
- Obtained recent flow data from the last five years of process water inletting to the two basins and the stormwater flow into MH-1 from Range Road Landfill (RRLF);
- Updated the model input parameters, including new peak flow information, updated basin capacity, and downstream conveyance ditches according to the bathymetric survey. The updated site plan is included as an attachment to this letter; and
- Re-ran the Autodesk Storm and Sanitary Analysis (SSA) modeling software with the updated data inputs. The updated model output is included as an attachment to this letter.

Based on information from the above actions, NTH summarizes the following for this IDFC periodic assessment:

- The current configuration and condition of the basins (as shown in the attached photographs) are consistent with those presented in the initial IDFC report. DTE personnel indicated that no alterations have been made to the basins and no substantive changes were apparent during NTH's field observation.
- The capacity of the basins has not significantly changed from that presented in the initial IDFC report:
    - 2.6 million gallons for the north basin (2.4 million gallons in 2016) and
    - 2.2 million gallons for the south basin (2.5 million gallons in 2016).

  As a point of clarification, the capacity of the basins at any given time is a function of the active dredging state and is not necessarily indicative of changes to the basin geometry. The west side overflow weirs control the basin water levels and flow and NTH staff observed no indication that the basin or weir geometries have been altered since the initial IDFC report.
- Analysis of the inflow data provided by DTE showed that the average flows into the north basin and south basin were lower than the flows from the initial report. The average flow from RRLF was slightly higher. The maximum flow into the north basin was higher than the flow from the initial report, while the maximum flows into the south basin and from

RRLF were both significantly lower. The previous and current input flow information is summarized in the following table. The flow values we used to run the model analysis were the highest maximum flows from all the data we have obtained from DTE since 2011. Therefore, it was 26.3 CFS for the North Basin, 23.8 CFS for the South Basin, and 4.97 CFS for RRLF.

BRPP Bottom Ash Basin Inflow Rate Summary

Average Inflow Rates		
	Previous Report (cfs)	**Current (cfs)**
North Basin	5.77	4.65
South Basin	5.86	4.62
RRLF	0.65	0.80

Maximum Inflow Rates		
`	**Previous Report (cfs)**	**Current (cfs)**
North Basin	22.3	26.30
South Basin	23.8	12.85
RRLF	4.97	3.96

- The pattern and controls of the process flow system are consistent with that documented in the initial report. No substantive changes were apparent during NTH's field observation.
- The approximate dimensions and capacities of the receiving ditches were slightly lower, but very similar to those presented in the initial report. See revised ditch sections in the updated site plan attached to this letter.
- Information from the supplemental survey indicates basin water surface elevations are consistent with that documented in the initial IDFC report.

Based on the findings summarized above, the inflow design flood control system plan presented in the initial report is applicable to the current condition of the BRPP bottom ash basins. The operational deficiencies of the downstream conveyance system still exist, but are still believed to be an operational item, not a regulatory one, as the discharge from the basins meets the regulatory requirements of the NPDES permit and would not be considered a release of CCR material.

CONCLUSIONS

Based on the findings summarized herein and the hydrologic and hydraulic capacity requirements for CCR surface impoundments presented in 40 CFR 257.82, NTH has determined that the bottom ash basins of the BRPP meet the criteria of this section. In accordance with 40 CFR 257.82(c)(5), a statement of Certification for the BRPP bottom ash basins is included with this letter as an attachment. A copy of this letter should be kept in the facility's operating record for future reference.

Please contact us if you have any questions or require additional information.

Sincerely,

NTH Consultants, Ltd.

DocuSigned by:
David R. Lutz
2BF41F0D0F4749B...

David R. Lutz, P.E.
Vice President

DocuSigned by:
Samantha L. Grant
A1E1683045E447D...

Samantha L. Grant, P.E.
Project Engineer

DRL/SLG/mam

Attachments

Photograph 1: North Basin Looking West from the East End of the Basin

Photograph 2: South Basin Looking West from the East End of the Basin

Photograph 3: South Basin Weir Looking South from Northwest Corner of South Basin

Photograph 4: North basin Weir Looking South from Northwest Corner of Basin

Photograph 5: South Discharge Channel Looking West from West End of South Basin

Photograph 6: North Discharge Channel Looking West from West End of North Basin

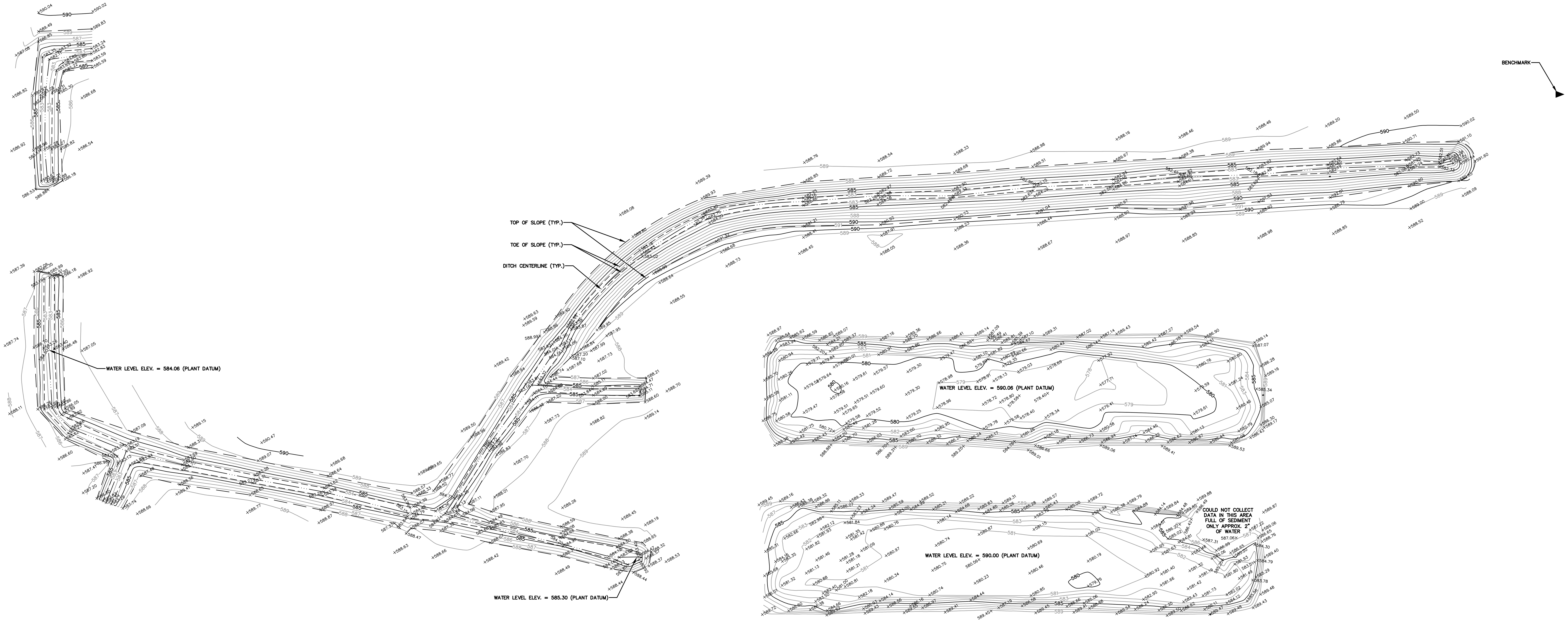
Photograph 7: North Discharge Channel Joining Flow From South Discharge Channel Looking East from West of the North Basin

Photograph 8: Combined Discharge Channel Looking Northeast from the Knife Gate

Photograph 9: Combined Discharge Channel Looking Northeast from North Side of North Basin

Photograph 10: MH-1 Junction of Flows from Basins and RRLF

BELLE RIVER POWER PLANT
ASH SETTLING BASINS



NOTES:
VERTICAL DATUM: DTE PLANT DATUM (ORIGIN UNKNOWN)

HORIZONTAL DATUM: DTE PLANT DATUM (ORIGIN UNKNOWN)

BENCHMARK:
DESCRIPTION: ATOP FOUND PAINTED "+" ON NORTH SIDE OF STORM MANHOLE RIM NORTHEAST OF ASH PONDS AND ±16' EAST OF ASH HAUL ROAD
ELEVATION = 590.52 (PLANT DATUM)

