



HAZARD POTENTIAL CLASSIFICATION
ASSESSMENT REPORT

D.E. KARN GENERATING FACILITY

KARN LINED IMPOUNDMENT HAZARD POTENTIAL CLASSIFICATION ASSESSMENT REPORT

Essexville, Michigan

Pursuant to 40 CFR 257.74

Submitted To: Consumers Energy Company
1945 W. Parnall Road
Jackson, MI 49201

Prepared By: Golder Associates Inc.
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Lansing, Michigan 48906

June 2018

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CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.74(a)(2)(ii)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.74 (40 CFR Part 257.74), I attest that this Hazard Potential Classification Assessment Report is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.74.

Golder Associates Inc.

Signature

June 4, 2018

Date of Report Certification

John D Puls, PE

Name

6201055787

Professional Engineer Certification Number

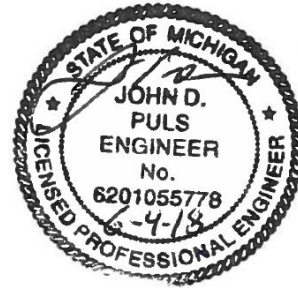




Table of Contents

CERTIFICATION.....	C-1
1.0 INTRODUCTION.....	1
2.0 HAZARD POTENTIAL CLASSIFICATION ASSESSMENT DETERMINATION.....	2
2.1 Dam Break Analysis.....	2
2.1.1 Dam Breach Hydrograph	2
2.1.2 2D Hydraulic Model.....	3
2.2 Dam Break Analysis Results.....	4
2.3 Hazard Classification	5
3.0 CONCLUSIONS AND SUMMARY.....	6
4.0 REFERENCES.....	7

List of Tables

Table 2.1 Dam Embankment and Breach Parameter Summary

List of Figures

Figure 1 Site Location Map
Figure 2.1 Discharge Hydrograph (in text)
Figure 2 Dam Break Maximum Inundation Map (With Downstream Culvert Open)
Figure 3 Dam Break Maximum Inundation Map (With Downstream Culvert Blocked)



1.0 INTRODUCTION

On April 17, 2015, the United States Environmental Protection Agency (EPA) issued the Coal Combustion Residual (CCR) Resource Conservation and Recovery Act (RCRA) Rule (40 CFR 257 Subpart D) (“CCR RCRA Rule”) to regulate the solid waste management of CCR generated at electric utilities. Section 257.74(4)(2) of the CCR RCRA Rule requires the owner or operator of a new CCR surface impoundment to document the hazard potential classification of each CCR unit as either a high hazard potential CCR surface impoundment, a significant hazard potential CCR surface impoundment, or a low hazard potential CCR surface impoundment. Consequently, the owner or operator must document the basis for each hazard potential classification.

Hazard potential classification means the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the diked CCR surface impoundment or mis-operation of the diked CCR surface impoundment or its appurtenances. The hazard potential classifications include high hazard potential CCR surface impoundment, significant hazard potential CCR surface impoundment, and low hazard potential CCR surface impoundment, which terms mean:

- High hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation will probably cause loss of human life.
- Significant hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life; but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.
- Low hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment owner's property.

According to 257.74(a)(2)(ii), the hazard potential classification assessment must be certified by a qualified professional engineer (QPE) stating that an initial hazard potential classification and each subsequent periodic classification was conducted in accordance with the requirements of 40 CFR 257.74. Golder Associates Inc. (Golder) is submitting this Hazard Potential Classification Assessment Report (Report) to certify a low hazard potential classification for the Karn Lined Impoundment CCR surface impoundment at the Consumers Energy Company (CEC) D.E. Karn Generating Facility (DE Karn) near Essexville, Michigan per 40 CFR Part 257.74(a)(2).



2.0 HAZARD POTENTIAL CLASSIFICATION ASSESSMENT DETERMINATION

The Karn Lined Impoundment is a new CCR surface impoundment at DE Karn (Figure 1). The Karn Lined Impoundment is located north of the DE Karn Generating Facility, and is located on the east side of the existing Bottom Ash Pond. Saginaw Bay of Lake Huron is located to the north, west, and east of the Karn Lined Impoundment, approximately 2,000 feet in each direction. The DE Karn Intake Channel is located approximately 900 feet west, and the DE Karn Discharge Channel is approximately 1,400 feet southeast of the Karn Lined Impoundment. Both channels are hydraulically connected to Lake Huron, but it is our understanding that they are not regulated as Waters of the State (WOS) since each of these channels serve as Plant Section 402 internal conveyances regulated under the National Pollutant Discharge Elimination System (NPDES) Permit as wastewater collection, treatment, and discharge conveyances.

