

**INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN
EAST AND WEST ASH BASINS
WAUKEGAN STATION
OCTOBER 2016**

Pursuant to Code of Federal Regulations Title 40, Part 257, Subpart D (40 CFR), herein referred to as the coal combustion residual (CCR) Rule, Section 257.82(c), Geosyntec Consultants (Geosyntec) prepared this Inflow Design Flood Control System Plan for the East and West Ash Basins (the Basins) at the Waukegan Station (Site) in Waukegan, Illinois. The Basins are owned and operated by Midwest Generation, LLC (Midwest Generation).

Section 257.82(c) of the CCR Rule requires that operators of every existing or new CCR surface impoundment design, construct, operate, and maintain an inflow design flood control system that adequately manages flow into the CCR unit during and following the peak discharge of the inflow design flood. The Preamble to the CCR Rule provides guidance on the documentation that should be provided for the inflow design flood control system plan.

This Inflow Design Flood Control System Plan for the Basins at the Site meets the requirements of §257.82(c). The inflow design flood control systems consist of maintaining minimum operating freeboards for the Basins. Justification and documentation of the adequacy of the inflow design flood control systems are presented in the sections below.

The work presented in this report was performed under the direction of Ms. Jane Soule, P.E., of Geosyntec Consultants, Inc. (Geosyntec) in accordance with §257.82(c). Mr. Robert White reviewed this plan in accordance with Geosyntec's senior review policy.

1. Basin Design

The Basins are located in the southeast portion of the Site (Figure 1). A common dike separates the East Ash Basin from the West Ash Basin. The Basins are operated to receive sluiced CCR and other process water from plant operations. Sluice water is provided by the Sluice Water Head Tank which typically receives makeup water from the Basins. Plant flows are generally directed to one basin (the receiving basin) while dewatering and CCR removal is conducted in the idle basin.

Inflows from plant operations are initiated manually such that each waste stream is discharged in the basin in a batch manner, generally once per shift via concrete inflow channels located along the northwest boundary of the West Ash Basin and the northeast boundary of the East Ash Basin. Outflow from the Basins is controlled through three 7,500-gallon per minute (gpm) pumps within a shared sump and weir wall system located between the East and West Ash Basins along

their northern perimeter (Figure 2). The Basins are operated with a maximum operating level of 600 feet above mean sea level (MSL)¹ for the West Ash Basin and 597.5 feet MSL for the East Ash Basin, maintaining a minimum freeboard of 2 feet. Basin water level measurements are collected using an automated remote sensor system in both Basins that provides notification (through text message) to station operators of an alarm condition. When the Basins are in service, the alarm conditions include:

- water levels within the Basins are within 12 inches of the maximum operating level;
- water levels below the anticipated minimum operating levels; or
- sensors are off line.

If the remote sensor and/or notification system is not functioning, the common sump has the ability to hydraulically connect the Basins to provide additional freeboard for the receiving basin. Effluent is pumped from the sump to the Sluice Water Head Tank for reuse or directed to one of two clarifiers operated in parallel prior to discharge to the intake canal. The Sluice Water Head Tank provides makeup water for ash transport to the Basins. The clarifiers are rated for flows up to 3,000 gpm.

2. Inflow Design Flood Control System Plan Documentation

Because of the relatively small size and design of the East and West Ash Basins, some of the references and drawings recommended for inclusion in the Inflow Design Flood Control System Plan by the Preamble to the CCR Rule (page 21392) are not applicable. Table 1 below provides a summary of this documentation.

¹ Vertical datum is based on North American Vertical Datum of 1988 (NAVD88).

Table 1: Recommended Documentation

Documentation	Assessment
Identification of the design storm event for the catchment area and CCR unit	Identification of the design storm event is provided in Section 4 and Appendix A. A drawing of the Basins and catchment areas is presented in Figure 2.
Characterization of the rainfall abstractions, including but not limited to depression storage and infiltration in the upstream catchment area	Full capture of the design precipitation event was assumed, so rainfall abstractions were assumed to be zero, i.e., 100% of the volume from the design storm was assumed to be held within the Basins. Typical abstractions include mechanisms that reduce run-off such as evaporation and infiltration.
Selection and basis of the appropriate run-off model and run-on or run-off routing model	A run-on model was not required because full capture within the limited catchment areas was assumed. No discharge from the design event is anticipated so a run-off model was not necessary to demonstrate compliance. Outflow is controlled through the pump station and circulated into the Station's flow control system as described in Section 1.
Identification and characterization of any intake or decant structures	Design features are provided in Section 1.
Characterization and capacity of spillways	The Basins do not include spillways. Pump capacities associated with the outflow system are provided in Section 1.
Characterization of downstream hydraulic structures	Process vessels downstream of the Basins are discussed in Section 1.

