Documentation of Initial Hazard Potential Classification Assessment

West Ash Ponds 1 and 2E
Wood River Power Station
Madison County, Illinois

Prepared for:
Dynegy

Stantec Consulting Services Inc.
Design with community in mind
www.stantec.com

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Executive Summary

This report documents the hazard potential classification assessment for West Ash Ponds 1 and 2E at the Wood River Power Station as required per the CCR Rule in 40 C.F.R. § 257.73(a)(2). The applicable hazard potential classifications are defined in 40 C.F.R. § 257.53 as follows:

> (1) High hazard potential CCR surface impoundment means a diked surface impoundment where failure or mis-operation will probably cause loss of human life.
>
> (2) 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.
>
> (3) 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.

Based on these definitions and the analysis herein, these impoundments should be classified as Significant hazard potential CCR surface impoundments.

This report contains supporting documentation for the hazard potential classification assessment. The hazard potential classification for this CCR unit was determined by a volume transfer analysis conducted by Stantec in September, 2016.

1. Introduction

1.1. Background

The CCR Rule was published in the Federal Register on April 17, 2015. The Rule requires that a hazard potential classification assessment be performed for existing CCR surface impoundments that are not incised. A previously completed assessment may be used in lieu of the initial assessment provided the previous hazard assessment was completed no earlier than April 17, 2013. The applicable hazard potential classifications are defined in the CCR Rule 40 C.F.R. § 257.53 as follows:

<u>High Hazard Potential CCR surface impoundment</u> means a diked surface impoundment where failure or mis-operation will probably cause loss of human life.

<u>Significant Hazard Potential CCR surface impoundment</u> 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.

<u>Low Hazard Potential CCR surface impoundment</u> 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.

Dynegy has contracted Stantec Consulting Services Inc. (Stantec) to prepare hazard potential classification assessments for selected impoundments[1].

It was determined that there was no existing available hazard potential classification assessment documentation for West Ash Ponds 1 and 2E.

1.2. Location

The Wood River Power Station is located southeast of the City of Alton in Madison County, Illinois on the east bank of the Mississippi River at the confluence with the Wood River. West Ash Ponds 1 and 2E are located adjacent to Pond 2W. These ponds collectively have a combined surface area at the crest of approximately 54 acres.

Because a failure of the Ponds 1 and/or 2E has the potential to lead to a progressive failure of Pond 2W, the potential hazard assessment for West Ash Ponds 1 and 2E was performed by evaluating a breach from three ponds combined.

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[1] Dynegy Administrative Services Company (Dynegy) contracted Stantec on behalf of the Wood River Power Station owner, Dynegy Midwest Generation, LLC. Thus, Dynegy is referenced in this report.

The impoundments are located north of the power station and west of the main railroad and plant access road, the Norfolk & Western Railroad and Chessen Lane, respectively. A site overview figure is included in Appendix A.

1.3. Methodology

Stantec performed a volume transfer breach analysis of impoundments. Estimates of the volume of material in each of the three impoundments were determined by comparing 2015 topographic and bathymetric survey data with pre-existing contours extracted from 1977 construction drawings for the facility. A series of potential breach scenarios was developed along with estimates of the volume of waste material and free standing water that would be displaced during each scenario. The impoundments were conservatively assumed to be full to the crest at the time of breach. The estimated total breach volume was then transferred to one of three adjacent low-lying contained areas. Stage-storage-volume relationships for the contained areas were based on Lidar topographic data obtained from the Illinois Height Modernization Program (ILHMP). Potential breach risk areas were identified for the interpolated elevations that the transferred volume would occupy within each contained area.

2. Source Data

The following information was used to perform the hazard assessment:

- Aerial Imagery (USDA National Aerial Imagery Program 2015)
- Topographic survey information (Weaver Consultants Group for Dynegy, December 2015 – 1 foot contour data and planimetrics)
- LiDAR Data (Illinois Height Modernization Program ILHMP 2011) – < 9 cm vertical accuracy
- IDNR Dam Safety Program, Emergency Action Plan, Wood River Power Station, Alton, Illinois, IDNR Permit No. DS2011079, Dam ID No. IL50536

3. Potential Failure Scenarios

3.1. Facility Description

West Ash Ponds 1 and 2E are illustrated by the Site Overview Figure in Appendix A. Unless otherwise noted, elevations herein are referenced to the North American Vertical Datum of 1988 (NAVD88).

- West Ash Pond No. 1 (WAP-1) is the largest of the cells at about 21.8 acres measured at its crest. The embankment is about 25 to 30 feet in height with a crest width of 20 to 30 feet at an approximate elevation of 444 feet. WAP-1 is mostly dry today, though 5 to 10 feet of ponding could occur between the top of stacked ash and crest of the embankment. WAP-1 has an embankment about 15 feet higher than the adjacent cells; it also has the largest amount of in-place waste. An internal dike failure could result in a sizeable portion of the waste and/or ponded water from this cell spilling into lower cells to the north or west (WAP-2E, -2W, and -3), possibly resulting in a progressive failure.

- West Ash Pond No. 2E (WAP-2E) is about 11.2 acres in size. The crest elevation is about 431 feet. The embankment height is in the range of 15-20 feet and the crest width is about 20 feet. WAP-2E is nearly full with about 3-5 feet of allowable ponding. WAP-2E is about 10-feet higher and could spill over to WAP-2W to the west. The available storage volume in the embankment is only slightly higher than WAP-3, so spill over in that direction would primarily result in equalization of the two cells.

- West Ash Pond No. 2W (WAP-2W) is about 21.1 acres in size. The embankment elevation is about 427 feet. It averages about 20 feet in height with a crest width of about 20 to 25 feet. WAP-2W currently has a sizeable operating pool and can hold approximately 12-15 feet of additional ponding before overtopping. WAP-2W is the lowest of the 4 cells and would receive discharge during an internal dike failure. Note that this pond was analyzed herein due to the potential for a progressive failure of West Ash Ponds 1 and 2E leading to a failure of 2W.

3.2. Failure Scenarios

Breach inundation areas were evaluated based on volume transfer analysis scenarios described below. Unless otherwise noted, each scenario assumed the water surface elevation in the subject impoundment equal to the crest elevation when the breach occurred.

The assumptions below that include 1/3 of the solids were based in part on Stantec's experience with other ash pond failures and are supported by industry literature.

3.2.1. West Ash Pond 2W

This scenario assumed WAP-2W breaches either to the north or west. Either direction would follow a flow path to a contained area to the west of WAP-2W, east of Cpl. Belchick Mem. Expy., and north of State Rte. 143 (Contained Area 1). For this scenario, all of the ponded water and 1/3 of the solids from cell WAP-2W was assumed to discharge Approximately 185 acre-feet of total outflow volume was assumed. This scenario would fill the contained area to an approximate elevation of 410.1 feet. A progressive failure that included volume from WAP-2E or WAP-1 was not considered because it was not expected to result in additional material being discharged through the outermost embankment.

3.2.2. West Ash Pond 2E

This scenario assumed WAP-2E breached to the north and then flowed westward along the perimeter of WAP-2W to Contained Area 1. The assumed total breach volume was approximately 60 acre-feet, which included ponded water and about 1/3 of the solids from WAP-2E. A progressive failure that included volume from WAP-1 was not considered because it was not expected to result in additional material being discharged through the outermost embankment.

3.2.3. West Ash Pond 1 – Southwest Embankment

This scenario assumed WAP-1 breached to the southwest side. The discharge would fill a ditch along the southwest portion of WAP-2W and drain west toward Contained Area 1. Since WAP-1 is a dry cell, ponding was assumed to be minimal and only solids were considered for this scenario; however, the solid volume, estimated to be about 135 acre-feet, was treated as a water discharge for volumetric transfer purposes.

3.2.4. West Ash Pond 1 – South or East Embankments

This scenario would result in approximately 135 acre-feet of material being discharged to the northeast into a low lying area on the Wood River Power Station footprint. The inundation limits extend around the Primary East Ash and are bounded by the power plant to the south, Wood River to the east, and a railroad to the north (Contained Area 2).

4. Hazard Classification

Inundation limits and depths for each of the breach scenarios described in Section 3.2 were evaluated for potential impacts on property and structures and the potential risk to human life. Results from the volume transfer analyses indicate that potential breach impacts from West Ash Ponds 1 and 2E will be confined to Contained Areas 1 and 2 as depicted in Section 3.2. Contained Area 1 consists of open area without structures or infrastructure, while Contained Area 2 is located on Wood River Power Station property. Potential breach impacts within Contained Area 2 include impairment and damage of power station structures, access roads, and railroad. The potentially impacted structures and access roads are typically intermittently used by Wood River Power Station personnel and the at-risk populations are considered transient. In accordance with Federal guidelines, loss of life is not considered probable for scenarios where persons are only temporarily in the potential inundation area (Reference 6).

Per the analysis findings outlined above, it is Stantec's opinion that a breach from these impoundments does not present probable loss of human life. However, a breach of West Ash Ponds 1 and 2E has potential to release stored CCR material and cause environmental damage. Therefore, West Ash Ponds 1 and 2E fit the definition for a Significant hazard potential CCR surface impoundment (as defined in the CCR Rule §257.53).

5. References

1. US Environmental Protection Agency. (2015). *Disposal of Coal Combustion Residuals from Electric Utilities, 40 CFR § 257 and § 261* (effective April 17, 2015).

2. Aerial Imagery (USDA National Aerial Imagery Program 2015)

3. Topographic survey information (Weaver Consultants Group for Dynegy, December 2015 – 1 foot contour data and planimetrics)

4. LiDAR Data (Illinois Height Modernization Program ILHMP 2011) – < 9 cm vertical accuracy

5. IDNR Dam Safety Program, DRAFT Emergency Action Plan, Wood River Power Station, Alton, Illinois, IDNR Permit No. DS2011079, Dam ID No. IL50536

6. Federal Emergency Management Association (FEMA). (2004). *Hazard Potential Classification System for Dams.*

Appendix A

Site Overview Figure

0 800
Feet
1:9,600 (At original document size of 11x17)

Stantec

Project Location
Latitude: 38.863714
Longitude: -90.134158
Madison County, Illinois

175605019
Prepared by WSW on 2017-02-08
Technical Review by NS on 2017-02-08
Independent Review by MH on 2017-02-08

Client/Project
Dynegy
Wood River Power Station
Hazard Potential Classification Assessment

Figure No.
1

Title
Site Overview Figure
West Ash Ponds 1 and 2E
Wood River Power Station

Notes
1. Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
2. Aerial Source: 2015 NAIP Imagery
3. Impoundment Boundaries Provided by Client (Dated 9/9/2015)

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This package summarizes the preliminary geotechnical analyses performed in support of the 30% West Ash Complex Closure Design submittal, for the Dynegy Wood River Plant. The following information and analyses are presented herein:

- Summary of Subsurface Investigation
- Summary of Subsurface Conditions
- Cap Settlement Analyses
- Dike Slope Stability Analyses

Figures, calculations and computer program outputs are provided as attachments and are referenced herein.

I. Summary of Subsurface Investigation

A subsurface exploration was performed at the west ash complex, including 15 soil borings, installation of 9 geotechnical piezometers to monitor groundwater, and a program of 11 cone-penetration test (CPT) soundings, with seismic wave velocity measurements and pore pressure dissipation testing. The borings were drilled by AECOM's subcontractor Terracon Consultants, Inc. of St. Louis, MO, under the full-time supervision of AECOM geotechnical personnel. Terracon used an All-Terrain Vehicle-mounted drill rig, in conjunction with 3-¼ inch inner diameter hollow stem augers and wash rotary methods to drill the borings. CPT soundings were performed by AECOM's subcontractor ConeTec, Inc., again with full-time oversight by AECOM personnel.

Boring depths varied from 30 to 70 ft and CPT depths varied from 30 to 50 ft below existing grades. Boring and CPT sounding locations are depicted in **Figure 1**.

Representative soil samples were collected from each of the borings for classification and/or testing. The soil samples were obtained by Standard Penetration Testing (SPT) with a split-spoon sampler, in general accordance with ASTM D 1586. Undisturbed samples of fly ash and/or fine-grained soils were obtained using 3-inch outside diameter steel (Shelby) tubes, either conventionally pushed in accordance with ASTM D 1587 or by utilizing a piston sampler in accordance with ASTM D 6519 (in ash and very soft soils).

The field investigation was complimented by a comprehensive laboratory testing program. The program was designed to establish the index and engineering properties of the soils encountered at the site, with a focus on establishing the parameters pertinent to the pond closure design (including shear strength of the soils for use in slope stability analyses, and compressibility of the ashes and soft soils underlying the site, for use in cap settlement analyses). The program included the following tests:

Index Tests:

- Moisture Content
- Atterberg Limits
- Grain Size Analyses

Compressibility:

- One-Dimensional Consolidation Testing

Strength Tests:

- Consolidated-Undrained Triaxial Testing
- Direct Simple Shear Testing
- Cyclic Direct Simple Shear Testing

At the time of this 30% design submittal, approximately 75% of the assigned testing has been received, but some tests are still in progress. Of particular note is that the cyclic testing on ash and clay samples has not been completed (which results could influence the seismic slope stability analyses presented herein). Furthermore, while several consolidation test results are available and have been incorporated, additional tests are still in progress. The complete data set may influence the settlement analyses presented herein. Therefore, some adjustments to the analyses and conclusions as a result of forthcoming data may be warranted, and will be appropriately incorporated at later design stages.

In addition to our investigation, AECOM reviewed historical geotechnical information that was available in Dynegy's files. This information included boring location map and boring logs for the subsurface investigation performed by Sargeant and Lundy (dating to 1977) to support the original design of the pond system. This information included 19 borings drilled to depths up to 85 ft below the pre-existing (pre-pond construction) grades. The historical information includes boring profile and SPT information, but no laboratory testing. The subsurface profile revealed by the historical borings was similar to that encountered by AECOM in the current investigation, and the historical borings were therefore used to supplement the current data in our evaluations.

II. Summary of Subsurface Conditions

The borings encountered the following generalized soil profile at the site (soil layers are listed from highest elevation to lowest):

Fine-Grained Dike Fill Materials: The perimeter dikes at Ponds 2W, 2E, and 3 are largely comprised of fine-grained soil fills classified as lean clay (CL) and fat clay (CH). The clays generally had a stiff to hard consistency and appeared to be well-compacted materials. The Pond 1 dikes were raised in the early 1990s, from an original elevation around 432 ft to the current elevation around 445 ft. Based on our borings, the material used to raise these dikes consists of a silty sand (SM) to sandy silt (ML). These fills were medium dense in the borings, and appeared to be well compacted.

Ponded Ash Materials: Sluiced ash materials were encountered in the borings drilled in Pond 2W and Pond 1. The material was generally classified as a silt (ML - fly ash). Above the residual pond water table, the ash was loose to medium dense. Below the water level, the ash became loose to very loose and saturated.

Native Alluvial Clay: Most of the west ash complex is underlain by a native clay of alluvial origin. The stratum was typically classified as fat clay (CH), with some zones lean clay (CL) occasionally identified. At the west complex, the clay consistency varied from soft to stiff, generally improving from east to west. The clay thickness generally thins from east to west.

Native Sand: Native sand materials, anticipated to be of alluvial origin, were encountered in all borings drilled at the west ash complex. In most cases, the sands were encountered below the alluvial clay, but in some instances were encountered directly below the dike fills or ponded ash. In general, the sands were medium dense, but some zones of looser material were also encountered at several borings. The sands were typically saturated, and were relatively clean (fines content typically in the range of 5 to 20%).

Groundwater Table: Based on preliminary data from the piezometers, the static groundwater table exists in the range of El. 400 to 410 across the complex, which corresponds to the native clay or sand deposits. A perched (residual) water table is also present within the ponds themselves. Generally, this perched water table exists within 10 ft of the existing ash surface in the ponds.

A geologic cross-section cut across the pond system (Section 1-1), providing a snapshot of the various strata described above is provided in **Figure 2.**

III. Cap Settlement Analysis

The proposed crown fill and cap materials (which are to be up to 25 ft thick in some areas) will surcharge the ash and native soil materials that they are placed over. Some of these soils (the ash and alluvial clays) have moderate to high compressibility. Long-term settlement of the crown will alter the as-constructed surface slopes, and short-term settlement (during construction) will affect the quantity of fill materials that are necessary to build the crown.

Settlements were calculated along a representative cross-section across the cap. The section is depicted on Figure 1. The section was selected to represent the conditions that exist in Pond 2W.

The following points summarize the methodology employed in the settlement analysis:

- The source of the surcharge that will induce settlement is the weight of the crown fill and surface cap soil. The crown fill will consist of bottom ash excavated from the adjacent East Ash Pond system. The surface cap will be constructed of suitable borrow materials obtained from on-site or imported. Bottom ash materials were conservatively assumed to have a total unit weight of 105 pcf, and cap soil was assumed to have 130 pcf. The surcharge loading at any point from each material was taken as the unit weight of the material times its thickness above existing grades.

- Classical settlement theory was used herein to estimate settlements of each stratum. For ash and clay materials, the following equation applies:

  $$s_i = \frac{H_i C_c}{1+e_0} \log \frac{\sigma_0' + \Delta\sigma}{\sigma_p'}$$

  For the native sand, the empirical Hough's Method was applied, using the following equation:

  $$s_i = \frac{H_i}{C'} \log \frac{\sigma_0' + \Delta\sigma}{\sigma_p'}$$

  Where,

  H_i = Thickness of layer
  C_c = Compression Index of layer
  e_0 = Initial void ratio at layer
  σ_0' = Effective overburden pressure at layer center
  σ_p' = Effective preconsolidation pressure
  $\Delta\sigma$ = Surcharge pressure at layer center, γz
  C' = A compressibility index based on SPT results for sands

- The various compressibility parameters were selected on the basis of laboratory consolidation testing available at this time, the results of the field borings, and using engineering judgment. Based on the test results, the ponded ash and native clay layers are considered to be lightly overconsolidated soils. An overconsolidation ratio of 1.25 was used in the calculations (the preconsolidation pressure parameter was assumed equal to 125% of the overburden pressure for these materials). **Table E-1** below summarizes the parameters used in the calculations.

Table E-1: Compressibility Parameters Used In Settlement Analyses

Layer	γ(pcf)	e_0	C_r	C_c
Ponded Ash (above water table)	90	1.35	0.016	0.06
Ponded Ash (below water table)	90	1.35	0.016	0.12
Native Alluvial Clay	119	0.75	0.04	0.35
Native Sand Alluvium	115	--	C' Index based on SPT values from borings	

- Settlements were calculated for a number of points along the reference Cross-Section 1-1, and a settlement profile was so developed.

- Time rate of settlement analyses have not yet been performed at this 30% design stage. Herein, we have assumed that the sluiced fly ash materials within the ponds and the underlying native sand materials in the profile (both of which are non-plastic materials) will consolidate relatively rapidly, and a majority of the settlement in these layers will occur during the course of crown and cap construction. Therefore, while the settlement of these layers will necessitate additional fill placement (to "recover" the grade lost to settlement), they will not contribute to long term reduction of slope grades of the surface cap. It is assumed that the alluvial clay deposit will experience slow consolidation, and the settlement from this stratum will contribute to long-term slope changes of the surface cap.

Results of Settlement Analysis

Table E-2 summarizes the results of the settlement calculations at each analysis point along Section 1-1. The results and conclusions of the settlement analysis are summarized as follows:

- Predicted long-term settlements in the alluvial clays vary from 2-in to 10-in across the section. These magnitudes indicate that nominal loss of surface slope could occur long-term.

- Short-term settlements in the ponded fly ash and alluvial sand materials is predicted to vary between about 4 and 16-inches, with an average of about 10-inches.

- As the intent of the design is to maintain a minimum 2% surface slope for drainage, the 30% grading plan has been configured at a constructed slope of 2.5% within Ponds 2W and 2E (where the majority of net crown fill is to be placed) to account for loss due to settlement. This will address the issues summarized above (loss of slope due to long term settlement, and account of additional volume of fill required to recover short-term settlement), in a preliminary fashion. The surface grading will be optimized in subsequent submittals.

Table E-2: Summary Results of Settlement Analyses

INPUT PARAMETERS					*Analysis Results*		
Point	Cross Section Analysis Location (STA.)	Proposed Crown Fill Thickness (ft)	Proposed Cap and Cover Thickness (ft)	Total Proposed Fill Thickness* (feet)	Total Settlement (inches)	Short-Term Settlement (Inches)	Long-Term Settlement (inches)
1	1+00	0	0	0	0	0	0
2	1+22	0	0	0	0	0	0
3	1+50	6	2	8	5.4	4.5	0.9
4	1+75	16	2	18	9.2	6.9	2.3
5	2+00	17.6	2	19.6	11.2	8.5	2.7
6	2+50	17	2	19	11.5	8.6	2.9
7	2+90	17	2	19	11.6	8.6	3
8	3+50	22	2	24	17	11.1	5.9
9	4+06	22	2	24	19.1	12.6	6.5
10	5+00	23	2	25	25.3	15.8	9.5
11	5+52	21.2	2	23.2	21.3	11.6	9.7
12	6+00	22.2	2	24.2	21.9	12	9.9
13	6+50	21.5	2	23.5	19	10.2	8.8
14	6+62	19.5	2	21.5	16.8	9.1	7.7
15	6+84	8	2	10	9.5	3.6	5.9
16	7+08	0	0	-	0	0	0
17	7+13	0	0	-	0	0	0
18	7+25				0	0	0

IV. Dike Slope Stability Analyses

For the 30% design submittal, limit-equilibrium slope stability analyses have been performed at four representative cross-sections, L-L, M-M, K-K, and G-G. The section locations are provided in **Figure 1**.

Analyses were performed using Spencer's Method which is a limit equilibrium slope stability analysis procedure. The computer program SLOPE/W 2007 by Geo-Slope International was utilized. The program analyzes a large number of potential slip surface geometries and identifies the geometry that results in a critical (i.e. lowest) factor of safety (FS). Additional information on the program is available at http://www.geo-slope.com/.

Each section was analyzed for the following cases:

Static Operating Case: This case models the closed ponds under static, long-term conditions. Drained (effective stress) shear strength parameters were used for all materials, and phreatic conditions were estimated based on the available piezometer data. The Programmatic target for post-earthquake analysis is a factor of safety greater than 1.5.

Post-Earthquake Case: This case models the closed ponds under conditions that are anticipated to exist following the design earthquake event. The design earthquake is an event with 2% probability of exceedance in 50 years (recurrence interval of approximately 2500 years). The purpose of the post-earthquake stability analysis is to assess stability conditions immediately following a seismic event. No horizontal seismic coefficient is included in these analyses, but selection of strength parameters for the analyses takes into account the potential for softening/ weakening of the soils as a result of pore pressures generated by the earthquake shaking. The Programmatic target for post-earthquake analysis is a factor of safety greater than 1.2.

Preliminary liquefaction screening analysis was performed for each section, to ascertain potential zones of liquefaction for use in the post-earthquake analyses. Reduced strengths of materials anticipated to liquefy or soften during the design earthquake were input to the post-earthquake analyses.

Models were established based on the following methodology:

- ***Surface Geometry:*** Surface topography corresponded to the proposed grades, as depicted in the 30% plans. For areas where grade changes are not proposed (such as at the perimeter dike slopes), topography is based on County LIDAR surveys.
- ***Subsurface Stratigraphy:*** Stratigraphy for each cross-section was based on the pertinent borings (both new AECOM borings and high-quality historical borings) that are in the vicinity of each cross-section. Groundwater tables were modeled as piezometric lines in

SLOPE/W, with elevations and configuration of the lines primarily established based on the recently installed piezometers. **Table E-3** summarizes the borings used to construct each section.

Table E-3: Borings Used To Develop Subsurface Stratigraphy

Cross-Section	Borings Utilized
G-G	WOR-B008 and D-9 (1977 Historic Boring)
K-K	WOR-B015, WOR-B016, D-15 (1977 Historic Boring)
L-L	WOR-B017 and WOR-B018
M-M	WOR-B020 and D-4 (1977 Historic Boring)

- ***Liquefaction Screening Analysis:*** Preliminary liquefaction screening analysis has been performed as part of this 30% submittal. Liquefaction screening was performed using SPT and CPT data obtained during the AECOM exploration, for borings pertinent to each analysis cross-section (as described in **Table E-3**). The screening procedure was based on the methodology by Idriss and Boulanger (2008, 2014). The procedure considers a stress-based approach to evaluate the potential for liquefaction triggering, and compares calculated earthquake-induced cyclic stress ratios (CSR) with the estimated cyclic resistance ratios (CRR) of the soil to establish the factor of safety against liquefaction triggering.

  The design earthquake for the screening procedure was the same as used for the post-seismic slope stability analysis (2500 year event). As the site-specific Probabilistic Seismic Hazard Analysis is still in progress at the time of this submittal, ground motions for the screening analysis were based on USGS seismic hazard data, corrected for Seismic Site Class D conditions assumed for the site. Site-specific information will be incorporated at later submittals.

  This methodology is considered to be a screening-level procedure. Adverse results from the screening procedure are generally considered to be grounds for more rigorous evaluation to be performed at a later phase of the project.

  The screening analysis indicates that there is potential for liquefaction of the ponded fly ash materials as well as the upper portions of the native sand alluvium deposit. The analyses also indicate that cyclic softening of the native alluvial clay may occur as a result of the design earthquake. These results were carried forward to the post-earthquake cases of the slope stability analyses.

- ***Material Properties:*** Unit weight and shear strength parameters were established on the basis of available laboratory testing and on field test results from the borings. For the post-earthquake cases, soils that are anticipated to liquefy or soften were assigned reduced strengths. **Table E-4** summarizes the shear strength parameters used in the slope stability analyses.

Table E-4: Soil Parameters Used In Slope Stability Analyses

Layer	γ(pcf)	*Properties For Static Operating Case*		*Properties For Post-Seismic Case*	
		ϕ' (deg)	***c' (psf)***	***ϕ (deg)***	***c (psf)***
Dike Fill (Clay)	130	30	200	30	200
Dike Fill (Sand)	120	33	0	33	0
Ponded Ash	100	27	0	$s_u/\sigma'_v = 0.06$ (See Note)	
Native Alluvial Clay	130	30	0	$s_u/\sigma'_v = 0.20$ (See Note)	
Native Sand Alluvium	120	32	0	$s_u/\sigma'_v = 0.20$ to 0.25 (See Note)	

Note: Materials that are anticipated to soften or liquefy during the design earthquake were modeled using undrained shear strengths that vary as a function of the overburden pressure. The alluvial clay was modeled with 80% of the anticipated static undrained strength (from lab testing). Strength of ponded ash was selected based on previous experience with ash materials (cyclic tests in fly ash are not yet available for Wood River). The alluvial sands were assigned residual strengths based on field test data (SPT N and CPT results), using procedures give in Idriss and Boulanger (2008, 2014).

Results of Stability Analysis

Table E-5 summarizes the results of the stability analyses for each section, and output figures from the slope models are provided at the back of this document.

Table E-5 – Results of Slope Stability Analysis

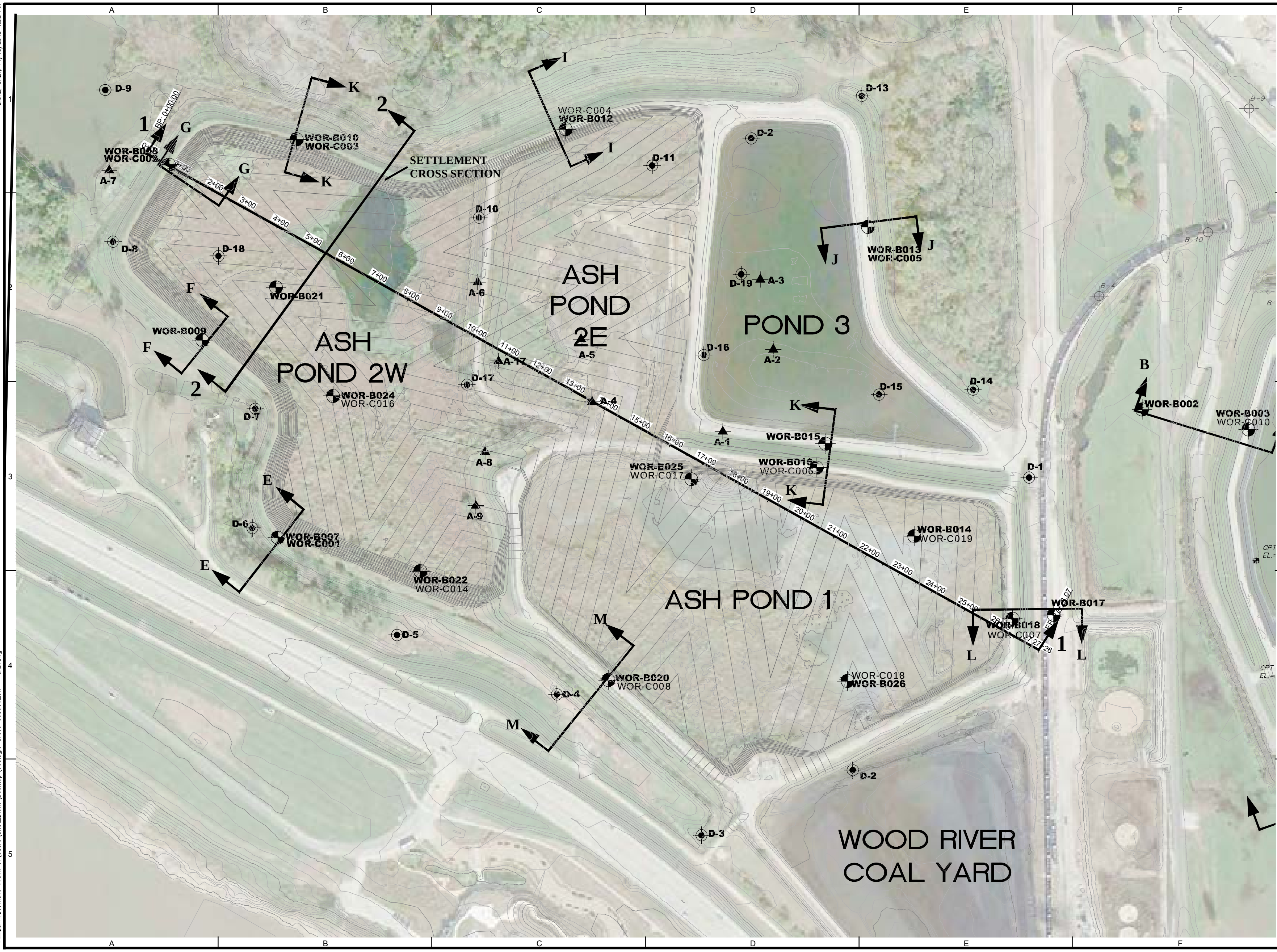
Loading Case	Program Criteria	Cross Section G-G	Cross Section K-K	Cross Section L-L	Cross Section M-M
Static, Operating	FS ≥ 1.5	2.55	3.26	3.45	3.23
Post-Earthquake	FS ≥ 1.2	1.29	2.37	2.50	1.98

The results indicate that all sections have acceptable factors of safety for all cases. Therefore, at the present design stage, we anticipate that slope stabilization measures will not be required for the closure design, and such measures are not depicted in the 30% plans. We do note that the post-earthquake factors of safety at some sections are relatively close to the programmatic minimum values. More definitive results await the PSHA and seismic site response analyses for the site, which are forthcoming. Furthermore, once these tests are received, additional cyclic lab testing in the alluvial clays and ponded ash will be assigned. Subsequent submittals will incorporate the results of these studies, including any changes to the design details, should they become necessary.

V. References

1. Idriss, I.M., and Boulanger, R. W. (2008). "SPT-Based Liquefaction Triggering Procedures", Report No. UCD/CGM-10-02, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.

2. Idriss, I.M., and Boulanger, R.W. (2014). "CPT and SPT Based Liquefaction Triggering Procedures", Report No. UCD/CGM-14-01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.



AECOM
564 White Pond Dr.
Akron, OH 44320
330-836-9111 (phone)
330-836-9115 (fax)

DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

WEST ASH COMPLEX CLOSURE

WOOD RIVER POWER PLANT
ALTON, IL

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△	30% DESIGN	2015-11-13
△		
△		
△		
△		

AECOM PROJECT NO:	60440115
DRAWN BY:	JSW
DESIGNED BY:	CAD
CHECKED BY:	VKG
DATE CREATED:	2015-10-13
PLOT DATE:	2015-10-13
SCALE:	1" = 120'
ACAD VER:	2015

SHEET TITLE

GEOTECHNICAL SITE PLAN

FIGURE 1

DICKE, CHET, 11/13/2015 1:32 PM

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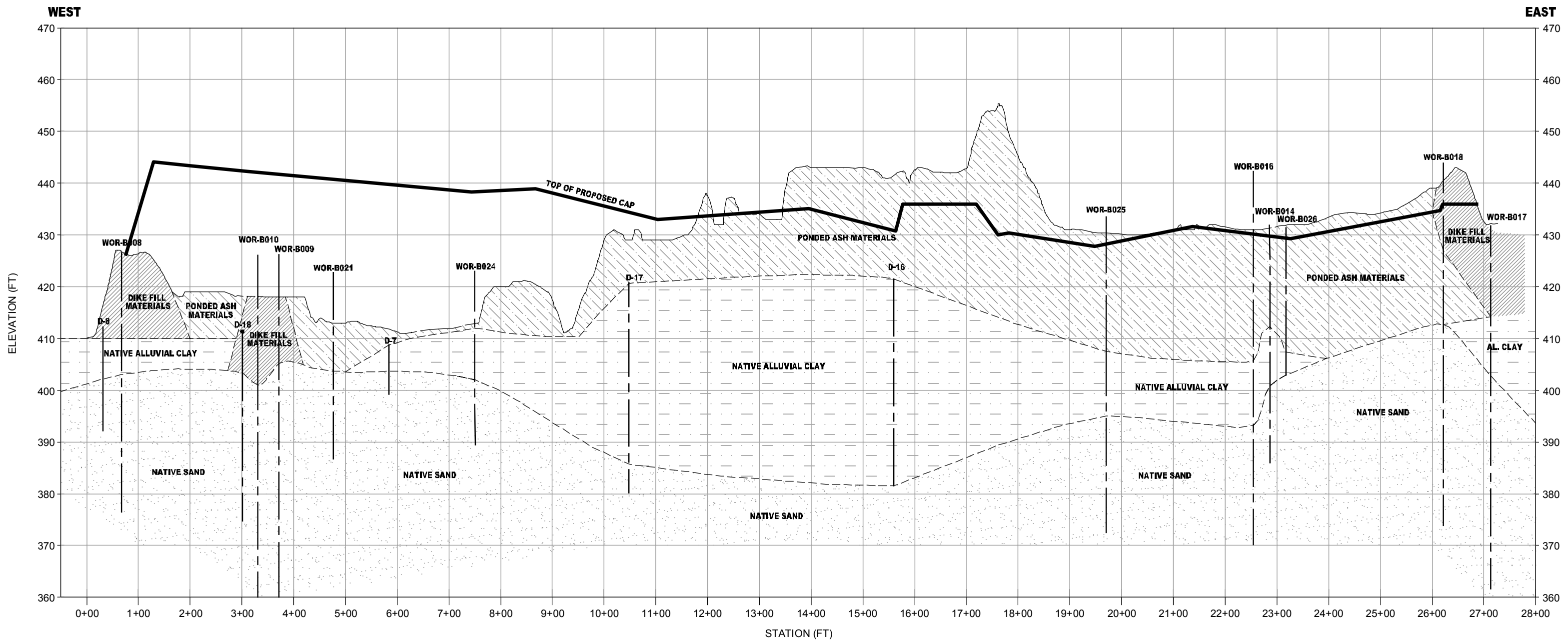
DICKE, CHET, 11/13/2015 12:51 PM



CROSS SECTION 1-1

LEGEND:

- Dike Fill Materials
- Ponded Ash Materials
- Native Alluvial Clay
- Native Sand

Dike Fill Materials: Soil fills were most often classified as lean clay (CL) and fat clay (CH). The clays generally had a stiff to hard consistency and appeared to be well-compacted materials. Pond raise dike materials at Pond 1 (circa 1990) were silty sand (SM) to sandy silt (ML). These fills were medium dense in the borings, and appeared to be well compacted.

Ponded Ash Materials: Sluiced ash materials consisted of brown to gray fly ash and had classification of silt (ML). Above the residual pond water table, the ash was loose to medium dense. Below the water level, the ash became loose to very loose and saturated.

Native Alluvial Clay: The stratum, anticipated to be of alluvial origin, was typically classified as a fat clay (CH), with some zones of lean clay (CL) occasionally identified. The clay consistency varied from soft to stiff, generally improving from east to west. Layers of loose silty sand (SM) and silt (ML) were occasionally interbedded in the clay deposits.

Native Sand: Native sand materials, anticipated to be of alluvial origin, were typically classified as poorly graded sand (SP). Layers of clay or silty sand (generally less than 5 ft thick) were occasionally interbedded in the sand. In general, the sands were medium dense, but some zones of looser material were also encountered at several borings. The sands were typically saturated.

