INFLOW DESIGN FLOOD CONTROL PLAN PERIODIC 5-YEAR REVIEW

30 TAC 352.821 (40 CFR 257.82)

Primary Bottom Ash Pond

Welsh Power Plant
Pittsburg, Texas

October, 2021

Prepared for: Southwest Electric Power Company – Welsh Power Plant

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

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Inflow Design Flood Control Plan
Periodic 5-year Review
CFR 257.82
Welsh Power Plant
Primary Bottom Ash Pond

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I certify to the best of my knowledge, information, and belief that the information contained in this Inflow Design Flood Control Plan meets the requirements of 40 CFR § 257.82

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1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.821 (40 CFR 257.82) for the hydrologic and hydraulic evaluation of CCR surface impoundments. This is the first periodic 5-year review of the inflow design flood control plan.

2.0 DESCRIPTION OF THE CCR UNIT

The AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The facility operates two surface impoundments for storing CCR materials called the Primary Bottom Ash pond and the Bottom Ash Storage pond. This report addresses the Primary Bottom Ash Pond. The Primary Bottom Ash pond CCR unit is located southwest of the Plant and directly west of the Welsh Reservoir.

The Primary Bottom Ash pond is bounded by natural ground surface (topographically higher areas) to the north and west, and embankment dikes to the south and east. The elevation at the top of embankment along the crest area is approximately 340.0 feet above msl. Presently, economizer ash and bottom ash from the generating plant is sluiced to the Primary Bottom Ash pond.

3.0 INFLOW DESIGN FLOOD 257.82(a)(3)

The facility is classified as a Low Hazard Potential Dam. This classification has not changed since the initial evaluation. The Inflow Design Flood is the 100-year storm event which is 9.85 inches in 24 hours.

4.0 FLOOD CONTROL PLAN 257.82(c)

All storm water runoff from the watershed drains into the reservoir created by the Primary Bottom Ash Pond Dam. The design to safely pass the inflow design flood without overtopping the crest of the dam is based on the normal pool being at maximum normal operating pool and utilizing the principal spillway and emergency spillway to handle the 100-year design storm without overtopping the crest of the dam.

The 2010 Hydraulic Analysis of Welsh Power Plant Ash Ponds report (Attachment A) provides the description of the drainage area, spillway system, flood storage capacity, inflow peak discharge and volume, peak discharge from the facility and maximum pool elevation at that time for the for the Primary Bottom Ash Pond.

The 2021 Hydraulic Analysis (Attachment B) was performed with the same 2010 model, except that the maximum normal operating poll level was revised to reflect current conditions. The maximum normal operating pool level was set at 333.0. Results of the analysis show that the maximum pool elevation from the 100-year storm is 335.5 which is less than the crest elevation of 340.0.

There has not been any changes to spillway system, flood storage capacity or rainfall estimates that would change the results presented in Attachment B. However, a new road crossing and culvert have been constructed in the discharge canal downstream of the primary bottom ash pond principal discharge weir structure. Results of the revised Hydraulic Analysis show that the peak discharge flow from principal discharge weir are less than the culvert capacity placed downstream. The attached calculations show that the facility has the capacity to manage the inflow design flood.

ATTACHMENT A

2010 Hydraulic Analysis

Of

Welsh Power Plant Ash Ponds

Innovative approaches
Practical results
Outstanding service

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Hydraulic Analysis of Welsh Power Plant Ash Ponds

American Electric Power Company

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
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AEP10412

Innovative approaches
Practical results
Outstanding service

Hydraulic Analysis of Welsh Power Plant Ash Ponds

American Electric Power Company

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144

The seal appearing on this document was authorized by Travis N. Attanasio on December 29, 2010

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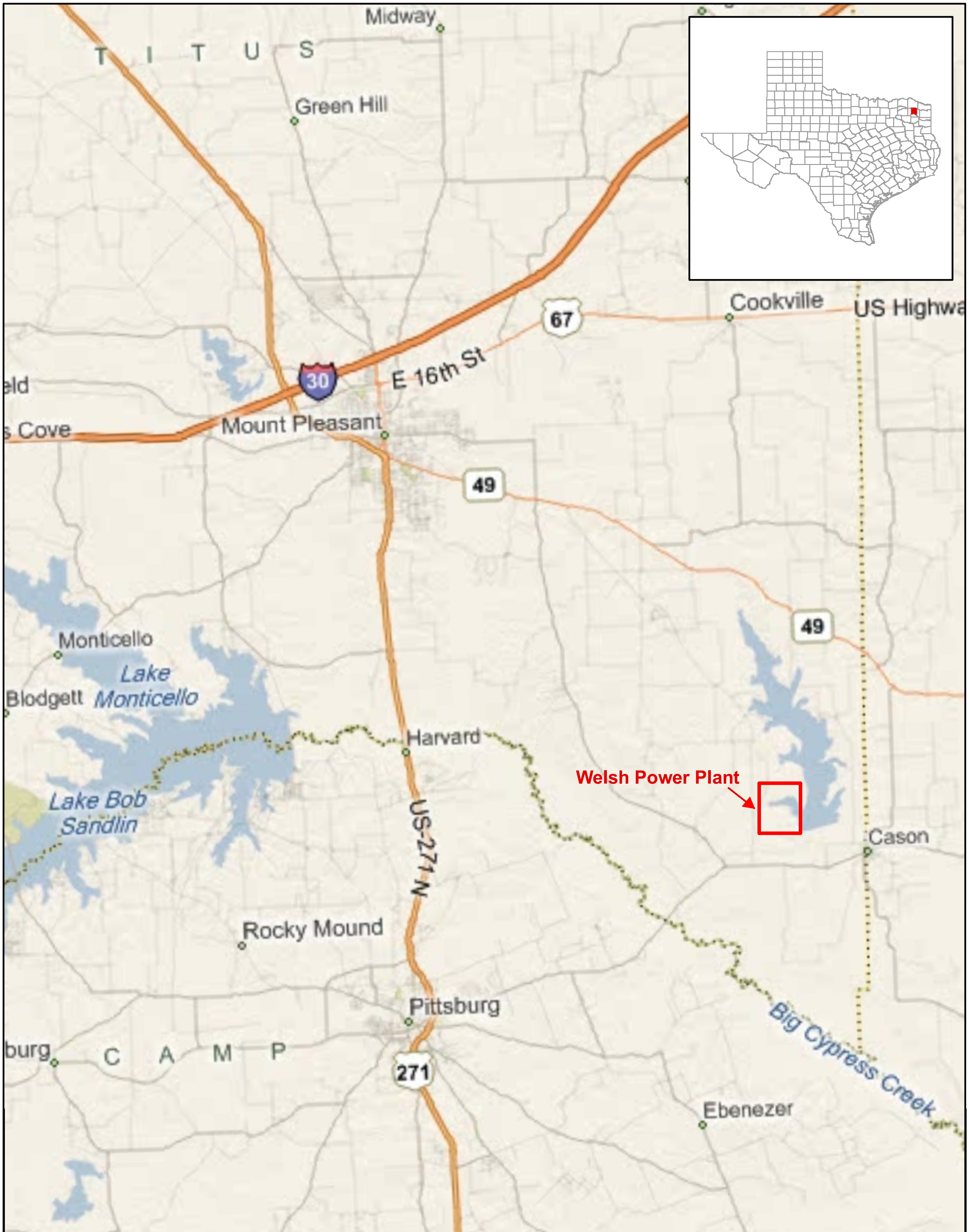
1.0 INTRODUCTION

In November of 2010, Freese and Nichols, Inc., (FNI) was retained by American Electric Power (AEP) to perform various hydrologic and hydraulic calculations to determine the hydraulic adequacy of the Primary Ash, Secondary Ash, and Bottom Ash Ponds for the Welsh Power Plant located near Pittsburg, TX. This report summarizes the results of the analysis for the 10-year, 25-year, 100-year, 25% PMF, 50% PMF, and 100% PMF events.

The three Ash Ponds are situated immediately south of the Welsh Power Plant on the west side of Welsh Reservoir. The general location of the power plant and associated reservoirs is shown in Figure 1.



FN PROJECT NO. AEP10412 FILE NAME H:\WR_DESIGN\FIGURES\Figure1_LocationMap.mxd DATUM & COORDINATE SYSTEM NAD83 STATE PLANE TEXAS NORTH CENTRAL (FT) DATE CREATED DECEMBER 2010 PREPARED BY JPM	FREESE AND NICHOLS 4055 International Plaza, Suite 200 Fort Worth, TX 76109-4895 817-735-7300	0 1.25 2.5 5 Miles WELSH POWER PLANT ASH PONDS LOCATION MAP	N	FIGURE 1

2.0 HYDROLOGIC MODEL DEVELOPMENT

2.1 BASIN DELINEATION & CONNECTIVITY

The hydrologic model for the Welsh Power Plant Ash Ponds was created in HEC-HMS[1] and consisted of seven total drainage basins, as shown in Figure 2. The total drainage area modeled is approximately 0.695 square miles, or 445 acres. Two basins, labeled *Primary* and *Power Plant*, drain directly into the Primary Ash Pond. The Ash Storage Area was divided into two drainage basins – *Ash Storage Area A* and *Ash Storage Area B* – based on a December 2009 survey of the area. A small portion of the Ash Storage Area, along with a small wooded area, drains into the Bottom Ash Pond and is shown as *to Bottom Ash* in Figure 2. Additionally, the area inside the embankment for the Bottom Ash Pond is labeled *Bottom Ash* and drains directly into the reservoir area. Finally, the basin labeled *Secondary* represents the area draining to the Secondary Ash Pond.

Each of the seven basins and three reservoir areas are connected in some way and form an intricate system of connectivity. The only discharges from the Primary Ash Pond flow through a drainage canal to the Secondary Ash Pond. This canal flows from west to east and is controlled by a weir box control structure. Discharges from the Primary Ash Pond emergency spillway also flow into this drainage canal; however, these flows enter the canal downstream of the weir box control structure. Runoff from the Ash Storage Area also enters the Primary Ash Pond via a small sump area with a 24-inch culvert. Rainfall is routed through a small ditch around the perimeter of the Ash Storage Area to this culvert. The principal spillway for the Bottom Ash Pond discharges into a 30-inch pipe which transports the outflows to the Ash Storage Area ditch. These outflows eventually discharge into the Primary Ash Pond. The emergency spillway for the Bottom Ash Pond discharges freely into the area downstream of the Welsh Reservoir emergency spillway. Finally, the combined flows from the drainage canal enter the Secondary Ash Pond, which has both a principal and emergency spillway. All discharges from the Secondary Ash Pond flow into Welsh Reservoir. Spillway capacities are discussed in further detail in Section 2.4.

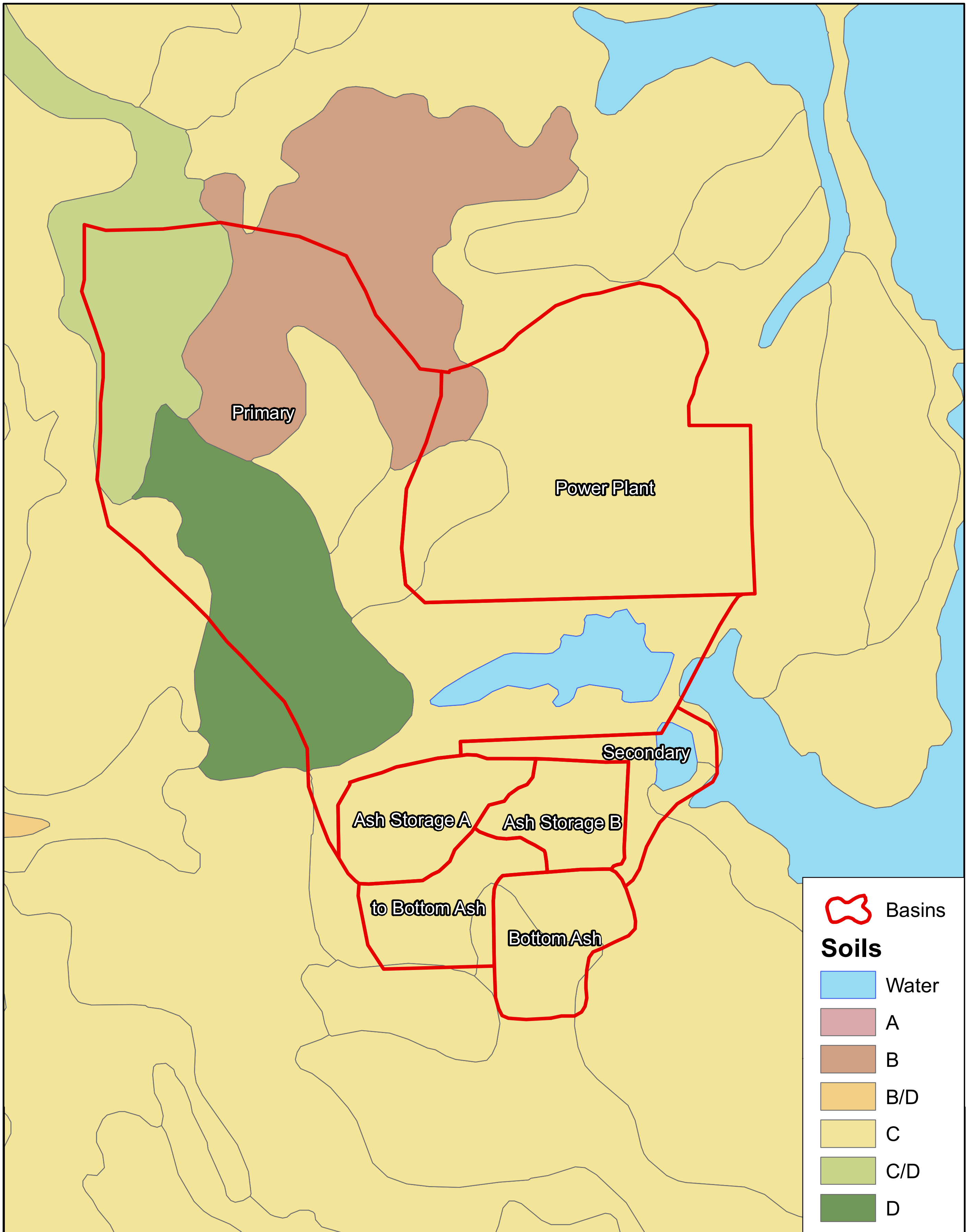
FN PROJECT NO. AEP10412	FREESE AND NICHOLS	WELSH POWER PLANT ASH PONDS		FIGURE 2
FILE NAME H:\WR_DESIGN\FIGURES\Figure2_Basins.mxd	4055 International Plaza, Suite 200 Fort Worth, TX 76109-4895 817-735-7300	DRAINAGE BASIN MAP		
DATUM & COORDINATE SYSTEM NAD83 STATE PLANE TEXAS NORTH CENTRAL (FT)				
DATE CREATED DECEMBER 2010				
PREPARED BY JPM				

2.2 HYDROLOGIC PARAMETERS

The HEC-HMS model incorporates the NRCS Curve Number and Unit Hydrograph methods for each basin. In this model, the curve numbers were based on hydrologic soil classifications and land cover. The instantaneous runoff effect of open water surfaces was accounted for in the development of the curve numbers. The soils dataset was obtained from the NRCS Soil Survey Geographic Database[2] (SSURGO), and land use dataset was obtained from the USGS Seamless Data Warehouse[3] in the form of the National Land Cover Dataset (NLCD) for 2001. Spatial information about soil types and land use classifications is presented in Figures 3 and 4, respectively. Table 1 provides the matrix used in determining the curve number for each basin. The curve numbers shown in Table 1 are for Antecedent Moisture Condition (AMC) II. These values were incorporated in the model for the frequency storm events, such as the 100-year storm event. In accordance with TCEQ recommendations, AMC III was applied to the model for PMF events. This represents a worst-case scenario with the ground fully saturated prior to the PMF event.

Table 1 – Curve Number Calculation Matrix

NLCD Classification		Curve Number (AMC II)					
#	**Description**	**A**	**B**	**B/C**	**C**	**C/D**	**D**
11	Open Water	100	100	100	100	100	100
21	Developed, Open Space	68	79	83	86	88	89
22	Developed, Low Intensity	51	68	74	79	82	84
23	Developed, Medium Intensity	77	85	88	90	91	92
24	Developed, High Intensity	89	92	93	94	95	95
31	Barren Land	77	86	89	91	93	94
41	Deciduous Forest	36	60	67	73	76	79
42	Evergreen Forest	36	60	67	73	76	79
43	Mixed Forest	36	60	67	73	76	79
52	Scrub/Shrub	35	56	63	70	74	77
71	Grassland/Herbaceous	39	61	68	74	77	80
81	Pasture/Hay	39	61	68	74	77	80
82	Cultivated Crops	67	78	82	85	87	89
90	Woody Wetlands	45	66	72	77	80	83



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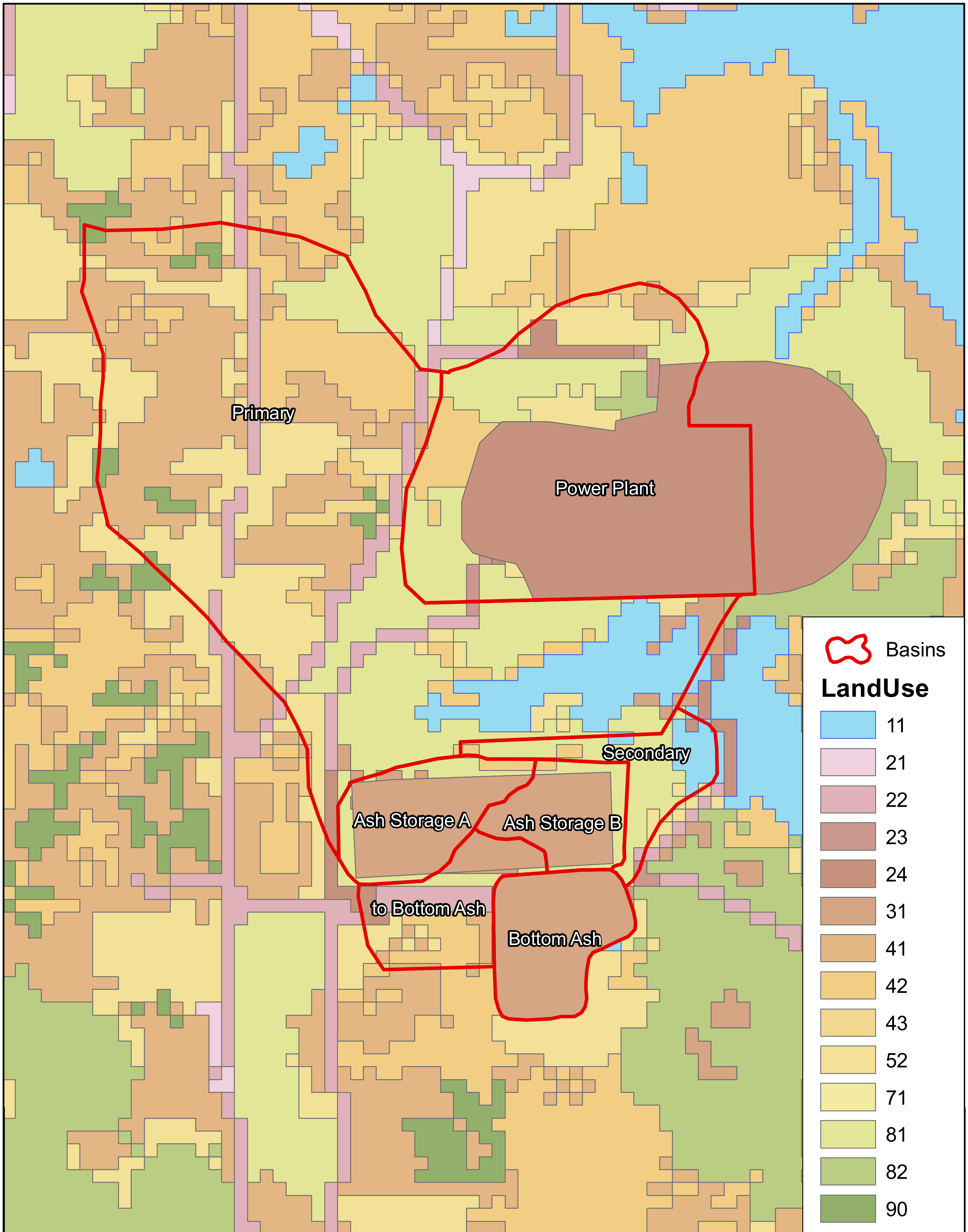
WELSH POWER PLANT ASH PONDS

HYDROLOGIC SOIL CLASSIFICATIONS

FIGURE
3



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DATE CREATED	DECEMBER 2010
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Fort Worth, TX 76109-4895
817-735-7300

0 500 1,000 2,000 Feet

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WELSH POWER PLANT ASH PONDS

LAND COVER DATA

FIGURE 4

The only input into HEC-HMS for the NRCS Dimensionless Unit Hydrograph is a lag time, which is calculated based on basin conditions, such as hydraulic length and average slope, according to the NRCS TR-55 Method. Table 2 provides a summary of the hydrologic parameters for each basin. Note that AMC II corresponds with the curve numbers used in the frequency model and that AMC III corresponds with the weighted curve numbers used in the PMP model.

Table 2 – Basin Parameters

Basin	Area (mi^2)	Lag Time (min)	Curve Number (AMC II)	Curve Number (AMC III)
Ash Storage A	0.034	5.28	87.1	93.9
Ash Storage B	0.025	7.51	87.1	93.9
Bottom Ash	0.034	4.78	91.0	95.9
Power Plant	0.180	18.77	85.3	93.0
Primary	0.366	36.14	76.0	88.0
Secondary	0.026	2.31	82.7	91.7
to Bottom Ash	0.031	16.51	77.8	89.0

2.3 ELEVATION-STORAGE DATA

Elevation-storage data for each reservoir was obtained from a combination of data sources. The elevation-storage relationship for the Primary Ash Pond was calculated from USGS 10-foot contours for the area and compared to calculations made by AEP. The Secondary Ash Pond used the AEP Calculations for elevation 320.0 ft-msl to elevation 330.0 ft-msl and a combination of USGS 10-foot contours and surveyed 2-foot contours. The Bottom Ash Pond used volume calculations from an April 2010 survey from elevation 346.13 ft-msl to elevation 355.92 ft-msl. The volume was then extrapolated to the top of dam elevation of 360.0 ft-msl by the average-end-area method and the assumption of 3:1 side slopes. These relationships were used in the hydrologic model for routing both frequency storm events and the PMF and are shown in Table 3 below.

Table 3 – Elevation-Storage Data

Primary	
Elevation (ft-msl)	Storage (acre-ft)
300	0.00
305	22.37
310	54.66
315	110.48
320	186.47
325	304.20
330	461.77
335	676.03
340	934.21

Secondary	
Elevation (ft-msl)	Storage (acre-ft)
320	0.00
330	36.87
331	41.31
332	46.30
333	51.82
334	57.67
335	63.77
336	70.09
337	76.59
338	83.26
339	90.22
340	97.45
341	105.06
342	112.68

Bottom Ash	
Elevation (ft-msl)	Storage (acre-ft)
346.13	0.00
347	0.22
348	1.31
349	3.17
350	5.51
351	8.33
352	11.94
353	16.77
354	23.57
355	33.04
356	45.07
357	65.66
358	86.50
359	107.61
360	128.98

2.4 DISCHARGE RATING CURVES

Each of the three dams has both a principal spillway and an emergency spillway. Information regarding the dimensions and elevations of each of these spillways was taken from a combination of original construction drawings, recent survey, and detailed descriptions from AEP personnel. Detailed calculations for the discharge rating curves of each spillway are included in Appendix B.

The principal spillway for the Primary Ash Pond is located in the canal connecting the Primary and Secondary Ash Ponds. It consists of a weir box with bottom elevation of 325.0 ft-msl and a 4-foot wide by 2-foot tall opening. Stop logs are placed in this opening according to regular dredging operations by AEP; however, normal conditions dictate that no stop logs are in place. This structure also consists of sheet piling to each side of the weir box, which will operate as a sharp-crested weir when flows reach the top elevation of 336.0 ft-msl. Additionally, the Primary Ash Pond has a 90-foot wide emergency spillway with a crest elevation of 334.0 ft-msl. Both the orifice and weir equations were utilized in calculating the discharge rating curves. The discharge rating curve for both spillways is shown in Table 4.

The principal spillway for the Secondary Ash Pond consists of a weir box with a 4-foot long weir discharging through a 36-inch conduit. The weir equation used for this weir box was obtained from Greg Carter of AEP from calculations he had performed in the design of a new weir plate, which is currently in place. Additionally, the Secondary Ash Pond has an approximately 45-foot wide earthen emergency spillway. The discharge rating curve for the emergency spillway was calculated with a simple HEC-RAS model with cross-sections cut through the spillway. The discharge rating curve for both spillways is shown in Table 4.

The principal spillway for the Bottom Ash Pond is a 40-foot long broad-crested weir with 6:1 side slopes and crest at elevation 355.0 ft-msl. It discharges into a small sump area connected to the 30-inch pipe directing flow back toward the Ash Storage Area. The emergency spillway is an 8-foot wide weir at elevation 358.0 ft-msl with a rock riprap discharge chute. The discharge rating curve for both spillways is shown in Table 4.

Table 4 – Discharge Rating Curves

Primary			
Elevation (ft-msl)	Principal Spillway (cfs)	Emergency Spillway (cfs)	Total Discharge (cfs)
325	0	---	0
326	39	---	39
327	54	---	54
328	67	---	67
329	77	---	77
330	86	---	86
331	94	---	94
332	102	---	102
333	109	---	109
334	116	0	116
335	122	285	407
336	128	849	976
337	340	1,637	1,977
338	723	2,640	3,363
339	1,217	3,857	5,074
340	1,801	5,291	7,092

Secondary			
Elevation (ft-msl)	Principal Spillway (cfs)	Emergency Spillway (cfs)	Total Discharge (cfs)
328.3	0	---	0
329	5	---	5
330	17	---	17
331	33	---	33
332	50	0	50
333	58	91	149
334	64	345	409
335	70	777	847
336	75	1,386	1,461
337	80	2,191	2,271
338	85	3,163	3,248
339	90	4,256	4,346
340	94	5,280	5,374

Bottom Ash			
Elevation (ft-msl)	Principal Spillway (cfs)	Emergency Spillway (cfs)	Total Discharge (cfs)
355.0	0	---	0
355.5	50	---	50
356.0	161	---	161
356.5	330	---	330
357.0	561	---	561
357.5	858	---	858
358.0	1,224	0	1,224
358.5	1,664	11	1,676
359.0	2,182	39	2,221
359.5	2,782	85	2,867
360.0	3,466	153	3,619

2.5 FREQUENCY MODEL RESULTS

Three frequency storm events were analyzed for the Welsh Ash Pond system – the 10-year, 25-year, and 100-year storm events. The hydrologic model described in the preceding sections was implemented in analyzing these events. Curve numbers were set to Antecedent Moisture Condition II, and initial abstractions were calculated automatically by HEC-HMS. These assumptions represent normal conditions, as would be expected prior to one of these storm events. The precipitation data was obtained from the National Oceanic and Atmospheric Administration's Technical Memorandum NWS HYDRO-35[4] and Technical Paper 40.[5] These values are presented in Table 5. Each storm event was assumed to have a duration of 24 hours.

Table 5 – Frequency Precipitation Depths

Frequency (yrs)	Precipitation (in)							
	5 min	15 min	60 min	2 hr	3 hr	6 hr	12 hr	24hr
1	0.42	0.89	1.69	1.99	2.20	2.64	3.12	3.58
2	0.51	1.08	1.97	2.45	2.68	3.19	3.78	4.41
5	0.58	1.25	2.54	3.14	3.40	4.15	4.92	5.81
10	0.64	1.38	2.91	3.64	3.95	4.90	5.90	6.82
25	0.72	1.57	3.36	4.22	4.62	5.73	6.76	7.90
50	0.79	1.72	3.75	4.75	5.18	6.41	7.74	8.83
100	0.86	1.88	4.13	5.23	5.78	7.09	8.62	9.85
500	1.12	2.45	5.39	6.83	7.54	9.26	11.26	12.86

These precipitation depths serve as input data into the hydrologic model, and were routed through the model as described previously. According to TCEQ recommendations and standard engineering practice, flood routings were started at the lowest spillway crest elevation for each dam. This corresponds to elevation 325.0 ft-msl, 328.3 ft-msl, and 355.0 ft-msl for the Primary, Secondary, and Bottom Ash Ponds, respectively. The results of the 10-year, 25-year, and 100-year storm events are shown in Tables 6, 7, and 8, respectively.

Table 6 – 10-Year Storm Results

	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
Primary	328.50	874.71	71.92
Secondary	332.37	112.41	72.35
Bottom Ash	355.53	157.81	55.99

Table 7 – 25-Year Storm Results

	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
Primary	329.35	1079.37	80.24
Secondary	332.51	137.68	81.67
Bottom Ash	355.62	187.44	76.21

Table 8 – 100-Year Storm Results

	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
Primary	330.80	1415.75	92.68
Secondary	332.62	177.95	95.96
Bottom Ash	355.76	234.22	108.10

2.6 PMF MODEL RESULTS

The Probable Maximum Flood (PMF) is defined as the greatest flood to be expected, and the Probable Maximum Precipitation (PMP) is theoretically the greatest depth of rainfall for a given duration that is physically possible over a given size storm area at a particular geographic location. Generally, the rainfall depth is calculated for the ten square miles of the watershed which receive the highest intensity rainfall.

Hydrometeorological Report No. 52 (HMR-52),[6] developed by the U.S. Army Corps of Engineers, was used to determine the rainfall for each basin. PMP estimates were taken from Hydrometeorological Report No. 51[7] and distributed according to HMR-52 to obtain average rainfall depths over the various drainage areas.

HMR-52 calculates rainfall depths for storm durations ranging from five minutes to seventy-two hours. Table 9 lists the point rainfall depths calculated by HMR-52 for storm durations from one hour to 72 hours. Because the total drainage area is less than ten square miles, these point rainfall depths were applied to each of the 7 basins. Additionally, the total rainfall depth was distributed according to the temporal distribution described by the TCEQ guidelines.

Table 9 – HMR-52 Point Rainfall Depths

Storm Duration (hr)	Depth (in)
1	16.62
2	20.86
3	24.18
6	30.47
12	36.82
24	42.10
48	46.98
72	49.74

Each PMF duration was modeled as described previously, with flood routing started at the lowest spillway crest elevation. The 12-hour event was critical for both the Primary and Secondary Ash Ponds, and the 1-hour event was critical for the Bottom Ash Pond. Additionally, the 25% and 50% PMF were calculated for the critical duration. Tables 10, 11, and 12 contain the results of these PMF model runs – the 25% PMF, 50% PMF, and 100% PMF, respectively.

Table 10 – 25% PMF Results

	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
Primary	331.83	690.29	100.59
Secondary	332.68	110.63	105.57
Bottom Ash	355.70	171.14	94.27

Table 11 – 50% PMF Results

	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
Primary	335.16	1385.23	122.79
Secondary	334.23	511.60	501.07
Bottom Ash	356.15	342.28	211.11

Table 12 – 100% PMF Results

	Peak Elevation (ft-msl)	Peak Inflow (cfs)	Peak Outflow (cfs)
Primary	337.46	2770.78	517.89
Secondary	337.39	2664.30	2637.73
Bottom Ash	356.78	684.55	458.48

3.0 SUMMARY AND CONCLUSIONS

Based on the results of the hydraulic analysis, each of the three dams is hydraulically adequate for the full range of storm events from the 10-year to the 100% PMF event. Table 13 lists the pertinent elevation data for each dam, including the top of dam elevation and principal and emergency spillway crest elevations. Comparing these elevations to the maximum water surface elevations shown in Table 14 indicates that, even during the 100% PMF event, each of the three dams would have almost 3 feet of freeboard. Additionally, the emergency spillway for the Primary Ash Pond is not engaged during a storm event less than the 50% PMF, and the emergency spillway for the Bottom Ash Pond is not engaged, even during the 100% PMF event. The emergency spillway for the Secondary Ash Pond is, however, engaged much more frequently, even during a storm event as low as the 10-year storm. This should have no adverse affects on this area though, as it appears to have been designed to withstand frequent engaging.

Table 13 – Pertinent Dam Information

	Top of Dam (ft-msl)	Principal Spillway (ft-msl)	Emergency Spillway (ft-msl)
Primary	340.0	325.0	334.0
Secondary	340.0	328.3	332.0
Bottom Ash	360.0	355.0	358.0

Table 14 – Summary of Results

	10-year	25-year	100-year	25% PMF	50% PMF	100% PMF
Primary	328.50	329.35	330.80	331.83	335.16	337.46
Secondary	332.37	332.51	332.62	332.68	334.23	337.39
Bottom Ash	355.53	355.62	355.76	355.70	356.15	356.78

It should be noted that these results reflect the best understanding of existing conditions and could be significantly affected by major changes to any of the three reservoirs. Specifically, major fluctuations in the available storage in each reservoir, as could be caused by the regular dredging and movement of bottom ash in and out of the pond areas, would greatly impact the results of this analysis. However, in their current conditions, the Primary Ash, Secondary Ash, and Bottom Ash Ponds associated with the Welsh Power Plant are deemed to be hydraulically adequate for any storm event up to the 100% PMF. Pertinent drawings for existing conditions are included in Appendix C.

Appendix A
References

References

1. U.S. Army Corps of Engineers, Hydrologic Engineering Center: *Hydrologic Modeling System HEC-HMS - User's Manual Version 3.4*, Davis, California, August 2009.

2. "Soil Data Mart." *NRCS Soil Survey Geographic (SSURGO) Database*. <http://soildatamart.nrcs.usda.gov>.

3. "National Land Cover Dataset 2001." *USGS Seamless Data Warehouse*. August 30, 2010. <http://seamless.usgs.gov/nlcd.php>.

4. U.S. Department of Commerce, National Oceanic and Atmospheric Administration: *Technical Memorandum NWS HYDRO-35, Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States*, Silver Spring, MD, June 1977.

5. U.S. Department of Commerce, Weather Bureau: *Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years*, Washington, D.C., May 1961.

6. U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Army, Corps of Engineers: *Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates, United States East of the 105th Meridian*, Washington, D.C., 1982.

7. U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Army, Corps of Engineers: *Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian*, Washington, D.C., 1978.

Appendix B
Calculations

Discharge Rating Curve
Primary Ash Pond

Elevation [ft-msl]	Orifice [cfs]	Sheet Pile [cfs]	Main [cfs]	Emerg [cfs]	Total [cfs]
325.00	0.00	0.00	0.00	0.00	0.00
326.00	38.52	0.00	38.52	0.00	38.52
327.00	54.48	0.00	54.48	0.00	54.48
328.00	66.72	0.00	66.72	0.00	66.72
329.00	77.04	0.00	77.04	0.00	77.04
330.00	86.13	0.00	86.13	0.00	86.13
331.00	94.35	0.00	94.35	0.00	94.35
332.00	101.91	0.00	101.91	0.00	101.91
333.00	108.95	0.00	108.95	0.00	108.95
334.00	115.56	0.00	115.56	0.00	115.56
335.00	121.81	0.00	121.81	285.00	406.81
336.00	127.76	0.00	127.76	848.53	976.28
337.00	133.44	206.46	339.90	1636.79	1976.68
338.00	138.89	583.96	722.84	2640.00	3362.84
339.00	144.13	1072.80	1216.93	3857.22	5074.14
340.00	149.19	1651.68	1800.87	5290.90	7091.76

Main Spillway		
Sill Crest	325	ft-msl
Height	2	ft
Sill Width	4	ft
Orifice C	0.6	
$Q = C*A*\sqrt{(2*g*H)}$		
Sheet Pile	336	ft-msl
Top Width	62	ft
Weir C	3.33	
$Q = C*L*H^{3/2}$		

Emergency Spillway		
Crest	334	ft-msl
Length	90	ft
SS	2.5	:1
Weir C	3	
$Q = C*(L+2*SS*H)*H^{3/2}$		

Discharge Rating Curve
Secondary Ash Pond

Elevation [ft-msl]	Weir [cfs]	Conduit [cfs]	Main [cfs]	Emerg [cfs]	Total [cfs]
328.30	0.00	12.77	0.00		0.00
328.50	0.75	15.39	0.75		0.75
329.00	4.85	22.36	4.85		4.85
329.50	10.62	29.44	10.62		10.62
330.00	17.43	35.94	17.43		17.43
330.50	24.97	40.33	24.97		24.97
331.00	33.01	44.34	33.01		33.01
331.50	41.36	48.10	41.36		41.36
332.00	49.90	51.65	49.90	0.00	49.90
332.50	58.50	55.03	55.03	25.00	80.03
333.00	67.07	58.27	58.27	90.91	149.18
333.50	75.51	61.37	61.37	193.62	254.99
334.00	83.73	64.36	64.36	344.83	409.19
334.50	91.67	67.24	67.24	537.74	604.98
335.00	99.25	70.03	70.03	777.17	847.20
335.50	106.41	72.72	72.72	1056.25	1128.97
336.00	113.09	75.34	75.34	1385.71	1461.05
336.50	119.24	77.87	77.87	1769.84	1847.71
337.00	124.79	80.34	80.34	2190.91	2271.25
337.50	129.70	82.74	82.74	2656.86	2739.60
338.00	133.91	85.08	85.08	3163.04	3248.12
338.50	137.39	87.36	87.36	3697.92	3785.28
339.00	140.09	89.59	89.59	4256.10	4345.69
339.50	141.96	91.76	91.76	4767.86	4859.62
340.00	142.96	93.89	93.89	5279.62	5373.51

Main Spillway		
Weir Box		
Crest	328.30	ft-msl
Length	4	ft
Weir C	2.152	

$Q = C*(L-0.2H)*H^{1/2}$

Weir Equation from AEP

Conduit		
Diameter	36	in
Length	350	ft
U/S Invert	326.5	ft-msl
D/S Invert	326	ft-msl

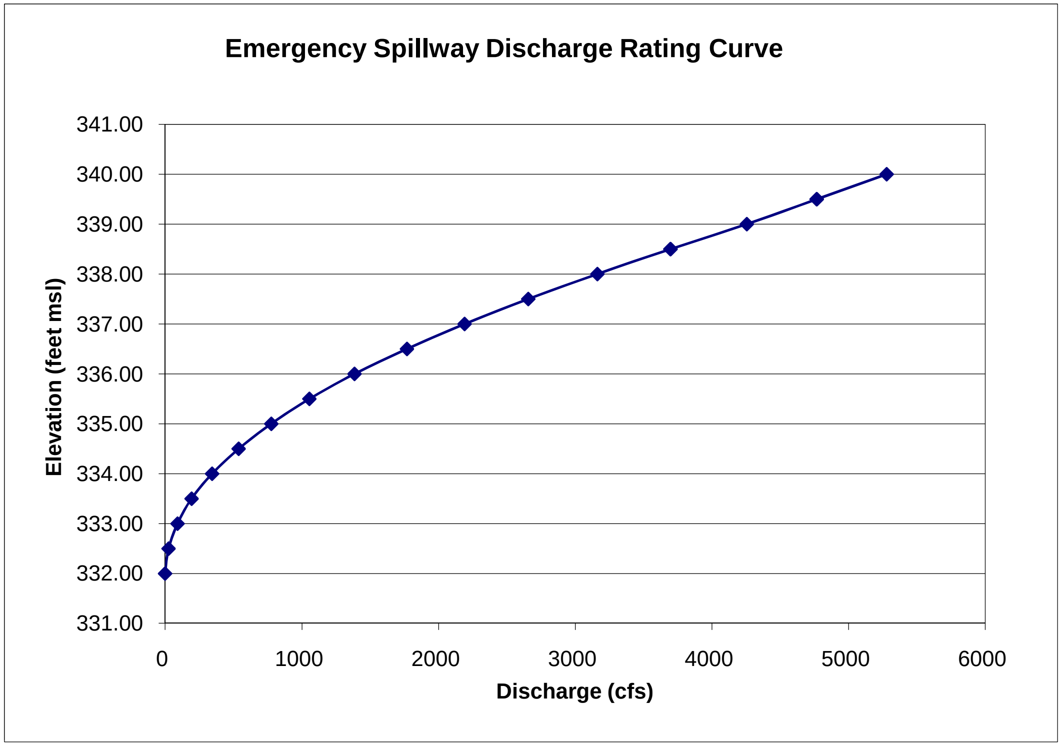
Calculated in FlowMaster

Emergency Spillway

Calculated in HEC-RAS; refer to following sheets for details.