3. Catchment Areas

The Basins are formed by embankments on the southern, eastern and northern perimeters and a broad area of fill on the western perimeter. A berm is located west of the West Ash Basin which diverts stormwater from areas west of the basins toward the south. Based on site topography shown in Figure 2, the Basins do not receive water from a natural stream and do not receive stormwater flows except for direct precipitation that falls on the embankment crest or within the Basins. The catchment areas for the Basins are shown in Table 2 and on Figure 2.

4. Design Event

Because the Basins are classified as significant hazard potential surface impoundments (Geosyntec, 2016), the inflow design flood is the 1,000 year flood. Because direct precipitation is collected within Basins and run-on is limited to the embankment crest areas, the inflow design is based on the 24-hour, 1,000 year precipitation event of 8.3 inches (NOAA, 2016), see Appendix

A. Total inflow from the design event is calculated as the depth of precipitation multiplied by the catchment area².

5. Freeboard

As discussed in Section 1, the Basins are operated to maintain a minimum of 2 feet of freeboard under normal operating conditions. The maximum potential increase in water levels in the Basins due to the design storm event, assuming basin outflows are limited to process water inflows (net zero), are based on the area-capacity curves for the Basins (see Appendix B) and are presented in Table 2. The volume of inflow water as a result of the 24-hour design event can be managed by the sump pumps and clarifiers in less than one shift. During such an event, the automated remote sensor system and visual inspections allow the plant operations to manage batch discharges while maintaining adequate freeboard.

Table 2: Inflow Design Volumes

Value	East Ash Basin	West Ash Basin
Catchment Area (acres)	11.8	11.0
Design Event Inflow (acre-feet)	8.1	7.6
Increased Basin Water Elevation (feet)	0.87	0.79
Remaining Freeboard (feet)	1.13	1.70

With full containment of the design event, the Basins maintain a minimum freeboard of 1 foot. The inflow design system, as designed and constructed, meets the requirements of 40 CFR §257.82.

6. Plan Amendments and Revisions

In accordance with §257.82(c)(2) and (4), this Inflow Design Flood Control System Plan will be amended or revised whenever there is a change in conditions that would substantially affect the plan or every five years.

² Depression storage or infiltration of stormwater into the embankment crest and other rainfall abstractions are negligible and are not included in inflow volume calculations. Similarly, this calculation does not require the use of a run-on model for the precipitation falling on the embankment crest.

7. Limitations and Certification

This inflow design flood control system plan meets the requirements of §257.82(c) of the Code of Federal Regulations Title 40, Part 257, Subpart D, and was prepared in accordance with current practices and the standard of care exercised by scientists and engineers performing similar tasks in the field of civil engineering. The contents of this report are based solely on the observations of the conditions observed by Geosyntec personnel and information provided to Geosyntec by Midwest Generation. Consistent with applicable professional standards of care, our opinions and recommendations were based in part on data furnished by others, which was consistent with other information that we developed in the course of our performance of the scope of services. The information contained in this report is intended for use solely by Midwest Generation and their subconsultants.



A handwritten signature in blue ink that reads "Jane W. Soule".

Jane W. Soule, P.E.
Illinois Professional Engineer No. 062-067766
License Expires: 11/30/17

