



Hazard Potential Classification Assessment Report

D.E. KARN GENERATING FACILITY

BOTTOM ASH POND HAZARD POTENTIAL CLASSIFICATION ASSESSMENT REPORT

Essexville, Michigan

Pursuant to 40 CFR 257.73

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

Prepared By: Golder Associates Inc.
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Lansing, Michigan 48906

October 2016

1655284





CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.73(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 257.73 (40 CFR Part 257.73), 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 257.73.

Golder Associates Inc.



Signature

October 14, 2016
Date of Report Certification

John D Puls, PE
Name

6201055787
Professional Engineer Certification Number

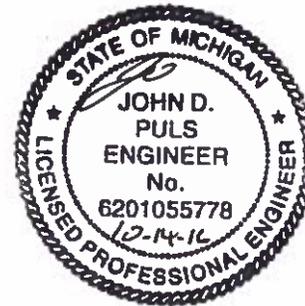




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1.0 INTRODUCTION

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 257.73(a)(2) of the CCR RCRA Rule requires the owner or operator of an existing 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 257.73(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 257.73. Golder Associates Inc. (Golder) is submitting this Hazard Potential Classification Assessment Report (Report) to certify a low hazard potential classification for the Bottom Ash Pond CCR surface impoundment at the Consumers Energy Company (CEC) D.E. Karn Generating Facility (DE Karn) near Essexville, Michigan per 40 CFR Part 257.73(a)(2).



2.0 HAZARD POTENTIAL CLASSIFICATION ASSESSMENT DETERMINATION

The Bottom Ash Pond is an existing CCR surface impoundment at DE Karn (Figure 1). The Bottom Ash Pond is located north of the D.E. Karn Generating Facility. Saginaw Bay of Lake Huron is located to the north, west, and east of the Bottom Ash Pond approximately 2,000 feet in each direction. The DE Karn Intake Channel is located approximately 400 feet west, and the DE Karn Discharge Channel is approximately 600 feet south. Both channels are hydraulically connected to Lake Huron but 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

Two dam break analyses were conducted (assuming downstream culverts were plugged and assuming downstream culverts were open) for the identification of 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 Bottom Ash Pond. From these parameters, the final breach dimensions were estimated based on the geometry of the Bottom Ash Pond 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 a topographic survey by Engineering and Environmental Solutions, LLC (EES) in June 2016. The water levels were set at the inflow design flood level as reported in the D.E. Karn Generating Facility Bottom Ash Pond, Inflow Design Flood Control System Plan (Golder 2016). Table 2.1.1 summarizes the basic dimensions and estimated breach parameters of the Bottom Ash Pond.

**Table 2.1.1 - Dam Embankment and Breach Parameter Summary**

Parameter	Bottom Ash Pond
Crest elevation ¹ (ft)	598.17
Water level at dam breach – 100-year storm event (ft)	593.97
Base elevation of breach (ft)	591.00
Height differential between begin water level and bottom of breach level (ft)	2.44
Dam Break Volume (ac-ft)	2.70
Peak discharge (cfs)	20.1
Breach development time (min)	3.3

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. The following are components of the hydraulic model:

- **Digital Elevation Model (DEM)** – A DEM for the hydraulic model was created by mosaicking three data sources using ArcGIS with NAVD88 as the vertical datum. The three data sources included:
 - Site topo – An AutoCAD file of the Bottom Ash Pond and adjacent area based on a topographic survey by EES in June 2016.
 - 2013 US Army Corps of Engineers (USACE) National Coastal Mapping Program (NCMP) Topobathy LiDAR Lake Huron. Downloaded from National Oceanic and Atmospheric Administration (NOAA) Digital Coast Data Access Viewer, August 2016.
 - 2004 NOAA LiDAR – Saginaw Bay, Lake Huron. Downloaded from NOAA Digital Coast Data Access Viewer, August 2016.
- **2D Grid Extents** – The hydraulic model’s 2D grid extends from the Bottom Ash Pond south extending both to the Intake Channel to the west and Discharge Channel to the east.
- **Cell Size and Time Step** – The model was run with a cell size of five-feet-by-five-feet and a 1.5 second time step.
- **Manning’s n-values** – All other areas were set to $n = 0.040$.
- **Culverts** – Five culverts were included in the model as 1D elements for the scenario with culverts. The dimensions of four of the culverts were part of the EES site survey and input into the model. They were between 9 and 36 inches in diameter. The other culvert west of the Bottom Ash Pond was approximated at 12 inches in diameter.
- **Outlet Boundary Condition** – The outlet boundary condition was set as a constant head of 580 feet (NAVD88). The recent long-term (1918-2013) mean lake level based measurements taken by the NOAA is 579.4 feet (NAVD88). To be conservative, the boundary condition was set at 580.0 feet (NAVD88). The boundary condition is located on the edge of the 2D grid at both the Intake Channel and 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 inundation maps are presented in Figure 2 – Dam Break Inundation Map with Downstream Culverts and Figure 3 – Dam Break Inundation Map with Culverts Plugged. Flooding caused by a potential dam break at the Bottom Ash Pond (with downstream culverts open) enters a ditch directly south of the Bottom Ash Pond. The majority of the flood wave overtops the ditch and spreads south and west. Approximately 0.74 acre-feet (peak discharge of 5.3 cfs) of stored water reaches the Intake Channel. A lesser amount spreads east around the power substation and south into the Discharge Channel. Approximately 0.14 acre-feet (peak discharge of 1.2 cfs) of stored water reaches the Discharge Channel.