Invert	332	Feet msl
Increment	0.5	Feet

Lake Level (feet msl)	Discharge (cfs)
332.00	0
332.50	25
333.00	91
333.50	194
334.00	345
334.50	538
335.00	777
335.50	1,056
336.00	1,386
336.50	1,770
337.00	2,191
337.50	2,657
338.00	3,163
338.50	3,698
339.00	4,256
339.50	4,768
340.00	5,280



HEC-RAS Results for most upstream cross section

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
SecondaryPon	EmergSpwy	871	PF 1	1	330	332.07		332.07	0	0	380.1	195.63	0
SecondaryPon	EmergSpwy	871	PF 2	10	330	332.29		332.29	0	0.02	423.67	197.71	0
SecondaryPon	EmergSpwy	871	PF 3	25	330	332.5		332.5	0.000002	0.06	465.34	200.66	0.01
SecondaryPon	EmergSpwy	871	PF 4	50	330	332.73		332.73	0.000005	0.1	511.65	204.53	0.01
SecondaryPon	EmergSpwy	871	PF 5	100	330	333.06		333.06	0.000012	0.18	579.79	208.93	0.02
SecondaryPon	EmergSpwy	871	PF 6	200	330	333.52		333.53	0.000031	0.32	677.95	215.13	0.03
SecondaryPon	EmergSpwy	871	PF 7	300	330	333.87		333.87	0.000051	0.43	752.96	221.16	0.04
SecondaryPon	EmergSpwy	871	PF 8	400	330	334.16		334.16	0.000071	0.54	818.24	228.29	0.05
SecondaryPon	EmergSpwy	871	PF 9	500	330	334.41		334.42	0.000091	0.64	876.57	234.47	0.05
SecondaryPon	EmergSpwy	871	PF 10	750	330	334.94		334.95	0.00014	0.85	1005.18	248.81	0.07
SecondaryPon	EmergSpwy	871	PF 11	1000	330	335.4		335.41	0.000184	1.03	1120.39	261.11	0.08
SecondaryPon	EmergSpwy	871	PF 12	1250	330	335.79		335.81	0.000224	1.19	1225.76	271.83	0.09
SecondaryPon	EmergSpwy	871	PF 13	1500	330	336.14		336.16	0.000261	1.34	1322.88	281.28	0.1
SecondaryPon	EmergSpwy	871	PF 14	2000	330	336.77		336.79	0.000326	1.6	1503.25	297.77	0.11
SecondaryPon	EmergSpwy	871	PF 15	2500	330	337.31		337.34	0.000381	1.82	1668.85	312.15	0.12
SecondaryPon	EmergSpwy	871	PF 16	3000	330	337.81		337.85	0.000427	2.01	1827.39	325.32	0.13
SecondaryPon	EmergSpwy	871	PF 17	3500	330	338.26		338.31	0.000468	2.19	1978.88	337.7	0.13
SecondaryPon	EmergSpwy	871	PF 18	4000	330	338.73		338.79	0.000495	2.34	2139.91	350.57	0.14
SecondaryPon	EmergSpwy	871	PF 19	4500	330	339.13		339.2	0.000525	2.48	2282.96	361.62	0.14
SecondaryPon	EmergSpwy	871	PF 20	5000	330	339.69		339.76	0.000513	2.55	2489.43	376.54	0.14

Discharge Rating Curve
Bottom Ash Pond

Elevation [ft-msl]	Main [cfs]	Emerg [cfs]	Total [cfs]
355.00	0.00	0.00	0.00
355.50	50.42	0.00	50.42
356.00	161.20	0.00	161.20
356.50	330.31	0.00	330.31
357.00	561.16	0.00	561.16
358.00	1224.21	0.00	1224.21
359.00	2182.40	39.00	2221.40
360.00	3465.91	152.74	3618.64
361.00	5102.78	358.53	5461.31
362.00	7119.19	672.00	7791.19
363.00	9539.72	1106.85	10646.57

Main Spillway		
Crest	355	ft-msl
Length	40	ft
SS	6	:1
Weir C	3.1	

$Q = C*(L+2*SS*H)*H^{3/2}$

Emergency Spillway		
Crest	358	ft-msl
Length	8	ft
SS	2.5	:1
Weir C	3	

$Q = C*(L+2*SS*H)*H^{3/2}$

Name	GRIDCODE	HSG	Area_ft^2	Area_acre	CN	Inc. CN
Ash Storage	31	C	1324276.445	30.401	91	70.06793
Ash Storage	42	C	53818.662	1.236	73	2.28431
Ash Storage	81	C	341795.137	7.847	74	14.70608
Bottom Ash	31	C	948778.856	21.781	91	91
Power Plant	41	B	1095.992	0.025	60	0.013099
Power Plant	42	B	101918.155	2.340	60	1.218085
Power Plant	81	B	99556.094	2.285	61	1.209685
Power Plant	22	C	15964.935	0.367	79	0.251229
Power Plant	23	C	70296.650	1.614	90	1.260236
Power Plant	24	C	2954103.082	67.817	94	55.31313
Power Plant	41	C	90963.024	2.088	73	1.322703
Power Plant	42	C	239129.961	5.490	73	3.477215
Power Plant	52	C	407500.071	9.355	70	5.68199
Power Plant	81	C	944143.815	21.675	74	13.91697
Power Plant	82	C	95577.482	2.194	85	1.618263
Primary	11	W	458394.580	10.523	100	4.490426
Primary	31	W	14036.955	0.322	100	0.137506
Primary	42	W	104596.947	2.401	100	1.02463
Primary	52	W	11325.853	0.260	100	0.110948
Primary	81	W	69931.187	1.605	100	0.685045
Primary	22	B	242034.352	5.556	68	1.612256
Primary	41	B	564582.710	12.961	60	3.318386
Primary	42	B	631114.853	14.488	60	3.709435
Primary	52	B	220919.125	5.072	56	1.211907
Primary	81	B	286358.868	6.574	61	1.711152
Primary	11	C	480754.464	11.037	100	4.709463
Primary	22	C	209907.569	4.819	79	1.624438
Primary	23	C	10746.609	0.247	90	0.094746
Primary	24	C	67309.636	1.545	94	0.619802
Primary	31	C	150242.962	3.449	91	1.339318
Primary	41	C	540228.652	12.402	73	3.863212
Primary	42	C	316050.970	7.256	73	2.260102
Primary	43	C	93028.069	2.136	73	0.66525
Primary	52	C	572546.147	13.144	70	3.926057
Primary	81	C	1192671.364	27.380	74	8.645709
Primary	82	C	10291.113	0.236	85	0.08569
Primary	90	C	82404.904	1.892	77	0.621573
Primary	41	C/D	916028.058	21.029	76	6.819781
Primary	42	C/D	135572.435	3.112	76	1.00933
Primary	52	C/D	331086.513	7.601	74	2.383839
Primary	90	C/D	101862.212	2.338	80	0.798273
Primary	22	D	301628.331	6.924	84	2.481987
Primary	31	D	13591.654	0.312	94	0.125155
Primary	41	D	558509.208	12.822	79	4.322207
Primary	42	D	58185.234	1.336	79	0.450286
Primary	43	D	21907.998	0.503	79	0.169542
Primary	52	D	973523.140	22.349	77	7.343195
Primary	81	D	435789.772	10.004	80	3.415192
Primary	90	D	31102.113	0.714	83	0.252881
Secondary	11	W	61159.403	1.404	100	8.574385
Secondary	22	W	0.178	0.000	100	2.49E-05
Secondary	24	W	284.987	0.007	100	0.039954
Secondary	52	W	3328.994	0.076	100	0.466716
Secondary	81	W	66883.300	1.535	100	9.37686
Secondary	11	C	100304.658	2.303	100	14.06244
Secondary	22	C	7813.937	0.179	79	0.865439
Secondary	23	C	5348.021	0.123	90	0.6748
Secondary	24	C	9873.918	0.227	94	1.301239
Secondary	31	C	300.129	0.007	91	0.03829
Secondary	42	C	37168.223	0.853	73	3.803946
Secondary	52	C	28941.171	0.664	70	2.840232
Secondary	81	C	391873.463	8.996	74	40.65531
to Bottom Ash	22	C	173034.687	3.972	79	17.29527

Basin	Area_acre
Ash Storage	39.48
Bottom Ash	21.78
Power Plant	115.25
Primary	234.35
Secondary	16.37
to Bottom Ash	18.14

Name	GRIDCODE	HSG	Area_ft^2	Area_acre	CN	Inc. CN
to Bottom Ash	23	C	2352.284	0.054	90	0.267855
to Bottom Ash	24	C	44395.328	1.019	94	5.279978
to Bottom Ash	31	C	108930.225	2.501	91	12.54171
to Bottom Ash	41	C	104222.261	2.393	73	9.626099
to Bottom Ash	42	C	197025.981	4.523	73	18.19757
to Bottom Ash	52	C	82351.521	1.891	70	7.293511
to Bottom Ash	81	C	78062.412	1.792	74	7.308709

Basin	Area_acre

BASIN LAG TIME CALCULATION

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	Ash Storage A	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	100	0.015
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	0	0
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.015

LENGTH	100	**FT.**	**MAX 100'**
2 YR. 24 HOUR PRECIP	4.31	**IN.**	
SLOPE	0.010	**FT/FT**	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	919.70	**FT**
SLOPE	0.021	**FT/FT**
COMPUTED VELOCITY FROM FIGURE 3.1=	2.319	

$$T_2 = \frac{L}{60 \times V}$$

PIPE FLOW - SOLVE FOR FULL FLOW VELOCITY

DIAMETER =	36	**IN.**
XSECT AREA =	7.07	**SQ FT**
WETTED PERIMETER	9.42	**FT**
SLOPE	0.002	**FT/FT**
MANNINGS N	0.024	
COMPUTED VELOCITY	2.39	**FT/S**
LENGTH	60	**FT**

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_4 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	**Ash Storage A**	**Tc (Min)**	**Tc (Min)**	**Tc (Min)**
SHEET FLOW	**Max 30 Min**	30.0	1.77	1.77
SHALLOW CONCENTRATED FLOW			6.61	6.61
SHALLOW CONCENTRATED FLOW			0.00	0.00
SHALLOW CHANNEL FLOW				0.00
PIPE FLOW			0.42	0.42
CHANNEL FLOW				0.00
TOTAL			8.79	8.79
			Lag (Hrs) =	**0.09**

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) =	**5.28**

BASIN LAG TIME CALCULATION

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	Ash Storage B	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	100	0.015
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	0	0
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.015

LENGTH	100	**FT.**	**MAX 100'**
2 YR. 24 HOUR PRECIP	4.31	**IN.**	
SLOPE	0.025	**FT/FT**	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	796.31	**FT**
SLOPE	0.020	**FT/FT**
COMPUTED VELOCITY FROM FIGURE 3.1=	2.287	

$$T_2 = \frac{L}{60 \times V}$$

CHANNEL FLOW

			TOPWIDTH	50
XSECT AREA=	112.000	**SQ FT**	**BOTTOM**	6
			DEPTH	4
WETTED PERIMETER	50.721	**FT**		
SLOPE	0.008	**FT/FT**		
MANNINGS N	0.08			
COMPUTED VELOCITY	2.768	**FT/S**		
LENGTH	911.59	**FT**		

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_6 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	**Ash Storage B**	**Tc (Min)**	**Tc (Min)**	**Tc (Min)**
SHEET FLOW	**Max 30 Min**	30.0	1.22	1.22
SHALLOW CONCENTRATED FLOW			5.80	5.80
CHANNEL FLOW			5.49	5.49
TOTAL			12.52	12.52
			Lag (Hrs) =	**0.13**

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) =	**7.51**

BASIN LAG TIME CALCULATION

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	Bottom Ash	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	100	0.015
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	0	0
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.015

LENGTH	100	**FT.**	**MAX 100'**
2 YR. 24 HOUR PRECIP	4.31	**IN.**	
SLOPE	0.020	**FT/FT**	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	627.21	**FT**
SLOPE	0.010	**FT/FT**
COMPUTED VELOCITY FROM FIGURE 3.1=	1.578	

$$T_2 = \frac{L}{60 \times V}$$

984.648438

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	**Bottom Ash**	**Tc (Min)**	**Tc (Min)**	**Tc (Min)**
SHEET FLOW	**Max 30 Min**	30.0	1.34	1.34
SHALLOW CONCENTRATED FLOW			6.62	6.62
TOTAL			7.96	7.96
			Lag (Hrs) =	**0.08**

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) = 4.78

BASIN LAG TIME CALCULATION

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	Power Plant	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	0	0
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	100	0.4
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.4

LENGTH	100	**FT.**	**MAX 100'**
2 YR. 24 HOUR PRECIP	4.31	**IN.**	
SLOPE	0.020	**FT/FT**	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	558.86	**FT**
SLOPE	0.036	**FT/FT**
COMPUTED VELOCITY FROM FIGURE 3.1=	3.052	

$$T_2 = \frac{L}{60 \times V}$$

CHANNEL FLOW

			TOPWIDTH	7
XSECT AREA=	8.000	**SQ FT**	**BOTTOM**	1
			DEPTH	2
WETTED PERIMETER	8.211	**FT**		
SLOPE	0.016	**FT/FT**		
MANNINGS N	0.05			
COMPUTED VELOCITY	3.720	**FT/S**		
LENGTH	2169.79	**FT**		

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_6 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	**Power Plant**	**Tc (Min)**	**Tc (Min)**	**Tc (Min)**
SHEET FLOW	**Max 30 Min**	30.0	18.50	18.50
SHALLOW CONCENTRATED FLOW			3.05	3.05
CHANNEL FLOW			9.72	9.72
TOTAL			31.28	31.28
			Lag (Hrs) =	**0.31**

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) =	**18.77**

BASIN LAG TIME CALCULATION

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	Primary	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	0	0
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	100	0.4
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.4

LENGTH	100	FT.	MAX 100'
2 YR. 24 HOUR PRECIP	4.31	IN.	
SLOPE	0.020	FT/FT	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	2757.28	FT
SLOPE	0.009	FT/FT
COMPUTED VELOCITY FROM FIGURE 3.1=	1.536	

$$T_2 = \frac{L}{60 \times V}$$

CHANNEL FLOW

			TOPWIDTH	10
XSECT AREA=	18.000	SQ FT	BOTTOM	2
			DEPTH	3
WETTED PERIMETER	12.000	FT		
SLOPE	0.010	FT/FT		
MANNINGS N	0.07			
COMPUTED VELOCITY	2.800	FT/S		
LENGTH	1984.65	FT		

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

$$T_6 = \frac{L}{60 \times V}$$

WATERSHED NUMBER	Conditions Primary	Adjusted Tc (Min)	NRCS Method Tc (Min)	Selected Tc (Min)
SHEET FLOW	Max 30 Min	30.0	18.50	18.50
SHALLOW CONCENTRATED FLOW			29.91	29.91
CHANNEL FLOW			11.81	11.81
TOTAL			60.23	60.23
			Lag (Hrs) =	0.60

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) =	36.14

BASIN LAG TIME CALCULATION
USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	Secondary	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	100	0.015
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	0	0
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.015

LENGTH	100	FT.	MAX 100'
2 YR. 24 HOUR PRECIP	4.31	IN.	
SLOPE	0.150	FT/FT	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	599.56	FT
SLOPE	0.036	FT/FT
COMPUTED VELOCITY FROM FIGURE 3.1=	3.070	

$$T_2 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	Secondary	Tc (Min)	Tc (Min)	Tc (Min)
SHEET FLOW	Max 30 Min	30.0	0.60	0.60
SHALLOW CONCENTRATED FLOW			3.26	3.26
TOTAL			3.85	3.85
			Lag (Hrs) =	0.04

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) =	2.31

BASIN LAG TIME CALCULATION

USING NRCS TR55 METHOD TO COMPUTE TIME OF CONCENTRATION

Existing Conditions

Project Data:		Comments:
PROJECT	AEP10412	
LOCATION	Welsh Power Plant	
DATE	Dec-10	
BASIN COND.		
BY:	JPM	
WSHED NAME	to Bottom Ash	

SHEET FLOW: (100' MAX)

Land Use Undeveloped	n value	% Land use	Inc n
Conc.,gravel,asphalt,bare soil	0.015	0	0
Grass Short Prairie	0.15	0	0
Maintained Grass	0.03	0	0
Woods Light Underbrush	0.4	100	0.4
Woods Dense underbrush	0.8	0	0
TOTAL		100	0.4

LENGTH	100	FT.	MAX 100'
2 YR. 24 HOUR PRECIP	4.31	IN.	
SLOPE	0.050	FT/FT	

$$T_1 = 0.007 \times \frac{(n \times L)^{0.8}}{R^{0.5} \times S^{0.4}}$$

SHALLOW CONCENTRATED FLOW

1=PAVED 2=UNPAVED	2	
LENGTH	763.95	FT
SLOPE	0.004	FT/FT
COMPUTED VELOCITY FROM FIGURE 3.1=	1.011	

$$T_2 = \frac{L}{60 \times V}$$

CHANNEL FLOW

			TOPWIDTH	16
XSECT AREA=	20.000	SQ FT	BOTTOM	4
			DEPTH	2
WETTED PERIMETER	16.649	FT		
SLOPE	0.008	FT/FT		
MANNINGS N	0.05			
COMPUTED VELOCITY	3.001	FT/S		
LENGTH	377.81	FT		

$$V = \frac{1.49 \times \left(\frac{a}{p_w}\right)^{\frac{2}{3}} \times s^{\frac{1}{2}}}{n}$$

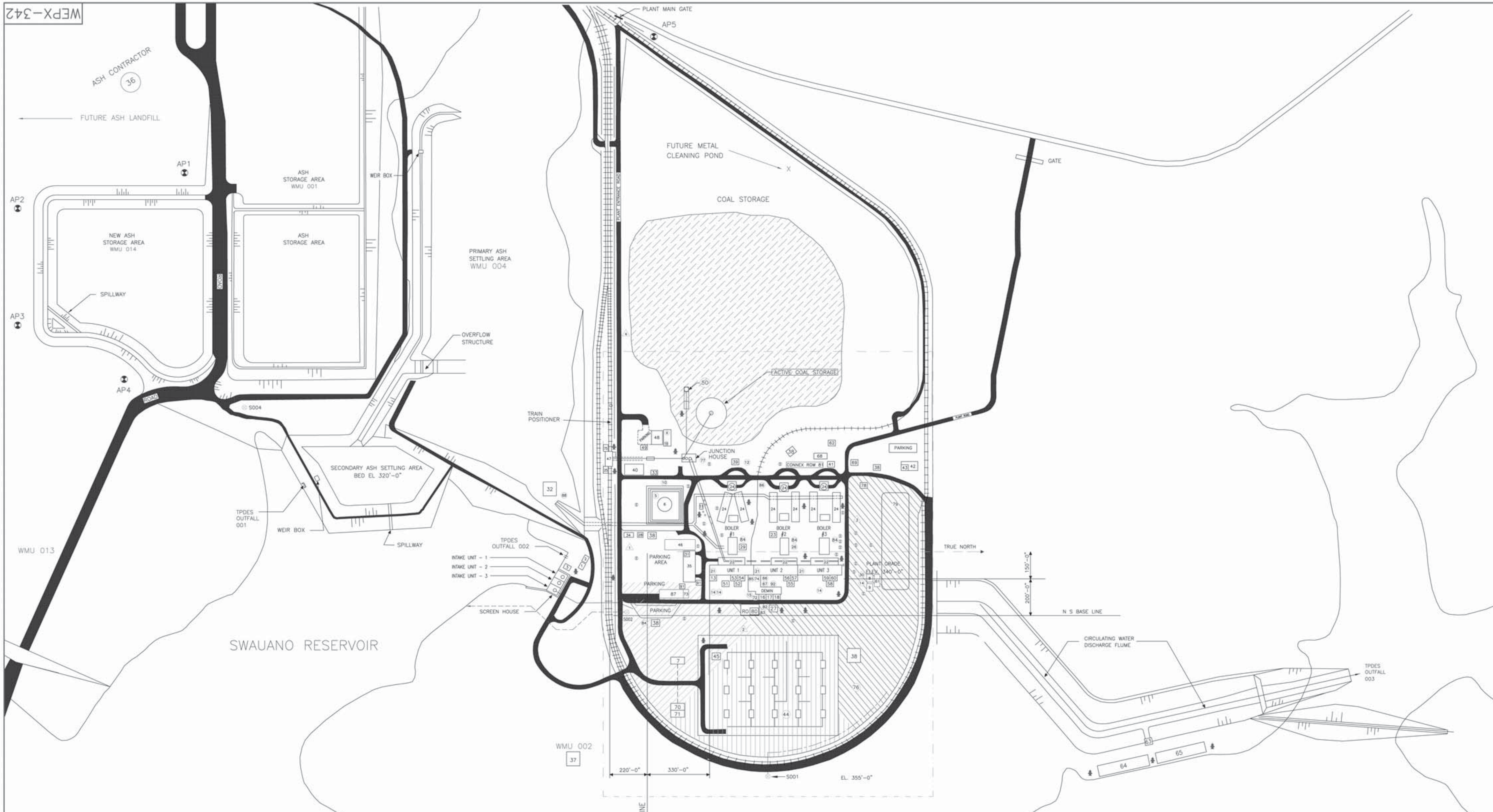
$$T_6 = \frac{L}{60 \times V}$$

	Conditions	Adjusted	NRCS Method	Selected
WATERSHED NUMBER	to Bottom Ash	Tc (Min)	Tc (Min)	Tc (Min)
SHEET FLOW	Max 30 Min	30.0	12.83	12.83
SHALLOW CONCENTRATED FLOW			12.59	12.59
CHANNEL FLOW			2.10	2.10
TOTAL			27.52	27.52
			Lag (Hrs) =	0.28

$$T_c = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Lag(min) =	16.51

Appendix C
Pertinent Drawings



ID	Description	Location	Size (Gallons)	SECONDARY CONTAINMENT (GALLONS)
1	Sewage Plant	Intake	N/A	N/A
2	Chlorine Building	W. of Intake	4 - 1 ton cylinders	N/A
3	Emergency Fire Pump	Plant Intake	500	500
4	Tractor Shop Diesel Tanks	NW corner tractor shop	5,000 5,000	4,375
5	Used Oil Tank	Inside containment area of bulk fuel tank	5,000	1,106,400*
6	#2 Fuel Oil Storage Tank	S of Unit #1 Precipitator	872,000	1,106,400*
7	Spare Transfer Runoff Containment	W. of Spare Transformer	NA	NA
8	Oil House	N.E of Unit #3	Varies	Inside Bldg.
9				
10	Fuel Oil Unloading Area	W of Fuel Oil Tank	NA	8,000
11	Ignitor Fuel Oil Pump Station	N. of Fuel Oil Tank	NA	2,600
12	Blasting Material storage	Veolia	Varies	NA
13	Clean & Dirty Oil Tanks	E. of Unit #1	2 @ 11,500 1 @ 2,000	2,300
14	Demineralized Water Storage Tanks	NE Turbine Bldg. E. of Unit #1 and #3	Varies	NA
15	Filtered Water Tank	E. of Unit #1	75,000	NA
16	Caustic - Sodium Hydroxide	E. of Unit #2	15,000	3,750**
17	Sulfuric Acid	E. of Unit #2	15,000	3,000**
18	Caustic - Sodium Hydroxide	E. of Unit #2	5,000	1,575**
19	Tractor Lube Oil	In tractor fuel containment North of tractor shop	5,000	4,375
20				
21	Turbine Oil Tanks	Inside Unit 1, 2 & 3 Turbine Buildings	Unit 1 - 7,000 Unit 2 - 7,000 Unit 3 - 7,000	Unit 1 - 1,700 Unit 2 - 1,700 Unit 3 - 1,700
22	Bulk Lube Oil Pulverizer Bays	Pulverizer Bay Each Unit	3 - 350	NA
23	Sodium Hypochlorite	Various Demin/RO	Totes/300 gal.	NA
24	Precipitators & Fly Ash Silos	W. of Boilers #1, #2 & #3	Silos: 18,000 tons each	NA
25	Car Dumper Hydraulic System	E. side of Dumper House	210	336

* The fuel oil and used oil tanks are located in a common diked area.

** Acid & Caustic tanks have small seperate containments that join on large containment. (13,000 gal)

ID	Description	Location	Size (Gallons)	SECONDARY CONTAINMENT (GALLONS)
26	CO2 Tank	Unit #2 Boiler Elevator	14 Tons	NA
27	Chlorine-Raw Water Chlorinator	E of Unit #2	3 - 1 ton cylinders	NA
28	CO2 Tank	W side of Main Parking Area	13 Tons	NA
29	CO2 Tank	Unit #1 Boiler Elevator	1 - 6 ton 1 - 4 ton	NA
30	Hydrogen Cylinders (14)	NE Unit #3	10 - 107,436 ft3 4 - 8,187 ft3	NA
31	Maintenance Shop	1st Floor Service Bldg.	NA	NA
32	Ash Recovery System	NE corner of Primary Ash Pond	NA	NA
33	Unleaded Gasoline	N of #2 Warehouse	1,000	1,145
34	WMU Ecology Pit - 017	SW Corner of Main Parking Area	5,760 ft3	NA
35	Service Building	N of Main Parking Area	NA	NA
36	Ash Contractor			
37	WMU Landfill - 002	S of Service Building	NA	NA
38	Material Storage Area	Various	NA	NA
39	Wash Rack for Ash Trucks	W of Unit #1 Ash Silo	NA	NA
40	#2 Warehouse (WMW 003)	E. of Tractor Shop	NA	NA
41	#3 Warehouse	W. of Unit #3	NA	NA
42	WMU Quonset Hut - 009	NW of Unit #3	NA	NA
43	Asbestos Storage Area in Quonset Hut	Quonset Hut	Variable	NA
44	Switchyard 345 KV	E of Unit #1	NA	NA
45	Switchyard Control House	S side Switchyard	NA	NA
46	Maintenance Building	W of Service Building	NA	NA
47	Car Dumper	S of Tractor Shop	NA	NA
48	Tractor Maintenance Building	SE of Coal Pile	NA	NA
49	Coal Yard Lube Oil Drum Storage	SE of Tractor Maint Bldg.	approx. 10-55 gal drums	Inside Bldg.
50	Reclaim Hopper	NW of Tractor Maint Bldg.	NA	NA
51	Reserve Auxiliary Transformer	East of Unit #1	7,000	Mote/Chat
52	Main Power Transformer Unit #1	East of Unit #1	17,125	Mote/Chat
53	Auxiliary A Transformer Unit #1	East of Unit #1	5,500	Mote/Chat
54	Auxiliary B Transformer Unit #1	East of Unit #1	5,500	Mote/Chat
55	Main Power Transformer Unit #2	East of Unit #2	16,300	Mote/Chat
56	Auxiliary A Transformer Unit #2	East of Unit #2	5,772	Mote/Chat

ID	Description	Location	Size (Gallons)	SECONDARY CONTAINMENT (GALLONS)
57	Auxiliary B Transformer Unit #2	East of Unit #2	5,772	Mote/Chat
58	Main Power Transformer Unit #3	East of Unit #3	17,700	Mote/Chat
59	Auxiliary A Transformer Unit #3	East of Unit #3	6,080	Mote/Chat
60	Auxiliary B Transformer Unit #3	East of Unit #3	6,080	Mote/Chat
61	Material Storage Warehouse	N. of Oil House		
62	WMU - Acid Pond 005	W of Unit RSO Building	Varies	NA
63	Cooling Tower Pump House	W. of Cooling Towers at discharge canal	NA	NA
64	Cooling Tower A	Discharge Canal	NA	NA
65	Cooling Tower B	Discharge Canal	NA	NA
66	Raw water tank	E of Unit #3	10,000	NA
67	Clearwell Tank	E of Unit #3	20,000	NA
68	[illegible] Offices	W. of Unit #3	NA	NA
69	RSO Shop	NA		NA
70	Spare Main Power Transformer	S. of Switchyard	10,038	Containment Runoff Pond
71	Spare Auxiliary Transformer	S. of Switchyard	4,200	Containment Runoff Pond
72	Bleach Tank	E. of Demin	6,000 gal	6,330*
73	Laboratory	N. of Warehouse	NA	NA
74	HTH Powder	Inside Demineralizer	<125 lbs	NA
75	Positioner Truck Lock (Hydraulic System)	W. of Dumper House	NA	NA
76	WMU #022	N. of Switchyard	NA	NA
77	Coal Suppressant	coal yard	8,000	NA
78	RSO Office	N. of #3 Silo	NA	NA
79	Material Storage	N of Turbine Bldg.	NA	NA
80	RO Bldg. & Chemical Storage	E. of Unit #2	NA	NA
81	Connex Row	S. of #3 Warehouse	NA	NA
82	WMU - RO Reject Tank 020	N. of RO Bldg.	20,000	NA
83	Sulfuric Acid Tote	E. Wall RO Outside	330 gal	330
84	Drum Reservoir	U #1 U #2 U #3 Mobile	500 gal 500 gal 500 gal 500 gal	OWT OWT OWT OWT
85	Demineralizer	E. of Unit #2	NA	NA
86	[illegible] Reject Box WMU 012			
87	Warehouse			
88	Nalco Polymer			
89	WMU 021			
90	1000 KVA Transformer	NE of Service Building	320	375
91	1000 KVA Transformer	W. of Warehouse	320	375
92	LP Tank (WMU 021)	E. of Unit #2	21,000	NA

MWO 007 Temporary Storage Frac Tanks
MWO 018 RCRA Exempt
MWO 019 Temporary Tank

STORM WATER OUTFALLS
S001
S002
S004
MONITORING WELLS
ASH POND MONITORING WELLS

PLANT ROAD
FIRE HYDRANT
1 EVACUATION AREA
2 EVACUATION AREA
3 EVACUATION AREA
4 EVACUATION AREA

SWAUANO RESERVOIR

SWAUANO LAKE RESERVOIR
NORMAL POOL AL. 320'-0
LOW WATER EL. 314'-0
AREA = 1365 ACRES

200' 0 200' 400'
GRAPHIC SCALE

REV	DESCRIPTION	DATE	DR	BY	APP
8	CONFORMS TO CONSTRUCTION RECORDS	5/2/07	ML		JM
10	FUTURE SITE AREAS	6/2/10	ML		MD
9	CONFORMS TO CONSTRUCTION RECORDS	9/25/08	ML		JM

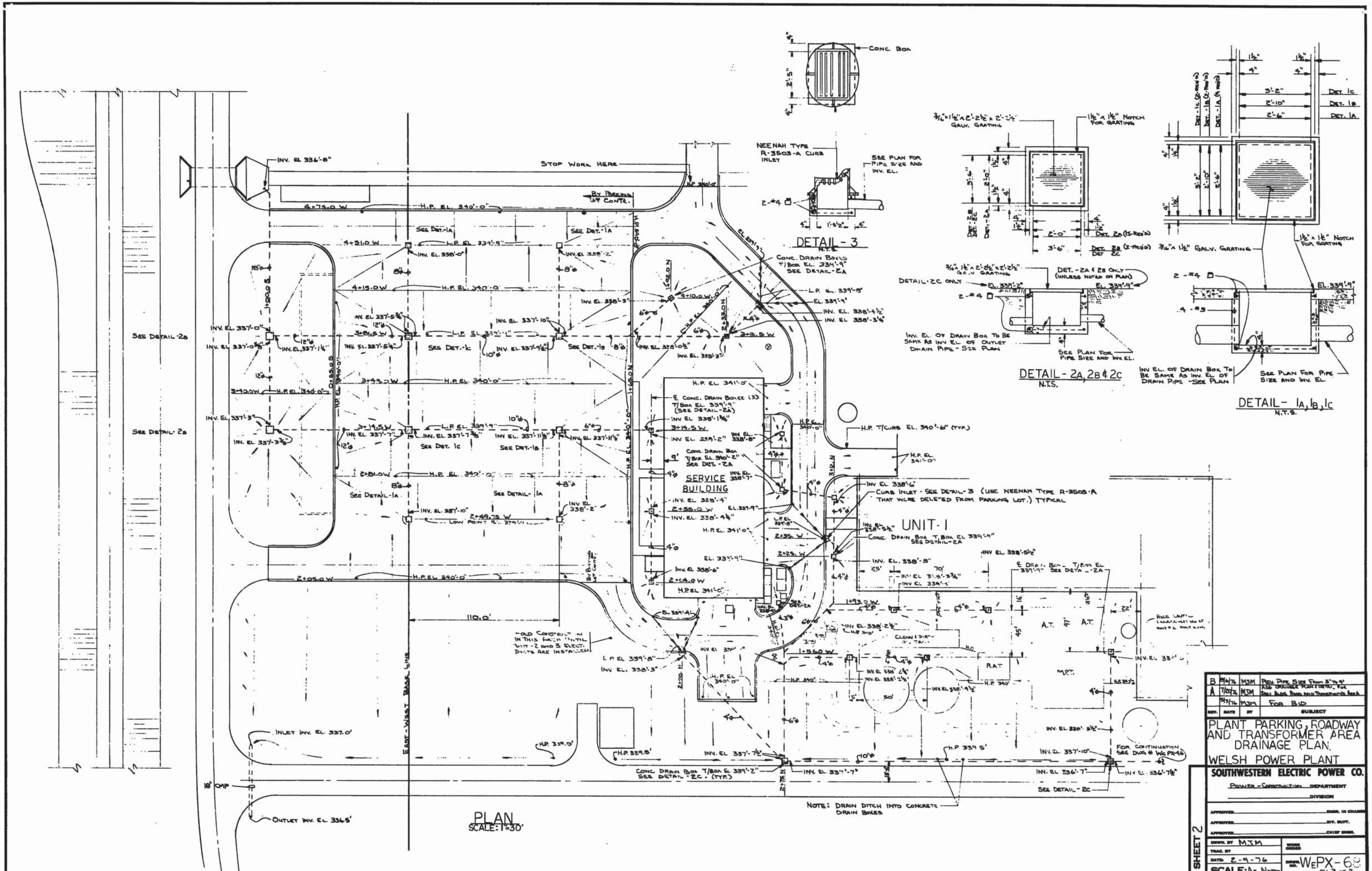
SPCC & STORM WATER SITE PLAN
WELSH POWER PLANT
PITTSBURG, TEXAS

SOUTHWESTERN ELECTRIC POWER

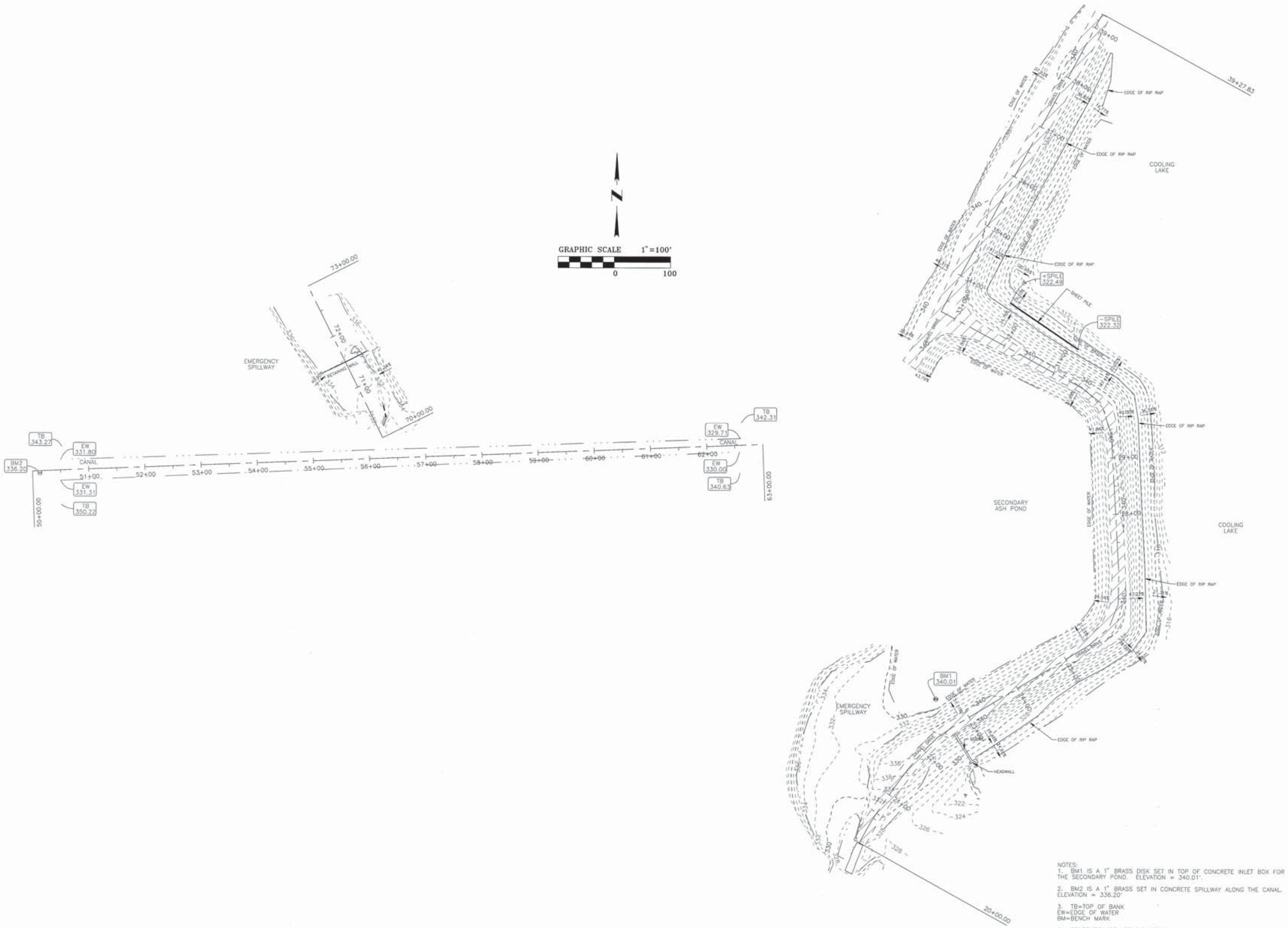
DRAFTING/ENGINEERING DFT.: M. LONG 9/19/00
ENG.:
APP.: J. MEYER 9/19/00
SCALE: 1"

DWG. NO. WEPX-342 SHT.
REV. No. 10

J:\CAD\Region V - SWEPCO\WELSH\Internal Drawings\Common\WEPX Drawings\WEPX-342.dwg 09/25/08 12:14



PLANT PARKING, ROADWAY AND TRANSFORMER AREA DRAINAGE PLAN
WELSH POWER PLANT
SOUTHWESTERN ELECTRIC POWER CO.
POWER - CONSTRUCTION DEPARTMENT
DRWN. BY MJM
DATE 2-9-76
SCALE: AS NOTED
WEPX-69
SH. 2 OF 2
SHEET 2
B 8/4/76 MJM REV. PIPE SIZE FROM 3" TO 4"
A 7/20/76 MJM ADD DRAINAGE PLAN & DETAIL FOR SERV. BLDG. ROAD AND TRANSFORMER AREA
5/13/76 MJM FOR BID
REV. DATE BY SUBJECT
PLAN
SCALE: 1"=30'
DETAIL - 3
N.T.S.
DETAIL - 2A, 2B & 2C
N.T.S.
DETAIL - 1A, 1B, 1C
N.T.S.
SERVICE BUILDING
UNIT-1
NEENAH TYPE R-3503-A CURB INLET
SEE PLAN FOR PIPE SIZE AND INV. EL.
CONC. BOX
STOP WORK HERE
EAST-WEST BASE LINE
NOTE: DRAIN DITCH INTO CONCRETE DRAIN BOXES
CONC DRAIN BOX T/BOX EL 339'-2" SEE DETAIL - 2C - (TYP.)
CURB INLET - SEE DETAIL-3 (USE NEENAH TYPE R-3503-A THAT WERE DELETED FROM PARKING LOT.) TYPICAL
FOR CONTINUATION SEE DWG # WEPX-46
INLET INV. EL. 337.0'
OUTLET INV. EL. 336.5'
18" CMP



SURVEYOR CERTIFICATE:

I HEREBY CERTIFY THAT THIS TOPOGRAPHICAL SURVEY WAS MADE ON THE GROUND UNDER MY SUPERVISION ON NOVEMBER 18, 2010, THAT THIS PLAT (MAP OR DRAWING) REPRESENTS THE FACTS FOUND AT THE TIME.

MIKE GARDNER
REGISTERED PROFESSIONAL LAND SURVEYOR
NO. 5760, STATE OF TEXAS
FIRM CERTIFICATE NO. 101011-00
DATE: NOVEMBER 23, 2010
REVISED: DECEMBER 6, 2010

STATE OF TEXAS
REGISTERED
MIKE GARDNER
#5760
PROFESSIONAL LAND SURVEYOR

NOTES:
1. BM1 IS A 1" BRASS DISK SET IN TOP OF CONCRETE INLET BOX FOR THE SECONDARY POND. ELEVATION = 340.01'.

2. BM2 IS A 1" BRASS SET IN CONCRETE SPILLWAY ALONG THE CANAL. ELEVATION = 336.20'

3. TB=TOP OF BANK
EW=EDGE OF WATER
BM=BENCH MARK

4. CONTOURS ARE ARE 2.0' APART.

5. LAKE ELEVATION PER WELSH POWER PLANT ON NOVEMBER 18, 2010 WAS 317.57 FEET MSL.

TOPOGRAPHIC SURVEY

DIKE'S AT WELSH POWER PLANT
FOR: GREG CARTER

Date	Revision/Description
12/6/10	ADDED LAKE LEVEL NOTE
12/6/10	ADDED CROSS SECTION SHEETS

Drawn By	Checked By	Project No.	Dwg. Date
MG	DW	104021	11/19/10

MTG engineers & surveyors
5930 SUMMERHILL RD. | P.O. BOX 3786
TEXARKANA TEXAS 75501
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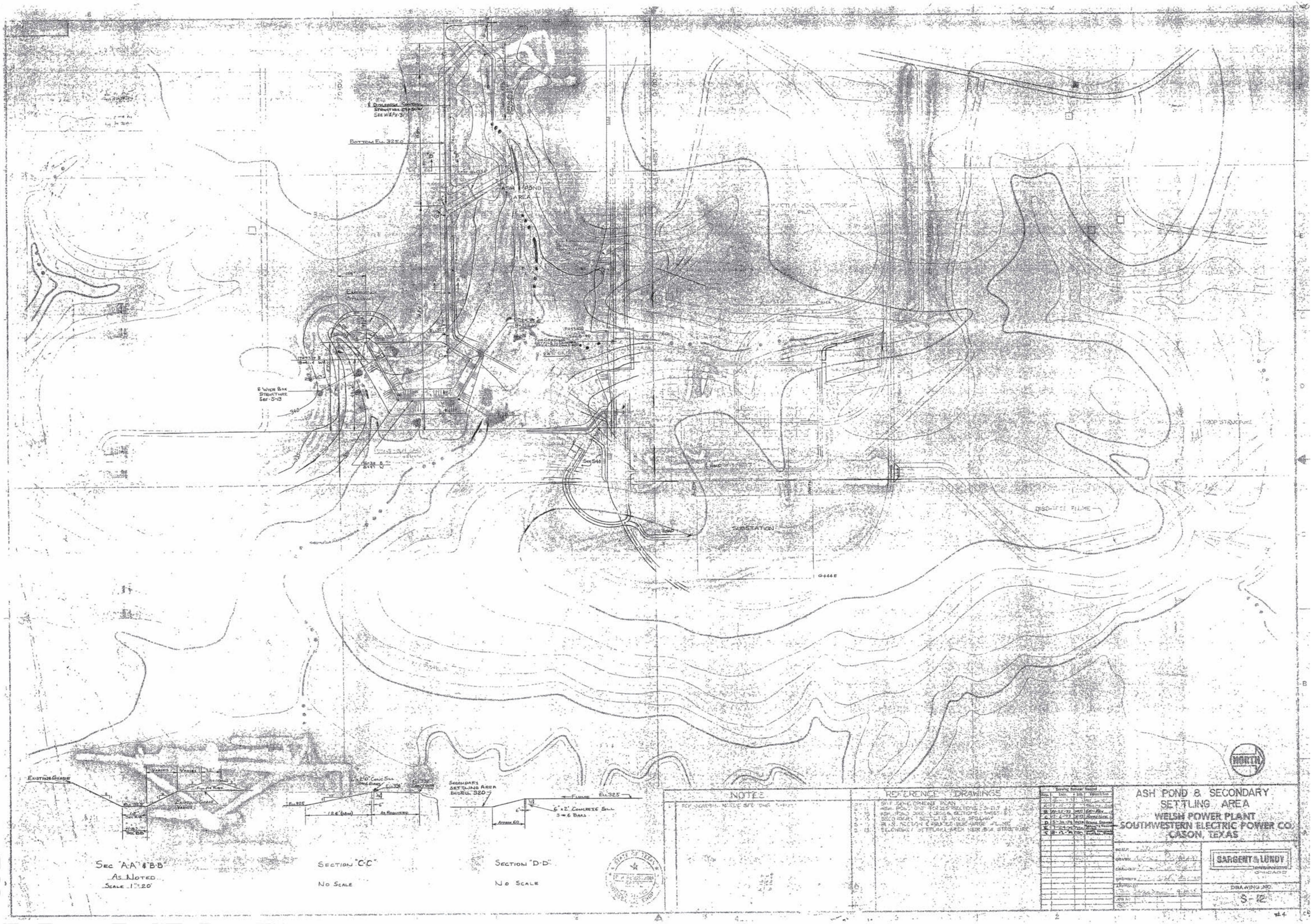
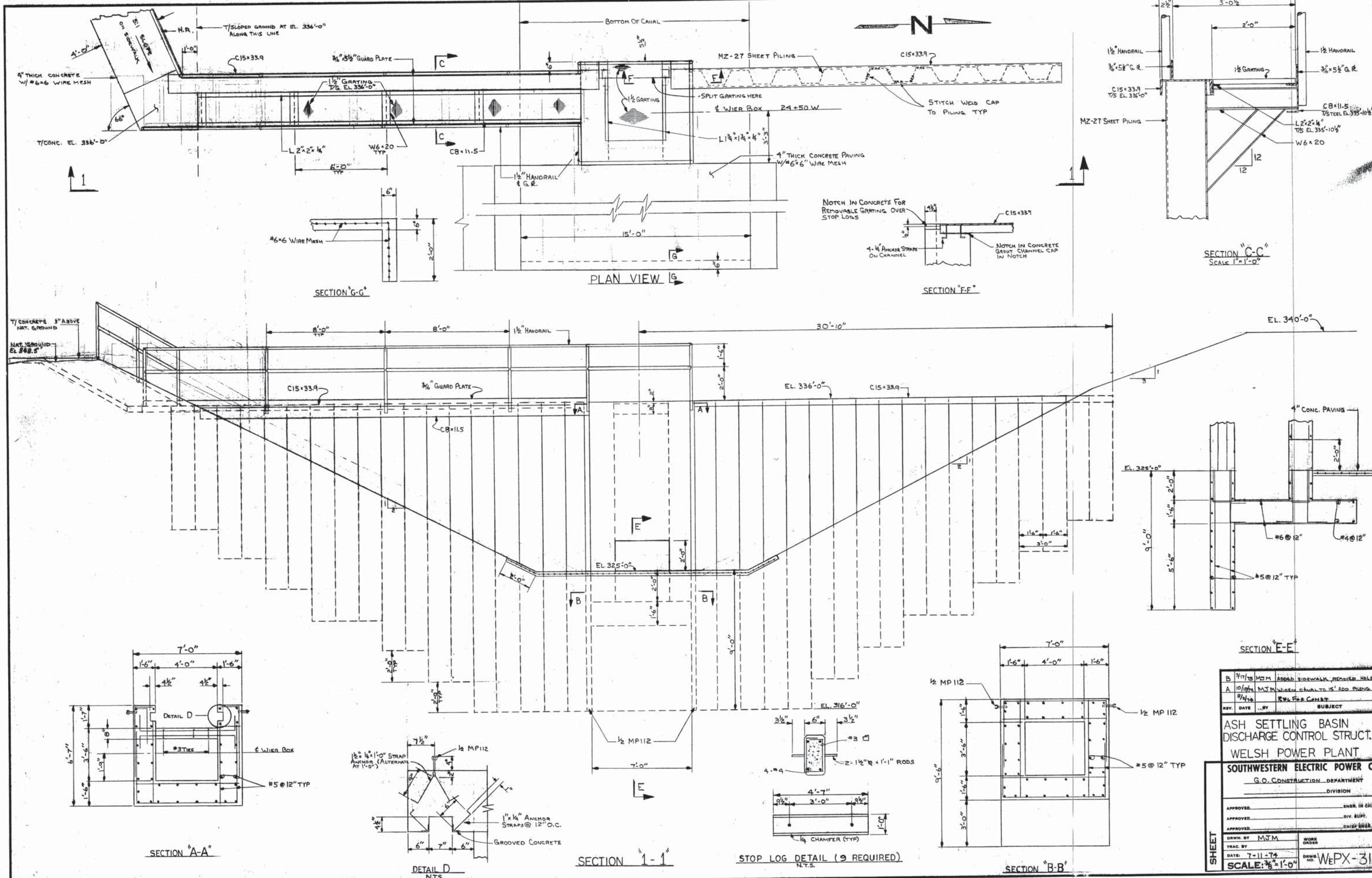
 TBPE NO. 354

File No.

