Project No. 1668072



November 16, 2017

Marissa M. Carrillo R.M. Schahfer Generating Station Engineer Northern Indiana Public Service Company 2723 E. 1500 N Wheatfield, Indiana 46392

### RE: AMENDMENT TO THE R.M. SCHAHFER GENERATING STATION INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN - HYDRAULIC EVALUATION OF THE WASTE DISPOSAL AREA AUXILIARY SPILLWAY

Dear Ms. Carrillo:

At the request of Northern Indiana Public Service Company (NIPSCO) Golder Associates Inc. (Golder) has prepared this letter to assess the ability of the R.M. Schahfer Generating Station's (RMSGS)'s Waste Disposal Area (WDA) to manage inflow during and following the peak discharge of the inflow design flood. Specifically, NIPSCO has requested that Golder evaluate the hydraulic capacity of the improved WDA auxiliary spillway and recommend an acceptable operational water level within the WDA, based on that evaluation.

## 1.0 BACKGROUND

In April 2015, the United States Environmental protection Agency (EPA) published the Coal Combustion Residuals (CCR) Final Rule (CCR RCRA Rule) to regulate the solid waste management of CCR generated at electric utilities. Pursuant to this rule, NIPSCO retained Golder to provide an Inflow Design Flood Control System Plan compliant with Section 257.82 of the CCR RCRA Rule. In the RMSGS Inflow Design Flood Control System Plan (Golder, 2016) it was identified that the existing auxiliary spillway of the WDA was not sized to manage the flow resulting from the inflow design flood and was, therefore, not compliant with Section 257.73(d)(1)(v) of the CCR RCRA Rule. As such, Golder recommended that NIPSCO reduce the maximum operational water level within the WDA to elevation 675.4 feet above mean sea level (Golder, 2016) to maintain compliance with the CCR RCRA Rule.

In 2017, engineered improvements were made to the WDA auxiliary spillway to increase the hydraulic capacity of the structure (see Attachments 1 and 2) and facilitate an increase to the maximum operational water level within the WDA. These improvements included removal of the former closed-conduit spillway and construction of a concrete open-channel spillway with a concrete down-chute and riprap armoring at the toe of the embankment.

## 2.0 HYDRAULIC ANALYSIS

To determine the adequacy of the improved as-built WDA auxiliary spillway, the maximum hydraulic capacity of the spillway was calculated and compared to the peak inflow associated with the design storm (3,708 cubic feet per second; cfs) presented in the Inflow Design Flood Control System Plan (Golder, 2016). Golder calculated the maximum hydraulic capacity of the improved condition of the WDA auxiliary spillway using Manning's open channel flow equation and the as-built dimensions and elevations provided (Attachment 2). The hydraulic analysis performed by Golder (see Attachment 3) indicates that the improved WDA auxiliary spillway can convey 3,768 cfs.

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Golder Associates Inc. 27200 Haggerty Road, Suite B-12 Farmington Hills, MI 48331-5719 USA Tel: (248) 295-0135 Fax: (248) 295-0133 www.golder.com



## 3.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the hydraulic analysis performed by Golder indicate that the improved WDA auxiliary spillway can adequately convey the peak flow rate associated with the inflow design flood without additional attenuation within the WDA. As such, it is no longer necessary to restrict the operational water level within the WDA to maintain compliance with the CCR RCRA Rule.

We appreciate this opportunity to work with the NIPSCO team on this project. This report is respectfully submitted to NIPSCO for use at the RMSGS. If you have any questions or require additional information, please feel free to call.

### GOLDER ASSOCIATES INC.

Aleven a. Ma Manus

Steven A. McManus Senior Geotechnical Project Engineer

Cc: Mr. Joseph Kutch – NIPSCO Mr. Kevin Sokolowski - NIPSCO

Iffany Johnson

Tiffany D. Johnson, P.E. Associate



### **References:**

Golder Associates Inc. (Golder), 2016. *R.M. Schahfer Generating Station CCR Surface Impoundment Inflow Design Flood Control System Plan.* Submitted to Northern Indiana Public Service Company (NIPSCO). October 2016.