Flooding caused by a potential dam break at the Bottom Ash Pond with downstream culverts plugged enters the ditch directly to the south, but quickly overtops it and spreads south and west, entering the Intake Channel. Approximately 1.1 acre-feet (peak discharge of 7.2 cfs) of stored water reaches the Intake Channel.

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 small amount of water and/or stored content would discharge across part of the DE Karn site and either into the Intake Channel or Discharge Channel (dependent on if the culverts are clear or plugged). 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 Bottom Ash Pond surface impoundment at DE Karn has been rated a low hazard potential classification.



3.0 CONCLUSIONS AND SUMMARY

The Bottom Ash Pond 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.

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 257.73, 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.

Handwritten signature of Scott Stoneman in blue ink.

Scott Stoneman, P.E.
Senior Water/Civil Engineer

Handwritten signature of John Puls in blue ink.

John Puls, P.E.
Senior Engineer



4.0 REFERENCES

- Golder Associates. 2016. D.E. Karn Generating Facility Bottom Ash Pond, Inflow Design Flood Control System Plan.
- MacDonald, Thomas C., and Jennifer Langridge-Monopolis. 1984. Breaching Characteristics of Dam Failures. *Journal of Hydraulic Engineering*, vol. 110, no. 5, p. 567-586.
- NOAA (National Oceanic and Atmospheric Administration). 2004. LiDAR – Saginaw Bay, Lake Huron. Downloaded from NOAA Digital Coast Data Access Viewer 8/2016.
- USACE (Army Corps of Engineers). 2013. NCMP Topobathy LiDAR Lake Huron. Downloaded from NOAA Digital Coast Data Access Viewer 8/2016.
- 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



Channel Island

Windy Point

Gull Island

SITE LOCATION

CHESTNUT ST

Saginaw

WEADOCK HWY

JTELL RD

NES RD

TACEY RD

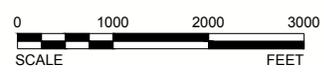


SITE LOCATION

MICHIGAN COUNTIES
NOT TO SCALE

REFERENCE(S)