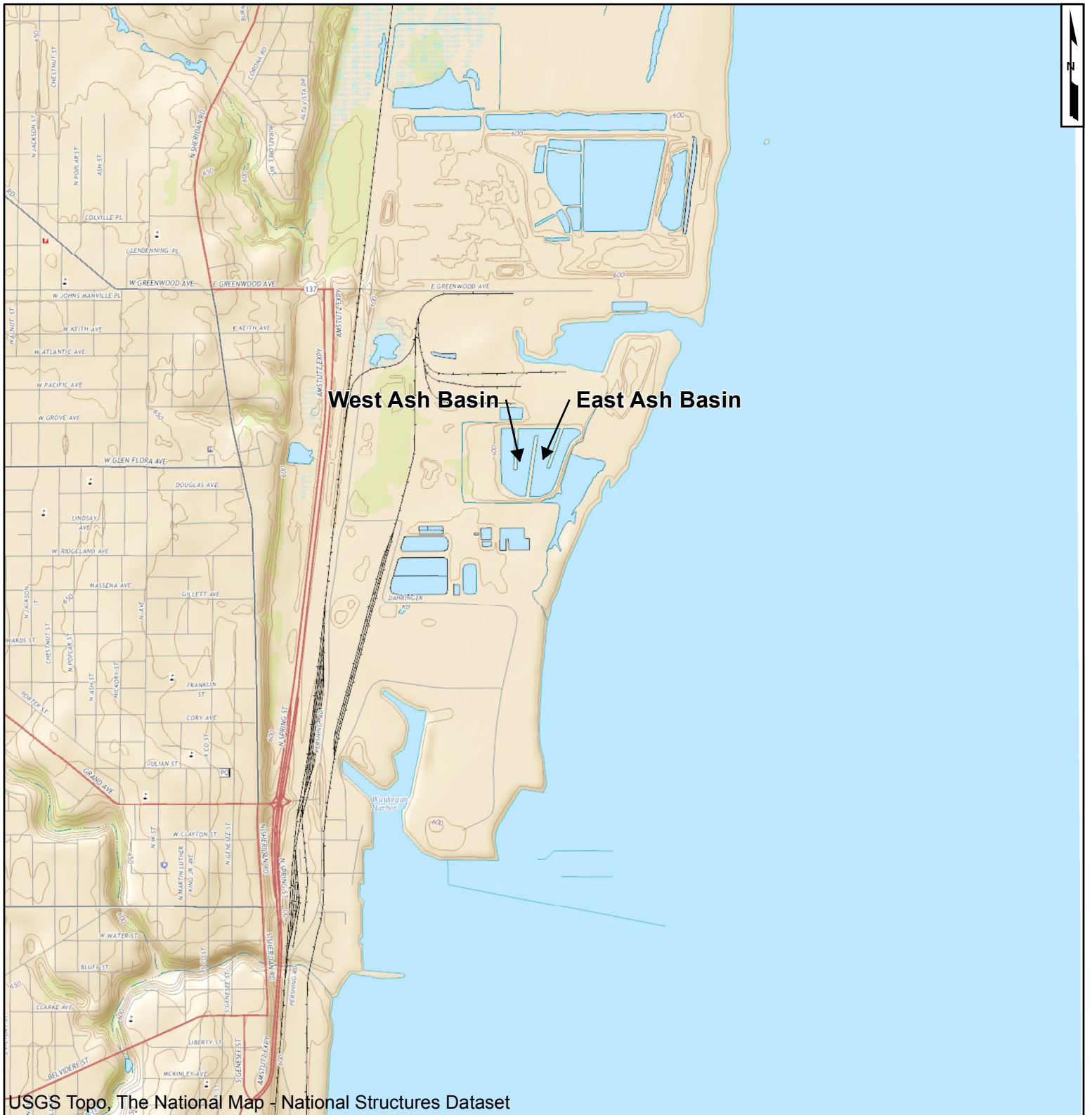
8. References

Geosyntec Consultants, 2016, Hazard Potential Classification Assessment, East and West Ash Basins, Waukegan Station, October 2016.

NOAA, 2016, NOAA Atlas 14 Point Precipitation Frequency Estimates: Illinois, available at: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