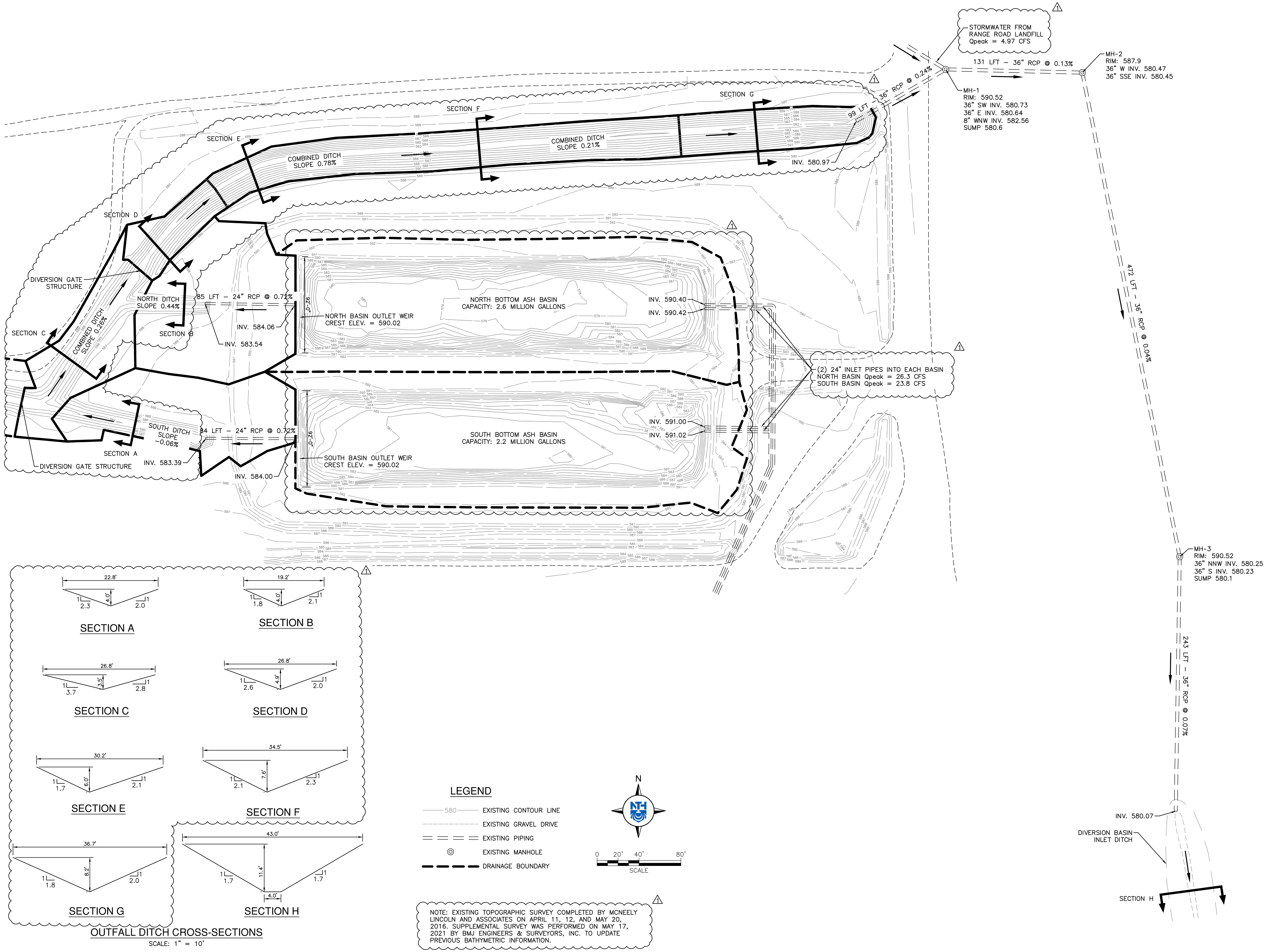
GRAPHIC SCALE
40 0 20 40 80
(IN FEET)
1 inch = 40 ft.

BMJ ENGINEERS & SURVEYORS, INC.
CIVIL ENGINEERS & LAND SURVEYORS
519 HURON AVE. PORT HURON, MI 48060
TEL: 810-984-5596 FAX: 810-984-8760
Web Page: www.bmjinc.com Email: mail@bmjinc.com

BATHYMETRIC SURVEY OF ASH SETTLING BASIN AT DTE BELLE RIVER POWER PLANT
KING ROAD, CHINA TOWNSHIP, ST. CLAIR COUNTY, MICHIGAN
FOR: NTH CONSULTANTS, LTD

NO	REVISIONS	DATE

SCALE: 1" = 40'
DATE: 5-17-21
SURVEYED: AMB
DRAWN: SWS
CHK'D: RJA
JOB NO. 1904.13
SHT 1 OF 1



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Cleveland, OH	216.334.4040

SUBMITTAL

REV	DESCRIPTION	DATE	BY
1	5-YR PERIODIC ASSESSMENT	9/7/2021	DGO

PROJECT NAME:

DTE BELLE RIVER POWER PLANT - BOTTOM ASH BASIN HYDRAULIC ANALYSIS

PROJECT LOCATION:

BELLE RIVER POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

NTH PROJECT NO.: 62-210081	CAD FILE NAME: 210081-BR-SP
DESIGNED BY: SLG	INCEP DATE: 9/7/2016
DRAWN BY: SLG	DRAWING SCALE: 1" = 40'
CHECKED BY: DRL	SUBMITTED DATE: 9/7/2021

SHEET TITLE:

BELLE RIVER POWER PLANT BOTTOM ASH BASIN

EXISTING SYSTEM COMPONENT PLAN

SHEET REFERENCE NUMBER:

3

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Autodesk® Storm and Sanitary Analysis 2016 - Version 13.2.202 (Build 0)
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*******************
Project Description
*******************
File Name ................ Belle River-EX-DGD.SPF


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Analysis Options
****************
Flow Units ............... cfs
Subbasin Hydrograph Method. Rational
Time of Concentration...... SCS TR-55
Return Period............. 100 years
Link Routing Method ....... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date ............ SEP-03-2021 00:00:00
Ending Date .............. SEP-03-2021 02:00:00
Report Time Step ......... 00:00:10


*************
Element Count
*************
Number of subbasins ....... 8
Number of nodes ........... 17
Number of links ........... 16


****************
Subbasin Summary
****************
Subbasin                 Total
                          Area
ID                         ft²
------------------------------
Sub-01                14535.91
Sub-02                18812.27
Sub-03                10255.64
Sub-04                 7087.49
Sub-05                53922.71
Sub-06                53523.35
Sub-07                 4052.46
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Sub-08 16326.13

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Node Summary
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Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
Ditch-to-Pipe	JUNCTION	580.37	590.07	0.00	
Jun-1	JUNCTION	583.22	589.22	4525.90	
Jun-2	JUNCTION	582.34	589.94	685.30	
Jun-3	JUNCTION	581.40	589.60	0.00	
MH-1	JUNCTION	580.60	590.52	0.00	Yes
MH-2	JUNCTION	580.40	587.90	0.00	
MH-3	JUNCTION	580.10	590.52	0.00	
North-Box-Structure	JUNCTION	582.79	597.62	0.00	
North-to-Comb-Ditch	JUNCTION	583.18	588.08	17403.30	
Pipe-to-Ditch-North	JUNCTION	583.54	587.54	0.00	
Pipe-to-Ditch-South	JUNCTION	583.39	587.39	0.00	
Pipe-to-Diversion-Ditch	JUNCTION	580.07	591.47	0.00	
South-Box-Structure	JUNCTION	582.81	597.27	0.00	
South-to-Comb-Ditch	JUNCTION	583.48	587.48	11105.70	
Out-01	OUTFALL	578.58	589.98	0.00	
North-Basin	STORAGE	577.69	592.05	0.00	Yes
South-Basin	STORAGE	578.07	591.95	0.00	Yes

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Link Summary
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Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
36-in-Pipe-1	Ditch-to-Pipe	MH-1	CONDUIT	98.7	0.2433	0.0150
36-in-Pipe-2	MH-1	MH-2	CONDUIT	130.5	0.1303	0.0150
36-in-Pipe-3	MH-2	MH-3	CONDUIT	471.9	0.0424	0.0130
36-in-Pipe-4	MH-3	Pipe-to-Diversion-Ditch	CONDUIT	243.2	0.0658	0.0130
Comb-Ditch-1	South-to-Comb-Ditch	North-to-Comb-Ditch	CHANNEL	117.4	0.2554	0.0320
Comb-Ditch-2	Jun-1	North-to-Comb-Ditch	CHANNEL	35.6	0.1124	0.0320
Comb-Ditch-3	Jun-1	Jun-2	CHANNEL	112.6	0.7815	0.0320
Comb-Ditch-4	Jun-2	Jun-3	CHANNEL	451.0	0.2084	0.0320
Comb-Ditch-5	Jun-3	Ditch-to-Pipe	CHANNEL	169.1	0.2544	0.0320
Diversion-Pond-Ditch	Pipe-to-Diversion-Ditch	Out-01	CHANNEL	103.7	1.4364	0.0320
North-24-in	North-Box-Structure	Pipe-to-Ditch-North	CONDUIT	85.3	0.6097	0.0130

North-Ditch	Pipe-to-Ditch-NorthNorth-to-Comb-DitchCHANNEL		81.8	0.4399	0.0320
South-24-in	South-Box-StructurePipe-to-Ditch-SouthCONDUIT		84.4	0.7231	0.0130
South-Ditch	South-to-Comb-DitchPipe-to-Ditch-SouthCHANNEL		150.2	0.0599	0.0320
North-Weir	North-Basin	North-Box-StructureWEIR			
South-Weir	South-Basin	South-Box-StructureWEIR			

****
Cross Section Summary
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Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
36-in-Pipe-1	CIRCULAR	3.00	3.00	1	7.07	0.75	28.51
36-in-Pipe-2	CIRCULAR	3.00	3.00	1	7.07	0.75	20.87
36-in-Pipe-3	CIRCULAR	3.00	3.00	1	7.07	0.75	13.73
36-in-Pipe-4	CIRCULAR	3.00	3.00	1	7.07	0.75	17.11
Comb-Ditch-1	TRIANGULAR	3.50	26.80	1	46.90	1.69	156.37
Comb-Ditch-2	TRIANGULAR	4.90	26.80	1	65.66	2.30	178.14
Comb-Ditch-3	TRIANGULAR	6.00	30.20	1	90.60	2.79	736.76
Comb-Ditch-4	TRIANGULAR	7.60	34.50	1	131.10	3.48	637.95
Comb-Ditch-5	TRIANGULAR	8.20	36.70	1	150.47	3.74	849.59
Diversion-Pond-Ditch	TRAPEZOIDAL	11.40	43.90	1	273.03	5.47	4714.71
North-24-in	CIRCULAR	2.00	2.00	1	3.14	0.50	17.66
North-Ditch	TRIANGULAR	4.00	19.20	1	38.40	1.85	177.98
South-24-in	CIRCULAR	2.00	2.00	1	3.14	0.50	19.24
South-Ditch	TRIANGULAR	4.00	22.80	1	45.60	1.89	79.15

****
Runoff Quantity Continuity
****

	Volume acre-ft	Depth inches
Total Precipitation	0.489	1.432
Continuity Error (%)	0.331	