2.1 Dam Break Analysis

A dam break analysis was conducted to identify potential hazards. The dam break analysis followed a two-step process. First, the dam breach hydrograph was estimated using empirical methods. Then, the breach hydrograph was routed using a 2D hydraulic model.

2.1.1 Dam Breach Hydrograph

Dam breach parameters, including the volume of material eroded and failure time (from inception to completion of breach), were estimated based on the MacDonald and Langridge-Monopolis (1984) empirical equations as presented in Prediction of Embankment Dam Breach Parameters (Wahl 1998). These parameters are both a function of the storage volume and height of the Karn Lined Impoundment. From these parameters, the final breach dimensions were estimated based on the geometry of the Karn Lined Impoundment and assumed side slope of breach.

Breach hydrographs were developed using level-pool routing techniques in a spreadsheet based on the above estimated breach parameters, a linear breach growth, and stage-storage relationships.

Stage-storage curves were based on the design surface of the top of liner of the Karn Lined Impoundment by Golder Associates Inc. (Golder) as of February 2018. The water levels were set at the inflow design flood level as reported in the Design Report (Golder 2018). Table 2.1 summarizes the basic dimensions and estimated breach parameters of the Karn Lined Impoundment.

Table 2.1: Embankment and Breach Parameter Summary

Parameter	Karn Lined Impoundment
Crest elevation ¹ (ft)	599.5
Water level at dam breach – 100-year storm event (ft)	598.1
Base elevation of breach (ft)	592.0
Height differential between begin water level and bottom of breach level (ft)	6.0



Dam Break Volume (ac-ft)	5.8
Peak discharge (cfs)	178
Breach development time (min)	5

Notes: ¹Elevations are in NAVD88

2.1.2 2D Hydraulic Model

Dam break flood routing was conducted using TUFLOW, a hydraulic model that solves the full 2D shallow water equations. Two models were run. One represents the current conditions, and the second modelled the case of the downstream culvert to the Discharge Channel as shut off or blocked during the event of an embankment failure. The following are components of the hydraulic model:

- **Digital Elevation Model (DEM)** – A DEM for the hydraulic model was created by mosaicking four data sources using ArcGIS with NAVD88 as the vertical datum. The four data sources included:
 - Design surface – An AutoCAD file of the top of liner of the Karn Lined Impoundment by Golder Associates Inc. (Golder) as of January 2018.
 - Site topo – An AutoCAD file of the topographic survey by Engineering and Environmental Solutions, LLC (EES) in June 2016. This file contained details of a berm along the east and north edges of the sub-station.
 - 2013 USACE NCMP Topobathy LiDAR Lake Huron. Downloaded from NOAA Digital Coast Data Access Viewer 8/2016. Bathymetry was estimated and extended down into the discharge canal and lake.
 - 2004 NOAA LiDAR – Saginaw Bay, Lake Huron. Downloaded from NOAA Digital Coast Data Access Viewer 8/2016.
- **2D Grid Extents** – The hydraulic model's 2D grid extends from the Karn Lined Impoundment south extending to the Discharge Channel to the east. At first, the grid had also extended to the Intake Channel to the west, but the grid extents were revised when it was clear that flood waters were not reaching the Intake Channel.
- **Cell Size and Time Step** – The model was run with a cell size of three-feet-by-three-feet and a 0.5 second time step.
- **Manning's n-values** – The entire area was uniformly set to $n = 0.040$.
- **Culverts** – Five culverts were included in the model as 1D elements for the scenario with culverts. The dimensions of the culverts were part of the EES site survey and input into the model. The culverts to the west of the proposed pond are one 9-inch and three 12-inch. The outlet culvert to the Discharge Channel southeast of the pond is 36 inches in diameter.
- **Outlet Boundary Condition** – The outlet boundary condition was set as a constant head of 579.4 feet (NAVD88). This is the recent long-term (1918-2013) mean lake level based on measurements taken by the National Oceanic and Atmospheric Administration (NOAA). The boundary condition is located on the edge of the 2D grid at the Discharge Channel.
- **Inflow Boundary Condition** – The inflow boundary condition is the dam breach hydrograph. It was positioned on the edge of the 2D grid at the southern edge of the impoundment embankment.