0 120 240 360
HORIZONTAL SCALE IN FEET

0 12 24 36
VERTICAL SCALE IN FEET

AECOM DRAWING PATH: I:\Temporary\witzberger\Geologic Cross Section_JW - Copy.dwg

AECOM
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330-836-9111 (phone)
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DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

WEST ASH COMPLEX CLOSURE

WOOD RIVER POWER PLANT
ALTON, IL

ISSUED FOR BIDDING DATE BY

ISSUED FOR CONSTRUCTION DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△	30% DESIGN	2015-11-13
△		
△		
△		
△		

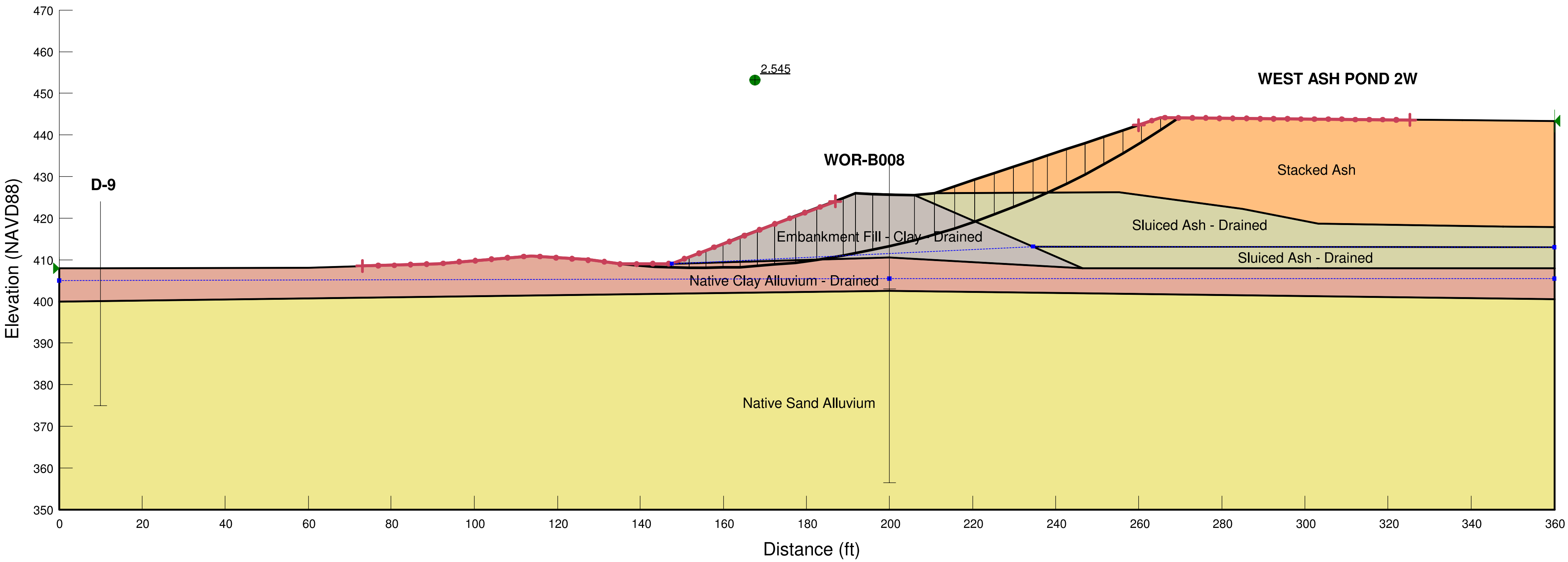
AECOM PROJECT NO:	60440115
DRAWN BY:	JSW
DESIGNED BY:	CAD
CHECKED BY:	VKG
DATE CREATED:	2015-10-13
PLOT DATE:	2015-10-13
SCALE:	H:1" = 120'; V:1"=12'
ACAD VER:	2015

SHEET TITLE

TYPICAL GEOLOGIC PROFILE

FIGURE 2

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: G-G (PROPOSED CLOSURE)
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

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Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °

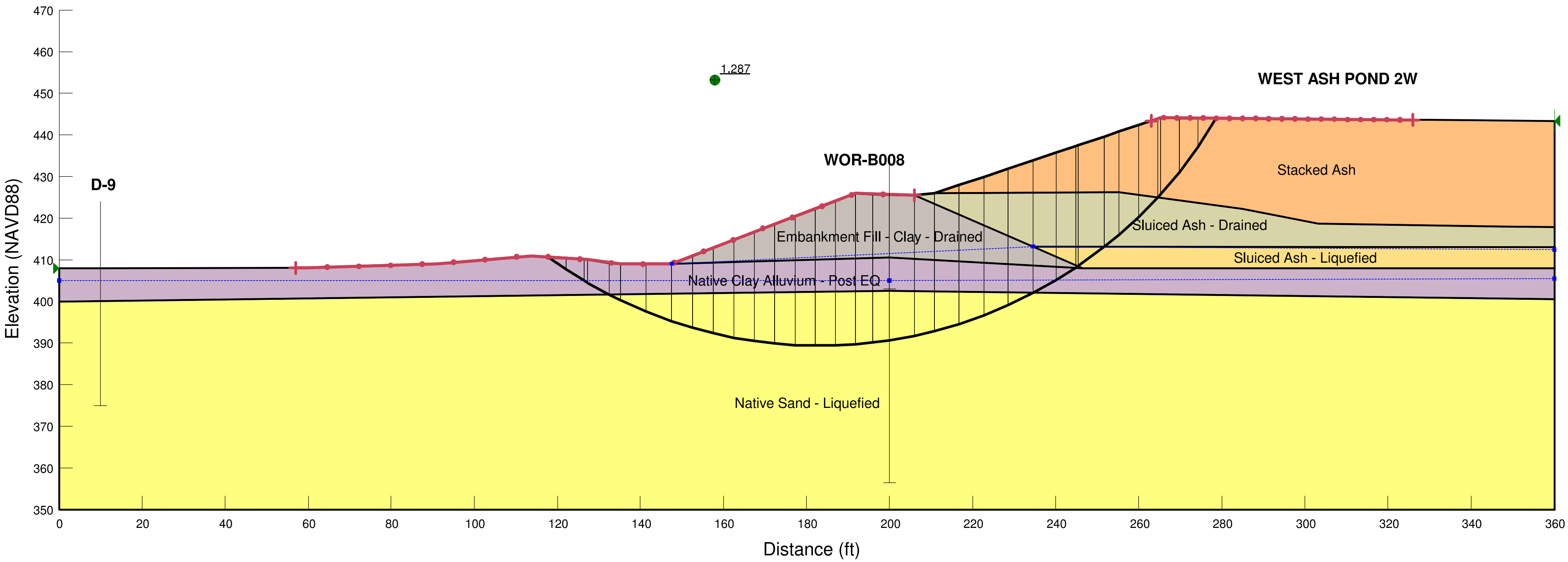
Name: Stacked Ash
Unit Weight: 95 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: G-G (PROPOSED CLOSURE)
ANALYSIS: Post-Earthquake Condition - Rotational
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

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Phi: 30 °

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Cohesion: 0 psf
Phi: 27 °

Name: Stacked Ash
Unit Weight: 95 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay Alluvium - Post EQ
Unit Weight: 120 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Native Sand - Liquefied
Unit Weight: 115 pcf
Tau/Sigma Ratio: 0.25
Minimum Strength: 0

Name: Sluiced Ash - Liquefied
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.06
Minimum Strength: 0

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
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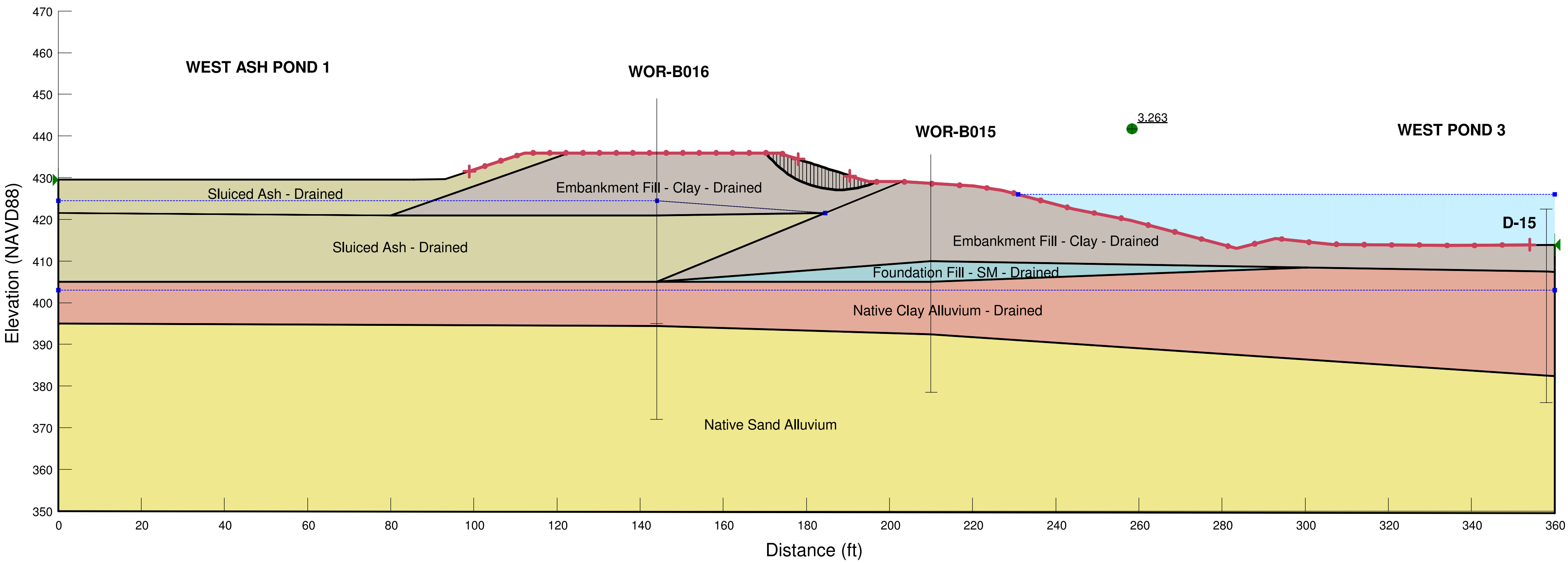
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



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Cohesion: 0 psf
Phi: 27 °

Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Native Sand Alluvium
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Cohesion: 0 psf
Phi: 32 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
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CROSS SECTION: K-K (PROPOSED CLOSURE)
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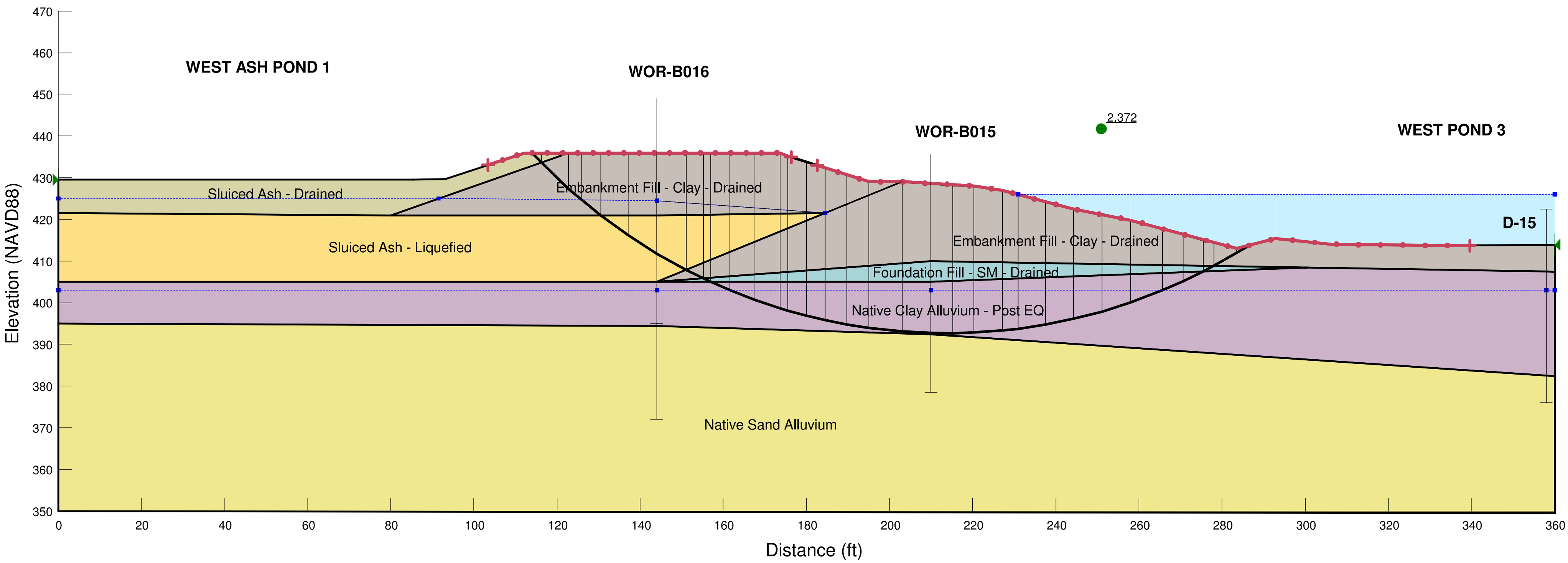

MATERIAL PROPERTIES

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Tau/Sigma Ratio: 0.06
Minimum Strength: 0

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Cohesion: 100 psf
Phi: 30 °

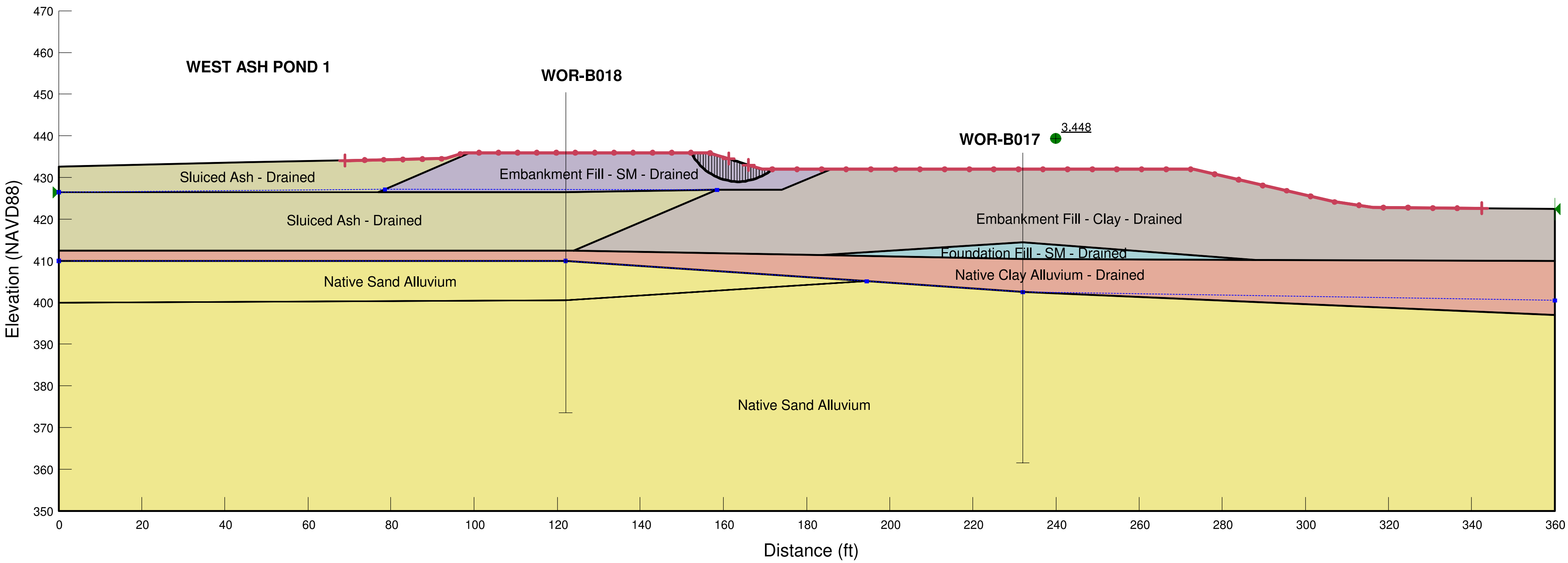
Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Native Clay Alluvium - Post EQ
Unit Weight: 120 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: L-L (PROPOSED CLOSURE)
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

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Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °
Piezometric Line: 2

Name: Embankment Fill - SM - Drained
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Piezometric Line: 1

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: L-L (PROPOSED CLOSURE)
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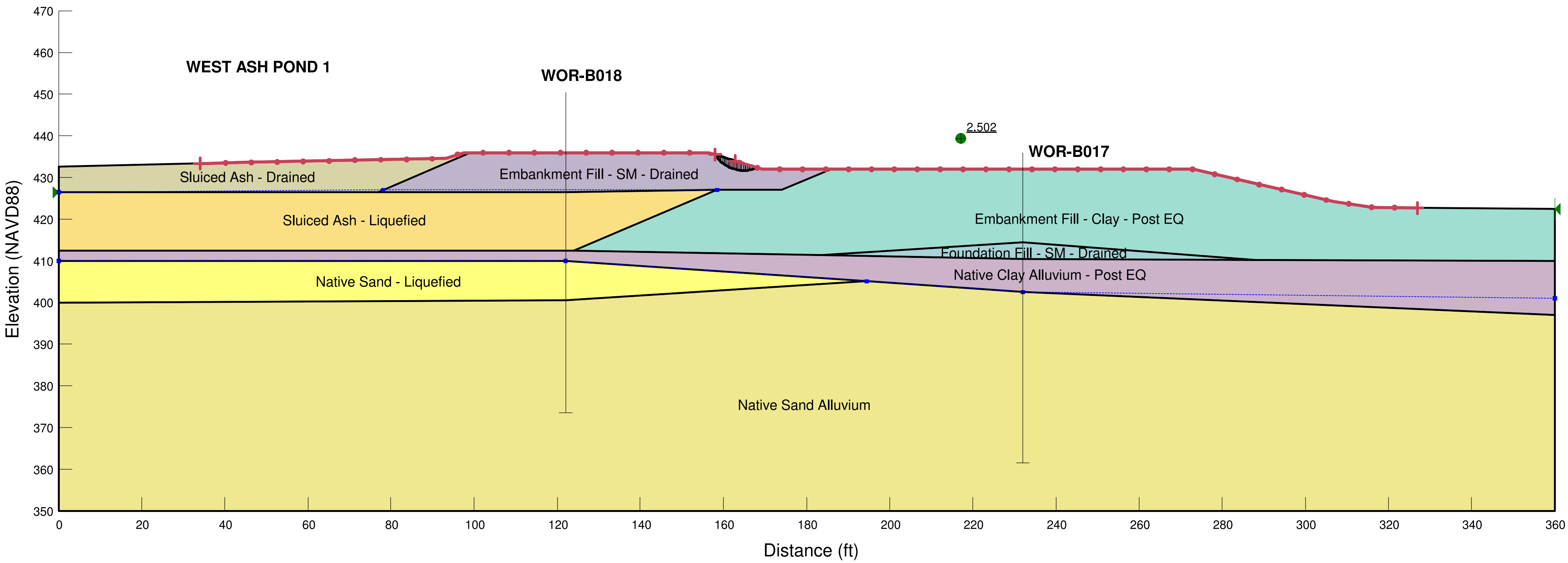

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Tau/Sigma Ratio: 0.06
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Tau/Sigma Ratio: 0.2
Minimum Strength: 0

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Minimum Strength: 0

Name: Foundation Fill - SM - Drained
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Cohesion: 0 psf
Phi: 28 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
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Name: Native Sand - Liquefied
Unit Weight: 115 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
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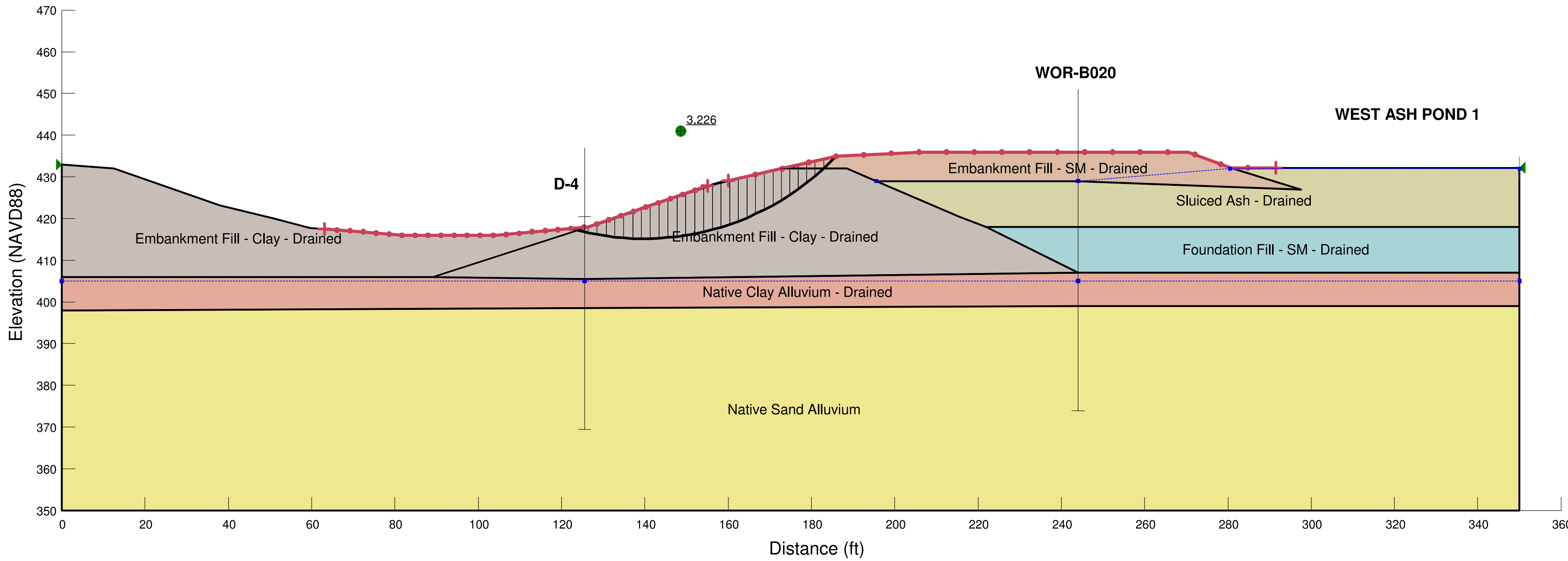
SEISMIC LOAD: 0 g



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Phi: 33 °

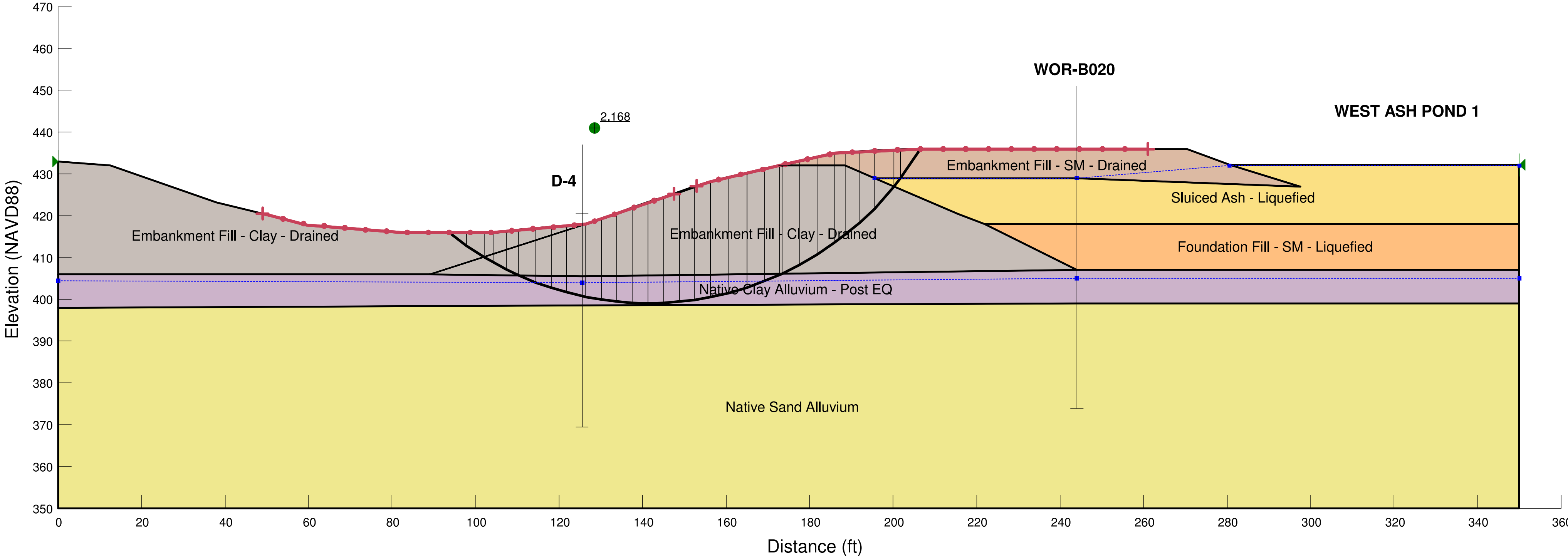
Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: M-M (PROPOSED CLOSURE)
ANALYSIS: Post-Earthquake Condition - Rotational
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

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Phi: 30 °

Name: Embankment Fill - SM - Drained
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 33 °

Name: Native Clay Alluvium - Post EQ
Unit Weight: 130 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Foundation Fill - SM - Liquefied
Unit Weight: 115 pcf
Tau/Sigma Ratio: 0.08
Minimum Strength: 0

Name: Sluiced Ash - Liquefied
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.06
Minimum Strength: 0

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Attorney Client Privileged

Attachment D.2
Hydrology and Hydraulics Analysis

<u>**Objective**</u>: **This analysis describes the independent investigation and design calculations and considerations of the on-site hydrology and hydraulics for closure of the West Ash Pond Complex as required by the Environmental Protection Agency's (EPA's) Final Coal Combustion Residuals (CCR) Rule. In particular, the analysis investigates the performance of the existing spillways and outlet structures for the West Ash Pond Complex during the 100-year/24-hour storm event as required by Illinois Department of Natural Resources regulations, as well as for a 100-year/24 hour storm for proposed conditions for the 30% closure design. AECOM evaluated how the onsite hydraulics will be affected by the proposed closure plan of the West Ash Pond Complex. AECOM also investigated the East Ash Ponds as they relate to concerns affecting the West Ash Pond Complex. In addition, the analyses evaluate how large flows from off-site affect the Station operations.**

I. Overview

Dynegy Wood River Power Station (WRPS) is located in Madison County and approximately 5 miles west of Alton, Illinois. The WRPS is effectively hydraulically divided into two sections, west and east, by the railroad east of Ponds 1 and 3.

The West Ash Pond Complex is a 50 acre inactive complex consisting of three CCR ponds, West Ash Ponds 1, 2E and 2W, separated by splitter dikes. Pond 3 acts as a stormwater polishing pond. All three CCR ponds will be closed in place using a combination of a conventional earth soil cover system and an alternative geosynthetic cover system. Pond 3 will remain operational after the closure of the West Ash Complex ash ponds.

West Ash Ponds 1, 2W, and 2E were all originally hydraulically linked as one pond, but have since been separated by previous projects completed in the 1990s. Currently, Ponds 1 and 2W are both hydraulically isolated from of the rest of the West Ash Pond Complex as they have no outlets and are completely surrounded by clay dikes. In addition, they both are no longer receiving ash. The only inflow into either pond comes from rain falling directly into them. Both ponds along with Pond 2E are to be capped and closed as a separate scope of this project.

Pond 2E and Pond 3 are hydraulically linked and are still active. Pond 2E receives both stormwater and plant process flows and Pond 3 receives only decanted water and stormwater. Plant flows into Pond 2E (approximately equal to 20.1 cubic feet per second (CFS)) travel from the southwest corner of Pond 2E where it settles, and decanted water flows into Pond 3 through a weir controlled catch basin at the northeast corner of Pond 2E. Pond 3 was originally separated into two sections, A and B, but they have since been connected into one lined pond. Pond 3 now polishes received water before it discharges into a riser and through a 24-inch HDPE pipe at the south end of the pond. The riser pipe discharges to a ditch east of the railroad track separating the west systems from the east. This discharge enters a series of ditches separated by culverts that runs along the north side of the East Ash Ponds and discharges into Wood River through a 72-inch culvert. The plant process water pipes will be rerouted to Pond 3 by others. Once Pond 1, 2W, and 2E are closed and capped, Pond 3 will receive plant process flows, stormwater runoff from these ponds (as well as the adjacent coal pile), and direct rainfall into the pond.

The East Ash Ponds consist of the Primary East Ash Pond and the Secondary East Ash Polishing Pond. The Primary East Ash Pond historically received sluiced ash and process flows from the plant aside from the flow that is pumped into the West Ash Pond Complex.

The perimeter dikes for all CCR surface impoundments on site have a "Significant" hazard rating as described in the EPA's Final Coal Combustion Residuals (CCR) Rule and by the Illinois Department of Natural Resources Title 17 Regulations.

Pond 3 is a polishing stormwater pond and not a CCR pond. Since it has a storage volume less than 1000 acre-feet it is considered to be a small Class II (Significant) dam according to IDNR Title 17 Regulations. The selected design storm under the proposed closure design shall be the 100-year/24-hour flood.

The engineering scope associated with this purpose is listed below:

- AECOM developed an existing and proposed H&H model for the west portion of the WRPS with the HydroCAD modeling program utilizing existing data, as built design drawings, and data from both an aerial survey and a ground survey performed in October 2015 (**Reference 2**). This data was supplemented with topographical LIDAR data obtained from the State. The topographical information was used to determine the offsite drainage areas. This offsite drainage area does not flow into the West Ash Pond Complex or East Ash Ponds, but it is necessary to analyze site tailwater conditions. The existing and proposed layouts of the modeling are shown in Figures 1 and 2 in **Attachment 1**. The modeling results are incorporated into this analysis with conclusions.
- HydroCAD modeling was used to estimate floods up to the 100-year flood for on-site flooding conditions, and to evaluate if off site flooding could impact the WRPS site.
- The East Ash Ponds and the West Ash Pond Complex were incorporated into the existing and proposed HydroCAD models for the entire site.
- On-site drainage was estimated from design drawings, reports, site visits, surveys and other available information and was one model included both the western and eastern systems.

- The West Ash Pond Complex consists of Pond 1, 2W, 2E, and is hydraulically connected to Pond 3. It also includes the series of ditches and culverts north of the East Ash Ponds. During large enough floods it is possible that the West Ash Pond Complex affects the flooding around the east ponds. Flooding in these areas is also a function of whether the levee is open or closed. Once the levee is closed, the low-lying area above the discharge pipe would tend to flood due to on site drainage not being able to leave the site, which is exacerbated due to discharges from Pond 3.
- The site modeling includes all impoundments, their drainage areas, and their control structures and includes all areas of the site that will act as additional storage during large floods.

II. Selected Methods:

- HydroCAD 10.00-12 was used to model the routing, storage, and conveyance of stormwater and process water flow through the ponds and ditches, and into Wood River.
- Within the HydroCAD program, runoff was calculated using the SCS TR-20 method and the routing was completed using the Dynamic Storage-Indication method, where the stage-discharge and storage-indication curves are re-evaluated at each time step, based on the current elevation of any downstream nodes. This allows the routing to respond to ongoing tailwater changes, rather than assuming static tailwater conditions. This results in a more accurate representation of controls on the system throughout a flood event.
- Drainage areas, volumes, and other site geometry were calculated using the AutoCAD 2014 Civil 3D software package.

III. Design Criteria

- Acceptance criteria for the closure design are based on whether Pond 3 and the proposed closure design for West Ash Pond Complex can pass the 100-year, 24- hour storm event without overtopping its embankments.
- All storm calculations are to include the anticipated tailwater conditions during high (100-year flood) flows on the Mississippi River and Wood River. It is assumed that during high flows on Wood River, the outlet through the levee will be closed off.
- All plant process flows along with stormwater flows from the coal pile will be routed to Pond 3.

IV. Data & Assumptions

The following is a list of assumptions and determining factors used for the HydroCAD modeling effort:

- All elevations are converted to the North American Vertical Datum of 1988 (NAVD88) from the National Geodetic Vertical Datum of 1929 (NGVD 29) which is about 1.5 inches lower than the NAVD88 datum.
- The storage areas north of the West Ash Pond Complex and the East Ash Ponds were derived from LIDAR information data. (**Reference 1**).
- There are no emergency spillways for the western or eastern stormwater systems at the site.
- The normal operating water surface elevations of the interior ponds, on-site berm elevations, control structure inverts, and other relevant hydraulic controls are taken from a site survey performed October, 2015 (**Reference 2**), from design drawings, and LIDAR information. The normal operating pool for Pond 3 was derived from the modeled steady-state condition using an estimated base flow of 20.1 cfs. This was estimated from the Wastewater Flow Diagram (**Reference 8**).
- Offsite drainage areas were estimated from the Alton Quadrangle and the Columbia Bottom Quadrangle topo from The National map **(References 3 and 4)**.
- The Mississippi River and Wood River 100-year flood elevation, as determined by the FEMA Flood Profile as shown in **Attachment 3**, was used for the worst-case tailwater condition (**References 5 and 6**).
- The maximum 100-year water surface elevation for Wood River at the discharge point of the final 72-inch CMP is due to Mississippi River backwater and is taken from the FEMA Flood Profile (**Reference 6**) for Wood River located in the Madison County Flood Insurance Study (**Reference 7**). The 100-year water surface elevation for Wood River and the Mississippi River is 437.0 ft.
- There is a large offsite storage area northwest of Pond 2W that collects the western portion of the offsite drainage area. This drainage area lies just north of the US Army Corps of Engineers pump station and stores stormwater up to an elevation of roughly 413.0 ft with a maximum surface area of about 31 acres.
- The expected maximum volume of process flows being discharged into Pond 3 is approximately 20.1 CFS (**Reference 8**).

V. Hydrology

The analysis of the West Pond Complex consists of estimating the watershed hydrology, the onsite storage area, the drainage control parameters, and the Wood River tailwater conditions. The on-site analysis consists of estimating the on-site drainage areas, storage area of the ash ponds and the capacity of the conveyance structures.

Pond storage areas were calculated by using AutoCAD Civil 3D and used as inputs into the HydroCAD model. Weirs and other control structure dimensions and elevations were taken from design plans, surveys, LIDAR data, and existing reports.

The description of what was used in the analysis is as follows:

West Pond Complex Drainage System

Proposed Conditions

Proposed Drainage Area – Survey and USGS

The proposed conditions include installation of a graded cap installed over Pond 2W, 2E and Pond 1. The cap that will be installed over Ponds 2W and 2E will have 2 channels graded into it that each flow into Pond 3 through a 24-inch pipe. The southern ditch has an approximate drainage area of 14.99 acres and the northern ditch has an approximate drainage area of 10.07 acres. The cap that will be installed over Pond 1 will have 3 channels graded into it that each flow into Pond 3 through a 24-inch pipe. The westernmost channel has an approximate drainage area of 7.32 acres. The middle channel has an approximate drainage area of 7.66 acres. The easternmost channel has an approximate drainage area of 5.73 acres. The drainage areas for proposed Pond 1 and Ponds 2E and 2W are confined to the area within their perimeter berms as shown on the clip below of the proposed Western Pond Complex.

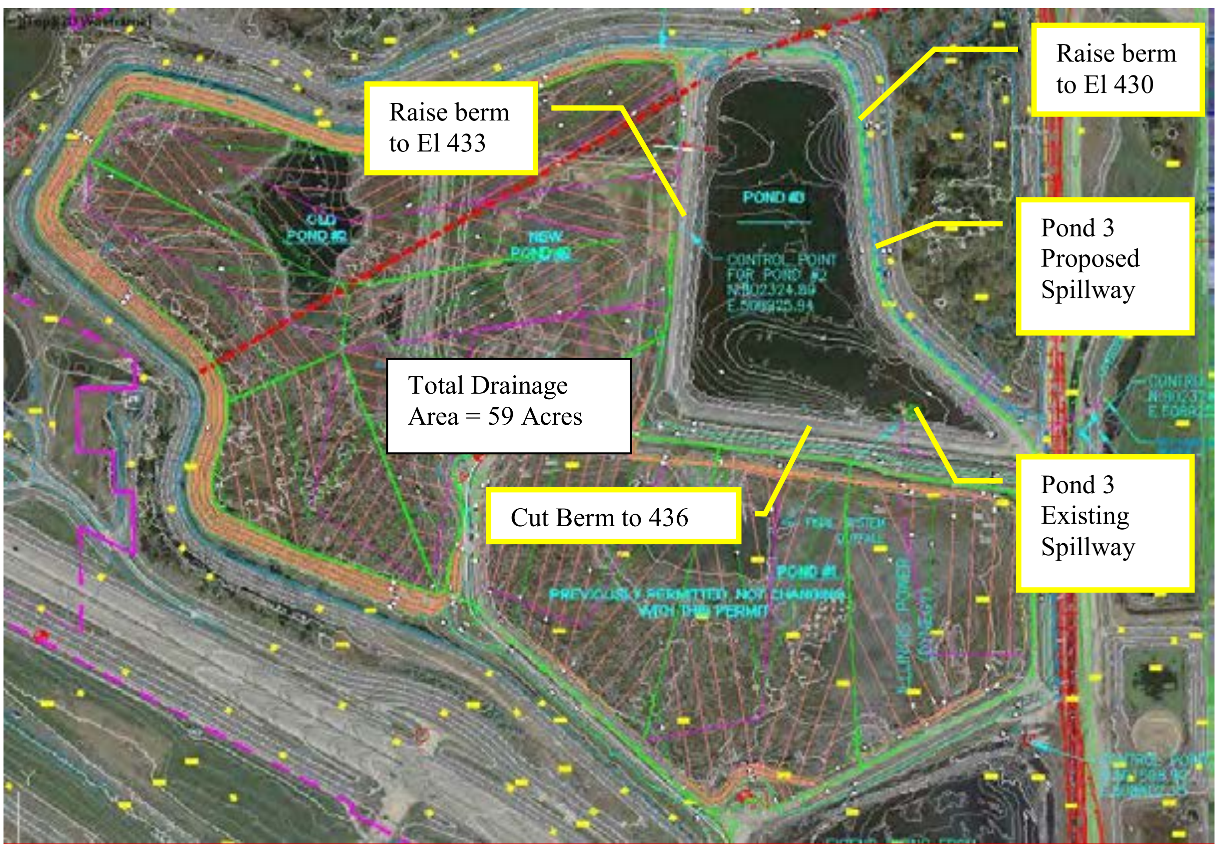
The proposed drainage area for the total watershed in the Western Pond Complex was estimated to be 59 acres. The digital elevation model (DEM) developed from LIDAR data was developed from the site survey performed October, 2015 (**Reference 2**).

AECOM developed the DEM of the site and the surrounding area with a 5-foot grid size to estimate the drainage area, pond storage areas and flow patterns as shown in the clip below. In this manner, the most accurate available information for the area was used to confirm that the watershed divide are accurately estimated. Based on the surveys, DEM, and USGS quadrangle, AECOM estimated the watershed drainage area to be 59 acres.

Proposed Watershed Data – CN, Flow Length, Land Use, Tc

AECOM used information from the site survey to calculate storage. For the drainage area to the northern ditch of the Pond 2E and 2W cap, a CN of 84 and a time of concentration of 11.4 minutes were used. For the drainage area to the southern ditch of the Pond 2E and 2W cap, a CN of 84 and a time of concentration of 12.1 minutes were used. For the drainage area to the western ditch of the Pond 1 cap, a CN of 84 and a time of concentration of 12.2 minutes were used. For the drainage area to the middle ditch of the Pond 1 cap, a CN of 84 and a time of concentration of 13.6 minutes were used. For the drainage area to the eastern ditch of the Pond 1 cap, a CN of 84 and a time of concentration of 12.1 minutes were used. The curve number of 84 was used for all flow over the cap system.

As part of the closure, the embankment around Pond 3 will need be raised to elevation of 430.0 ft is sufficient to allow 0.5 feet of freeboard during the 100-year flood. The embankment between Pond 2E and Pond 3 will need to be raised to an elevation of 433.0 ft and the embankment between Pond 1 and Pond 3 will be lowered to an elevation of 436.0 ft. As a result of these configurations around the perimeter of Pond 3, all of the access roads surrounding the pond will drain into it. This added drainage area is estimated to be 4.63 acres with a CN of 84 and a time of concentration of 2.2 minutes.



Clip of AutoCAD Civil 3-D showing West Pond Complex Drainage Areas

Proposed Storage Areas

AECOM used information from the proposed surfaces to calculate proposed storage areas for the analysis, which included all the ponded areas above Pond 3. Existing storages that will not change in the proposed conditions model were not revised. Original storage areas were used for the area east of the railroad near the West Ash Pond Complex, where stormwater discharges from Pond 3.

To calculate all of the storage areas, AECOM used the AutoCAD Civil 3D to determine stage storage relationships from the proposed surface data. In this manner, accurate estimated stage-storage relationships are used to calculate storage. AECOM used the cumulative storage at each stage as input in HydroCAD to calculate how much the storage attenuates flood discharges.

Using the stage-storage relationships for the pond system, the flood peak attenuation due to storage was estimated for the proposed cap system, as was the maximum water surface in Pond 3. Water surface elevations in each basin were calculated to determine if raising of the embankments are required due to lack of capacity. Flooding impacts were evaluated to develop flood improvement alternatives for the West Ash Pond Complex.

The clip on the previous page depicts the locations of the West Ash Pond Complex units and depiction of the proposed HydroCAD modeling that shows the drainage areas and storage areas that will convey flows to Pond 3 which will discharge from the existing spillway. It also depicts the East Ash Ponds which discharge to Wood River.

The top of the eastern embankment is set to 430.0 ft to have a minimum of 0.5 feet of freeboard during the design storm and to allow for dewatering of the pond to prevent subsequent storms from overtopping the pond.

Western Pond Complex Drainage System

Rainfall Information and Distributions

The rainfall information used in the HydroCAD modeling was based on the NOAA Atlas 14, Volume 8, Version 2 (**Reference 10**) which provides rainfall data for storm events with average recurrence intervals ranging from 1 to 1,000 years and durations ranging from 5 minutes to 60 days. The data obtained from the NOAA website is presented in **Attachment 2** and the NOAA depths used for the AECOM modeling are provided below. The maximum estimated rainfall depths were used in the modeling to be conservative.