****
Flow Routing Continuity
****

	Volume acre-ft	Volume Mgallons
External Inflow	9.098	2.965
External Outflow	5.576	1.817
Initial Stored Volume	34.733	11.318
Final Stored Volume	36.925	12.033
Continuity Error (%)	0.001	

```
*************************************
Runoff Coefficient Computations Report
*************************************

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Subbasin Sub-01
------------------
                                                        Area          Soil        Runoff
Soil/Surface Description                               (ft²)         Group        Coeff.
-------------------------------------------------------------------------------------------
GrassyArea                                          11106.75             -          0.30
Ditch                                                3429.07             -          0.90
Composite Area & Weighted Runoff Coeff.             14535.83                        0.44

------------------
Subbasin Sub-02
------------------
                                                        Area          Soil        Runoff
Soil/Surface Description                               (ft²)         Group        Coeff.
-------------------------------------------------------------------------------------------
-                                                   17403.24             -          0.30
-                                                    1408.99             -          0.90
Composite Area & Weighted Runoff Coeff.             18812.22                        0.34

------------------
Subbasin Sub-03
------------------
                                                        Area          Soil        Runoff
Soil/Surface Description                               (ft²)         Group        Coeff.
-------------------------------------------------------------------------------------------
GrassyArea                                           4525.78             -          0.30
Ditch                                                5729.77             -          0.90
Composite Area & Weighted Runoff Coeff.             10255.55                        0.64

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Subbasin Sub-04
------------------
                                                        Area          Soil        Runoff
Soil/Surface Description                               (ft²)         Group        Coeff.
-------------------------------------------------------------------------------------------
Ditch                                                7078.47             -          0.90
Composite Area & Weighted Runoff Coeff.              7078.47                        0.90

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Subbasin Sub-05

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
DirtRoad	16967.81	-	0.30
Basin	36954.85	-	0.90
Composite Area & Weighted Runoff Coeff.	53922.66		0.71

Subbasin Sub-06

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
DirtRoad	17246.82	-	0.30
Basin	36276.45	-	0.90
Composite Area & Weighted Runoff Coeff.	53523.26		0.71

Subbasin Sub-07

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	4052.46	-	0.90
Composite Area & Weighted Runoff Coeff.	4052.46		0.90

Subbasin Sub-08

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	16326.13	-	0.90
Composite Area & Weighted Runoff Coeff.	16326.13		0.90

SCS TR-55 Time of Concentration Computations Report

Sheet Flow Equation

$$Tc = (0.007 * ((n * Lf)^{0.8})) / ((P^{0.5}) * (Sf^{0.4}))$$

```
        Where:

        Tc = Time of Concentration (hrs)
        n  = Manning's Roughness
        Lf = Flow Length (ft)
        P  = 2 yr, 24 hr Rainfall (inches)
        Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation
----------------------------------

        V  = 16.1345 * (Sf^0.5) (unpaved surface)
        V  = 20.3282 * (Sf^0.5) (paved surface)
        V  = 15.0 * (Sf^0.5) (grassed waterway surface)
        V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
        V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
        V  = 7.0 * (Sf^0.5) (short grass pasture surface)
        V  = 5.0 * (Sf^0.5) (woodland surface)
        V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
        Lf = Flow Length (ft)
        V  = Velocity (ft/sec)
        Sf = Slope (ft/ft)

Channel Flow Equation
---------------------

        V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
        R  = Aq / Wp
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
        Lf = Flow Length (ft)
        R  = Hydraulic Radius (ft)
        Aq = Flow Area (ft²)
        Wp = Wetted Perimeter (ft)
        V  = Velocity (ft/sec)
        Sf = Slope (ft/ft)
        n  = Manning's Roughness
```

```
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Subbasin Sub-01
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        User-Defined TOC override (minutes):      1.50

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Subbasin Sub-02
------------------

        User-Defined TOC override (minutes):      3.10

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Subbasin Sub-03
------------------

        User-Defined TOC override (minutes):      0.60

------------------
Subbasin Sub-04
------------------

        User-Defined TOC override (minutes):      0.50

------------------
Subbasin Sub-05
------------------

        User-Defined TOC override (minutes):      1.00

------------------
Subbasin Sub-06
------------------

        User-Defined TOC override (minutes):      1.50

------------------
Subbasin Sub-07
------------------

        User-Defined TOC override (minutes):      0.50

------------------
Subbasin Sub-08
------------------
```

User-Defined TOC override (minutes): 0.50

****
Subbasin Runoff Summary
****

Subbasin ID	Accumulated Precip in	Rainfall Intensity in/hr	Total Runoff in	Peak Runoff cfs	Weighted Runoff Coeff	Time of Concentration days	Time of Concentration hh:mm:ss
Sub-01	1.43	5.73	0.63	0.84	0.440	0	00:15:00
Sub-02	1.43	5.73	0.49	0.84	0.340	0	00:15:00
Sub-03	1.43	5.73	0.92	0.86	0.640	0	00:15:00
Sub-04	1.43	5.73	1.29	0.84	0.900	0	00:15:00
Sub-05	1.43	5.73	1.02	5.04	0.710	0	00:15:00
Sub-06	1.43	5.73	1.02	5.00	0.710	0	00:15:00
Sub-07	1.43	5.73	1.29	0.48	0.900	0	00:15:00
Sub-08	1.43	5.73	1.29	1.93	0.900	0	00:15:00

****
Node Depth Summary
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Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
Ditch-to-Pipe	6.10	7.01	587.38	0	00:49	0	0	0:00:00
Jun-1	3.61	4.17	587.39	0	00:50	0	0	0:00:00
Jun-2	4.37	5.05	587.39	0	00:50	0	0	0:00:00
Jun-3	5.11	5.98	587.38	0	00:49	0	0	0:00:00
MH-1	5.29	6.08	586.68	0	00:49	0	0	0:00:00
MH-2	4.56	5.22	585.62	0	00:49	0	0	0:00:00
MH-3	3.05	3.44	583.54	0	00:49	0	0	0:00:00
North-Box-Structure	6.34	6.87	589.66	0	00:50	0	0	0:00:00
North-to-Comb-Ditch	3.71	4.22	587.40	0	00:50	0	0	0:00:00
Pipe-to-Ditch-North	3.41	3.88	587.42	0	00:50	0	0	0:00:00
Pipe-to-Ditch-South	3.56	4.00	587.39	0	00:47	19.30	73	0:00:00
Pipe-to-Diversion-Ditch	1.20	1.35	581.42	0	00:50	0	0	0:00:00
South-Box-Structure	5.93	6.40	589.21	0	00:47	0	0	0:00:00

South-to-Comb-Ditch	3.42	3.92	587.40	0 00:50	0	0	0:00:00
Out-01	1.12	1.25	579.83	0 00:50	0	0	0:00:00
North-Basin	12.52	12.54	590.23	0 00:20	0	0	0:00:00
South-Basin	12.14	12.16	590.23	0 00:19	0	0	0:00:00

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Node Flow Summary
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Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days hh:mm
Ditch-to-Pipe	JUNCTION	0.84	35.28	0 00:48	0.00	
Jun-1	JUNCTION	0.86	55.00	0 00:18	0.00	
Jun-2	JUNCTION	0.48	54.28	0 00:17	0.00	
Jun-3	JUNCTION	1.93	49.56	0 00:15	0.00	
MH-1	JUNCTION	4.97	38.94	0 00:50	0.00	
MH-2	JUNCTION	0.00	38.95	0 00:50	0.00	
MH-3	JUNCTION	0.00	38.95	0 00:50	0.00	
North-Box-Structure	JUNCTION	0.00	29.62	0 00:20	0.00	
North-to-Comb-Ditch	JUNCTION	0.84	55.68	0 00:18	0.00	
Pipe-to-Ditch-North	JUNCTION	0.00	29.59	0 00:20	0.00	
Pipe-to-Ditch-South	JUNCTION	0.00	27.34	0 00:19	22.09	0 00:52
Pipe-to-Diversion-Ditch	JUNCTION	0.00	38.95	0 00:50	0.00	
South-Box-Structure	JUNCTION	0.00	27.36	0 00:19	0.00	
South-to-Comb-Ditch	JUNCTION	0.84	27.35	0 00:18	0.00	
Out-01	OUTFALL	0.00	38.94	0 00:50	0.00	
North-Basin	STORAGE	31.30	31.30	0 00:15	0.00	
South-Basin	STORAGE	28.81	28.81	0 00:15	0.00	

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 ft³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 ft³	Average Ponded Volume (%)	Maximum Storage Node Outflow cfs	Maximum Exfiltration Rate cfm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 ft³
North-Basin	788.822	89	0 00:20	787.647	89	29.62	0.00	0:00:00	0.000

South-Basin	745.472	91	0	00:19	744.390	90	27.36	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
Out-01	97.86	34.46	38.94
System	97.86	34.46	38.94

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
36-in-Pipe-1	CONDUIT	0 00:50	4.81	1.00	33.97	28.51	1.19	1.00	107	SURCHARGED
36-in-Pipe-2	CONDUIT	0 00:50	5.51	1.00	38.95	20.87	1.87	1.00	106	SURCHARGED
36-in-Pipe-3	CONDUIT	0 00:50	5.51	1.00	38.95	13.73	2.84	1.00	94	SURCHARGED
36-in-Pipe-4	CONDUIT	0 00:50	7.10	1.00	38.95	17.11	2.28	0.72	0	> CAPACITY
Comb-Ditch-1	CHANNEL	0 00:18	0.94	1.00	25.94	156.37	0.17	1.00	83	FLOODED
Comb-Ditch-2	CHANNEL	0 00:18	2.84	1.00	54.30	178.14	0.30	0.86	0	Calculated
Comb-Ditch-3	CHANNEL	0 00:17	3.27	1.00	53.88	736.76	0.07	0.77	0	Calculated
Comb-Ditch-4	CHANNEL	0 00:15	2.64	1.00	47.67	637.95	0.07	0.73	0	Calculated
Comb-Ditch-5	CHANNEL	0 00:48	2.09	1.00	35.28	849.59	0.04	0.76	0	Calculated
Diversion-Pond-Ditch	CHANNEL	0 00:50	4.78	1.00	38.94	4714.71	0.01	0.11	0	Calculated
North-24-in	CONDUIT	0 00:20	9.42	1.00	29.59	17.66	1.67	1.00	111	SURCHARGED
North-Ditch	CHANNEL	0 00:19	3.03	1.00	29.20	177.98	0.16	0.98	0	Calculated
South-24-in	CONDUIT	0 00:19	8.70	1.00	27.34	19.24	1.42	1.00	113	SURCHARGED
South-Ditch	CHANNEL	0 00:18	1.67	1.00	26.70	79.15	0.34	0.99	0	Calculated
North-Weir	WEIR	0 00:20			29.62			0.08		
South-Weir	WEIR	0 00:19			27.36			0.08		

****

```
Highest Flow Instability Indexes
********************************
All links are stable.


WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node North-Box-Structure.
WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node South-Box-Structure.

Analysis began on:  Tue Sep  7 14:05:01 2021
Analysis ended on:  Tue Sep  7 14:05:02 2021
Total elapsed time: 00:00:01
```

STATEMENT OF CERTIFICATION

I, David R. Lutz, a Professional Engineer licensed in the State of Michigan, certify[1] that NTH Consultants, Ltd. have reviewed available historical information, conducted a field visit, performed engineering and hydraulic/hydrologic analysis, modeling, and calculations on the inflow design flood control system for the bottom ash CCR surface impoundments at the DTE Belle River Power Plant, located in East China Township, Michigan. To the best of my knowledge and belief, the analysis and documentation presented in this report for the bottom ash basins at the aforementioned facility is accurate and has been developed in substantial conformance with the requirements stipulated in 40 CFR Part 257.82.

David R. Lutz, P.E.
State of Michigan Professional Engineer
Registration No. 57487

([1]) I am rendering my professional opinion based on the information available to me at the time of this report's writing. This certification does not comprise a guarantee or warranty that certain conditions exist, nor does it relieve any other party of their requirements to abide by all applicable local, state, and federal regulations, and to honor all express or customary guarantees and warranties associated with their work.

Report

Inflow Design Flood Control System Plan
Belle River Power Plant
East China, Michigan

DTE Energy Company
One Energy Plaza, Detroit, MI

October 14, 2016
NTH Project No. 62-160047-04

NTH Consultants, Ltd.
41780 Six Mile Road
Northville, MI 48168

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INTRODUCTION

NTH Consultants, Ltd. (NTH), in conjunction with personnel from DTE Energy Company (DTE) has completed an inflow design flood control system plan for the bottom ash basins at Belle River Power Plant (BRPP) in accordance with the Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities 40 CFR Part 257.82. This plan details the hydraulic and hydrologic capacity of the CCR impoundment system, including the basins, intake structures, and downstream hydraulic structures. The intent of the plan is to ensure that the CCR impoundment has the capacity to manage the discharge from the process flows along with a specified design rainfall event "inflow design flood", based on the hazard potential classification of the basins.

The BRPP was constructed in the 1980's in East China Township, just west of the DTE St. Clair Power Plant (STCPP). The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan. The bottom ash basins are physical sedimentation basins, located north of BRPP near the Webster Drain and receive bottom ash and other process flow effluent pumped from the power plant. Discharge water from each basin flows over an outlet weir and gravity flows to a site storm water conveyance network of ditches and pipes, eventually outfalling with other site storm water effluent authorized via a National Pollution Discharge Elimination System (NPDES) permit. An overall site plan is included as Figure 1, in the attachments.

Regulatory Basis

In accordance with 40 CFR Part 257.82, NTH has prepared this inflow design flood control system plan to demonstrate and document the hydrologic and hydraulic capacity and performance requirements for the bottom ash coal CCR surface impoundments. Specifically, this plan details how the bottom ash CCR surface impoundments collect and control the peak discharge from the inflow design flood, in addition to the peak discharge into the impoundments from plant process flow. The inflow design flood requirements for the capacity evaluation depend on the hazard potential classification of the basins in accordance with 40 CFR 257.82(a)(3). The basins at BRPP have been classified as low-hazard surface impoundments in accordance with 40 CFR 257.73(a)(2) and are not incised CCR impoundments based on the definition prescribed in 40 CFR 257.53. Because of this, the BRPP bottom ash CCR surface impoundments system are being analyzed to handle a 100-year flood event in addition to the plant process flows. As stipulated in Section VI (H)(3) of the rule preamble, the plan also includes a:

- Characterization of the design storm, catchment area, run-on and run-off routing models;
- Characterization of the intake, decant, and spillway structures and their capacity;
- Characterization of the downstream hydraulic structures which receive the discharge from the CCR surface impoundments; and
- Supporting engineering calculations and analysis results.

MODELING OF CCR IMPOUNDMENT SYSTEM

NTH evaluated the bottom ash CCR surface impoundment system using the Autodesk ® Storm and Sanitary Analysis 2017 computer modeling software. This software was used to develop runoff hydrographs, or temporal flow distribution models, for the watersheds contributing to the system as well as to route the inflow hydrographs through the bottom ash CCR impoundment and conveyance structures.

Model Input

In order to compile the data necessary for input into the model, NTH conducted several steps including:

- Performed a site visit to meet DTE personnel, learn about the DTE assets, and field review the existing system conditions;
- Reviewed historic site drawings and flow data provided by DTE plant staff; and

- Procured ground surface topographical elevations by McNeely & Lincoln Associates (MLA), a registered land surveyor, on April 11, 12, and May 20, 2016. MLA also sounded the bottom of the basins to allow for accurate capacity calculations and surveyed components of the system, including the basins, the weir and box structure, ditch dimensions, and pipe and manhole inverts (see Figure 2 for the detailed survey information).

NTH performed the analysis using design precipitation data adopted from the National Oceanic Atmospheric Administration (NOAA) Atlas 14, Volume 8, Version 2 (2013). We evaluated the bottom ash CCR surface impoundment system for a 100-year storm event and utilized the rational method to calculate the storm water runoff generated from each of the sub-watersheds. The rational method determines the peak discharge rate from each sub-watershed based on the following equation:

$$\mathbf{Q = CiA}$$

Where:

Q = Peak discharge rate (cubic feet per second (CFS))

C = Runoff coefficient (presented in table below)

i = Rainfall intensity from IDF curves based on design storm return period and Tc (in/hr)

A = Sub-watershed drainage area (Acres)

The CCR bottom ash basin system was divided into sub-watersheds based on existing ground topography to determine the contributing runoff amount for each basin and the downstream conveyance ditches which ultimately receive the discharge from the impoundments. The ditches were broken up into sub-areas based on changing depths, widths, and side slopes. The contributing area, time of concentration, and runoff coefficient were determined for each watershed area. These input parameters are used to determine both the amount and intensity of runoff generated in each watershed during the design storm and the overall amount of runoff collected and conveyed by the storm water system (see Figure 3 for depiction of drainage areas).

The time of concentration, Tc, is the time required for the entire sub-watershed to contribute runoff to the system and is dependent on flow path, slope and ground type. In general, Tc for each sub-area was very small due to the small nature of the watersheds. Based on state-of-the-practice engineering standards, we utilized a minimum Tc of 15 minutes for each sub-watershed, which is the minimum amount of time used in a typical analysis, even though the actual flow time may be much less. The model was allowed to run for a 2-hour duration to allow enough time for all of the storm water runoff from the design storm to contribute to the CCR impoundment and the downstream structures.

The runoff coefficient is a function of land use and ground condition. We adopted runoff coefficients from our past experience and generally-acceptable industry standards. The runoff coefficients used for this study are summarized in the following table:

Ground Type	Runoff Coefficient (C)
Grass	**0.30**
Pavements/Parking Lots	**0.90**
Compacted Gravel Covered Areas	**0.85**

We selected the hydrodynamic routing method in Storm and Sanitary Analysis software program because it is the most sophisticated method and produces the most theoretically accurate results. It solves the one-dimensional Saint-Venant flow equations which consists of continuity and momentum equations for pipes and ditches and a volume continuity equation at the storage nodes and junctions. This routing method can represent pressurized flows when the piping or ditch becomes full and can model the amount of flooding in storage nodes and junctions.