2.2 Dam Break Analysis Results

The resulting dam break maximum inundation maps are presented in Figures 2 and 3. Flooding caused by a potential dam break at the Karn Lined Impoundment enters a ditch directly south of the Karn Lined Impoundment. The majority of the flood wave overtops the ditch and spreads south and east through a canal, and discharges to the Discharge Channel through the 36-inch downstream culvert that outlets into the Discharge Channel. Approximately 3.2 acre-feet (peak discharge of 24.9 cfs) of stored water reaches the Discharge Channel.

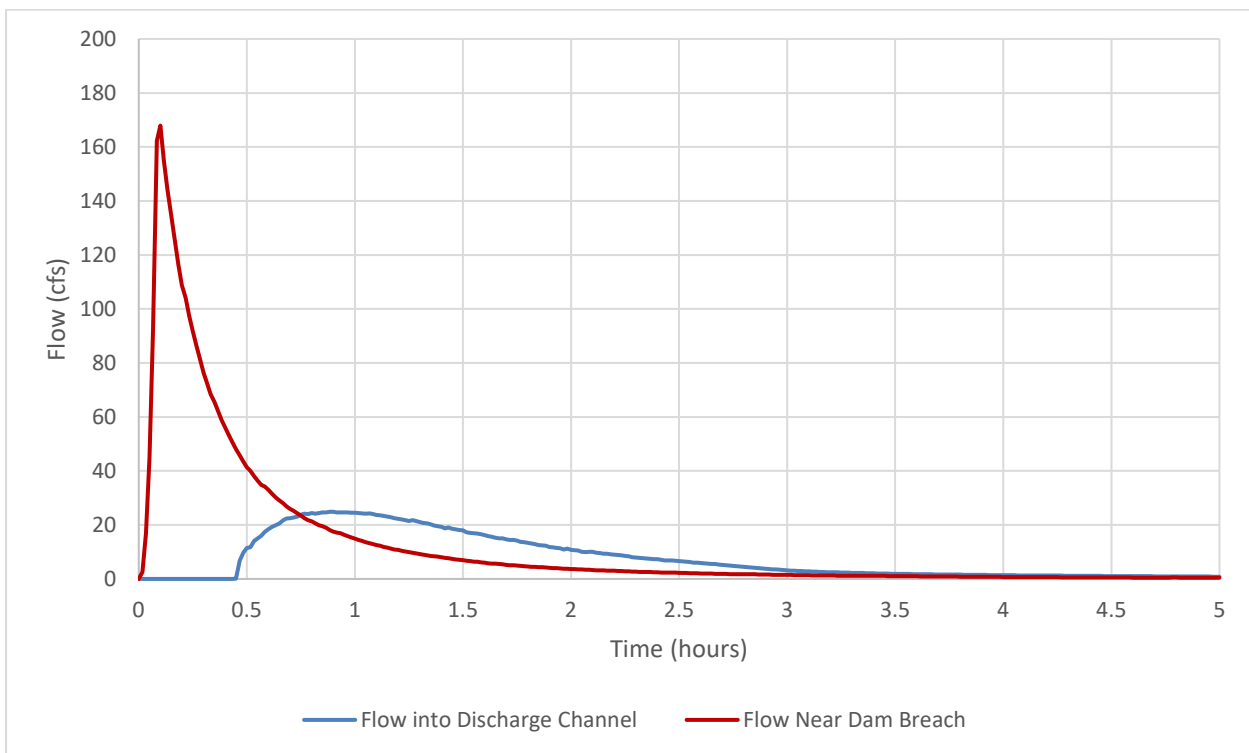


Figure 2.1: Discharge Hydrograph (With Downstream Culvert Open)

Flooding caused by a potential dam break at the Karn Lined Impoundment with the downstream 36-inch culvert blocked enters the ditch directly to the south like the previous run. However floodwater backs up behind the blocked culvert. With the blocked culvert, no water enters the Discharge Channel. The backed up water surface rises to a maximum elevation of 584.8 feet, where the road over the 36-inch culvert holding back the water is elevation 586.5 feet. For this run, the downstream culvert to the Discharge Channel is shut off or blocked during the event of an embankment failure. Options to block or shut off the culvert may include: 1) CEC could maintain an excavator onsite at all times that could place a soil barrier at the inlet of the culvert or a steel sheet in front of the the culvert, or 2) install a shutoff valve at the culvert.