The following chart shows the rainfall depths and recurrence intervals for the storms modeled, in addition to the distributions applied to the rainfall depth.

Return Period (Years)	Rainfall Depth (Inches)	Duration (Hours)	Rainfall Distribution
10-year	5.47	24	SCS Type II
25-year	6.95	24	SCS Type II
50-year	8.06	24	SCS Type II
100-year	9.38	24	SCS Type II

The SCS Type II storm, 24-hour rainfall distribution used by AECOM is appropriate to use for storms up to the 100-year flood at the project site.

In addition to the 100-year storm, AECOM estimated the smaller storms for comparison and to allow for only pipe full conditions during the 25-year storm in the ponded areas upstream of Pond 3. The rainfall depths used in the analysis are dependent on the return period of the storm, but their distribution is not.

Wood River/Mississippi River Water Levels

The final outfall of the West Pond Complex is through a 72-inch pipe controlled by the Wood River Drainage and Levee District (WRDLD) that discharges into Wood River. The WRDLD controls when the pipe through the levee will be closed and monitors high water conditions of Wood River and the Mississippi River. Since the 72-inch CMP discharge directly into Wood River, high water surface elevations in the river will submerge the pipe and reduce its capacity. The 72-inch pipe was assumed to be closed during high water levels on the river to determine tailwater effects on the Pond 3 spillway performance.

The maximum 100-year water surface elevation of Mississippi River was used to model high tailwater conditions as a worst case scenario. In this condition, the 72-inch discharge pipe through the levee was considered closed. For the high water level, the FEMA Flood Insurance Study Flood Profile (**Reference 7**) was used to estimate the water surface elevation at the outlet point of the 72-inch pipe. The 100-year water surface elevation that AECOM calculated off of the Flood Insurance Rate maps is 437.0 ft, which was used in the AECOM HydroCAD modeling for high tailwater conditions. For low water conditions, the river level was assumed to be below the culvert outlet invert elevations and the culverts remain inlet controlled. Low flow conditions on the river do not influence the culverts' performance and the culverts' outlets are in free discharge conditions. AECOM used a low flow river elevation of 395.5 ft (**Reference 12**) in the models.

The required drawdown for the site is based on the Programmatic Document which requires that the ash ponds shall be drained to normal pool within 3 days after the design storm. None of the West Ash Pond Complex ponds are controlled by high water elevation of Wood River or the Mississippi River.

In addition, TR-60 Guidelines suggests that the required drawdown at a critical facility shall be 85% of the inflow volume released within 10-days. To drain 85% of the design inflow volume in the current pond system, if the Mississippi River was at low or high stage, it would take approximately 1 day to drain Pond 3.

The Pond 3 primary spillway acts as a drawdown structure to drain 85% of the proposed design inflow volume from the pond within the required time. Drawdown calculations are provided in in the HydroCAD output in **Attachment 4**.

VI. <u>Hydraulics</u>

All hydraulic modeling was done on HydroCAD using information from the aforementioned LIDAR data, site survey, and as-built drawings provided by Dynegy. Storage areas were calculated based on the most recent topography while inverts and other details for outlet structures were taken from surveys and as built drawings.

Manning's Roughness Coefficient (n-value)

Manning's values were selected on HydroCAD based on the material of each conveyance structure. Each 24-inch pipe draining the ditches on the proposed caps used a Manning's number of 0.012.

Headwall Inlet Losses

The AECOM HydroCAD model incorporated the same head loss coefficient for each outlet. Unless otherwise specified, a square edged concrete headwall was selected in the HydroCAD model. This is the most conservative approach.

Road Weir Length, Geometry, and Weir Coefficients

- Discharges over roads are most accurately modeled using the broad-crested weir equation. The HydroCAD modeling included broad crested weirs at the perimeters of each pond and each miscellaneous drainage area.

$$Q = C \times L \times H^{1.5}$$

Where Q = Flow over weirs,

L = Crest length

H = Head above invert elevation

C = Weir coefficient, variable based on head and breadth of weir

	Weir Breadth--(ft)										
Head	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.0	15.0
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

Broad Crested Weir Coefficients

- The weir lengths estimated for each elevation are not fixed, but vary based upon depth of flow and the surveyed topography. The flow lengths are dynamically calculated in HydroCAD based upon the depth of flow at each time interval.
- The overtopping weir lengths were taken from the road information developed in the LIDAR survey, as it was considered the most accurate information. The weir lengths were calculated in AutoCAD Civil 3D. The survey was used to estimate inverts (low points on the crown of the roads/top of railroad tracks) for the broad crested overtopping weirs.
- The broad crested weir coefficient is a function of depth of flow, and the weir geometry controls depth. The overtopping width of the road weir is over 15-feet and the weir coefficient is expected to range from 2.63 to 2.70. A weir coefficient of 2.70 was used to model the road weirs to be conservative. The railroad track control width is approximately 7 ft and the weir coefficient is expected to range from 2.40 to 2.68 based on the anticipated maximum depth of 1 ft. A weir coefficient of 2.68 was used to model the railroad track weirs as they are less efficient, and to be conservative.

VII. Results

HydroCAD H&H Model Output –Proposed Conditions

Table 1 below summarizes the results of AECOM's HydroCAD model for the proposed site conditions. Refer to **Attachment 4** for the associated detailed HydroCAD output reports.

Table 1 - Flooding Scenarios for Proposed conditions

Storage Area	Flood Event	Qpeak in (cfs)	Qpeak out (cfs)	Storage[1] (acre-feet)	Max WSE(ft)
Pond 1 cap west ditch	100-yr/24-hr	126	21	1.91	431.20
Pond 1 cap middle ditch	100-yr/24-hr	93	23	2.96	430.72
Pond 1 cap east ditch	100-yr/24-hr	57	17	1.06	430.51
Pond 2 cap North Ditch	100-yr/24-hr	104	29	1.64	431.88
Pond 2 cap South Ditch	100-yr/24-hr	142	29	1.65	431.91
Pond 3	100-yr/24-hr	276.9	97.3	42.4	429.6

[1] The storage is the amount of water stored in the area upstream of the outlet structure

It should be noted that **Table 1** represents the proposed conditions "worst-case" scenario for the 100-yr/24-hr storm with the outlet to Wood River closed off. The top of the adjacent road is verified by the surveyed low point on each road and is the overtopping control elevation. The weir lengths were also taken from the aerial survey and weir coefficients are estimated based on flow depth.

Pond 2W and 2E

- Ponds 2W and 2E will be regraded and capped. There will be two ditches, north and south, that convey the stormwater runoff from each of their respective drainage areas.
- Both ponds have a 24-inch culvert to convey their stormwater into Pond 3. Culverts were designed to pass the 25-year storm at pipe full conditions, and attenuate the 100-year storm.
- The only inflow into these ditches is the rainfall that falls directly onto the cap, as there is no run-on to the cap system. The northern ditch has a storage area of 4 acre-feet. The southern ditch has a storage area of 3.36 acre-feet.

- The road between Pond 2E and Pond 3 will need to be raised to an elevation of 433.0 ft to avoid overtopping during the 100-year flood. In addition, the liner for the pond must be at or above an elevation of 427.0 ft.

Pond 1

- Pond 1 will be regraded and capped. There will be three ditches, east, middle, and west, that convey the stormwater runoff from each of their respective drainage areas.
- All three ditches will have a 24-inch culvert to convey the stormwater into Pond 3. Culverts were designed to pass the 25-year storm at pipe full conditions, and attenuate the 100-year storm.
- The only inflow into these ditches is the rainfall that falls directly onto the cap, as there is no run-on to the cap system. The western ditch has a storage area of 6.51 acre-feet. The middle ditch has a storage area of 12.06 acre-feet. The eastern ditch has a storage area of 7.34 acre-feet.
- The road between Pond 1 and Pond 3 is to be lowered to an elevation of 436.0 ft to minimize elevation differences in the access road. The liner for Pond 3 should be at or above an elevation of 427.0 ft.

Pond 3

- Pond 3 will be hydraulically connected to Ponds 2E, 2W, and 1.Pond 3 will also receive rainwater that falls directly onto Pond 3 and its surrounding embankments.
- It is estimated that Pond 3 will receive approximately 20.1 CFS of plant process flows. This was estimated from the Wastewater Flow Diagram (**Reference 8**).
- The pond has a live storage volume of 49.1 acre-feet.
- The Pond 3 existing spillway will not be modified in the proposed conditions, however an emergency spillway will need to be constructed.
- The proposed emergency spillway will have a bottom width of 15 feet with 10H:1V side slopes to allow for vehicle traffic. It has an invert elevation of 428.5 feet and shall be lined with a minimum of 30 inches thick of grouted IDOT RR 7 Stone with 12 inches of bedding. The relevant calculations can be found in **Attachment 5**.
- With the updated LIDAR survey data, the elevation of the lowest portions of the access road around Pond 3 was shown to be 428.0 ft. With all of the new inflows from plant process water, Ponds 2W, 2E and 1 the maximum water surface elevation of Pond 3 gets to 429.6 ft. To maintain 0.5 feet of freeboard during the 100-year flood, it will be necessary to the access road at an elevation of at least 430.0 ft.

- The water that leaves Pond 3 through the original outlet structure still travels through a series of ditches and culverts north of the East Ash Ponds before finally reaching the 72-inch CMP that drains into Wood River.
- The 100-year inflow into the pond is 276 cfs , with a discharge of 97.3 cfs and a peak elevation of 429.6 ft.
- With AECOM's proposed design, there is no overtopping from the 100-year flood.
- The inlet and outlet inverts for the 72-inch CMP are below the 100-year water surface of Mississippi River. The Pond 3 primary spillway discharge is a function of the downstream tailwater. The 72-inch CMP would need to be closed to prevent the site from being submerged by the Mississippi River during its 100-year peak. Closure of the 72-inch CMP due to high water levels on Mississippi River would affect the tailwater condition of the Pond 3 primary spillway.

VIII. Conclusions/Recommendations

The following conclusions and recommendations are based on the Existing Conditions HydroCAD model of the West Ash Pond Complex.

Conclusions

- There is no anticipated overtopping of the West Ash Pond Complex or the East Ash Ponds during the 100-year flood in the existing conditions.
- West Ash Ponds 1, 2W, 2E, and 3 have no overtopping during the 100-year/24-hr flood that is required per the IDNR regulations.
- The 72-inch CMP that outlets into Wood River will need to be closed during semi-recurrent intervals due to backwater from the Wood River and Mississippi River to prevent flooding of the site. The 100-year flood elevation of the Mississippi River is 437.0 ft.
- All on-site and off-site drainage areas are able to contain the 100-year/24-hr flood within the site without overtopping and potentially failing ash pond embankments.
- The extent of the ponded water upstream of the 72-inch CMP remains within the property boundaries during the 100-year flood with Wood River at its normal pool elevation.
- Existing West Ash Ponds 1, 2W, 2E, and Pond 3 all have 0.5 ft of freeboard during the 100-year/24-hr flood.

Recommendations

The following recommendations were developed based on the results of the hydrologic and hydraulic analysis of the existing on-site drainage conditions and are based on the Existing and Proposed Conditions HydroCAD models of the West Ash Pond Complex.

- It is recommended that each ditch in the Pond West Ash 2E, 2W, and 1 cap drains into a separate 24-inch culvert that drains into Pond 3. The inverts will vary and are provided as part of the HydroCAD output in **Attachment 4.**
- It is recommended that the road between West Ash Pond 2E and Pond 3 is raised to an elevation no less than 433.0 ft to avoid overtopping into Pond 3. In addition, it is recommended that the road between Pond 1 and Pond 3 be lowered to an elevation no more than 436.0 ft to minimize grade changes on the access road.
- It is recommended that a minimum of 0.5 ft of freeboard is maintained on the ponds during the 100-year flood. The north and eastern portions of the access road surrounding Pond 3 should be raised to an elevation of 430.0 ft due to the peak

100-year water surface elevation of 429.6 ft. The access road between Pond 2 and Pond 3 should be maintained at a constant elevation of 433.0 ft due to the peak 100-year water surface elevation of 432.0 ft in Pond 2E.

IX. References

1) LIDAR Survey, Illinois Geospatial Data Clearinghouse, Prairie Research Institute, 2014.

2) Topographical Survey, Weaver Consulting Group, October 2015.

3) Alton Quadrangle,7.5-minute series , Alton, Illinois, U.S. Topo, The National Map, U.S. Geological Survey, United States Department of the Interior, 2015.

4) Columbia Bottom Quadrangle,7.5-minute series , Alton, Illinois, U.S. Topo, The National Map, U.S. Geological Survey, United States Department of the Interior, 2015.

5) Flood Profile, Mississippi River, FEMA Flood Insurance Study page 24, Madison County, Illinois, Effective January, 1980.

6) Flood Profile, Wood River, FEMA Flood Insurance Study page 25, Madison County, Illinois, Effective January, 1980.

7) FEMA Flood Insurance Study, Madison County, Illinois, Effective January, 1980.

8) Wastewater Flow Diagram Wood River Power Station, Illinois Power Company, Plotted 8-18-1988.

9) Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds, United States Department of Agriculture (USDA), 1986.

10) NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 8, Version 2, 2013. http://hdsc.nws.noaa.gov/hdsc/pfds/index.html.

11) NOAA Hydrometeorological Report No. 51 (HMR-51) "Probable Maximum Precipitation Estimates, United State East of the 105th Meridian", dated June, 1978.

12) River and Reservoir Daily Report, U.S Army Corps of Engineers, St. Louis District, Dated November 11, 2015.

13) Design Drawings, East Ash Pond, Wood River Power Station, URS Corp., 2006.

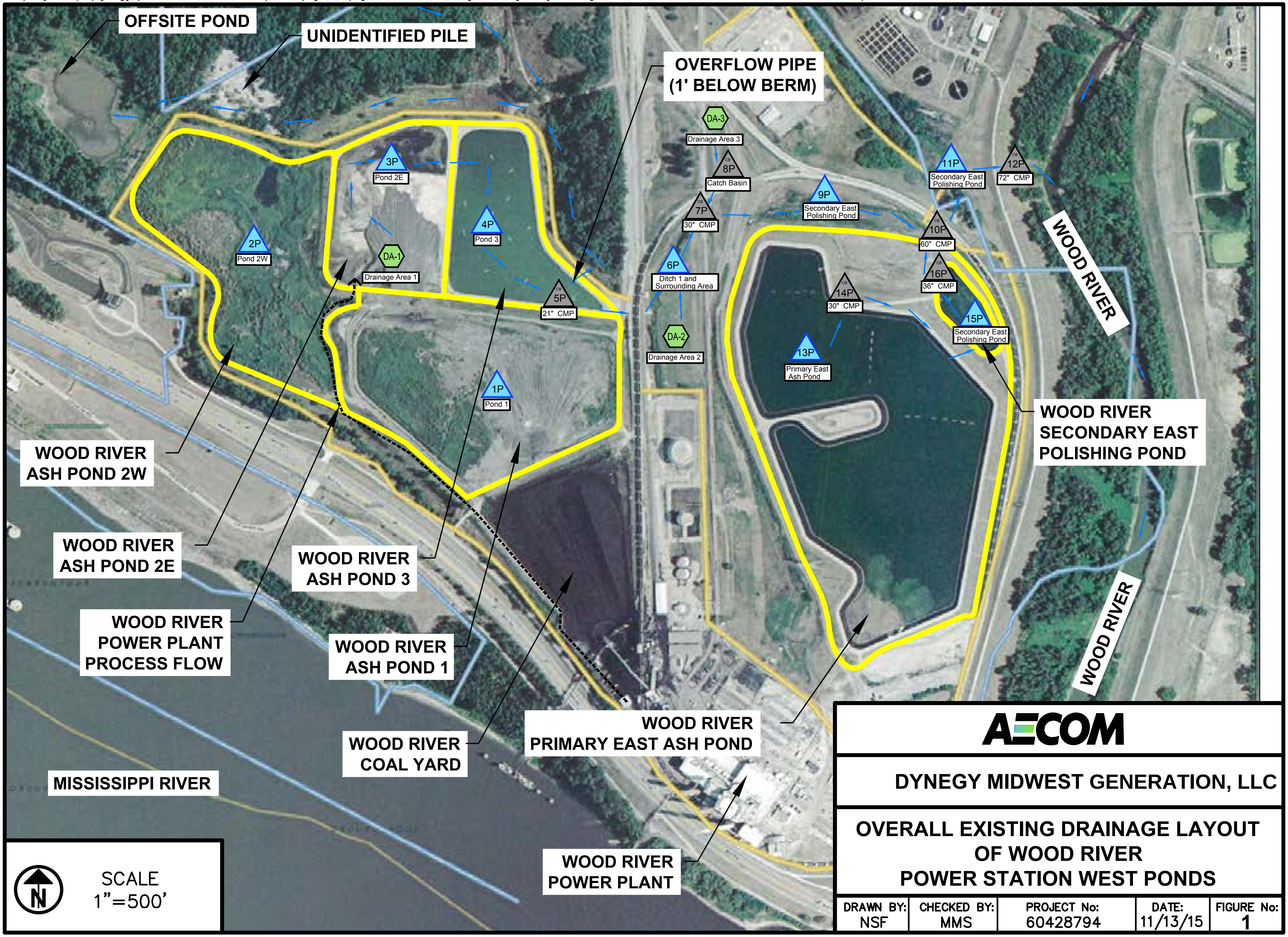
List of Figures

List of Attachments

ATTACHMENT 1

AUTOCAD FIGURES

K:\Projects\D\Dynegy\60428794_WoodRiver\DWGs\Figures\Fig 1_Overall Existing Drainage Layout.dwg User: michael_shore Nov 11, 2015 – 6:01pm



AECOM

DYNEGY MIDWEST GENERATION, LLC

OVERALL EXISTING DRAINAGE LAYOUT OF WOOD RIVER POWER STATION WEST PONDS

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
NSF	MMS	60428794	11/13/15	1

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AECOM

DYNEGY MIDWEST GENERATION, LLC.

OVERALL PROPOSED DRAINAGE LAYOUT OF WOOD RIVER POWER STATION WEST POND COMPLEX

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
NSF	MMS	60428794	11/13/15	2

AECOM

ATTACHMENT 2

WOOD RIVER, ILLINOIS, US, POINT PRECIPITATION FREQUENCY ESTIMATES

NOAA Atlas 14, Volume 8, Version 2
Location name: Wood River, Illinois, US*
Latitude: 38.8587°, Longitude: -90.1131°
Elevation: 425 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point 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	0.369 (0.293-0.464)	0.433 (0.344-0.544)	0.536 (0.425-0.676)	0.621 (0.490-0.785)	0.737 (0.563-0.948)	0.825 (0.619-1.07)	0.913 (0.665-1.20)	1.00 (0.704-1.34)	1.11 (0.758-1.52)	1.20 (0.800-1.66)
10-min	0.540 (0.429-0.679)	0.634 (0.503-0.797)	0.785 (0.622-0.990)	0.910 (0.717-1.15)	1.08 (0.825-1.39)	1.21 (0.906-1.57)	1.34 (0.974-1.76)	1.46 (1.03-1.97)	1.63 (1.11-2.23)	1.76 (1.17-2.43)
15-min	0.658 (0.523-0.828)	0.773 (0.614-0.972)	0.958 (0.759-1.21)	1.11 (0.875-1.40)	1.32 (1.01-1.69)	1.47 (1.10-1.91)	1.63 (1.19-2.15)	1.79 (1.26-2.40)	1.99 (1.35-2.72)	2.14 (1.43-2.97)
30-min	0.939 (0.747-1.18)	1.11 (0.879-1.39)	1.38 (1.09-1.73)	1.60 (1.26-2.02)	1.89 (1.44-2.43)	2.12 (1.59-2.75)	2.34 (1.70-3.08)	2.56 (1.80-3.43)	2.84 (1.93-3.88)	3.05 (2.03-4.22)
60-min	1.22 (0.968-1.53)	1.43 (1.13-1.79)	1.77 (1.40-2.23)	2.05 (1.62-2.59)	2.45 (1.87-3.16)	2.75 (2.07-3.58)	3.06 (2.23-4.05)	3.38 (2.38-4.54)	3.80 (2.59-5.21)	4.12 (2.75-5.70)
2-hr	1.50 (1.20-1.86)	1.75 (1.40-2.17)	2.16 (1.73-2.69)	2.51 (2.00-3.14)	3.00 (2.33-3.85)	3.39 (2.58-4.38)	3.79 (2.79-4.98)	4.20 (2.99-5.62)	4.76 (3.27-6.49)	5.19 (3.48-7.14)
3-hr	1.67 (1.35-2.06)	1.93 (1.56-2.39)	2.38 (1.92-2.95)	2.77 (2.22-3.44)	3.33 (2.61-4.26)	3.79 (2.90-4.88)	4.26 (3.17-5.59)	4.76 (3.41-6.36)	5.46 (3.77-7.42)	6.00 (4.04-8.23)
6-hr	1.99 (1.63-2.43)	2.28 (1.87-2.79)	2.80 (2.29-3.43)	3.27 (2.65-4.02)	3.97 (3.15-5.05)	4.55 (3.53-5.83)	5.17 (3.88-6.74)	5.83 (4.22-7.75)	6.77 (4.72-9.17)	7.52 (5.11-10.2)
12-hr	2.35 (1.95-2.84)	2.69 (2.23-3.26)	3.31 (2.73-4.01)	3.88 (3.18-4.71)	4.72 (3.79-5.97)	5.44 (4.26-6.92)	6.21 (4.71-8.04)	7.04 (5.14-9.29)	8.22 (5.78-11.1)	9.18 (6.27-12.4)
24-hr	2.75 (2.30-3.28)	3.16 (2.64-3.77)	3.89 (3.24-4.66)	4.55 (3.78-5.47)	5.56 (4.51-6.95)	6.41 (5.07-8.06)	7.31 (5.60-9.38)	8.29 (6.10-10.9)	9.69 (6.87-13.0)	10.8 (7.44-14.5)
2-day	3.18 (2.70-3.76)	3.67 (3.11-4.34)	4.54 (3.83-5.37)	5.31 (4.46-6.31)	6.47 (5.30-7.98)	7.43 (5.93-9.25)	8.45 (6.52-10.7)	9.55 (7.08-12.4)	11.1 (7.92-14.7)	12.3 (8.55-16.5)
3-day	3.49 (2.98-4.09)	4.04 (3.44-4.74)	4.99 (4.24-5.87)	5.83 (4.93-6.89)	7.08 (5.82-8.66)	8.10 (6.50-10.0)	9.17 (7.12-11.6)	10.3 (7.68-13.3)	11.9 (8.54-15.7)	13.2 (9.19-17.6)
4-day	3.75 (3.22-4.38)	4.34 (3.72-5.07)	5.35 (4.57-6.26)	6.23 (5.29-7.32)	7.52 (6.21-9.15)	8.57 (6.90-10.5)	9.66 (7.52-12.1)	10.8 (8.08-13.9)	12.4 (8.93-16.3)	13.7 (9.57-18.2)
7-day	4.46 (3.86-5.15)	5.09 (4.41-5.89)	6.17 (5.32-7.15)	7.09 (6.08-8.26)	8.42 (6.99-10.1)	9.47 (7.68-11.5)	10.6 (8.27-13.1)	11.7 (8.79-14.9)	13.3 (9.57-17.3)	14.5 (10.2-19.1)
10-day	5.08 (4.43-5.84)	5.76 (5.02-6.62)	6.89 (5.98-7.94)	7.85 (6.77-9.08)	9.20 (7.68-11.0)	10.3 (8.36-12.4)	11.4 (8.93-14.0)	12.5 (9.40-15.8)	14.0 (10.1-18.2)	15.2 (10.7-20.0)
20-day	6.86 (6.05-7.79)	7.70 (6.79-8.74)	9.06 (7.96-10.3)	10.2 (8.89-11.6)	11.7 (9.87-13.8)	12.9 (10.6-15.3)	14.1 (11.2-17.1)	15.2 (11.6-19.1)	16.8 (12.2-21.6)	17.9 (12.7-23.4)
30-day	8.33 (7.40-9.39)	9.33 (8.28-10.5)	10.9 (9.68-12.4)	12.2 (10.8-13.9)	14.0 (11.8-16.3)	15.3 (12.6-18.0)	16.6 (13.2-20.0)	17.8 (13.6-22.1)	19.4 (14.2-24.8)	20.6 (14.7-26.8)
45-day	10.2 (9.12-11.4)	11.4 (10.2-12.8)	13.4 (11.9-15.0)	14.9 (13.2-16.8)	17.0 (14.4-19.5)	18.4 (15.3-21.6)	19.9 (15.9-23.8)	21.2 (16.2-26.2)	22.9 (16.8-29.1)	24.1 (17.3-31.3)
60-day	11.8 (10.6-13.1)	13.2 (11.9-14.7)	15.5 (13.9-17.3)	17.2 (15.3-19.3)	19.5 (16.7-22.4)	21.2 (17.7-24.7)	22.7 (18.3-27.1)	24.2 (18.6-29.7)	26.0 (19.1-32.8)	27.2 (19.5-35.2)

[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.

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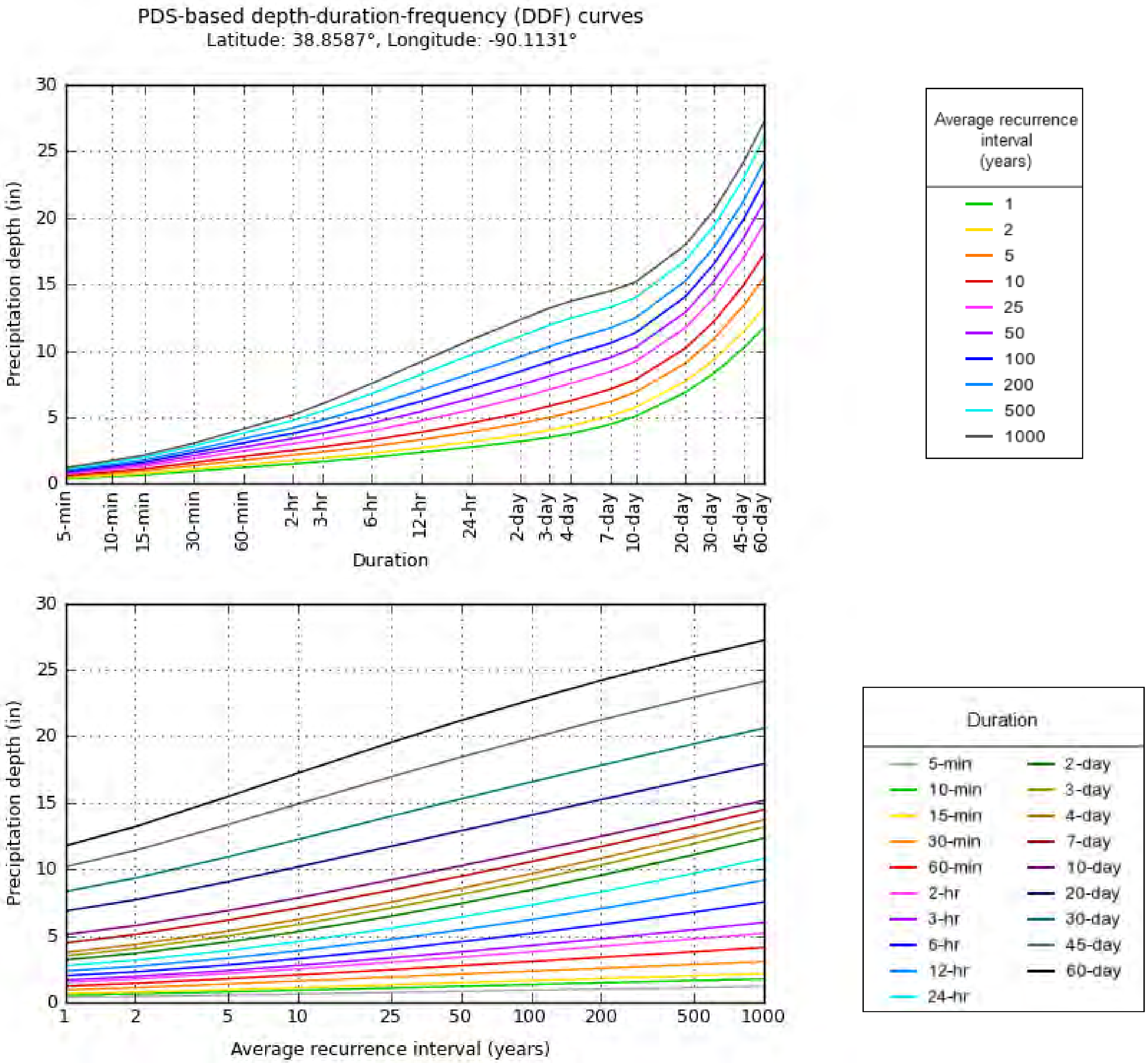
PF graphical



NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Wed Aug 12 18:36:35 2015

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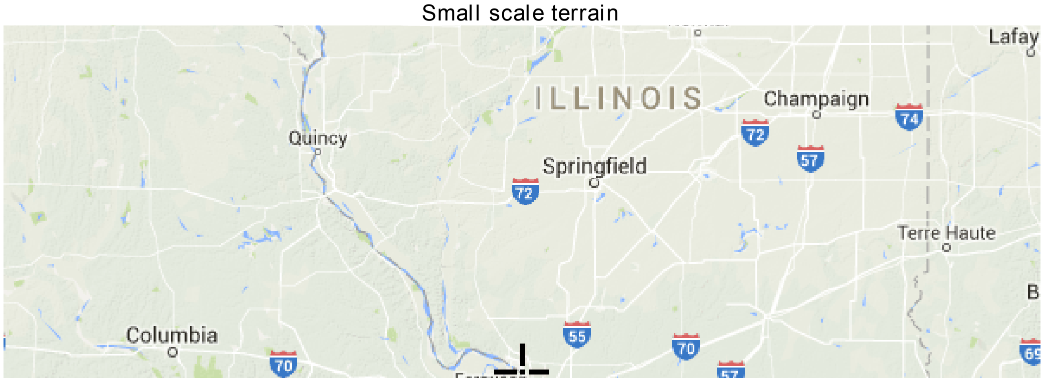
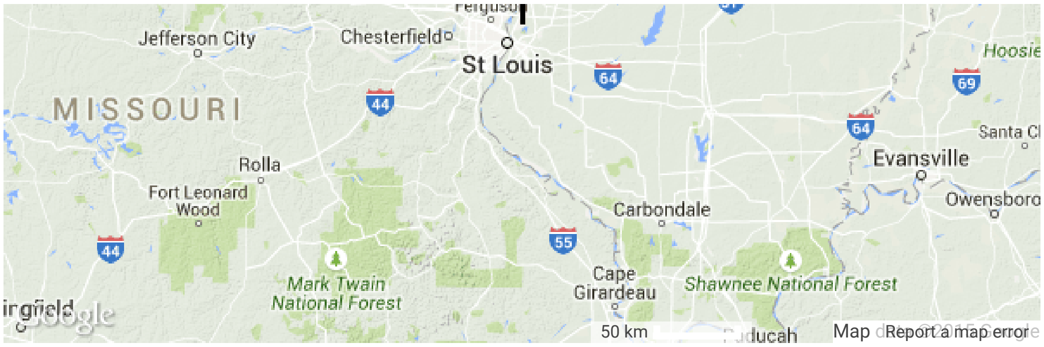
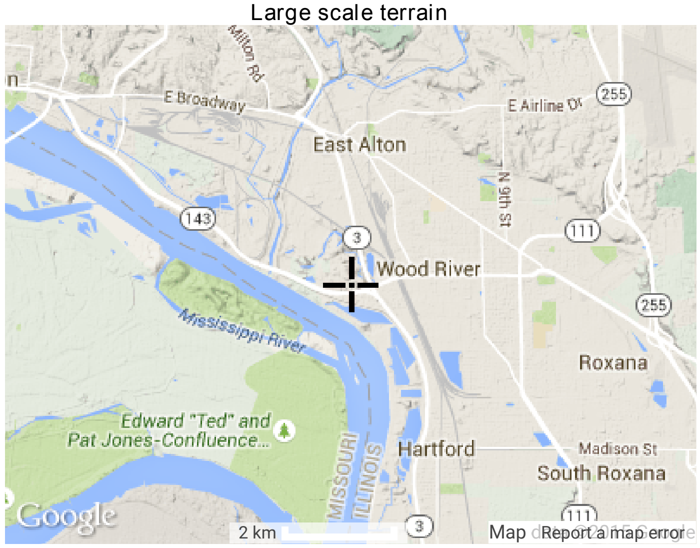
Maps & aerials

Small scale terrain

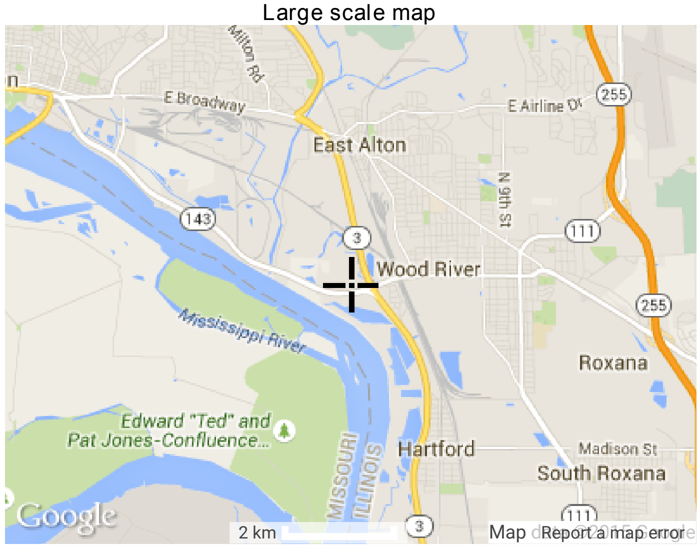




Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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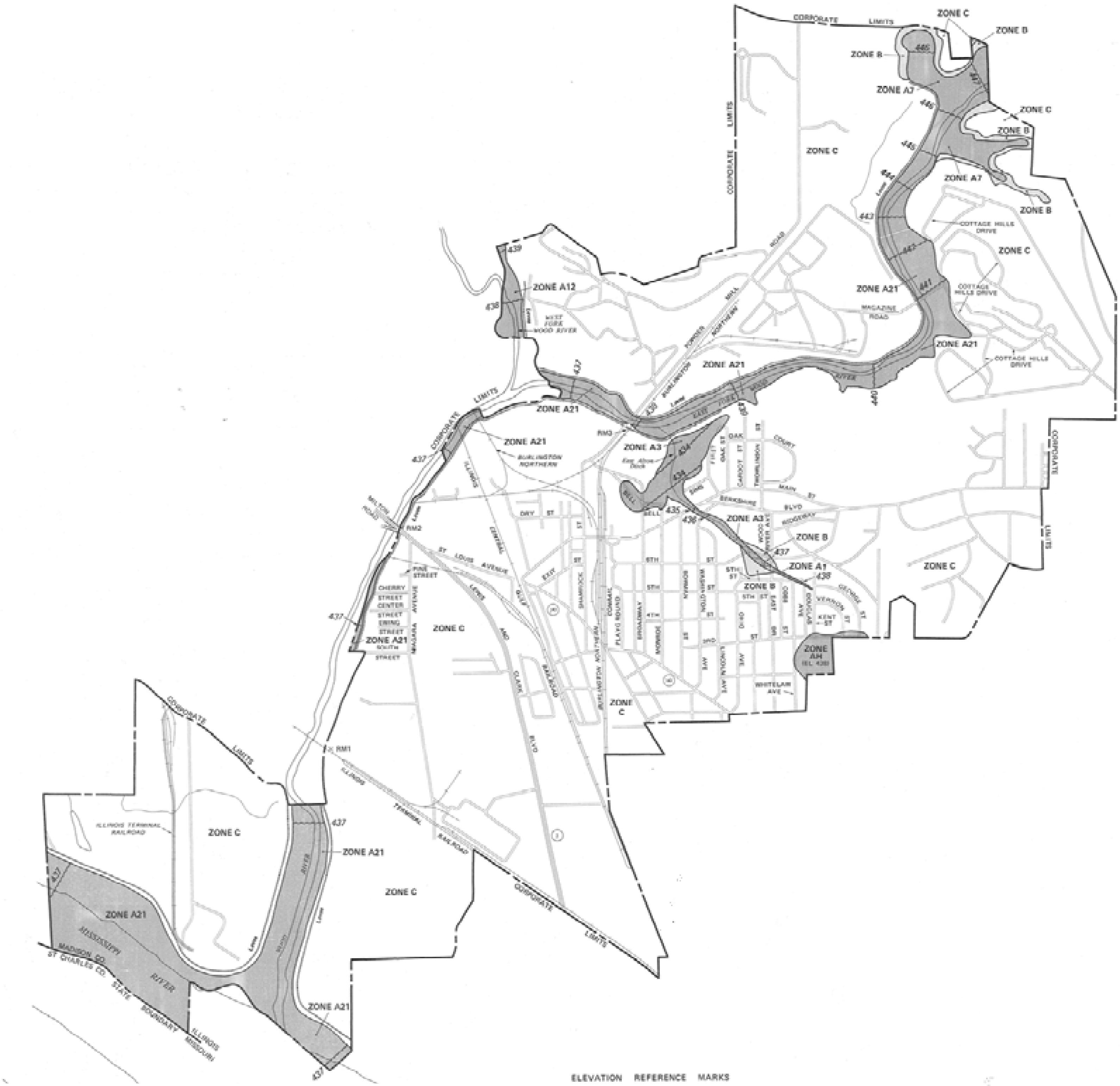
ATTACHMENT 3

FEMA DATA



Elevation Reference Mark RM7 x

River Mile • M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
AO	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

INITIAL IDENTIFICATION:
MAY 17, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:
APRIL 9, 1976

FLOOD INSURANCE RATE MAP EFFECTIVE:
MARCH 18, 1980

FLOOD INSURANCE RATE MAP REVISIONS:

Refer to the CONVERSION TO REGULAR PROGRAM date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620, or (800) 424-8872.