See Figure 3 in the attachments, which depicts the CCR system and contributing drainage areas based on the results of our field survey and investigation, and review of historical site drawings. Refer to the model output results in the attachments for additional input information.

Model Input Assumptions

NTH utilized information obtained from topographic surveys, historical information, and field investigations to build the model of the CCR impoundment and conveyance network. When available, items such as pipe/manhole diameter, inverts, material of construction, ditch dimensions, and inlet/cover type were utilized to accurately model the conveyance network.

Additionally, NTH obtained five years of historical flow data from DTE plant staff to characterize the process inflows into the bottom ash CCR surface impoundment system. This included daily flow readings from an electronic integrator to measure process flows. NTH completed a statistical analysis to determine appropriate parameters for the peak inflows to use for the:

- North Bottom Ash Basin through the (2) 24-inch diameter inlet pipes;
- South Bottom Ash Basin through the (2) 24-inch diameter inlet pipes; and
- Range Road Landfill stormwater at manhole MH-1 into the 36-inch diameter sewer.

While every attempt was made to accurately model the existing system, assumptions introduce unknown parameters into the model. If any of these assumptions are incorrect, the results of the model will be impacted. Should actual conditions vary from the assumptions utilized in the model, the predicted model results, and subsequent recommendations to correct any deficiencies identified, may be impacted. We have relatively high confidence that the model for the CCR impoundment and conveyance structures depicts the most conservative anticipated conditions during the modeled flood event.

Existing System Components

There are two bottom ash basins at BRPP, the north basin and the south basin. The basins constructed side slopes of 2H:1V inclination are riprap protected, with a portion of the exterior dikes constructed above-grade of compacted clay (according to a review of historical construction drawings). The north basin has a capacity of 2.4 million gallons and the south basin has a capacity of 2.5 million gallons. Water containing bottom ash enters on the east side of each basin through two 24-inch underground pipes. DTE staff-provided flow data for the basins for the past five years indicated the peak flow into the north basin was 22.3 cubic feet per second (cfs) and the peak flow into the south basin was 23.8 cfs.

The basins each discharge over an outlet weir into a box structure on the west side of the basins. The weirs span the entire width of the basins (approximately 90 feet) and each box structure flows into a 24-inch reinforced concrete pipe (RCP) which discharges into a surface ditch. The ditches combine into a larger ditch located along the north side of the north basin and the water is then routed into a 36-inch RCP underground pipe through a series of three manholes before discharging into another site storm/process water pond, the Diversion Pond. Additional flow is pumped from the storm water pond at the Range Road Ash Disposal Landfill (RRLF), approximately 1.5 miles north of the plant facility, with a peak flow of 4.97 cfs, based on a review of historical flow data provided by DTE staff.

The water levels in the bottom ash basins are controlled by the fixed elevation of the outlet weirs, establishing a high water level in the basins at 590.0 feet, which is higher than the surrounding grade outside the embankments. The basins historically outfalled directly to the Webster Drain through a set of knife gate structures, but now the gates divert the flow through the ditch and piping system to the Diversion Pond. The gate structures can be opened to allow emergency overflow for the basins, but are always closed under normal conditions.

Model Output

The model produces output from the basin watersheds that includes inflow, outflow, peak outflow rate, and total runoff inflow/outflow volumes. The model also provides output from the CCR impoundment and conveyance structures including peak flow rates / velocities, maximum hydraulic grade lines, flow depths, and flooding/surcharged structures. To determine where system deficiencies exist, the results were analyzed for:

1. Locations where the modeled water surface elevation exceeded the rim/ground surface elevation at a the basins, ditches, and manholes (i.e. Flooding);

2. Locations were the modeled water surface exceeded the crown of the pipes within the manholes (i.e. Surcharging); or

3. Locations where the anticipated flow in a conveyance structure was greater than its design capacity (i.e. flow is > capacity).

While items noted as surcharging or below capacity identify a system deficiency, this does not necessarily warrant upgrades or improvements. These system deficiencies show that the system is still operating, but as a pressure flow system, instead of a gravity flow system. If no flooding is observed, the flow is still contained within the conveyance system, and the modeling software calculates theoretically accurate downstream and upstream system results based on the operating condition of these components.

Analysis of Design Flood Event –Existing Conditions

The modeled results show a few deficiencies in the downstream conveyance structures of the existing CCR bottom ash impoundment system at BRPP; however, the large capacity of the spillway overflow weir boxes in the basins prevent the CCR basins themselves from experiencing any modeled deficiencies. During the design flood event, the depth of the water within the basins only rises 0.19 feet above the crest elevation of the weir (elevation 590.0 feet), which still provides approximately 2.0 feet of freeboard to the top elevation of the bottom ash basins (elevation 592.0), more than the industry standard freeboard. The weirs can manage the peak flow produced by the design flood and peak process flow (25.6 cfs for the north basin and 27.2 cfs for the south basin), with a maximum calculated capacity of 1,211 cfs/weir (see Weir Capacity Calculation in the attachments for details).

The model predicts that the 24-inch outlet pipes from the basin weir outfall structure to the outlet ditches are below capacity and the surcharge flow causes the water to back up into the outfall weir box structure. The maximum capacity of the north pipe is 17.7 cfs (about 69% of the design peak flow). The flow backs up into the north weir outfall structure until it is approximately 70% percent full, but capacity of the structure still allows for an operational freeboard of 2.88 feet below the weir crest, preventing impact to the operation of the north bottom ash basin. The capacity of the south pipe allows for a flow of 19.2 cfs (approximately 69% of the design peak flow). The pipe surcharges, creating backflow into the weir outfall structure until it is 73% full, but capacity of the structure allows for a freeboard of 2.68 feet below the weir crest, preventing impact to the operation of the south bottom ash basin.

The 36-inch piping from the combined outlet ditch to the Diversion Pond is also undersized according to the model. The surcharging from this pipe causes portions of the combined and basin outflow ditches to overflow the top of bank of the ditch. The ditch itself has, at a minimum, four times greater capacity to covey the actual peak flow, but the piping restriction causes the ditch to back up during the design flood event, which causes to water to pond in the site ditches until sufficient capacity develops in the 36-inch piping to release the stored runoff. Also, the combined ditch where the south basin ditch and the north basin ditch enter has a negative slope and a low depth based on the topographical survey information. These issues, combined with the downstream restriction at the 36-inch outfall pipe causes the modeled water depth to be approximately 0.5 foot to 1 foot higher than the top of bank elevation. However, even though the model shows portions of the ditches in flooding conditions, the flooding stays within each ditch section's contributing drainage area. The water floods over the top of bank of the ditch, but based on a review of the topographic survey information, the water does not flow out of the CCR impoundment discharge area. Once downstream capacity becomes available in the 36-inch sewer, the flooded waters will re-enter the ditch and outfall the CCR surface impoundment system via the permitted discharge outfall location. The north basin ditch and south basin ditch do not flood but both are at approximately 95% capacity. All three of the manholes which connect the basin outflow ditches to the Diversion Pond via the 36-inch sewer, surcharge but do not flood, with the worst-case surcharging condition at MH-2, where the manhole is 75% full, with a freeboard of 1.88 feet, greater than the industry standard freeboard.