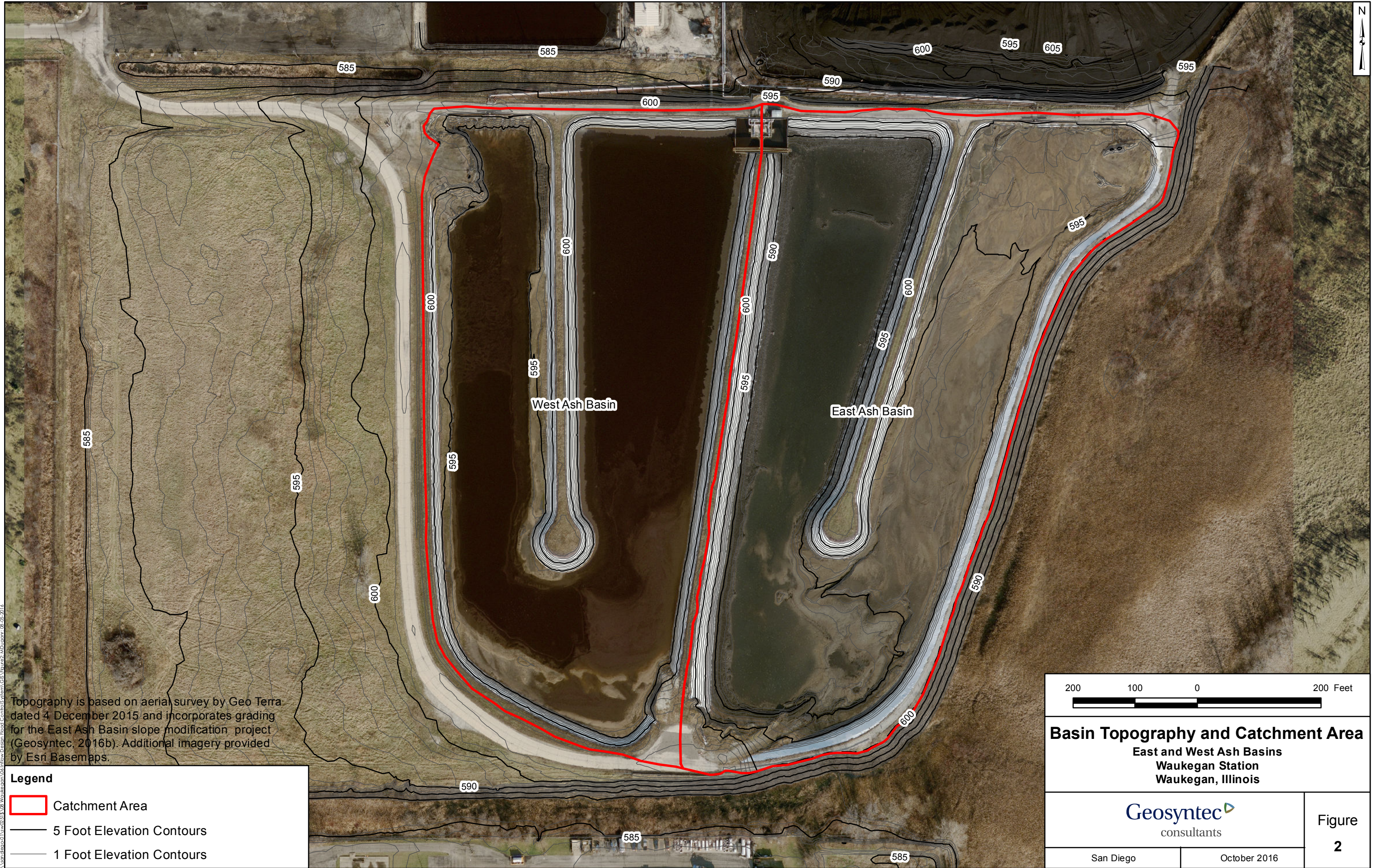
Attachments

- | | |
|-------------|-------------------------------------|
| Figure 1: | Site Location |
| Figure 2: | Basin Topography and Catchment Area |
| Appendix A: | Design Storm Event Depth |
| Appendix B: | Basin Area Capacity Curves |



2,000 1,000 0 2,000 Feet 	
Site Location East and West Ash Basins Waukegan Station Waukegan, Illinois	
Figure 1	San Diego October 2016

K:\GIS\Waukegan\SiteLocation.mxd - J.Gordon



Topography is based on aerial survey by Geo Terra dated 4 December 2015 and incorporates grading for the East Ash Basin slope modification project (Geosyntec, 2016b). Additional imagery provided by Esri Basemaps.