Sheet No. 1


ASH POND AREA
SUBSTATION
BOTTOM EL. 325.0
E WIER BOX STRUCTURE SEE S-13
EXISTING GRADE
SECONDARY SETTLING AREA BOT. EL. 320
FLUME EL. 325
6" x 2" CONCRETE SILL
SEC "A-A" & "B-B"
AS NOTED
SCALE 1" = 20'
SECTION "C-C"
NO SCALE
SECTION "D-D"
NO SCALE
NORTH
NOTES
REFERENCE DRAWINGS
SITE DEVELOPMENT PLAN
ASH POND & SECONDARY
SETTLING AREA
WELSH POWER PLANT
SOUTHWESTERN ELECTRIC POWER CO.
CASON, TEXAS
SARGENT & LUNDY
ENGINEERS
CHICAGO
DRAWING NO.
S-12



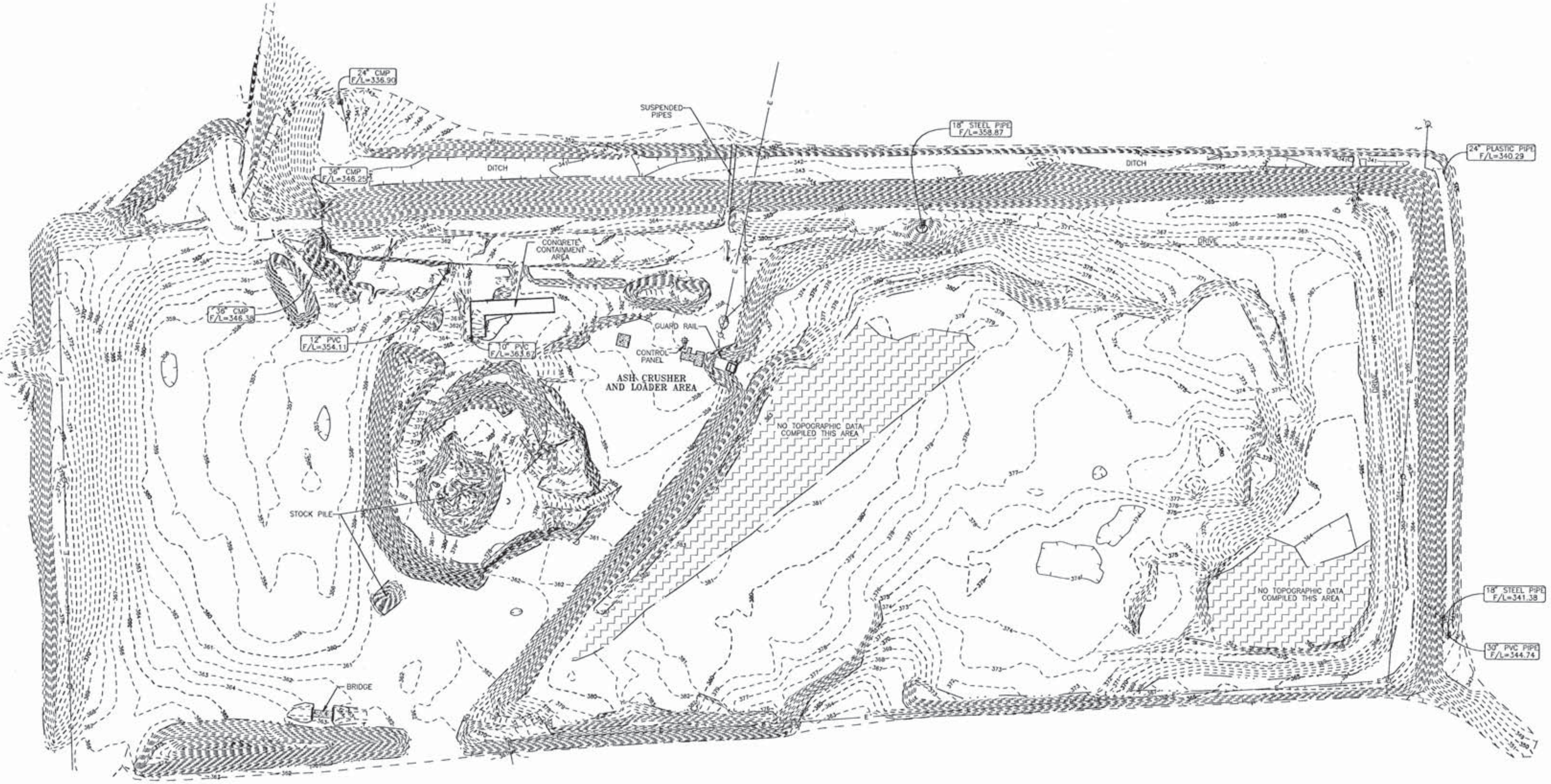
REV.	DATE	BY	SUBJECT
B	9/17/75	MJM	ADDED SIDEWALK, REMOVED HOLD
A	10/8/74	MJM	WIDEN CANAL TO 15' ADD PILING
	8/4/74		REL. FOR CONST.

ASH SETTLING BASIN
DISCHARGE CONTROL STRUCT.
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.
G.O. CONSTRUCTION DEPARTMENT
DIVISION

APPROVED ENGR. IN CHARGE
APPROVED DIV. SUPT.
APPROVED CHIEF ENGR.

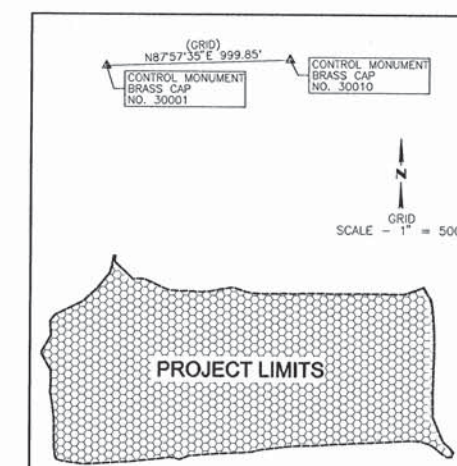
DRWN. BY MJM
TRAC. BY
DATE: 7-11-74
SCALE: 3/16"=1'-0"
WORK ORDER
DRWG. NO. WEPX-31
SHEET
FILE



N
GRID
GRAPHIC SCALE 1"=100'
0 100

LEGEND

OVERHEAD ELECTRIC LINE
TOP OF BANK / SLOPE
TOE OF SLOPE / BANK
PIPING
EDGE OF DRIVE
EDGE OF GRAVEL
1.0' CONTOUR INTERVAL
5.0' CONTOUR INTERVAL
POWER POLE
PIPE LOCATION
GUY WIRE
CONTROL MONUMENT
LIGHT POLE
CONCRETE SURFACE
AREA NOT SURVEYED



CONTROL MONUMENT LOCATIONS

THE BEARINGS ARE BASED ON GRID NORTH WITHIN THE "TEXAS COORDINATE SYSTEM OF 1983, NORTH CENTRAL ZONE", NAD83 (CORS96, EPOCH 2002.0), WITH A BEARING OF NORTH 87 DEGREES 57 MINUTES 35 SECONDS EAST. THE COMBINED SCALE FACTOR TO GO FROM GRID TO SURFACE IS 1.00012. THE FOLLOWING CONTROL MONUMENTS WERE USED TO ESTABLISH THE BASIS OF BEARINGS:

CONTROL MONUMENT NO. 30001
N-7085417.3416
E-3087023.3084

CONTROL MONUMENT NO. 30010
N-7085452.9367
E-3088022.5268

STATE OF TEXAS REGISTERED MIKE GARDNER 5760 PROFESSIONAL LAND SURVEYOR

SURVEYOR CERTIFICATE:

I HEREBY CERTIFY THAT THIS TOPOGRAPHICAL SURVEY WAS MADE ON THE GROUND UNDER MY SUPERVISION ON DECEMBER 14, 2009, THAT THIS PLAT (MAP OR DRAWING) REPRESENTS THE FACTS FOUND AT THE TIME.

MIKE GARDNER
REGISTERED PROFESSIONAL LAND SURVEYOR
NO. 5760, STATE OF TEXAS
FIRM CERTIFICATE NO. 101011-00
DATE: DECEMBER 17, 2009

TOPOGRAPHIC SURVEY

ASH STORAGE AREA
WELSH POWER PLANT
FOR: AEP

Date	Revision/Description

Drawn By	Checked By	Project No.	Dwg. Date
J.B.D.	M.G.	094027	12-17-09

MTG engineers & surveyors
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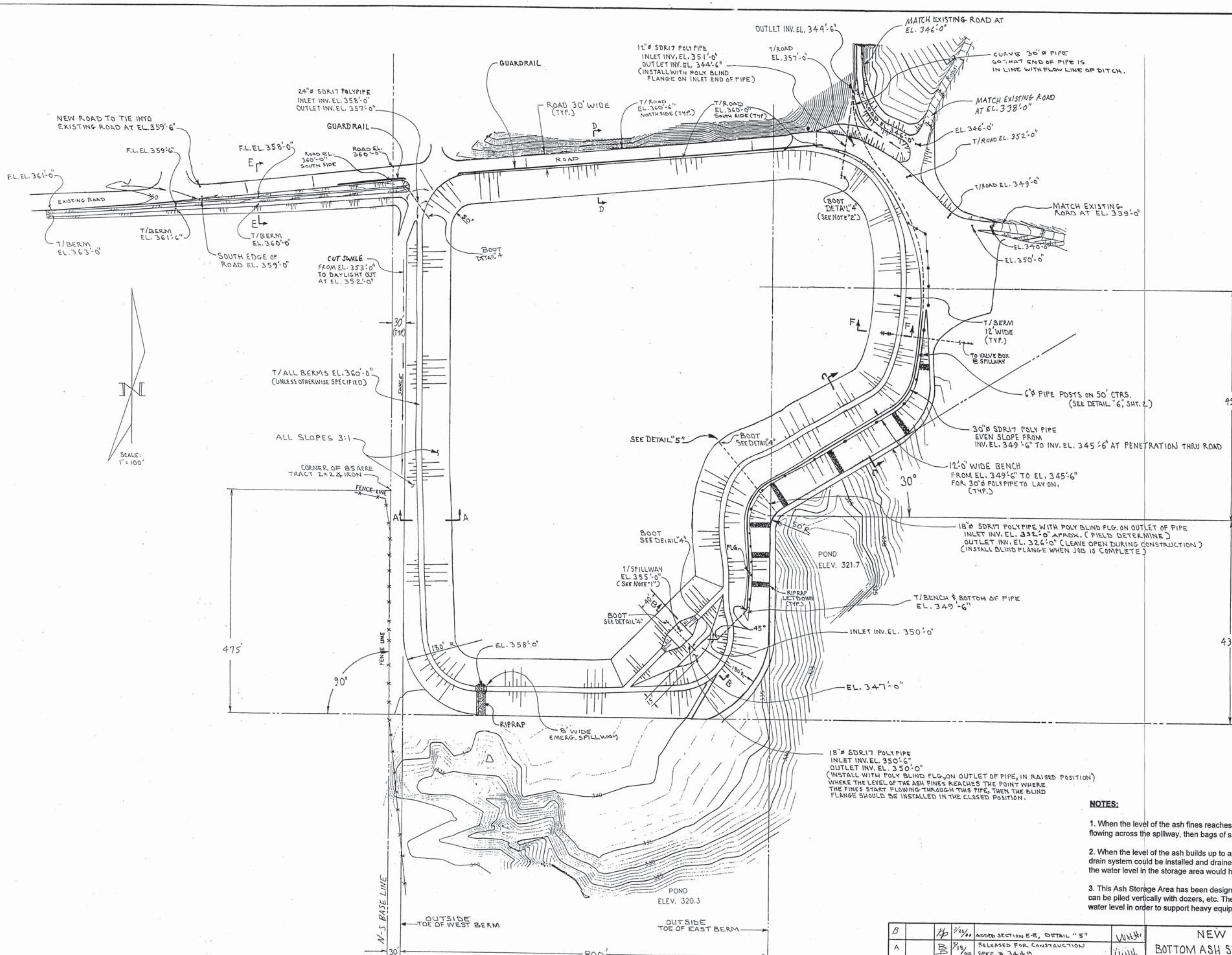
 TBPE NO. 354

File No. Sheet No.



NOTES:

1. When the level of the ash fines reaches the point where the fines start flowing across the spillway, then bags of sackrete can be installed to raise the spillway elevation.

2. When the level of the ash builds up to approx. elev. 355 along the north and east sides, a french drain system could be installed and drained to this outlet to help hold the water table down. Of course the water level in the storage area would have to be at elev. 351 or above for the french drain to function.

3. This Ash Storage Area has been designed to hold the water level as low as possible so the ash can be piled vertically with dozers, etc. The ash level needs to be approx. 4 ft. to 5 ft. above the water level in order to support heavy equipment.

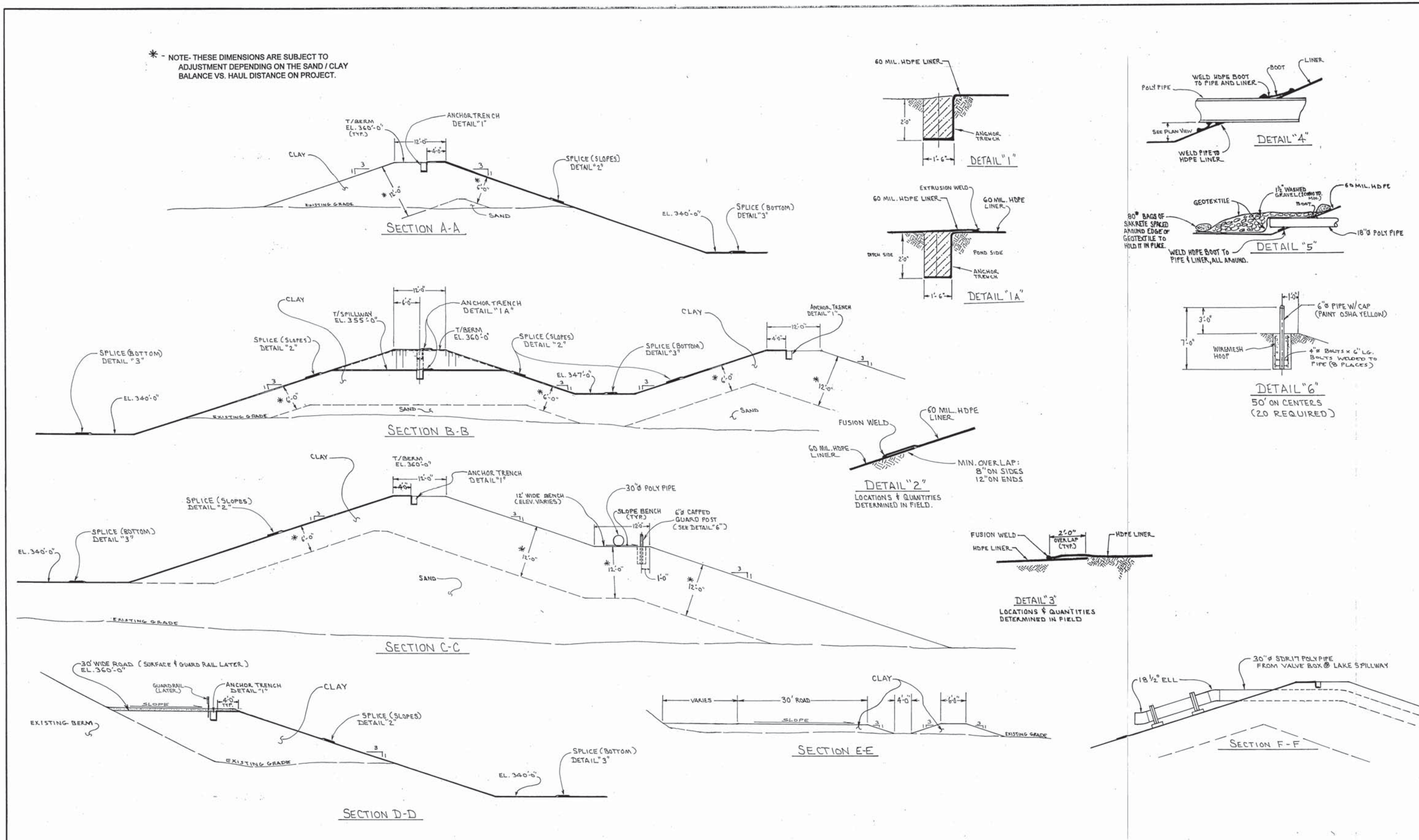
REV	W.O.	BY	DATE	SUBJECT	APPROVED
B		BP	3/22/00	ADDED SECTION E-E, DETAIL "5"	WHH
A		BP	5/18/00	RELEASED FOR CONSTRUCTION SPEC.# 3449	WHH
1		BP	3/13/00	RELEASED FOR BIDS SPEC.#3449 (ADDENDUM #1)	
		BP	3-10-00	RELEASED FOR BIDS	

REV.	W.O.	BY	DATE	SUBJECT	APPROVED
C		BP	10-29-00	AS BUILT	

NEW
BOTTOM ASH STORAGE AREA
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.

DEPT.	
DIV.	
APPROVED	
DRWN. BY: BP	DATE: 3-10-00
SCALE: 1" = 100'	W.O.
SH. 1 of 2	DRWG. NO. WEPX-335



REV	W.O.	BY	DATE	SUBJECT	APPROVED
B		BP	10/29/00	AS BUILT	
A		BP	5/18/00	RELEASED FOR CONSTRUCTION SPEC. # 3449	WHR
1		BP	3/13/00	(ADDENDUM #1) RELEASED FOR BIDS SPEC. # 3449	
		BP	3/10/00	RELEASED FOR BIDS	

NEW
BOTTOM ASH STORAGE AREA
WELSH POWER PLANT

SOUTHWESTERN ELECTRIC POWER CO.

DEPT.	
DIV.	
APPROVED	
DRWN. BY: BP	DATE: 3-10-00
SCALE: AS SHOWN	W.O.
SH. 2 of 2	DRWG. NO. WEPX-335

SURFACE TO DATUM VOLUME REPORT

Murray, Thomas & Griffin, Inc.
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Project: X:\2009 Projects\094025 ASH POND TOPO WELSH - GREG CARTER\VOLUME CALC 4-12-10.pro

Report Generated: Monday, April 12, 2010 9:22:04 AM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

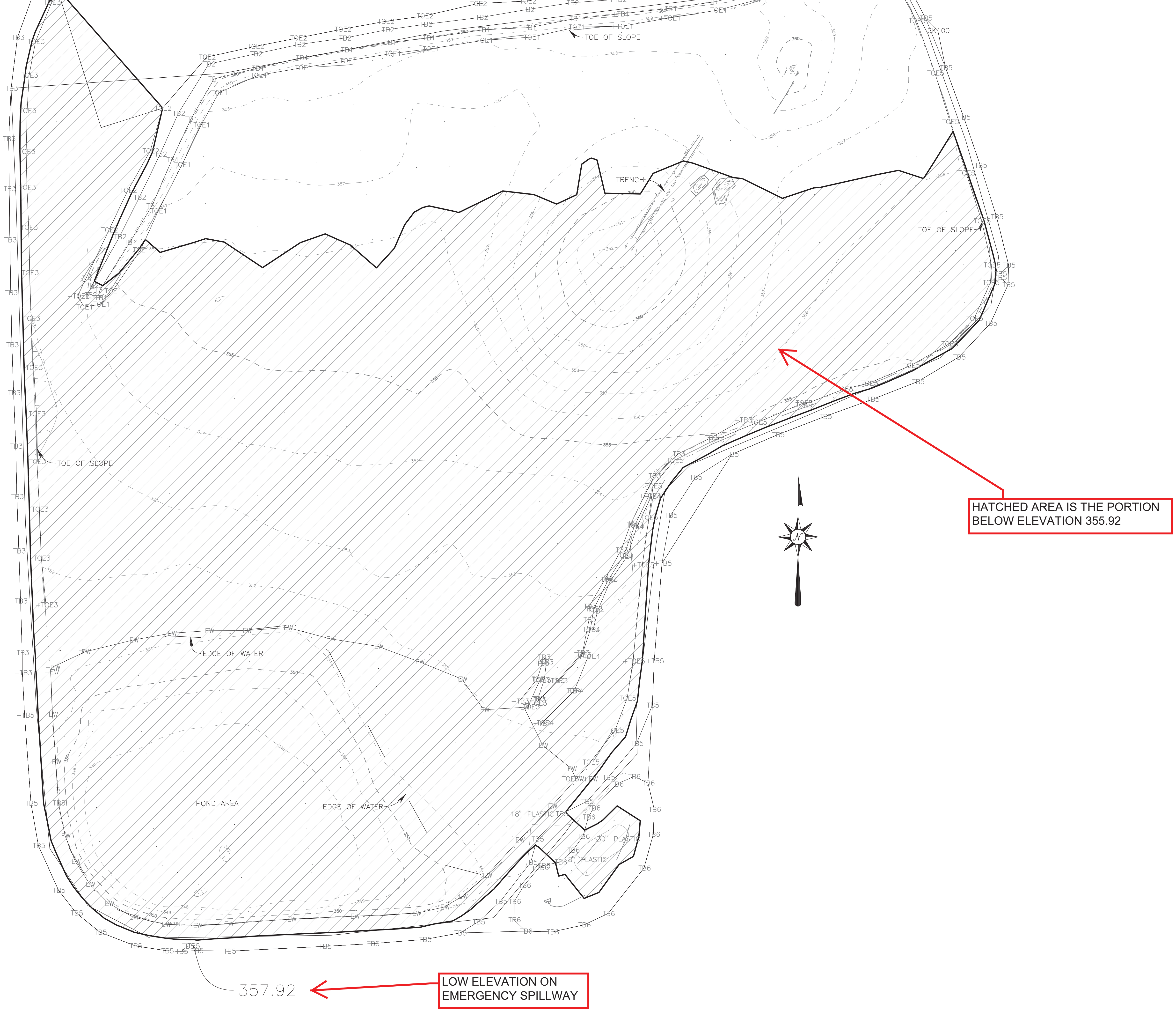
DTM Surface Layer Name	Number of Points	Datum Elevation
POINTS COMPOSITE	632	355.92

Volume limited to that within the constraining boundary - Object 18228
Area within boundary: 600,437.78 SQ FT (13.784 ACRES)
Total triangulated area: 594,973.58 SQ FT (13.659 ACRES)

Elev Range (ft)	Cut Volume (yd3)	Fill Volume (yd3)
346.13 > 346.92	213.3	0.0
346.92 > 347.92	1,674.4	0.0
347.92 > 348.92	2,922.6	0.0
348.92 > 349.92	3,724.2	0.0
349.92 > 350.92	4,444.3	0.0
350.92 > 351.92	5,674.4	0.0
351.92 > 352.92	7,552.1	0.0
352.92 > 353.92	10,632.0	0.0
353.92 > 354.92	14,916.3	0.0
354.92 > 355.92	19,411.2	0.0
355.92 > 355.94	0.0	0.0

Excavation Volume Beneath Datum (yd3)	Fill Volume Above Datum(yd3)
71,164.9	0.0

Net Difference: 71,164.9 yd3 excess volume beneath datum



ASH POND VOLUME
BELOW ELEVATION 355.92

ATTACHMENT B

2021 Hydraulic Analysis

Of

Welsh Power Plant Ash Ponds

Welsh Plant
2021 H&H Analysis for Ash Pond Systems
(Utilized F&N Model from the 2010 H&H Analysis)
(Performed on 9/28/2021)

HMS Version: 4.8

Executed: 28 September 2021, 16:27

Global Parameter Summary - Subbasin

Area (ft^2)

Element Name	Area (ft^2)
Primary	0.37
Power Plant	0.18
Bottom Ash	0.03
To Bottom Ash	0.03
Ash Storage B	0.02
Ash Storage A	0.03
Secondary	0.03

Downstream

Element Name	Downstream
Primary	Primary Pond
Power Plant	Primary Pond
Bottom Ash	Bottom Ash Pond
To Bottom Ash	Bottom Ash Pond
Ash Storage B	Reach - 2
Ash Storage A	Ash Culvert
Secondary	Secondary Pond

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Primary	0	76
Power Plant	0	85.3
Bottom Ash	0	91
To Bottom Ash	0	77.8
Ash Storage B	0	87.1
Ash Storage A	0	87.1
Secondary	0	82.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Primary	36.14	Standard
Power Plant	18.77	Standard
Bottom Ash	4.78	Standard
To Bottom Ash	16.51	Standard
Ash Storage B	7.51	Standard
Ash Storage A	5.28	Standard
Secondary	2.31	Standard

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
Reach - 3	Reach - 2
Reach - 2	Ash Culvert
Reach - 1	Secondary Pond

Route: Muskingum Cunge

Element Name	Method	Channel	Length (ft)	Energy Slope	Mannings n	Bottom Width	Side Slope	Initial Variable	Space - Time Method	Index Parameter Type	Index Celerity	Invert Elevation	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - 3	Muskingum Cunge	Circular	1460	0	0.01	Not Specified	Not Specified	Combined Inflow	Automatic DX and DT	Index Celerity	5	350	20	30
Reach - 2	Muskingum Cunge	Trapezoid	1430	0	0.08	26.46	2	Combined Inflow	Automatic DX and DT	Index Celerity	5	341	20	30
Reach - 1	Muskingum Cunge	Trapezoid	1210	0	0.08	15	2.5	Combined Inflow	Automatic DX and DT	Index Celerity	5	325	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Primary	0.37	776.77	01Jan2000, 12:40	6.86
Power Plant	0.18	585.58	01Jan2000, 12:20	8.04
Bottom Ash	0.03	168.05	01Jan2000, 12:05	8.75
To Bottom Ash	0.03	96.13	01Jan2000, 12:20	7.09
Bottom Ash Pond	0.06	107.92	01Jan2000, 12:35	7.97
Reach - 3	0.06	107.22	01Jan2000, 12:40	7.96
Ash Storage B	0.02	111.2	01Jan2000, 12:10	8.27
Reach - 2	0.09	118.43	01Jan2000, 12:30	7.9
Ash Storage A	0.03	157.92	01Jan2000, 12:05	8.27
Ash Culvert	0.12	253.9	01Jan2000, 12:10	7.97
Primary Pond	0.67	60.6	01Jan2000, 13:20	2.71
Reach - 1	0.67	60.16	01Jan2000, 13:35	2.71
Secondary	0.03	139.43	01Jan2000, 12:05	7.71
Secondary Pond	0.7	597.6	01Jan2000, 13:40	7.23
BottomAsh_ES	0	0	31Dec1999, 24:00	Not specified

Subbasin: Primary

Area (ft²) : 0.37
Downstream : Primary Pond

Loss Rate: Scs

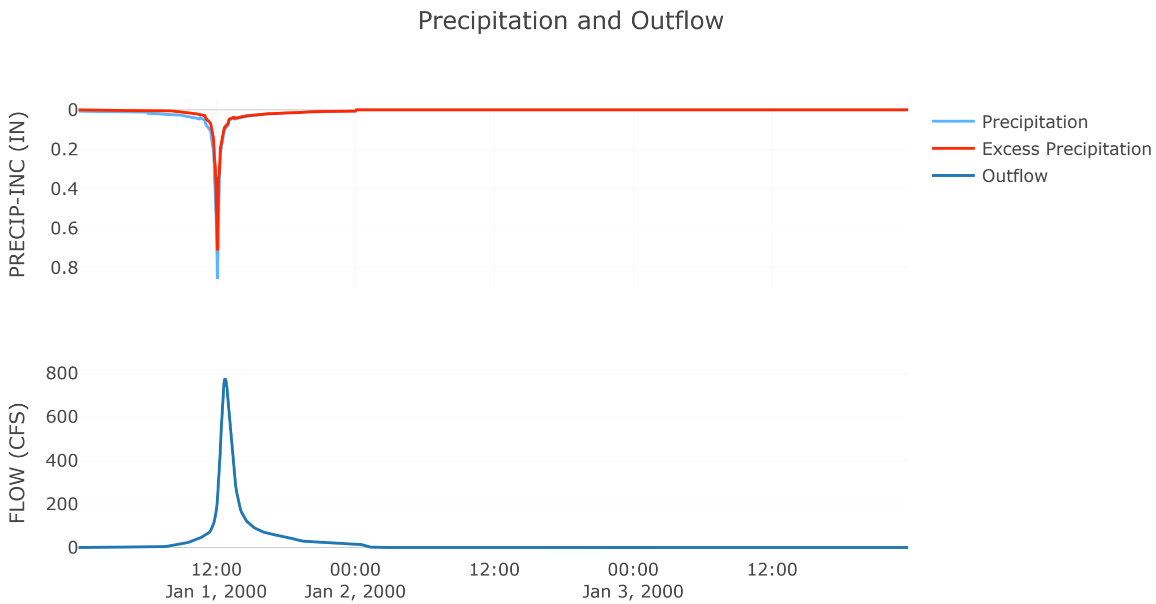
Percent Impervious Area	0
Curve Number	76

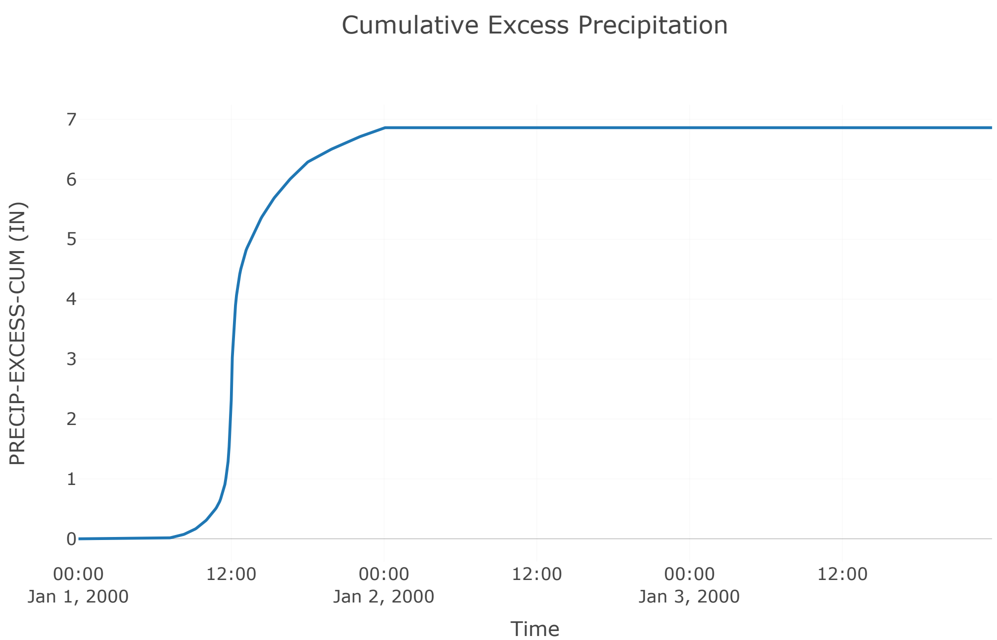
Transform: Scs

Lag	36.14
Unitgraph Type	Standard

Results: Primary

Peak Discharge (CFS)	776.77
Time of Peak Discharge	01Jan2000, 12:40
Volume (IN)	6.86
Precipitation Volume (AC - FT)	192.27
Loss Volume (AC - FT)	58.26
Excess Volume (AC - FT)	134
Direct Runoff Volume (AC - FT)	134
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
800
600
400
200
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
7
6
5
4
3
2
1
0
00:00
Jan 1, 2000
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00:00
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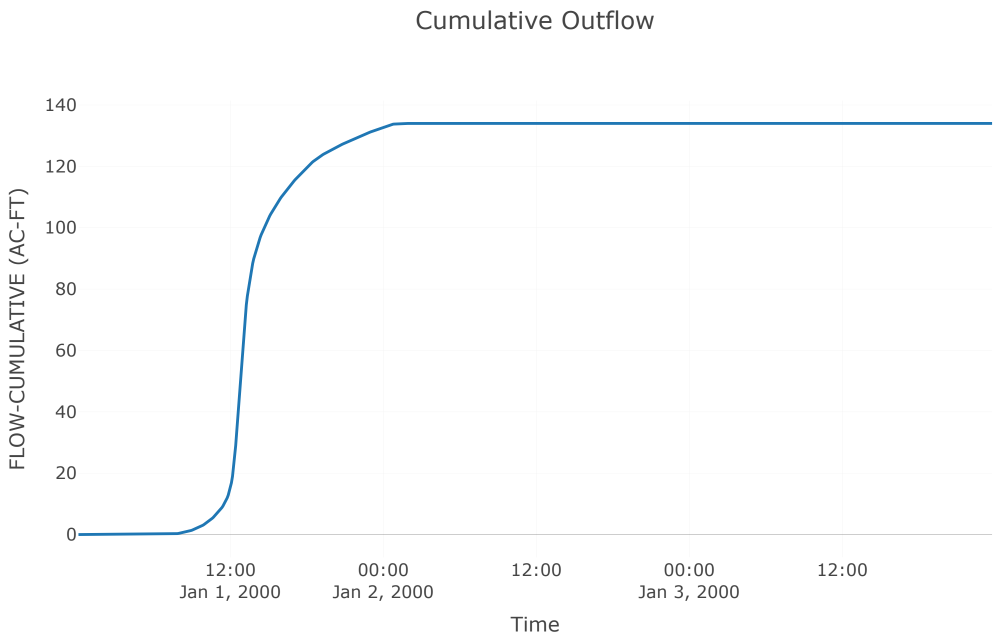
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
140
120
100
80
60
40
20
0
FLOW-CUMULATIVE (AC-FT)
12:00
Jan 1, 2000
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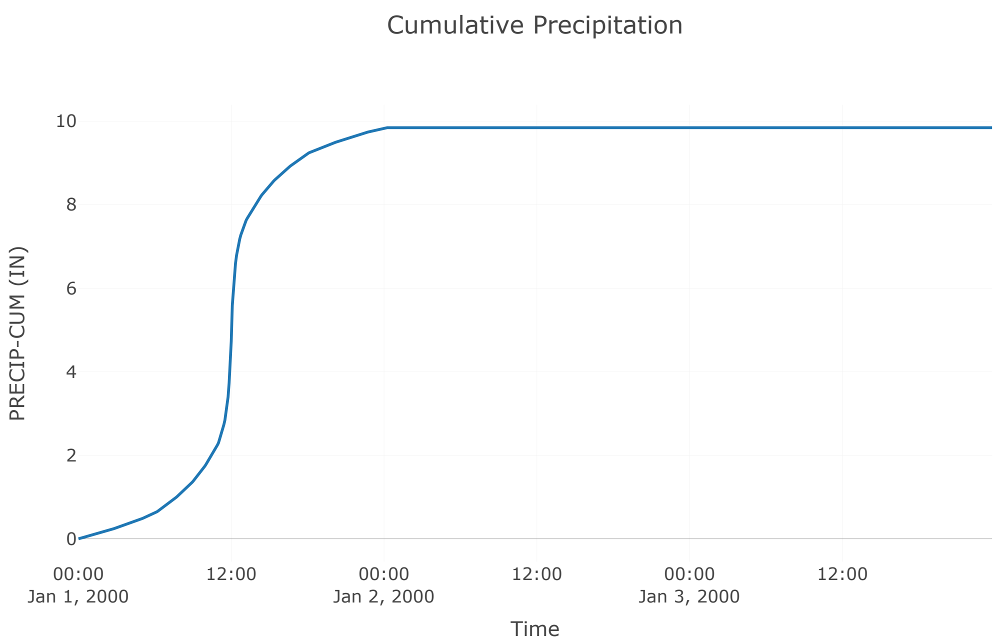
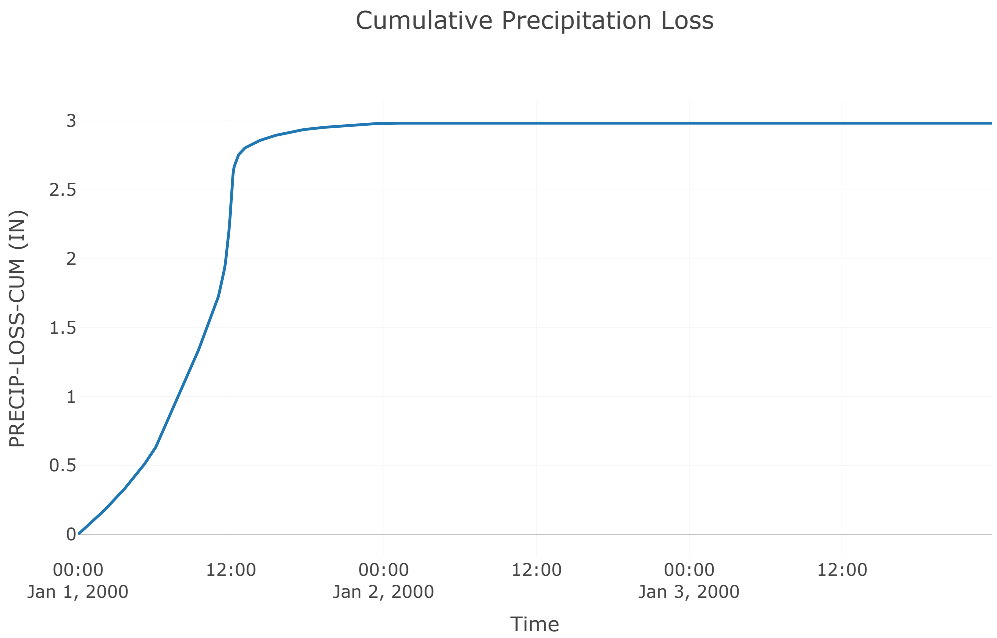
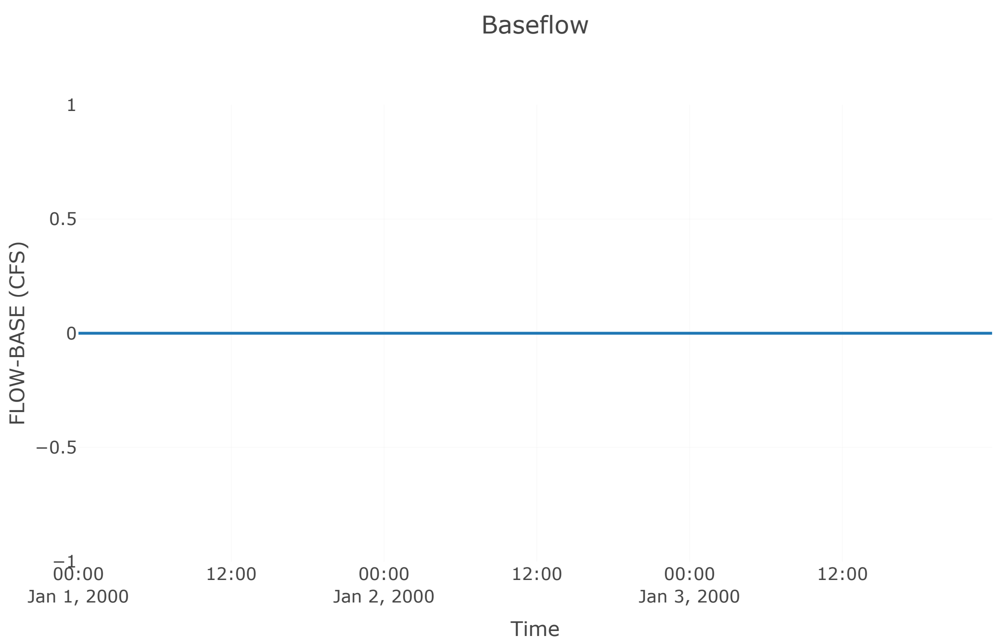
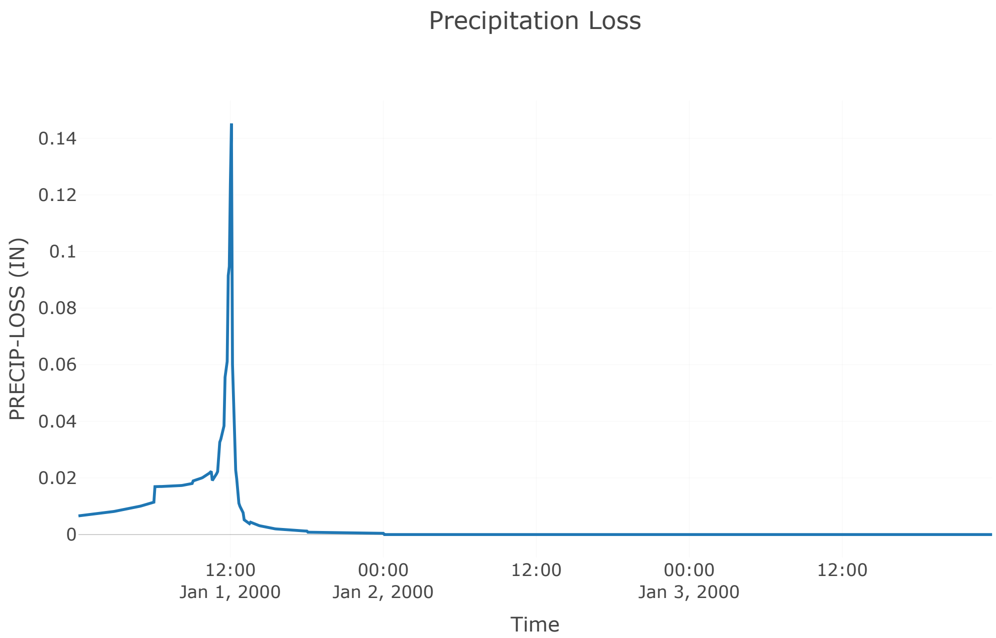
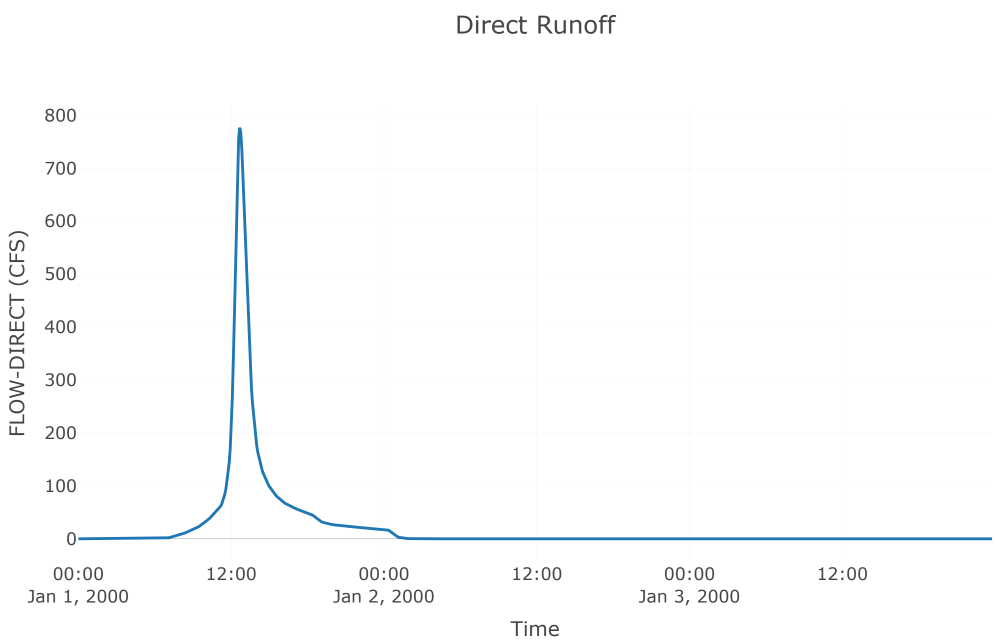
12:00
00:00
Jan 3, 2000
12:00
Time