BASE MAP TAKEN FROM USGS 7.5 MINUTE QUADRANGLE
BAY CITY NE, MICHIGAN
DATED 2014



CLIENT
CONSUMERS ENERGY COMPANY
2742 NORTH WEADOCK HIGHWAY
ESSEXVILLE, MI. 48732

PROJECT
D.E. KARN UNITS #1 AND #2
BOTTOM ASH POND

CONSULTANT	YYYY-MM-DD	2016-08-22
	DESIGNED	MAL
	PREPARED	MAL
	REVIEWED	JRP
	APPROVED	MAB

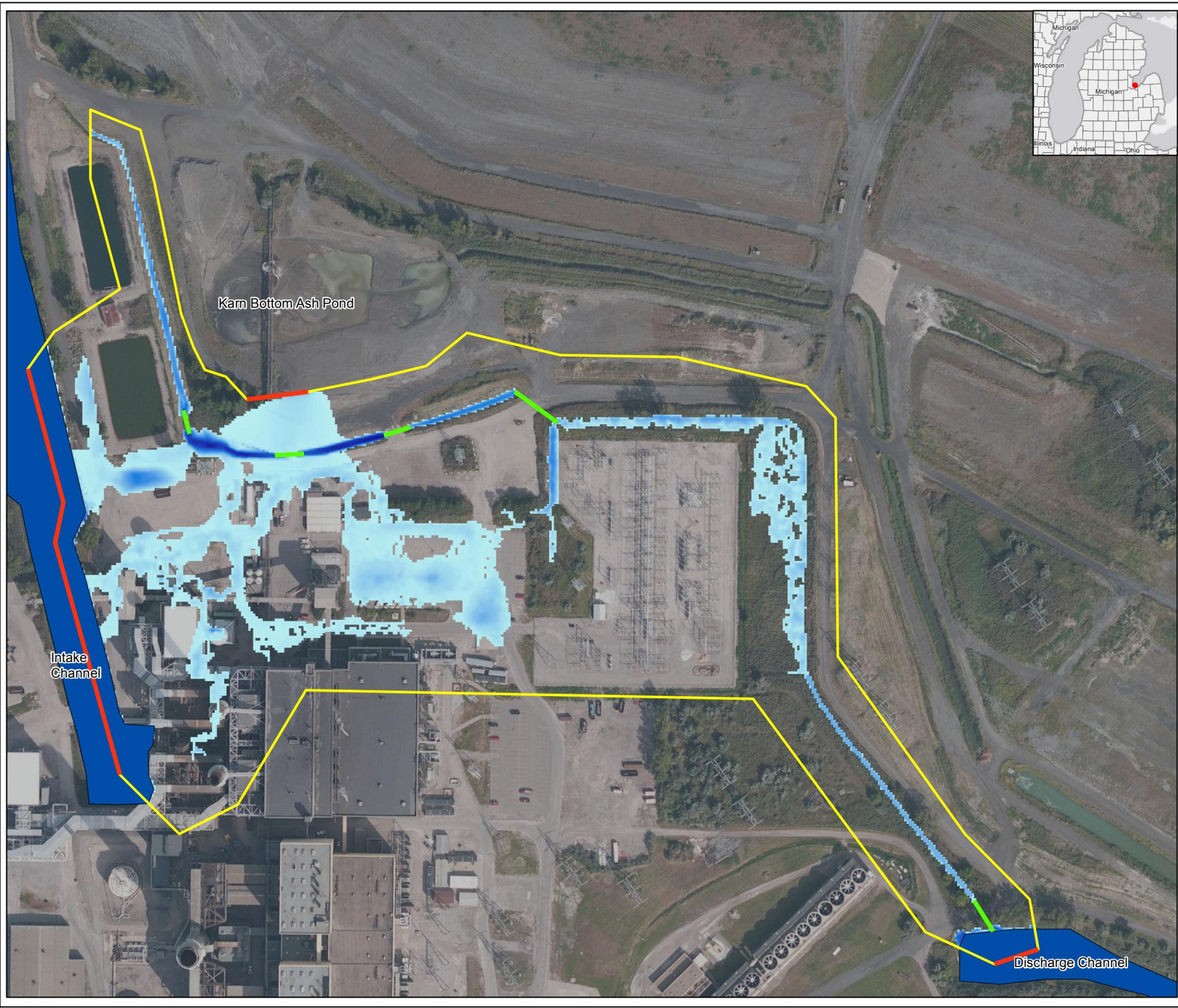


TITLE
SITE LOCATION MAP

PROJECT NO.
1655284

REV.
0

FIGURE
1



LEGEND

- 2D Grid Extents
- Inflow and Outlet Boundaries
- Culvert
- Waterbody (El. 580)

Maximum Inundation Depth (ft)

High : 3

Low : 0



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

REFERENCE(S)

1. SITE TOPO KARN BOTTOM ASH POND BY ENGINEERING AND ENVIRONMENTAL SOLUTIONS (MAY 2016).
2. 2013 USACE NCMPT TOPOBATHY LIDAR LAKE HURON.
3. 2004 NOAA LIDAR - SAGINAW BAY, LAKE HURON.
4. BATHYMETRY IN LAKE HURON AND INTAKE AND DISCHARGE CHANNELS ESTIMATED.