### Attachments:

Attachment 1 - Waste Disposal Area Spillway Improvement Drawings; NIPSCO R.M. Schahfer generating Station. Golder Associates Inc., August 29, 2017.

Attachment 2 - WDA Auxiliary Spillway Improvements As-Built Documentation Provided by NIPSCO.

Attachment 3 – Hydraulic Analysis of the WDA Auxiliary Spillway Improvements

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ATTACHMENT 1 WASTE DISPOSAL AREA SPILLWAY IMPROVEMENT DRAWINGS NIPSCO R.M. SCHAHFER GENERATING STATION GOLDER ASSOCIATES INC., AUGUST 29, 2017

# WASTE DISPOSAL AREA SPILLWAY IMPROVEMENT DRAWINGS

NIPSCO **R.M. SCHAHFER GENERATING STATION** KANKAKEE TOWNSHIP, JASPER COUNTY, INDIANA



WHEATFIELD, INDIANA: REVISED 1992.



INDIANA COUNTIES



JASPER COUNTY

NIPSCO

**PREPARED FOR:** NIPSCO R.M. SCHAHFER **GENERATING STATION** 2723 EAST 1500 NORTH WHEATFIELD, INDIANA 46392



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PREPARED BY: **GOLDER ASSOCIATES INC.** 15851 SOUTH US-27, SUITE 50 **S** LANSING, MICHIGAN 48906

SHEET NO.	REV	FILE NO.	SHEET TITLE	
0	0	1668072B000	TITLE SHEET	
1	0	1668072B001	AUXILIARY SPILLWAY IMPROVEMENT PLAN	
2	0	1668072B002	AUXILIARY SPILLWAY IMPROVEMENT DETAILS 1 OF 2	
3	0	1668072B002	AUXILIARY SPILLWAY IMPROVEMENT DETAILS 2 OF 2	
4	0	1668072B003	AUXILIARY SPILLWAY IMPROVEMENT SPECIFICATIONS	

**AUGUST 2017** 

NOT TO SCALE NOT TO SCALE CLIENT NIPSCO **R.M. SCHAHFER GENERATING STATION** KANKAKEE TOWNSHIP, JASPER COUNTY, INDIANA CONSULTANT Golder Associates Inc. 15851 South US-27, Suite 50 Lansing, Michigan 48906 USA Golder 2017-08-29 ISSUED FOR BID SAM (517) 482-2262 DJC TDJ Associates www.golder.com YYYY-MM-DD DESCRIPTION PREPARED DESIGN REVIEW APPROVED



## INDEX OF SHEETS

## **ISSUED FOR BID**

#### PRO JECT WASTE DISPOSAL AREA AUXILIARY SPILLWAY IMPROVEMENT

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	CONTROL 1668072B000.dwg	CONTROL Rev. 1668072B000.dwg 0	CONTROL Rev. 1 of 5 1668072B000.dwg 0



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SPOT ELEVATIONS

#### REFERENCE

BASE DRAWING ADAPTED FROM "EMBANKMENT ELEVATION SURVEY/ FINAL SETTLING BASIN," CAD FILE 0221-2011.dwg, PROVIDED BY MARBACH, BRADY & WEAVER, INC. ENGINEERING, DATED 12-30-11.

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0 2017-08-29 ISSUED FOR BID	DJC SAM TDJ	CONSULTANT	Golder Associates Inc. 15851 South US-27, Suite 50 Lansing, Michigan 48906 USA (517) 482-2262
Rev. YYYY-MM-DD DESCRIPTION	PREPARED DESIGN REVIEW APPROVED		www.golder.com





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PROJECT №. 1668072	CONTROL 1668072B002.dwg	Rev. 0	4 of 5	SHEET