2.3 Hazard Classification

If a release of stored water due to failure or mis-operation were to occur, the dam break analysis predicts that a relatively small volume of water and/or stored content would discharge across part of the DE Karn site and into the Discharge Channel. No probable loss of human life and low economic and/or environmental losses are expected. Any losses are principally limited to the surface impoundment owner's property. As a result, the Karn Lined Impoundment at DE Karn has been rated a low hazard potential classification.



3.0 CONCLUSIONS AND SUMMARY

The Karn Lined Impoundment at DE Karn has been rated a low hazard potential classification, as a dike failure or mis-operation would result in no probable loss of human life and low economic and/or environmental losses. Any losses are principally limited to the surface impoundment owner's property. Furthermore, if a release of stored water due to failure or mis-operation were to occur, the owner could block the downstream culvert to prevent a discharge to the Discharge Channel.

Low hazard potential classification assessments for existing CCR surface impoundments provide the design inflow criterion of the 100-year storm event in the inflow design flood control system and the factor of safety assessment required in 40 CFR 257.82 and 40 CFR 257.74, respectively.

This initial hazard potential classification certification must be placed in the facility's operating record in accordance with 257.105(f) and must be made available on the facility's publicly accessible internet site in accordance with 257.107(f).

Sincerely,

GOLDER ASSOCIATES INC.

Vanessa Nancarrow, PE (WA)
Senior Project Engineer

Scott Stoneman, PE (WA)
Senior Consultant

John Puls, PE
Senior Engineer



4.0 REFERENCES

- Golder Associates Inc. (Golder). 2018. D.E. Karn Bottom Ash Handling System Design Report.
- MacDonald, Thomas C., and Jennifer Langridge-Monopolis. 1984. Breaching Characteristics of Dam Failures. *Journal of Hydraulic Engineering*, vol. 110, no. 5, p. 567-586.
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- USEPA (Environmental Protection Agency). 2015. Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 40 CFR Part 257. Effective Date October 19, 2015.
- Wahl, Tony L. 1998. Prediction of Embankment Dam Breach Parameters – A Literature Review and Needs Assessment. DSO-98-004. US Department of Interior. Bureau of Reclamation, Dam Safety Office.

FIGURES



CLIENT
CONSUMERS ENERGY

PROJECT
KARN LINED IMPOUNDMENT
HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