HORIZONTAL DATUM: NAD 1983 STATE PLANE MICHIGAN SOUTH FIPS 2113, FEET
VERTICAL DATUM: NAVD 88

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CONSUMERS ENERGY

PROJECT
**KARN BOTTOM ASH POND
HAZARD POTENTIAL CLASSIFICATION ASSESSMENT
D.E. KARN PLANT**

TITLE
**DAM BREAK INUNDATION MAP
KARN BOTTOM ASH POND (WITH DOWNSTREAM CULVERTS)**

CONSULTANT	YYYY-MM-DD	2016-08-18
DESIGNED	SS	
PREPARED	SS	
REVIEWED	JP	
APPROVED	MW	



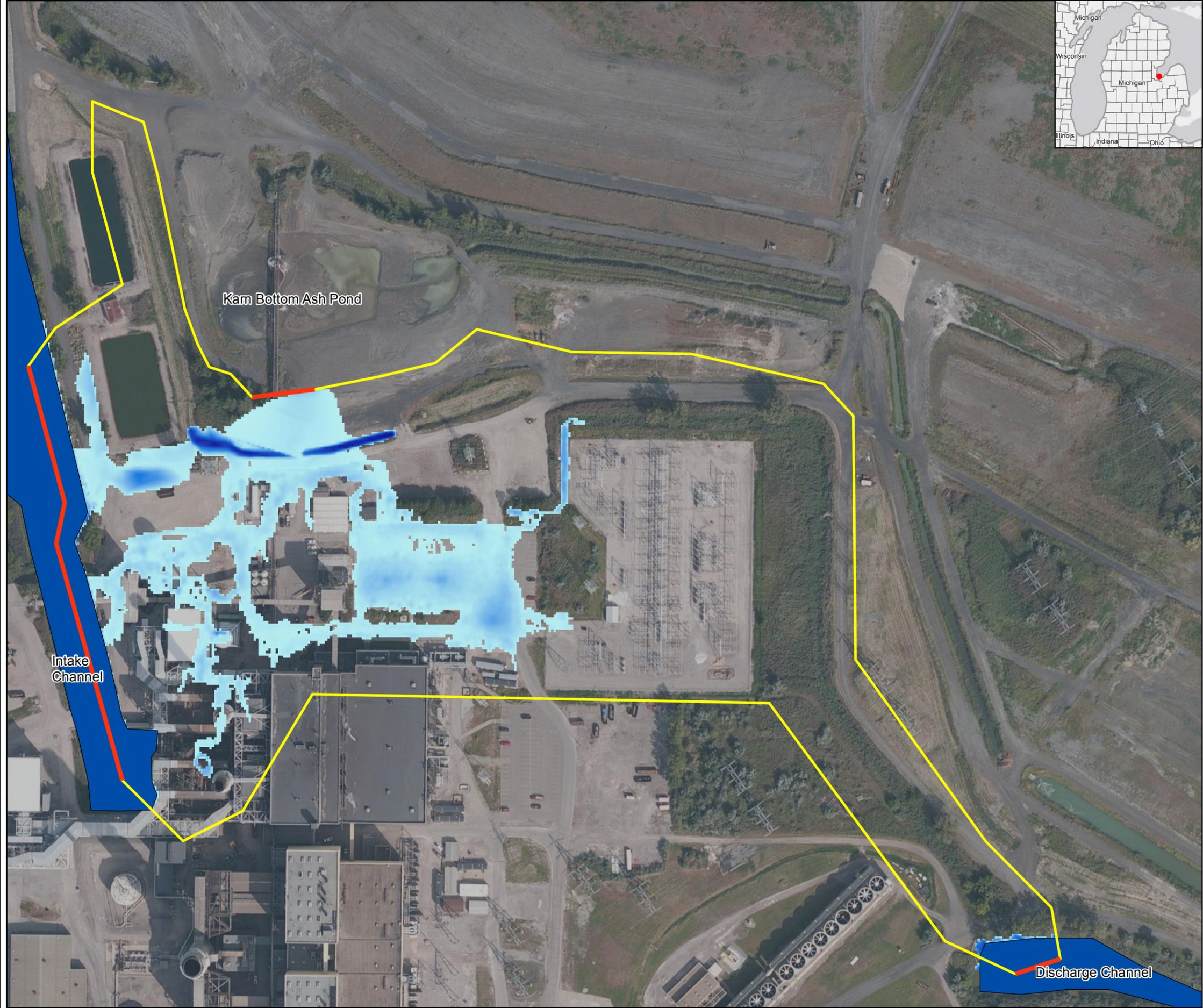
PROJECT NO.
1655284

REV.
B

FIGURE
2

PATH: G:\Consumers_Energy\DE_Karn\09_PROJECTS\1655284_Karn_HazAssess\02_PRODUCTION\XDR\0611655284_FIG_2_DamBreakInundation.mxd

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



LEGEND

- 2D Grid Extents
- Inflow and Outlet Boundaries
- Waterbody (El. 580)

Maximum Inundation Depth (ft)

High : 3

Low : 0



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

- REFERENCE(S)**
1. SITE TOPO KARN BOTTOM ASH POND BY ENGINEERING AND ENVIRONMENTAL SOLUTIONS (MAY 2016).
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HORIZONTAL DATUM: NAD 1983 STATE PLANE MICHIGAN SOUTH FIPS 2113, FEET
VERTICAL DATUM: NAVD 88

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PROJECT
**KARN BOTTOM ASH POND
HAZARD POTENTIAL CLASSIFICATION ASSESSMENT
D.E. KARN PLANT**

TITLE
**DAM BREAK INUNDATION MAP
KARN BOTTOM ASH POND (CULVERTS PLUGGED)**

CONSULTANT	YYYY-MM-DD	2016-08-18
DESIGNED	SS	
PREPARED	SS	
REVIEWED	JP	
APPROVED	MW	



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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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