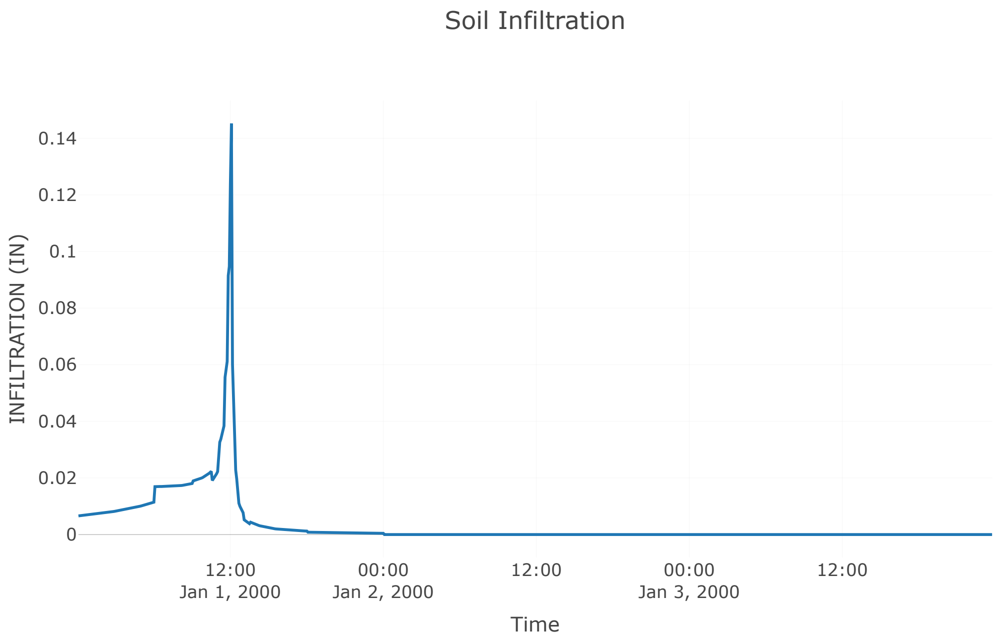

Cumulative Precipitation
10
8
6
4
2
0
PRECIP-CUM (IN)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Direct Runoff
FLOW-DIRECT (CFS)
800
700
600
500
400
300
200
100
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Soil Infiltration
INFILTRATION (IN)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Subbasin: Power Plant

Area (ft²) : 0.18
Downstream : Primary Pond

Loss Rate: Scs

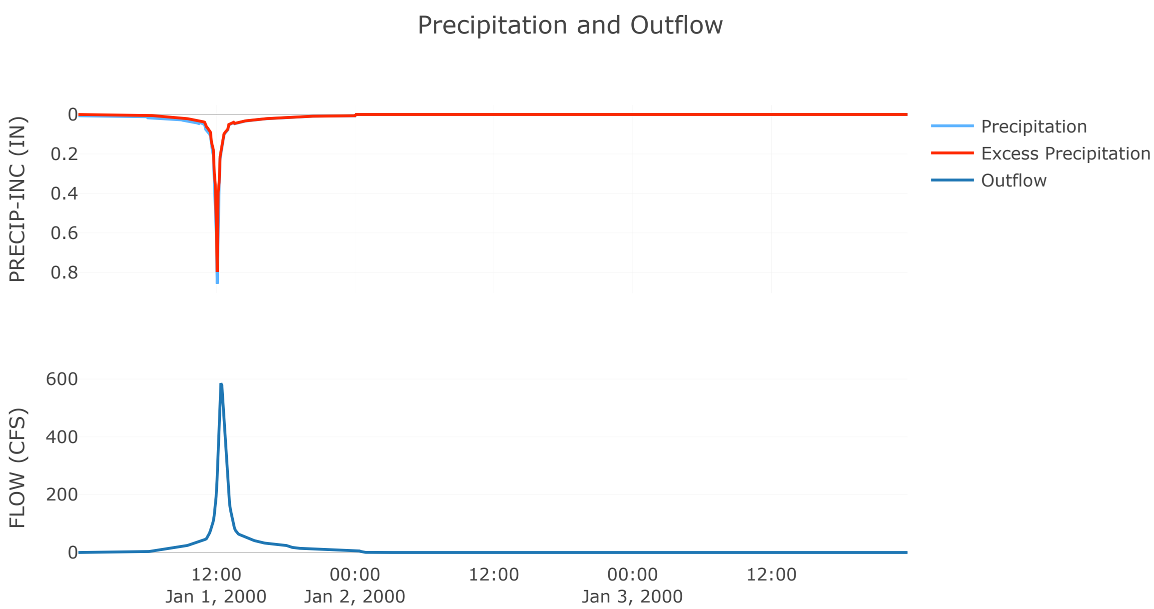
Percent Impervious Area	0
Curve Number	85.3

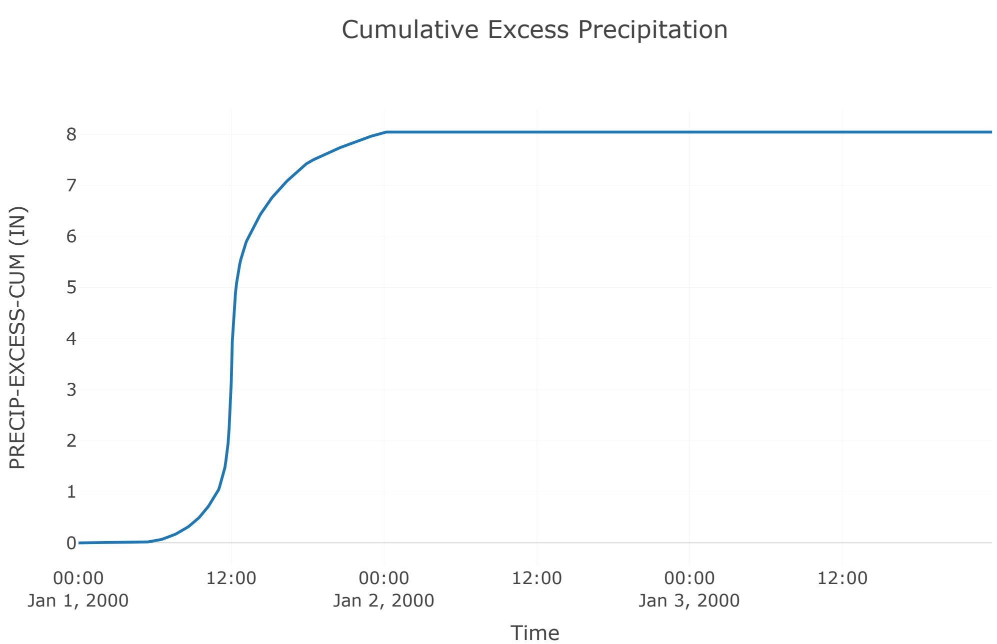
Transform: Scs

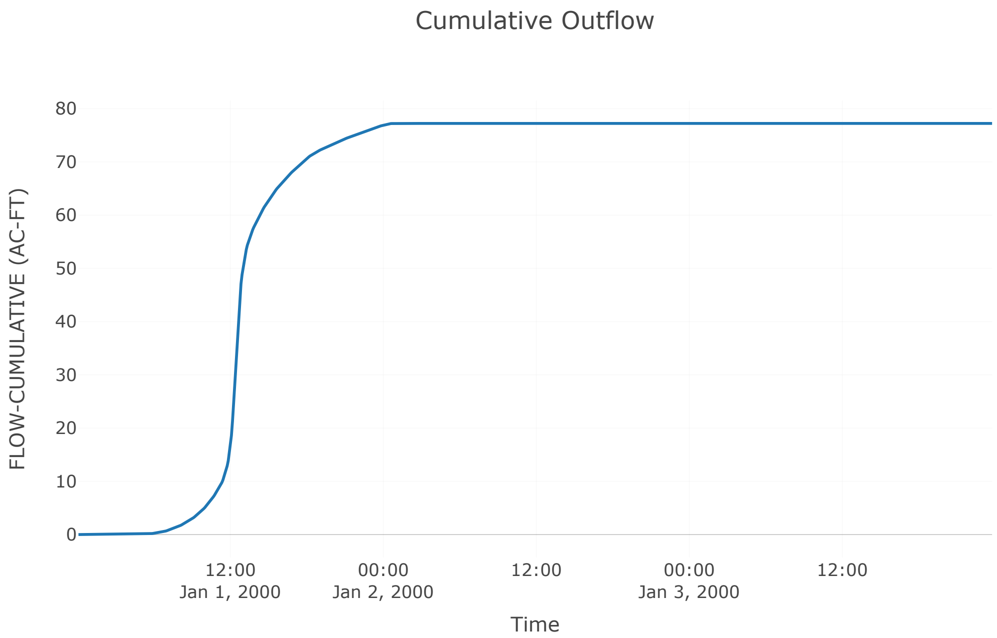
Lag	18.77
Unitgraph Type	Standard

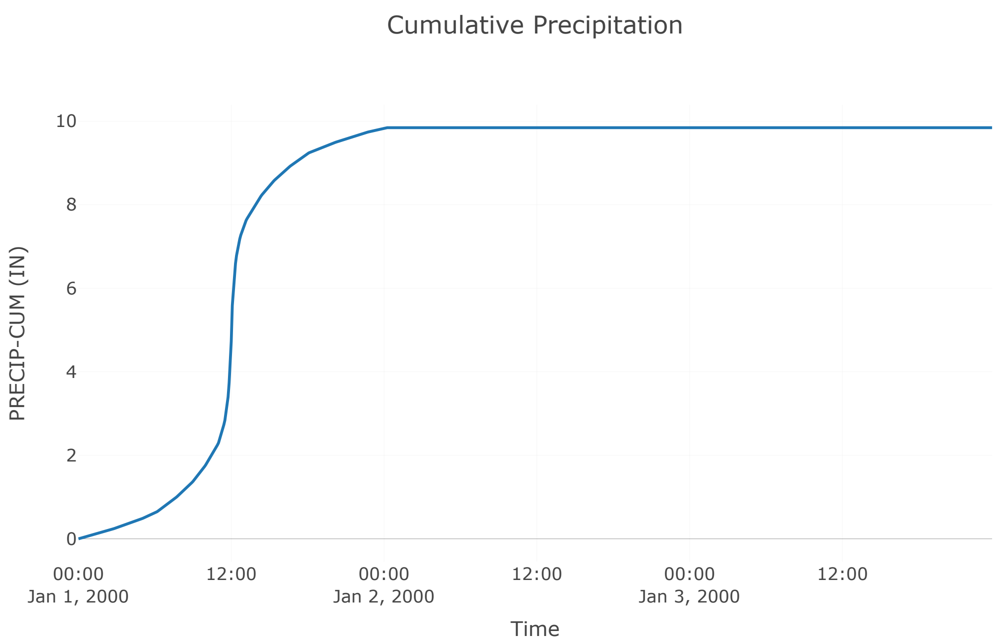
Results: Power Plant

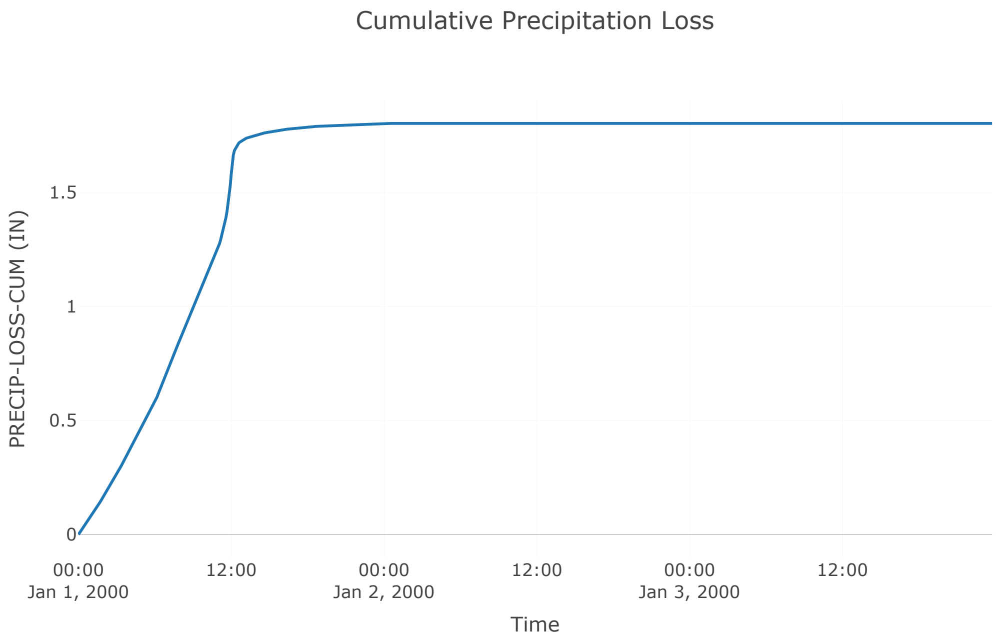
Peak Discharge (CFS)	585.58
Time of Peak Discharge	01Jan2000, 12:20
Volume (IN)	8.04
Precipitation Volume (AC - FT)	94.55
Loss Volume (AC - FT)	17.32
Excess Volume (AC - FT)	77.23
Direct Runoff Volume (AC - FT)	77.23
Baseflow Volume (AC - FT)	0

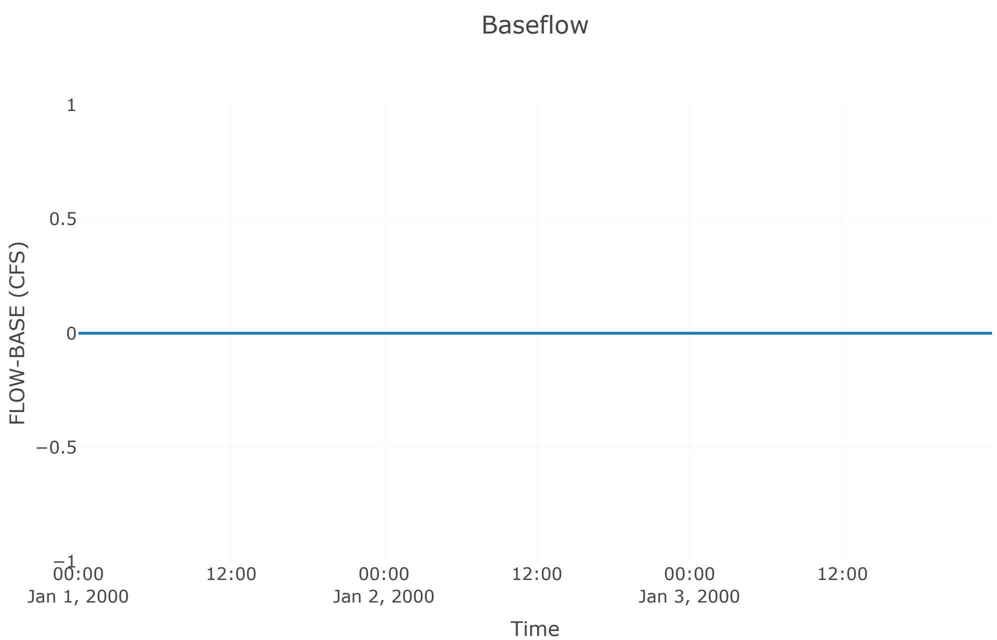

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
600
400
200
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00

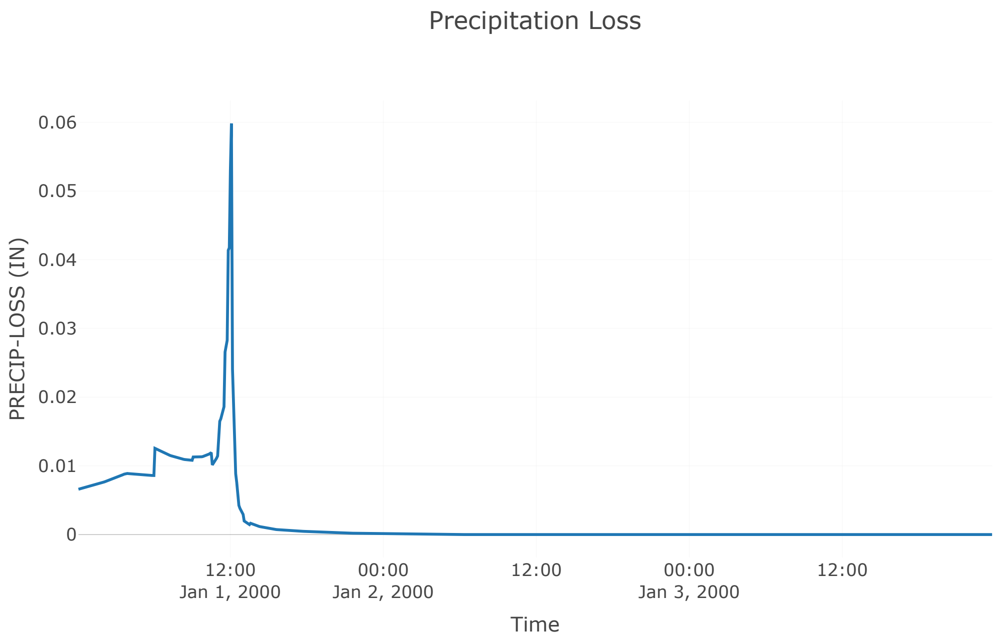

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
8
7
6
5
4
3
2
1
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

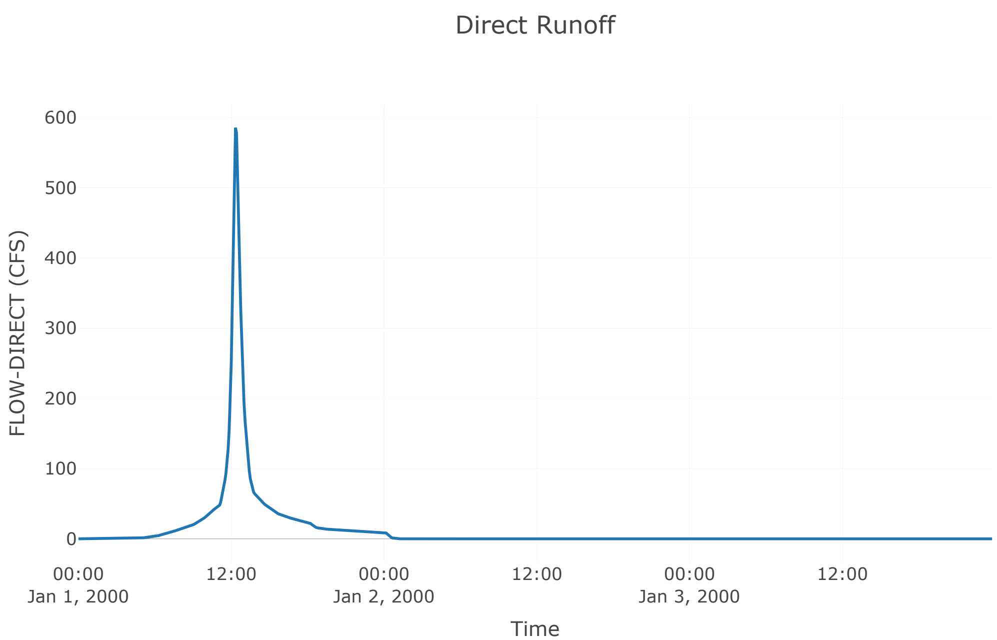

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
80
70
60
50
40
30
20
10
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

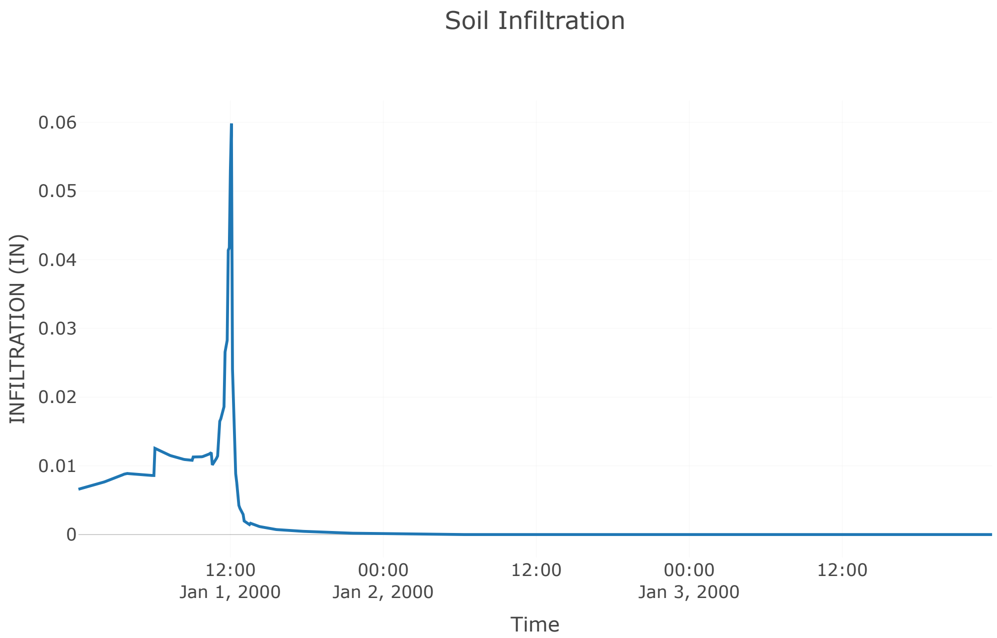

Cumulative Precipitation
PRECIP-CUM (IN)
10
8
6
4
2
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
0
0.5
1
1.5
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.06
0.05
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Direct Runoff
FLOW-DIRECT (CFS)
600
500
400
300
200
100
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Soil Infiltration
INFILTRATION (IN)
0.06
0.05
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Subbasin: BottomAsh

Area (ft^2) : 0.03
Downstream : Bottom Ash Pond

Loss Rate: Scs

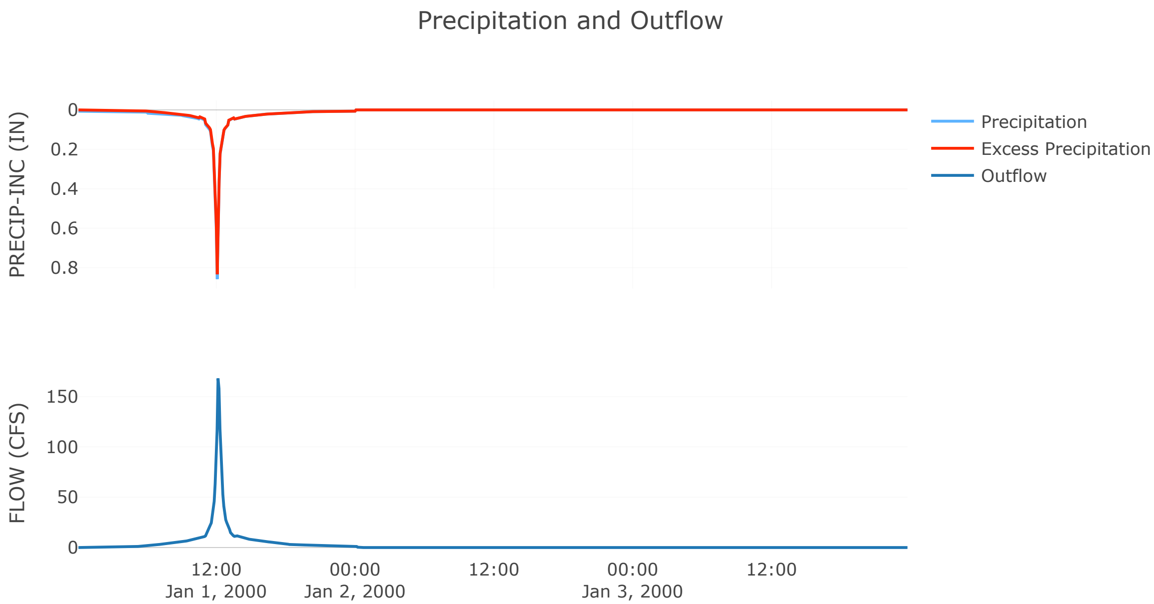
Percent Impervious Area	0
Curve Number	91

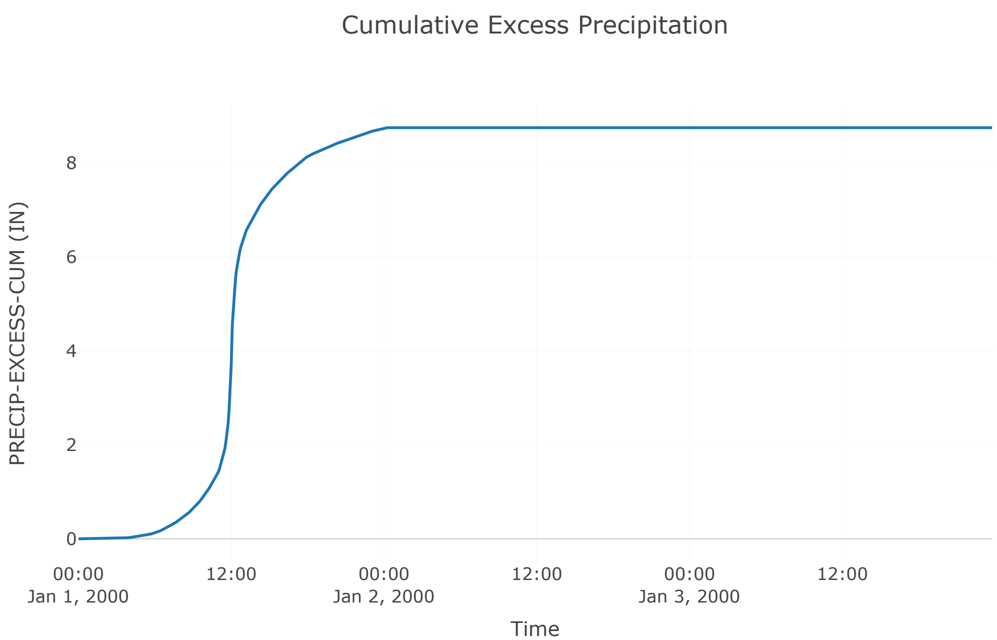
Transform: Scs

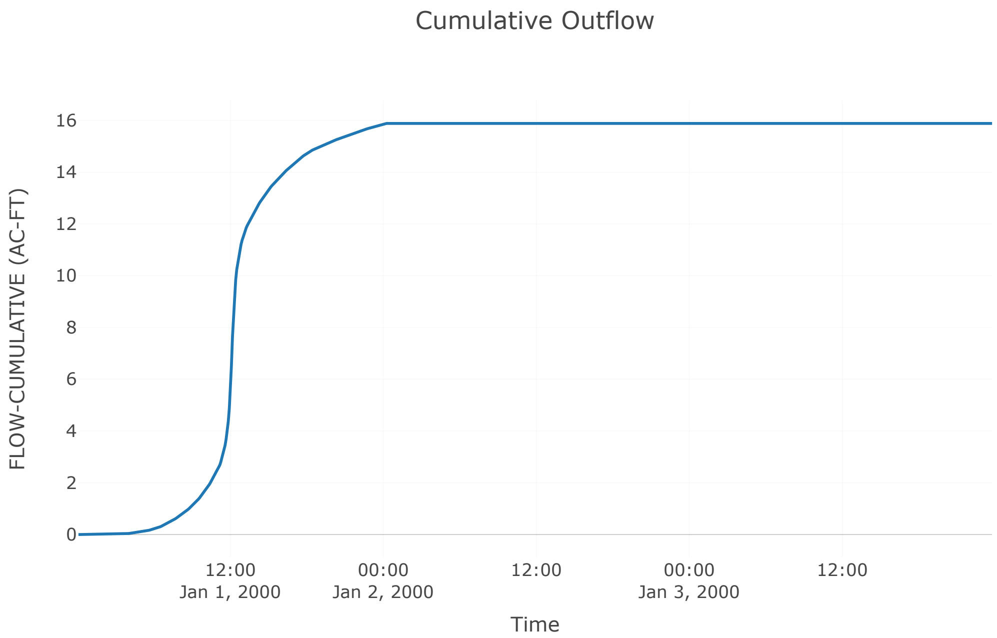
Lag	4.78
Unitgraph Type	Standard

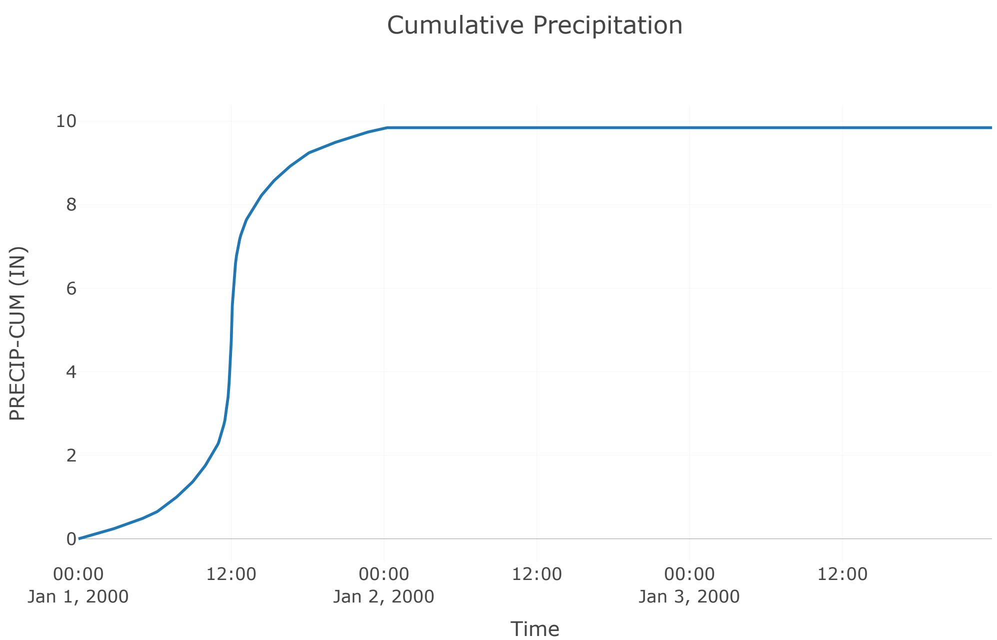
Results: BottomAsh

Peak Discharge (CFS)	168.05
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	8.75
Precipitation Volume (AC - FT)	17.87
Loss Volume (AC - FT)	1.99
Excess Volume (AC - FT)	15.88
Direct Runoff Volume (AC - FT)	15.88
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
FLOW (CFS)
150
100
50
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Precipitation
Excess Precipitation
Outflow


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
8
6
4
2
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
2
4
6
8
10
12
14
16
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation
PRECIP-CUM (IN)
0
2
4
6
8
10
00:00
Jan 1, 2000
12:00
00:00
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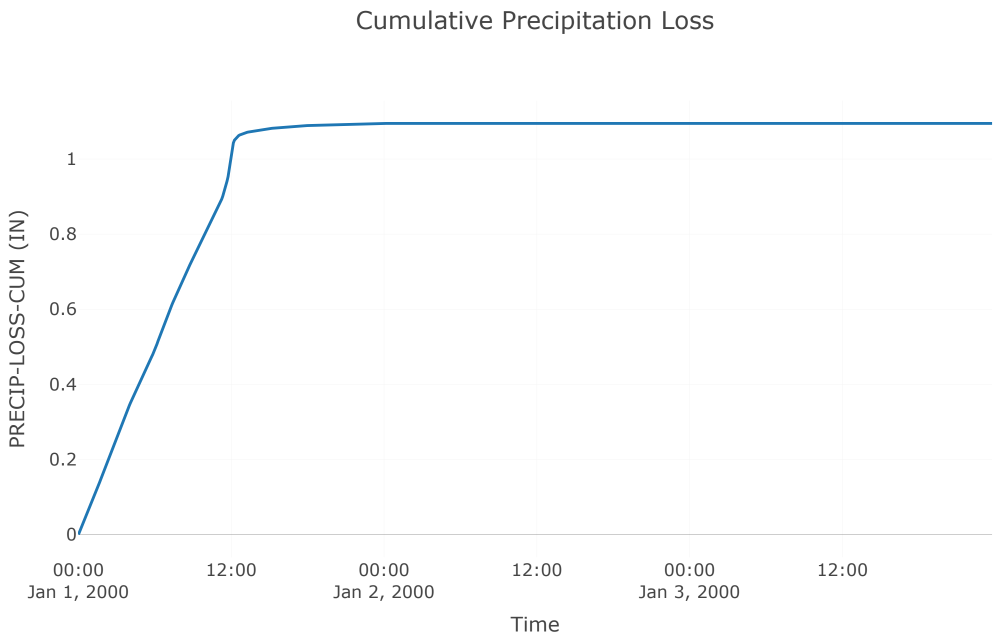
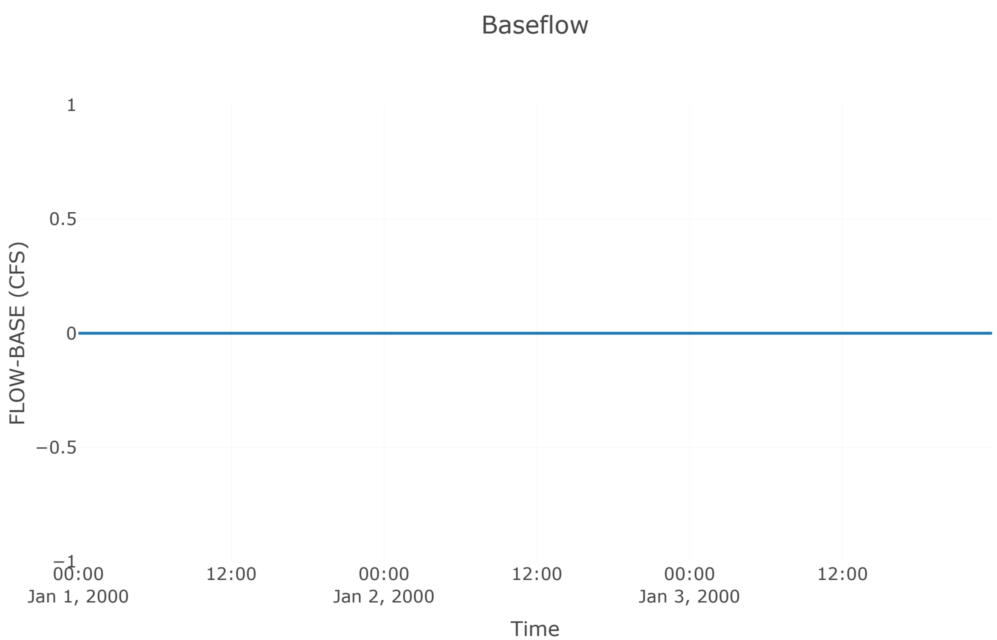
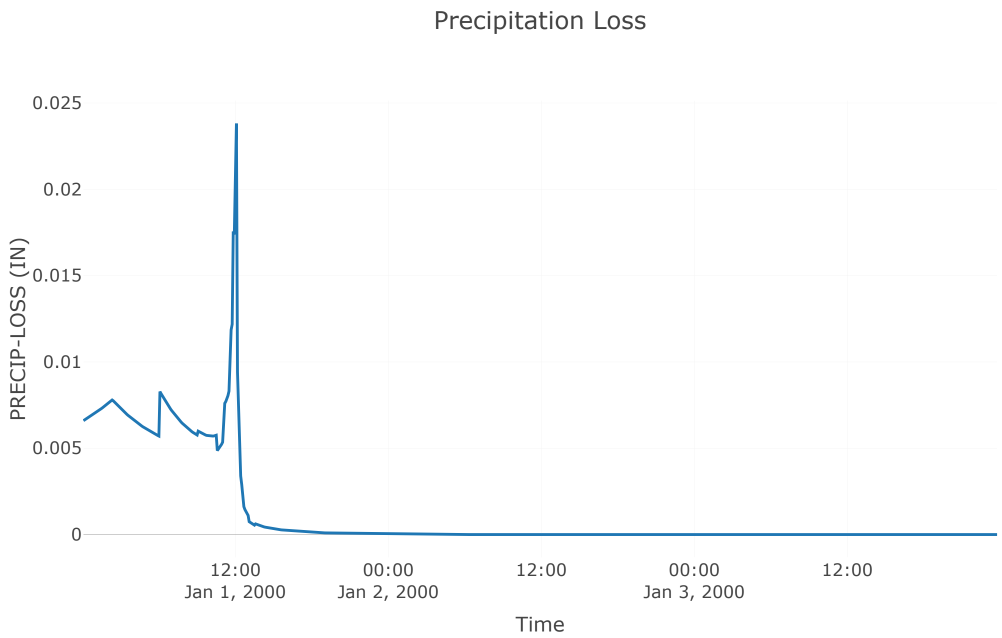
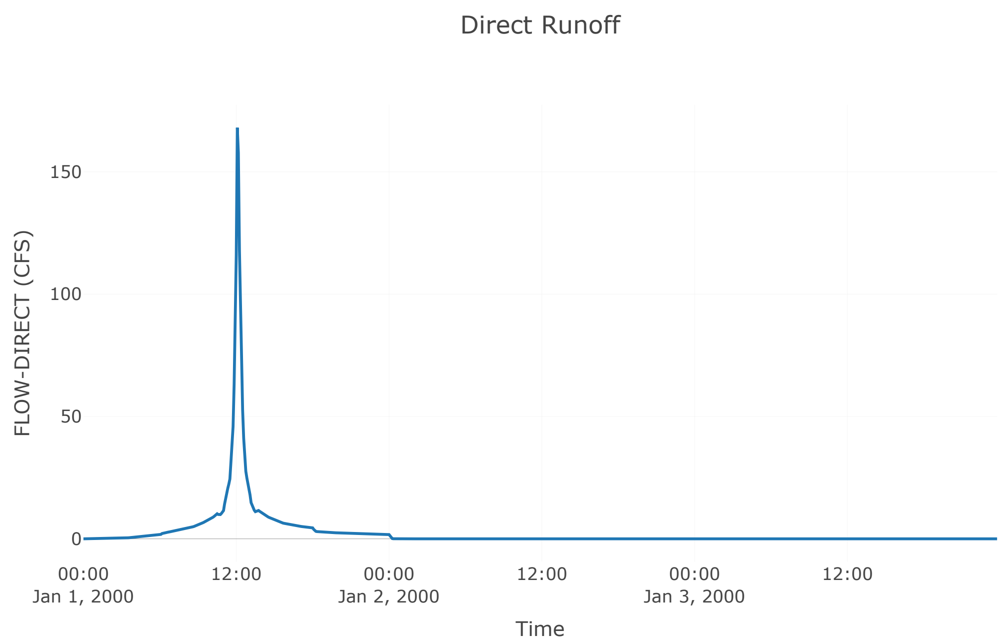
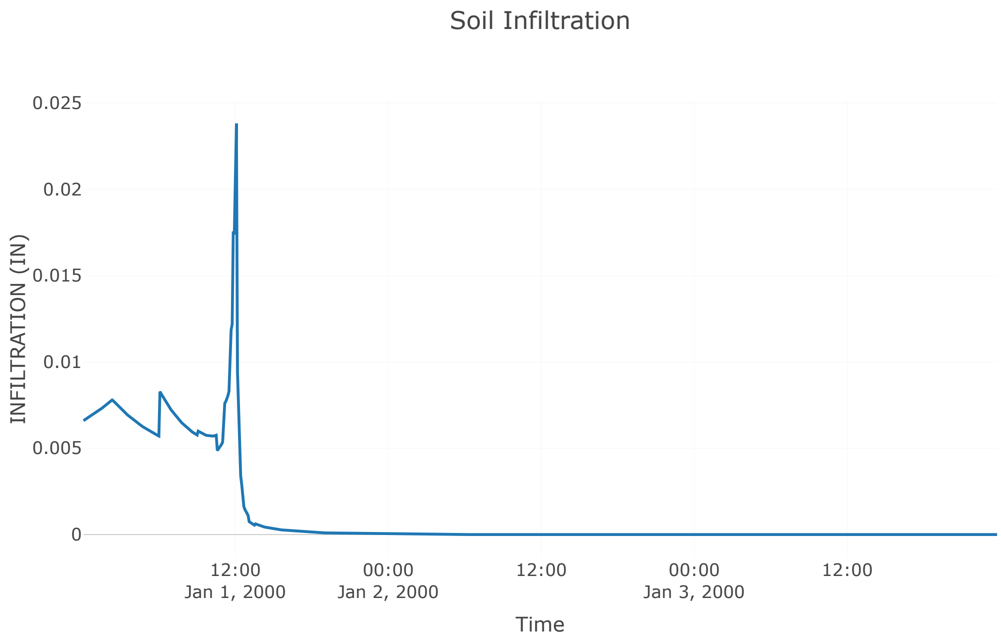
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
0
0.2
0.4
0.6
0.8
1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Precipitation Loss
0.025
0.02
0.015
0.01
0.005
0
PRECIP-LOSS (IN)
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Direct Runoff
150
100
50
0
FLOW-DIRECT (CFS)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Soil Infiltration
INFILTRATION (IN)
0.025
0.02
0.015
0.01
0.005
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Subbasin: toBottomAsh