#### GENERAL NOTES:

- G1. THE CONTRACTOR SHALL VISIT THE SITE TO BECOME FAMILIAR WITH THE SITE'S EXISTING CONDITIONS AND TO DETERMINE OWNER'S REQUIREMENTS FOR ACCESS TO THE SITE AND CONTINUED OPERATION DURING CONSTRUCTION.
- G2. THE CONTRACTOR SHALL PROVIDE ALL NECESSARY TEMPORARY BRACING AND SHORING WHERE REQUIRED DURING CONSTRUCTION.
- G3. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE ERECTION PROCEDURE AND SEQUENCING
- G4. THE CONTRACTOR SHALL SUBMIT SHOP FABRICATION DRAWINGS FOR THE CONCRETE REINFORCING MESH PRIOR TO FABRICATION TO THE ENGINEER OF RECORD FOR REVIEW. ALLOW TWO WEEKS FOR ENGINEER REVIEW.
- G5. SITE LAYOUT TO BE BASED UPON COORDINATES AND DIMENSIONS INDICATED ON CIVIL DRAWINGS.
- G6. THE CONTRACTOR SHALL NOT, UNDER ANY CIRCUMSTANCES, OVER EXCAVATE THE EXISTING SLURRY WALL OR OTHERWISE DISTURB THE SLURRY WALL BELOW THE ELEVATION OF THE PROPOSED SPILLWAY. REPAIRS TO THE SLURRY WALL WILL BE PERFORMED AT THE CONTRACTOR'S EXPENSE

#### GENERAL STRUCTURAL NOTES:

- GS1. THE GENERAL STRUCTURAL NOTES ARE INTENDED TO AUGMENT THE DRAWINGS. SHOULD CONFLICTS EXIST BETWEEN THE DRAWINGS AND THE GENERAL STRUCTURAL NOTES, THE STRICTEST PROVISION SHALL GOVERN.
- GS2. TYPICAL DETAILS AND OTHER DETAILS APPLY TO CONDITIONS WHICH ARE SIMILAR TO THE CONDITIONS DESCRIBED IN THE DETAILS EVEN IF THEY ARE NOT SPECIFICALLY REFERENCED ON THE PLANS.
- GS3. ALL CONSTRUCTION SHALL COMPLY FULLY WITH THE APPLICABLE PROVISIONS OF OSHA AND THE LOCAL GOVERNING CODES, LATEST EDITION, AND ALL REQUIREMENTS SPECIFIED IN THE CODES SHALL BE ADHERED TO AS IF THEY WERE CALLED FOR OR SHOWN ON THE DRAWINGS. THIS SHALL NOT BE CONSTRUED TO MEAN THAT ANY REQUIREMENTS SET FORTH ON THE DRAWING MAY BE MODIFIED BECAUSE THEY ARE MORE STRINGENT THAN THE CODE REQUIREMENTS OR BECAUSE THEY ARE NOT SPECIFICALLY REQUIRED BY CODE.
- GS4. GOVERNING BUILDING CODE 2014 INDIANA BUILDING CODE
- GS5. ALL WORK CONSTRUCTED PER THESE DRAWINGS SHALL BE INSPECTED BY AN INDEPENDENT TESTING AGENCY RETAINED TO ENSURE COMPLIANCE WITH THE REQUIREMENTS SHOWN ON THE DRAWINGS.

#### BACKFILLING AND ROAD REPAIR:

- B1. SOIL USED FOR STRUCTURAL FILL SHALL BE NATURAL SOILS, FREE OF ORGANICS, DEBRIS, FROZEN MATERIAL, AND EXCESSIVE MOISTURE. IT SHALL HAVE A MAXIMUM PARTICLE SIZE OF 0.5 INCHES. GRADE TO MATCH NECESSARY SUBGRADES.
- B2. STRUCTURAL FILL IN THE BACKFILL ENVELOPE FOR THE CULVERTS. WILL BE NO. 30, NO. 4, OR 1/2 IN. (SECTION 904.05 OF THE INDOT SPECIFICATIONS)
- B3. ROAD FILL FOR ROAD REPAIR SHALL BE INDOT NO. 73 AGGREGATE.

#### EROSION PROTECTION AND SEDIMENT CONTROL:

- E1. CONTRACTOR SHALL INSTALL AND MAINTAIN EROSION CONTROL MEASURES, SUCH AS SILT FENCE, AROUND HE DOWNSTREAM LIMITS OF DISTURBANCE.
- E2. CONTRACTOR WILL BE RESPONSIBLE FOR OFF-SITE MIGRATION OF SEDIMENT FROM CONSTRUCTION AREA.