Historically, the basins have performed well and have never flooded in adverse conditions according to DTE personnel. There is an adequate amount of freeboard in the basins to account for a reasonable level of unforeseen incidents in the event additional flow into or restricted flow downstream of the basins occurs. DTE staff also inspects the bottom ash CCR impoundment system weekly and after significant rain or storm events to remediate any observed issues as soon as practical.

The model output result file provides additional information regarding the output and results. Refer to Figure 3 for additional information on the existing bottom ash CCR surface impoundment components.

CONCLUSIONS

NTH has prepared this inflow design flood control system plan to demonstrate and document the hydrologic and hydraulic capacity and performance requirements for the bottom ash coal CCR surface impoundments of the BRPP in accordance with 40 CFR 257.82.

The existing bottom ash CCR impoundment system at BRPP currently conveys both bottom ash and other plant process water, on-site stormwater, as well as stormwater from RRLF. The overall hydraulic system comprises the two bottom ash basins, overflow outfall weirs, and downstream conveyance ditches, piping, and manholes. While our analysis indicates that the existing downstream conveyance system, which outflows water from the bottom ash basins, experiences deficiencies when modeled at the specified 100-year design event, these deficiencies are independent of and on the hydraulic performance of the bottom ash basin and outfall structures themselves. Additionally, since the discharge from the basins meets the regulatory National Pollution Discharge Elimination System (NPDES) permit requirements stipulated in the facility's individual permit for both total suspended solids (TSS) and fats, oils, and grease (FOG), the impoundment discharge water that is flooding the downstream conveyance structures would not be considered a release of CCR or regulated wastewater and is therefore not a regulatory, but an operational item.

STATEMENT OF CERTIFICATION

I, David R. Lutz, a Professional Engineer licensed in the State of Michigan, certify[1] that NTH Consultants, Ltd. have reviewed available historical information, conducted a field visit, performed engineering and hydraulic/hydrologic analysis, modeling, and calculations on the inflow design flood control system for the bottom ash CCR surface impoundments at the DTE Belle River Power Plant, located in East China Township, Michigan. To the best of my knowledge and belief, the analysis and documentation presented in this report for the bottom ash basins at the aforementioned facility is accurate and has been developed in substantial conformance with the requirements stipulated in 40 CFR Part 257.82.

STATE OF MICHIGAN
DAVID R. LUTZ
ENGINEER
No. 57487
LICENSED PROFESSIONAL ENGINEER

10/14/16

David R. Lutz, P.E.
State of Michigan Professional Engineer
Registration No. 57487

([1]) I am rendering my professional opinion based on the information available to me at the time of this report writing. This certification does not comprise a guarantee or warranty that certain conditions exist, nor does it relieve any other party of their requirements to abide by all applicable local, state, and federal regulations, and to honor all express or customary guarantees and warranties associated with their work.

ATTACHMENTS

- Figure 1: Overall Site Plan
- Figure 2: Topographic Survey
- Figure 3: Existing System Component Plan
- Weir Capacity Calculation
- Time of Concentration Calculation
- Autodesk Storm and Sanitary Analysis Model Output

REFERENCE DOCUMENTS

- 6C1258-15-1 "YARD PIPING & DUCT BANK PLAN"
- 6C1258-15-3 "ASH SETTLING SYSTEM PLAN SECTIONS & DETAILS"
- 6C1258-841 "CONCRETE PLAN SECTIONS & DETAILS"
- 6C1258-853 "ASH SETTLING BASIN COLD WEATHER DIVERSION SYSTEM PLAN SHEET 1"
- 6C1258-854 "ASH SETTLING BASIN COLD WEATHER DIVERSION SYSTEM PLAN SHEET 2"
- BOTTOM ASH/RRLF FLOW 2011-PRESENT DATA

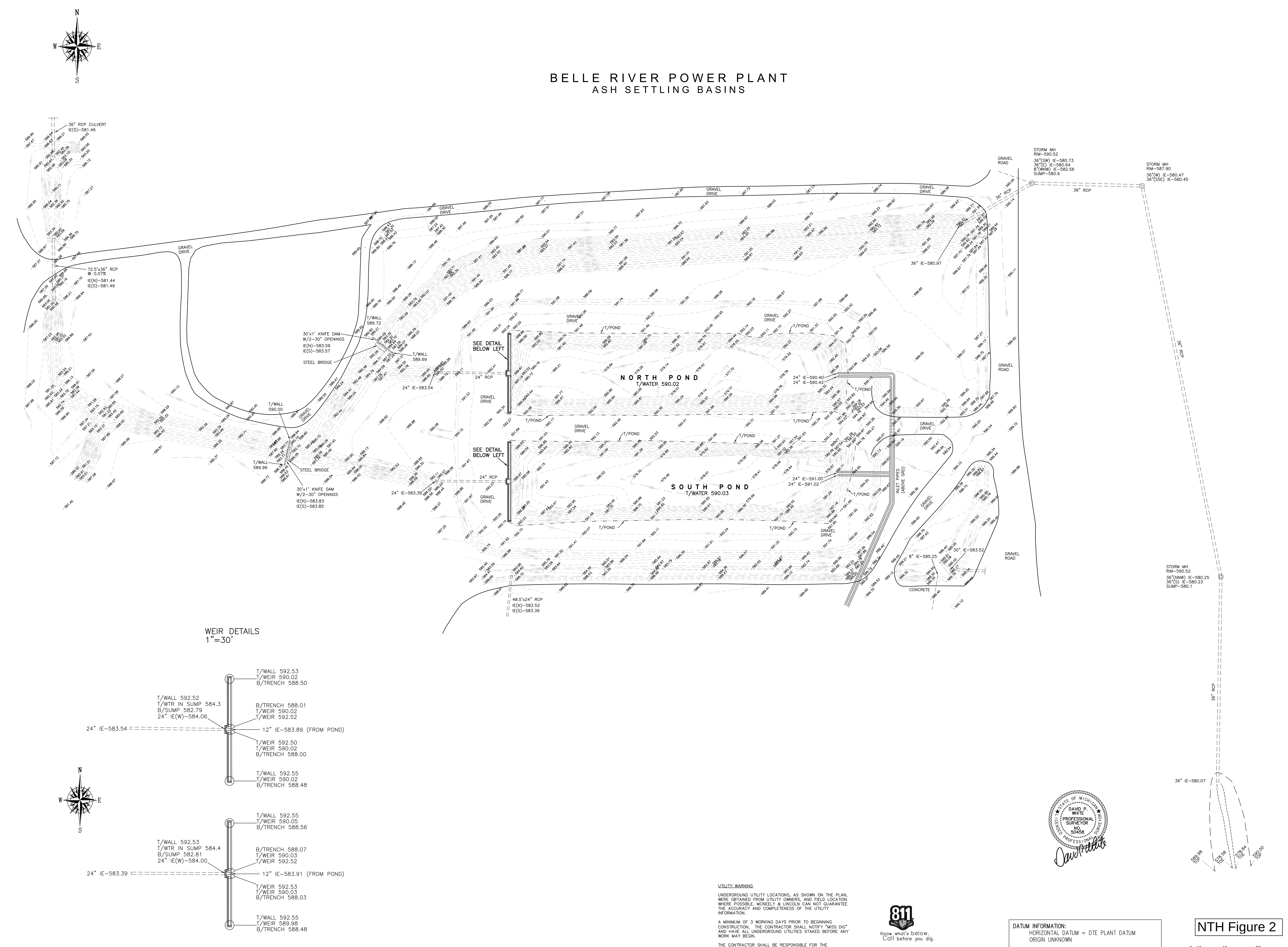
ATTACHMENTS

- **FIGURE 1: OVERALL SITE PLAN**
- **FIGURE 2: TOPOGRAPHIC SURVEY**
- **FIGURE 3: EXISTING SYSTEM COMPONENT PLAN**
- **WEIR CAPACITY CALCULATION**
- **TIME OF CONCENTRATION CALCULATION**
- **AUTODESK STORM AND SANITARY ANALYSIS MODEL OUTPUTS**

j:\2016\62\160047\production sets\brpp\160047-brpp.dwg Plotted: 10/10/2016 11:29 AM by sgrant

NTH PROJECT No.: 62–160047	CAD FILE NAME: 160047–BRPP	NTH Consultants, Ltd. Infrastructure Engineering and Environmental Services	SITE LOCATION PLAN	FIGURE: 1
DESIGNED BY: SLG	PLOT DATE: 10/10/2016		BELLE RIVER POWER PLANT EAST CHINA TOWNSHIP, MI	
DRAWN BY: SLG	DRAWING SCALE: 1" = 400'			
CHECKED BY: DRL	INCEPTION DATE: 9/7/2016			

BELLE RIVER POWER PLANT
ASH SETTLING BASINS



UTILITY WARNING

UNDERGROUND UTILITY LOCATIONS, AS SHOWN ON THE PLAN, WERE OBTAINED FROM UTILITY OWNERS, AND FIELD LOCATION WHERE POSSIBLE, McNEELY & LINCOLN CAN NOT GUARANTEE THE ACCURACY AND COMPLETENESS OF THE UTILITY INFORMATION.

A MINIMUM OF 3 WORKING DAYS PRIOR TO BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY "MISS DIG" AND HAVE ALL UNDERGROUND UTILITIES STAKED BEFORE ANY WORK MAY BEGIN.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL UTILITIES THAT MAY INTERFERE WITH CONSTRUCTION.

811 Know what's below. Call before you dig.

DATUM INFORMATION:
HORIZONTAL DATUM = DTE PLANT DATUM ORIGIN UNKNOWN
VERTICAL DATUM = DTE PLANT DATUM ORIGIN UNKNOWN

NTH Figure 2

SCALE: 1 INCH = 40 FEET

DATE: 060316
SURV. BY: TFS
DRWN BY: DPW
CHKD BY: MRD
F.B.: 840

CLIENT: NTH CONSULTANTS, LTD. 41780 SIX MILE RD NORTHVILLE, MI 48168

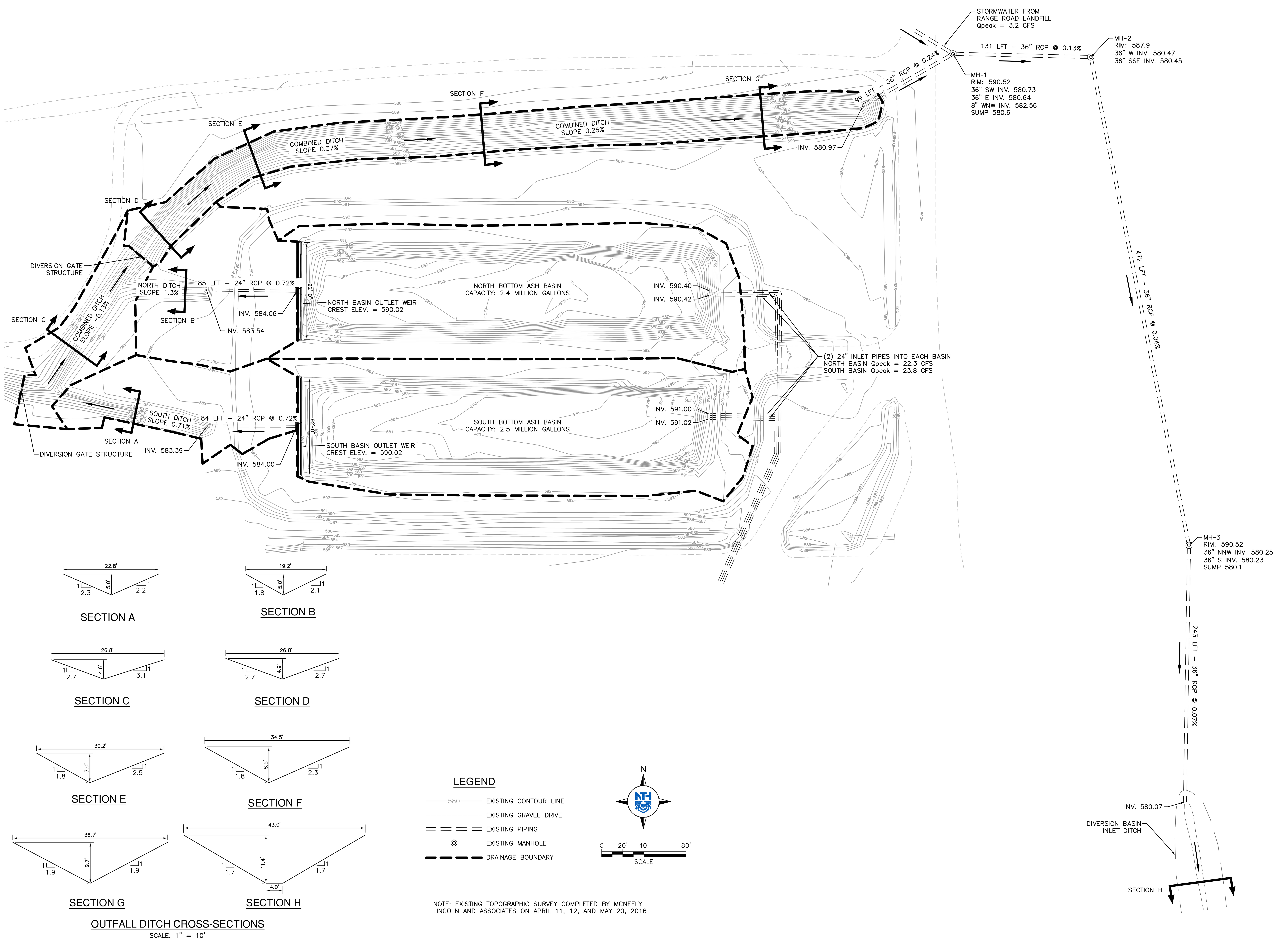
McNEELY & LINCOLN Associates, Inc.
CIVIL ENGINEERING & LAND SURVEYING
PH. (734) 432-9777 FAX (734) 432-9786
37741 PEMBROKE, LIVONIA, MICHIGAN 48152

REV. | REVISIONS

TOPOGRAPHIC SURVEY – ASH BASINS
BELLE RIVER POWER PLANT
SE 1/4 SECTION 13, CHINA TWP.
ST. CLAIR COUNTY, MICHIGAN

1

SCALE: 1"=40'
PROJECT NO.: 8243.01
FILE NAME: 8243.01 TOPO
SHEET 1 OF 1



NOTE: EXISTING TOPOGRAPHIC SURVEY COMPLETED BY MCNEELY LINCOLN AND ASSOCIATES ON APRIL 11, 12, AND MAY 20, 2016

NTH Consultants, Ltd.

Infrastructure Engineering and Environmental Services

Northville, MI	248.553.6300
Detroit, MI	313.237.3900
Lansing, MI	517.484.6900
Grand Rapids, MI	616.451.6270
Cleveland, OH	216.334.4040

SUBMITTAL

REV	DESCRIPTION	DATE	BY

PROJECT NAME:

DTE BELLE RIVER POWER PLANT - BOTTOM ASH BASIN HYDRAULIC ANALYSIS

PROJECT LOCATION:

BELLE RIVER POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

NTH PROJECT NO.: 62-160047	CAD FILE NAME: 160047-BR-SP
DESIGNED BY: SLG	INCEP DATE: 9/7/2016
DRAWN BY: SLG	DRAWING SCALE: 1" = 40'
CHECKED BY: DRL	SUBMITTED DATE: 9/9/2016

SHEET TITLE:

BELLE RIVER POWER PLANT BOTTOM ASH BASIN

EXISTING SYSTEM COMPONENT PLAN

SHEET REFERENCE NUMBER:

3

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

Job DTE Hydro Analysis	Project No. 62-160047	Sheet No. 1
Subject BRPP Weir	By SLG	Date 8/1/16
Capacity Calculation	Checked By KBD	Date 9/21/16

Calculate capacity of weir in BRPP bottom ash ponds

Use broad-crested weir equation

$$Q = C_s b H^{3/2}$$

$C_s = 3.33 \ ft^{0.5}/sec$

$b = 92 \ ft$

$H = 2.5 \ ft$

$$Q = 3.33 \ ft^{0.5}/sec \cdot 92 \ ft \cdot (2.5 \ ft)^{3/2} = \boxed{1{,}211 \ cfs}$$

Height of water at maximum flow rate:

$Q_{max} = 28 \ cfs$

$$Q = C_s b H^{3/2} \rightarrow H = \left(\frac{Q}{C_s b}\right)^{2/3} = \left(\frac{28}{3.33 \cdot 92}\right)^{2/3}$$

$$\boxed{H = 0.2 \ ft}$$

DTE Belle River Power Plant
Drainage Areas
62-160047

Area #	Overland Flow		Channel Flow	Tc (hrs.)	**Tc (min.)**
South Basin Ditch	L (ft)	96			
	S (%)	4.70			
	V (ft/s)	1.04			
	T (hrs)	0.026		0.026	**1.5**
Tc	1.5				
North Basin Ditch	L (ft)	174.00			
	S (%)	3.90			
	V (ft/s)	0.95			
	T (hrs)	0.051		0.051	**3.1**
Tc	3.1				
South Basin Ditch North	L (ft)	35.00			
	S (%)	4.10			
	V (ft/s)	0.97			
	T (hrs)	0.010		0.010	**0.6**
Tc	0.6				
Combined Ditch	L (ft)	23.00			
	S (%)	2.40			
	V (ft/s)	0.74			
	T (hrs)	0.009		0.009	**0.5**
Tc	0.5				
South Basin	L (ft)	35.00			
	S (%)	1.50			
	V (ft/s)	0.59			
	T (hrs)	0.017		0.017	**1.0**
Tc	1.0				
North Basin	L (ft)	86.00			
	S (%)	4.00			
	V (ft/s)	0.96			
	T (hrs)	0.025		0.025	**1.5**
Tc	1.5				

L = distance in feet
S = slope in %
T = time of travel in hours = L / (V * 3600)
V=0.48*sqrt(S)-Sheet Flow<300'
V=2.1*sqrt(S)-Channel Flow