Legend

- Catchment Area
- 5 Foot Elevation Contours
- 1 Foot Elevation Contours

<p>200 100 0 200 Feet</p>	
<p>Basin Topography and Catchment Area East and West Ash Basins Waukegan Station Waukegan, Illinois</p>	
<p>Geosyntec consultants</p>	
<p>San Diego</p>	<p>October 2016</p>
<p>Figure 2</p>	

Appendix A

Design Storm Event Depth

NOAA's National Weather Service
Hydrometeorological Design Studies Center
 Precipitation Frequency Data Server (PFDS)



Home Site Map News Organization

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General Info

- Homepage
- Current Projects
- FAQ
- Glossary

Precipitation Frequency (PF)

- PF Data Server
- PF in GIS Format
- PF Maps
- Temporal Distr.
- Time Series Data
- PFDS Perform.
- PF Documents

Probable Maximum Precipitation (PMP)

- PMP Documents

Miscellaneous

- Publications
- AEP Storm Analysis
- Record Precipitation

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NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: IL

DATA DESCRIPTION

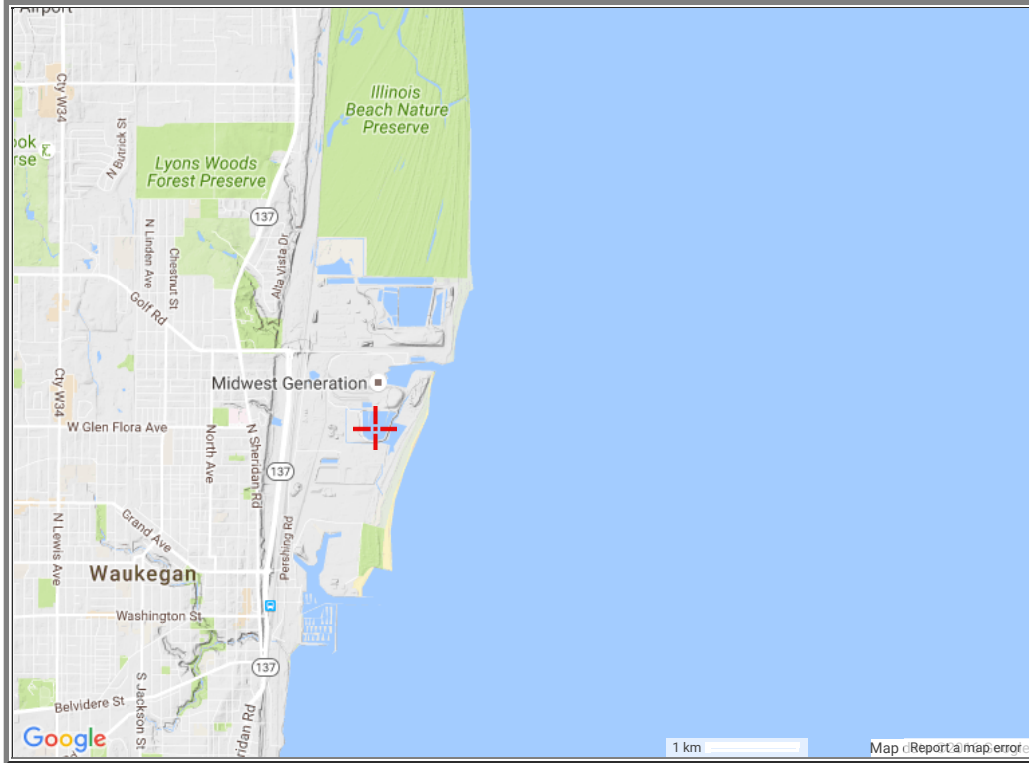
Data type: Units: Time series type:

SELECT LOCATION

1. Manually:

- a) Enter location (decimal degrees, use "-" for S and W): latitude: longitude:
- b) Select station (click here for a list of stations used in frequency analysis for IL):

2. Use map:



- a) Select location (move crosshair or double click)
- b) Click on station icon show stations on map

LOCATION INFORMATION:
 Name: Waukegan, Illinois, US*
 Latitude: 42.3773°
 Longitude: -87.8149°
 Elevation: 594 ft*

* source: Google Maps

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
 NOAA Atlas 14, Volume 2, Version 3