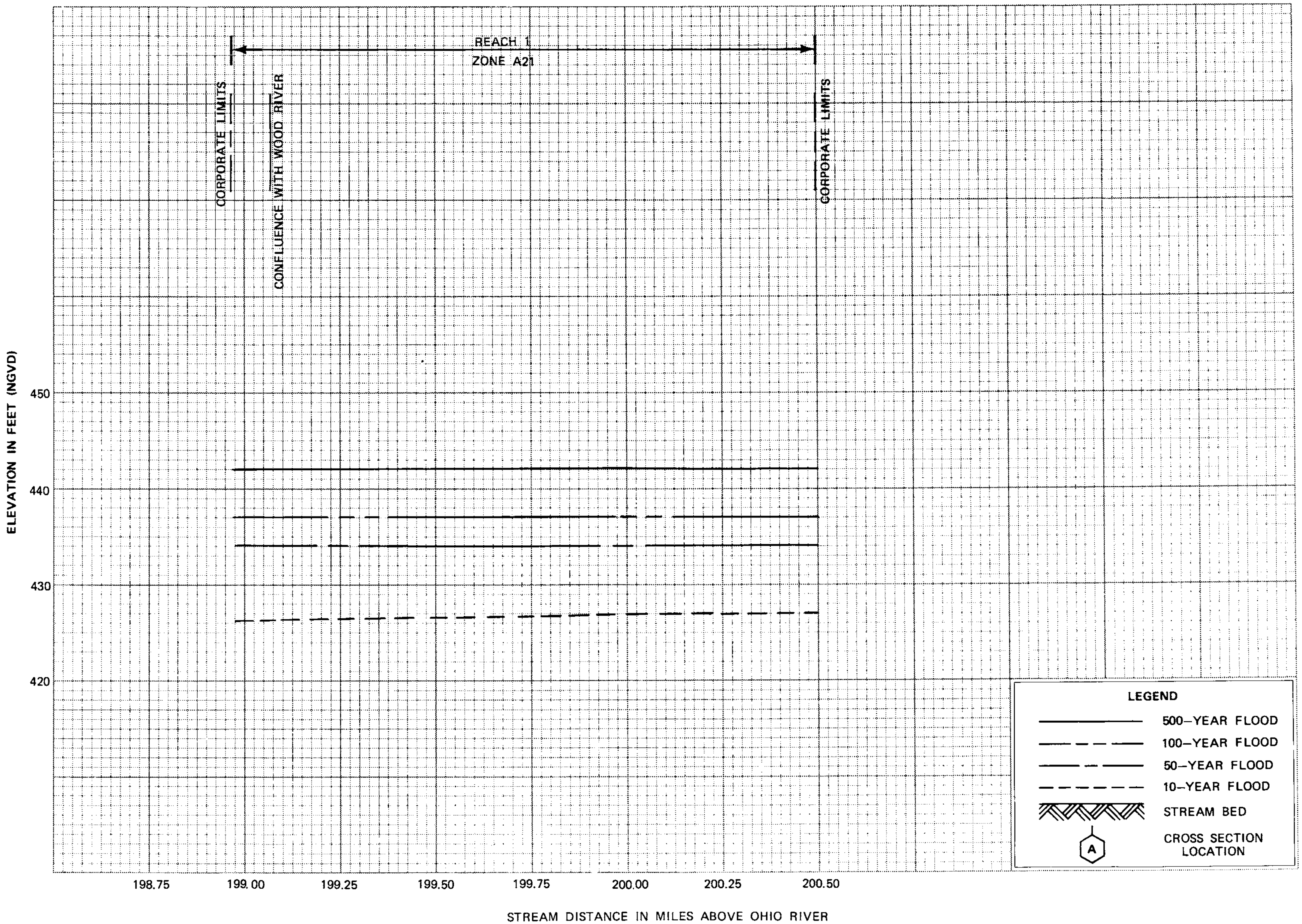
APPROXIMATE SCALE
1000 0 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

VILLAGE OF
EAST ALTON,
ILLINOIS
MADISON COUNTY

(ONLY PANEL PRINTED)



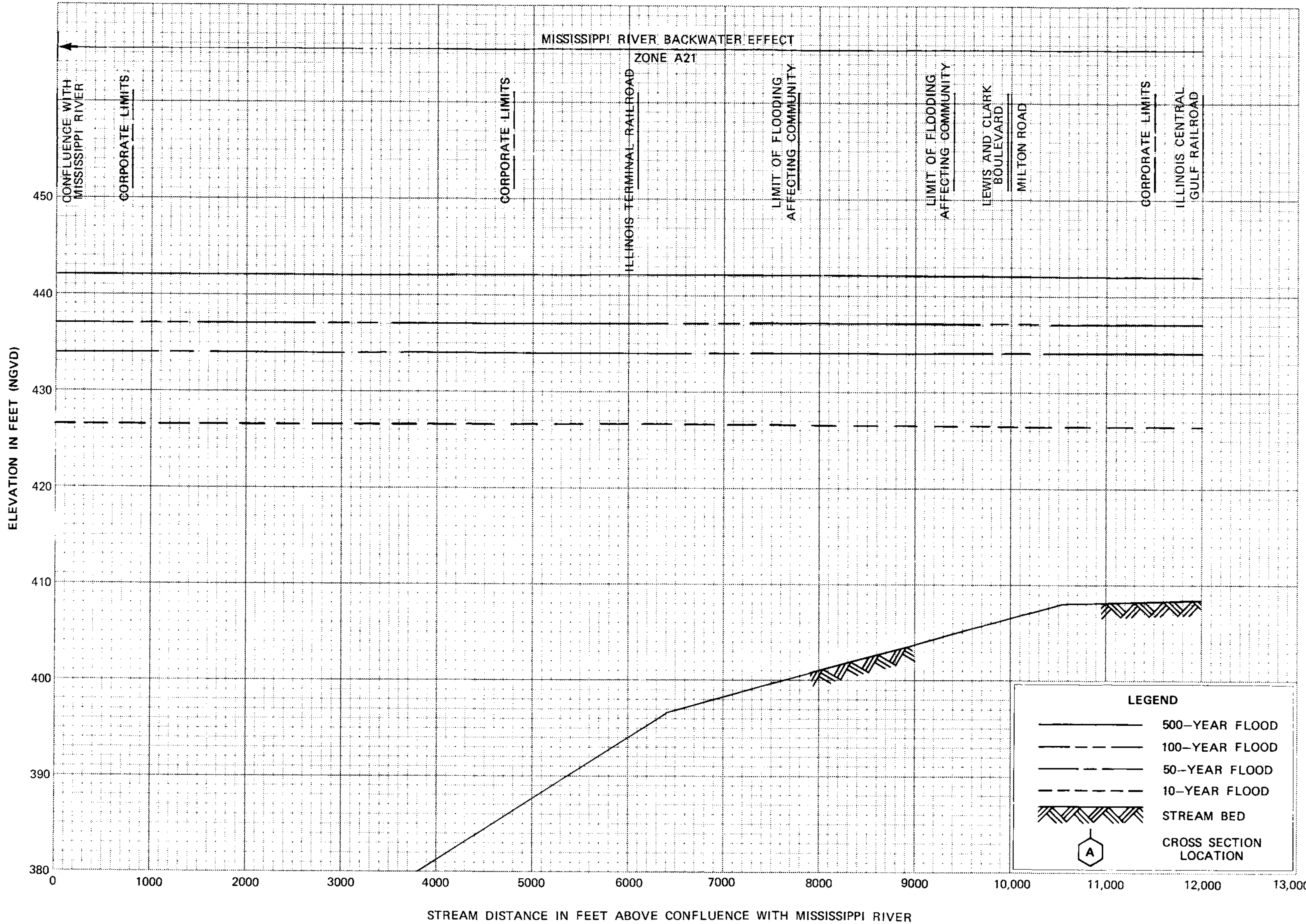
FLOOD PROFILES

MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

VILLAGE OF EAST ALTON, IL
(MADISON CO.)

01P



FLOOD PROFILES

WOOD RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

VILLAGE OF EAST ALTON, IL
(MADISON CO.)

02P

TABLE 1 - SUMMARY OF DISCHARGES

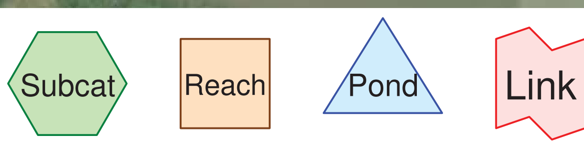
FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CORAL BRANCH CREEK					
Mouth	5.25	2,456	3,584	3,954	4,589
Just upstream of confluence of Black Creek	0.83	816	1,162	1,285	1,490
BELT LINE CREEK					
Mouth	1.16	722	1,169	1,300	1,513
Belt Line Road	0.99	1,041	1,437	1,587	1,883
WEST FORK WOOD RIVER					
At State Highway 140	54.2	9,200	14,600	18,200	24,700
MISSISSIPPI RIVER					
Mile 203	171,000	355,000	460,000	510,000	*650,000
WOOD RIVER					
At mouth	123.0	15,956	25,460	30,450	39,800

*Urban Design

AECOM

ATTACHMENT 4

HYDROCAD REPORT – PROPOSED WEST COMPLEX POND – 100-YEAR



Routing Diagram for Pr West Pond Closure Wood River Station_Buttress_7_8_2016

Prepared by AECOM, Printed 7/8/2016

HydroCAD® 10.00-14 s/n 04378 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Pond 2 South Lower DA

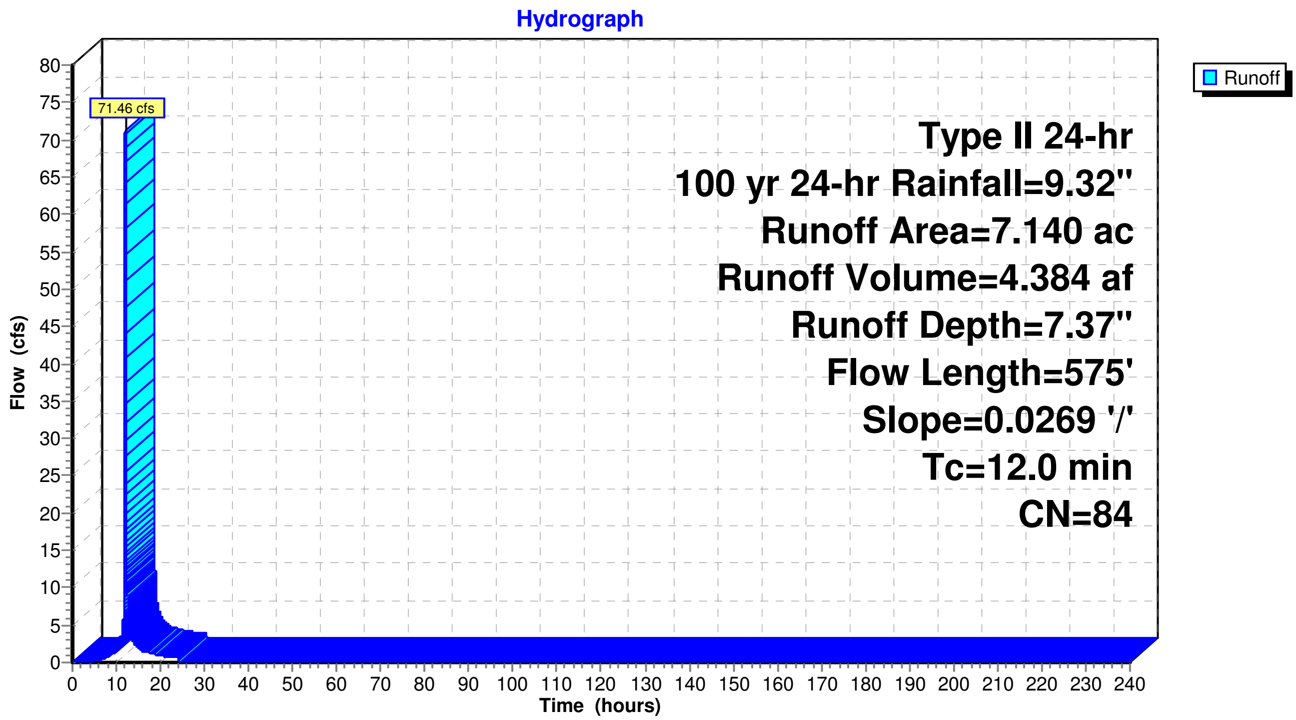
Runoff = 71.46 cfs @ 12.03 hrs, Volume= 4.384 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
7.140	84	50-75% Grass cover, Fair, HSG D
7.140		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	100	0.0269	0.19		**Sheet Flow, sheet flow** Grass: Short n= 0.150 P2= 3.10"
3.2	475	0.0269	2.46		**Shallow Concentrated Flow, shallow conc** Grassed Waterway Kv= 15.0 fps
12.0	575	Total			

Subcatchment 1S: Pond 2 South Lower DA



Summary for Subcatchment 16S: Pond 2 South Upper DA

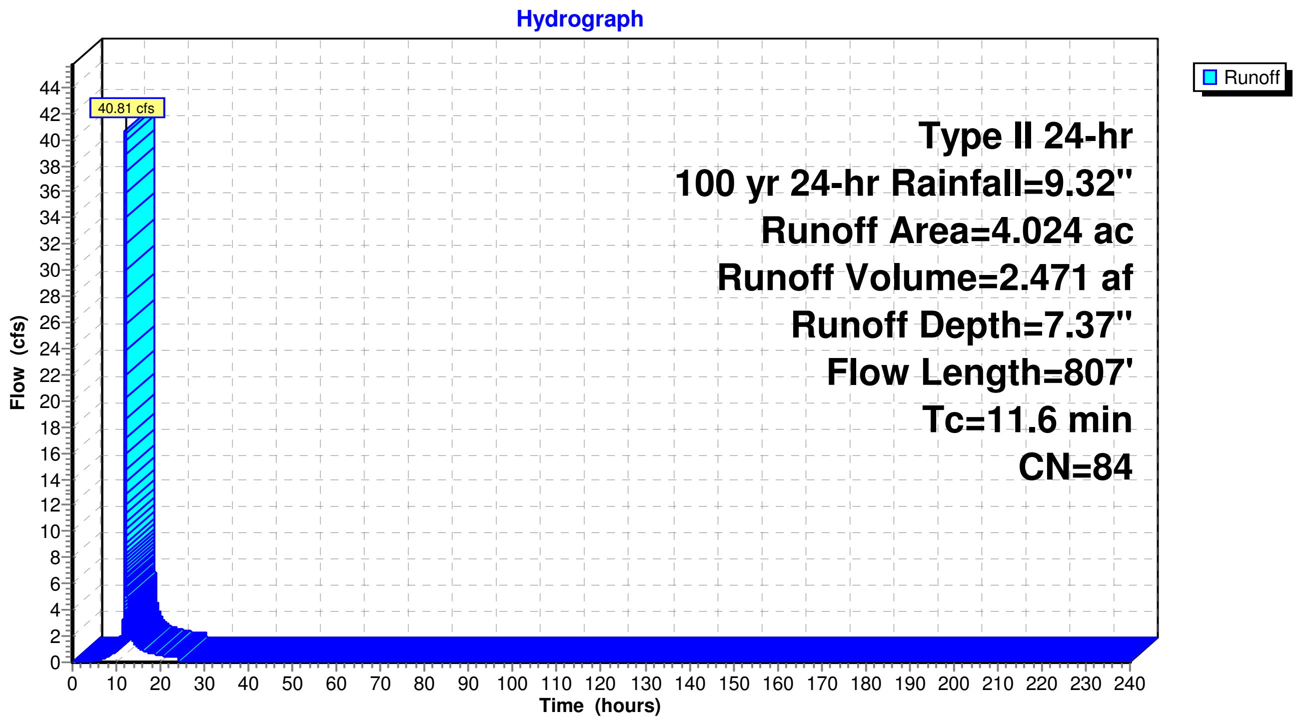
Runoff = 40.81 cfs @ 12.03 hrs, Volume= 2.471 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
4.024	84	50-75% Grass cover, Fair, HSG D
4.024		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	121	0.0251	0.19		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
1.0	686	0.0100	10.95	11,986.99	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=0.00' D=5.00' Z= 47.6 & 40.0 '/' Top.W=438.00' n= 0.025 Earth, grassed & winding
11.6	807	Total			

Subcatchment 16S: Pond 2 South Upper DA



Summary for Subcatchment 19S: Area northwest 1

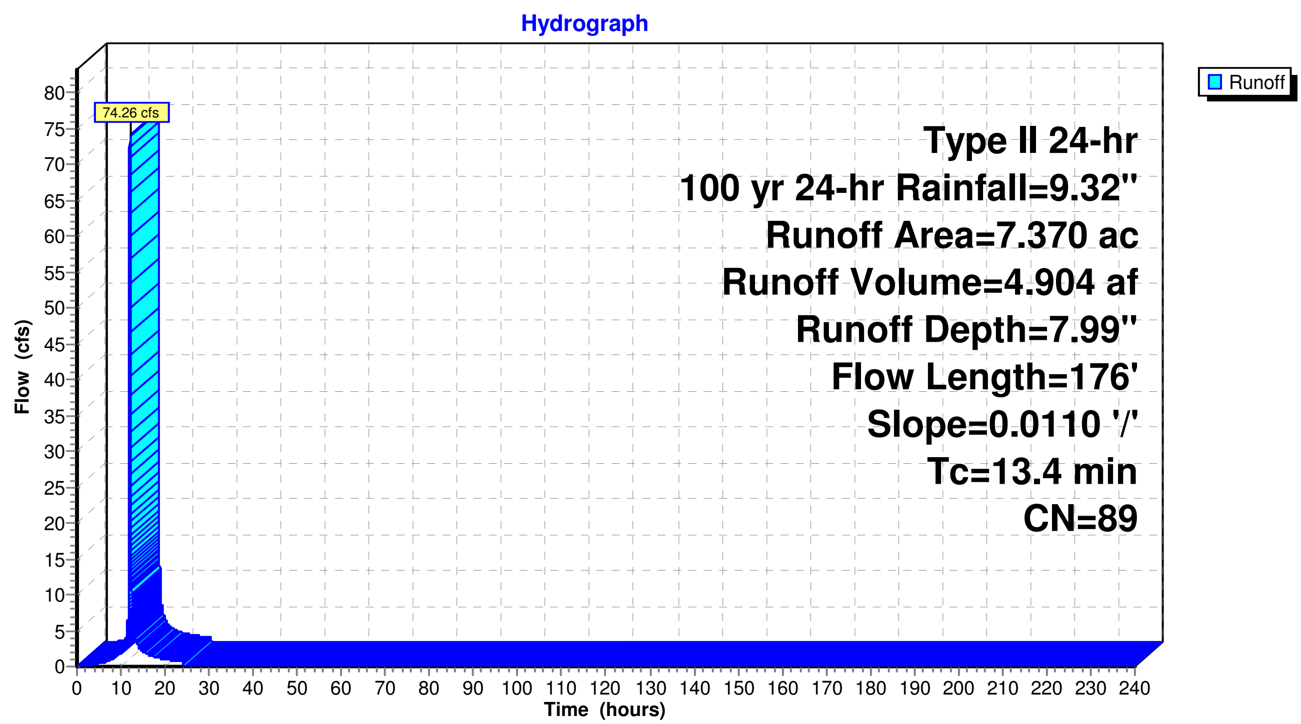
Runoff = 74.26 cfs @ 12.05 hrs, Volume= 4.904 af, Depth= 7.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
7.370	89	<50% Grass cover, Poor, HSG D
7.370		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	100	0.0110	0.13		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
0.8	76	0.0110	1.57		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
13.4	176	Total			

Subcatchment 19S: Area northwest 1



Summary for Subcatchment 20S: Pond 2 South Upper DA

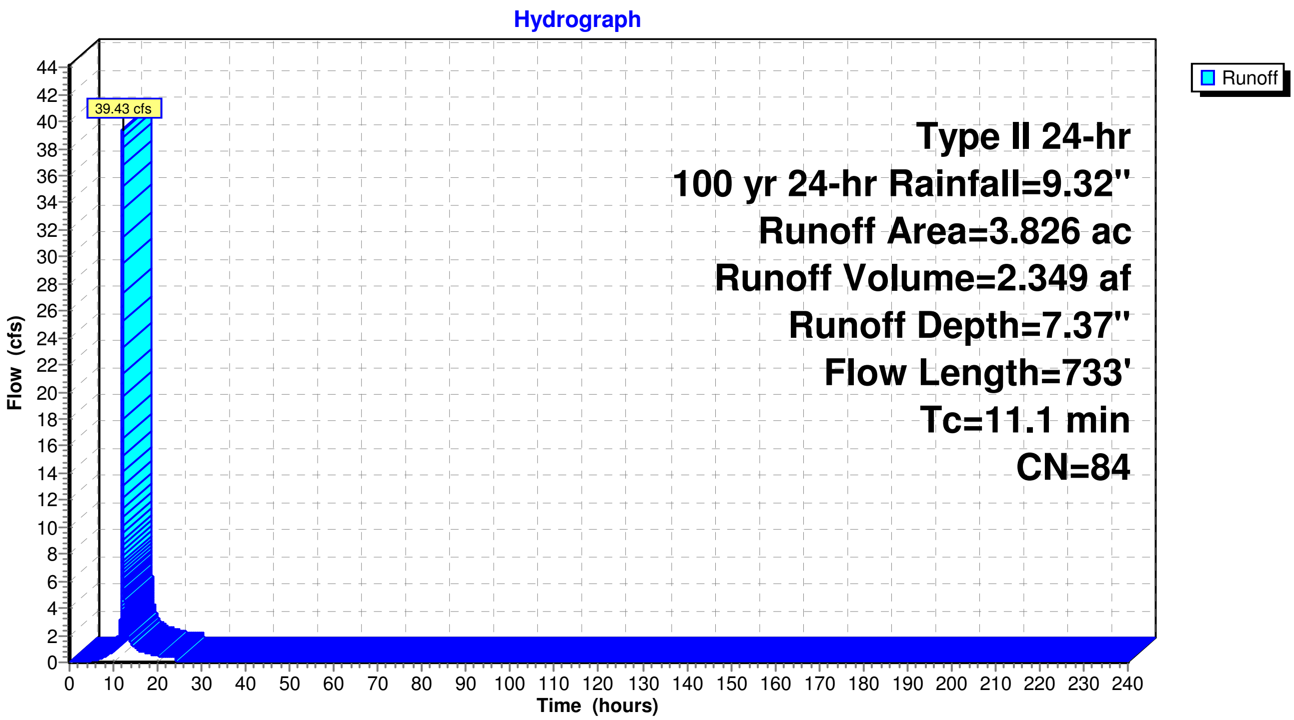
Runoff = 39.43 cfs @ 12.02 hrs, Volume= 2.349 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
3.826	84	50-75% Grass cover, Fair, HSG D
3.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	100	0.0269	0.19		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
1.7	258	0.0269	2.46		**Shallow Concentrated Flow, Shallow Concentrated** Grassed Waterway Kv= 15.0 fps
0.6	375	0.0100	10.95	10,919.28	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=0.00' D=5.00' Z= 39.8 & 40.0 '/' Top.W=399.00' n= 0.025 Earth, grassed & winding
11.1	733	Total			

Subcatchment 20S: Pond 2 South Upper DA



Summary for Subcatchment 23S: Area northeast 4

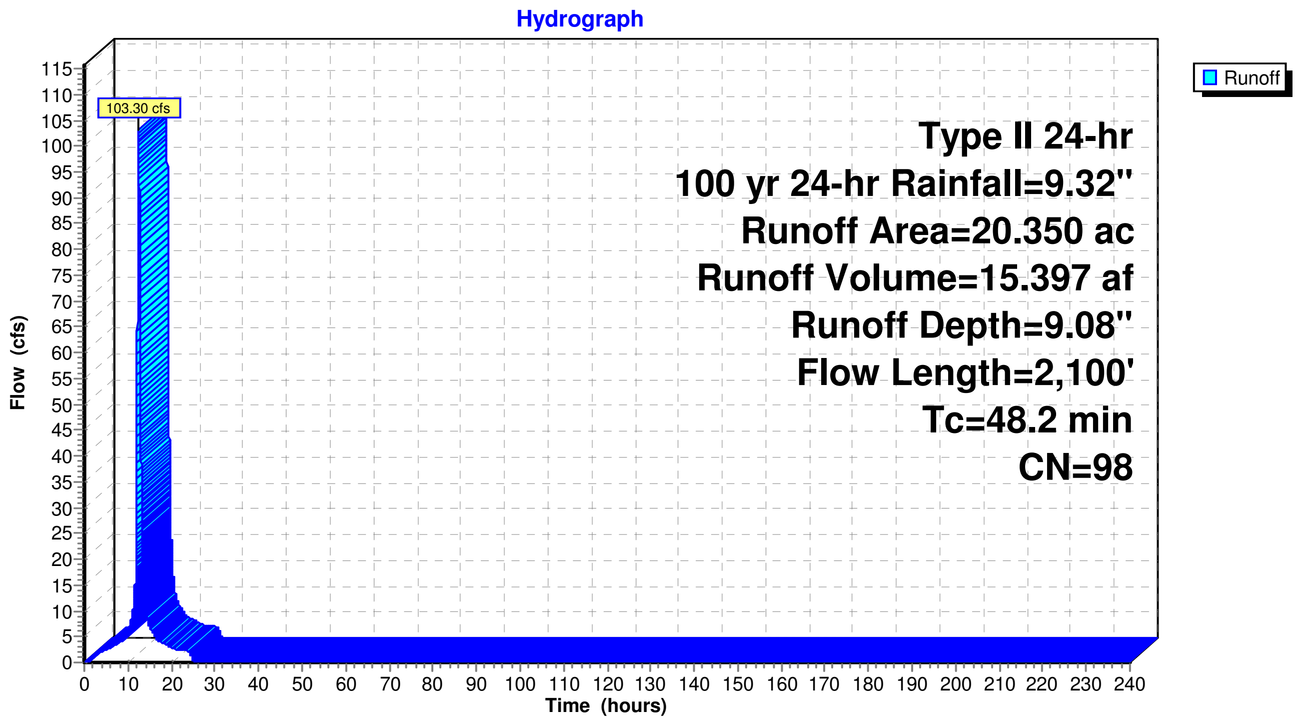
Runoff = 103.30 cfs @ 12.43 hrs, Volume= 15.397 af, Depth= 9.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
20.350	98	Water Surface, HSG A
20.350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.1	100	0.0100	0.13		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
35.1	2,000	0.0040	0.95		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
48.2	2,100	Total			

Subcatchment 23S: Area northeast 4



Summary for Subcatchment 24S: Area southeast 1

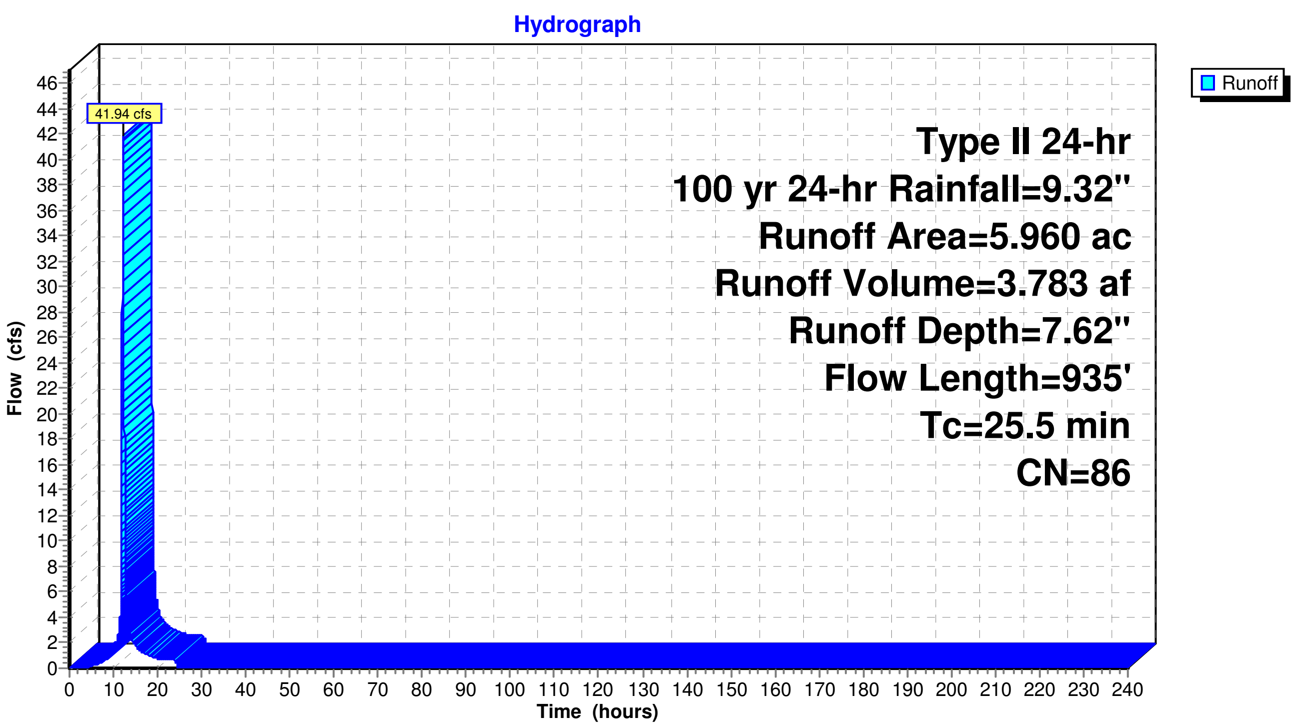
Runoff = 41.94 cfs @ 12.18 hrs, Volume= 3.783 af, Depth= 7.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
5.960	86	<50% Grass cover, Poor, HSG C
5.960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	100	0.0200	0.17		**Sheet Flow, se** Grass: Short n= 0.150 P2= 3.10"
12.7	135	0.0200	0.18		**Sheet Flow, scf** Grass: Short n= 0.150 P2= 3.10"
2.8	700	0.0040	4.11	461.82	**Channel Flow, cf** Area= 112.5 sf Perim= 75.0' r= 1.50' n= 0.030 Short grass
25.5	935	Total			

Subcatchment 24S: Area southeast 1



Summary for Subcatchment 25S: Pond 2 North DA

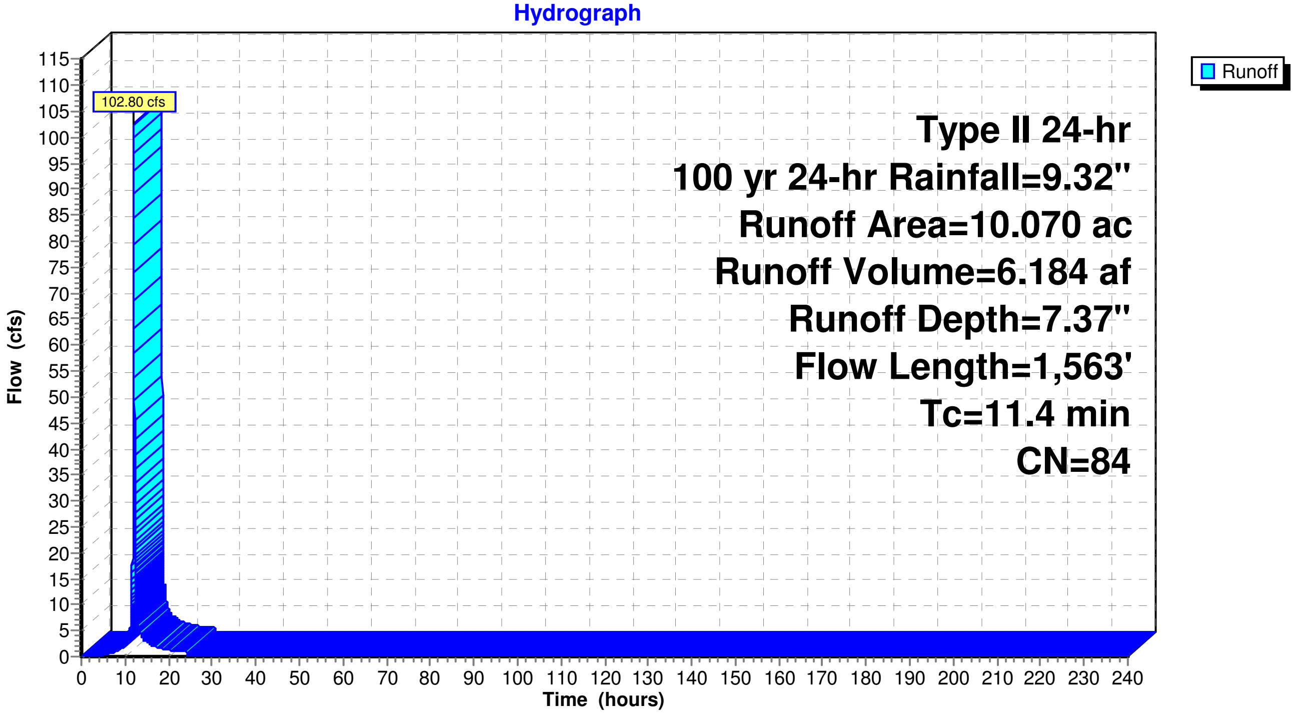
Runoff = 102.80 cfs @ 12.02 hrs, Volume= 6.184 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
10.070	84	50-75% Grass cover, Fair, HSG D
10.070		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	100	0.0263	0.19		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.4	65	0.0263	2.43		**Shallow Concentrated Flow, Shallow Concentrated** Grassed Waterway Kv= 15.0 fps
0.9	609	0.0100	10.95	11,617.40	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=0.00' D=5.00' Z= 38.6 & 46.3 '/' Top.W=424.50' n= 0.025 Earth, grassed & winding
1.2	789	0.0100	10.95	10,522.28	**Trap/Vee/Rect Channel Flow, Channel flow** Bot.W=0.00' D=5.00' Z= 35.2 & 41.7 '/' Top.W=384.50' n= 0.025 Earth, grassed & winding
11.4	1,563	Total			

Subcatchment 25S: Pond 2 North DA



Summary for Subcatchment 26S: Pond 1 DA-Left

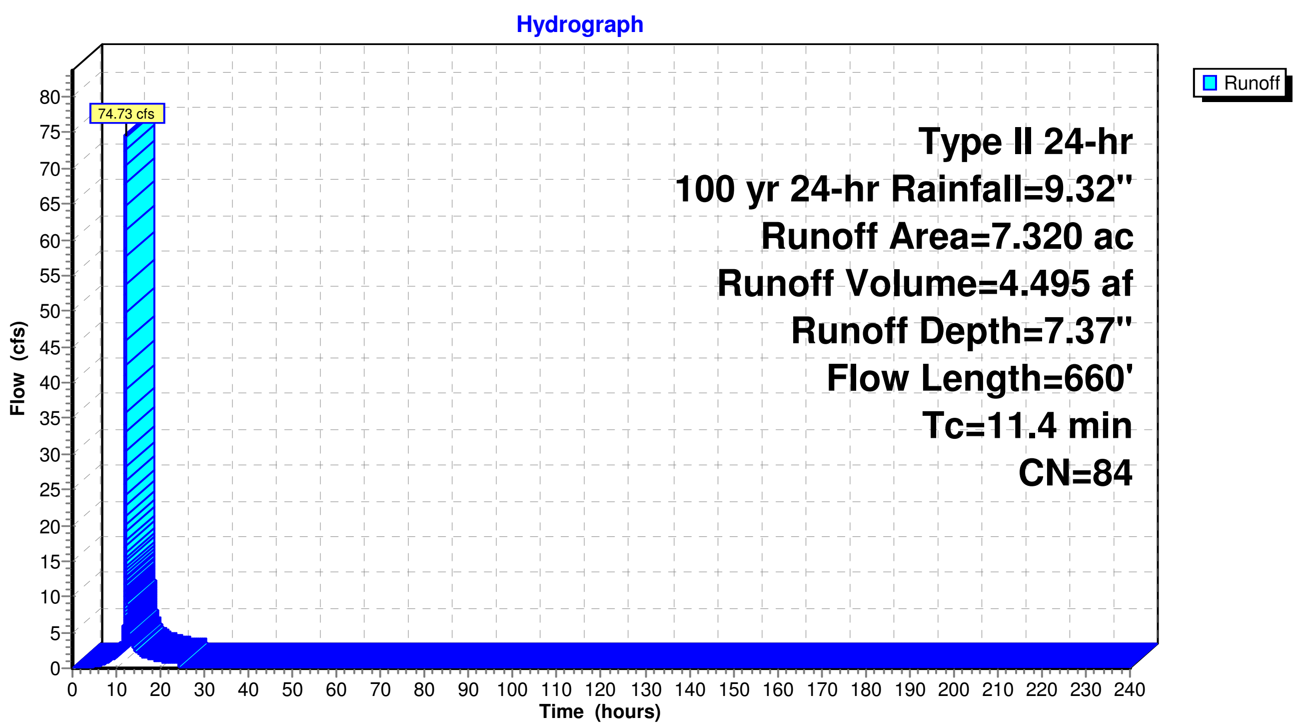
Runoff = 74.73 cfs @ 12.02 hrs, Volume= 4.495 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
7.320	84	50-75% Grass cover, Fair, HSG D
7.320		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	100	0.0280	0.19		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
1.1	160	0.0280	2.51		**Shallow Concentrated Flow, Shallow Concentrated** Grassed Waterway Kv= 15.0 fps
1.6	400	0.0050	4.20	731.20	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=2.00' Z= 50.0 & 37.0 '/' Top.W=174.00' n= 0.025 Earth, grassed & winding
11.4	660	Total			

Subcatchment 26S: Pond 1 DA-Left



Summary for Subcatchment 28S: Pond 3 DA

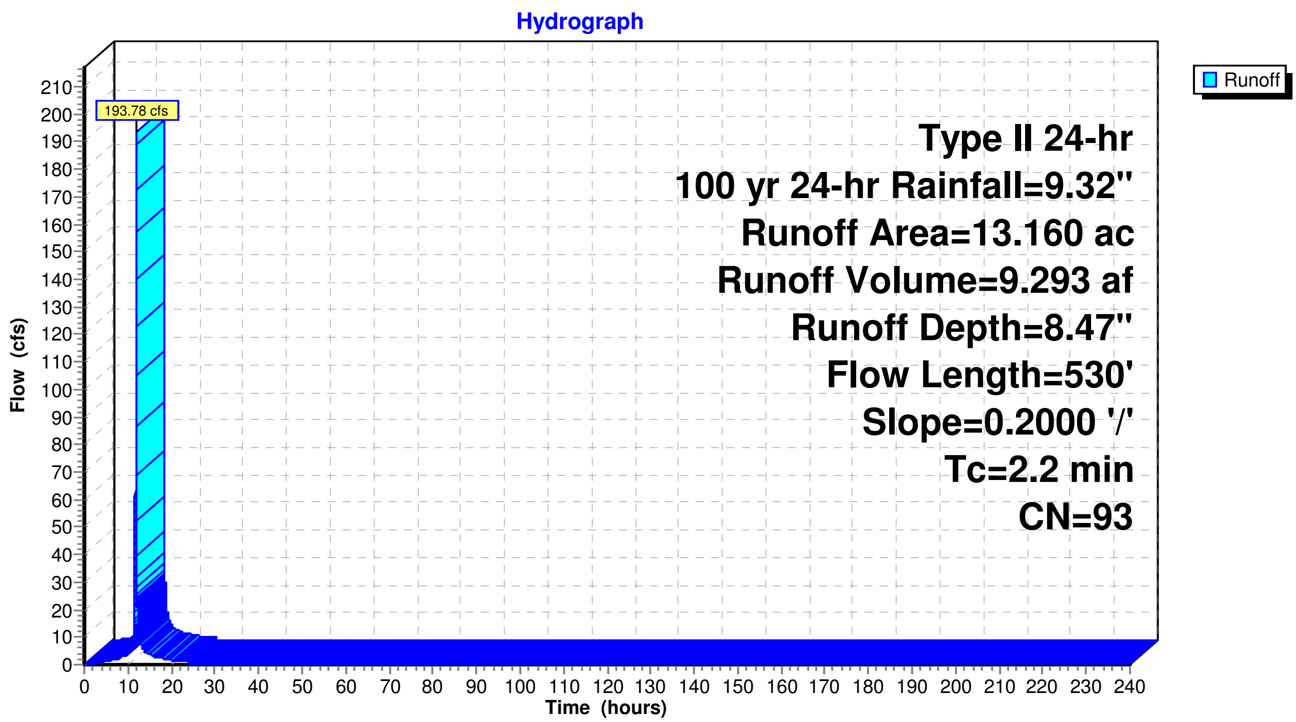
Runoff = 193.78 cfs @ 11.92 hrs, Volume= 9.293 af, Depth= 8.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
8.530	98	Water Surface, 0% imp, HSG C
4.630	84	50-75% Grass cover, Fair, HSG D
13.160	93	Weighted Average
13.160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	500		12.69		**Lake or Reservoir,** Mean Depth= 5.00'
1.5	30	0.2000	0.33		**Sheet Flow, Side Slope of Pond** Grass: Short n= 0.150 P2= 3.10"
2.2	530	Total			