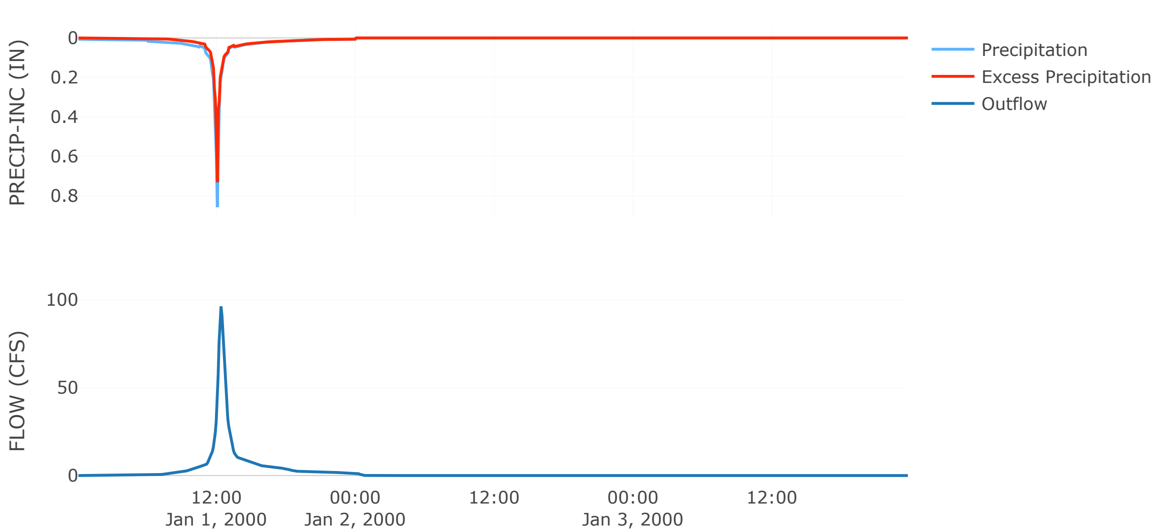
Area (ft²) : 0.03
Downstream : Bottom Ash Pond

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	77.8

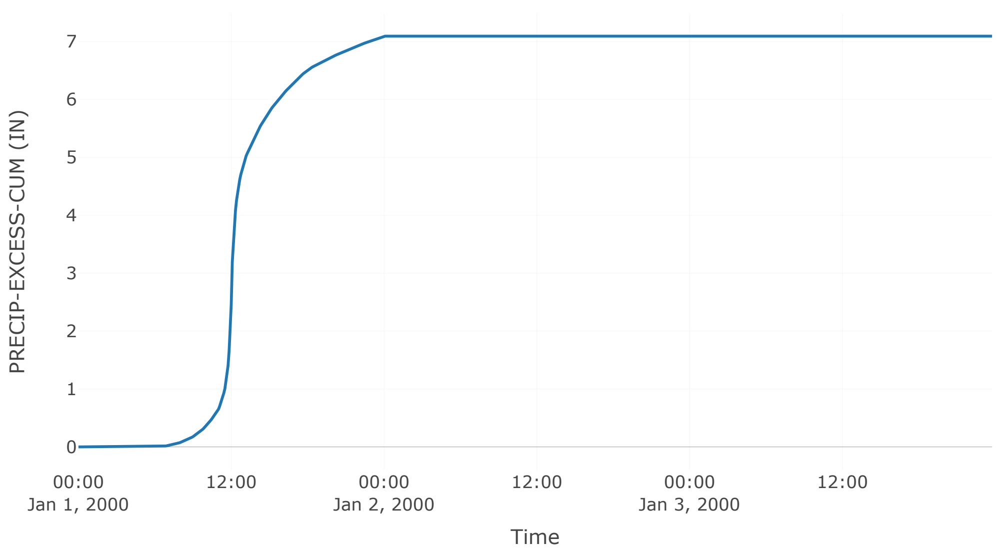
Transform: Scs	
Lag	16.51
Unitgraph Type	Standard

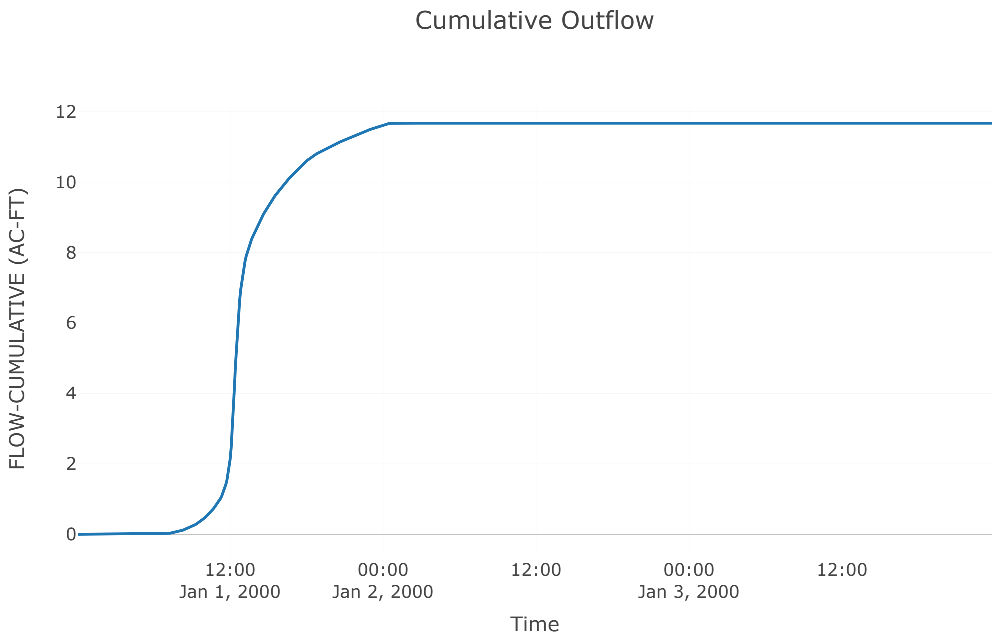
Results: toBottomAsh	
Peak Discharge (CFS)	96.13
Time of Peak Discharge	01Jan2000, 12:20
Volume (IN)	7.09
Precipitation Volume (AC - FT)	16.2
Loss Volume (AC - FT)	4.53
Excess Volume (AC - FT)	11.67
Direct Runoff Volume (AC - FT)	11.67
Baseflow Volume (AC - FT)	0

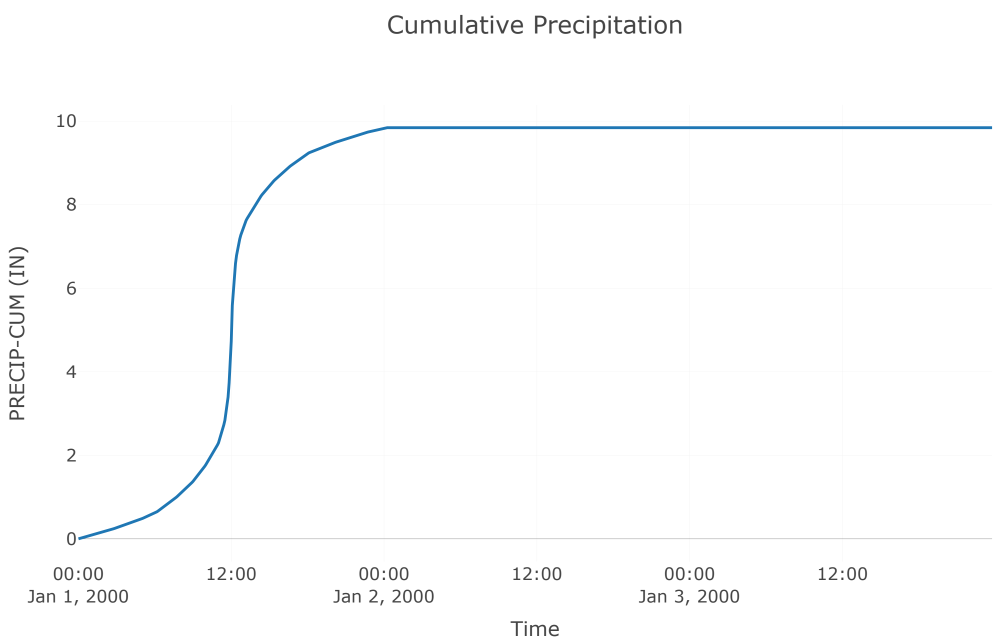
Precipitation and Outflow

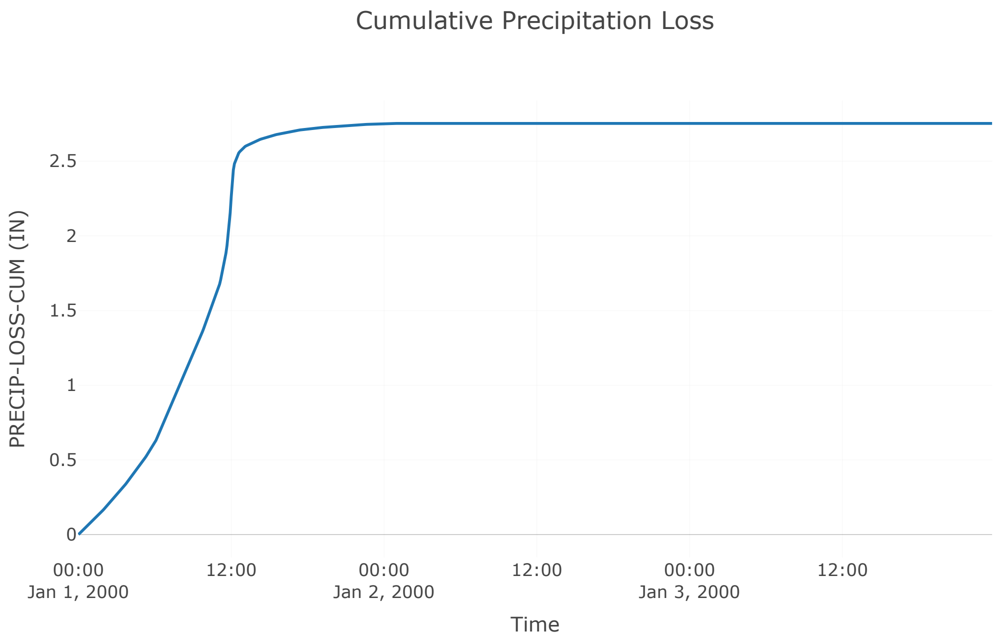


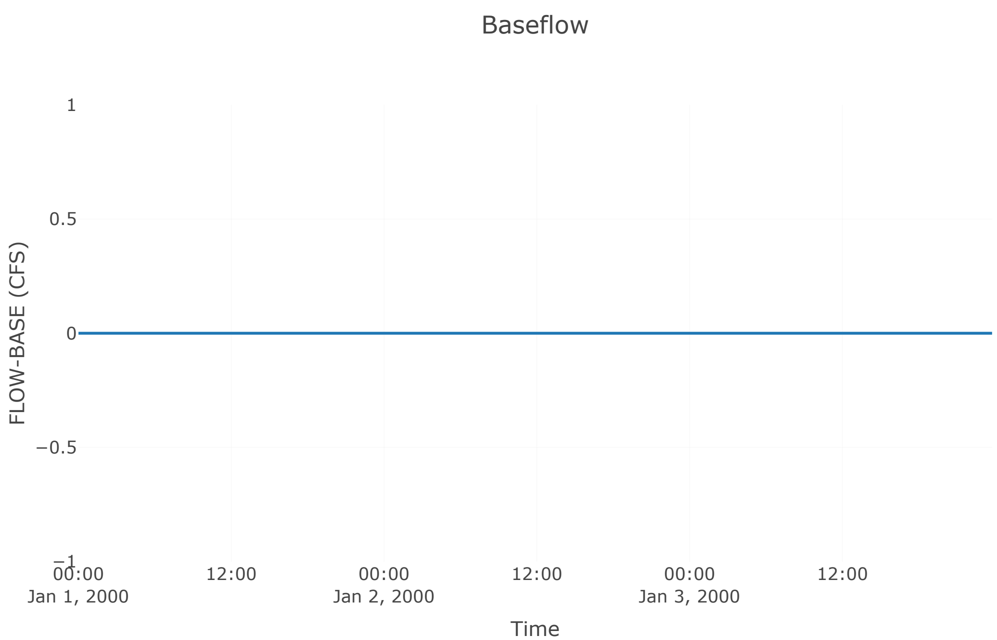
Cumulative Excess Precipitation

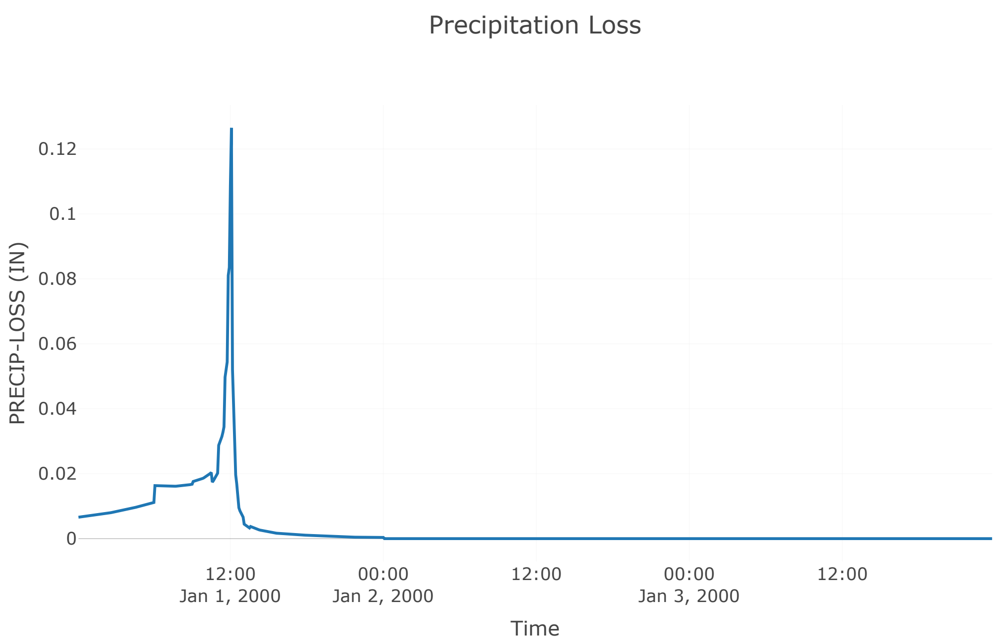


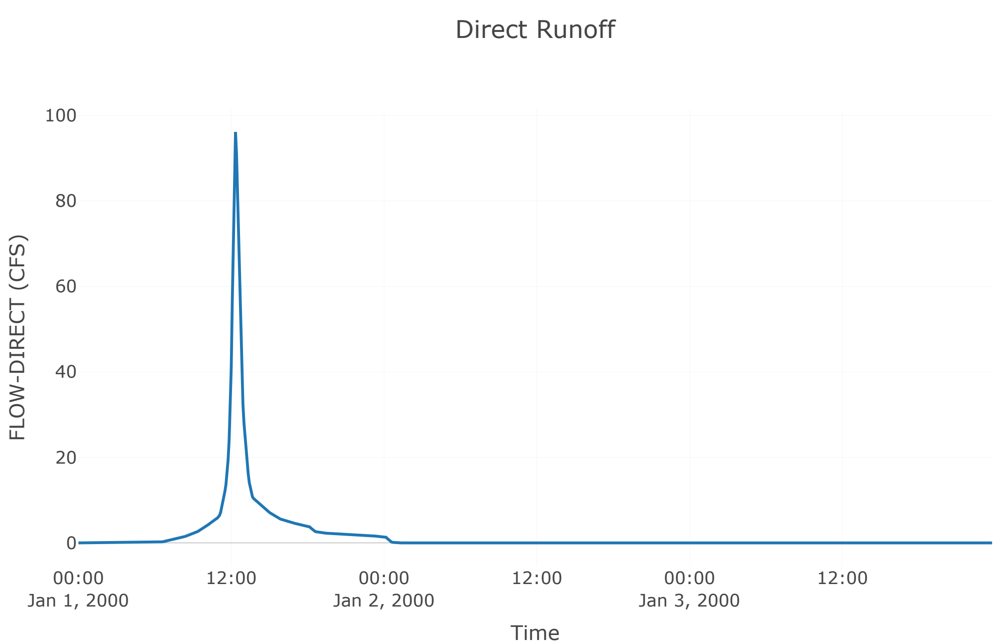

Cumulative Outflow
12
10
8
6
4
2
0
FLOW-CUMULATIVE (AC-FT)
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

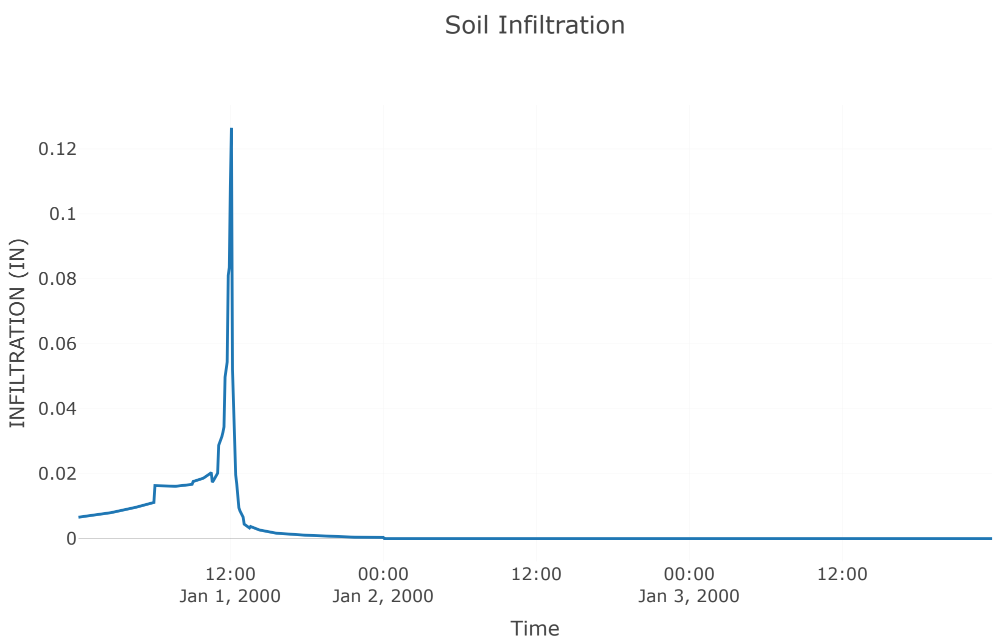

Cumulative Precipitation
10
8
6
4
2
0
PRECIP-CUM (IN)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.12
0.1
0.08
0.06
0.04
0.02
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Direct Runoff
FLOW-DIRECT (CFS)
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

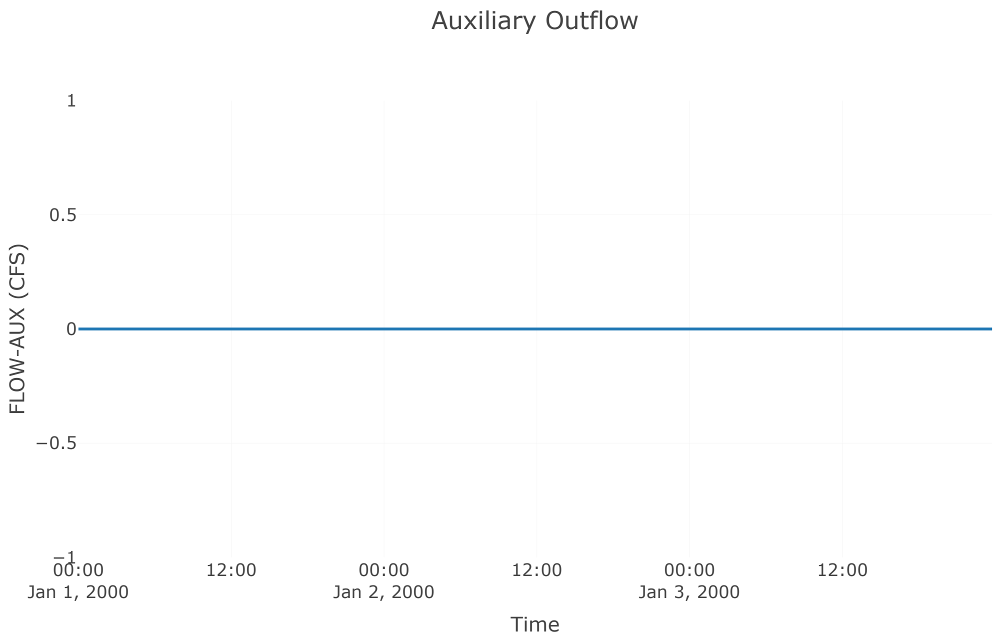

Soil Infiltration
INFILTRATION (IN)
0.12
0.1
0.08
0.06
0.04
0.02
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

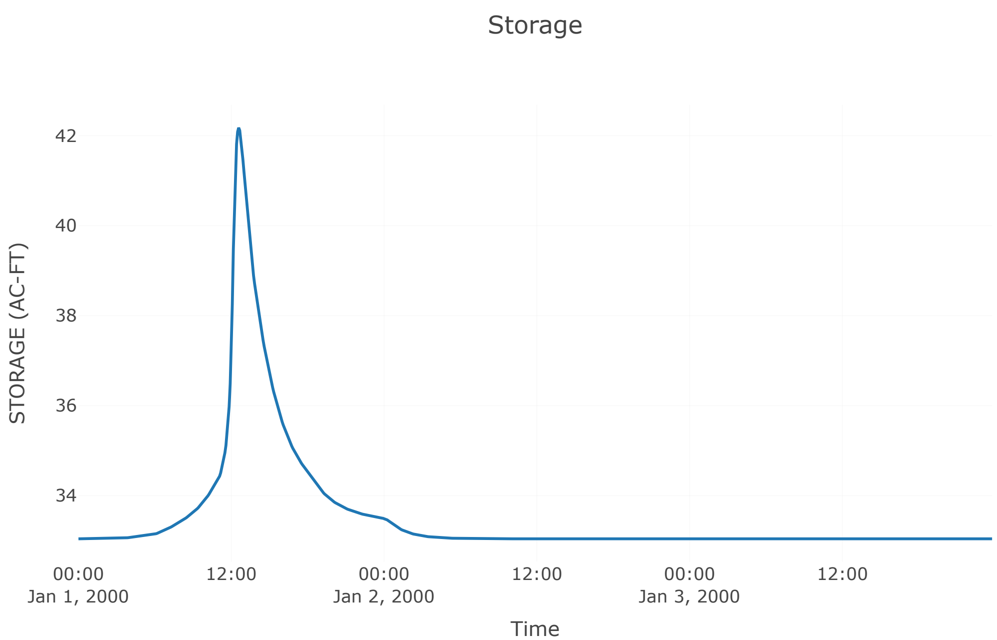
Reservoir: BottomAshPond

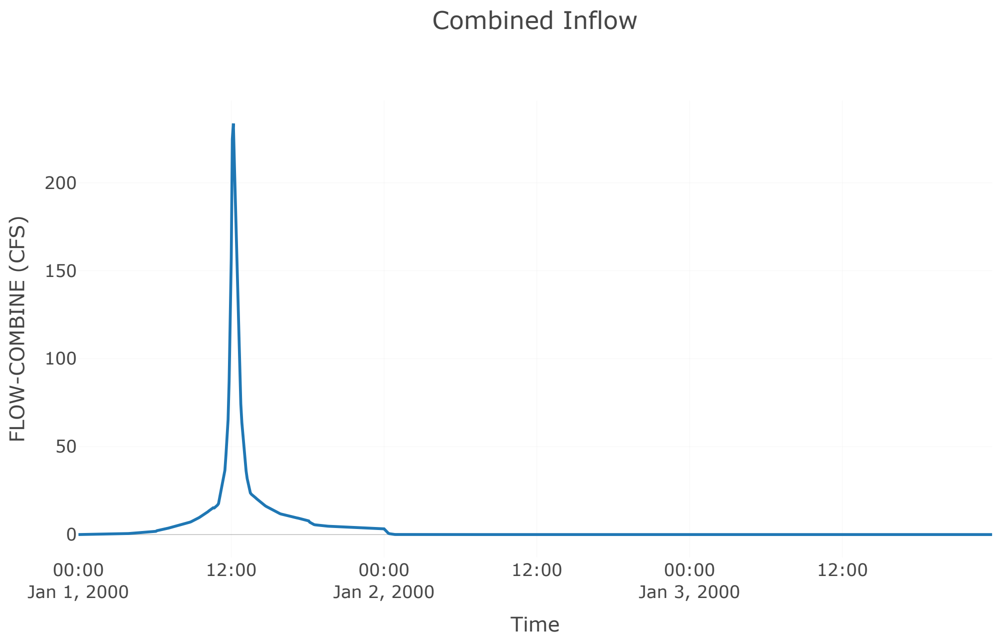
Downstream : Reach - 3

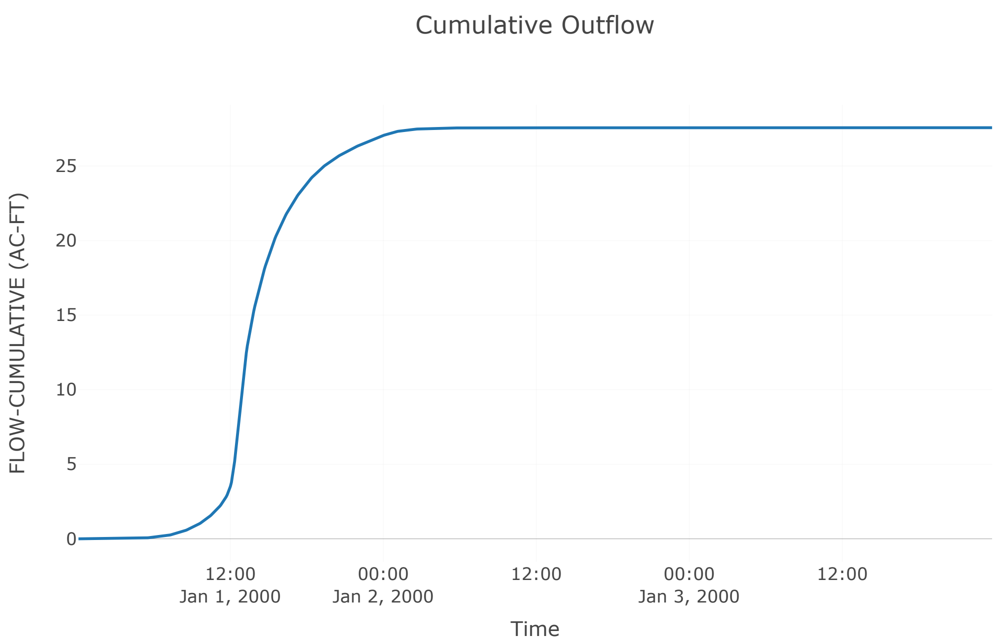
Results: BottomAshPond

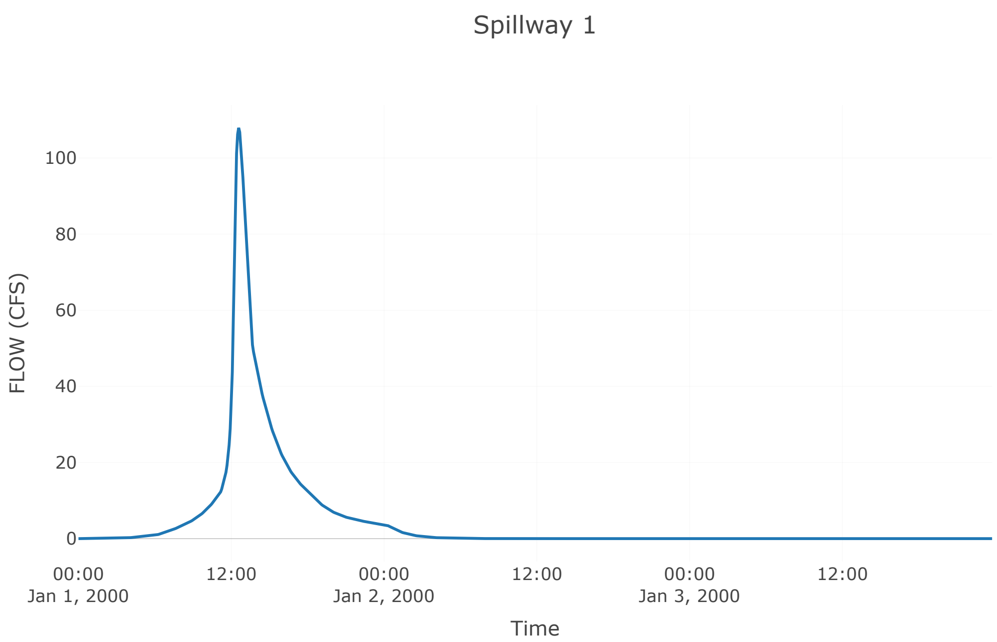
Peak Discharge (CFS)	107.92
Time of Peak Discharge	01Jan2000, 12:35
Volume (IN)	7.97
Peak Inflow (CFS)	233.78
Time of Peak Inflow	01Jan2000, 12:20
Inflow Volume (AC - FT)	27.56
Maximum Storage (AC - FT)	42.18
Peak Elevation (FT)	355.76
Discharge Volume (AC - FT)	27.57

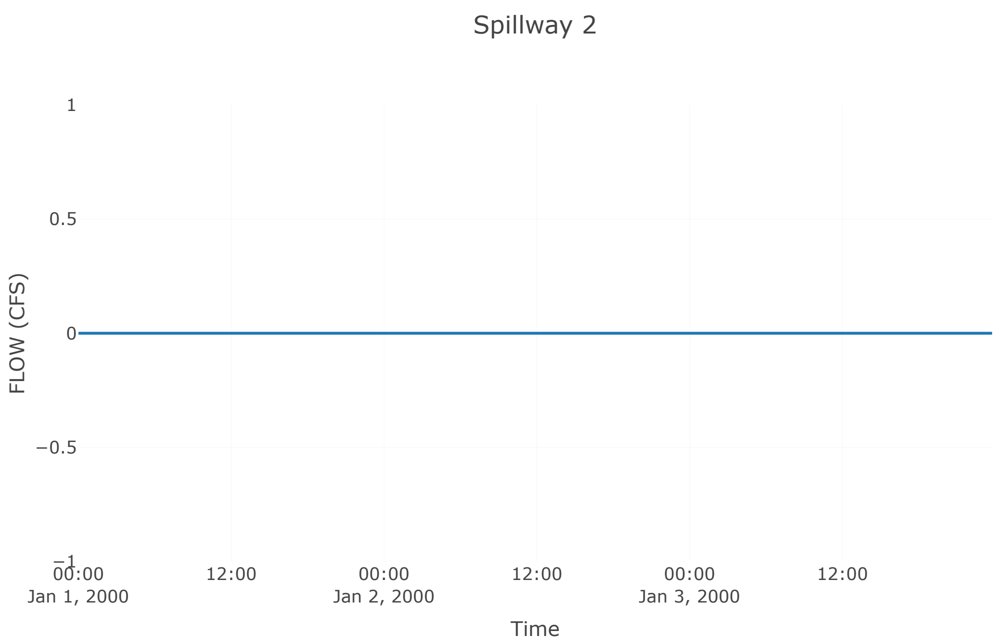

Auxiliary Outflow
1
0.5
0
−0.5
−1
FLOW-AUX (CFS)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

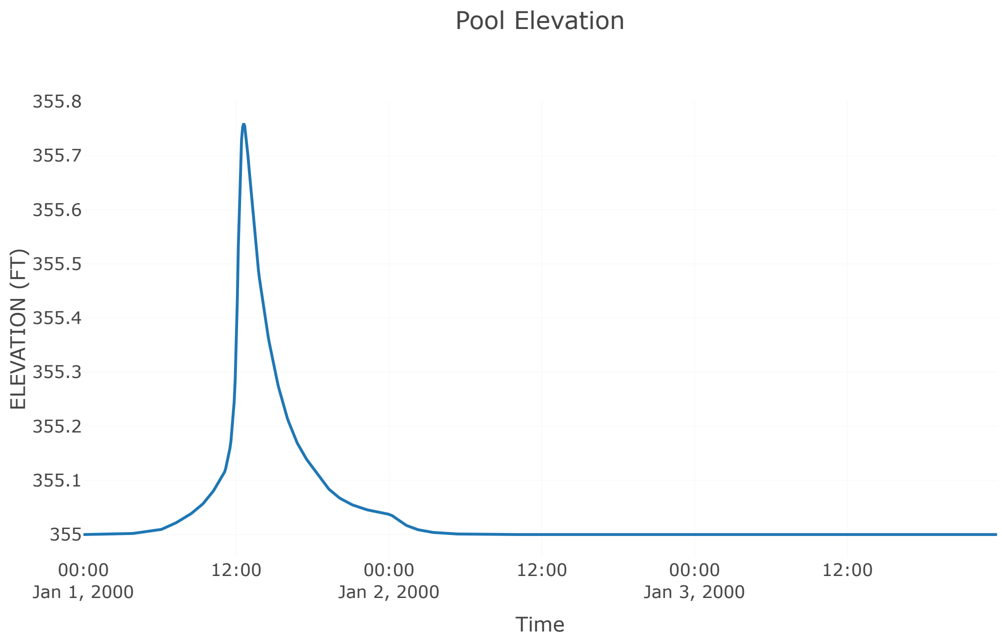

Storage
42
40
38
36
34
STORAGE (AC-FT)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

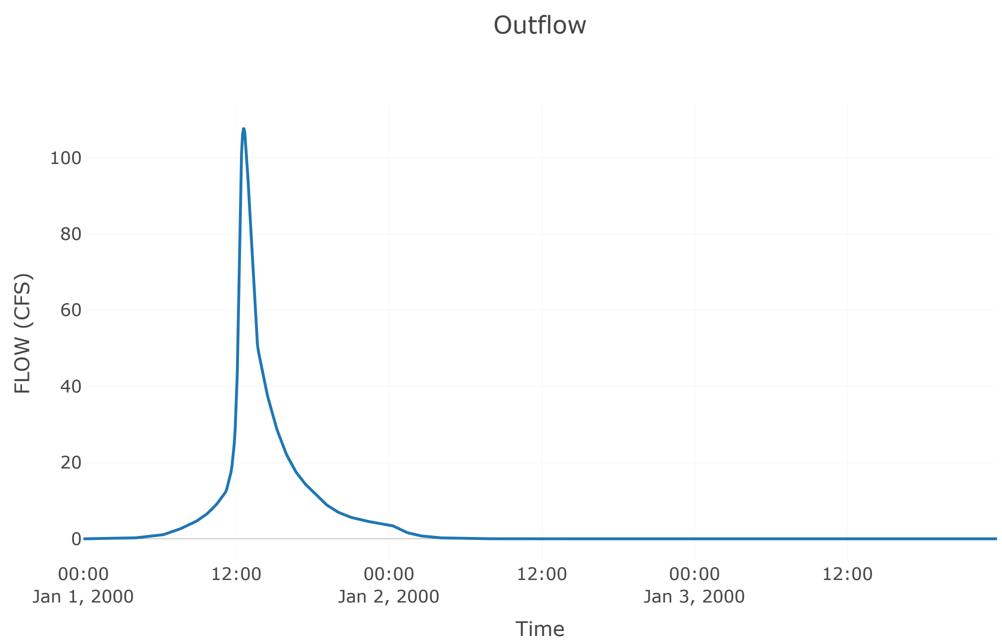

Combined Inflow
FLOW-COMBINE (CFS)
200
150
100
50
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
25
20
15
10
5
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Spillway 1
FLOW (CFS)
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Spillway 2
FLOW (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Pool Elevation
355.8
355.7
355.6
355.5
355.4
355.3
355.2
355.1
355
ELEVATION (FT)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Outflow
100
80
60
40
20
0
FLOW (CFS)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Reach: Reach-3

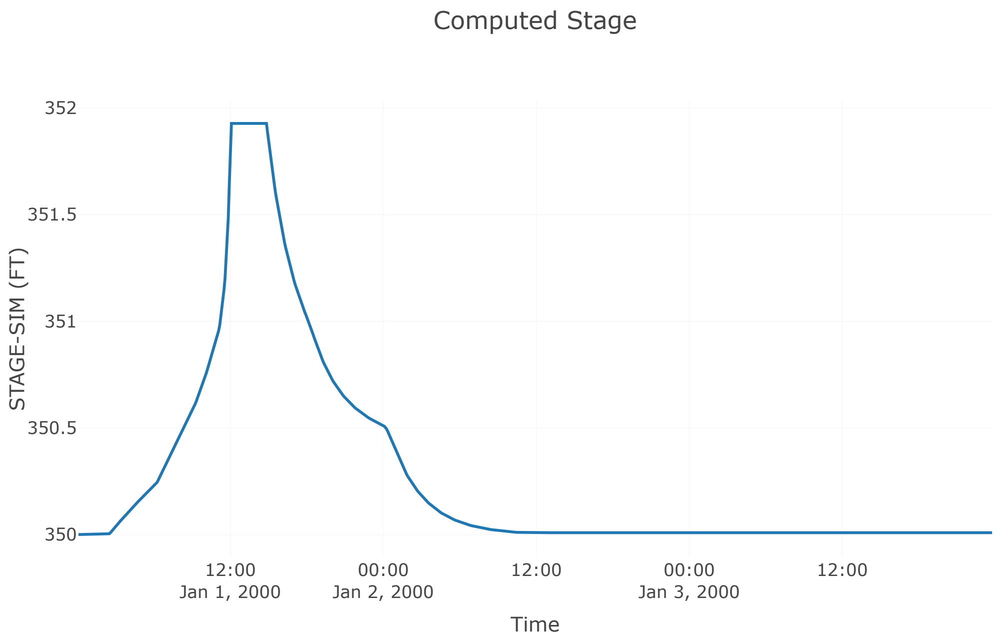
Downstream : Reach - 2

Route: Muskingum Cunge

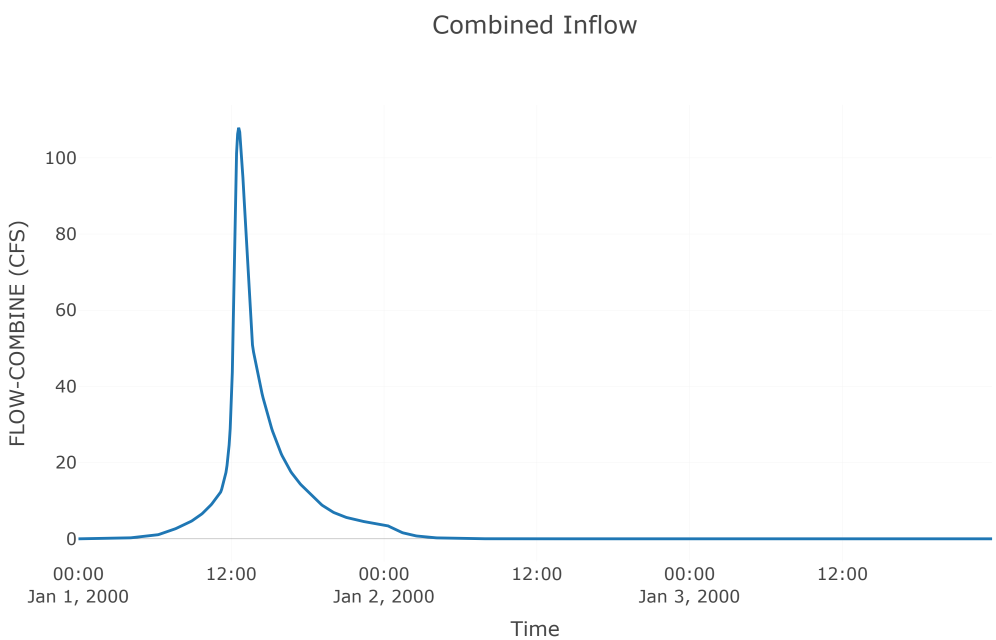
Method	Muskingum Cunge
Channel	Circular
Length (ft)	1460
Energy Slope	0
Mannings n	0.01
Diameter	2.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	5
Invert Elevation	350
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-3

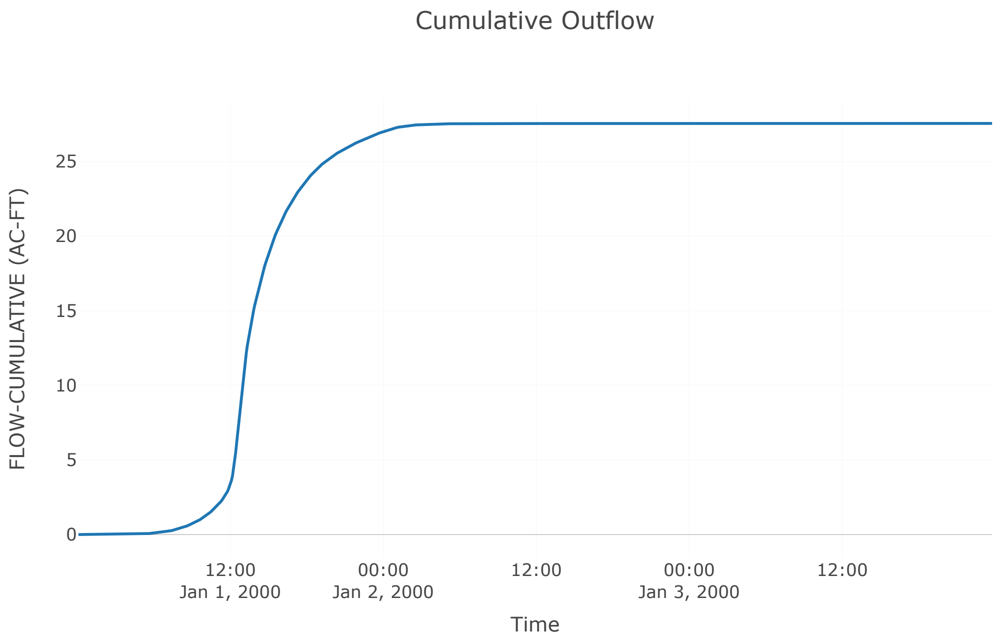
Peak Discharge (CFS)	107.22
Time of Peak Discharge	01Jan2000, 12:40
Volume (IN)	7.96
Peak Inflow (CFS)	107.92
Inflow Volume (AC - FT)	27.57