```
Autodesk® Storm and Sanitary Analysis 2016 - Version 11.1.55 (Build 1)
------------------------------------------------------------------------------------------

*******************
Project Description
*******************
File Name ................ Belle River-EX.SPF


****************
Analysis Options
****************
Flow Units ............... cfs
Subbasin Hydrograph Method. Rational
Time of Concentration...... SCS TR-55
Return Period............. 100 years
Link Routing Method ....... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date ............ JUL-08-2016 00:00:00
Ending Date .............. JUL-08-2016 02:00:00
Report Time Step ......... 00:00:10


*************
Element Count
*************
Number of subbasins ....... 8
Number of nodes ........... 17
Number of links ........... 16


****************
Subbasin Summary
****************
Subbasin                Total
                         Area
ID                        ft²
------------------------------
Sub-01               14535.91
Sub-02               18812.27
Sub-03               10255.64
Sub-04                7087.49
Sub-05               53922.71
Sub-06               53523.35
Sub-07                4052.46
```

Sub-08 16326.13

****
Node Summary
****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
Ditch-to-Pipe	JUNCTION	580.37	590.07	0.00	
Jun-1	JUNCTION	582.28	589.28	4525.90	
Jun-2	JUNCTION	581.86	590.36	685.30	
Jun-3	JUNCTION	580.90	590.60	0.00	
MH-1	JUNCTION	580.60	590.52	0.00	Yes
MH-2	JUNCTION	580.40	587.90	0.00	
MH-3	JUNCTION	580.10	590.52	0.00	
North-Box-Structure	JUNCTION	582.79	597.62	0.00	
North-to-Comb-Ditch	JUNCTION	582.48	587.48	17403.30	
Pipe-to-Ditch-North	JUNCTION	583.54	588.54	0.00	
Pipe-to-Ditch-South	JUNCTION	583.39	588.39	0.00	
Pipe-to-Diversion-Ditch	JUNCTION	580.07	591.47	0.00	
South-Box-Structure	JUNCTION	582.81	597.27	0.00	
South-to-Comb-Ditch	JUNCTION	582.33	587.33	11105.70	
Out-01	OUTFALL	578.58	589.98	0.00	
North-Basin	STORAGE	577.69	592.05	0.00	Yes
South-Basin	STORAGE	578.07	591.95	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
36-in-Pipe-1	Ditch-to-Pipe	MH-1	CONDUIT	98.7	0.2433	0.0150
36-in-Pipe-2	MH-1	MH-2	CONDUIT	130.5	0.1303	0.0150
36-in-Pipe-3	MH-2	MH-3	CONDUIT	471.9	0.0424	0.0130
36-in-Pipe-4	MH-3	Pipe-to-Diversion-Ditch	CONDUIT	243.2	0.0658	0.0130
Comb-Ditch-1	North-to-Comb-Ditch	South-to-Comb-Ditch	CHANNEL	117.4	0.1277	0.0320
Comb-Ditch-2	North-to-Comb-Ditch	Jun-1	CHANNEL	35.6	0.5618	0.0320
Comb-Ditch-3	Jun-1	Jun-2	CHANNEL	112.6	0.3730	0.0320
Comb-Ditch-4	Jun-2	Jun-3	CHANNEL	451.0	0.2129	0.0320
Comb-Ditch-5	Jun-3	Ditch-to-Pipe	CHANNEL	169.1	0.3135	0.0320
Diversion-Pond-Ditch	Pipe-to-Diversion-Ditch	Out-01	CHANNEL	103.7	1.4364	0.0320
North-24-in	North-Box-Structure	Pipe-to-Ditch-North	CONDUIT	85.3	0.6097	0.0130

```
North-Ditch      Pipe-to-Ditch-NorthNorth-to-Comb-DitchCHANNEL      81.8    1.2952     0.0320
South-24-in      South-Box-StructurePipe-to-Ditch-SouthCONDUIT      84.4    0.7231     0.0130
South-Ditch      Pipe-to-Ditch-SouthSouth-to-Comb-DitchCHANNEL     150.2    0.7055     0.0320
North-Weir       North-Basin      North-Box-StructureWEIR
South-Weir       South-Basin      South-Box-StructureWEIR
```

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
36-in-Pipe-1	CIRCULAR	3.00	3.00	1	7.07	0.75	28.51
36-in-Pipe-2	CIRCULAR	3.00	3.00	1	7.07	0.75	20.87
36-in-Pipe-3	CIRCULAR	3.00	3.00	1	7.07	0.75	13.73
36-in-Pipe-4	CIRCULAR	3.00	3.00	1	7.07	0.75	17.11
Comb-Ditch-1	TRIANGULAR	4.60	26.80	1	61.64	2.18	171.75
Comb-Ditch-2	TRIANGULAR	4.90	26.80	1	65.66	2.30	398.32
Comb-Ditch-3	TRIANGULAR	7.00	30.20	1	105.70	3.18	647.64
Comb-Ditch-4	TRIANGULAR	8.50	34.50	1	146.63	3.81	766.62
Comb-Ditch-5	TRIANGULAR	9.70	36.70	1	178.00	4.29	1221.51
Diversion-Pond-Ditch	TRAPEZOIDAL	11.40	43.90	1	273.03	5.47	4714.71
North-24-in	CIRCULAR	2.00	2.00	1	3.14	0.50	17.66
North-Ditch	TRIANGULAR	5.00	19.20	1	48.00	2.22	431.35
South-24-in	CIRCULAR	2.00	2.00	1	3.14	0.50	19.24
South-Ditch	TRIANGULAR	5.00	22.80	1	57.00	2.29	386.21

```
**************************        Volume         Depth
Runoff Quantity Continuity       acre-ft        inches
**************************     ---------       -------
Total Precipitation ......         0.489         1.432
Continuity Error (%) .....         0.331