#### RIPRAP AND RIPRAP BEDDING

- R1. CONTRACTOR SHALL INSTALL RIPRAP AND RIPRRAP BEDDING TO THE LINES AND GRADES SHOWN ON THE DRAWINGS AND IN ACCORDANCE WITH THE REQUIREMENTS OF 616.06 of THE INDOT CONSTRUCTION SPECIFICATIONS, MOST RECENT VERSION.
- R2 RIPRAP WILL HAVE A MEDIAN STONE SIZE AS INDICATED ON THE DRAWINGS AND WILL CONFORM TO THE SPECIFICATIONS IN SECTIONS 904.03 AND 904.04 OF THE INDOT CONSTRUCTION SPECIFICATIONS, MOST RECENT VERSION.
- R3. RIPRAP BEDDING WILL CONFORM TO THE SPECIFICATIONS IN SECTION 904.03 OF THE INDOT CONSTRUCTION SPECIFICATIONS, MOST RECENT VERSION. GRADATION OF THE RIPRAP BEDDING WILL MEET THE REQUIREMENTS OF A NUMBER 5 COARSE GRADED AGGREGATE, AS IDENTIFIED IN THE INDOT CONSTRUCTION SPECIFICATIONS, MOST RECENT VERSION.

CONCRETE NOTES:	RESTORATION SPECIF
C1. THE LATEST EDITION OF THE FOLLOWING CODES AND SPECIFICATIONS GOVERN THE DESIGN, DETAILING, FABRICATION, CONSTRUCTION AND REMOVAL (FOR EXISTING CONCRETE) OF ALL REINFORCED CONCRETE.	1. GENERAL - ALL MATERIALS TRANSPORTATION STANDA OTHERWISE IN THESE DRAV
A.) ACI-318 BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.	2. SEEDING SHALL CONFORM
B.) SECTION 907 - 2016 INDOT CONSTRUCTION SPECIFICATION FOR REINFORCED CONCRETE.	
C.) ACI-315 DETAILING REQUIREMENTS FOR CONCRETE REINFORCEMENT.	MATERIALS (621.02)
D.) CRSI "MANUAL OF STANDARD PRACTICE"	FERTILIZER 914
C2. PROPORTION NORMAL - WEIGHT CONCRETE MIXTURE AS FOLLOWS:	GRASS SEED 914
A) MINIMUM 28-DAY COMPRESSIVE STRENGTH AS FOLLOWS:	
REINFORCED CONCRETE WALLS: 4000 PSI SLABS ON GRADE: 4000 PSI	MULCH 914
B.) MAXIMUM WATER-CEMENT RATIO: 0.45	
C.) MAXIMUM SLUMP: 4 INCHES, PLUS OR MINUS 1 INCH	
D.) AIR ENTRAINMENT: ALL CONCRETE EXPOSED TO WEATHER SHALL HAVE AN ENTRAINED AIR CONTENT	CONSTRUCTION REG
0F 5.5% FL03 0K WIIY03 1.5 %.	GROUND PREP
C3. ALL CONCRETE AND REINFORCING STEEL MESH SHALL CONFORM TO THE LATEST EDITION OF SECTION 907 OF THE INDOT CONSTRUCTION SPECIFICATION SPECIFICATION FOR REINFORCED CONCRETE CONSTRUCTION.	W/ ECB
C4. THE CONTRACTOR SHALL SUBMIT A COPY OF THE CONCRETE MIX DESIGN WITH THE APPROPRIATE TEST DATA TO THE ENGINEER OF RECORD FOR APPROVAL PRIOR TO CONCRETE PLACEMENT. ALLOW TWO WEEKS FOR ENGINEER APPROVAL.	APPLY FERTILIZER, SEED, MULCH
C5. PROTECT ALL CONCRETE FROM FREEZING DURING PLACEMENT AND CURING.	
C6. PROVIDE 3/4" CHAMFER STRIP AT ALL EXPOSED CORNERS OF CONCRETE.	
C7. LOCATE ALL SLEEVES, OPENINGS AND EMBEDDED ITEMS, ETC., AS INDICATED ON THE DRAWINGS. THE CONCRETE CONTRACTOR SHALL CHECK WITH OTHER TRADES TO MAKE SURE THE SLEEVES, OPENINGS AND EMBEDDED ITEMS THAT ARE TO BE PROVIDED AND SET BY THEM ARE IN PLACE PRIOR TO PLACING OF CONCRETE IN THE AREA INVOLVED.	SEED MIX
C8. REINFORCEMENT SHALL BE GALVANIZED STEEL WELDED WIRE MESH, CONFORMING TO ASTM SPECIFICATION A1064/1064M-17 WITH A MINIMUM YIELD STRENGTH OF 65,000 PSI.	
PIPE GATE NOTES:	
P1. PIPE GATES SHALL BE CONSTRUCTED OF TUBULAR GALVANIZED STEEL, AT LEAST 3" IN DIAMETER WITH END CAPS.	
P2. POSTS SHALL BE AND AT LEAST 4" IN DIAMETER AND SET IN CONCRETE FOOTINGS EXTENDING TO THE DEPTH OF THE LOCAL FROST LINE.	PREPARING DISTURBED AREAS
P3. GATES SHALL BE CONSTRUCTED WITH A HASP TO FACILITATE A PADLOCK.	
P4. EACH GATE SHALL HAVE A SIGN AFFIXED TO IT. THE SIGN SHALL CONFORM TO SECTION 919.01 OF THE INDOT SPECIFICATIONS AND SHALL CONTAIN THE TEXT IDENTIFIED ON THE CONTRACT DRAWINGS.	MEASUREMENT AND PAYMENT