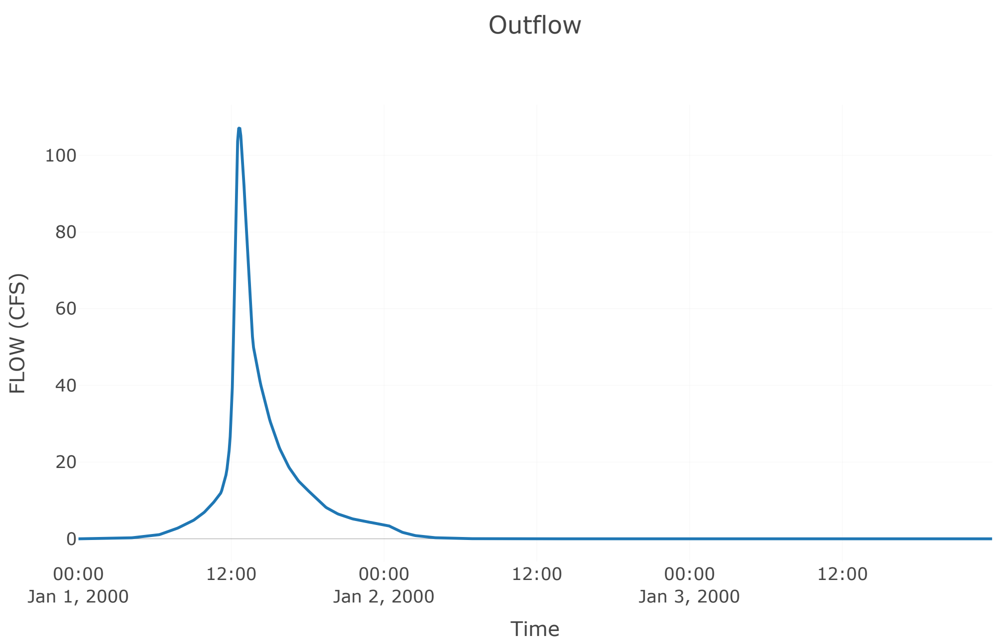


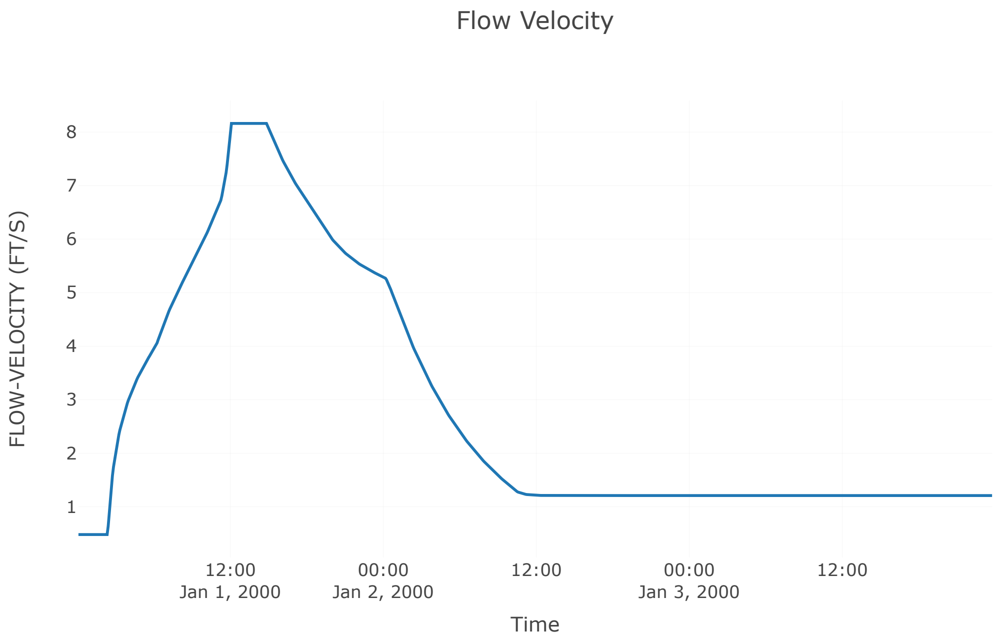
Computed Stage
352
351.5
351
350.5
350
STAGE-SIM (FT)
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time



Combined Inflow
100
80
60
40
20
0
FLOW-COMBINE (CFS)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
25
20
15
10
5
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Outflow
FLOW (CFS)
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Flow Velocity
FLOW-VELOCITY (FT/S)
8
7
6
5
4
3
2
1
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

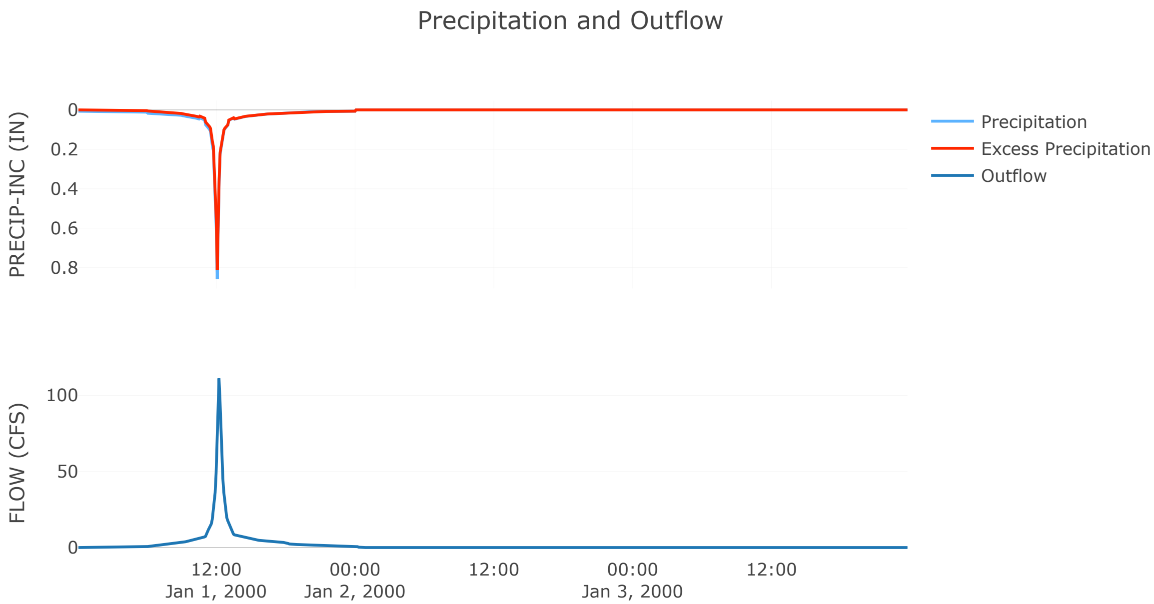
Subbasin: AshStorageB

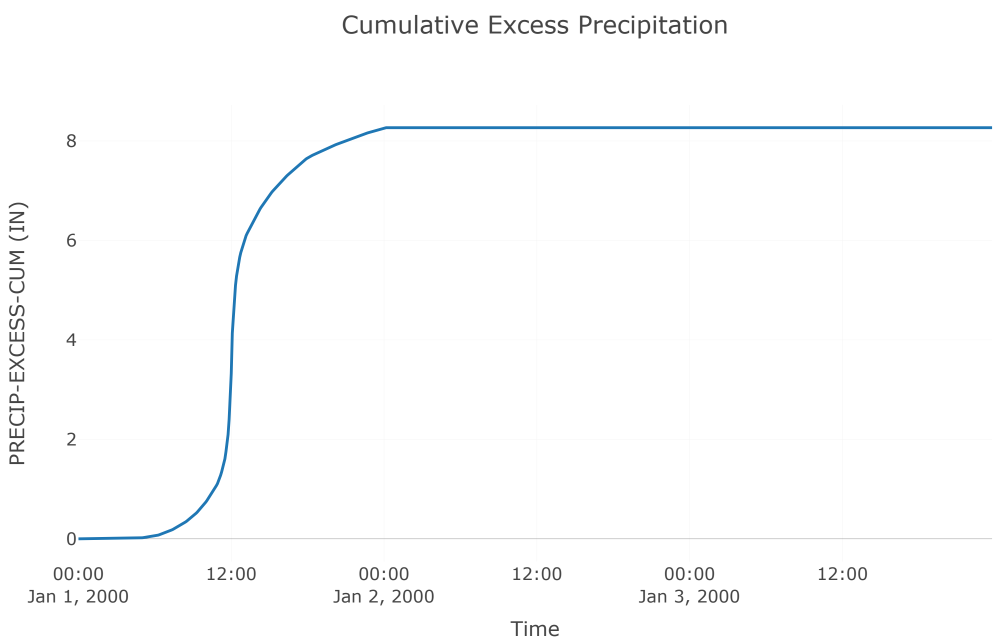
Area (ft²) : 0.02
Downstream : Reach - 2

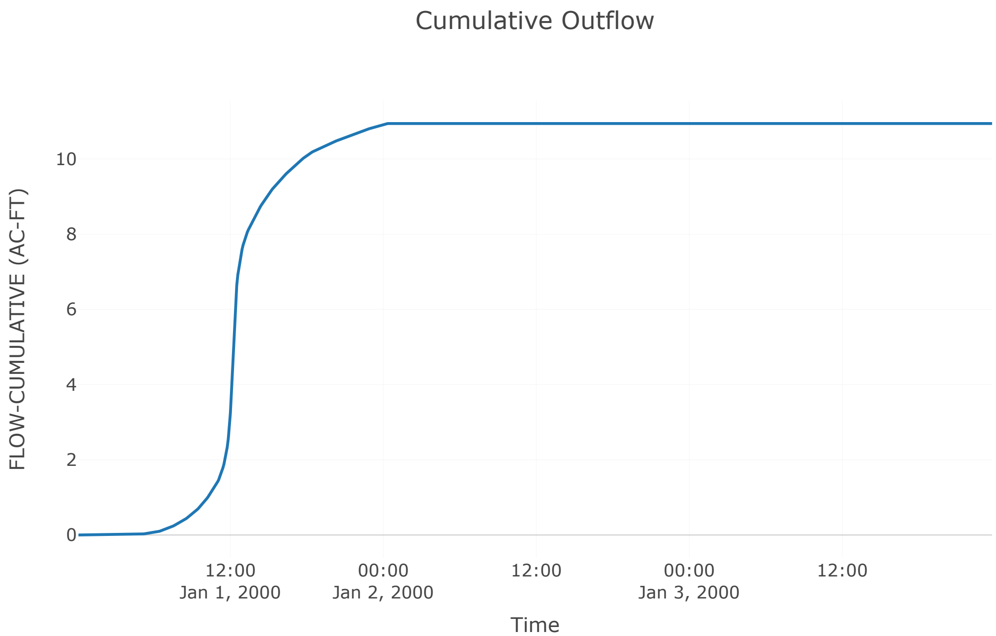
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	87.1

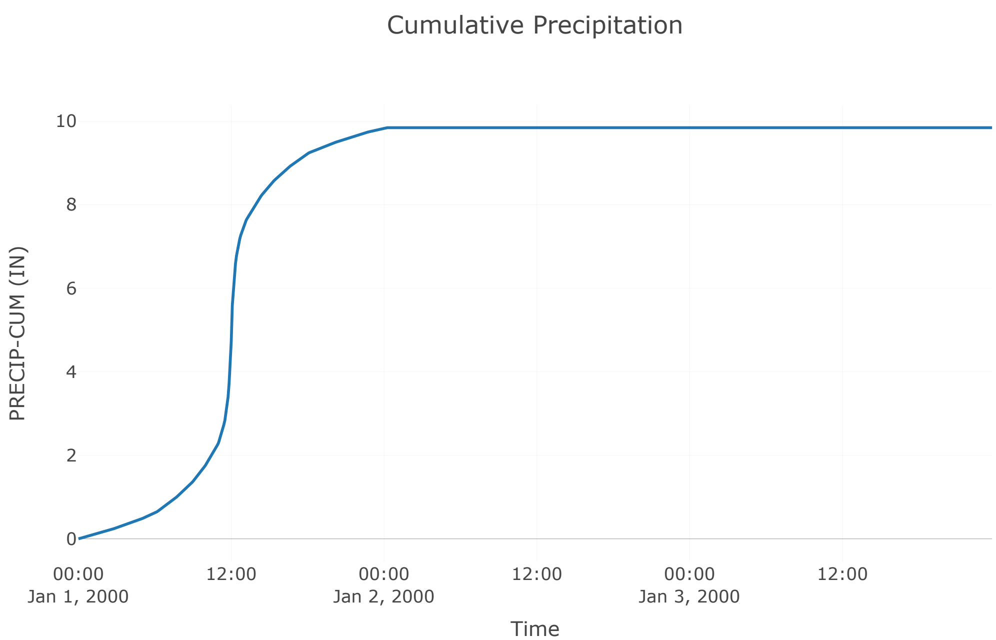
Transform: Scs	
Lag	7.51
Unitgraph Type	Standard

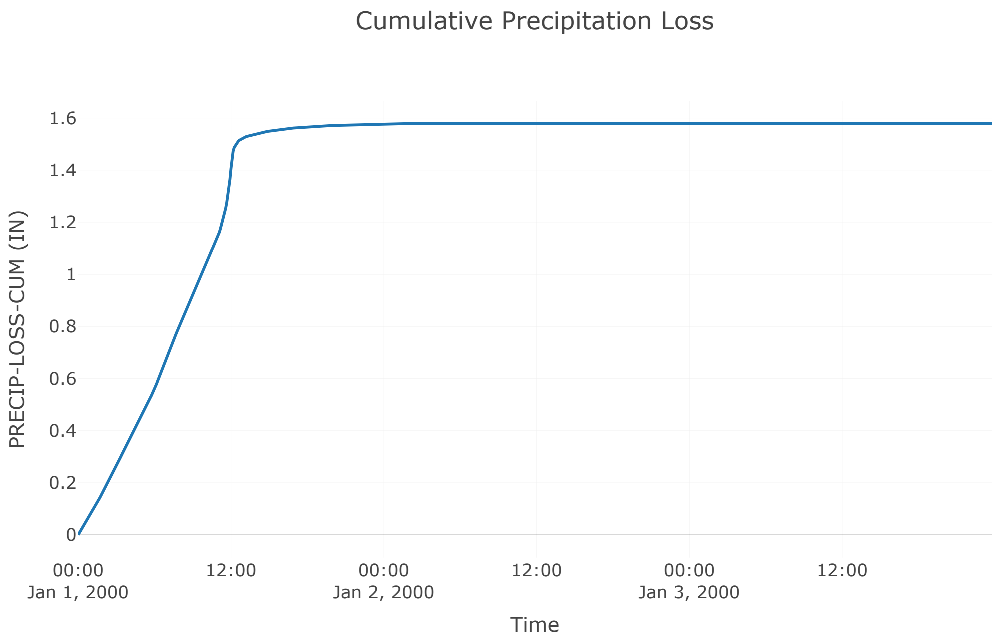
Results: AshStorageB	
Peak Discharge (CFS)	111.2
Time of Peak Discharge	01Jan2000, 12:10
Volume (IN)	8.27
Precipitation Volume (AC - FT)	13.03
Loss Volume (AC - FT)	2.09
Excess Volume (AC - FT)	10.94
Direct Runoff Volume (AC - FT)	10.94
Baseflow Volume (AC - FT)	0

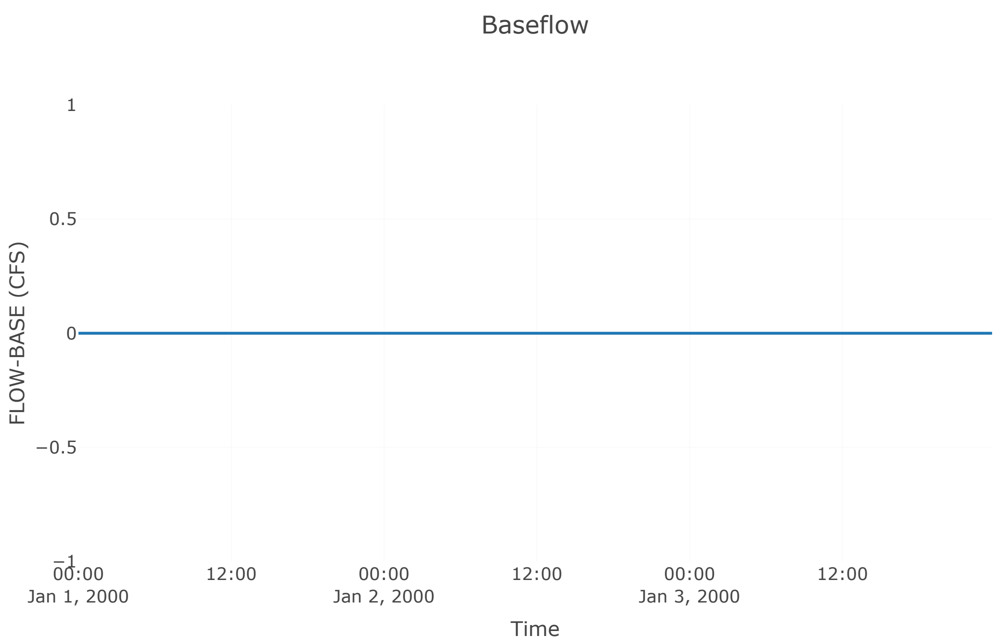

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
100
50
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00

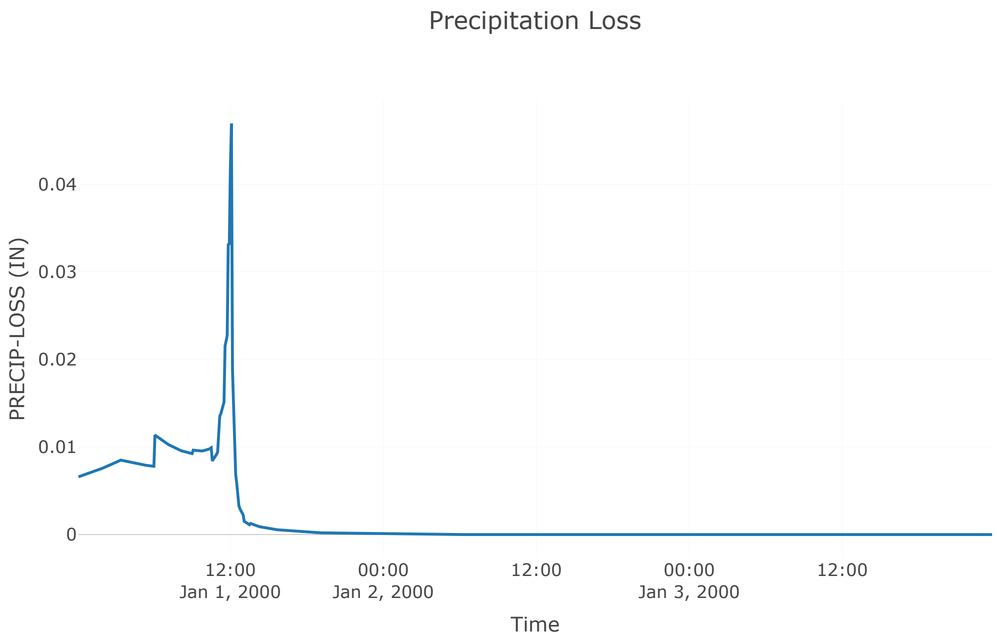

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
8
6
4
2
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

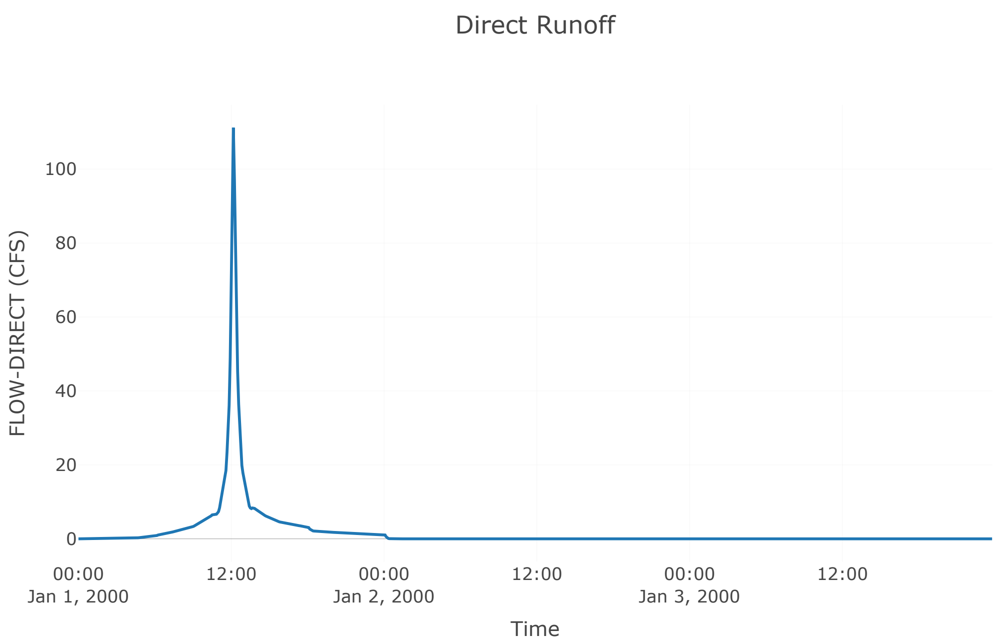

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
2
4
6
8
10
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

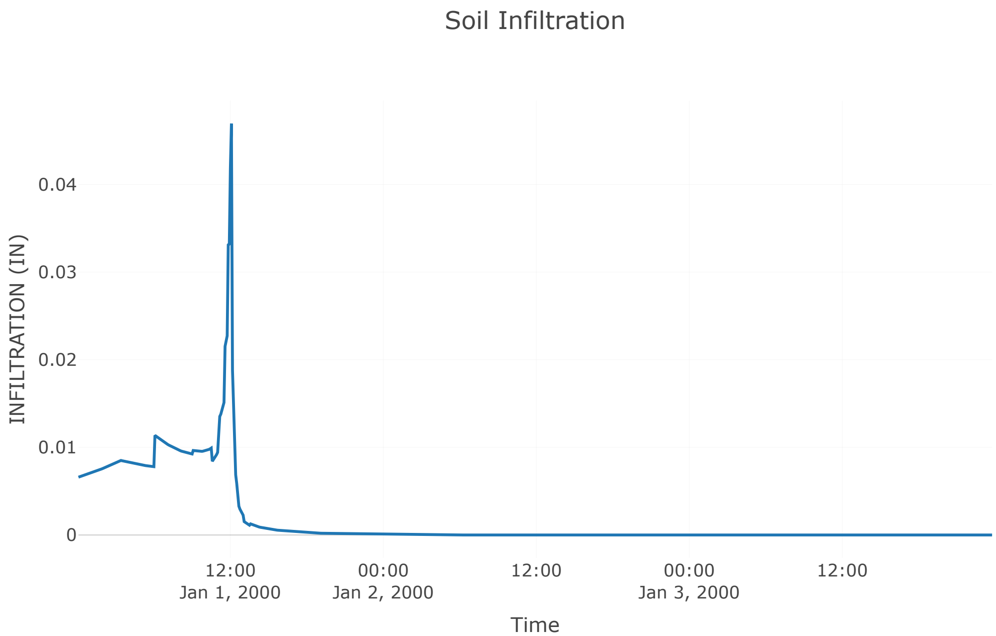

Cumulative Precipitation
PRECIP-CUM (IN)
0
2
4
6
8
10
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Direct Runoff
FLOW-DIRECT (CFS)
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Soil Infiltration
INFILTRATION (IN)
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Reach: Reach-2

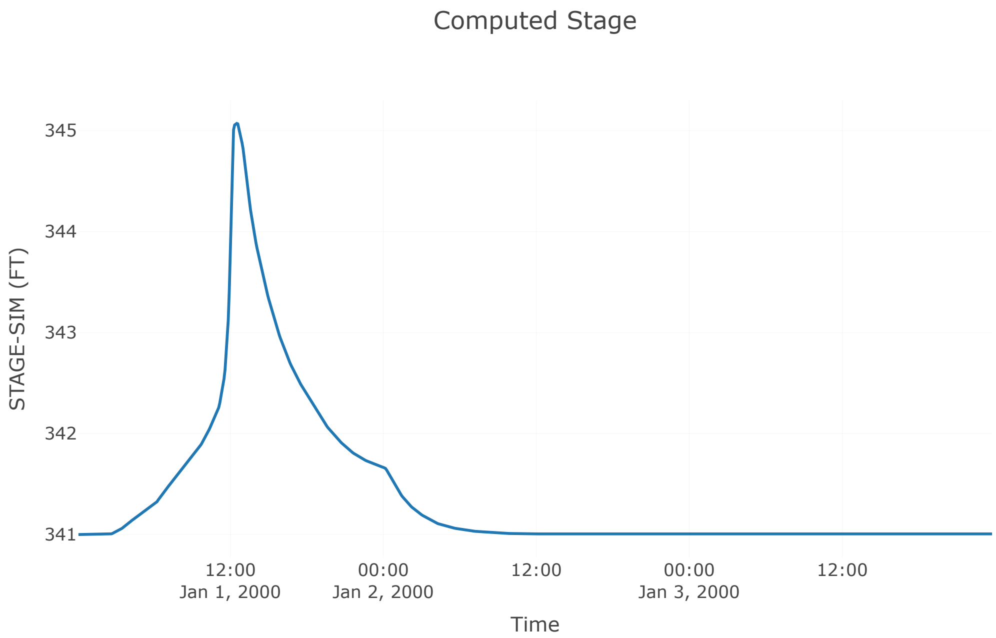
Downstream : Ash Culvert

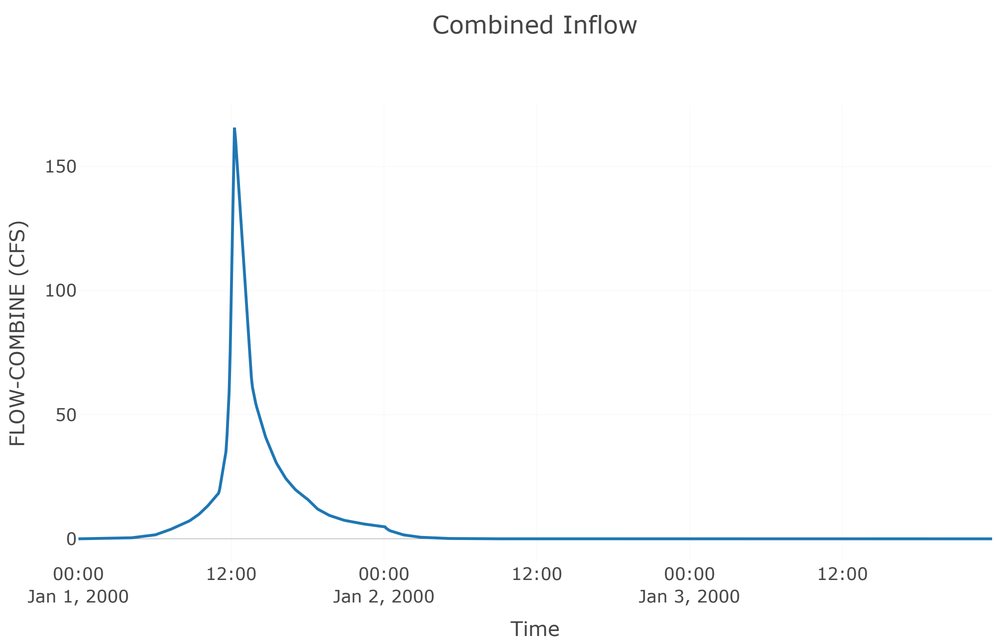
Route: Muskingum Cunge

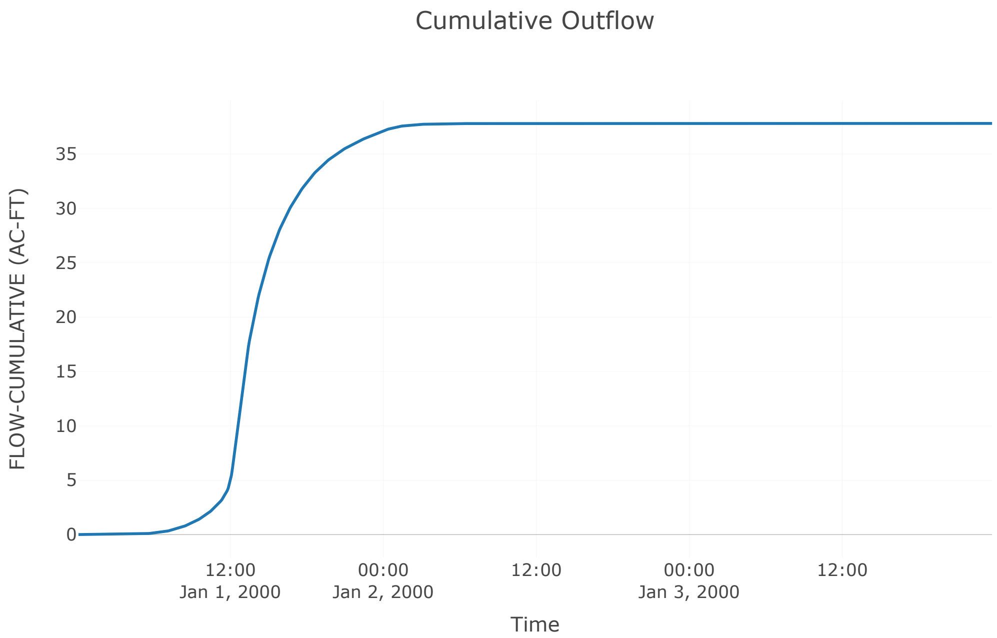
Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	1430
Energy Slope	0
Mannings n	0.08
Bottom Width	26.46
Side Slope	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	5
Invert Elevation	341
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-2

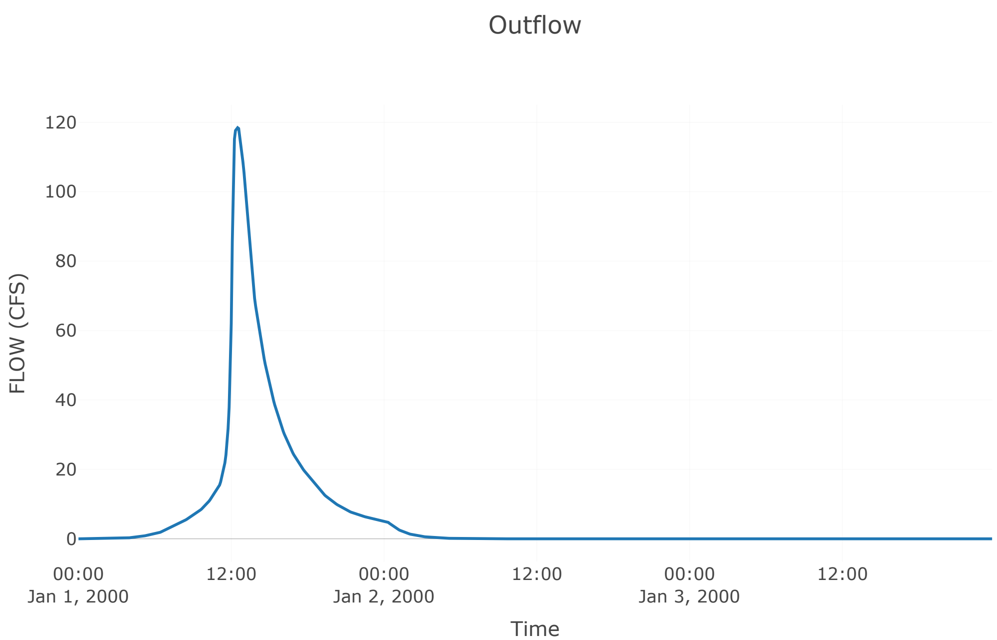
Peak Discharge (CFS)	118.43
Time of Peak Discharge	01Jan2000, 12:30
Volume (IN)	7.9
Peak Inflow (CFS)	165.7
Inflow Volume (AC - FT)	38.5


Computed Stage
STAGE-SIM (FT)
345
344
343
342
341
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

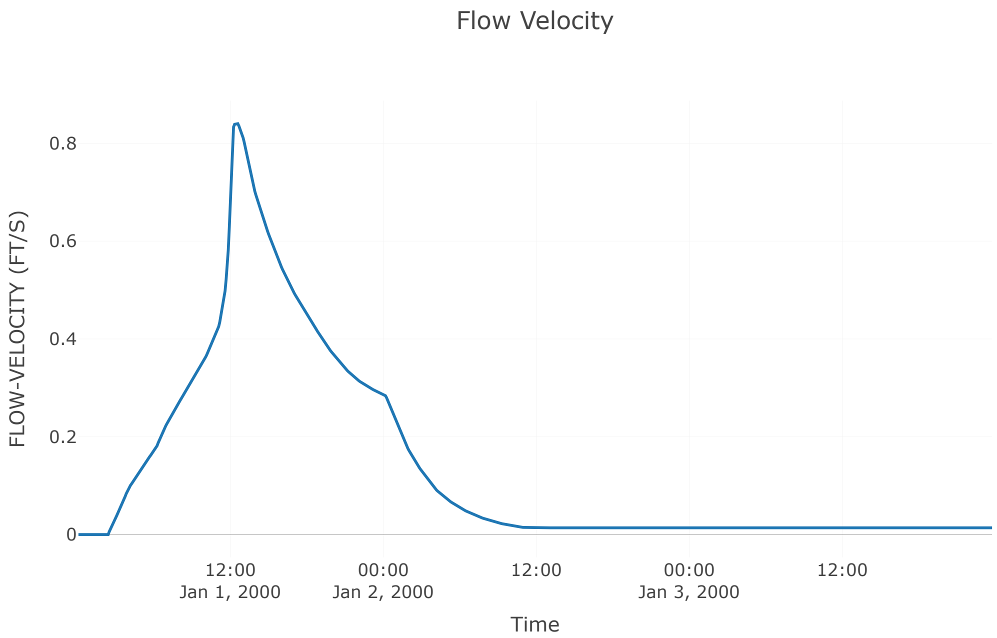

Combined Inflow
FLOW-COMBINE (CFS)
150
100
50
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time



Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
35
30
25
20
15
10
5
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time



Outflow
FLOW (CFS)
120
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Flow Velocity
FLOW-VELOCITY (FT/S)
0.8
0.6
0.4
0.2
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Subbasin: AshStorageA

Area (ft²) : 0.03
Downstream : Ash Culvert

Loss Rate: Scs

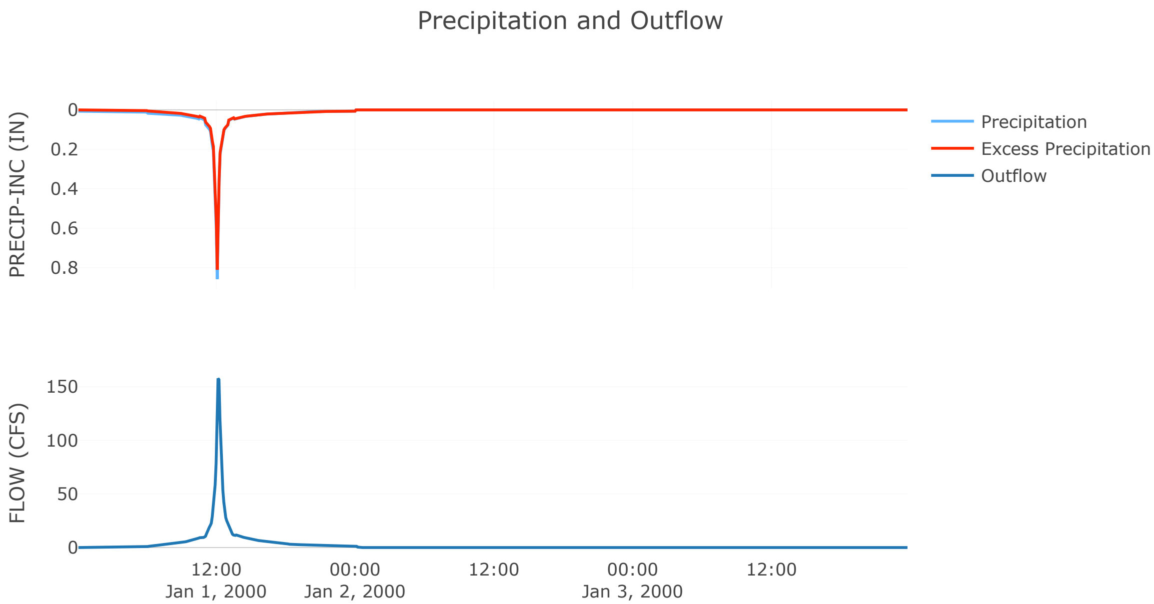
Percent Impervious Area	0
Curve Number	87.1

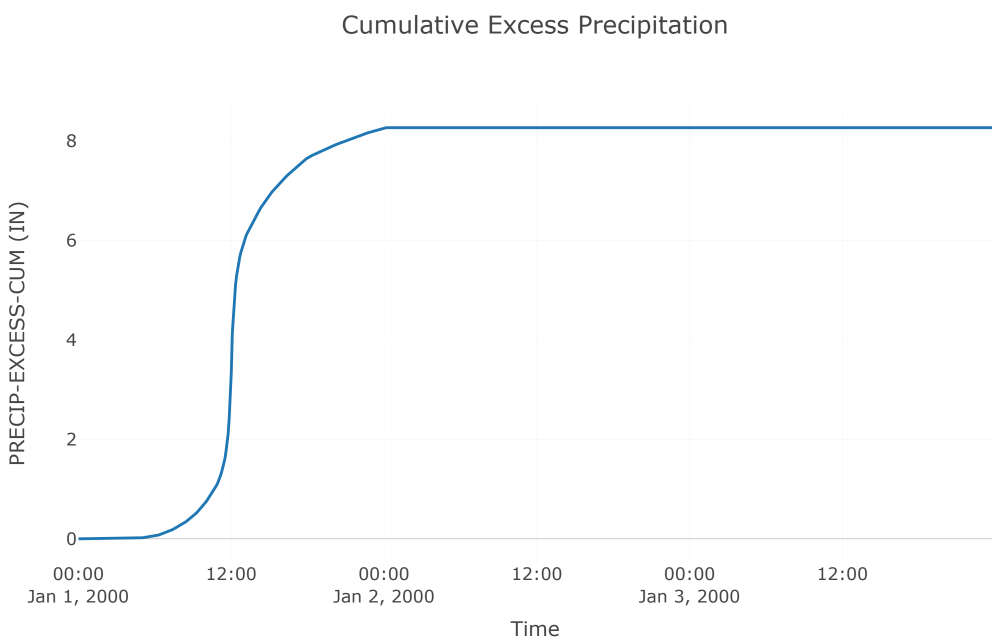
Transform: Scs

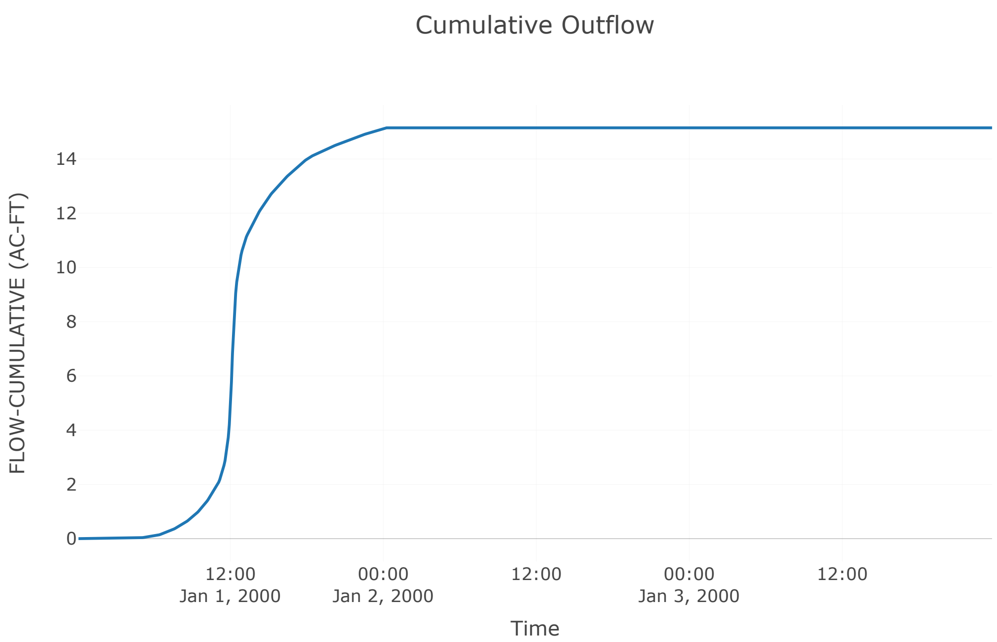
Lag	5.28
Unitgraph Type	Standard

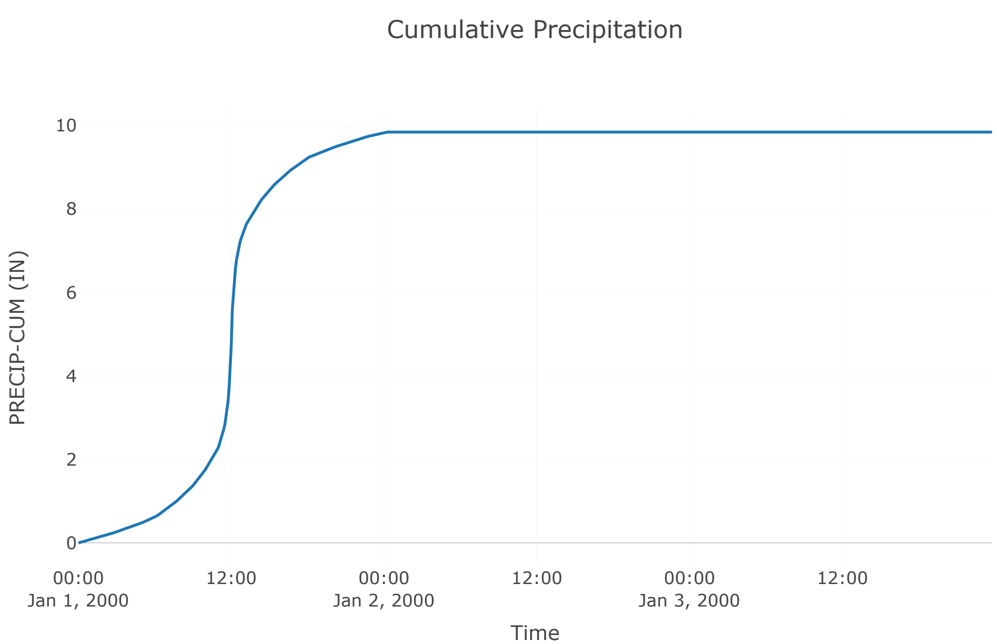
Results: AshStorageA

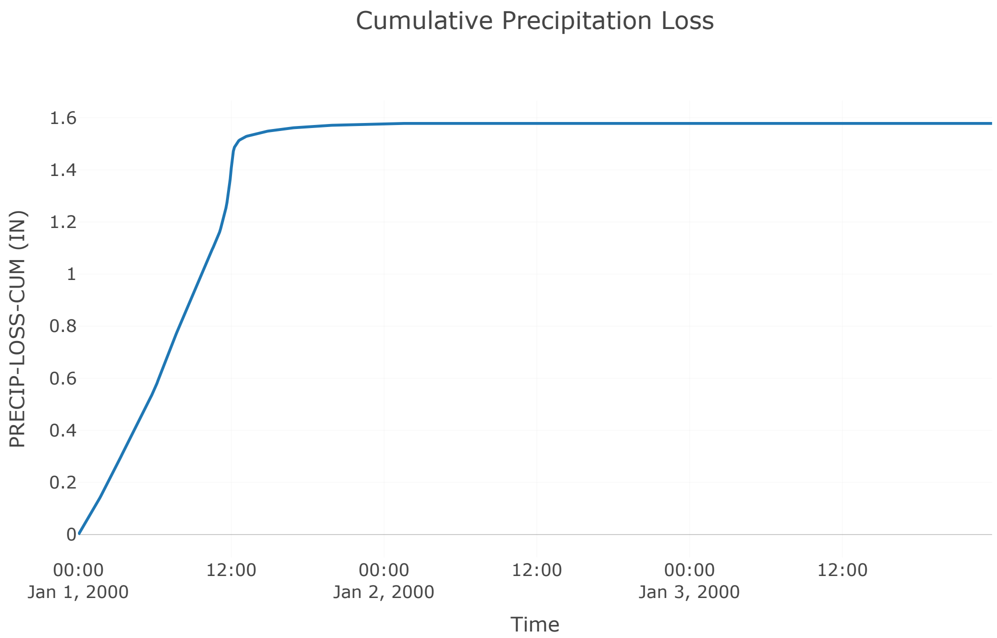
Peak Discharge (CFS)	157.92
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	8.27
Precipitation Volume (AC - FT)	18.04
Loss Volume (AC - FT)	2.89
Excess Volume (AC - FT)	15.15
Direct Runoff Volume (AC - FT)	15.15
Baseflow Volume (AC - FT)	0