Subcatchment 28S: Pond 3 DA



Summary for Subcatchment 29S: East Primary DA

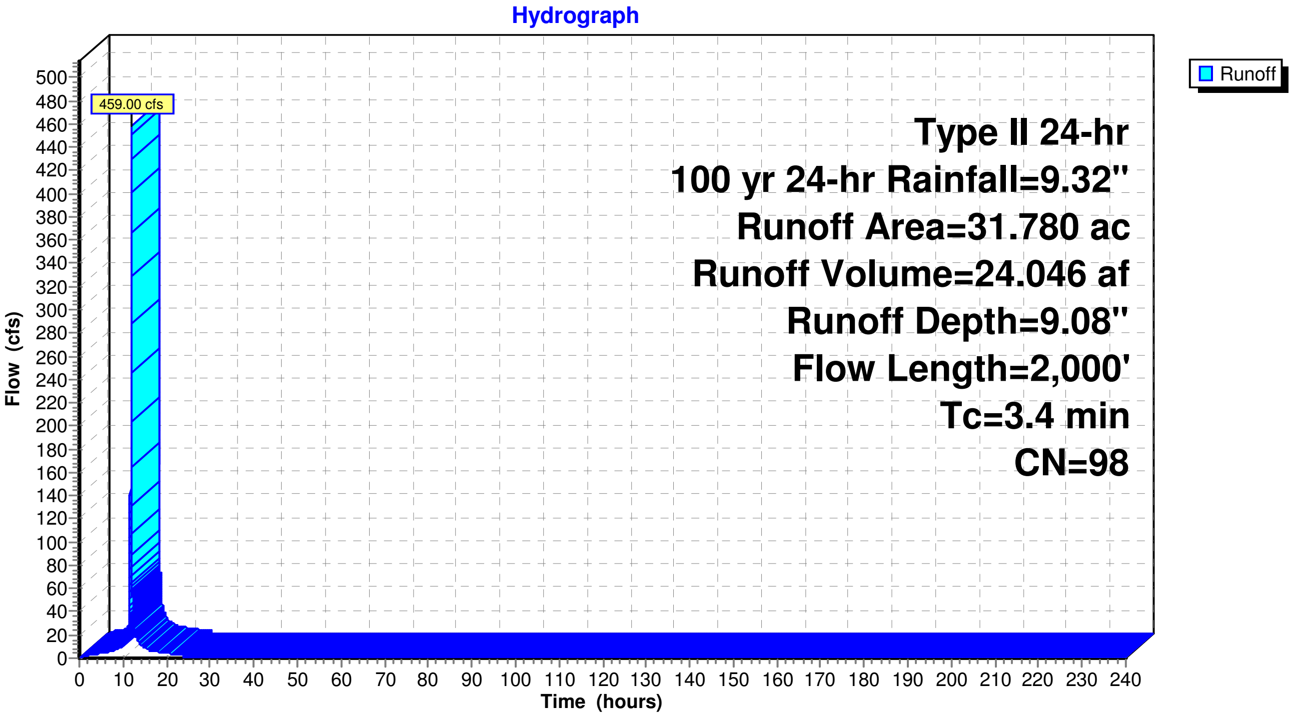
Runoff = 459.00 cfs @ 11.94 hrs, Volume= 24.046 af, Depth= 9.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
31.780	98	Water Surface, HSG C
31.780		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	2,000		9.83		**Lake or Reservoir,** Mean Depth= 3.00'

Subcatchment 29S: East Primary DA



Summary for Subcatchment 30S: East Secondary DA

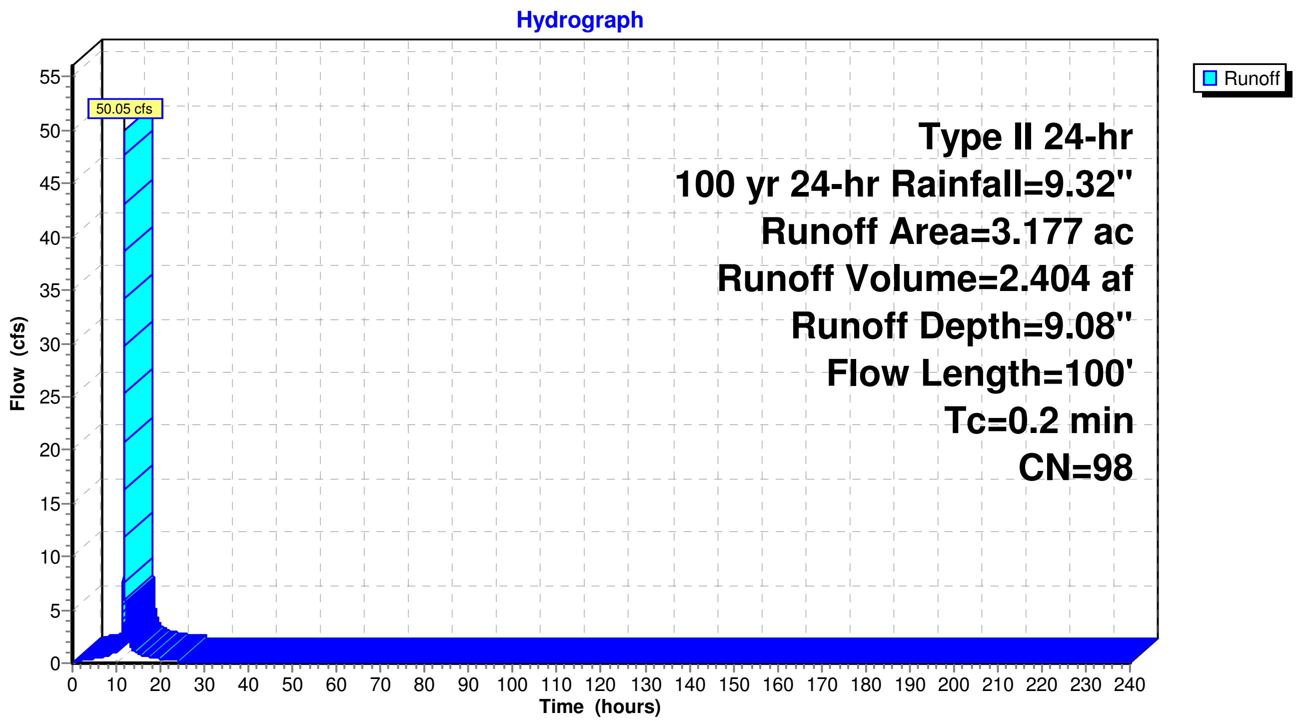
Runoff = 50.05 cfs @ 11.90 hrs, Volume= 2.404 af, Depth= 9.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
3.177	98	Water Surface, HSG C
3.177		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	100		8.02		**Lake or Reservoir,** Mean Depth= 2.00'

Subcatchment 30S: East Secondary DA



Summary for Subcatchment 31S: Area northeast 1

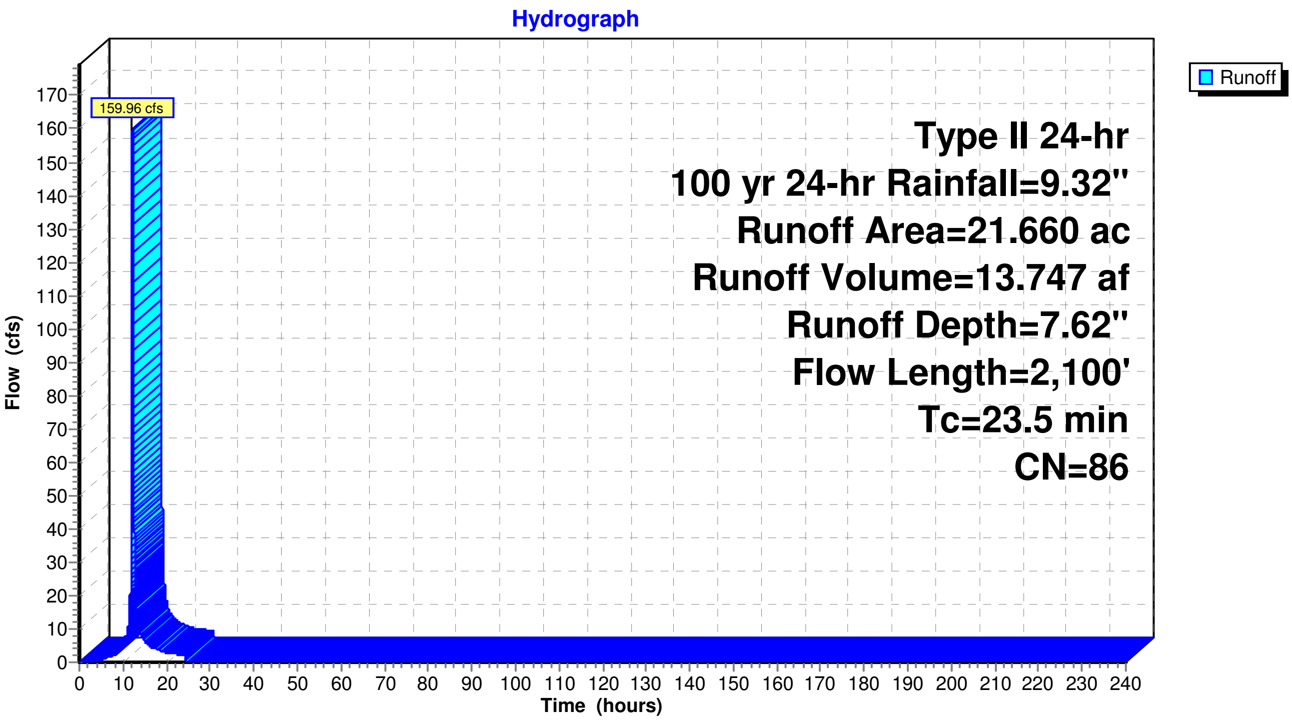
Runoff = 159.96 cfs @ 12.15 hrs, Volume= 13.747 af, Depth= 7.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
21.660	86	<50% Grass cover, Poor, HSG C
21.660		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	100	0.0580	0.26		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
17.0	2,000	0.0100	1.97	24.57	**Channel Flow,** Area= 12.5 sf Perim= 50.0' r= 0.25' n= 0.030 Short grass
23.5	2,100	Total			

Subcatchment 31S: Area northeast 1



Summary for Subcatchment 32S: Area southeast 2

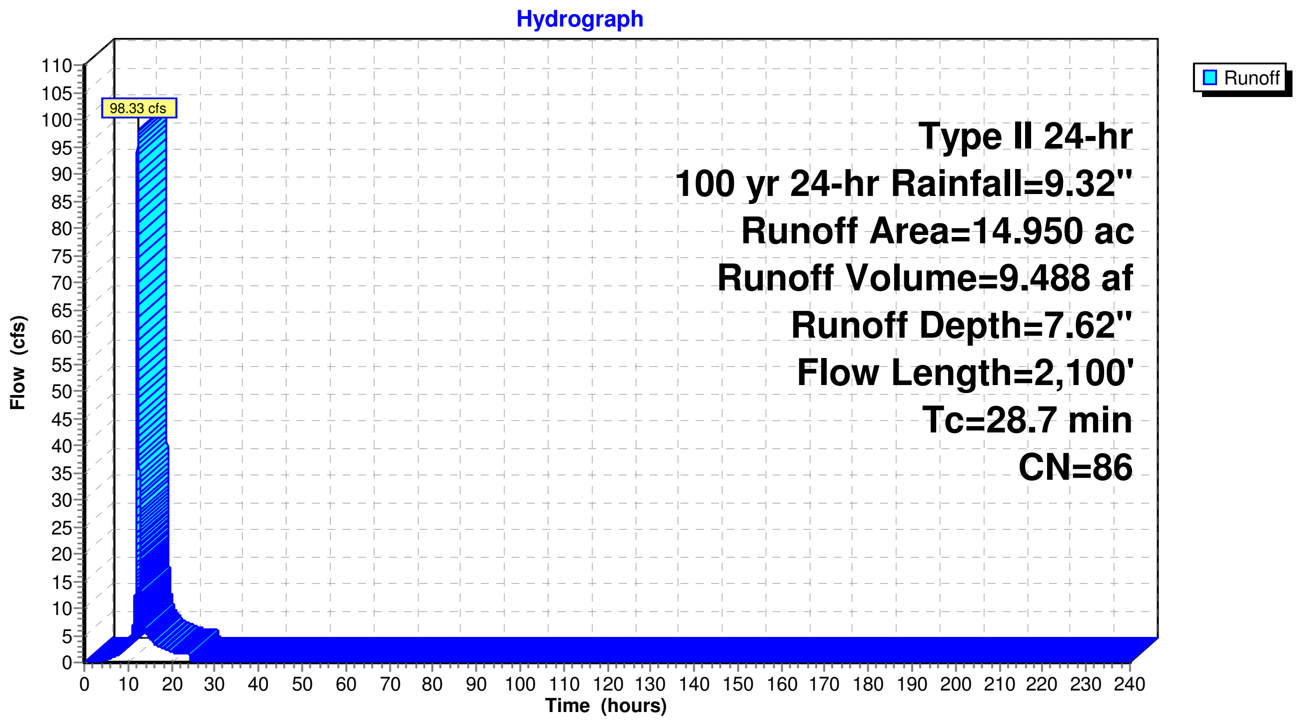
Runoff = 98.33 cfs @ 12.21 hrs, Volume= 9.488 af, Depth= 7.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
14.950	86	<50% Grass cover, Poor, HSG C
14.950		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	100	0.0580	0.26		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
22.2	2,000	0.0100	1.50		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
28.7	2,100	Total			

Subcatchment 32S: Area southeast 2



Summary for Subcatchment 33S: Area northeast 2

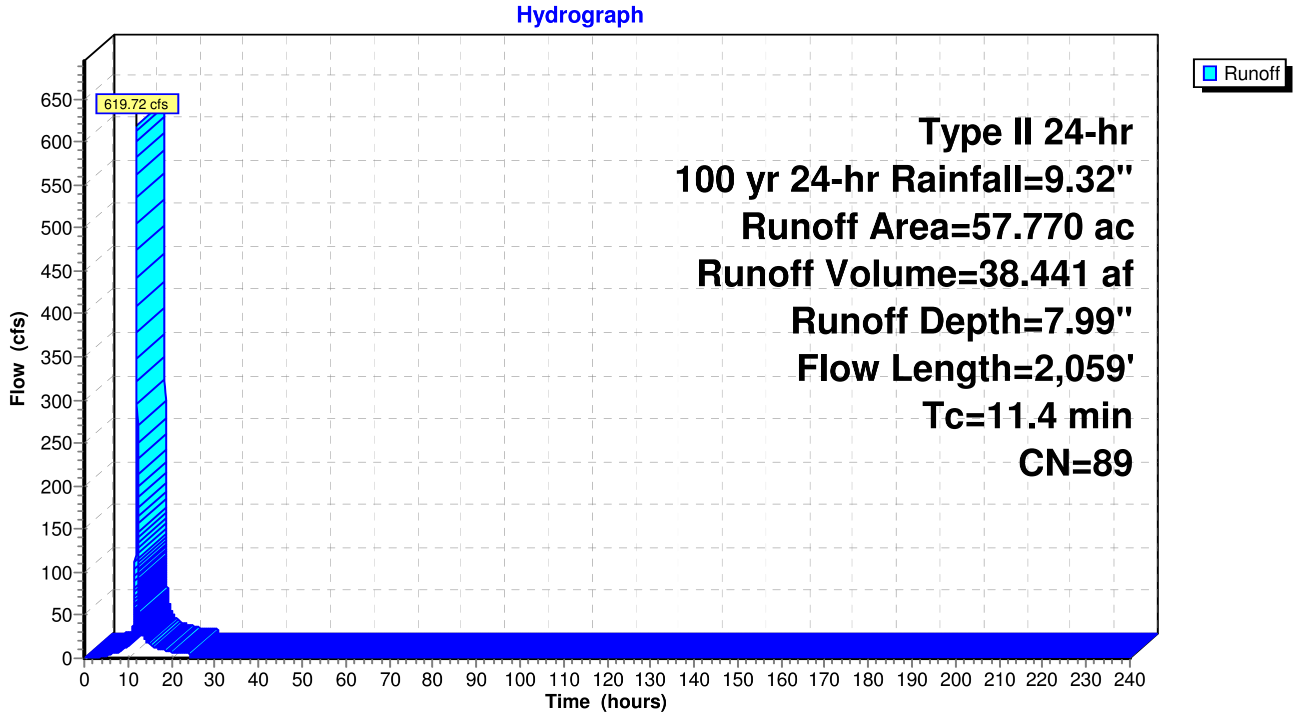
Runoff = 619.72 cfs @ 12.02 hrs, Volume= 38.441 af, Depth= 7.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
57.770	89	<50% Grass cover, Poor, HSG D
57.770		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	100	0.0674	0.27		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
0.8	191	0.0674	3.89		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
4.5	1,768	0.0034	6.61	1,074.68	**Channel Flow, channel** Area= 162.5 sf Perim= 46.9' r= 3.46' n= 0.030 Earth, grassed & winding
11.4	2,059	Total			

Subcatchment 33S: Area northeast 2



Summary for Subcatchment 34S: Pond 1 DA-Middle

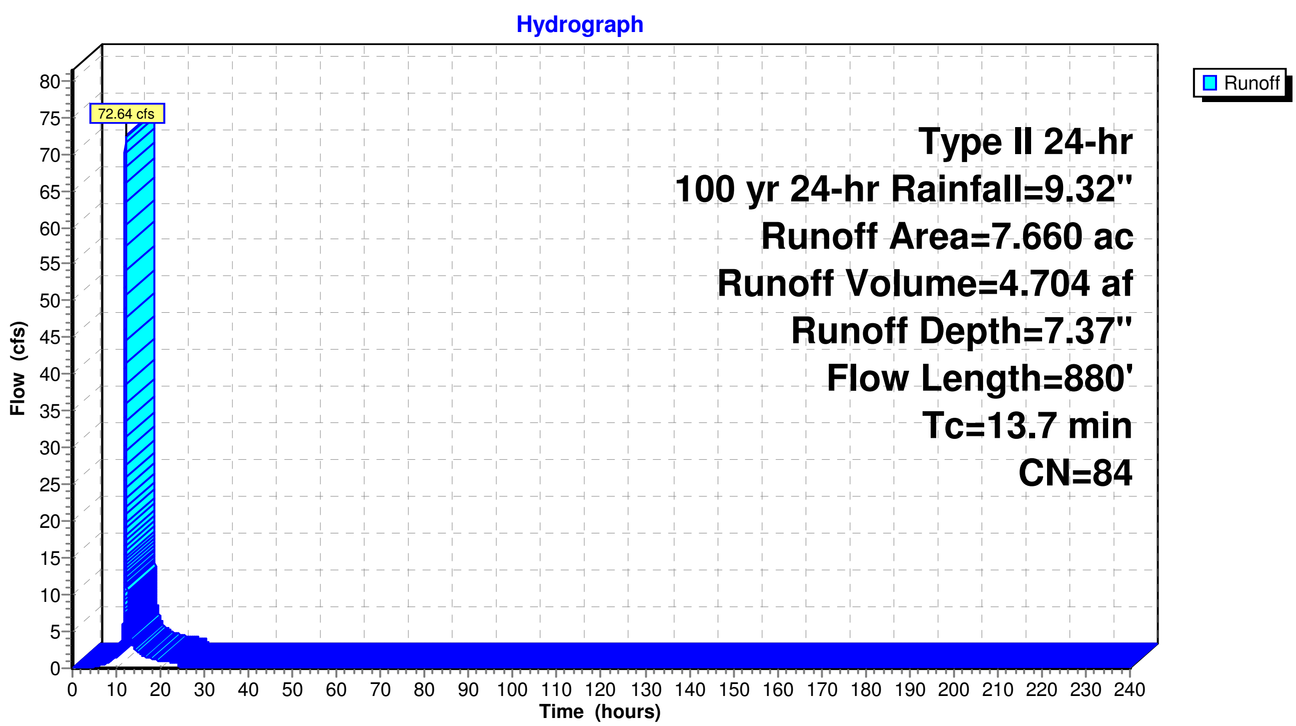
Runoff = 72.64 cfs @ 12.05 hrs, Volume= 4.704 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
7.660	84	50-75% Grass cover, Fair, HSG D
7.660		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	100	0.0205	0.17		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
1.4	180	0.0205	2.15		**Shallow Concentrated Flow, Shallow Concentrated** Grassed Waterway Kv= 15.0 fps
2.4	600	0.0050	4.20	840.50	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=2.00' Z= 50.0 '/' Top.W=200.00' n= 0.025 Earth, grassed & winding
13.7	880	Total			

Subcatchment 34S: Pond 1 DA-Middle



Summary for Subcatchment 35S: Area northwest 3

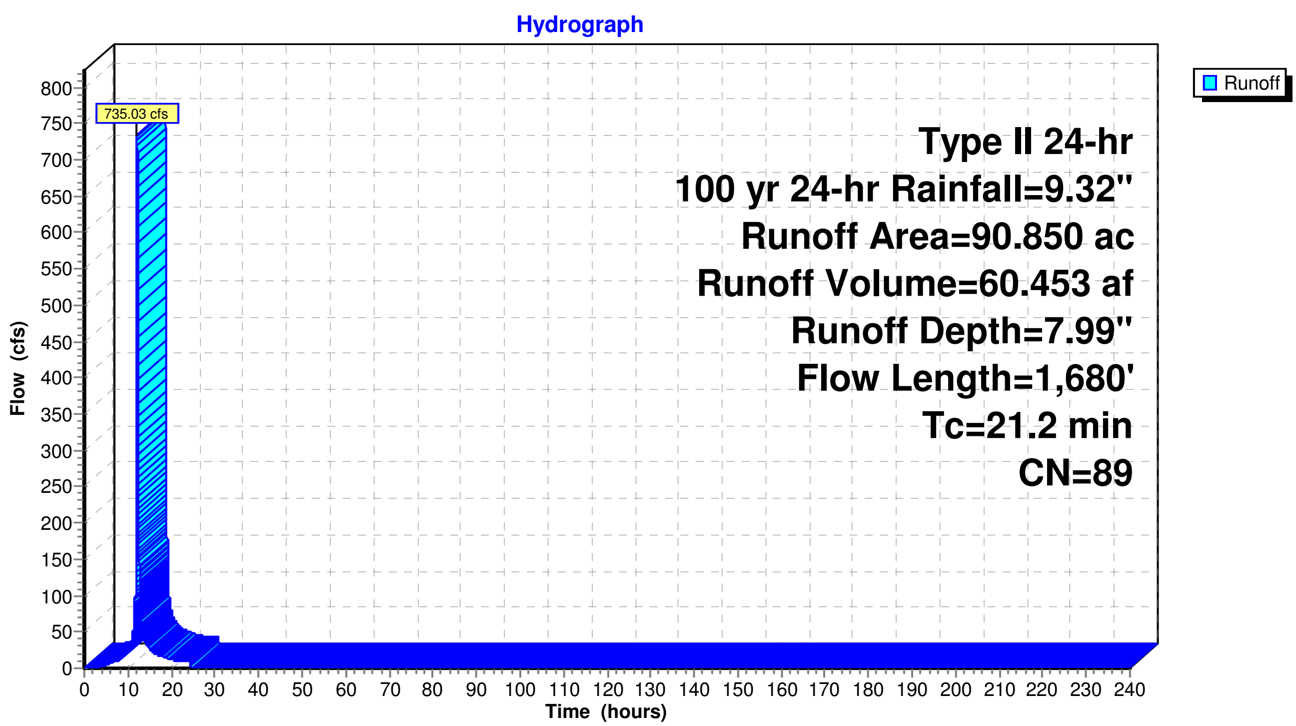
Runoff = 735.03 cfs @ 12.13 hrs, Volume= 60.453 af, Depth= 7.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
90.850	89	<50% Grass cover, Poor, HSG D
90.850		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.1	100	0.0100	0.13		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
7.2	648	0.0100	1.50		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
0.9	932	0.0300	16.80	1,679.82	**Channel Flow, cf** Area= 100.0 sf Perim= 36.5' r= 2.74' n= 0.030 Earth, grassed & winding
21.2	1,680	Total			

Subcatchment 35S: Area northwest 3



Summary for Subcatchment 36S: Pond 1 DA-Right

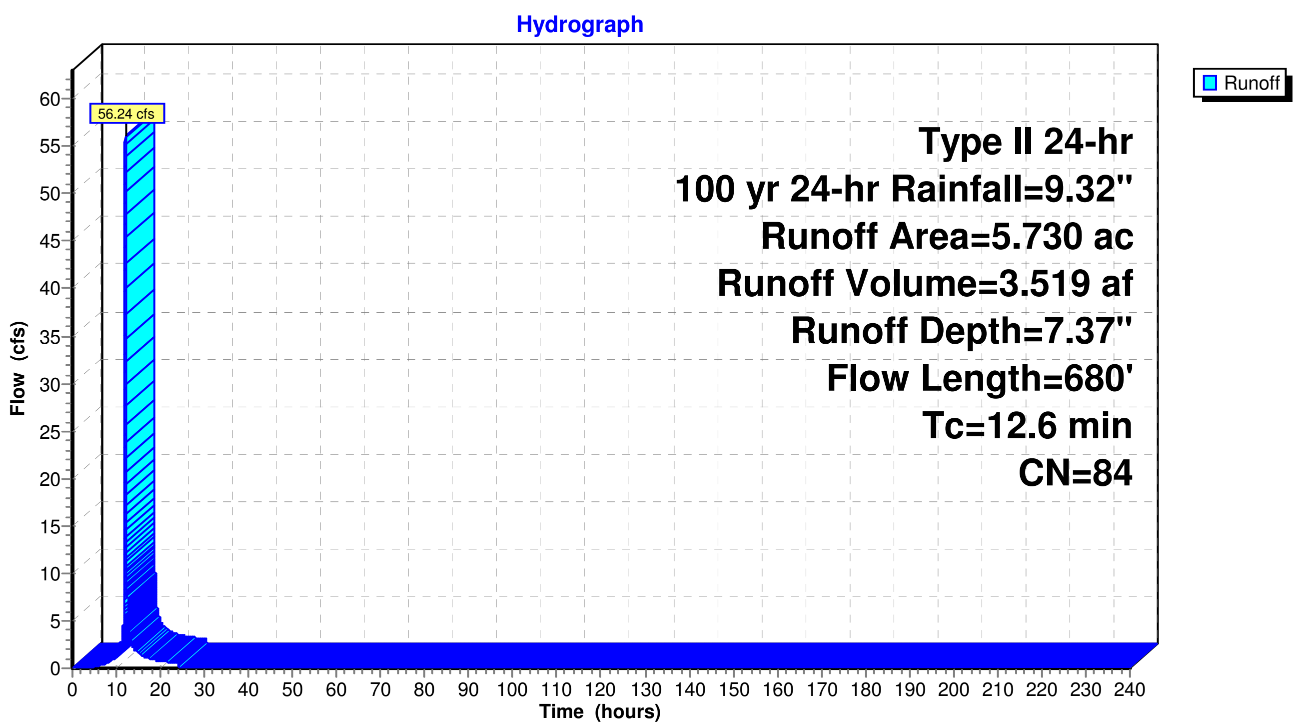
Runoff = 56.24 cfs @ 12.04 hrs, Volume= 3.519 af, Depth= 7.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
5.730	84	50-75% Grass cover, Fair, HSG D
5.730		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	100	0.0206	0.17		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
1.0	130	0.0206	2.15		**Shallow Concentrated Flow, Shallow Concentrated** Grassed Waterway Kv= 15.0 fps
1.8	450	0.0050	4.20	840.50	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=2.00' Z= 50.0 '/' Top.W=200.00' n= 0.025 Earth, grassed & winding
12.6	680	Total			

Subcatchment 36S: Pond 1 DA-Right



Summary for Subcatchment 37S: Area northwest 2

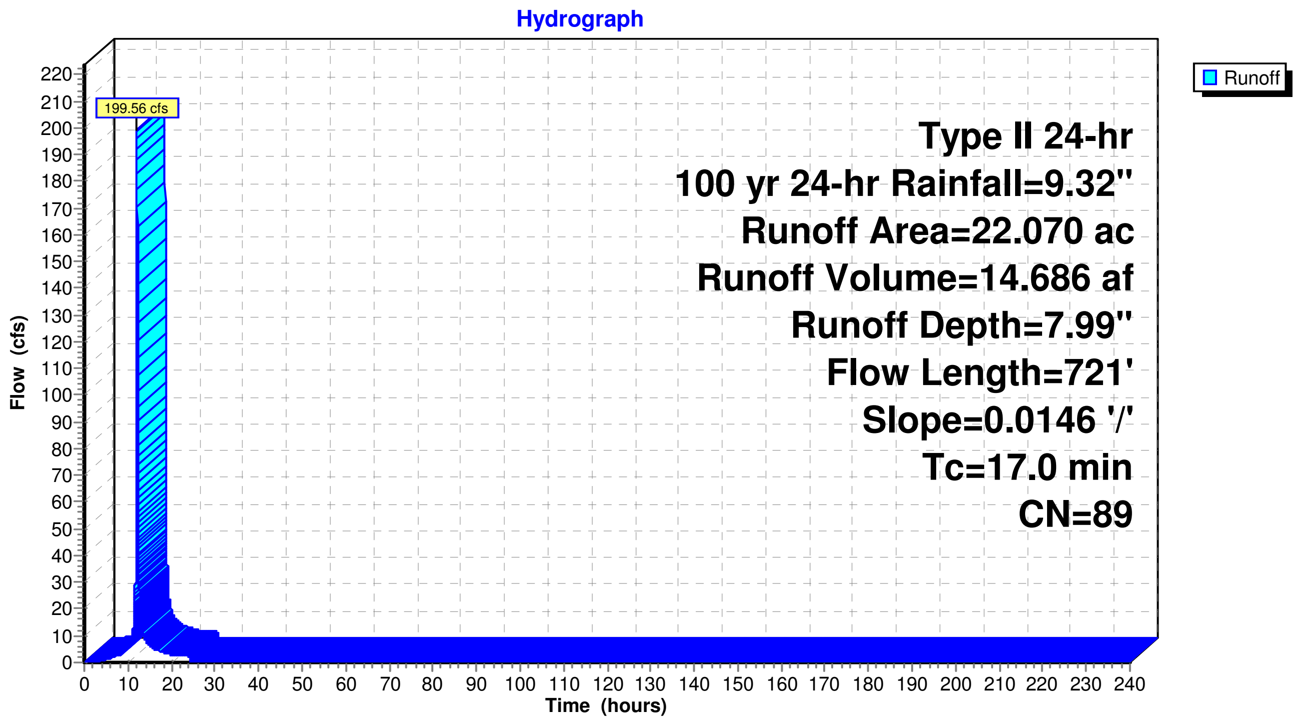
Runoff = 199.56 cfs @ 12.08 hrs, Volume= 14.686 af, Depth= 7.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
22.070	89	<50% Grass cover, Poor, HSG D
22.070		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.3	100	0.0146	0.15		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
5.7	621	0.0146	1.81		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
17.0	721	Total			

Subcatchment 37S: Area northwest 2



Summary for Subcatchment 38S: Area northeast 3

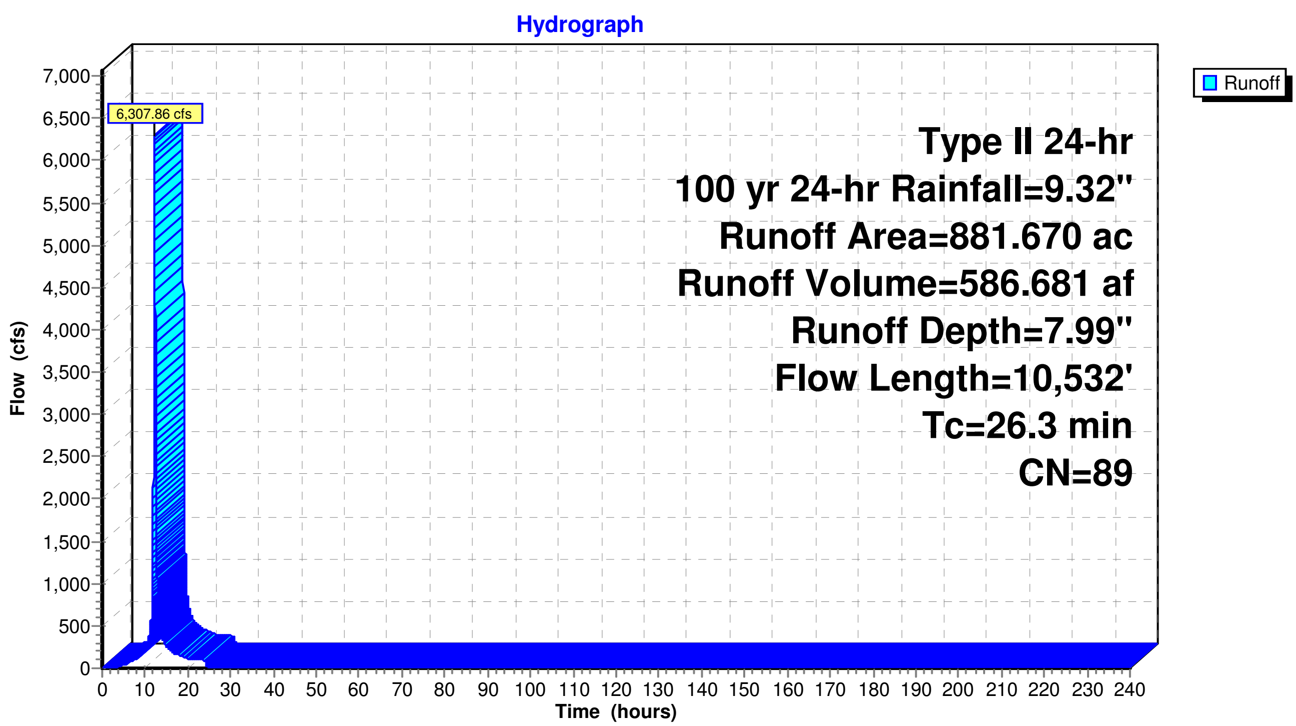
Runoff = 6,307.86 cfs @ 12.19 hrs, Volume= 586.681 af, Depth= 7.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 yr 24-hr Rainfall=9.32"

Area (ac)	CN	Description
881.670	89	<50% Grass cover, Poor, HSG D
881.670		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	100	0.0674	0.27		**Sheet Flow, sf** Grass: Short n= 0.150 P2= 3.10"
0.8	191	0.0674	3.89		**Shallow Concentrated Flow, scf** Grassed Waterway Kv= 15.0 fps
19.4	10,241	0.0060	8.79	1,427.62	**Channel Flow, channel** Area= 162.5 sf Perim= 46.9' r= 3.46' n= 0.030 Earth, grassed & winding
26.3	10,532	Total			

Subcatchment 38S: Area northeast 3



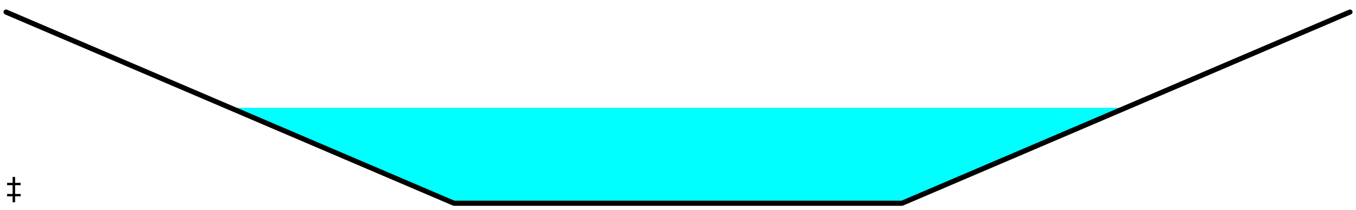
Summary for Reach 16R: Emergency Spillway Shallow Slope

Inflow = 79.06 cfs @ 13.28 hrs, Volume= 221.595 af
Outflow = 79.06 cfs @ 13.28 hrs, Volume= 221.595 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.70 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.29 fps, Avg. Travel Time= 0.1 min

Peak Storage= 337 cf @ 13.28 hrs
Average Depth at Peak Storage= 0.75'
Bank-Full Depth= 1.50' Flow Area= 45.0 sf, Capacity= 310.29 cfs

15.00' x 1.50' deep channel, n= 0.034
Side Slope Z-value= 10.0 '/' Top Width= 45.00'
Length= 20.0' Slope= 0.0250 '/'
Inlet Invert= 428.50', Outlet Invert= 428.00'



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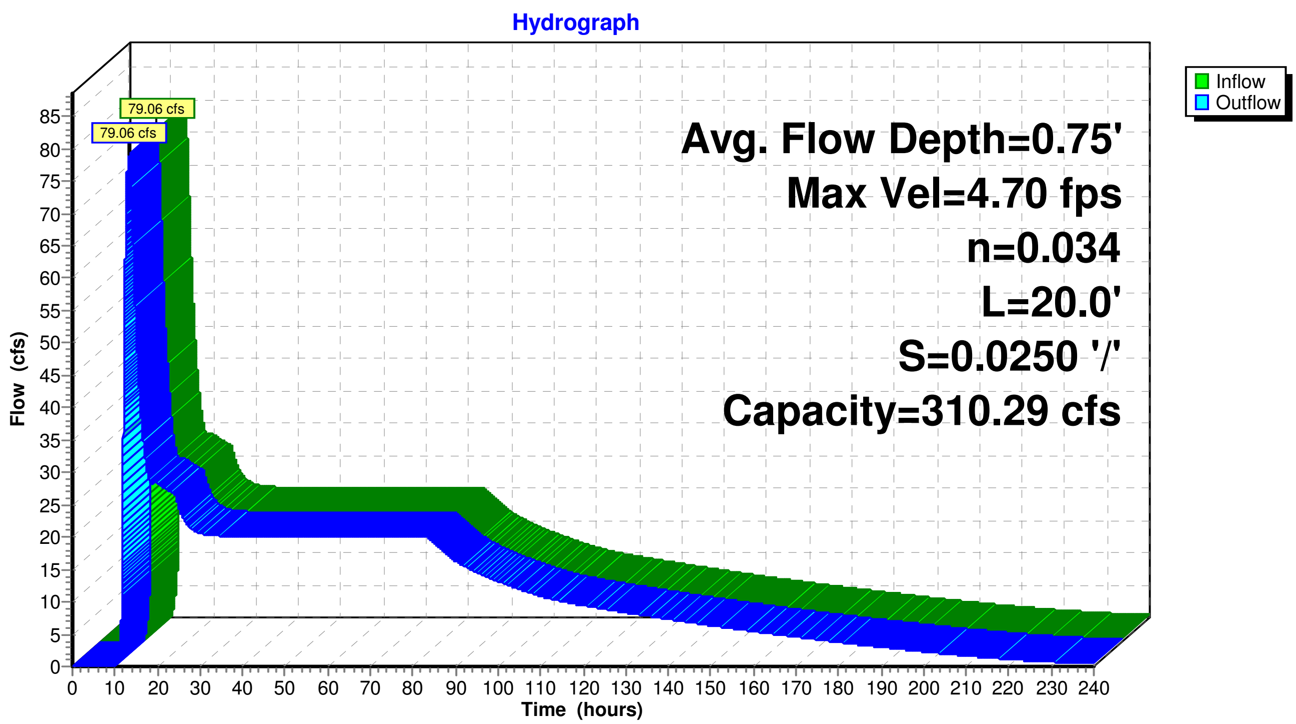
Reach 16R: Emergency Spillway Shallow Slope



Summary for Reach 17R: Emergency Spillway Steep Slope

Inflow = 79.06 cfs @ 13.28 hrs, Volume= 221.595 af
Outflow = 79.06 cfs @ 13.28 hrs, Volume= 221.595 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.79 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.57 fps, Avg. Travel Time= 0.1 min

Peak Storage= 323 cf @ 13.28 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.50' Flow Area= 45.0 sf, Capacity= 895.31 cfs

15.00' x 1.50' deep channel, n= 0.038
Side Slope Z-value= 10.0 '/' Top Width= 45.00'
Length= 40.0' Slope= 0.2600 '/'
Inlet Invert= 428.40', Outlet Invert= 418.00'