P5 CONTRACTOR SHALL SUBMIT TO THE OWNER FOR APPROVAL A SHOP DRAWING OF THE PROPOSED PIPES GATES

ESTIMATED QUANTITIES FOR WDA SPILLWAY IMPROVEMENTS					
ІТЕМ	QUANTITY	UNIT			
EXISTING CAST-IN-PLACE CONCRETE TO BE REMOVED	480	CF			
EXISTING CMP PIPES TO BE REMOVED	88	LF			
EXCAVATION FOR SPILLWAY CONSTRUCTION	1,300	CY			
SUBGRADE PREPARATION	8,600	SF			
CAST-IN-PLACE REINFORCED CONCRETE	5,900	CF			
RIPRAP BEDDING	170	CY			
RIPRAP	270	CY			
AREA OF ROAD REPAIR	600	SF			
AREA OF DISTURBANCE FOR RESTORATION	2,900	SF			
GATES AND SIGNS	2	EA			

#### CLIENT NIPSCO **R.M. SCHAHFER GENERATING STATION** KANKAKEE TOWNSHIP, JASPER COUNTY, INDIANA

CONSULTANT



Golder Associates Inc. 15851 South US-27, Suite 50 Lansing, Michigan 48906 USA (517) 482-2262 www.golder.com

0	2017-08-29	ISSUED FOR BID	DJC	SAM	TDJ		
Rev.	YYYY-MM-DD	DESCRIPTION	PREPARED	DESIGN	REVIEW	APPROVED	

### ION SPECIFICATIONS:

ALL MATERIALS AND WORK SHALL CONFORM TO 2012 INDIANA DEPARTMENT OF ITATION STANDARD SPECIFICATIONS (INDOT STD SPECS) UNLESS INDICATED E IN THESE DRAWINGS AND CONTRACT DOCUMENTS.

HALL CONFORM TO SECTION 621 OF INDOT STD SPECS.

- 914.03 STANDARD COMMERCIAL FERTILIZER WITH ANALYSIS OF 12-12-12
- ASS SEED 914.04 IN BAGS AND TAGGED, NO NOXIOUS SEED, AND FROM SOURCES OF SUPPLY THAT HAVE BEEN SAMPLED, TESTED AND REPORTED BY THE STATE SEED COMMISSIONER AND FOUND TO BE SATISFACTORY.
  - 914.05 TYPE 5-STRAW MAT 90% STRAW (WITH UP TO 30% COCONUT FIBERS IN PLACE OF STRAW), 1/2 INCH THICK ±1/8 INCH, TOP SIDE WITH BIODEGRADABLE PLASTIC NETTING WET KNITTED TO THE STRAW, AND NOT LESS THAN 0.7 lbs./SQYD DRY WEIGHT.