PF tabular

PF graphical

Supplementary information

Print Page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.376 (0.341-0.417)	0.445 (0.403-0.493)	0.529 (0.477-0.586)	0.601 (0.540-0.664)	0.690 (0.617-0.762)	0.763 (0.678-0.845)	0.835 (0.737-0.927)	0.911 (0.796-1.01)	1.01 (0.874-1.14)	1.10 (0.936-1.24)
10-min	0.585 (0.529-0.648)	0.695 (0.628-0.770)	0.822 (0.741-0.911)	0.927 (0.834-1.02)	1.05 (0.943-1.17)	1.16 (1.03-1.28)	1.26 (1.11-1.40)	1.36 (1.19-1.51)	1.49 (1.28-1.67)	1.60 (1.36-1.81)
15-min	0.717 (0.649-0.795)	0.850 (0.769-0.942)	1.01 (0.910-1.12)	1.14 (1.03-1.26)	1.30 (1.17-1.44)	1.43 (1.27-1.59)	1.56 (1.38-1.73)	1.69 (1.48-1.88)	1.86 (1.60-2.09)	2.00 (1.70-2.26)
30-min	0.948 (0.858-1.05)	1.14 (1.03-1.26)	1.38 (1.25-1.53)	1.58 (1.43-1.75)	1.84 (1.65-2.03)	2.05 (1.82-2.27)	2.25 (1.99-2.50)	2.47 (2.16-2.75)	2.75 (2.38-3.09)	3.00 (2.55-3.39)
60-min	1.16 (1.05-1.28)	1.40 (1.26-1.55)	1.73 (1.56-1.92)	2.02 (1.81-2.23)	2.39 (2.13-2.64)	2.70 (2.40-2.99)	3.01 (2.66-3.35)	3.35 (2.92-3.73)	3.81 (3.29-4.27)	4.21 (3.59-4.76)
2-hr	1.31 (1.17-1.47)	1.57 (1.40-1.76)	1.97 (1.76-2.21)	2.31 (2.05-2.59)	2.76 (2.44-3.08)	3.14 (2.75-3.51)	3.53 (3.06-3.94)	3.92 (3.38-4.40)	4.47 (3.81-5.04)	4.94 (4.15-5.60)
3-hr	1.37 (1.22-1.54)	1.65 (1.47-1.86)	2.08 (1.85-2.34)	2.45 (2.17-2.75)	2.93 (2.58-3.28)	3.34 (2.92-3.74)	3.76 (3.26-4.22)	4.19 (3.61-4.72)	4.79 (4.06-5.42)	5.29 (4.43-6.01)
6-hr	1.60 (1.41-1.83)	1.92 (1.69-2.20)	2.45 (2.15-2.81)	2.93 (2.56-3.35)	3.60 (3.11-4.10)	4.19 (3.59-4.78)	4.82 (4.09-5.50)	5.50 (4.61-6.29)	6.49 (5.34-7.46)	7.36 (5.95-8.51)

PFDS: Contiguous US

12-hr	1.86 (1.65-2.12)	2.23 (1.97-2.54)	2.82 (2.48-3.22)	3.35 (2.94-3.82)	4.09 (3.56-4.65)	4.74 (4.09-5.39)	5.43 (4.63-6.18)	6.19 (5.21-7.05)	7.27 (6.01-8.32)	8.22 (6.68-9.47)