TITLE
SITE LOCATION MAP

CONSULTANT	YYYY-MM-DD	2018-06-04
	DESIGNED	BVJ
	PREPARED	BVJ
	REVIEWED	VN
	APPROVED	SS

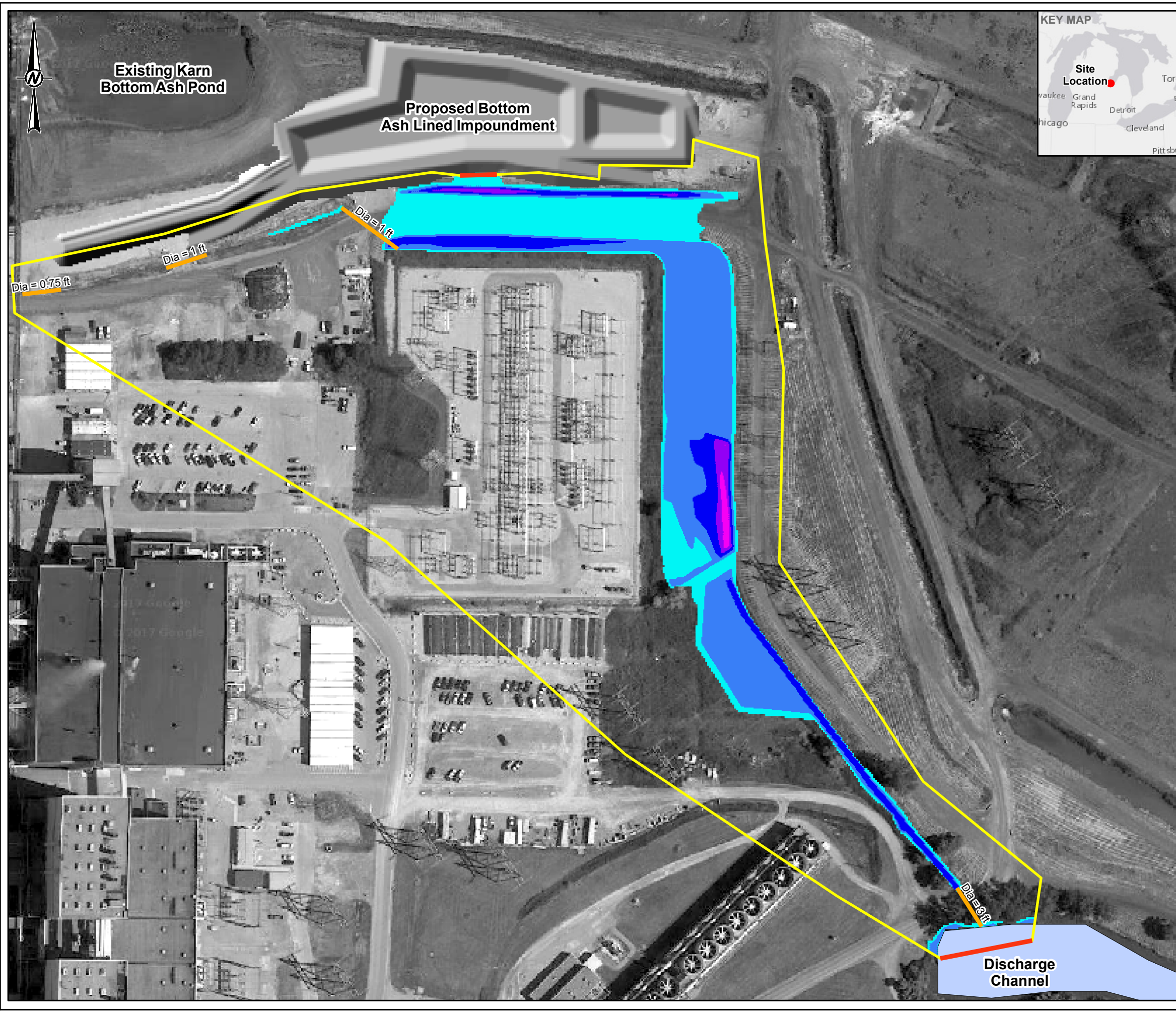


PROJECT NO. 1781451	PHASE 0006	REV. A	FIGURE 1
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REFERENCE(S)

1. GOLDER ASSOCIATES INC. (PROPOSED POND)
 2. COORDINATE SYSTEM: NAD 1983 STATE PLANE MICHIGAN SOUTH (FT)
 3. SERVICE LAYER CREDITS: ESRI, HERE, DELORME, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
- SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AERGRID, IGN, AND THE GIS USER COMMUNITY



- LEGEND**
- Inflow/Outflow Boundary
 - Model Domain
 - Culvert
 - Waterbody (El. 579.4)
- Maximum Flood Depth (ft)**
- 0.00 - 1.00
 - 1.01 - 2.00
 - 2.01 - 3.00
 - 3.01 - 4.00
 - 4.01 - 5.00



NOTE(S)
 1. RESULTS FROM TUFLOW 2D HYDRAULIC MODEL.

- REFERENCE(S)**
1. GOLDR ASSOCIATES INC. (TUFLOW MODEL RESULTS AND PROPOSED POND)
 2. GOOGLE EARTH (BACKGROUND IMAGE)
 3. COORDINATE SYSTEM: NAD 1983 STATE PLANE MICHIGAN SOUTH (FT)
 4. SERVICE LAYER CREDITS: ESRI, HERE, DELORME, MAPMYINDIA, © OPENSTREETMAP