#### RUCTION REQUIREMENTS

- 621.03 LOOSEN SOIL TO 3 INCH DEPTH
- 621.04 REMOVE ALL ROCKS AND CLODS OVER 1 1/2 INCHES IN DIAMETER. REMOVE ALL STICKS AND DEBRIS THAT INHIBITS CLOSE CONTACT OF THE EROSION CONTROL BLANKET (ECB) AND THE SEED BED
- 621.05 SPREAD FERTILIZER UNIFORMLY AT A RATE OF 800 lbs/ac. SEED WITH WATER, DRILL OR OTHER OWNER APPROVED MECHANICAL METHOD. COVER SEED NO MORE THAT 1/8 INCH. MULCH WITH STRAW MAT WITHIN 24 HOURS OF SEEDING. STAPLE MAT IN PLACE WITH NETTING ON TOP AND MAT IN SNUG UNIFORM CONTACT WITH THE SOIL. AND MWAT IN STORE OF A DEAL AND A RECOMMENDATIONS
- 621.06 SEED MIXTURES
  - (g) SEED MIXTURE GRASS <u>1. TYPE 1</u> APPLY AT A TOTAL RATE OF 195 lbs/ac CONSISTING OF: (a) SEED MIX R CONSISTING OF: 95 lbs/ac low endophyte Kentucky 31 Fescue 65 lbs/ac perennial ryegrass 10 lbs/ac Jasper Red Fescue
- 621.11 SMOOTH, LOOSEN, PREPARE FERTILIZE AND SEED ALL DISTURBED AREAS IN ACCORDANCE WITH ALL OF THESE REQUIREMENTS ABOVE.
- SUREMENT AND MEASUREMENT OF COMPLETE IN PLACE REPAIR TYPE T1-REVEGETATION WILL BE BY THE SQUARE YARD. PAYMENT WILL BE BASED ON THE SQUARE YARD AND WILL BE A LENGTH AND WIDTH FIELD MEASUREMENT BY ROLL-ATAPE, TAPE MEASURE OR OTHER METHOD MADE BY THE OWNER.
  - THE CONTRACTOR WILL BE INVITED TO OBSERVE OWNER'S REPRESENTATIVE MEASURING OF TYPE T1 REVEGETATION. NO ALLOWANCE FOR OVERLAP, WASTE, OR OTHER FACTORS WILL BE MADE

## **ISSUED FOR BID**

#### PRO IECT WASTE DISPOSAL AREA AUXILIARY SPILLWAY IMPROVEMENT

#### TITLE AUXILIARY SPILLWAY IMPROVEMENT SPECIFICATIONS

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## ATTACHMENT 2 WDA AUXILIARY SPILLWAY IMPROVEMENTS AS-BUILT DOCUMENTATION PROVIDED BY NIPSCO



October 26, 2017

Ms. Marissa Carrillo - NIPSCO

Re: RMSGS Waste Disposal Area Auxiliary Spillway

Ms. Carrillo,

Superior Construction completed work on the Waste Disposal Area Auxiliary Spillway on October 20, 2017. All work was performed in accordance with the drawings provided by Golder Associates. Attached is as-built data that reflects the required top of spillway elevation of 677.50

If you have any questions, please do not hesitate to ask.

Thank you,

Palert 9 Pany

Bob Ryan, Project Manager Superior Construction









\*\* Indicates dimensions measured using the drawing scale



ATTACHMENT 3 HYDRAULIC ANALYSIS OF THE WDA AUXILIARY SPILLWAY IMPROVEMENTS



## CALCULATIONS

Date:	16-Nov-17	Made by:	Steven McManus			
Project No.:	1668072 Hydraulic Analysis of the WDA Auxiliary	Checked by:	Samantha Fentress			
Subject:	Spillway Improvements	Reviewed by:	Tiffany Johnson			
Project Short Title:	R.M Schahfer Generating Station Waste Disposal Area Spillway Improvements					

## **1.0 OBJECTIVE**

The objective of this calculation brief is to assess the adequacy of the R.M. Schahfer Generating Station (RMSGS) Waste Disposal Area (WDA) auxiliary spillway, as improved during 2017.