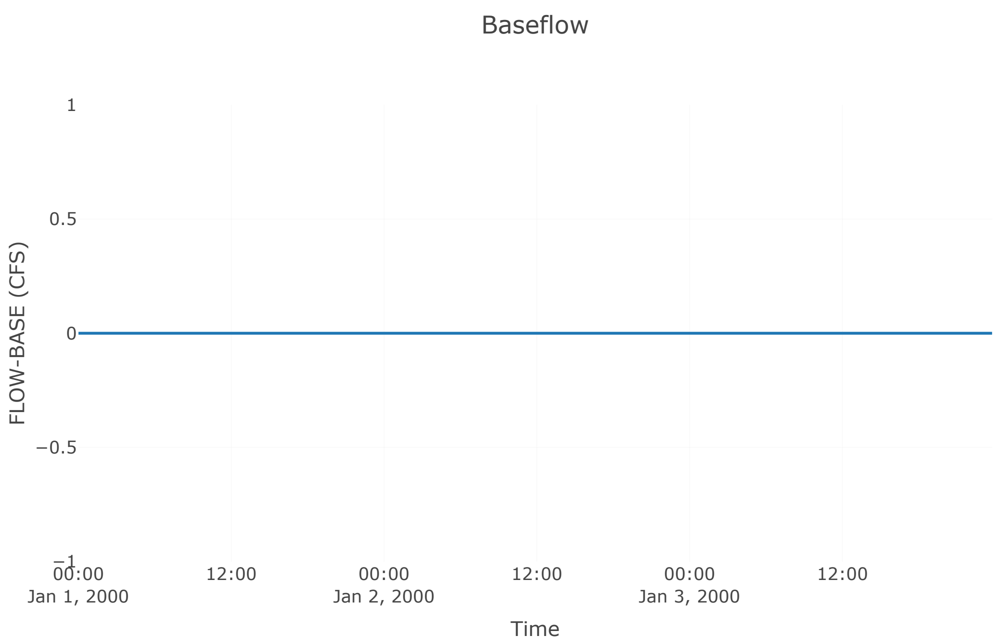

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
150
100
50
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00

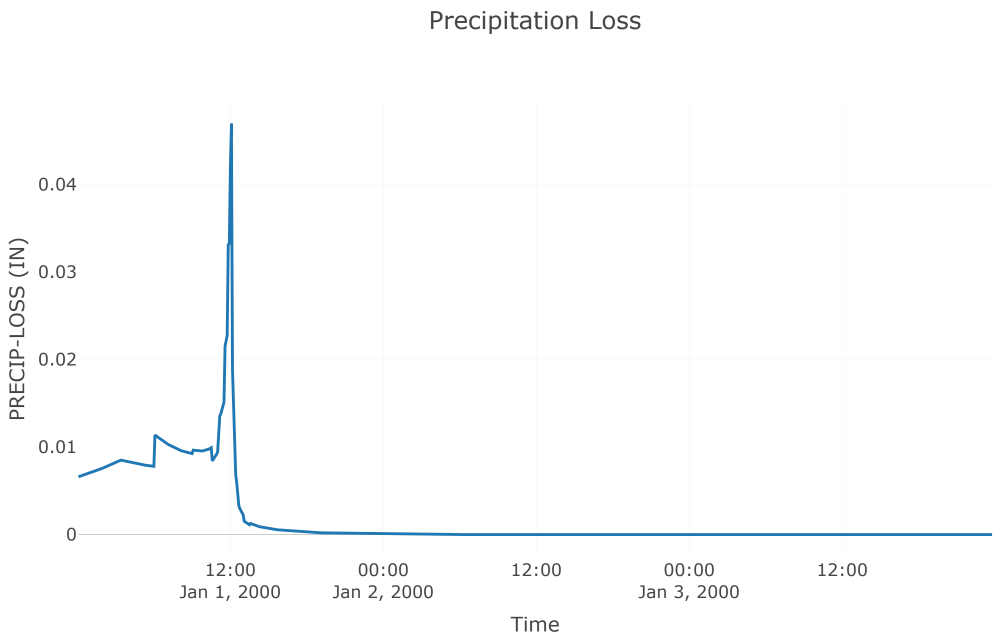

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
8
6
4
2
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

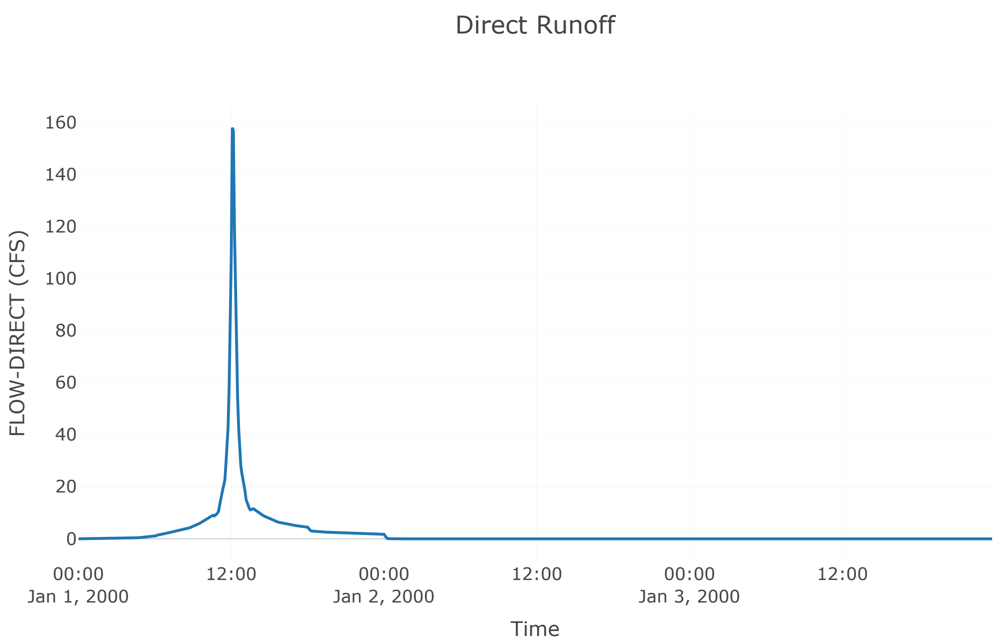

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
2
4
6
8
10
12
14
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

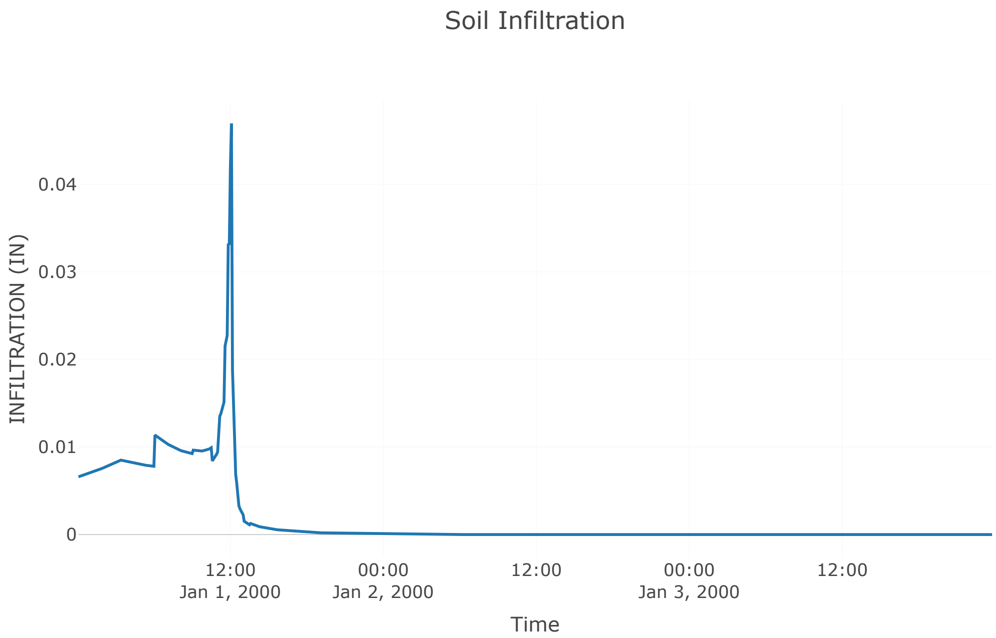

Cumulative Precipitation
PRECIP-CUM (IN)
0
2
4
6
8
10
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Direct Runoff
FLOW-DIRECT (CFS)
160
140
120
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

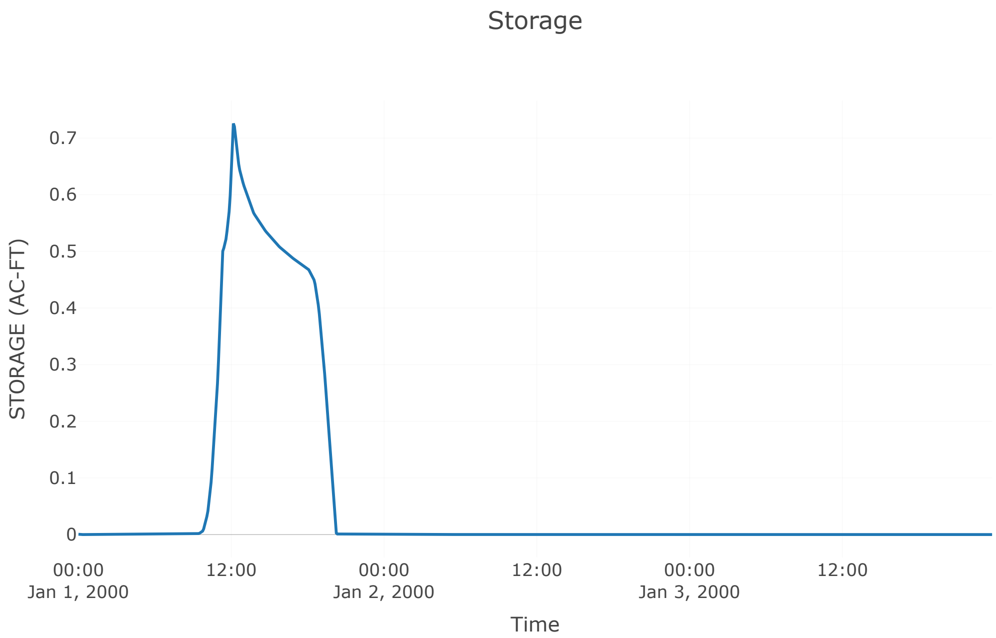

Soil Infiltration
INFILTRATION (IN)
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

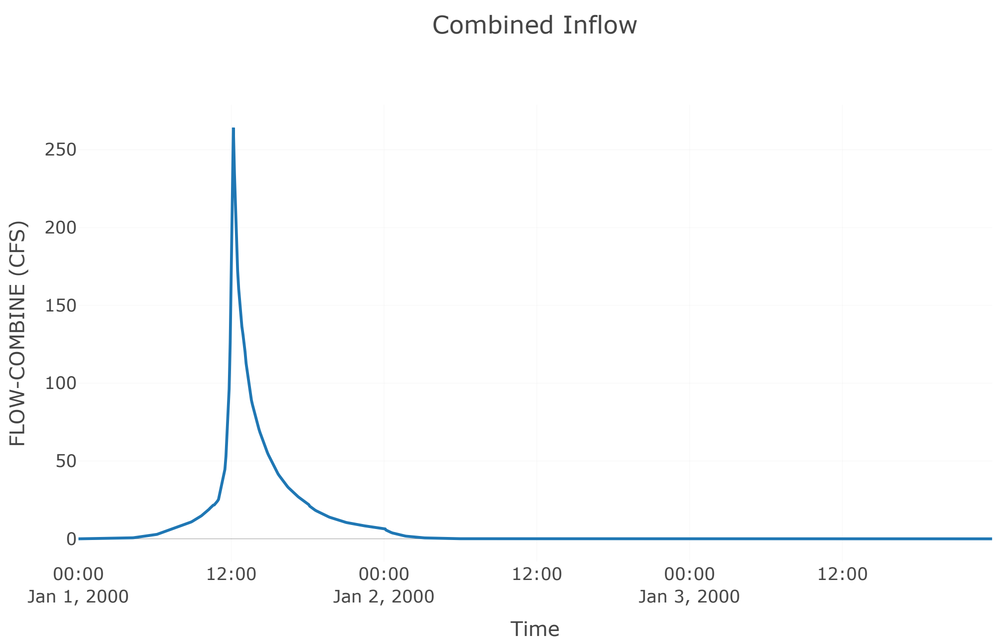
Reservoir: AshCulvert

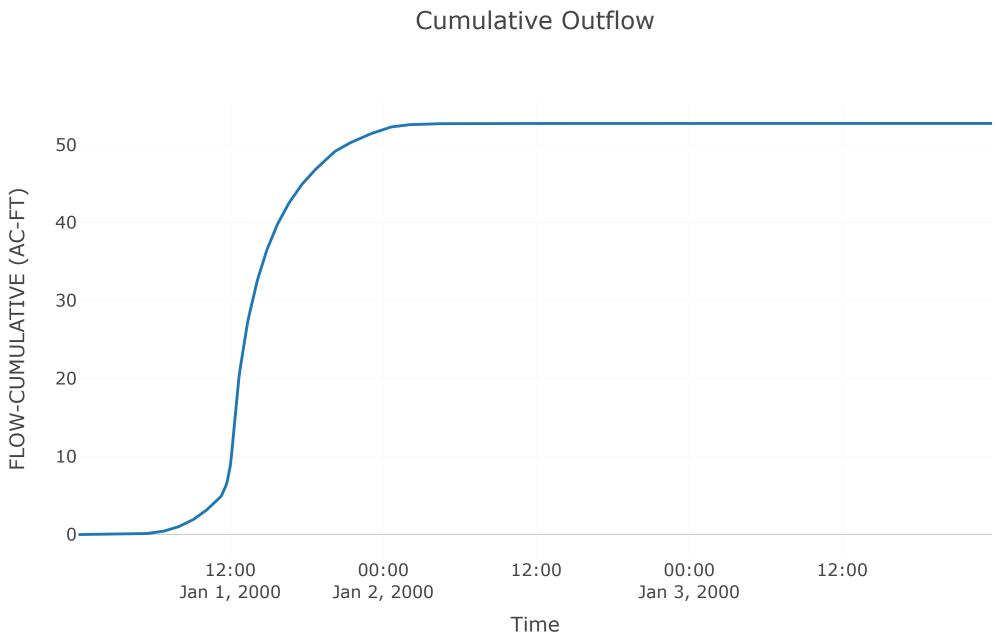
Downstream : Primary Pond

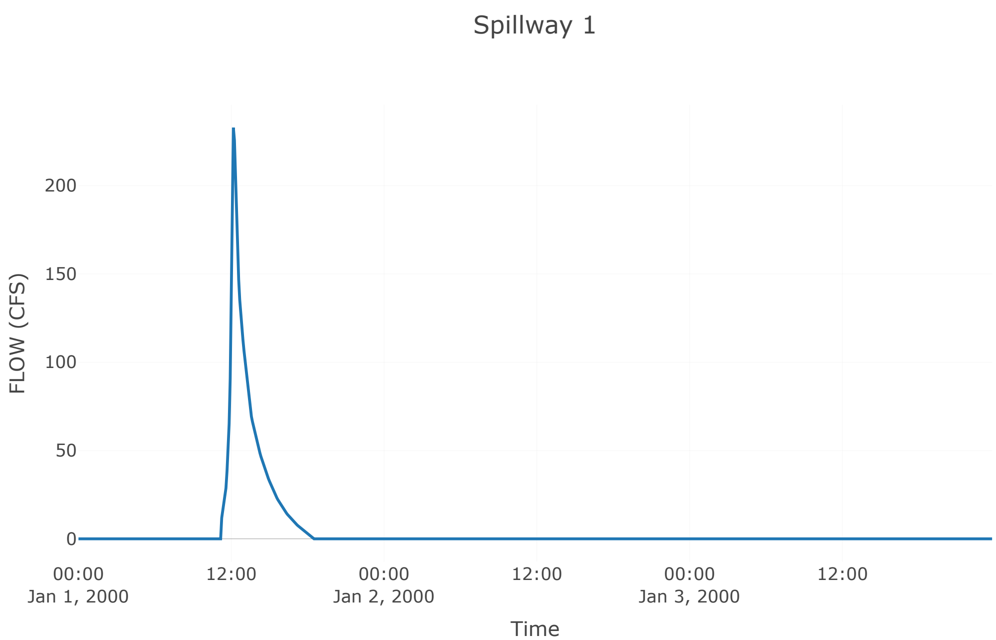
Results: AshCulvert

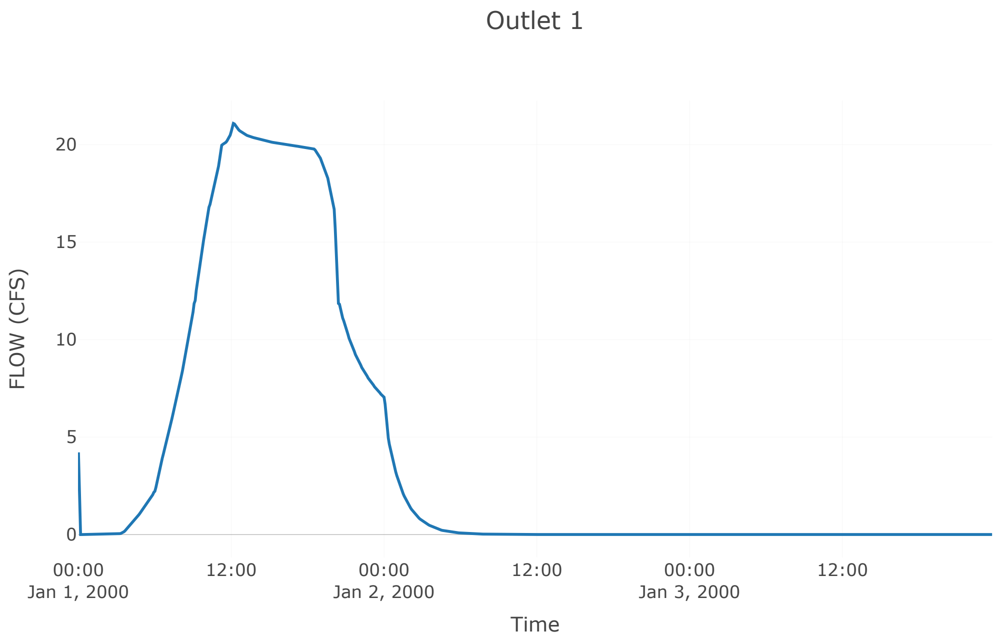
Peak Discharge (CFS)	253.9
Time of Peak Discharge	01Jan2000, 12:10
Volume (IN)	7.97
Peak Inflow (CFS)	264.17
Time of Peak Inflow	01Jan2000, 12:15
Inflow Volume (AC - FT)	52.97
Maximum Storage (AC - FT)	0.73
Peak Elevation (FT)	343.91
Discharge Volume (AC - FT)	52.74

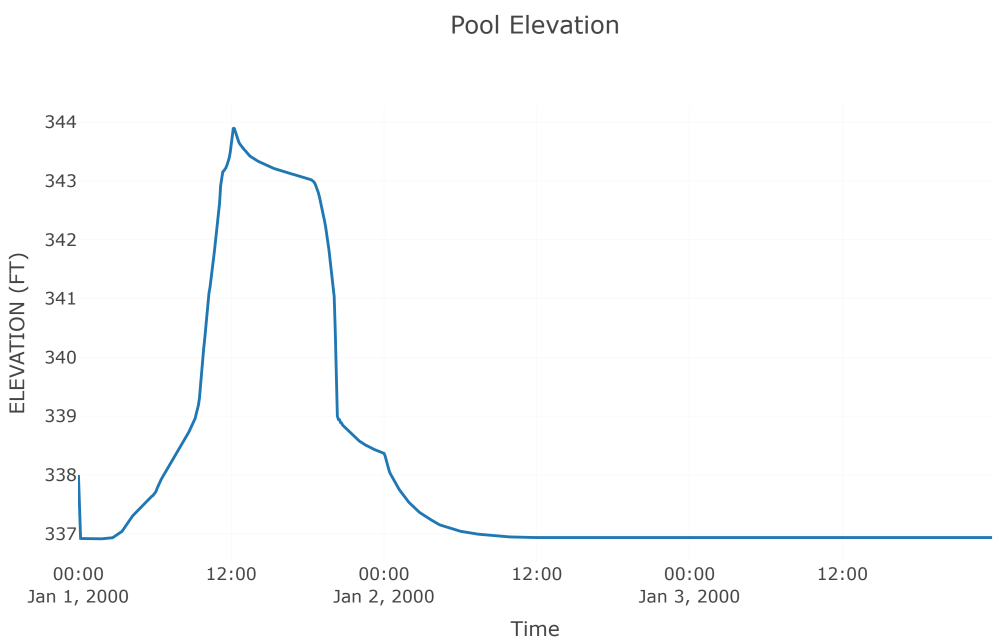

Storage
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
STORAGE (AC-FT)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

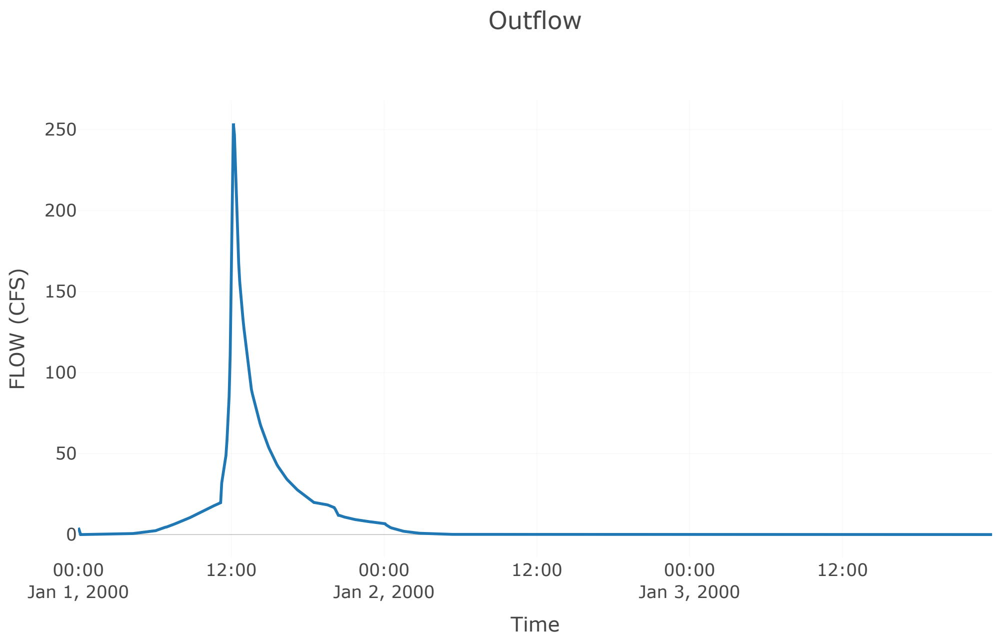

Combined Inflow
250
200
150
100
50
0
FLOW-COMBINE (CFS)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
50
40
30
20
10
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Spillway 1
FLOW (CFS)
200
150
100
50
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Outlet 1
FLOW (CFS)
20
15
10
5
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Pool Elevation
ELEVATION (FT)
344
343
342
341
340
339
338
337
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

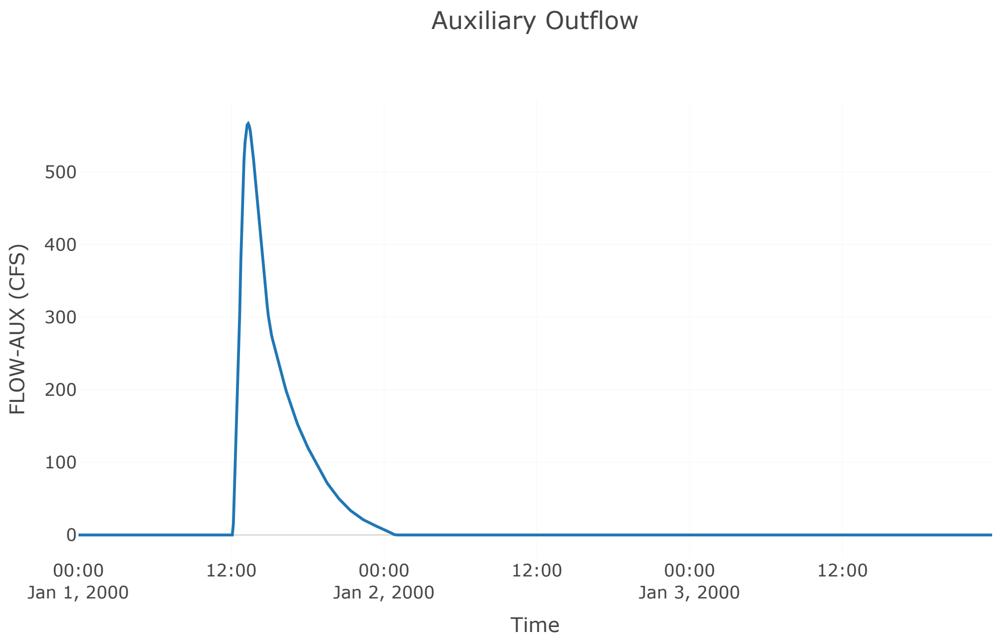

Outflow
FLOW (CFS)
250
200
150
100
50
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

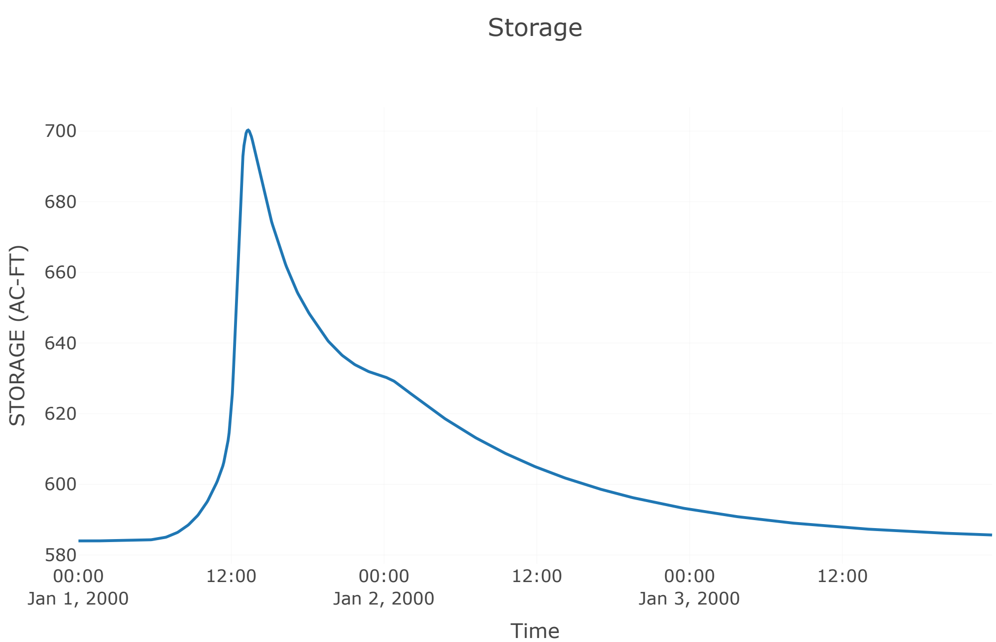
Reservoir: PrimaryPond

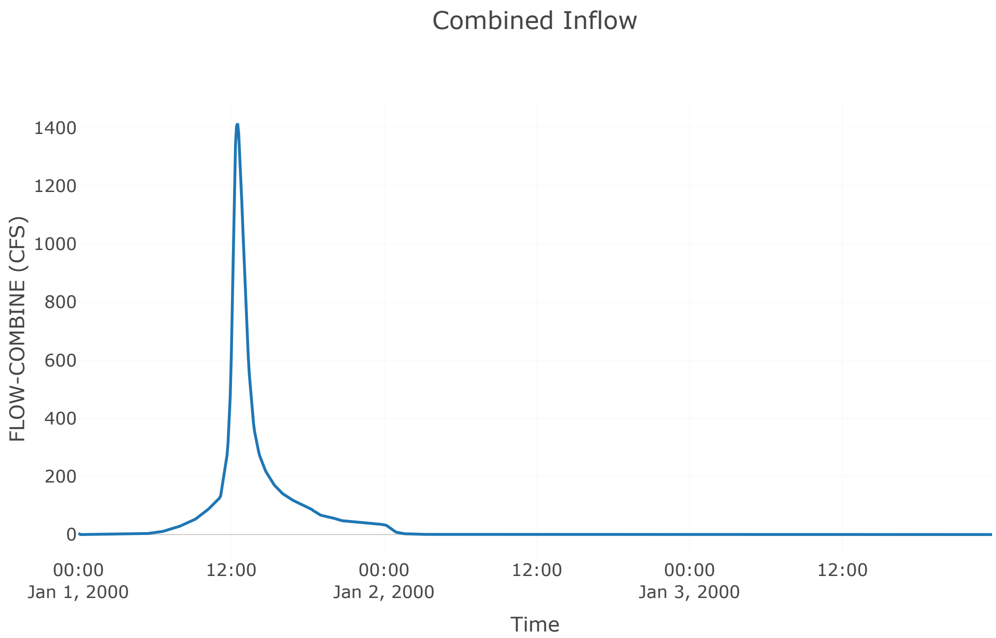
Downstream : Reach - 1

Results: PrimaryPond

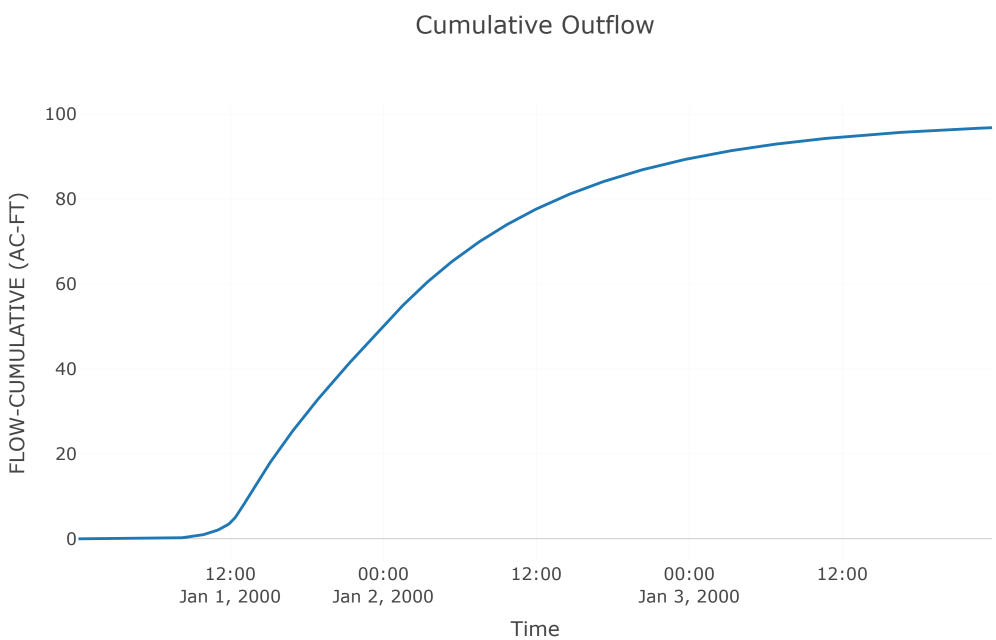
Peak Discharge (CFS)	60.6
Time of Peak Discharge	01Jan2000, 13:20
Volume (IN)	2.71
Peak Inflow (CFS)	1415.62
Time of Peak Inflow	01Jan2000, 12:35
Inflow Volume (AC - FT)	264
Maximum Storage (AC - FT)	700.28
Peak Elevation (FT)	335.5
Discharge Volume (AC - FT)	96.8


Auxiliary Outflow
FLOW-AUX (CFS)
500
400
300
200
100
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

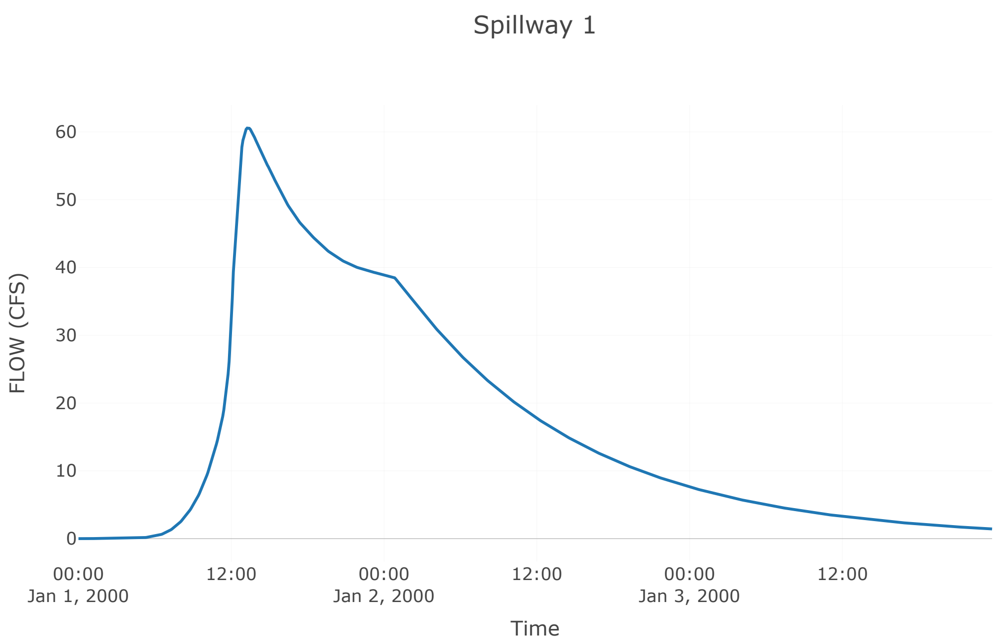

Storage
STORAGE (AC-FT)
700
680
660
640
620
600
580
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

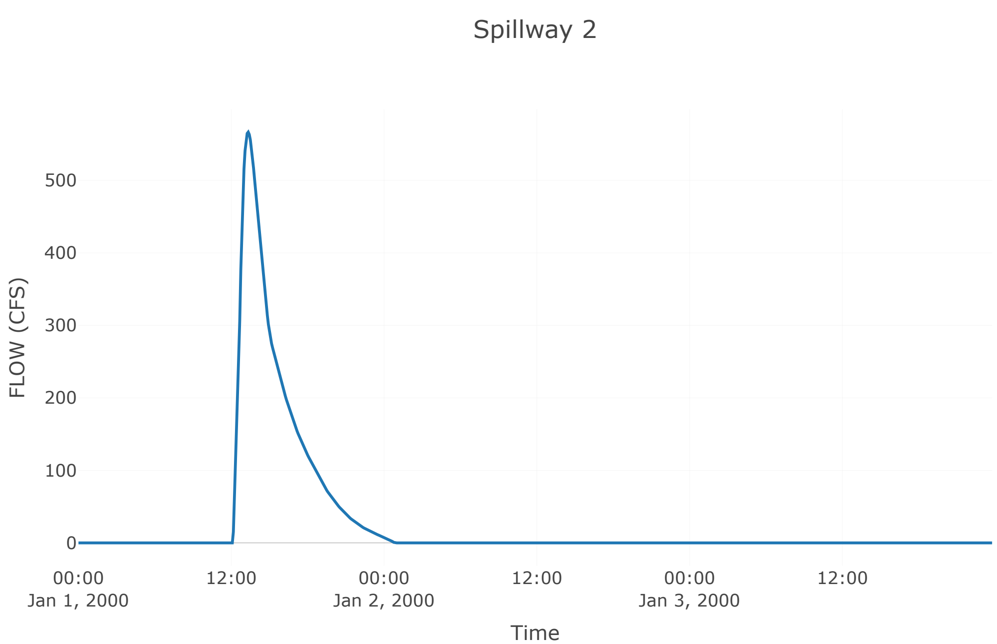


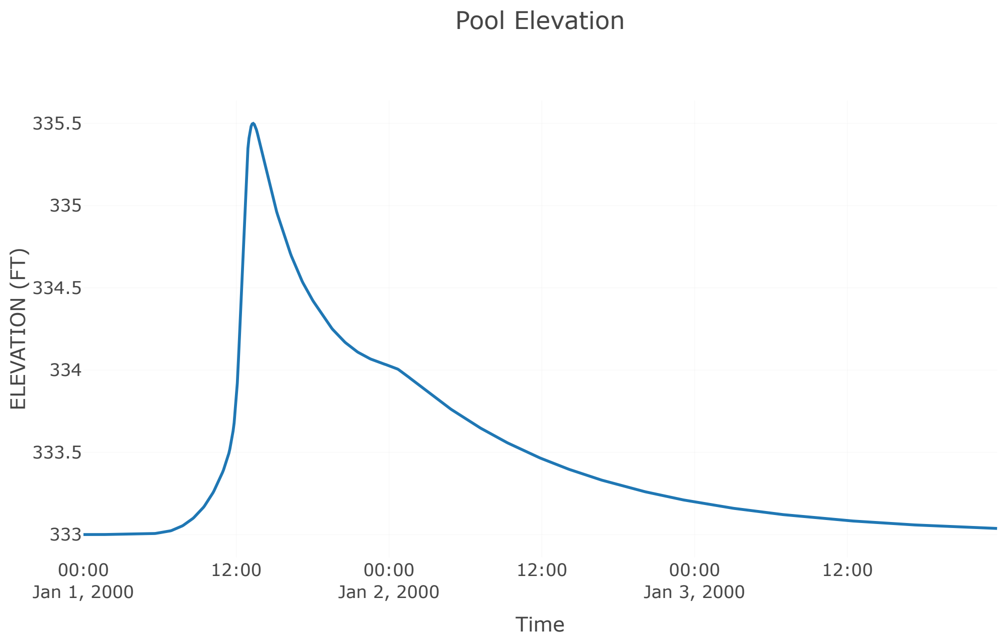
Combined Inflow
FLOW-COMBINE (CFS)
1400
1200
1000
800
600
400
200
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

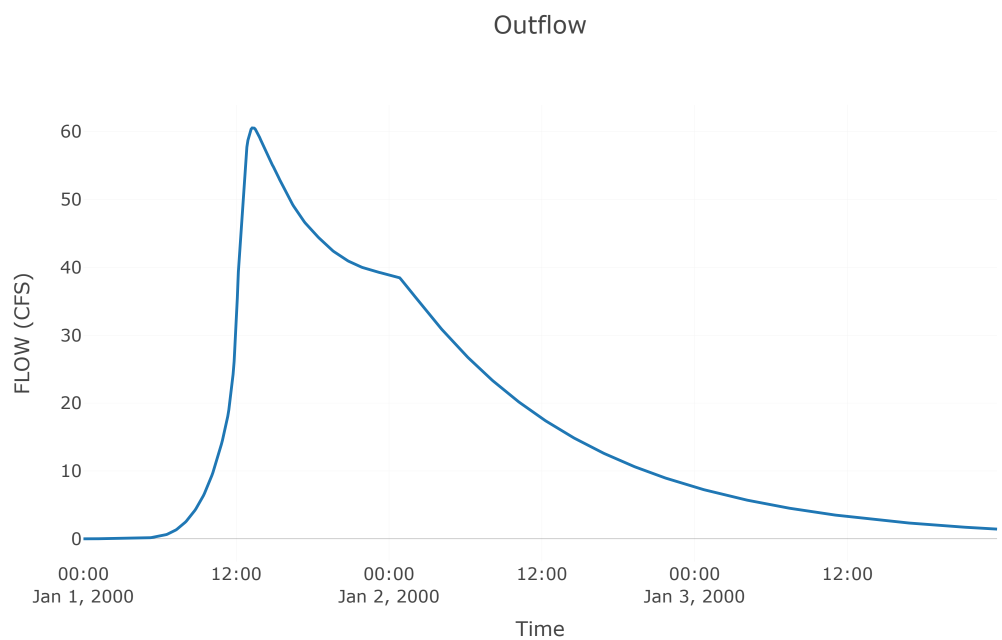


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
100
80
60
40
20
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Spillway 1
FLOW (CFS)
0
10
20
30
40
50
60
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Spillway 2
FLOW (CFS)
0
100
200
300
400
500
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Pool Elevation
ELEVATION (FT)
335.5
335
334.5
334
333.5
333
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Outflow
FLOW (CFS)
60
50
40
30
20
10
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Reach: Reach-1

Downstream : Secondary Pond

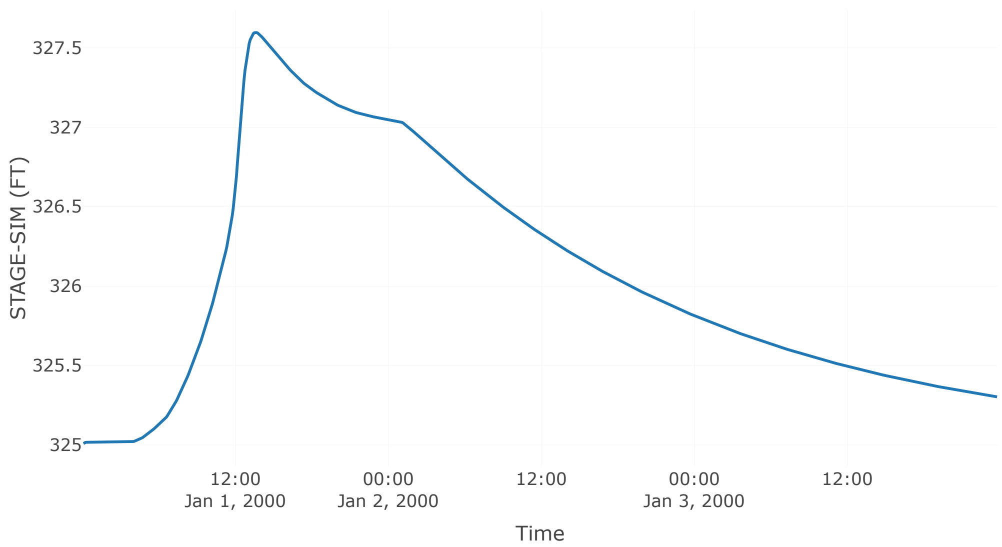
Route: Muskingum Cunge

Method	Muskingum Cunge
Channel	Trapezoid
Length (ft)	1210
Energy Slope	0
Mannings n	0.08
Bottom Width	15
Side Slope	2.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	5
Invert Elevation	325
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