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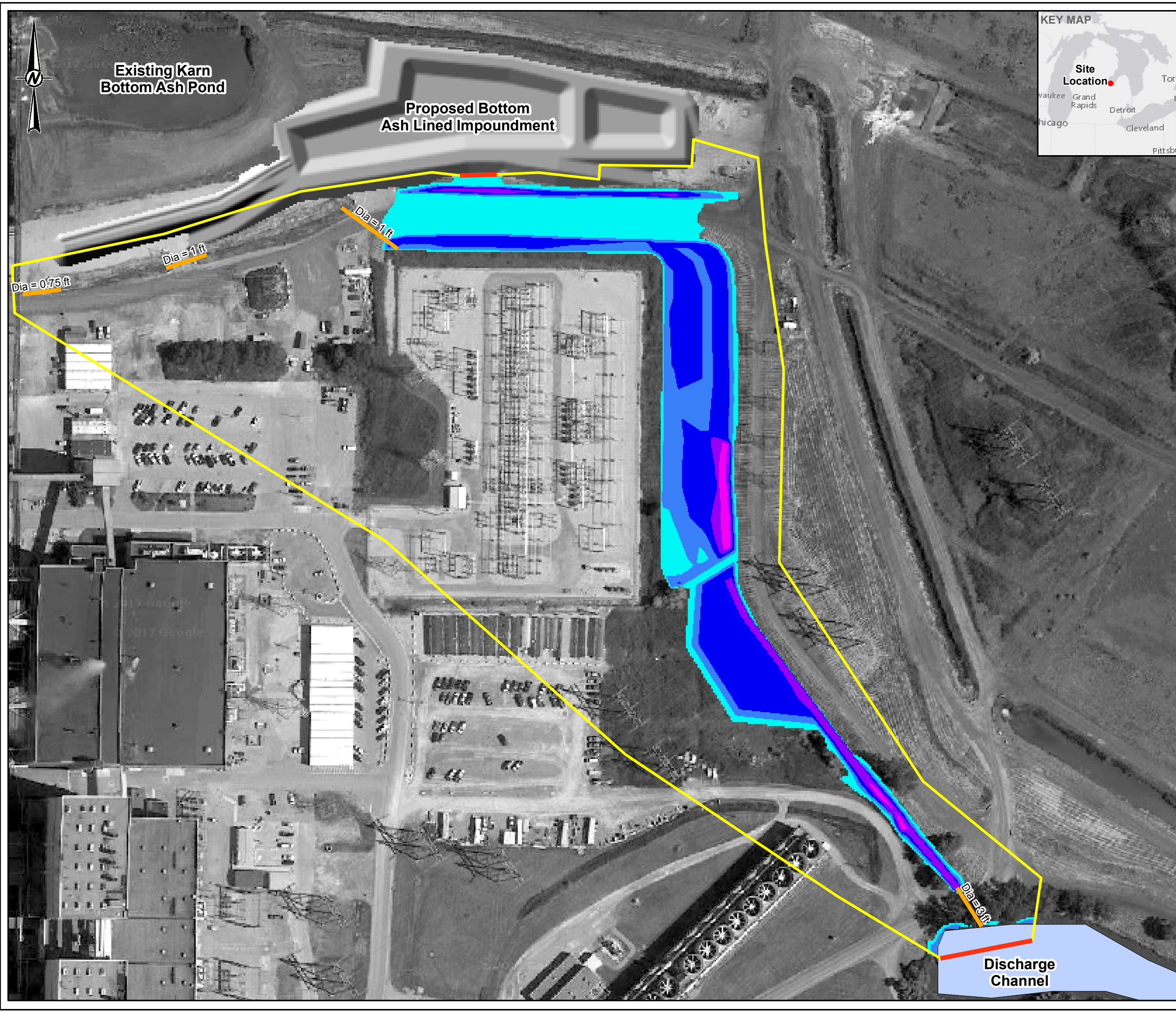
PROJECT
 KARN LINED IMPOUNDMENT
 HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

TITLE
 DAM BREAK MAXIMUM INUNDATION DEPTH
 (WITH CULVERTS OPEN)

CONSULTANT	YYYY-MM-DD	2018-06-04
DESIGNED	VN/BVJ	
PREPARED	BVJ	
REVIEWED	VN	
APPROVED	SS	

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1 in. IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B



LEGEND

- Inflow/Outflow Boundary
- Model Domain
- Culvert
- Waterbody (El. 579.4)

Maximum Flood Depth (ft)

- 0.00 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
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- 4.01 - 5.00



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3. COORDINATE SYSTEM: NAD 1983 STATE PLANE MICHIGAN SOUTH (FT)
4. SERVICE LAYER CREDITS: ESRI, HERE, DELORME, MAPMYINDIA, © OPENSTREETMAP

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PROJECT
KARN LINED IMPOUNDMENT
HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

TITLE
DAM BREAK MAXIMUM INUNDATION DEPTH
(WITH CULVERTS BLOCKED)

CONSULTANT	YYYY-MM-DD	2018-06-04
	DESIGNED	VN/BVJ
	PREPARED	BVJ
	REVIEWED	VN
	APPROVED	SS

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1 in. IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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