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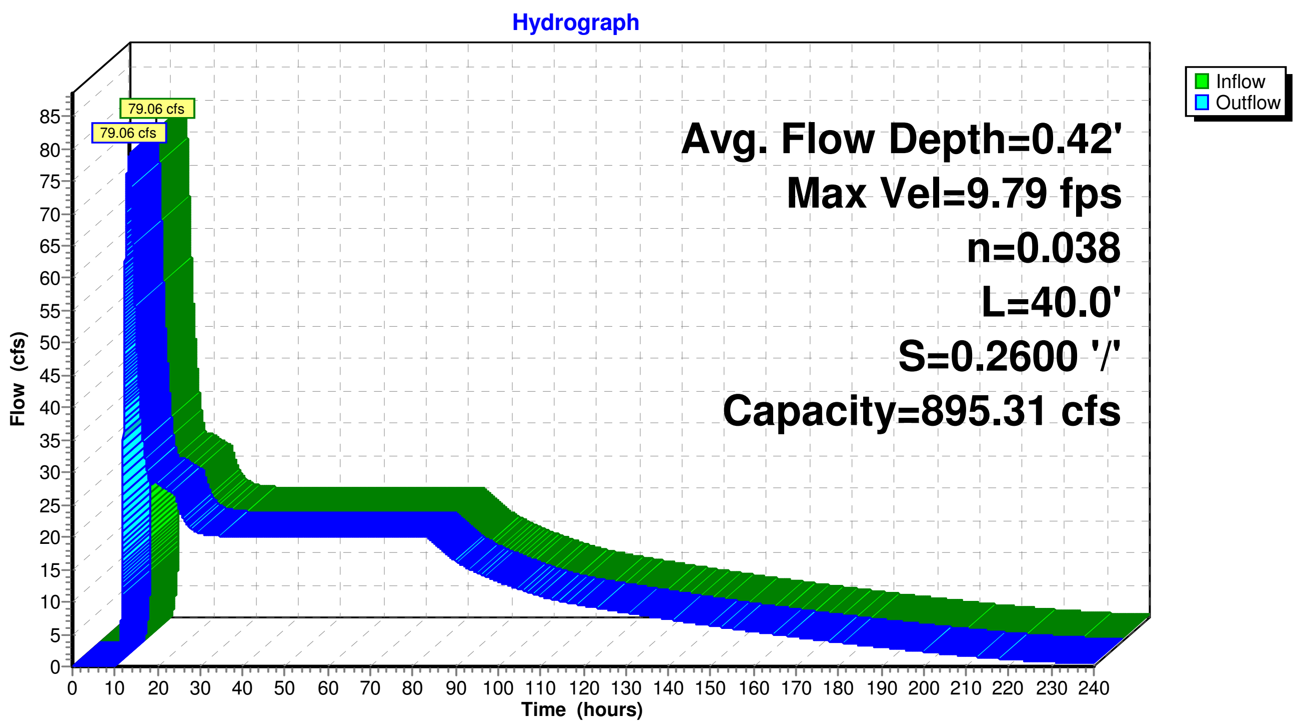
Reach 17R: Emergency Spillway Steep Slope



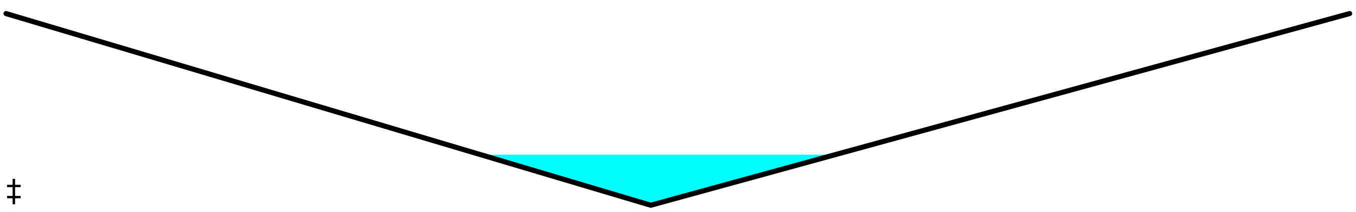
Summary for Reach 19R: V Ditch to South Pond 2 Outlet

Inflow Area = 14.990 ac, 0.00% Impervious, Inflow Depth = 7.37" for 100 yr 24-hr event
Inflow = 151.56 cfs @ 12.03 hrs, Volume= 9.205 af
Outflow = 139.41 cfs @ 12.07 hrs, Volume= 9.205 af, Atten= 8%, Lag= 2.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.24 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 12.4 min

Peak Storage= 33,692 cf @ 12.07 hrs
Average Depth at Peak Storage= 1.06'
Defined Flood Depth= 2.00' Flow Area= 153.8 sf, Capacity= 761.65 cfs
Bank-Full Depth= 4.00' Flow Area= 615.2 sf, Capacity= 4,836.18 cfs

0.00' x 4.00' deep channel, n= 0.030 Short grass
Side Slope Z-value= 36.9 40.0 '/' Top Width= 307.60'
Length= 783.0' Slope= 0.0100 '/'
Inlet Invert= 436.00', Outlet Invert= 428.17'



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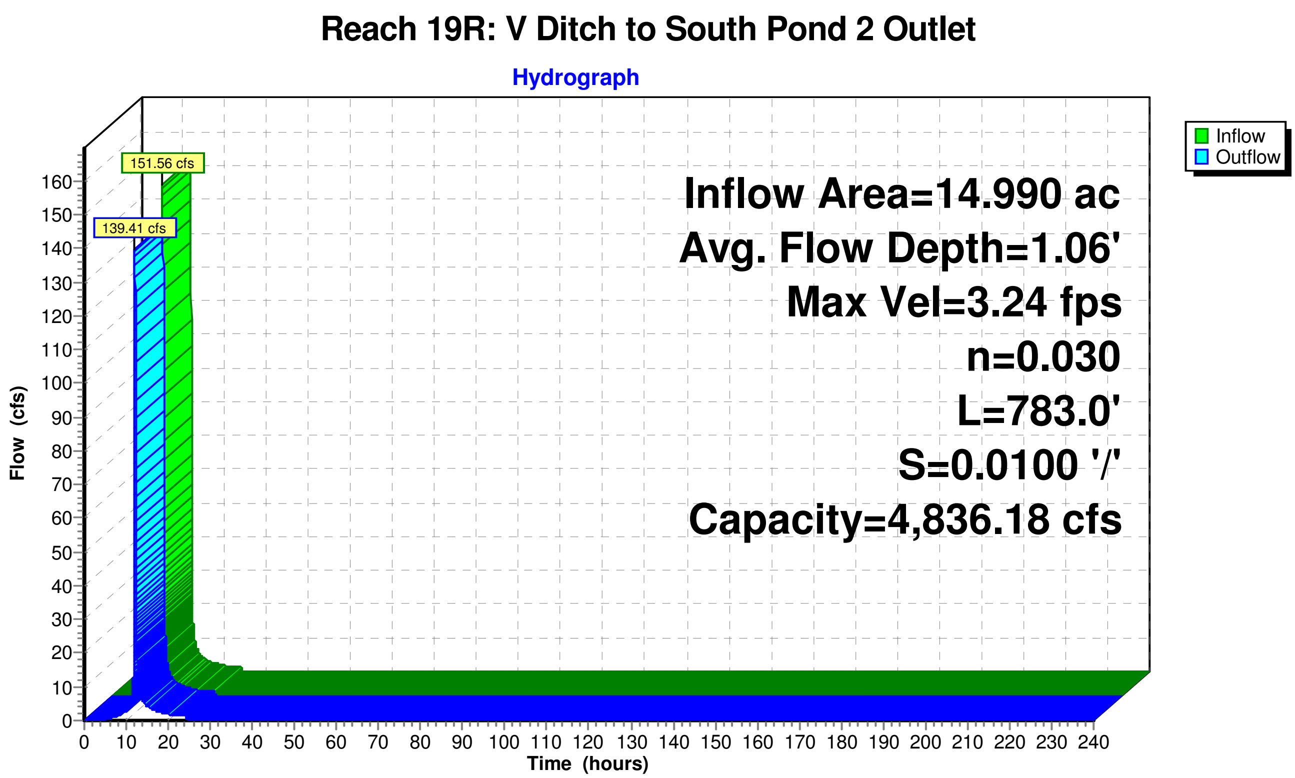


Summary for Pond 1P: Pond 1-Proposed Left

Inflow Area = 7.320 ac, 0.00% Impervious, Inflow Depth = 10.97" for 100 yr 24-hr event
Inflow = 131.47 cfs @ 12.12 hrs, Volume= 6.693 af
Outflow = 89.40 cfs @ 12.23 hrs, Volume= 6.675 af, Atten= 32%, Lag= 6.9 min
Primary = 18.77 cfs @ 12.21 hrs, Volume= 4.779 af
Secondary = 70.66 cfs @ 12.23 hrs, Volume= 1.896 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.24' @ 12.23 hrs Surf.Area= 0.000 ac Storage= 1.988 af

Plug-Flow detention time= 65.2 min calculated for 6.675 af (100% of inflow)
Center-of-Mass det. time= 63.5 min (835.2 - 771.8)

Volume	Invert	Avail.Storage	Storage Description
#1	428.00'	6.531 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
428.00	0.000
429.00	0.032
430.00	0.388
431.00	1.485
432.00	3.561
433.00	6.531

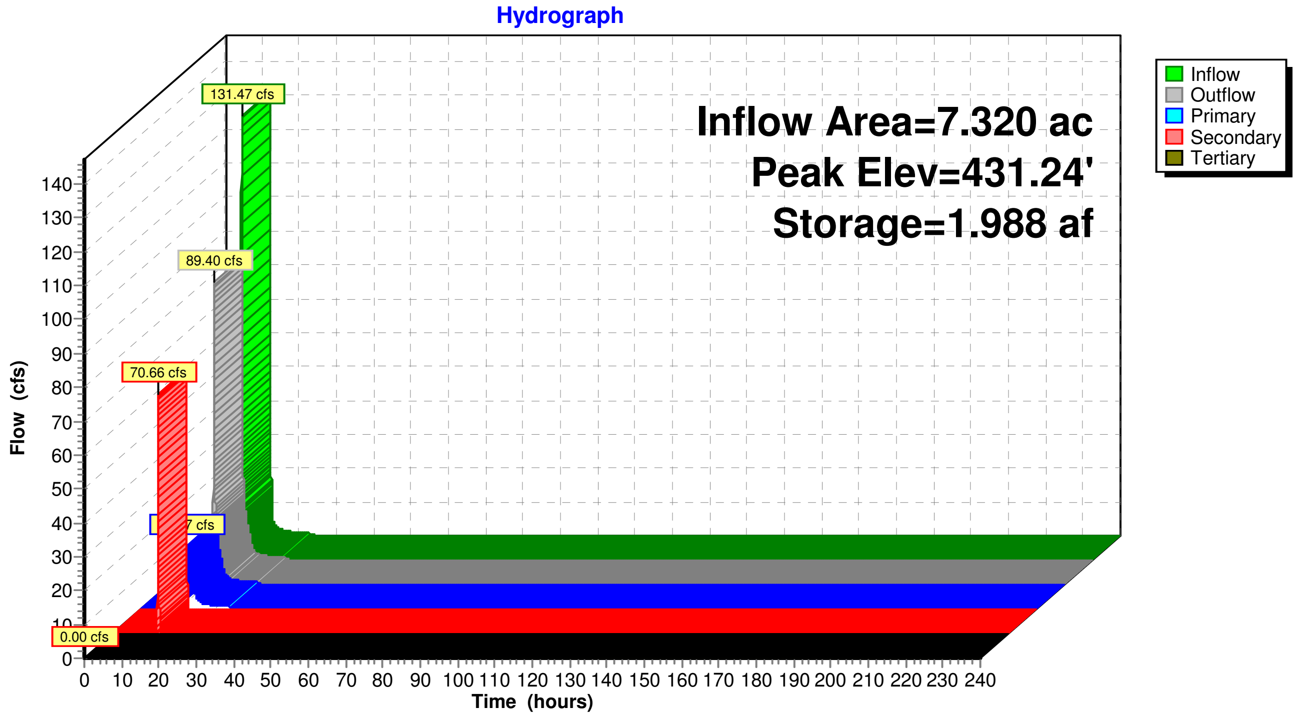
Device	Routing	Invert	Outlet Devices
#1	Primary	428.30'	**24.0" Round Culvert** L= 170.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 428.30' / 425.30' S= 0.0176 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Secondary	430.50'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 1.00 2.00 Width (feet) 10.00 90.00 190.00
#3	Tertiary	432.99'	**500.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=18.77 cfs @ 12.21 hrs HW=431.24' TW=429.40' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 18.77 cfs @ 5.97 fps)

Secondary OutFlow Max=70.65 cfs @ 12.23 hrs HW=431.24' TW=430.56' (Dynamic Tailwater)
└─**2=Custom Weir/Orifice** (Weir Controls 70.65 cfs @ 2.40 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=428.00' TW=428.40' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Pond 1-Proposed Left



Summary for Pond 2P: Pond 2 South

Outfall information from 1998 plans E-WDR1-C131 X.
Assumed HDPE be DR 17.

Inflow Area = 14.990 ac, 0.00% Impervious, Inflow Depth = 7.37" for 100 yr 24-hr event
Inflow = 139.41 cfs @ 12.07 hrs, Volume= 9.205 af
Outflow = 110.74 cfs @ 12.15 hrs, Volume= 9.216 af, Atten= 21%, Lag= 4.8 min
Primary = 24.22 cfs @ 12.14 hrs, Volume= 7.019 af
Secondary = 86.53 cfs @ 12.15 hrs, Volume= 2.197 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 428.91' Surf.Area= 0.000 ac Storage= 0.020 af
Peak Elev= 431.93' @ 12.15 hrs Surf.Area= 0.000 ac Storage= 1.674 af (1.654 af above start)
Flood Elev= 431.00' Surf.Area= 0.000 ac Storage= 0.731 af (0.711 af above start)

Plug-Flow detention time= 27.2 min calculated for 9.196 af (100% of inflow)
Center-of-Mass det. time= 25.4 min (822.7 - 797.3)

Volume	Invert	Avail.Storage	Storage Description
#1	428.00'	3.360 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
428.00	0.000
429.00	0.022
430.00	0.208
431.00	0.731
432.00	1.742
433.00	3.360

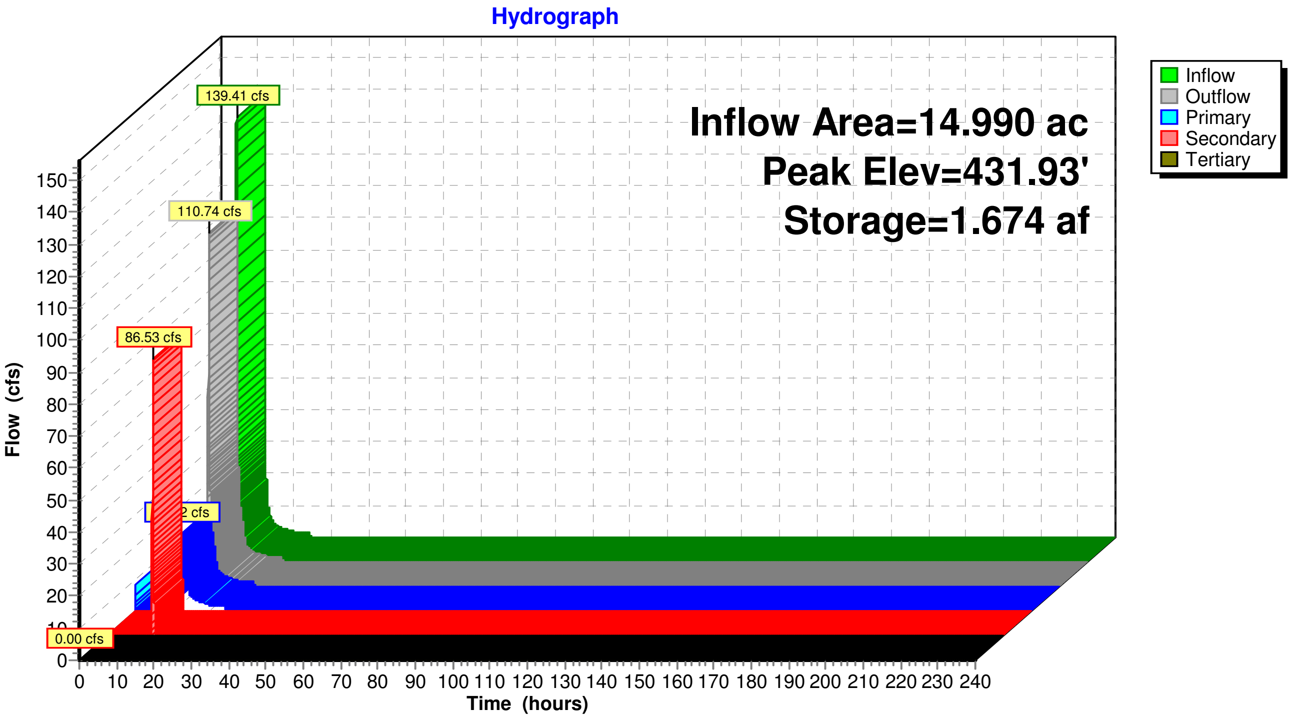
Device	Routing	Invert	Outlet Devices
#1	Primary	427.30'	**24.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 427.30' / 425.30' S= 0.0400 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Secondary	431.00'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 2.00 4.00 Width (feet) 10.00 114.50 310.00
#3	Tertiary	432.99'	**350.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=24.22 cfs @ 12.14 hrs HW=431.93' TW=429.37' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 24.22 cfs @ 7.71 fps)

Secondary OutFlow Max=86.49 cfs @ 12.15 hrs HW=431.93' TW=431.17' (Dynamic Tailwater)
└─**2=Custom Weir/Orifice** (Weir Controls 86.49 cfs @ 2.70 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=428.91' TW=428.40' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Pond 2 South



Summary for Pond 3P: Pond 2 North

Inflow Area = 10.070 ac, 0.00% Impervious, Inflow Depth = 7.37" for 100 yr 24-hr event
Inflow = 102.80 cfs @ 12.02 hrs, Volume= 6.184 af
Outflow = 24.51 cfs @ 12.20 hrs, Volume= 6.171 af, Atten= 76%, Lag= 10.6 min
Primary = 24.51 cfs @ 12.20 hrs, Volume= 6.171 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 432.04' @ 12.26 hrs Surf.Area= 0.000 ac Storage= 1.827 af
Flood Elev= 431.00' Surf.Area= 0.000 ac Storage= 0.731 af

Plug-Flow detention time= 47.0 min calculated for 6.171 af (100% of inflow)
Center-of-Mass det. time= 45.7 min (835.4 - 789.7)

Volume	Invert	Avail.Storage	Storage Description
#1	428.00'	4.000 af	**Custom Stage Data** Listed below

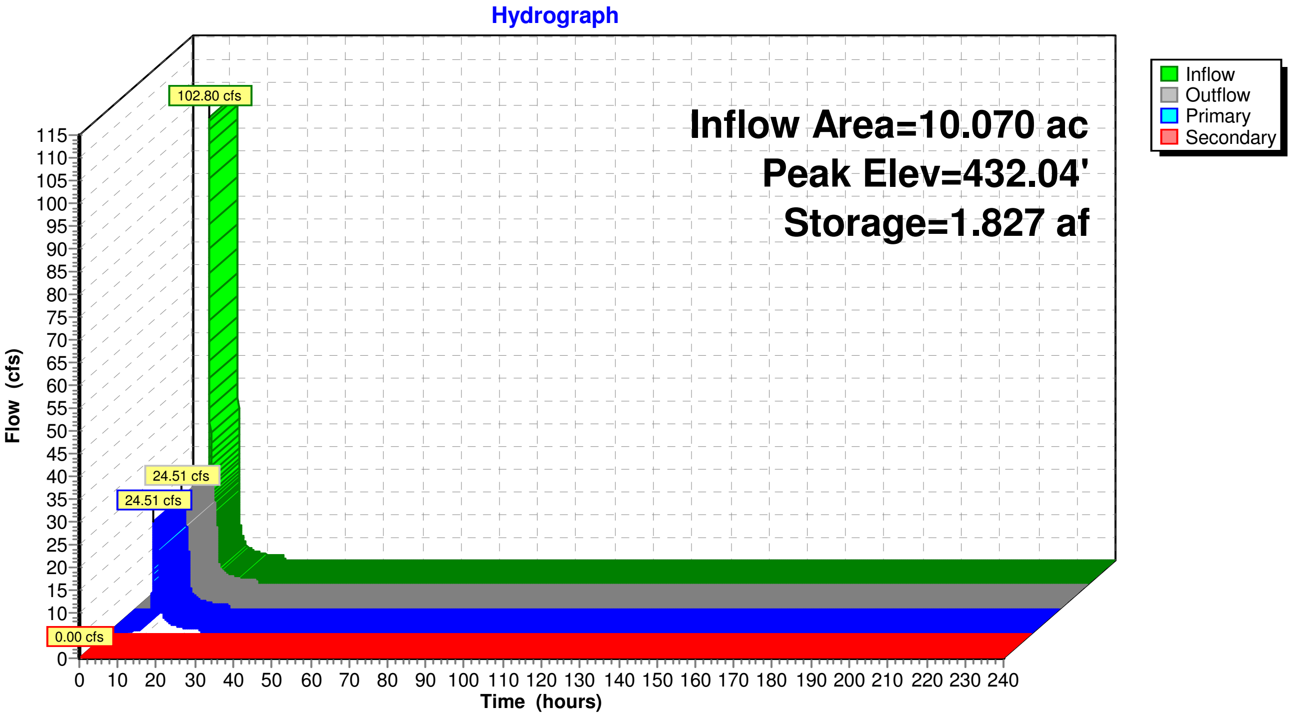
Elevation (feet)	Cum.Store (acre-feet)
428.00	0.000
429.00	0.023
430.00	0.210
431.00	0.731
432.00	1.756
433.00	3.434
434.00	4.000

Device	Routing	Invert	Outlet Devices
#1	Primary	427.30'	**24.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 427.30' / 425.30' S= 0.0400 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Secondary	432.99'	**350.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=24.51 cfs @ 12.20 hrs HW=432.03' TW=429.40' (Dynamic Tailwater)
└—**1=Culvert** (Inlet Controls 24.51 cfs @ 7.80 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=428.00' TW=428.40' (Dynamic Tailwater)
└—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Pond 2 North



Summary for Pond 4P: Proposed Pond 3 with Auxiliary Spillway

Outfall information from 1997 As-Built plans E-WDR1-C101, EWDR1 C-109.

Inflow Area = 58.930 ac, 0.00% Impervious, Inflow Depth > 88.80" for 100 yr 24-hr event
Inflow = 276.89 cfs @ 11.93 hrs, Volume= 436.077 af, Incl. 20.11 cfs Base Flow
Outflow = 97.30 cfs @ 13.25 hrs, Volume= 434.658 af, Atten= 65%, Lag= 79.6 min
Primary = 25.60 cfs @ 0.01 hrs, Volume= 213.063 af
Secondary = 79.06 cfs @ 13.28 hrs, Volume= 221.595 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 428.40' Surf.Area= 0.000 ac Storage= 30.218 af
Peak Elev= 429.64' @ 13.28 hrs Surf.Area= 0.000 ac Storage= 42.390 af (12.172 af above start)

Plug-Flow detention time= 1,142.5 min calculated for 404.429 af (93% of inflow)
Center-of-Mass det. time= 110.0 min (6,770.3 - 6,660.3)

Volume	Invert	Avail.Storage	Storage Description
#1	425.00'	96.000 af	**Custom Stage Data** Listed below

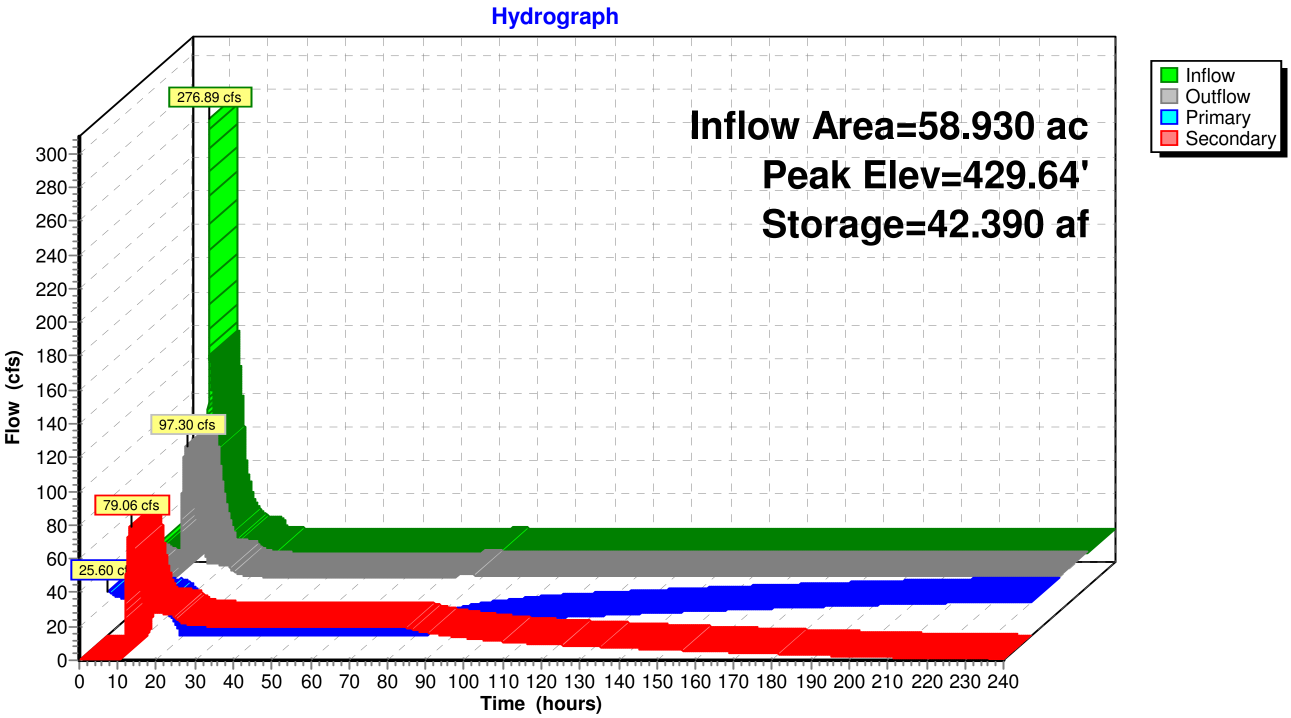
Elevation (feet)	Cum.Store (acre-feet)
425.00	0.000
426.00	8.514
427.00	17.331
428.00	26.438
429.00	35.887
430.00	45.977
435.00	96.000

Device	Routing	Invert	Outlet Devices
#1	Primary	419.74'	**24.0" Round 24" Culvert** L= 650.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 417.50' / 419.74' S= -0.0034 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	425.83'	**90.0 deg x 3.2' long x 1.50' rise Sharp-Crested Vee/Trap Weir X 2.00** Cv= 2.50 (C= 3.13)
#3	Device 1	427.33'	**46.0" x 46.0" Horiz. Orifice/Grate X 0.90** C= 0.600 Limited to weir flow at low heads
#4	Secondary	432.00'	**1,200.0' long x 15.0' breadth Proposed Crest-Broad-Crested Rectangular Weir X** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#5	Secondary	428.50'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 1.50 Width (feet) 15.00 45.00

Primary OutFlow Max=25.60 cfs @ 0.01 hrs HW=428.40' TW=415.29' (Dynamic Tailwater)
└─**1=24" Culvert** (Outlet Controls 25.60 cfs @ 8.15 fps)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Passes < 86.57 cfs potential flow)
  └─**3=Orifice/Grate** (Passes < 50.04 cfs potential flow)

Secondary OutFlow Max=79.06 cfs @ 13.28 hrs HW=429.64' TW=429.25' (Dynamic Tailwater)
├─**4=Proposed Crest-Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└─**5=Custom Weir/Orifice** (Weir Controls 79.06 cfs @ 2.61 fps)

Pond 4P: Proposed Pond 3 with Auxiliary Spillway



Summary for Pond 10P: Wood River

Inflow Area = 939.440 ac, 0.00% Impervious, Inflow Depth = 0.00" for 100 yr 24-hr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 407.00' Surf.Area= 31,600.000 ac Storage= 61,600.000 af
Peak Elev= 407.00' @ 0.00 hrs Surf.Area= 31,600.000 ac Storage= 61,600.000 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

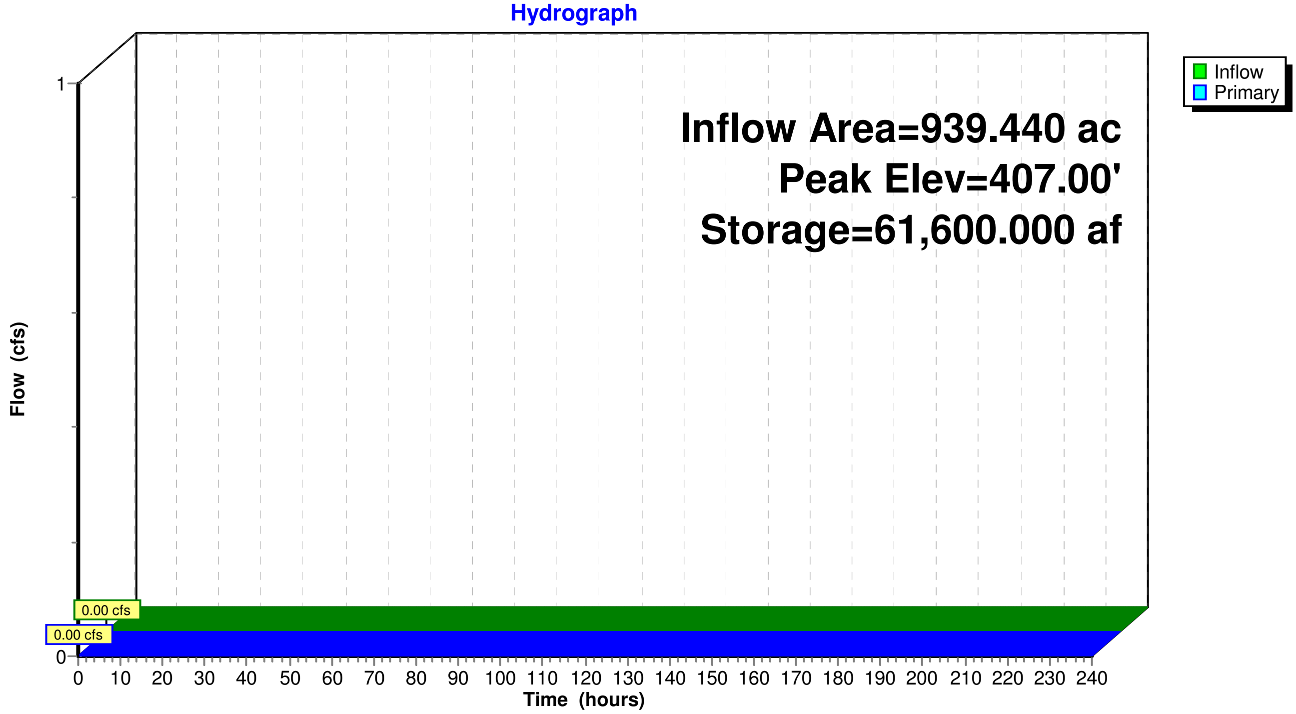
Volume	Invert	Avail.Storage	Storage Description
#1	405.00'	1,000,000.000 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
405.00	30,000.000	0.000	0.000
430.00	50,000.000	1,000,000.000	1,000,000.000

Device	Routing	Invert	Outlet Devices
#1	Primary	420.00'	**300.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=407.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 10P: Wood River



Summary for Pond 11P: Pond northeast 1

48" outlet culvert information is from pipe survey done in 2015.
Assumed a CB located on 48" line at 224.5' measured from east.

Inflow Area = 56.617 ac, 61.74% Impervious, Inflow Depth > 101.29" for 100 yr 24-hr event
Inflow = 280.04 cfs @ 12.15 hrs, Volume= 477.898 af
Outflow = 114.98 cfs @ 17.03 hrs, Volume= 472.836 af, Atten= 59%, Lag= 292.8 min
Primary = 68.66 cfs @ 14.63 hrs, Volume= 250.338 af
Secondary = 67.42 cfs @ 17.64 hrs, Volume= 222.499 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 416.50' Surf.Area= 0.379 ac Storage= 0.819 af
Peak Elev= 431.42' @ 39.19 hrs Surf.Area= 23.350 ac Storage= 112.686 af (111.867 af above start)

Plug-Flow detention time= 1,233.4 min calculated for 471.988 af (99% of inflow)
Center-of-Mass det. time= 1,107.7 min (4,489.2 - 3,381.5)

Volume	Invert	Avail.Storage	Storage Description
#1	413.00'	313.043 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

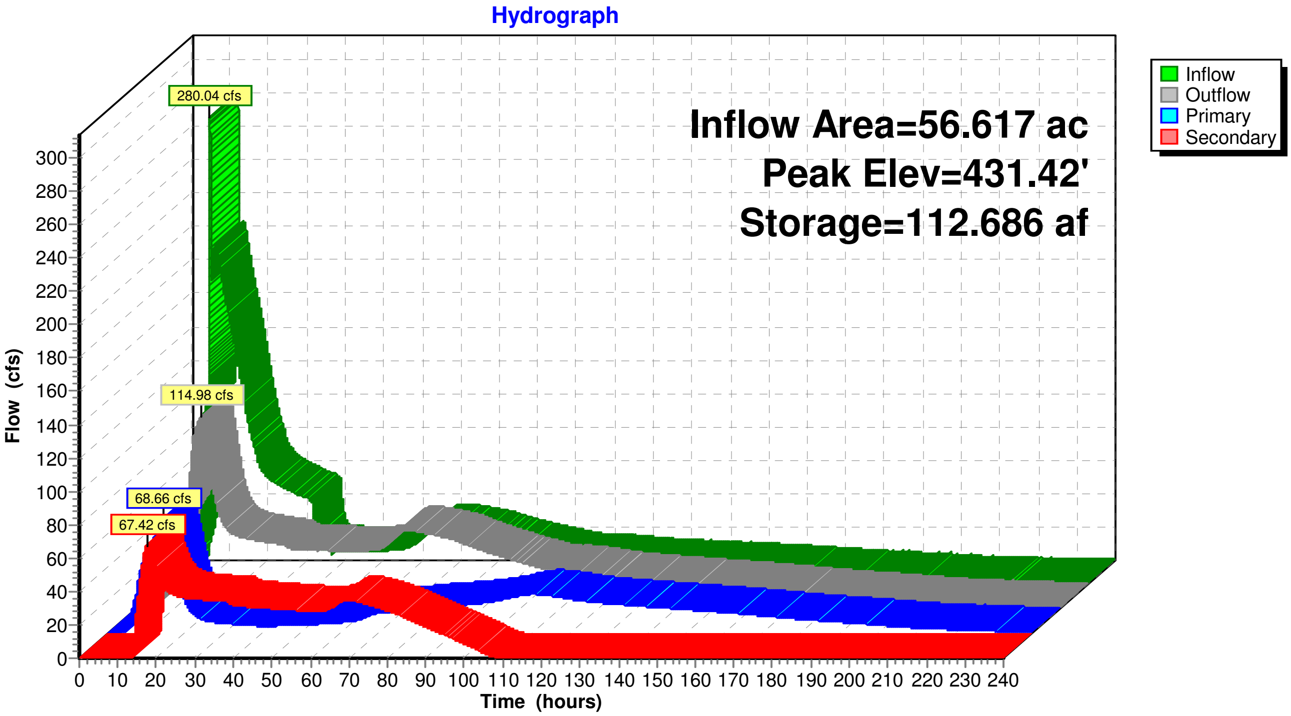
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
413.00	0.100	350.0	0.000	0.000	0.100
416.00	0.350	1,766.0	0.637	0.637	5.574
422.00	0.770	1,852.0	3.278	3.915	6.195
430.00	23.350	10,827.0	75.627	79.543	214.082
437.00	23.350	10,827.0	163.450	242.993	215.822
440.00	23.350	10,827.0	70.050	313.043	216.568

Device	Routing	Invert	Outlet Devices
#1	Primary	418.12'	**48.0" Round 48" Culvert** L= 224.5' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 415.09' / 418.12' S= -0.0135 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 12.57 sf
#2	Secondary	428.00'	**15.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=68.66 cfs @ 14.63 hrs HW=428.67' TW=426.07' (Dynamic Tailwater)
└─**1=48" Culvert** (Outlet Controls 68.66 cfs @ 5.46 fps)

Secondary OutFlow Max=67.43 cfs @ 17.64 hrs HW=429.50' TW=428.48' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 67.43 cfs @ 2.99 fps)

Pond 11P: Pond northeast 1



Summary for Pond 12P: Pond southeast 1

36" outlet culvert information is from pipe survey done in 2015.

Inflow Area = 156.807 ac, 35.27% Impervious, Inflow Depth > 66.55" for 100 yr 24-hr event
Inflow = 125.18 cfs @ 16.54 hrs, Volume= 869.635 af
Outflow = 76.71 cfs @ 39.52 hrs, Volume= 860.561 af, Atten= 39%, Lag= 1,378.7 min
Primary = 76.71 cfs @ 39.52 hrs, Volume= 860.561 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.40' @ 39.15 hrs Surf.Area= 5.956 ac Storage= 48.539 af

Plug-Flow detention time= 415.7 min calculated for 860.551 af (99% of inflow)
Center-of-Mass det. time= 324.8 min (5,962.2 - 5,637.5)

Volume	Invert	Avail.Storage	Storage Description
#1	415.00'	99.749 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

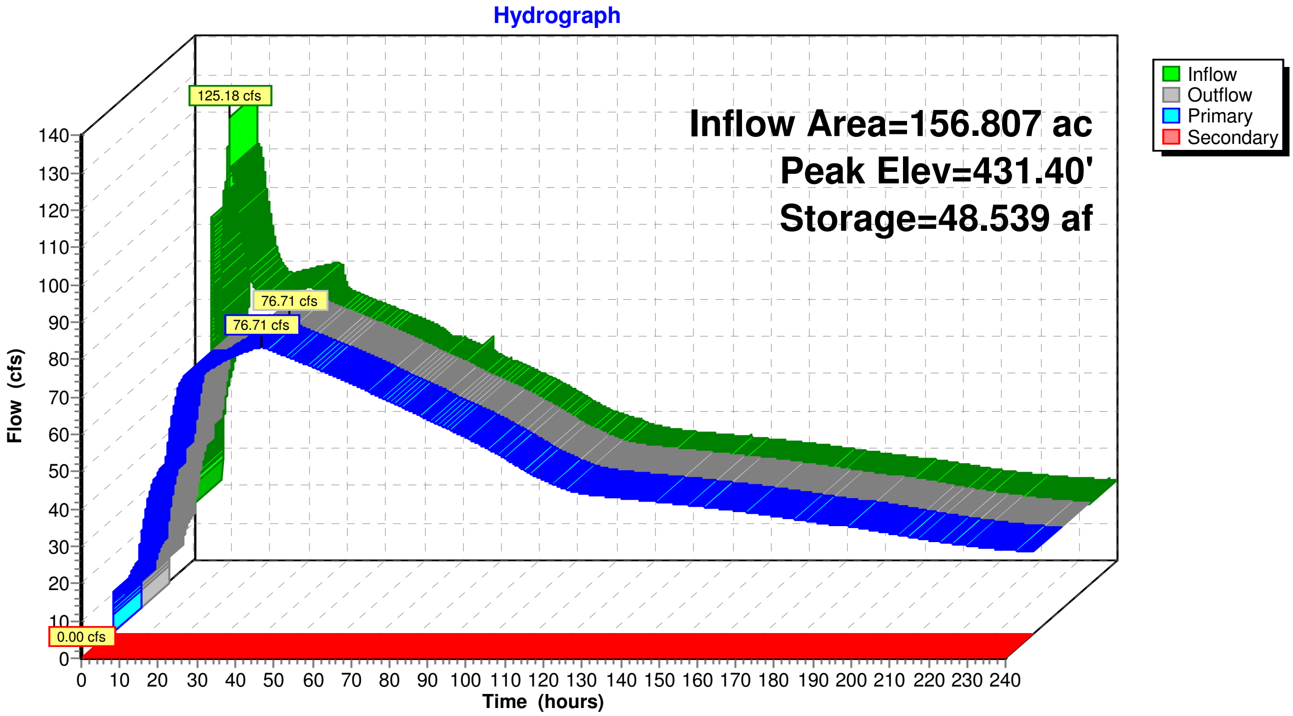
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
415.00	0.100	350.0	0.000	0.000	0.100
419.00	0.497	1,823.0	1.093	1.093	5.948
423.00	3.370	2,327.0	6.882	7.975	9.774
430.00	5.956	2,360.0	32.214	40.189	10.245
440.00	5.956	2,360.0	59.560	99.749	10.787

Device	Routing	Invert	Outlet Devices
#1	Primary	415.99'	**36.0" Round Culvert** L= 189.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 415.99' / 415.00' S= 0.0052 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 7.07 sf
#2	Secondary	431.50'	**700.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=76.71 cfs @ 39.52 hrs HW=431.40' TW=426.32' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 76.71 cfs @ 10.85 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=415.10' TW=420.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 12P: Pond southeast 1



Summary for Pond 13P: Pond southeast 2

48" outlet culvert information is from pipe survey done in 2015. Assumed a CB located on 48" line at 224.5' measured from east.