**************************        Volume        Volume
Flow Routing Continuity          acre-ft      Mgallons
**************************     ---------     ---------
External Inflow ..........         8.434         2.748
External Outflow .........         5.567         1.814
Initial Stored Volume ....        34.722        11.315
Final Stored Volume ......        37.863        12.338
Continuity Error (%) .....         0.001
```

Runoff Coefficient Computations Report

Subbasin Sub-01

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
GrassyArea	11106.75	-	0.30
Ditch	3429.07	-	0.90
Composite Area & Weighted Runoff Coeff.	14535.83		0.44

Subbasin Sub-02

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
-	17403.24	-	0.30
-	1408.99	-	0.90
Composite Area & Weighted Runoff Coeff.	18812.22		0.34

Subbasin Sub-03

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
GrassyArea	4525.78	-	0.30
Ditch	5729.77	-	0.90
Composite Area & Weighted Runoff Coeff.	10255.55		0.64

Subbasin Sub-04

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
Ditch	7078.47	-	0.90
Composite Area & Weighted Runoff Coeff.	7078.47		0.90

Subbasin Sub-05

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
DirtRoad	16967.81	-	0.30
Basin	36954.85	-	0.90
Composite Area & Weighted Runoff Coeff.	53922.66		0.71

Subbasin Sub-06

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
DirtRoad	17246.82	-	0.30
Basin	36276.45	-	0.90
Composite Area & Weighted Runoff Coeff.	53523.26		0.71

Subbasin Sub-07

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
-	4052.46	-	0.90
Composite Area & Weighted Runoff Coeff.	4052.46		0.90

Subbasin Sub-08

Soil/Surface Description	Area (ft^2)	Soil Group	Runoff Coeff.
-	16326.13	-	0.90
Composite Area & Weighted Runoff Coeff.	16326.13		0.90

****
SCS TR-55 Time of Concentration Computations Report
****

Sheet Flow Equation

```
Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))
```

```
        Where:

        Tc = Time of Concentration (hrs)
        n  = Manning's Roughness
        Lf = Flow Length (ft)
        P  = 2 yr, 24 hr Rainfall (inches)
        Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation
----------------------------------

        V  = 16.1345 * (Sf^0.5) (unpaved surface)
        V  = 20.3282 * (Sf^0.5) (paved surface)
        V  = 15.0 * (Sf^0.5) (grassed waterway surface)
        V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
        V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
        V  = 7.0 * (Sf^0.5) (short grass pasture surface)
        V  = 5.0 * (Sf^0.5) (woodland surface)
        V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
        Lf = Flow Length (ft)
        V  = Velocity (ft/sec)
        Sf = Slope (ft/ft)

Channel Flow Equation
---------------------

        V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
        R  = Aq / Wp
        Tc = (Lf / V) / (3600 sec/hr)

        Where:

        Tc = Time of Concentration (hrs)
        Lf = Flow Length (ft)
        R  = Hydraulic Radius (ft)
        Aq = Flow Area (ft²)
        Wp = Wetted Perimeter (ft)
        V  = Velocity (ft/sec)
        Sf = Slope (ft/ft)
        n  = Manning's Roughness
```

```
------------------
Subbasin Sub-01
------------------

        User-Defined TOC override (minutes):     1.50

------------------
Subbasin Sub-02
------------------

        User-Defined TOC override (minutes):     3.10

------------------
Subbasin Sub-03
------------------

        User-Defined TOC override (minutes):     0.60

------------------
Subbasin Sub-04
------------------

        User-Defined TOC override (minutes):     0.50

------------------
Subbasin Sub-05
------------------

        User-Defined TOC override (minutes):     1.00

------------------
Subbasin Sub-06
------------------

        User-Defined TOC override (minutes):     1.50

------------------
Subbasin Sub-07
------------------

        User-Defined TOC override (minutes):     0.50

------------------
Subbasin Sub-08
------------------
```

User-Defined TOC override (minutes): 0.50

****
Subbasin Runoff Summary
****

Subbasin ID	Accumulated Precip in	Rainfall Intensity in/hr	Total Runoff in	Peak Runoff cfs	Weighted Runoff Coeff	Time of Concentration days	hh:mm:ss
Sub-01	1.43	5.73	0.63	0.84	0.440	0	00:15:00
Sub-02	1.43	5.73	0.49	0.84	0.340	0	00:15:00
Sub-03	1.43	5.73	0.92	0.86	0.640	0	00:15:00
Sub-04	1.43	5.73	1.29	0.84	0.900	0	00:15:00
Sub-05	1.43	5.73	1.02	5.04	0.710	0	00:15:00
Sub-06	1.43	5.73	1.02	5.00	0.710	0	00:15:00
Sub-07	1.43	5.73	1.29	0.48	0.900	0	00:15:00
Sub-08	1.43	5.73	1.29	1.93	0.900	0	00:15:00

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
Ditch-to-Pipe	6.11	7.66	588.03	0	02:00	0	0	0:00:00
Jun-1	4.48	5.77	588.05	0	02:00	0	0	0:00:00
Jun-2	4.81	6.18	588.04	0	02:00	0	0	0:00:00
Jun-3	5.59	7.13	588.03	0	02:00	0	0	0:00:00
MH-1	5.29	6.63	587.23	0	02:00	0	0	0:00:00
MH-2	4.55	5.64	586.04	0	02:00	0	0	0:00:00
MH-3	3.03	3.60	583.70	0	02:00	0	0	0:00:00
North-Box-Structure	5.70	6.88	589.67	0	02:00	0	0	0:00:00
North-to-Comb-Ditch	4.32	5.58	588.06	0	02:00	3.22	51	0:00:00
Pipe-to-Ditch-North	3.36	4.52	588.06	0	02:00	0	0	0:00:00
Pipe-to-Ditch-South	3.51	4.68	588.07	0	02:00	0	0	0:00:00
Pipe-to-Diversion-Ditch	1.20	1.39	581.46	0	02:00	0	0	0:00:00
South-Box-Structure	5.89	7.08	589.89	0	02:00	0	0	0:00:00

South-to-Comb-Ditch	4.48	5.73	588.06	0	02:00	2.89	59	0:00:00
Out-01	1.12	1.29	579.87	0	02:00	0	0	0:00:00
North-Basin	12.50	12.52	590.21	0	00:20	0	0	0:00:00
South-Basin	12.14	12.16	590.23	0	00:19	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	hh:mm
Ditch-to-Pipe	JUNCTION	0.84	36.73	0	02:00	0.00		
Jun-1	JUNCTION	0.86	49.64	0	00:17	0.00		
Jun-2	JUNCTION	0.48	48.86	0	00:17	0.00		
Jun-3	JUNCTION	1.93	44.27	0	00:15	0.00		
MH-1	JUNCTION	4.97	41.27	0	02:00	0.00		
MH-2	JUNCTION	0.00	41.27	0	02:00	0.00		
MH-3	JUNCTION	0.00	41.27	0	02:00	0.00		
North-Box-Structure	JUNCTION	0.00	25.61	0	00:20	0.00		
North-to-Comb-Ditch	JUNCTION	0.84	50.67	0	00:17	5.83	0	01:10
Pipe-to-Ditch-North	JUNCTION	0.00	25.56	0	00:20	0.00		
Pipe-to-Ditch-South	JUNCTION	0.00	27.16	0	00:20	0.00		
Pipe-to-Diversion-Ditch	JUNCTION	0.00	41.27	0	02:00	0.00		
South-Box-Structure	JUNCTION	0.00	27.20	0	00:19	0.00		
South-to-Comb-Ditch	JUNCTION	0.84	27.02	0	00:18	5.83	0	01:04
Out-01	OUTFALL	0.00	41.26	0	02:00	0.00		
North-Basin	STORAGE	27.29	27.29	0	00:15	0.00		
South-Basin	STORAGE	28.81	28.81	0	00:15	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 ft³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days	hh:mm	Average Ponded Volume 1000 ft³	Average Ponded Volume (%)	Maximum Storage Node Outflow cfs	Maximum Exfiltration Rate cfm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 ft³
North-Basin	780.960	89	0	00:20	779.808	89	25.61	0.00	0:00:00	0.000

South-Basin	752.168	90	0	00:19	751.027	90	27.20	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
Out-01	97.85	34.42	41.26
System	97.85	34.42	41.26

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
36-in-Pipe-1	CONDUIT	0	02:00	5.14	1.00	36.30	28.51	1.27	1.00	106	SURCHARGED
36-in-Pipe-2	CONDUIT	0	02:00	5.84	1.00	41.27	20.87	1.98	1.00	105	SURCHARGED
36-in-Pipe-3	CONDUIT	0	02:00	5.84	1.00	41.27	13.73	3.01	1.00	86	SURCHARGED
36-in-Pipe-4	CONDUIT	0	02:00	7.45	1.00	41.27	17.11	2.41	0.73	0	> CAPACITY
Comb-Ditch-1	CHANNEL	0	00:17	0.99	1.00	25.09	171.75	0.15	1.00	67	FLOODED
Comb-Ditch-2	CHANNEL	0	00:17	2.17	1.00	48.90	398.32	0.12	1.00	56	FLOODED
Comb-Ditch-3	CHANNEL	0	00:17	3.74	1.00	48.44	647.64	0.07	0.85	0	Calculated
Comb-Ditch-4	CHANNEL	0	00:15	2.55	1.00	42.38	766.62	0.06	0.78	0	Calculated
Comb-Ditch-5	CHANNEL	0	02:00	1.67	1.00	36.73	1221.51	0.03	0.76	0	Calculated
Diversion-Pond-Ditch	CHANNEL	0	02:00	4.85	1.00	41.26	4714.71	0.01	0.12	0	Calculated
North-24-in	CONDUIT	0	00:20	8.14	1.00	25.56	17.66	1.45	1.00	102	SURCHARGED
North-Ditch	CHANNEL	0	00:19	3.46	1.00	25.15	431.35	0.06	0.95	0	Calculated
South-24-in	CONDUIT	0	00:20	8.65	1.00	27.16	19.24	1.41	1.00	106	SURCHARGED
South-Ditch	CHANNEL	0	00:18	2.35	1.00	26.37	386.21	0.07	0.97	0	Calculated
North-Weir	WEIR	0	00:20			25.61			0.08		
South-Weir	WEIR	0	00:19			27.20			0.08		

****

```
Highest Flow Instability Indexes
********************************
All links are stable.


WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node North-Box-Structure.
WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node South-Box-Structure.

Analysis began on:  Thu Sep 22 17:13:20 2016
Analysis ended on:  Thu Sep 22 17:13:21 2016
Total elapsed time: 00:00:01
```