24-hr	2.15 (1.99-2.33)	2.59 (2.40-2.81)	3.21 (2.98-3.48)	3.70 (3.42-4.00)	4.36 (4.01-4.72)	4.89 (4.48-5.44)	5.49 (4.94-6.24)	6.25 (5.41-7.12)	7.34 (6.03-8.41)	8.30 (6.75-9.57)
2-day	2.52 (2.34-2.72)	3.03 (2.81-3.28)	3.74 (3.46-4.04)	4.29 (3.97-4.63)	5.05 (4.64-5.45)	5.65 (5.17-6.09)	6.25 (5.70-6.76)	6.87 (6.22-7.44)	7.70 (6.91-8.49)	8.34 (7.43-9.66)
3-day	2.69 (2.50-2.89)	3.23 (3.00-3.47)	3.95 (3.67-4.24)	4.51 (4.19-4.84)	5.27 (4.87-5.66)	5.86 (5.39-6.30)	6.45 (5.91-6.95)	7.05 (6.42-7.61)	7.85 (7.09-8.56)	8.45 (7.59-9.71)
4-day	2.85 (2.67-3.06)	3.42 (3.19-3.66)	4.15 (3.88-4.45)	4.72 (4.40-5.05)	5.49 (5.09-5.87)	6.07 (5.62-6.50)	6.65 (6.13-7.14)	7.23 (6.63-7.78)	7.99 (7.27-8.64)	8.56 (7.74-9.76)
7-day	3.34 (3.14-3.56)	3.98 (3.74-4.24)	4.77 (4.48-5.08)	5.37 (5.04-5.72)	6.16 (5.76-6.56)	6.75 (6.30-7.20)	7.34 (6.82-7.84)	7.91 (7.31-8.47)	8.64 (7.94-9.30)	9.20 (8.41-9.92)
10-day	3.84 (3.61-4.09)	4.57 (4.29-4.86)	5.44 (5.12-5.79)	6.11 (5.73-6.50)	6.98 (6.54-7.43)	7.65 (7.13-8.15)	8.30 (7.70-8.86)	8.93 (8.26-9.56)	9.74 (8.94-10.5)	10.3 (9.43-11.1)
20-day	5.24 (4.94-5.56)	6.23 (5.88-6.61)	7.36 (6.93-7.80)	8.17 (7.70-8.66)	9.19 (8.63-9.75)	9.94 (9.31-10.6)	10.6 (9.94-11.3)	11.3 (10.5-12.0)	12.1 (11.2-12.9)	12.7 (11.7-13.6)
30-day	6.55 (6.19-6.94)	7.77 (7.33-8.23)	9.12 (8.59-9.65)	10.1 (9.48-10.7)	11.2 (10.6-11.9)	12.0 (11.3-12.8)	12.8 (12.0-13.6)	13.5 (12.6-14.4)	14.3 (13.3-15.3)	14.9 (13.8-16.0)
45-day	8.24 (7.80-8.69)	9.75 (9.23-10.3)	11.3 (10.7-12.0)	12.4 (11.8-13.1)	13.8 (13.0-14.5)	14.7 (13.9-15.5)	15.5 (14.6-16.4)	16.3 (15.3-17.2)	17.2 (16.1-18.2)	17.8 (16.6-18.9)
60-day	9.90 (9.38-10.4)	11.7 (11.1-12.3)	13.4 (12.7-14.1)	14.6 (13.9-15.4)	16.0 (15.2-16.9)	17.0 (16.1-17.9)	17.9 (16.9-18.9)	18.7 (17.6-19.7)	19.6 (18.4-20.7)	20.1 (18.9-21.3)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in csv format:

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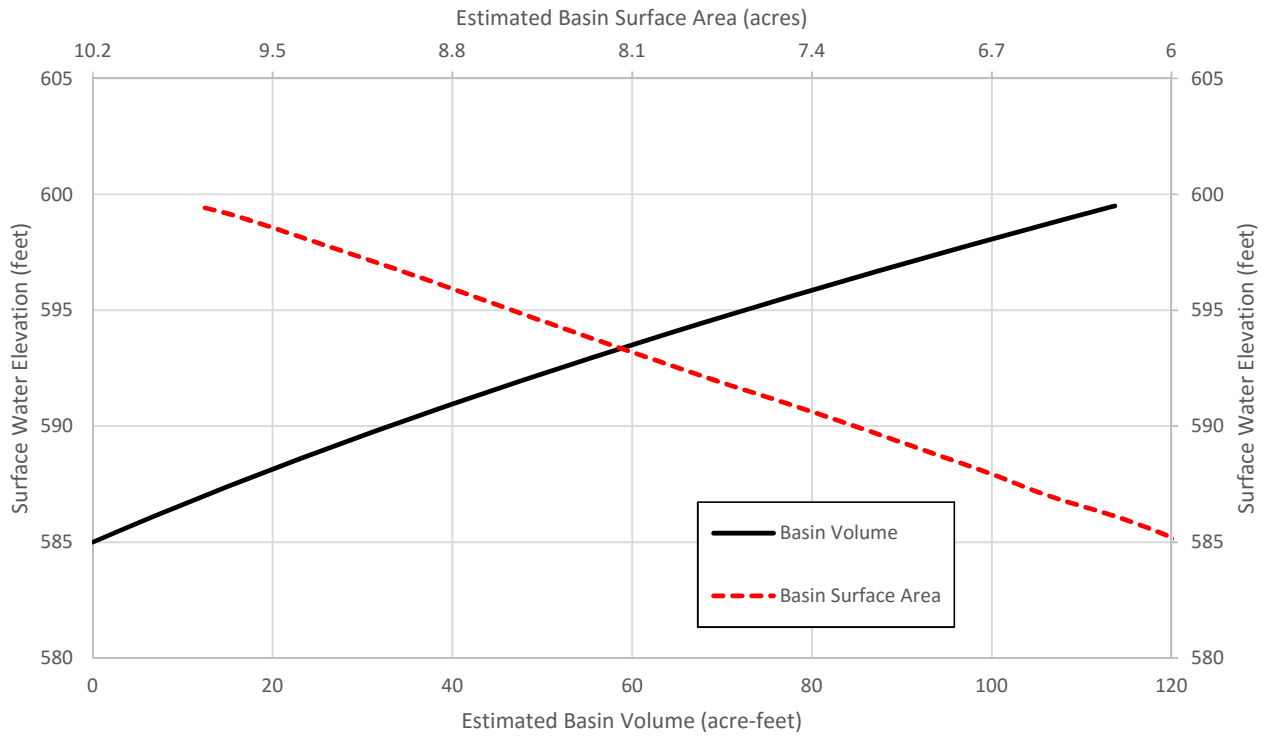
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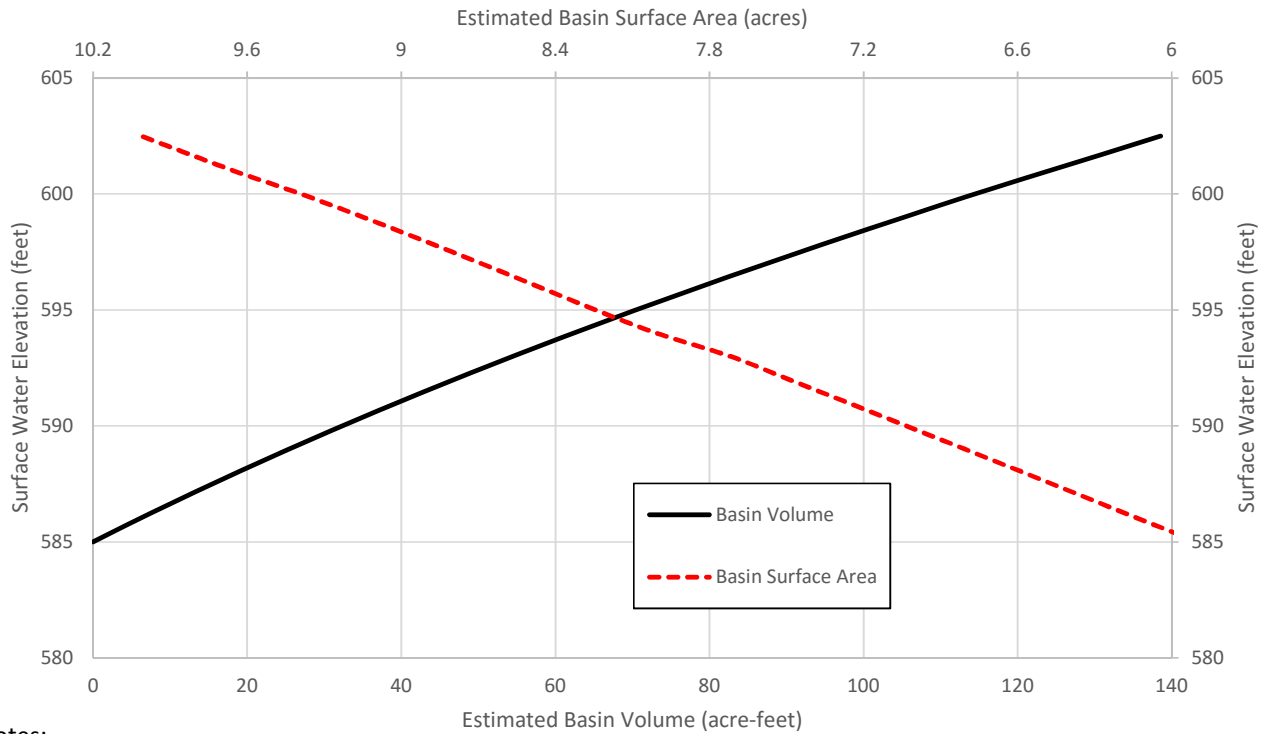
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Appendix B
Basin Area Capacity Curves

East Ash Basin



West Ash Basin



Notes:

- (1) Surface water elevations are NAVD88.
- (2) Basin volumes are estimated based on as-built information and 2015 site

OCTOBER 2016
SW0251-08

AREA-CAPACITY CURVES
 EAST AND WEST ASH BASINS
 WAUKEGAN STATION
 WAUKEGAN, ILLINOIS

**FIGURE
B-1**