Inflow Area = 71.567 ac, 48.85% Impervious, Inflow Depth > 80.87" for 100 yr 24-hr event
Inflow = 156.11 cfs @ 12.21 hrs, Volume= 482.325 af
Outflow = 56.65 cfs @ 70.84 hrs, Volume= 477.227 af, Atten= 64%, Lag= 3,517.7 min
Primary = 39.28 cfs @ 12.49 hrs, Volume= 160.543 af
Secondary = 46.13 cfs @ 68.75 hrs, Volume= 316.715 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.41' @ 39.21 hrs Surf.Area= 14.950 ac Storage= 88.358 af

Plug-Flow detention time= 1,048.7 min calculated for 477.207 af (99% of inflow)
Center-of-Mass det. time= 953.3 min (5,369.9 - 4,416.6)

Volume	Invert	Avail.Storage	Storage Description
#1	419.00'	216.816 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

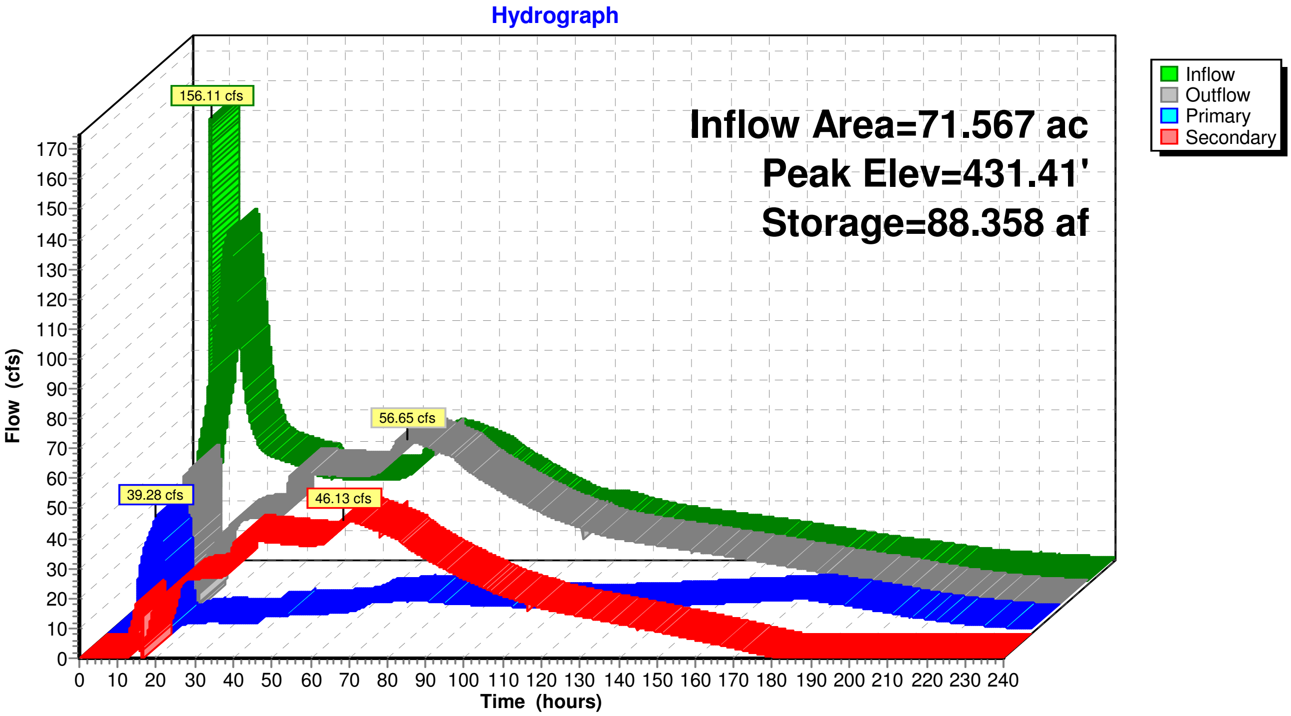
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
419.00	0.100	350.0	0.000	0.000	0.100
423.00	2.530	1,465.0	4.177	4.177	3.798
424.00	4.870	2,426.0	3.637	7.814	10.629
425.00	6.990	3,464.0	5.898	13.712	21.798
430.00	14.950	6,415.0	53.604	67.316	75.059
440.00	14.950	6,415.0	149.500	216.816	76.532

Device	Routing	Invert	Outlet Devices
#1	Primary	419.08'	**48.0" Round 48" Culvert** L= 70.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 418.12' / 419.08' S= -0.0137 '/' Cc= 0.900 n= 0.011, Flow Area= 12.57 sf
#2	Secondary	425.00'	**10.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=39.28 cfs @ 12.49 hrs HW=425.24' TW=424.82' (Dynamic Tailwater)
↑—**1=48" Culvert** (Inlet Controls 39.28 cfs @ 3.13 fps)

Secondary OutFlow Max=46.14 cfs @ 68.75 hrs HW=429.84' TW=429.81' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 46.14 cfs @ 0.95 fps)

Pond 13P: Pond southeast 2



Summary for Pond 14P: Pond northeast 4

Inflow Area = 20.350 ac,100.00% Impervious, Inflow Depth = 113.34" for 100 yr 24-hr event
Inflow = 164.71 cfs @ 15.13 hrs, Volume= 192.212 af
Outflow = 93.92 cfs @ 17.01 hrs, Volume= 177.133 af, Atten= 43%, Lag= 112.6 min
Primary = 93.92 cfs @ 17.01 hrs, Volume= 175.532 af
Secondary = 24.41 cfs @ 38.75 hrs, Volume= 1.601 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.53' @ 38.75 hrs Surf.Area= 12.513 ac Storage= 34.284 af

Plug-Flow detention time= 544.1 min calculated for 177.133 af (92% of inflow)
Center-of-Mass det. time= 389.3 min (2,161.4 - 1,772.1)

Volume	Invert	Avail.Storage	Storage Description
#1	423.00'	204.679 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

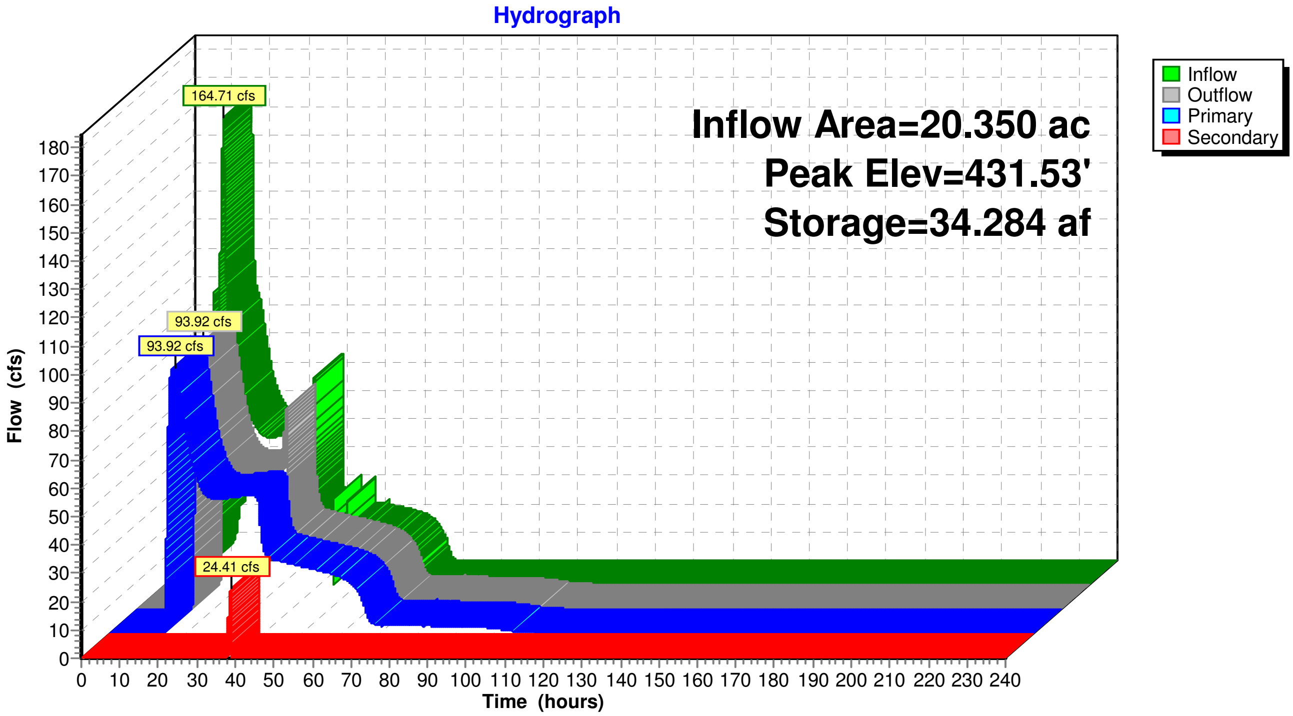
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
423.00	2.000	1,505.0	0.000	0.000	2.000
424.00	2.000	1,505.0	2.000	2.000	2.035
425.00	2.740	1,731.0	2.360	4.360	3.371
426.00	3.240	1,874.0	2.987	7.347	4.314
427.00	4.000	2,325.0	3.613	10.960	7.774
428.00	4.230	2,490.0	4.114	15.075	9.226
429.00	4.530	2,672.0	4.379	19.454	10.943
430.00	4.840	2,851.0	4.684	24.138	12.751
431.00	5.880	3,173.0	5.352	29.489	16.295
432.00	20.350	6,542.0	12.390	41.879	76.087
440.00	20.350	6,542.0	162.800	204.679	77.289

Device	Routing	Invert	Outlet Devices
#1	Primary	428.00'	**8.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Secondary	431.50'	**1,500.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=93.92 cfs @ 17.01 hrs HW=430.71' TW=428.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 93.92 cfs @ 4.33 fps)

Secondary OutFlow Max=24.36 cfs @ 38.75 hrs HW=431.53' TW=426.35' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Weir Controls 24.36 cfs @ 0.49 fps)

Pond 14P: Pond northeast 4



Summary for Pond 16P: East primary pond

Outfall information from 2005 East Ash Pond Expansion plans (URS) sheets P-05 and D-01 (WDR1-C173).
Outlet #5 is a proposed weir.

Inflow Area = 31.780 ac,100.00% Impervious, Inflow Depth = 9.08" for 100 yr 24-hr event
Inflow = 459.00 cfs @ 11.94 hrs, Volume= 24.046 af
Outflow = 4.07 cfs @ 19.80 hrs, Volume= 23.250 af, Atten= 99%, Lag= 471.8 min
Primary = 4.07 cfs @ 19.80 hrs, Volume= 23.250 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 439.50' Surf.Area= 0.000 ac Storage= 22.011 af
Peak Elev= 441.73' @ 19.80 hrs Surf.Area= 0.000 ac Storage= 41.853 af (19.842 af above start)
Flood Elev= 450.00' Surf.Area= 0.000 ac Storage= 144.222 af (122.211 af above start)

Plug-Flow detention time= 10,412.7 min calculated for 1.239 af (5% of inflow)
Center-of-Mass det. time= 2,936.3 min (3,669.0 - 732.7)

Volume	Invert	Avail.Storage	Storage Description
#1	420.00'	187.743 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
420.00	0.000
434.00	4.290
436.00	6.840
438.00	14.429
440.00	24.538
448.00	104.822
450.00	144.222
451.00	165.532
452.00	187.743

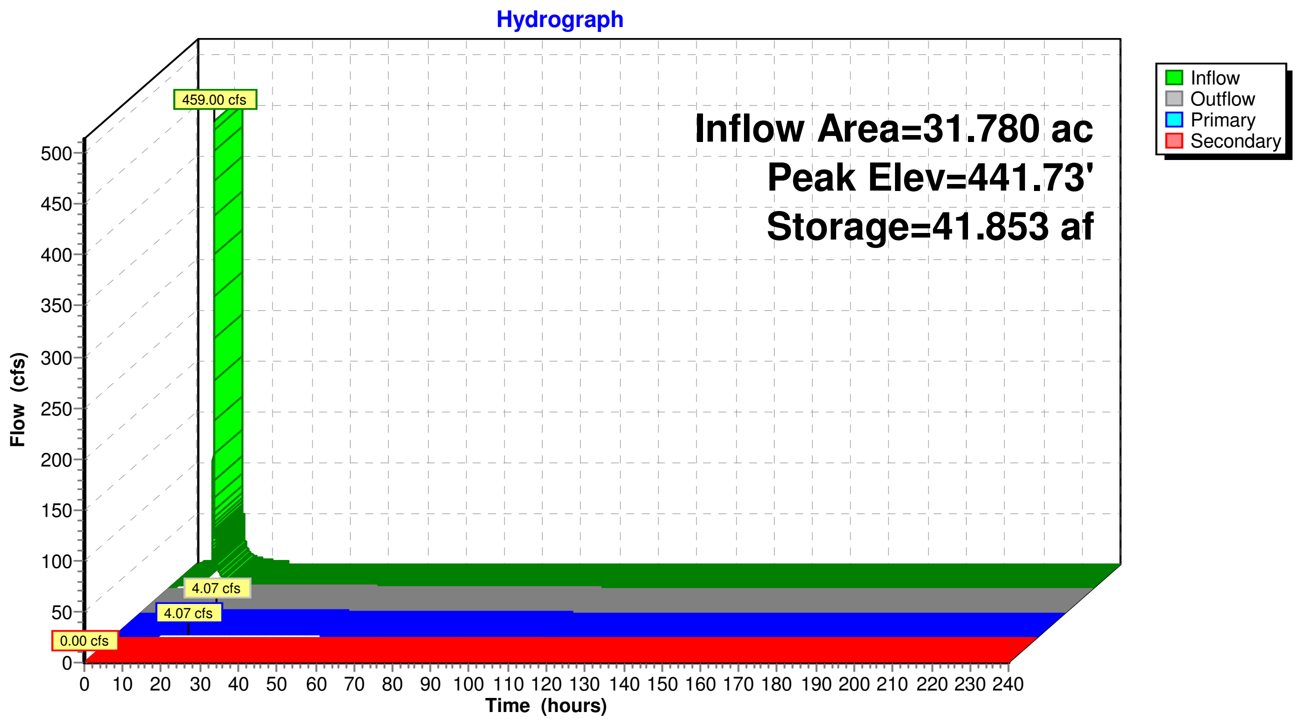
Device	Routing	Invert	Outlet Devices
#1	Primary	435.00'	**26.3" Round 30" HDPE SDR 17 Culvert** L= 679.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 435.00' / 431.94' S= 0.0045 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.77 sf
#2	Device 1	439.50'	**11.2" Round 12" HDPE SDR 17 Culvert** L= 30.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 439.50' / 439.40' S= 0.0033 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.68 sf
#3	Device 1	443.65'	**11.2" Round 12" HDPE SDR 17 Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 443.65' / 443.55' S= 0.0067 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.68 sf
#4	Device 1	446.60'	**11.2" Round 12" HDPE SDR 17 Culvert** L= 5.0' RCP, square edge headwall, Ke= 0.500

			Inlet / Outlet Invert= 446.60' / 446.50' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.68 sf
#5	Device 1	447.60'	**3.5' long x 0.7' breadth Broad-Crested Rectangular Weir X 2.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#6	Device 1	449.60'	**60.0" x 60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#7	Secondary	450.00'	**Custom Weir top of Embankment, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 1.00 2.00 Width (feet) 380.00 550.00 2,200.00

Primary OutFlow Max=4.07 cfs @ 19.80 hrs HW=441.73' TW=431.20' (Dynamic Tailwater)
└─**1=30" HDPE SDR 17 Culvert** (Passes 4.07 cfs of 27.82 cfs potential flow)
  ├─**2=12" HDPE SDR 17 Culvert** (Barrel Controls 4.07 cfs @ 5.95 fps)
  ├─**3=12" HDPE SDR 17 Culvert** (Controls 0.00 cfs)
  ├─**4=12" HDPE SDR 17 Culvert** (Controls 0.00 cfs)
  ├─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
  └─**6=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=439.50' TW=416.53' (Dynamic Tailwater)
└─**7=Custom Weir top of Embankment** (Controls 0.00 cfs)

Pond 16P: East primary pond



Summary for Pond 17P: East secondary pond

Inflow Area = 34.957 ac,100.00% Impervious, Inflow Depth > 8.81" for 100 yr 24-hr event
Inflow = 52.52 cfs @ 11.90 hrs, Volume= 25.654 af
Outflow = 23.68 cfs @ 0.00 hrs, Volume= 32.587 af, Atten= 55%, Lag= 0.0 min
Primary = 23.68 cfs @ 0.00 hrs, Volume= 32.587 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 431.61'   Surf.Area= 0.000 ac   Storage= 8.700 af
Peak Elev= 431.61' @ 0.00 hrs   Surf.Area= 0.000 ac   Storage= 8.700 af

Plug-Flow detention time= 2,836.6 min calculated for 23.886 af (93% of inflow)
Center-of-Mass det. time= 1,060.5 min (4,454.2 - 3,393.6)

Volume	Invert	Avail.Storage	Storage Description
#1	419.00'	15.748 af	**Custom Stage Data** Listed below

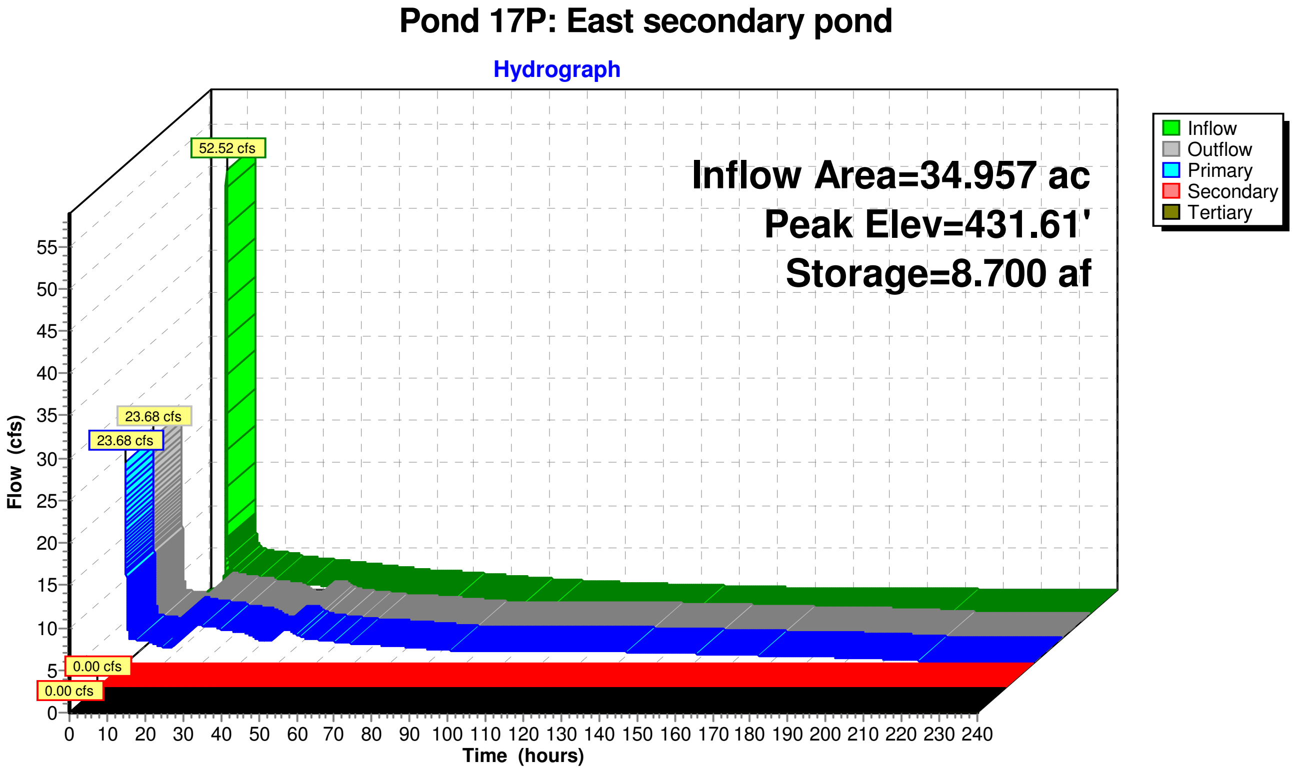
Elevation (feet)	Cum.Store (acre-feet)
419.00	0.000
420.00	0.388
425.00	2.466
430.00	6.876
431.00	7.976
432.00	9.163
433.00	10.426
436.70	15.748

Device	Routing	Invert	Outlet Devices
#1	Primary	420.00'	**31.5" Round 36" HDPE SDR 17 Culvert** L= 566.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 420.00' / 415.60' S= 0.0078 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 5.41 sf
#2	Device 1	420.50'	**5.8" Round 6" HDPE SDR 17 Culvert** L= 4.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 420.50' / 420.40' S= 0.0250 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.18 sf
#3	Device 1	431.00'	**90.0 deg x 3.0' long Sharp-Crested Vee/Trap Weir X 4.00** Cv= 2.50 (C= 3.13)
#4	Device 1	432.60'	**1.0' long x 0.5' breadth Broad-Crested Rectangular Weir X 4.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#5	Secondary	433.00'	**15.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#6	Tertiary	434.00'	**430.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=23.68 cfs @ 0.00 hrs HW=431.61' TW=416.53' (Dynamic Tailwater)
1=36" HDPE SDR 17 Culvert (Passes 23.68 cfs of 62.76 cfs potential flow)
2=6" HDPE SDR 17 Culvert (Inlet Controls 2.91 cfs @ 15.87 fps)
3=Sharp-Crested Vee/Trap Weir (Weir Controls 20.77 cfs @ 2.36 fps)
4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=431.61' TW=417.00' (Dynamic Tailwater)
5=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=431.61' (Free Discharge)
6=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

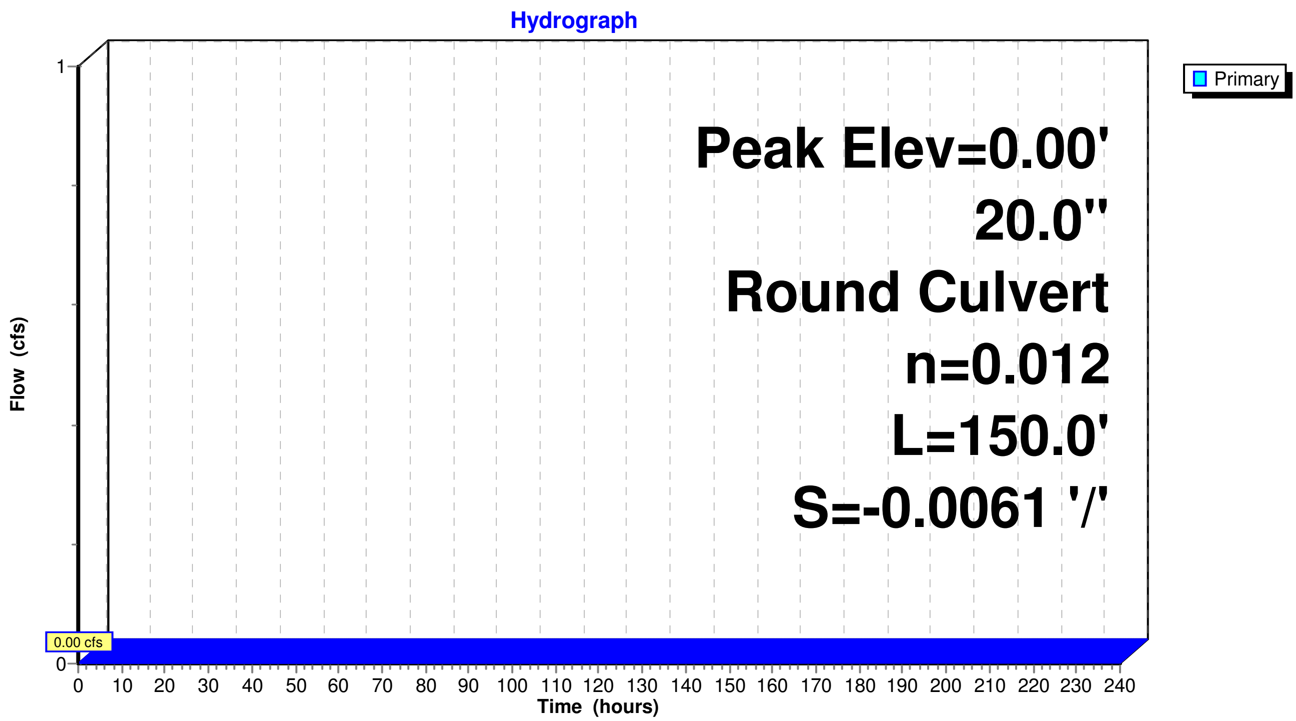


Summary for Pond 18P: MH 2- Pond 3 outlet

Device	Routing	Invert	Outlet Devices
#1	Primary	419.74'	**20.0" Round 24" DI Culvert** L= 150.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 418.83' / 419.74' S= -0.0061 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 2.18 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
↑—**1=24" DI Culvert** (Controls 0.00 cfs)

Pond 18P: MH 2- Pond 3 outlet



Summary for Pond 19P: Pond northeast 2

72" secondary outlet culvert information is from pipe survey done in 2015.
72" primary outlet to Wood River - invert information from pipe survey done in 2015. pipe size needs to be verified.

Inflow Area = 939.440 ac, 0.00% Impervious, Inflow Depth = 7.99" for 100 yr 24-hr event
Inflow = 1,377.00 cfs @ 12.73 hrs, Volume= 625.169 af
Outflow = 332.29 cfs @ 15.13 hrs, Volume= 608.359 af, Atten= 76%, Lag= 143.7 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 188.02 cfs @ 13.76 hrs, Volume= 431.565 af
Tertiary = 158.04 cfs @ 15.13 hrs, Volume= 176.815 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.54' @ 38.74 hrs Surf.Area= 57.490 ac Storage= 254.687 af

Plug-Flow detention time= 1,826.6 min calculated for 608.359 af (97% of inflow)
Center-of-Mass det. time= 1,795.3 min (2,940.1 - 1,144.7)

Volume	Invert	Avail.Storage	Storage Description
#1	417.00'	568.575 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
417.00	0.100	350.0	0.000	0.000	0.100
419.00	1.990	5,689.0	1.691	1.691	59.002
421.00	3.760	4,359.0	5.657	7.348	83.417
424.00	4.590	4,650.0	12.504	19.852	88.216
426.00	17.660	9,055.0	20.836	40.688	198.504
428.00	26.300	8,763.0	43.674	84.362	208.018
430.00	57.490	11,537.0	81.783	166.145	310.893
437.00	57.490	11,537.0	402.430	568.575	312.747

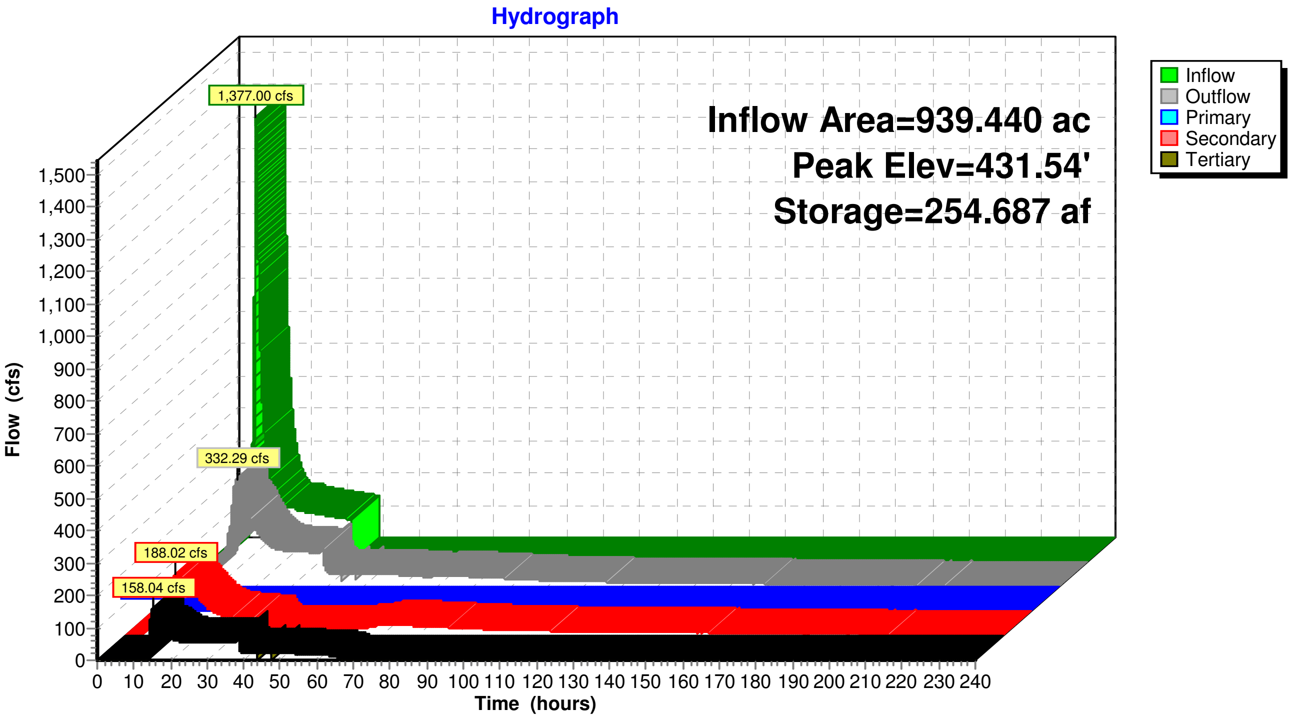
Device	Routing	Invert	Outlet Devices
#1	Primary	408.36'	**72.0" Round 72" Conc Culvert X 0.00** L= 272.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 408.36' / 406.76' S= 0.0059 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 28.27 sf
#2	Secondary	412.67'	**72.0" Round 72" CMP Culvert** L= 149.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 411.82' / 412.67' S= -0.0057 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 28.27 sf
#3	Tertiary	430.00'	**100.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=417.00' TW=407.00' (Dynamic Tailwater)
└─**1=72" Conc Culvert** (Controls 0.00 cfs)

Secondary OutFlow Max=188.02 cfs @ 13.76 hrs HW=430.27' TW=428.15' (Dynamic Tailwater)
└─**2=72" CMP Culvert** (Outlet Controls 188.02 cfs @ 6.65 fps)

Tertiary OutFlow Max=158.04 cfs @ 15.13 hrs HW=430.71' TW=430.01' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 158.04 cfs @ 2.24 fps)

Pond 19P: Pond northeast 2



Summary for Pond 20P: Pond northwest 1

36" outlet culvert information from pipe survey done in 2015.

Inflow Area = 164.177 ac, 33.69% Impervious, Inflow Depth > 79.57" for 100 yr 24-hr event
Inflow = 155.12 cfs @ 12.05 hrs, Volume= 1,088.662 af
Outflow = 117.38 cfs @ 38.75 hrs, Volume= 1,082.616 af, Atten= 24%, Lag= 1,601.7 min
Primary = 50.41 cfs @ 38.86 hrs, Volume= 795.983 af
Secondary = 83.51 cfs @ 13.17 hrs, Volume= 54.475 af
Tertiary = 57.21 cfs @ 38.88 hrs, Volume= 232.158 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 420.00' Surf.Area= 1.627 ac Storage= 3.038 af
Peak Elev= 426.36' @ 38.88 hrs Surf.Area= 4.565 ac Storage= 25.789 af (22.751 af above start)
Flood Elev= 431.00' Surf.Area= 6.072 ac Storage= 51.273 af (48.235 af above start)

Plug-Flow detention time= 247.5 min calculated for 1,079.578 af (99% of inflow)
Center-of-Mass det. time= 159.6 min (5,784.5 - 5,624.8)

Volume	Invert	Avail.Storage	Storage Description
#1	417.00'	73.223 af	**Custom Stage Data (Irregular)** Listed below

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
417.00	0.240	1,004.0	0.000	0.000	0.240
421.00	2.090	3,177.0	4.051	4.051	16.839
422.00	2.660	3,203.0	2.369	6.420	17.150
423.00	3.220	3,233.0	2.936	9.356	17.511
424.00	3.800	3,249.0	3.506	12.862	17.714
435.00	7.370	3,202.0	60.361	73.223	18.699

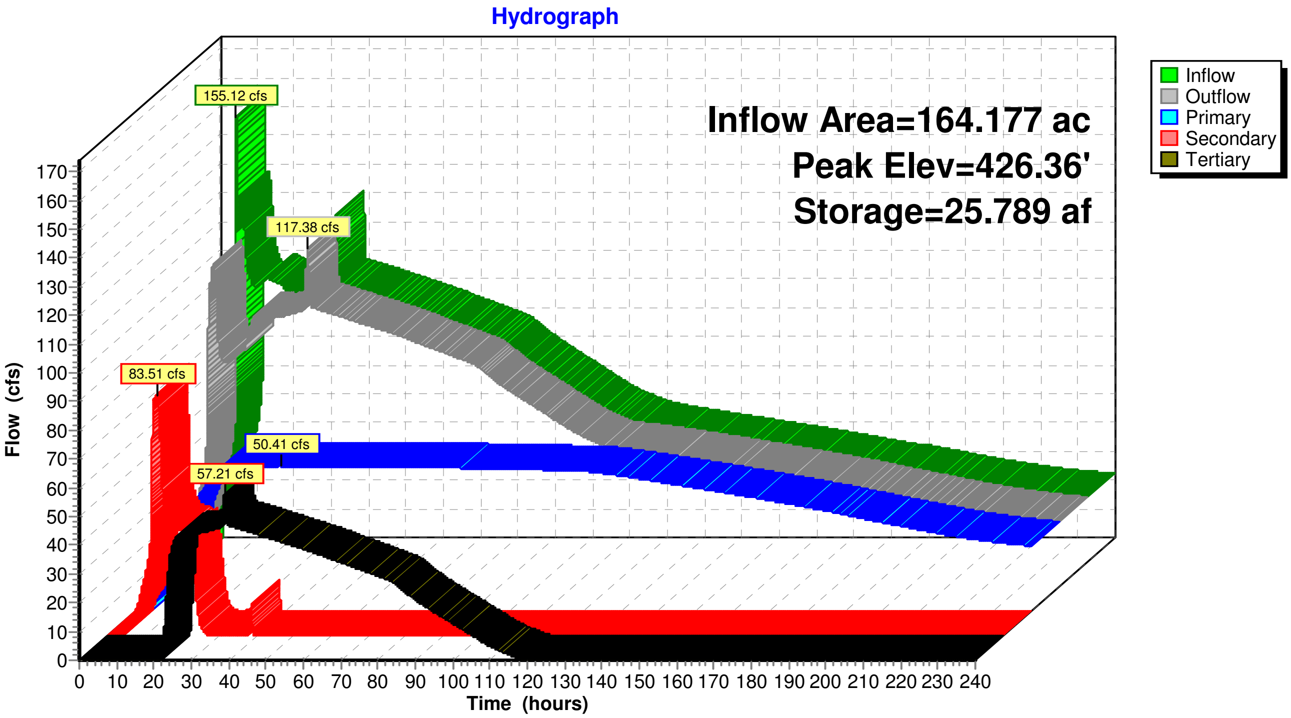
Device	Routing	Invert	Outlet Devices
#1	Primary	411.77'	**36.0" Round Culvert** L= 141.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 411.77' / 411.58' S= 0.0013 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 7.07 sf
#2	Secondary	422.00'	**25.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#3	Tertiary	426.00'	**100.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=50.41 cfs @ 38.86 hrs HW=426.36' TW=422.18' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 50.41 cfs @ 7.13 fps)

Secondary OutFlow Max=83.51 cfs @ 13.17 hrs HW=423.52' TW=423.12' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 83.51 cfs @ 2.20 fps)

Tertiary OutFlow Max=57.21 cfs @ 38.88 hrs HW=426.36' TW=422.18' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 57.21 cfs @ 1.61 fps)

Pond 20P: Pond northwest 1

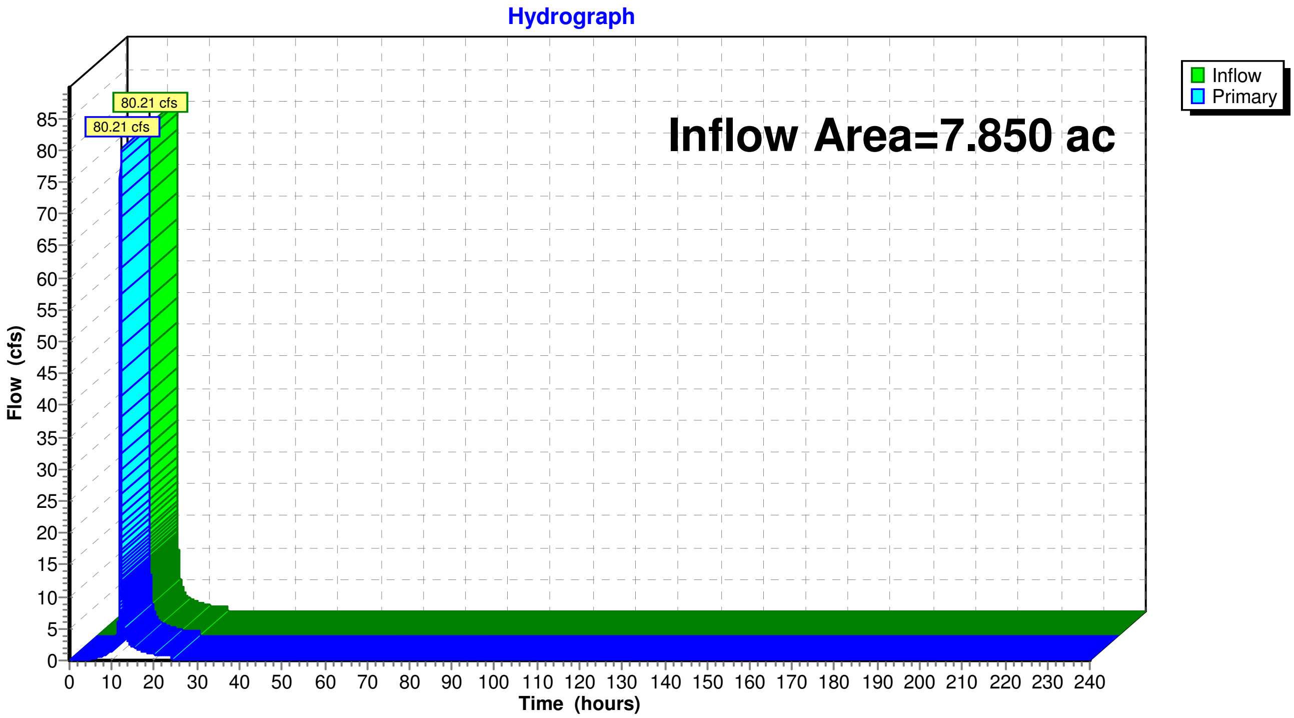


Summary for Pond 21P: Ccombined Upper Pond 2 South DA

Inflow Area = 7.850 ac, 0.00% Impervious, Inflow Depth = 7.37" for 100 yr 24-hr event
Inflow = 80.21 cfs @ 12.03 hrs, Volume= 4.820 af
Primary = 80.21 cfs @ 12.03 hrs, Volume= 4.820 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3

Pond 21P: Ccombined Upper Pond 2 South DA



Summary for Pond 23P: Pond northeast 3

Outlet culvert information assumed. Needs to be veiyfied.