## 2.0 ASSUMPTIONS

As specified in the final rule on coal combustion residuals (CCR) generated by electric utilities (40 CFR 257.73 and 257.82), the WDA must be capable of adequately managing "...flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood..."

As specified in 40 CFR 257.82.(a)(3), the inflow design flood for the WDA is the probable maximum flood.

As noted in the RMSGS CCR Surface Impoundment Inflow Design Flood Control System Plan (Golder, 2016; Reference 1), the condition of the WDA auxiliary spillway at that time was not adequate to control the peak discharge (3,708 cubic feet per second; cfs) resulting from the inflow design flood.

The WDA auxiliary spillway was improved in 2017 in accordance with the design drawings (Golder, 2017; Attachment 1) and the as-built documentation provided to Golder by Northern Indiana Public Service Company (NIPSCO; Attachment 2).

A minimum of 0.5 feet (ft) of freeboard is required to safely operate the impoundment during the design storm event to prevent dam overtopping by wave action.

The lowest point of the embankment crest is at elevation 680.0 ft above mean sea level (amsl), per the most recent survey by Marbach, Brady, and Weaver, Inc. (Attachment 3.1).

## 3.0 METHODS

Using Manning's open channel flow equation, calculate the maximum flowrate through the improved auxiliary spillway while maintaining the specified minimum freeboard between the maximum water surface and the lowest point of the embankment crest.



## CALCULATIONS

Date:	16-Nov-17	Made by:	Steven McManus
Project No.:	1668072	Checked by:	Samantha Fentress
Subject:	Hydraulic Analysis of the WDA Auxiliary Spillway Improvements	Reviewed by:	Tiffany Johnson
Project Short Title:	R.M Schahfer Generating Station Waste Dis	posal Area Spillway I	Improvements

## 4.0 CALCULATIONS

Manning's Open Channel Flow Equation:

 $V = \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$ 

Reference 2

Flow rate equation:

Q = V \* A

Reference 2

Where:

Q = flow rate (cubic feet per second; cfs)

V = average flow velocity (feet/second; ft/sec)

n = Manning's coefficient

 $R = hydraulic radius (ft) = A/P_w$ 

S = longitudinal channel slope (ft/ft)

A = cross-sectional area of flow (square feet;  $ft^2$ )

 $P_w$  = wetted perimeter (ft)

W = channel bottom width (ft)

Y = depth of flow (ft)

Z = slope of channel sides (ZH:1V)

The wetted perimeter is the length of wetted surface for a given cross-section (Reference 2).

680.0	ft	minimum embankment crest elevation
677.5	ft	spillway invert elevation
0.5	ft	required height of freeboard
46.0	ft	spillway channel bottom width, W
0.030	ft/ft	minimum longitudinal slope of the spillway, S
5.7	ZH:1V	slope of left slope of spillway
5.5	ZH:1V	slope of right slope of spillway

3,768	cfs	flow rate
32.9	ft/sec	average flow velocity, V
0.011		Mannings coefficient of smooth concrete, n (Reference 2)
1.66	ft	hydraulic radius, R
114.4	ft <sup>2</sup>	cross-sectional area of flow, A
68.72	ft	wetted perimeter, P <sub>w</sub>
2.0	ft	maximum depth of flow, Y



## CALCULATIONS

Date:	16-Nov-17	Made by:	Steven McManus
Project No.:	1668072 Hydraulic Analysis of the WDA Auxiliary	Checked by:	Samantha Fentress
Subject:	Spillway Improvements	Reviewed by:	Tiffany Johnson
Project Short Title:	R.M Schahfer Generating Station Waste Disposal Area Spillway Improvements		

## **5.0 CONCLUSIONS**

The as-built condition of the improved WDA auxiliary spillway can pass a flow rate of 3,768 cfs while maintaining 0.5 ft of freeboard. This is adequate to control the peak discharge (3,708 cfs) of the probable maximum flood.

## **6.0 REFERENCES AND ATTACHMENTS**

### **6.1 References**

1. Golder Associates Inc. (Golder), 2016. *R.M. Schahfer Generating Station CCR Surface Impoundment Inflow Design Flood Control System Plan*. October, 2016.

2. Chow, Ven Te, 1959. Open-Channel Hydraulics. McGraw-Hill Publishing Company, New York.

### **6.2 Attachments**

Attachment 3.1 - Embankment Elevation Survey Waste Disposal Area and Recycle Pond; NIPSCO Schahfer Generating Station. Marbach, brady, and Weaver, Inc., December 30, 2011.

ATTACHMENT 3.1 EMBANKMENT ELEVATION SURVEY WASTE DISPOSAL AREA AND RECYCLE POND NIPSCO SCHAHFER GENERATING STATION MARBACH, BRADY, AND WEAVER, INC., DECEMBER 30, 2011



DRAWN BY HDB ©2011 Marbach, Brady & Weaver, Inc. SHEET 3 OF 3 A-31565

## **NIPSCO Schahfer Generating Station**

Station	Elevation
10+00	681.9
10+50	682.1
11+00	682.1
11+50	682.1
12+00	682.1
12+50	682.2
13+00	682.3
13+50	682.3
14+00	682.1
14+50	681.3
15+00	680.3
15+50	680.1
16+00	680.3
16+50	680.5
17+00	680.5
17+50	680.6
18+00	680.5
18+50	680.4
19+00	680.4
19+50	680.5
20+00	680.5
20+50	680.5
21+00	680.5
21+50	680.6
22+00	680.5
22+50	680.4
23+00	680.3
23+50	680.3
24+00	680.3
24+50	680.4
25+00	680.4
25+50	680.4
26+00	680.5
26+50	680.5
27+00	680.5
27+50	680.4
28+00	680.4
28+50	680.4
20+00	680.5
20+00	680.6
20+00	680.6
30+00	680 5
31±00	680.0
31-50	680.4
32-00	680 5
22+00	000.0 600 E
32+30	0.000

Station	Elevation
33+00	680.5
33+50	680.4
34+00	680.4
34+50	680.4
35+00	680.4
35+50	680.5
36+00	680.6
36+50	680.7
37+00	680.7
37+50	680.7
38+00	680.6
38+50	680.4
39+00	680.3
39+50	680.2
40+00	680.3
40+50	680.3
41+00	680.3
41+50	680.3
42+00	680.4
42+50	680.4
43+00	680.5
43+50	680.5
44+00	680.5
44+50	680.7
45+00	680.8
45+50	680.8
46+00	680.7
46+50	680.8
47+00	680.9
47+50	680.8
48+00	680.8
48+50	680.8
49+00	680.7
49+50	680.7
50+00	680.6
50+50	680.3
51+00	680.7
51+50	680.7
52+00	680.8
52+50	680.6
53+00	680.5
53+50	680.5
54+00	680.6
54+50	680.4
55+00	680.3
55+50	680.6

Station	Elevation
56+00	680.7
56+50	680.7
57+00	680.5
57+50	680.5
58+00	680.5
58+50	680.6
59+00	680.5
59+50	680.3
60+00	680.2
60+50	680.3
61+00	680.3
61+50	680.4
62+00	680.5
62+50	680.4
63+00	680.3
63+50	680.5
64+00	680.5
64+50	680.5
65±00	680.5
65+50	680.5
66±00	680.5
66+50	680.4
67:00	680.4
67+50	690.4
68,00	680.0
69.50	680.0
00+00	680.0
69+00	080.0
70+00	080.0
70+00	680.3
70+46.80	680.5
71+85.32	680.8
72+00	680.7
72+50	680.5
72+62.39	680.5
73+00	680.3
/3+08.42	680.3
73+50	680.5
74+00	680.7
/4+50	680.6
75+00	680.8
75+50	680.8
76+00	680.8
76+50	680.6
77+00	680.6
77+50	680.4
78+00	680.5

Station	Elevation
78+50	680.2
79+00	680.5
79+50	680.8