Inflow Area = 881.670 ac, 0.00% Impervious, Inflow Depth = 7.99" for 100 yr 24-hr event
Inflow = 6,307.86 cfs @ 12.19 hrs, Volume= 586.681 af
Outflow = 1,331.28 cfs @ 12.74 hrs, Volume= 586.727 af, Atten= 79%, Lag= 33.3 min
Primary = 215.43 cfs @ 10.05 hrs, Volume= 423.796 af
Secondary = 1,137.59 cfs @ 12.75 hrs, Volume= 162.931 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 436.38' @ 12.75 hrs Surf.Area= 192.320 ac Storage= 265.401 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 379.0 min (1,168.9 - 789.9)

Volume	Invert	Avail.Storage	Storage Description
#1	435.00'	961.600 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

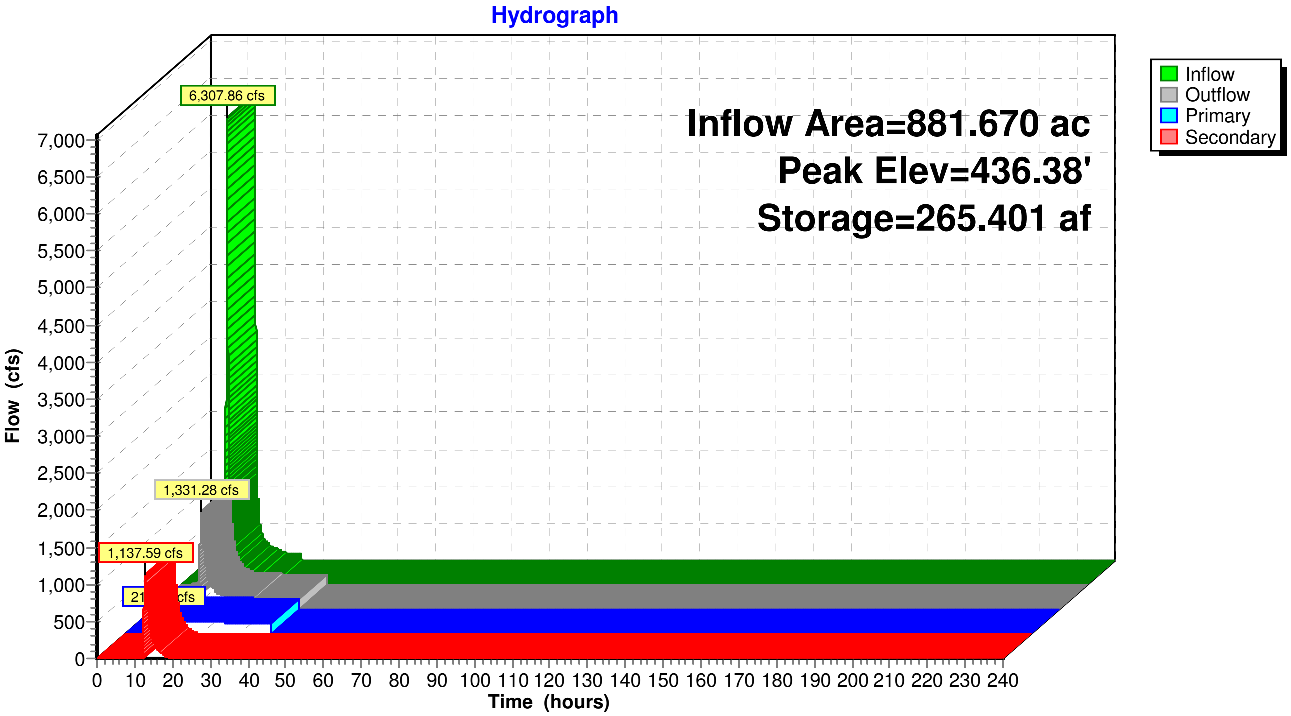
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
435.00	192.320	11,582.0	0.000	0.000	192.320
440.00	192.320	11,582.0	961.600	961.600	193.649

Device	Routing	Invert	Outlet Devices
#1	Primary	418.00'	**60.0" Round 60" Culvert** L= 260.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 418.00' / 417.00' S= 0.0038 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 19.63 sf
#2	Secondary	436.00'	**1,800.0' long x 15.0' breadth Br-Crest Rec Weir over RR** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=215.52 cfs @ 10.05 hrs HW=435.00' TW=425.58' (Dynamic Tailwater)
└—**1=60" Culvert** (Outlet Controls 215.52 cfs @ 10.98 fps)

Secondary OutFlow Max=1,137.52 cfs @ 12.75 hrs HW=436.38' TW=428.78' (Dynamic Tailwater)
└—**2=Br-Crest Rec Weir over RR** (Weir Controls 1,137.52 cfs @ 1.66 fps)

Pond 23P: Pond northeast 3

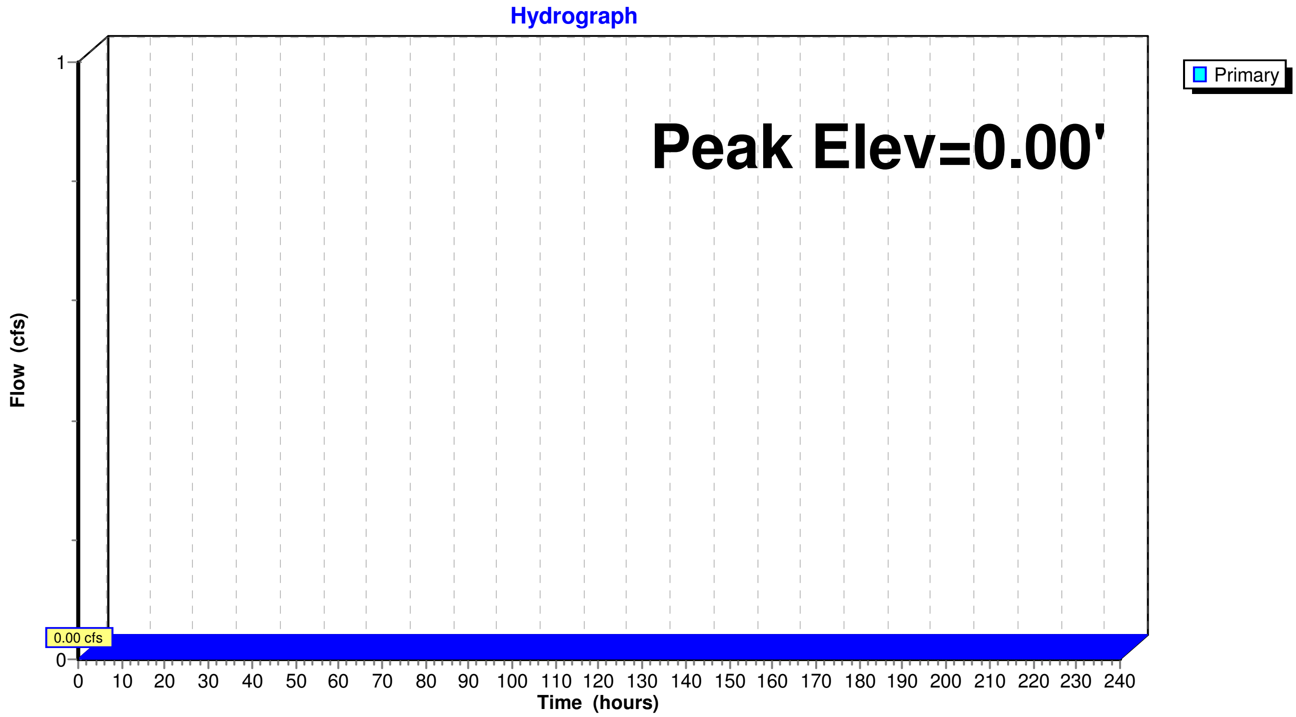


Summary for Pond 29P: outlet

Device	Routing	Invert	Outlet Devices
#1	Primary	418.00'	**Special & User-Defined** Head (feet) 0.00 0.10 200.00 Disch. (cfs) 0.000 1,250.000 1,250.000

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
└─**1=Special & User-Defined** (Controls 0.00 cfs)

Pond 29P: outlet



Summary for Pond 30P: Pond northwest 3

Inflow Area = 277.097 ac, 19.96% Impervious, Inflow Depth > 47.14" for 100 yr 24-hr event
Inflow = 756.07 cfs @ 12.13 hrs, Volume= 1,088.594 af
Outflow = 473.79 cfs @ 12.30 hrs, Volume= 1,086.520 af, Atten= 37%, Lag= 10.3 min
Secondary = 473.79 cfs @ 12.30 hrs, Volume= 1,086.520 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 422.00' Surf.Area= 31.349 ac Storage= 245.508 af
Peak Elev= 422.50' @ 12.30 hrs Surf.Area= 32.717 ac Storage= 261.444 af (15.937 af above start)

Plug-Flow detention time= 2,913.7 min calculated for 841.012 af (77% of inflow)
Center-of-Mass det. time= 31.4 min (5,779.5 - 5,748.1)

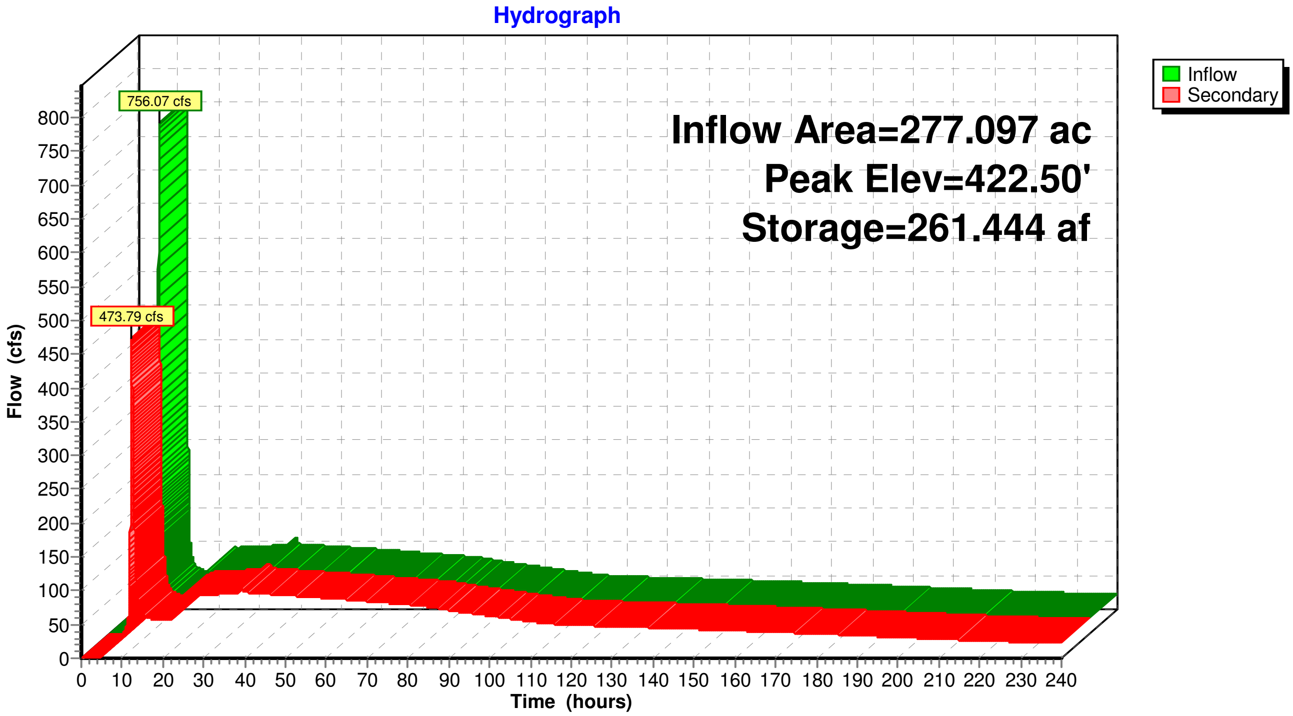
Volume	Invert	Avail.Storage	Storage Description
#1	404.00'	1,070.034 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
404.00	3.950	1,865.0	0.000	0.000	3.950
409.00	5.960	3,891.0	24.603	24.603	25.257
429.00	53.280	7,862.0	513.733	538.336	110.560
432.00	77.590	9,000.0	195.166	733.502	145.621
436.00	90.850	10,130.0	336.532	1,070.034	185.121

Device	Routing	Invert	Outlet Devices
#1	Secondary	422.00'	**500.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Secondary OutFlow Max=473.73 cfs @ 12.30 hrs HW=422.50' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 473.73 cfs @ 1.90 fps)

Pond 30P: Pond northwest 3



Summary for Pond 35P: Pond 1-Proposed Middle

Inflow Area = 7.660 ac, 0.00% Impervious, Inflow Depth = 10.34" for 100 yr 24-hr event
Inflow = 106.73 cfs @ 12.16 hrs, Volume= 6.600 af
Outflow = 17.56 cfs @ 12.54 hrs, Volume= 6.425 af, Atten= 84%, Lag= 22.5 min
Primary = 17.45 cfs @ 12.49 hrs, Volume= 6.423 af
Secondary = 0.15 cfs @ 12.57 hrs, Volume= 0.002 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.03' @ 12.57 hrs Surf.Area= 0.000 ac Storage= 3.678 af

Plug-Flow detention time= 314.2 min calculated for 6.424 af (97% of inflow)
Center-of-Mass det. time= 298.5 min (1,074.6 - 776.1)

Volume	Invert	Avail.Storage	Storage Description
#1	427.00'	12.057 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
427.00	0.000
428.00	0.015
429.00	0.306
430.00	1.341
431.00	3.586
432.00	7.223
433.00	12.057

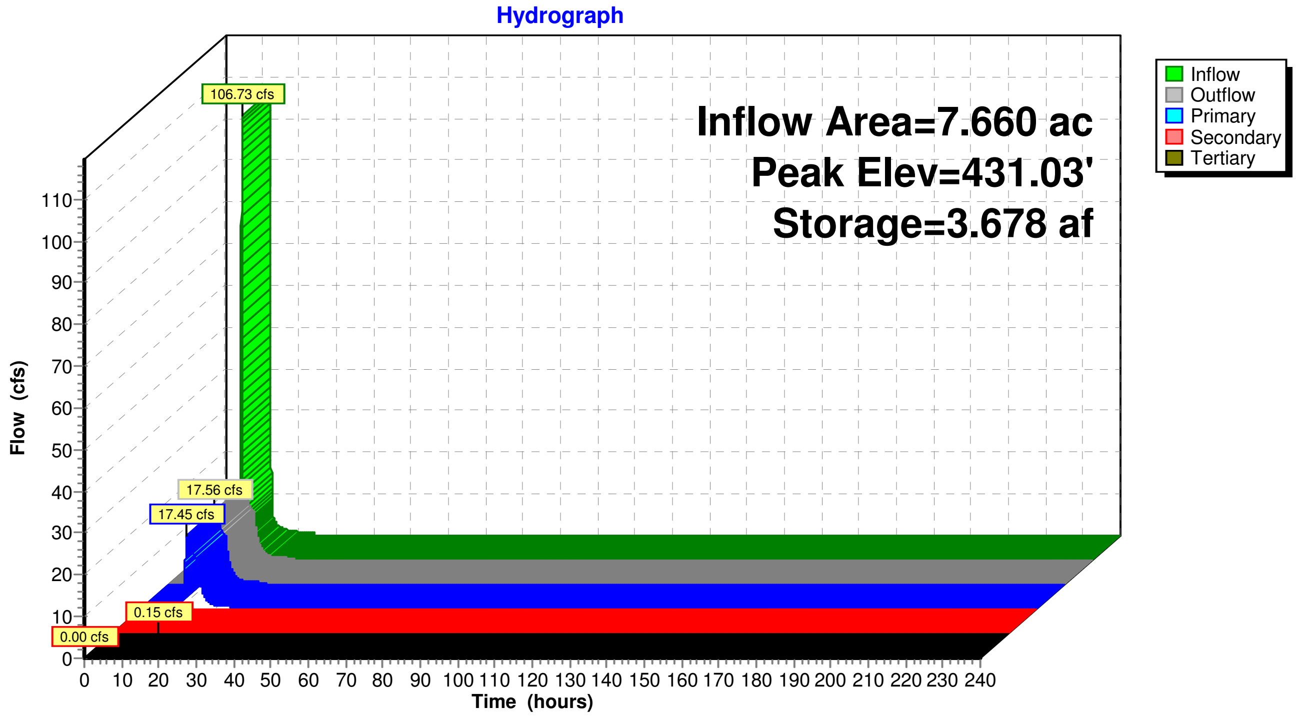
Device	Routing	Invert	Outlet Devices
#1	Primary	427.50'	**24.0" Round Culvert** L= 150.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 427.50' / 425.30' S= 0.0147 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Secondary	431.00'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.50 1.50 2.50 Width (feet) 10.00 140.00 240.00
#3	Tertiary	432.99'	**500.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=17.45 cfs @ 12.49 hrs HW=431.01' TW=429.53' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 17.45 cfs @ 5.56 fps)

Secondary OutFlow Max=0.15 cfs @ 12.57 hrs HW=431.03' TW=430.51' (Dynamic Tailwater)
└─**2=Custom Weir/Orifice** (Weir Controls 0.15 cfs @ 0.51 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=427.00' TW=428.40' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 35P: Pond 1-Proposed Middle



Summary for Pond 36P: Pond northwest 2

Inflow Area = 22.070 ac, 0.00% Impervious, Inflow Depth = 37.60" for 100 yr 24-hr event
Inflow = 273.96 cfs @ 12.09 hrs, Volume= 69.161 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 420.00' Surf.Area= 5.845 ac Storage= 5.485 af
Peak Elev= 426.36' @ 90.56 hrs Surf.Area= 13.725 ac Storage= 74.646 af (69.161 af above start)
Flood Elev= 431.00' Surf.Area= 19.780 ac Storage= 150.850 af (145.365 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

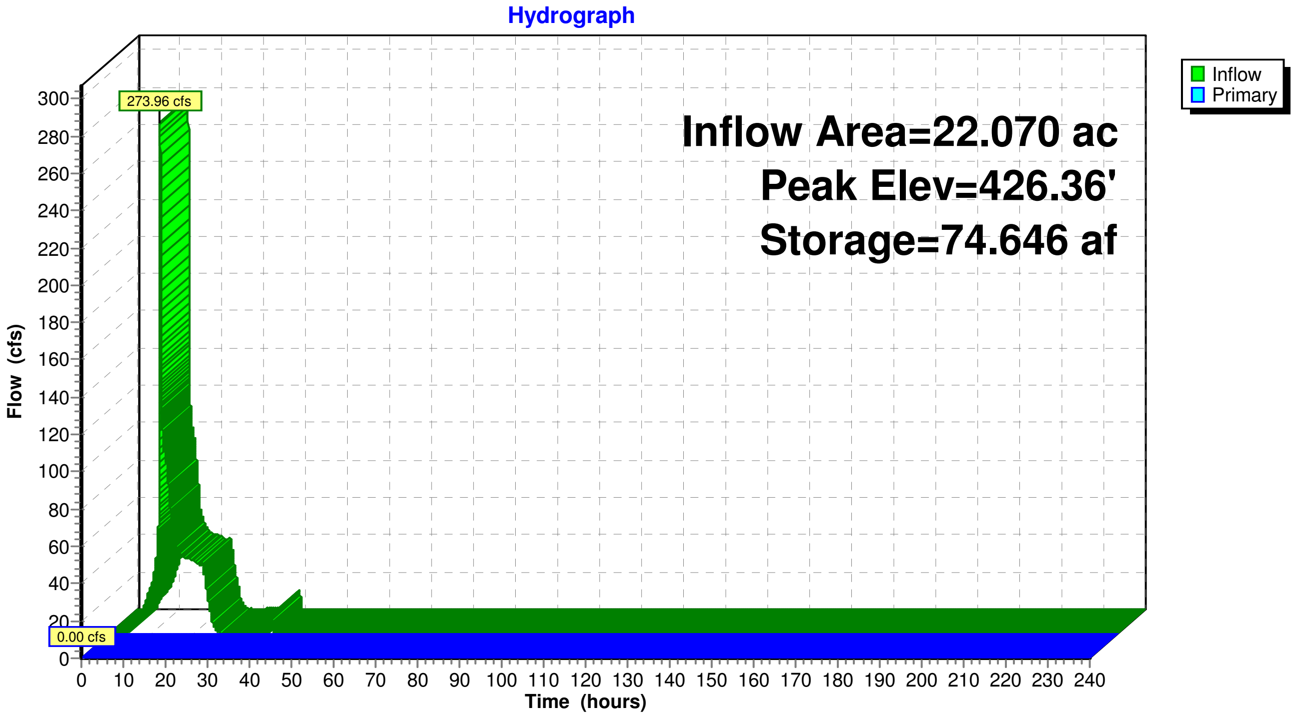
Volume	Invert	Avail.Storage	Storage Description
#1	419.00'	150.850 af	**Custom Stage Data (Irregular)** Listed below

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
419.00	2.460	2,939.0	0.000	0.000	2.460
421.00	9.230	3,000.0	10.970	10.970	3.136
422.00	10.130	3,100.0	9.677	20.647	4.252
423.00	11.400	3,166.0	10.759	31.405	5.011
424.00	12.290	3,477.0	11.842	43.248	8.786
426.00	13.260	3,816.0	25.544	68.791	13.306
431.00	19.780	4,882.0	82.059	150.850	30.252

Device	Routing	Invert	Outlet Devices
#1	Primary	430.00'	**50.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=420.00' TW=422.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 36P: Pond northwest 2



Summary for Pond 37P: Pond 1-Proposed Right

Inflow Area = 5.730 ac, 0.00% Impervious, Inflow Depth = 7.37" for 100 yr 24-hr event
Inflow = 56.24 cfs @ 12.04 hrs, Volume= 3.520 af
Outflow = 15.22 cfs @ 12.23 hrs, Volume= 3.501 af, Atten= 73%, Lag= 11.4 min
Primary = 15.22 cfs @ 12.23 hrs, Volume= 3.501 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 430.61' @ 12.27 hrs Surf.Area= 0.000 ac Storage= 1.186 af

Plug-Flow detention time= 113.3 min calculated for 3.500 af (99% of inflow)
Center-of-Mass det. time= 110.1 min (900.8 - 790.8)

Volume	Invert	Avail.Storage	Storage Description
#1	428.00'	7.338 af	**Custom Stage Data** Listed below

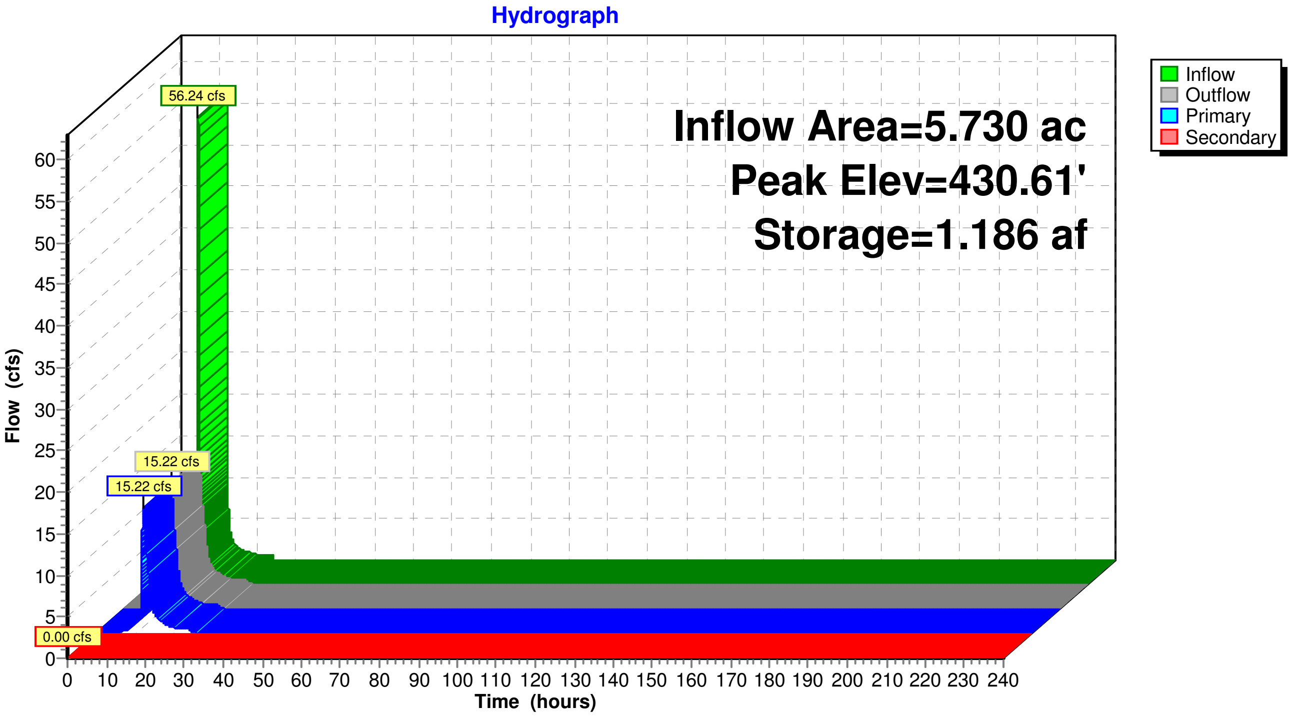
Elevation (feet)	Cum.Store (acre-feet)
428.00	0.000
429.00	0.036
430.00	0.437
431.00	1.670
432.00	4.001
433.00	7.338

Device	Routing	Invert	Outlet Devices
#1	Primary	428.30'	**24.0" Round Culvert** L= 150.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 428.30' / 425.30' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Secondary	432.99'	**500.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=15.22 cfs @ 12.23 hrs HW=430.60' TW=429.42' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 15.22 cfs @ 5.28 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=428.00' TW=428.40' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 37P: Pond 1-Proposed Right



AECOM

ATTACHMENT 5

RIPRAP SIZING FOR PROPOSED EMERGENCY SPILLWAY

Dynegy Wood River Power Plant Pond 3

Riprap Sizing Calculation

Project Number:	60501542		
Calculated By:	NSF	Date	7/6/2016
Checked By:	MMS	Date	7/6/2016

Resources: USACE, 1994. *Hydraulic Design of Flood Control Channels*, Engineer Manual No. 1110-2-1601.
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-1601.pdf

Objective: Calculate Require Riprap Size for Proposed Stormwater Channel

Values to be changed
Intermediate Values
Final output

Assumptions:

Design Conditions

Maximum Flow (Q)	=	79	ft^3/s	
Average Channel Width	=	17	ft	
Flow per unit width (q)	=	4.647059	ft^2/s	
Design Velocity	=	9.8	ft/s	
Slope	=	0.26	ft/ft	***Use eq. 3-3*** [redacted]
Bottom width		15	ft	
Sideslope Horizontal	=	10	ft	
Sideslope Vertical	=	1	ft	
Side Slope Angle	=	0.099669	radians	
Mannings n trial	=	0.38	-	*<- Complete iterations until these*
Mannings n output	=	0.037866	-	*<- two match*
Factor of Safety (min 1.1)	=	1.5	-	
Stability Coefficient (Cs)	=	0.3	-	
Vertical Velocity Dist. Coeff (Cv)	=	1	-	
Thickness Coeff. (Ct)	=	1	-	
Local Flow Depth (d)	=	0.4	ft	
Specific Weight of Stone	=	165	lb/ft^3	
Unit Weight of Water	=	62.4	lb/ft^3	
Gravitational Constant (g)	=	32.2	ft/s/s	

Selected Riprap Sizing = RR 7 , 30 inches thick minimum w/ 12 inches of bedding

Calculated Values (3-3):

Sideslope Correction Factor (K1)	=	0.987946	-
D30	=	1.209408	ft
	=	14.5129	in
Volume of spherical stone with D30	=	0.925758	ft^3
Weight of D30 Stone	=	152.7501	lb
Weight of D90 Stone	=	600	lb
Volume of D90 Stone	=	3.636364	
Selected D90 from gradation with D30 matching calculated D30	=	1.908315	ft
Mannings n Value	=	0.037866	-
K value	=	0.034	-

$$K_1 = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\phi}} \quad (3\text{-}4)$$

$$D_{30} = S_f C_s C_v C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)^{1/2} \frac{V}{\sqrt{K_1 g d}}\right]^{2.5} \quad (3\text{-}3)$$

$$D_{90} = D_{30}\,(D_{90}/D_{30})^{[illegible]}$$

$$n = K\,[D_{90}(\text{min})]^{1/6} \quad (3\text{-}2)$$

where

K = 0.036, average of all flume data
= 0.034 for velocity and stone size calculations
= 0.038 for capacity and freeboard calculations

$D_{90}(\text{min})$ = size of which 90 percent of sample is finer, from minimum or lower limit curve of gradation specification, ft

D_{30} = riprap size of which 30 percent is finer by weight, length

S_f = safety factor (see c below)

* C_s = stability coefficient for incipient failure, D_{85}/D_{15} = 1.7 to 5.2
= 0.30 for angular rock
* = 0.375 for rounded rock

C_v = vertical velocity distribution coefficient
= 1.0 for straight channels, inside of bends
= 1.283 - 0.2 log (R/W), outside of bends (1 for (R/W) > 26)
= 1.25, downstream of concrete channels
= 1.25, ends of dikes

C_T = thickness coefficient (see d(1) below)
* = 1.0 for thickness = $1D_{100}$(max) or 1.5 D_{50}(max), whichever is greater

* d = local depth of flow, length (same location as V)

γ_w = unit weight of water, weight/volume

* V = local depth-averaged velocity, V_{ss} for side slope riprap, length/time

K_1 = side slope correction factor (see d(1) below)

g = gravitational constant, length/time²

EROSION PROTECTION AND SEDIMENT CONTROL GRADATIONS	
Percent Passing Rock Size (lb)	[illegible]

Gradation	Min. Thickness	Bedding Thickness
[illegible]	[illegible]	-
[illegible]	[illegible]	-
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Calculated Values (3-5):

D30	=	#NAME?	ft
	=	#NAME?	in
Selected D90 from gradation with D30 matching calculated D30	=		ft
Mannings n Value	=	0	
K value	=	0.034	

$$D_{30} = \frac{1.95\,S^{0.555}\,q^{2/3}}{g^{1/3}} \quad (3\text{-}5)$$

where

S = slope of bed

q = unit discharge

Equation 3-5 is applicable to thickness = 1.5 D_{100}, angular rock, unit weight of 167 pcf, D_{85}/D_{15} from 1.7 to 2.7, slopes from 2 to 20 percent, and uniform flow on a downslope with no tailwater. The following steps should be used in application of Equation 3-5:

(1) Estimate $q = Q/b$, where b = bottom width of chute.

(2) Multiply q by flow concentration factor of 1.25. Use greater factor if approach flow is skewed.

(3) Compute D_{30} using Equation 3-5.

(4) Use uniform gradation having $D_{85}/D_{15} \le 2$, such as Table 3-1.

(5) Restrict application to straight channels with side slope of 1V:2.5H or flatter.

(6) Use filter fabric beneath rock.

The guidance for steep slope riprap generally results in large riprap sizes. Grouted riprap is often used instead of loose riprap in steep slope applications.

APPENDIX D — INDOT COURSE AGGREGATE SIZE SPECIFICATIONS

Riprap Gradation Requirements (Percent Smaller)					
Size, in. (mm)	Revetment	Class 1	Class 2	Uniform A	Uniform B
30 (750)			100		
24 (600)		100	85-100		
18 (450)	100	85-100	60-80		
12 (300)	90-100	35-50	20-40		
8 (200)				100	
6 (150)	20-40	10-30	0-20	35-80	95-100
3 (75)	0-10	0-10	0-10		35-80
1 (25)				0-20	0-20
Depth of Riprap, minimum	18 in. (450 mm)	24 in. (600 mm)	30 in. (750 mm)		

$$n = K\,[D_{90}(\text{min})]^{1/6} \quad (3\text{-}2)$$

where

K = 0.036, average of all flume data
= 0.034 for velocity and stone size calculations
= 0.038 for capacity and freeboard calculations

$D_{90}(\text{min})$ = size of which 90 percent of sample is finer, from minimum or lower limit curve of gradation specification, ft

Attachment E. Supporting Data

Attachment E. Supporting Data

Subsurface Investigation

A subsurface exploration was performed at the west ash complex, including 15 soil borings, installation of 9 geotechnical piezometers to monitor groundwater, and a program of 11 cone-penetration test (CPT) soundings, with seismic wave velocity measurements and pore pressure dissipation testing. The borings were drilled by AECOM's subcontractor Terracon Consultants, Inc. of St. Louis, MO, under the full-time supervision of AECOM geotechnical personnel. Terracon used an All-Terrain Vehicle-mounted drill rig in conjunction with 3-¼ inch inner diameter hollow stem augers to drill the borings. CPT soundings were performed by AECOM's subcontractor ConeTec, Inc., again with full-time oversight by AECOM personnel.

Boring depths varied from 30 to 70 feet and CPT depths varied from 30 to 50 feet below existing grades. Boring and CPT sounding locations are depicted in Figure 1 (Attachment E).

Representative soil samples were collected from each of the borings for classification and/or testing. The soil samples were obtained by Standard Penetration Testing (SPT) with a split-spoon sampler, in general accordance with ASTM D 1586. Undisturbed samples of fly ash and/or fine-grained soils were obtained using 3-inch outside diameter steel (Shelby) tubes, either conventionally pushed in accordance with ASTM D 1587 or by utilizing a piston sampler in accordance with ASTM D 6519 (in ash and very soft soils).

The field investigation was complimented by a comprehensive laboratory testing program. The program was designed to establish the index and engineering properties of the soils encountered at the site, with a focus on establishing the parameters pertinent to the pond closure design (including shear strength of the soils for use in slope stability analyses, and compressibility of the ashes and soft soils underlying the site, for use in cap settlement analyses). The program included the following tests:

- Moisture Content
- Atterberg Limits
- Grain Size Analyses
- One-Dimensional Consolidation Testing
- Consolidated-Undrained Triaxial Testing
- Direct Simple Shear Testing
- Cyclic Direct Simple Shear Testing

At the time of this 30% design submittal, approximately 75% of the assigned testing has been received, but some tests are still in progress. Our design evaluations have been based on the data in hand. Some adjustment as a result of forthcoming data may be warranted, and will be appropriately incorporated at later design stages.

Additionally, AECOM reviewed historical geotechnical information that was available in Dynegy's files. This information included boring location map and boring logs for the subsurface investigation performed by Sargent and Lundy (dating to 1977) to support the original design of the pond system. This information included 19 borings drilled to depths up to 85 feet below the pre-existing (pre-pond construction) grades. The historical information includes boring profile and SPT information, but no laboratory testing. The subsurface profile revealed by the historical borings was similar to that encountered by AECOM in the current investigation, and the historical borings were therefore used to supplement the current data in our evaluations.

1.1.1. Subsurface Investigation Findings and Interpretation

The borings encountered the following generalized soil profile at the site (soil layers are listed from highest elevation to lowest):

Fine-Grained Dike Fill Materials: The perimeter dikes at Ponds 2W, 2E, and 3 are largely comprised of fine-grained soil fills classified as lean clay (CL) and fat clay (CH). The clays generally had a stiff to hard consistency and appeared to be well-compacted materials. The Pond 1 dikes were raised in the early 1990s, from an original elevation around 432 feet to the current elevation around 445 ft. Based on our borings, the material used to raise these dikes consists of a silty sand (SM) to sandy silt (ML). These fills were medium dense in the borings, and appeared to be well compacted.

Ponded Ash Materials: Sluiced ash materials were encountered in the borings drilled in Pond 2W and Pond 1. The material was generally classified as a silt (fly ash). Above the residual pond water table, the ash was loose to medium dense. Below the water level, the ash became loose to very loose and saturated.

Native Alluvial Clay: Most of the west ash complex is underlain by a native clay of alluvial origin. The stratum was typically classified as a fat clay (CH), with some zones lean clay (CL) occasionally identified. At the west complex, the clay consistency varied from soft to stiff, generally improving from east to west. The clay thickness generally thins from east to west.

Native Sand: Native sand materials, anticipated to be of alluvial origin, were encountered in all borings drilled at the west ash complex. In most cases, the sands were encountered below the alluvial clay, but in some instances were encountered directly below the dike fills or ponded ash. In general, the sands were medium dense, but some zones of looser material were also encountered at several borings. The sands were typically saturated, and were relatively clean (fines content typically in the range of 5 to 20%).

Groundwater Table: Based on preliminary data from the piezometers, the static groundwater table exists in the range of El. 400 to 410 across the complex, which corresponds to the native clay or sand deposits. A perched (residual) water table is also present within the ponds themselves. Generally, this perched water table exists within 10 feet of the existing ash surface in the ponds.

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1859 Bowles Avenue Suite 250, Fenton MO 63026-1944

File: let_007_175666013_certification
Revision 0

Initial Hazard Potential Classification Assessment
EPA Final CCR Rule
West Ash Ponds 1 and 2E
Wood River Power Station
Madison County, Illinois

1.0 PURPOSE

This report documents Stantec's certification of the initial hazard potential classification assessment for Wood River Power Station West Ash Ponds 1 and 2E.

40 CFR 257.73(a)(2) provides for the owner or operator of an existing CCR surface impoundment to conduct an initial hazard potential classification assessment and document the hazard potential classification, and the basis for the classification, of the 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.

2.0 FINDINGS

A volume transfer breach analysis was performed in September 2016 to evaluate potential hazards associated with a failure of West Ash Ponds 1 and 2E's perimeter containment dike. The analysis involved transferring stored volumes within the ponds at various selected breach locations to evaluate potential impacts to downstream areas. Breaches were evaluated using calculated storage volumes corresponding to a pond level equal to the perimeter dike crest elevation.

Results from the analysis indicate that the breach volumes will be contained in nearby downstream areas that are located just west of and on the Wood River Power Station Property. Power station structures, access roads, and railroad are located within breach inundation extents and therefore have the potential to be impacted. The potentially impacted structures and access roads are typically intermittently used by Wood River Power Station personnel and the at-risk populations are considered transient. In accordance with Federal guidelines, loss of life is not considered probable for scenarios where persons are only temporarily in the potential inundation area. It was concluded that a breach failure of these impoundments does not present probable loss of human life. However, a breach of these impoundments perimeter dike has potential to release stored CCR material and cause environmental damage.

40 CFR 257.53 defines a "significant hazard potential CCR surface impoundment" as 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.

Based on the results of the analysis summarized above and the relevant definitions in 40 CFR 257.53, the West Ash Ponds 1 and 2E were assigned a significant hazard potential classification.

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Matthew Hoy, being a Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that;

1. the information contained in this report and the underlying data in the operating record was prepared in accordance with the accepted practice of engineering and is accurate as of the date of my signature below; and
2. the initial hazard potential classification assessment for Wood River Power Station West Ash Ponds 1 and 2E was conducted in accordance with the requirements specified in 40 CFR 257.73.

SIGNATURE ______________________ DATE 2/7/17

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