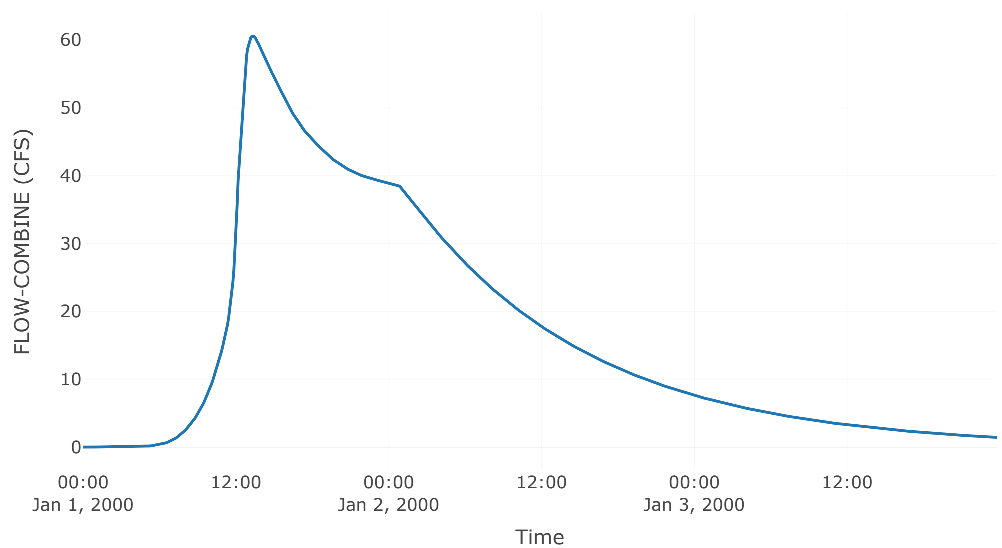
Results: Reach-1

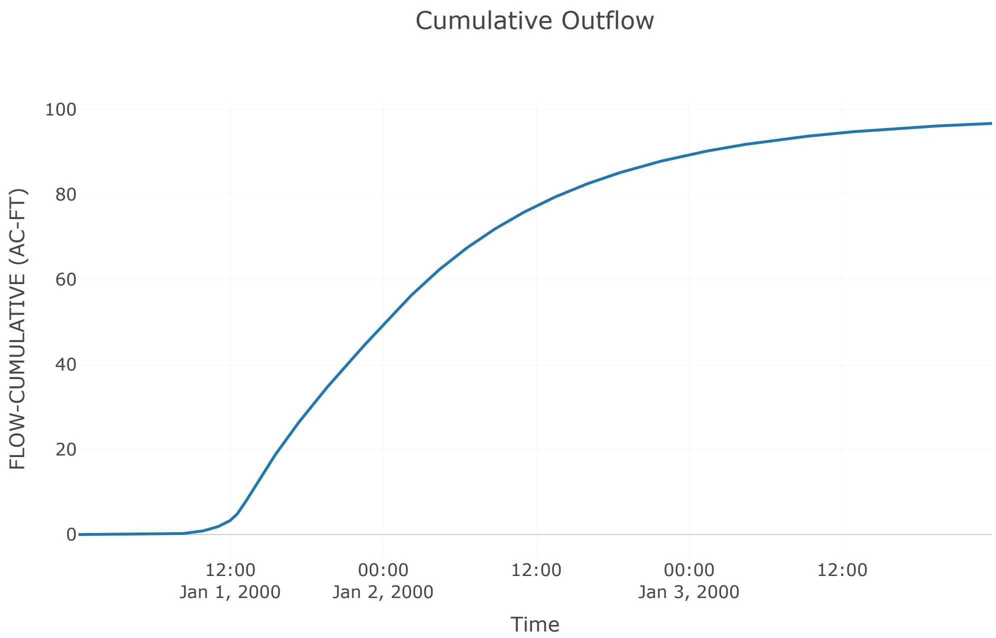
Peak Discharge (CFS)	60.16
Time of Peak Discharge	01Jan2000, 13:35
Volume (IN)	2.71
Peak Inflow (CFS)	60.6
Inflow Volume (AC - FT)	96.8

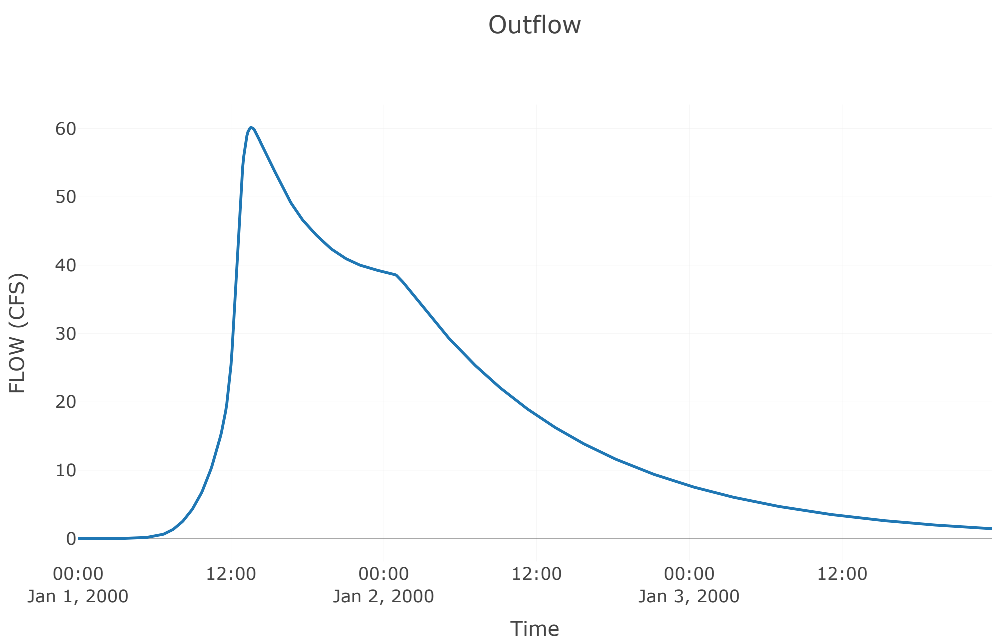
Computed Stage

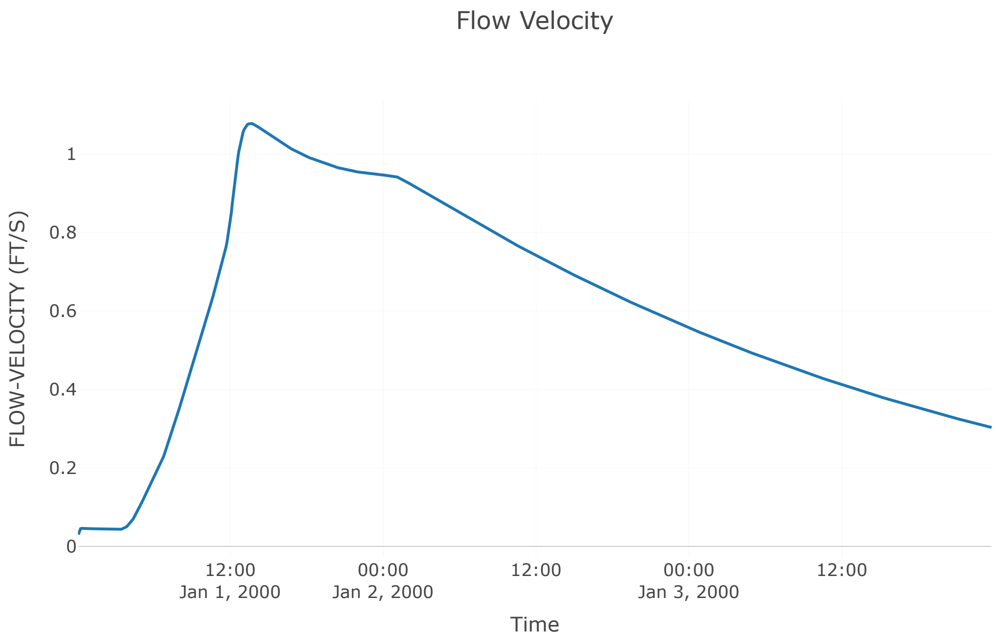


Combined Inflow




Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
20
40
60
80
100
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Outflow
FLOW (CFS)
0
10
20
30
40
50
60
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Flow Velocity
FLOW-VELOCITY (FT/S)
1
0.8
0.6
0.4
0.2
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

Subbasin: Secondary

Area (ft²) : 0.03
Downstream : Secondary Pond

Loss Rate: Scs

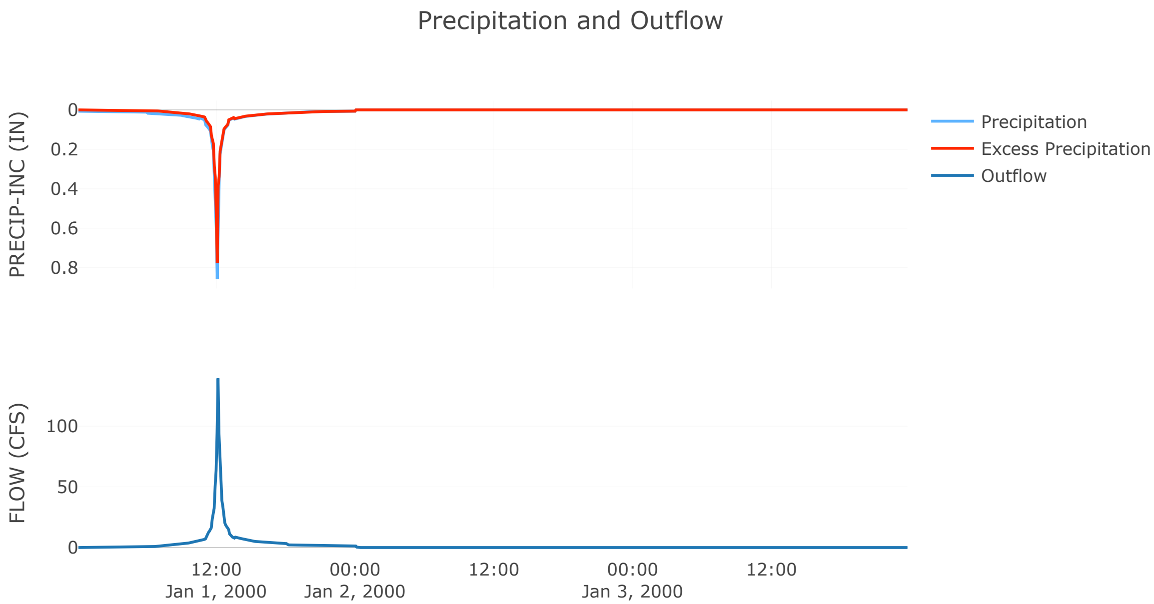
Percent Impervious Area	0
Curve Number	82.7

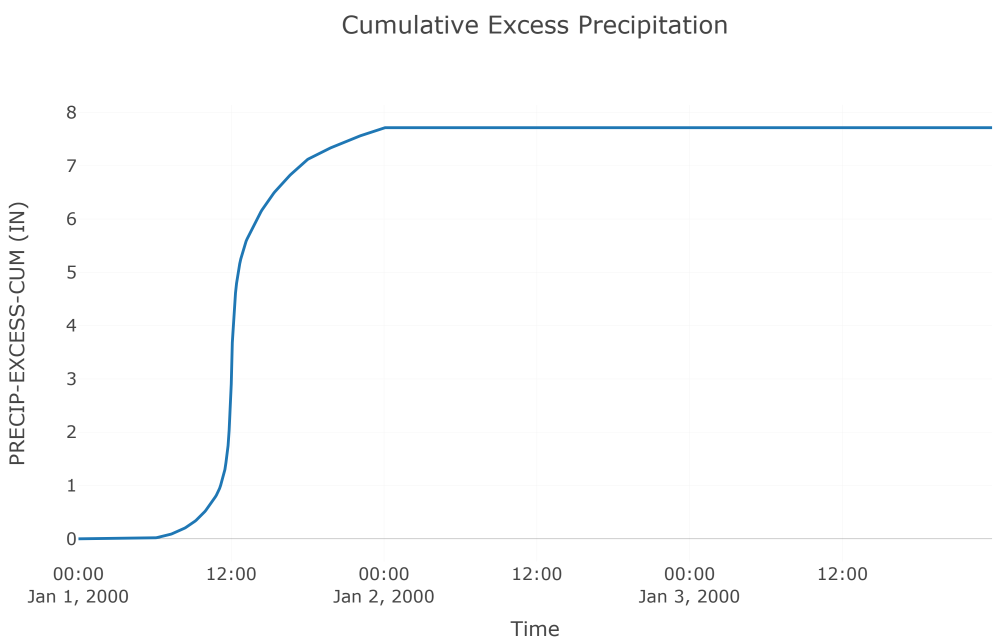
Transform: Scs

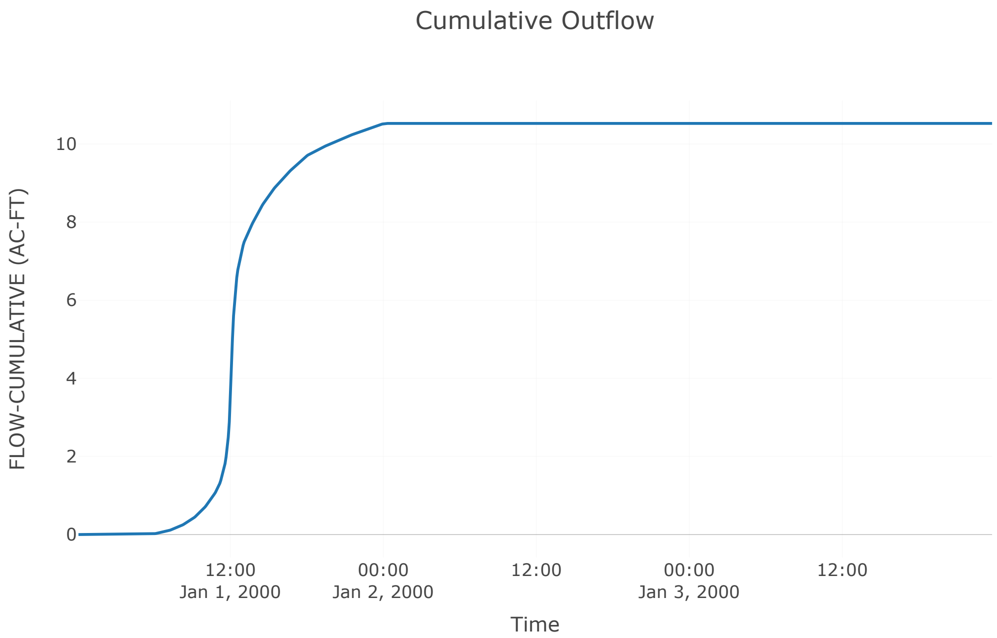
Lag	2.31
Unitgraph Type	Standard

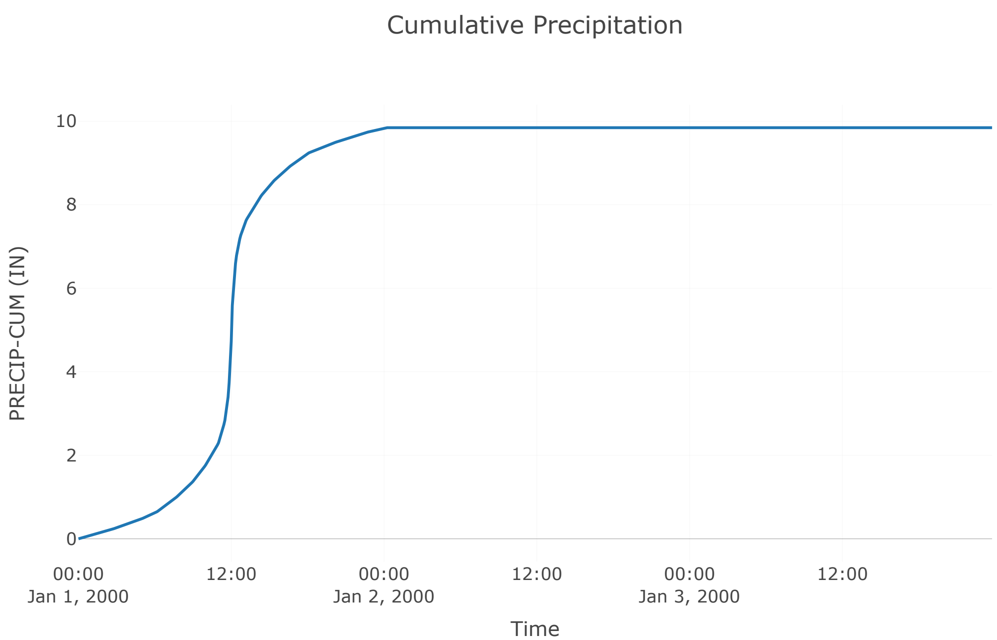
Results: Secondary

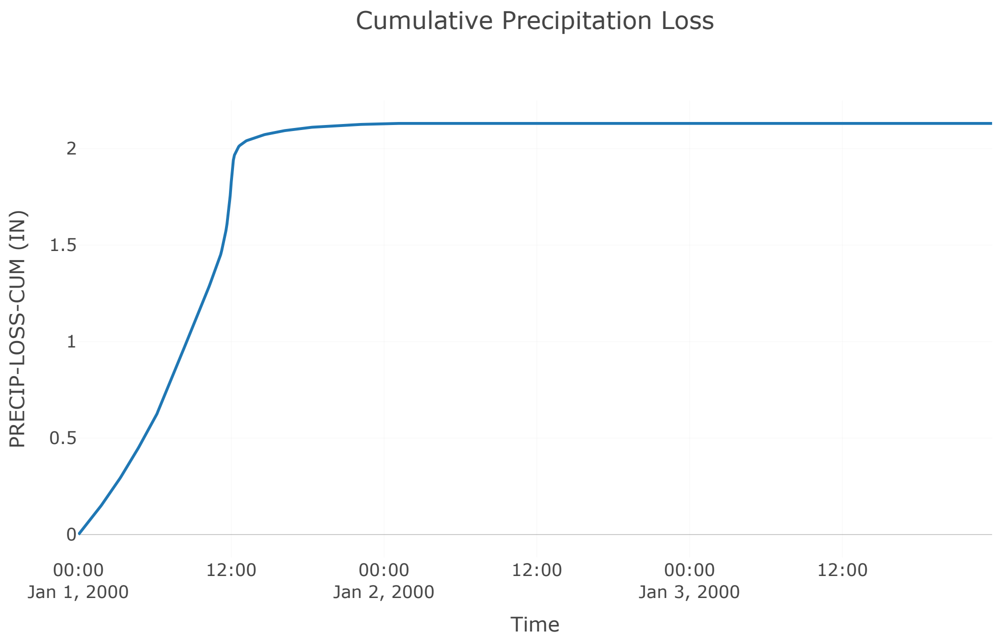
Peak Discharge (CFS)	139.43
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	7.71
Precipitation Volume (AC - FT)	13.43
Loss Volume (AC - FT)	2.91
Excess Volume (AC - FT)	10.53
Direct Runoff Volume (AC - FT)	10.53
Baseflow Volume (AC - FT)	0

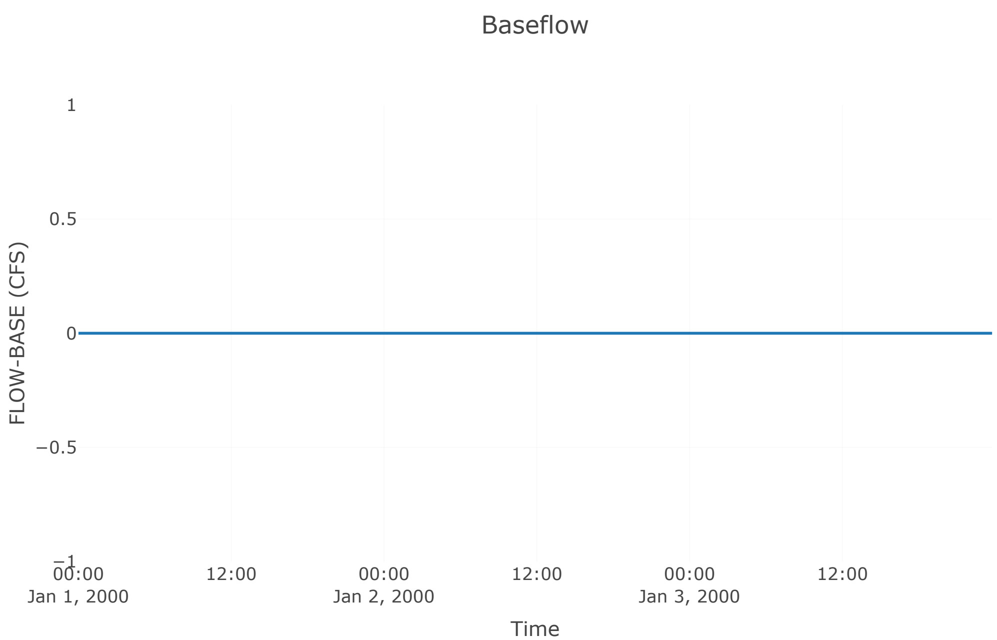

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
100
50
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00

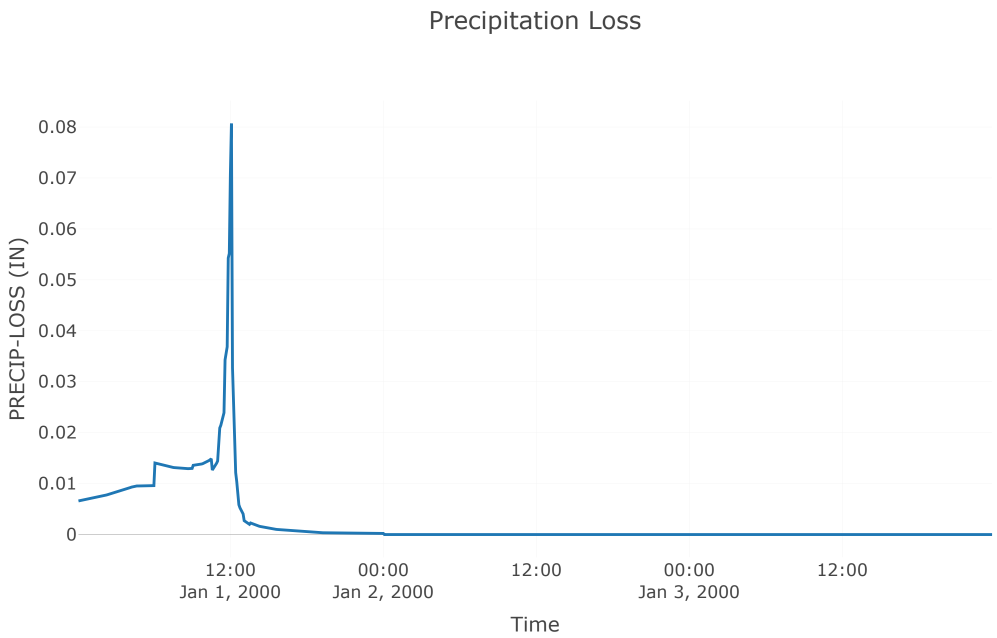

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
8
7
6
5
4
3
2
1
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

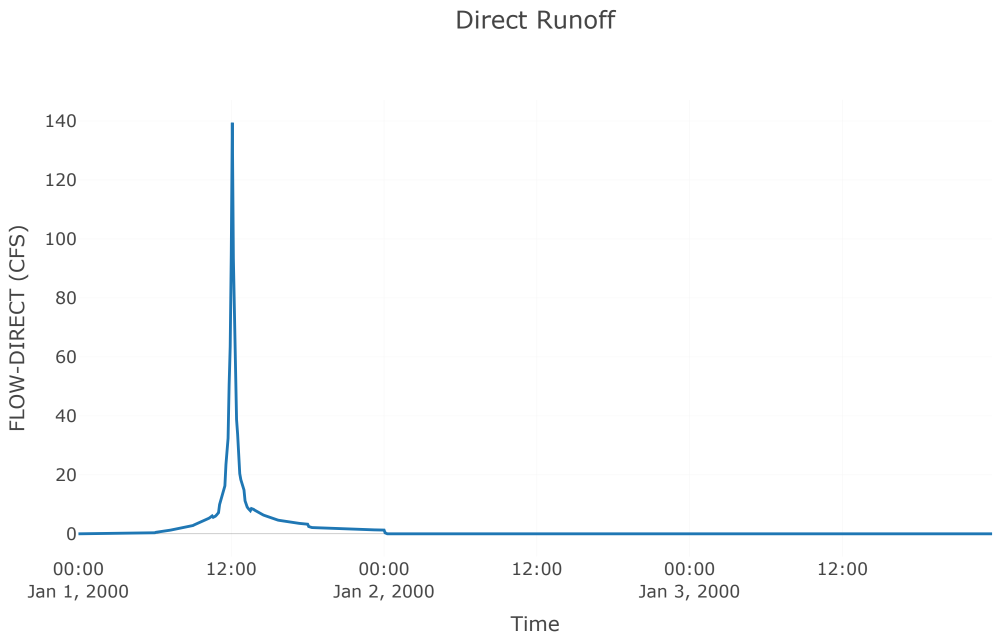

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
2
4
6
8
10
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

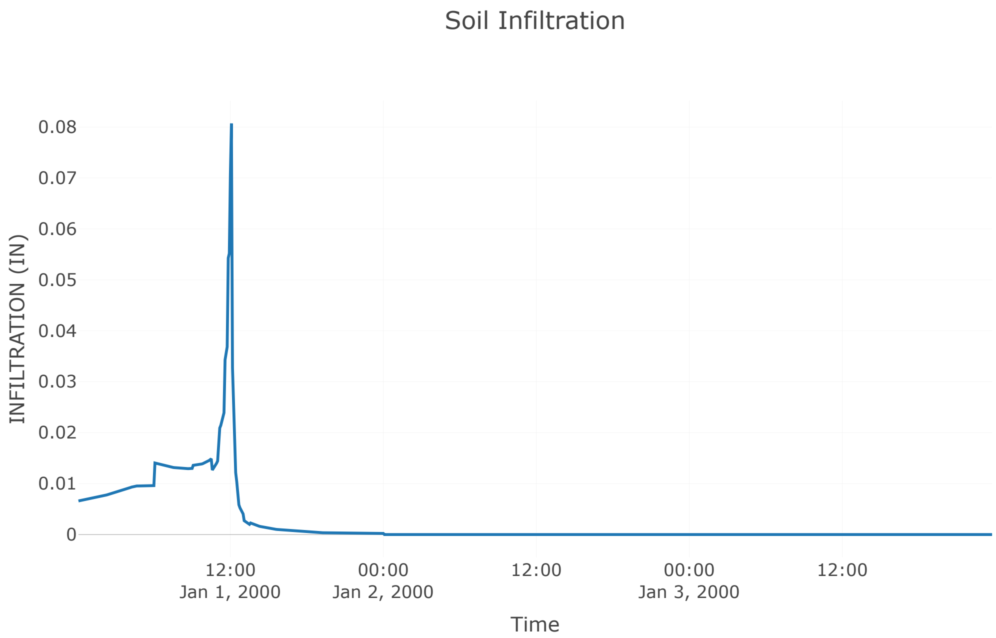

Cumulative Precipitation
PRECIP-CUM (IN)
0
2
4
6
8
10
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
0
0.5
1
1.5
2
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

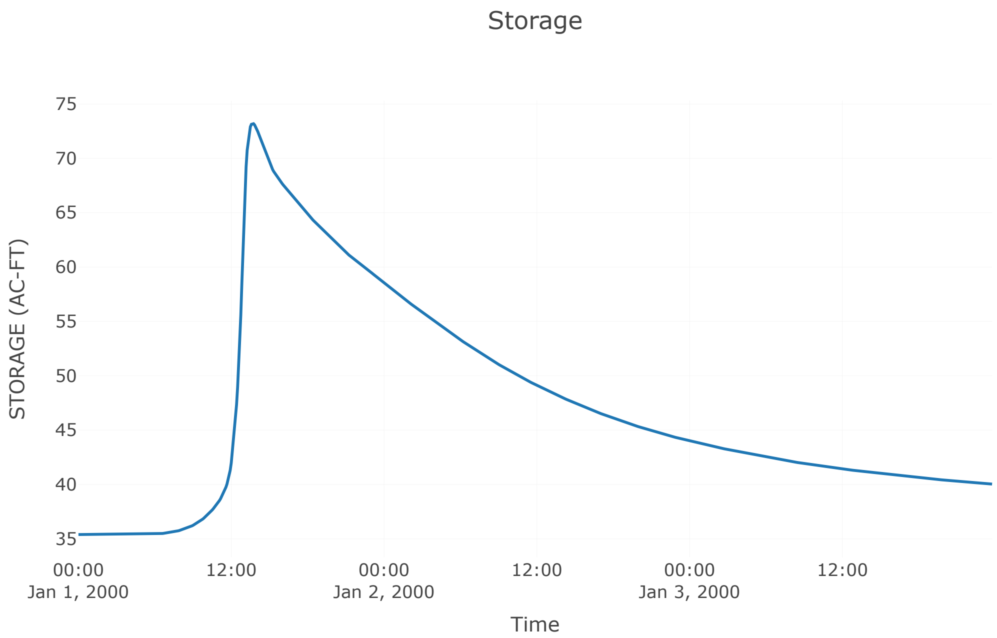

Precipitation Loss
PRECIP-LOSS (IN)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

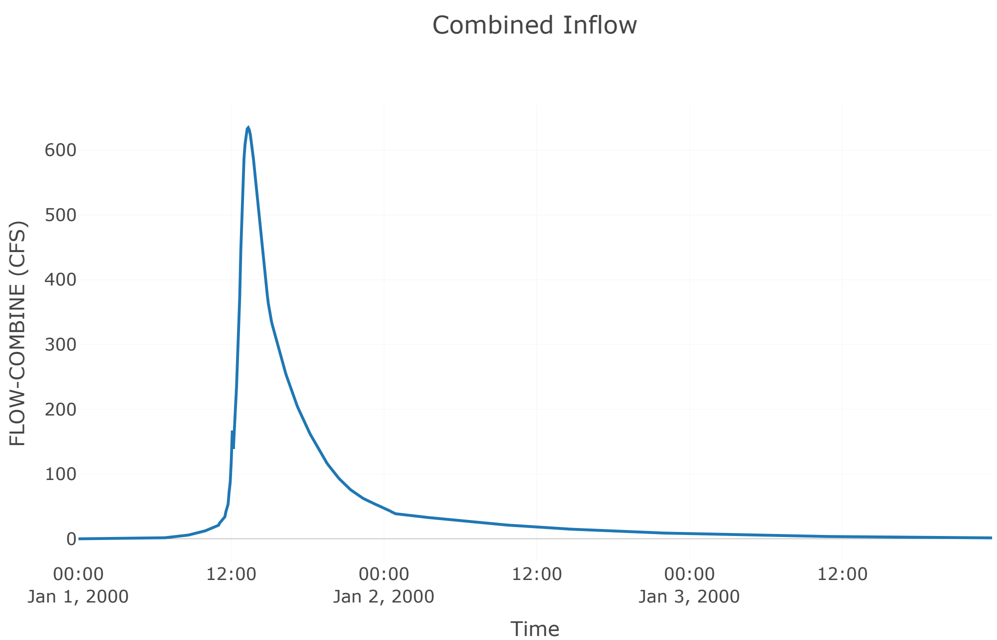

Direct Runoff
FLOW-DIRECT (CFS)
140
120
100
80
60
40
20
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

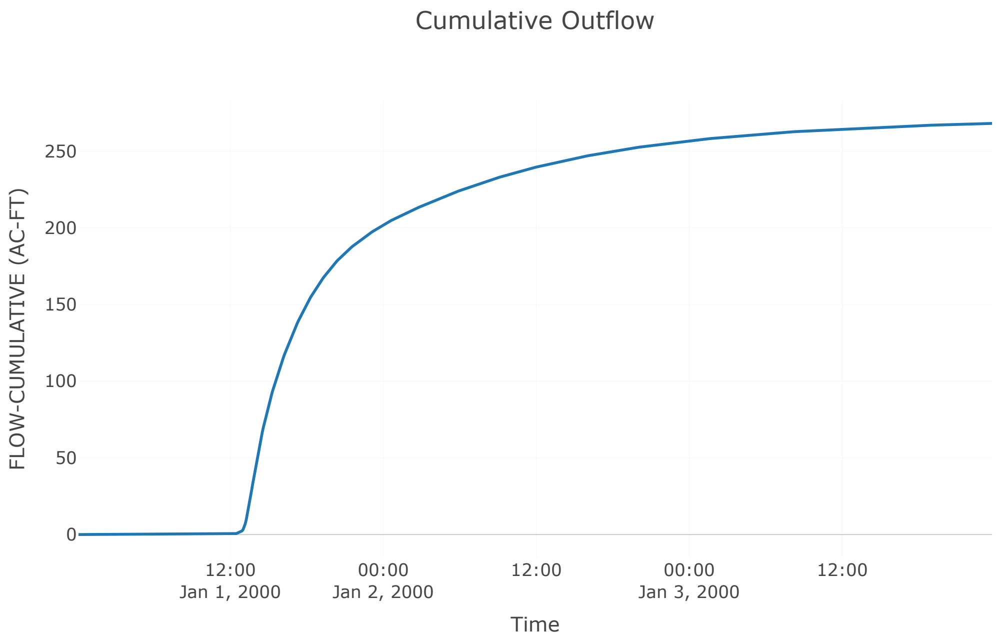

Soil Infiltration
INFILTRATION (IN)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

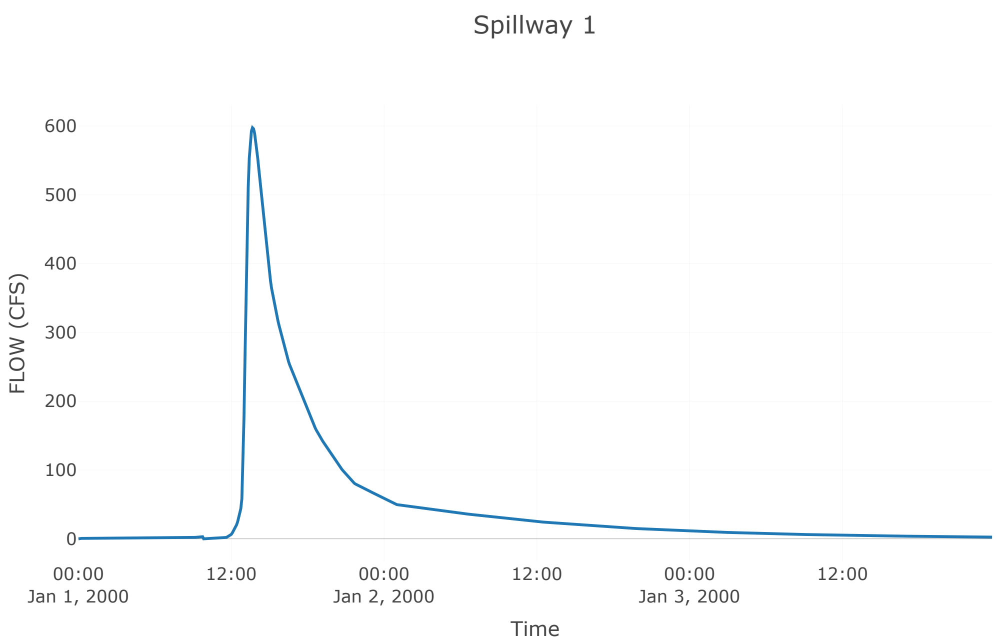
Reservoir: SecondaryPond

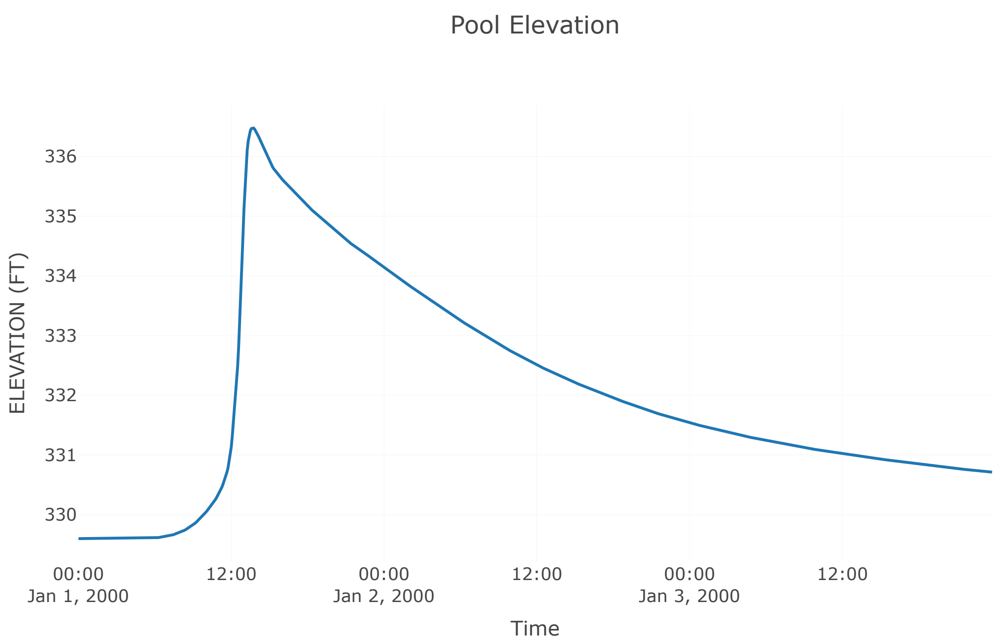
Results: SecondaryPond	
Peak Discharge (CFS)	597.6
Time of Peak Discharge	01Jan2000, 13:40
Volume (IN)	7.23
Peak Inflow (CFS)	634.78
Time of Peak Inflow	01Jan2000, 13:20
Inflow Volume (AC - FT)	272.82
Maximum Storage (AC - FT)	73.22
Peak Elevation (FT)	336.48
Discharge Volume (AC - FT)	268.19

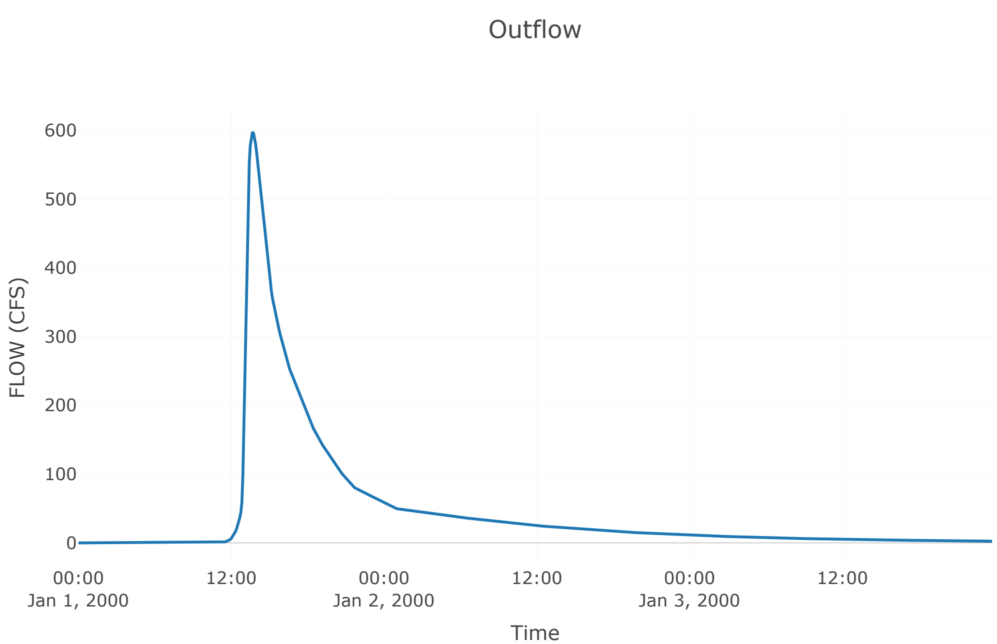

Storage
STORAGE (AC-FT)
75
70
65
60
55
50
45
40
35
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Combined Inflow
FLOW-COMBINE (CFS)
600
500
400
300
200
100
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
250
200
150
100
50
0
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Spillway 1
FLOW (CFS)
600
500
400
300
200
100
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

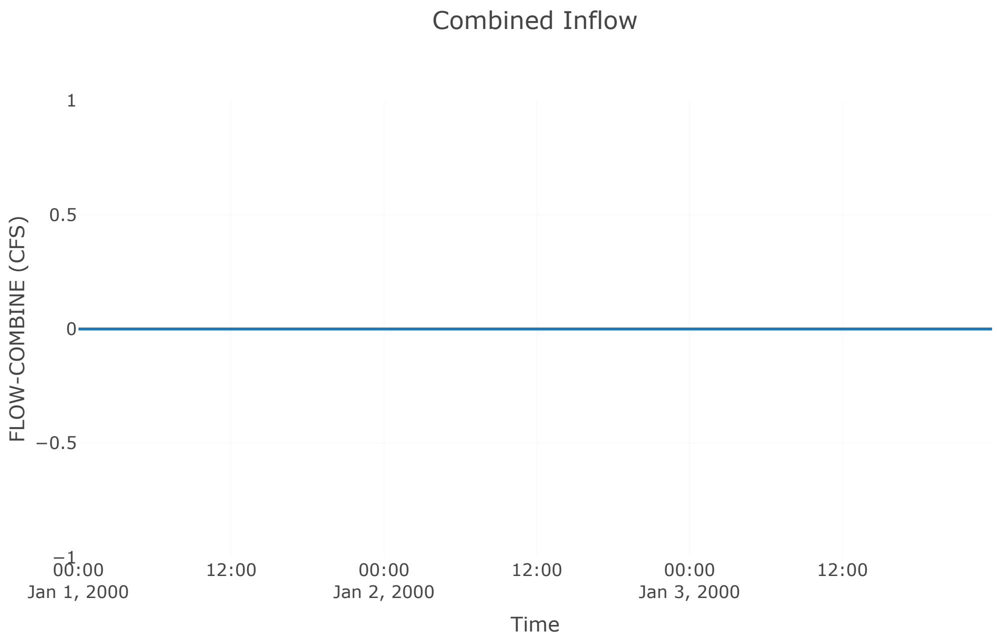

Pool Elevation
ELEVATION (FT)
336
335
334
333
332
331
330
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

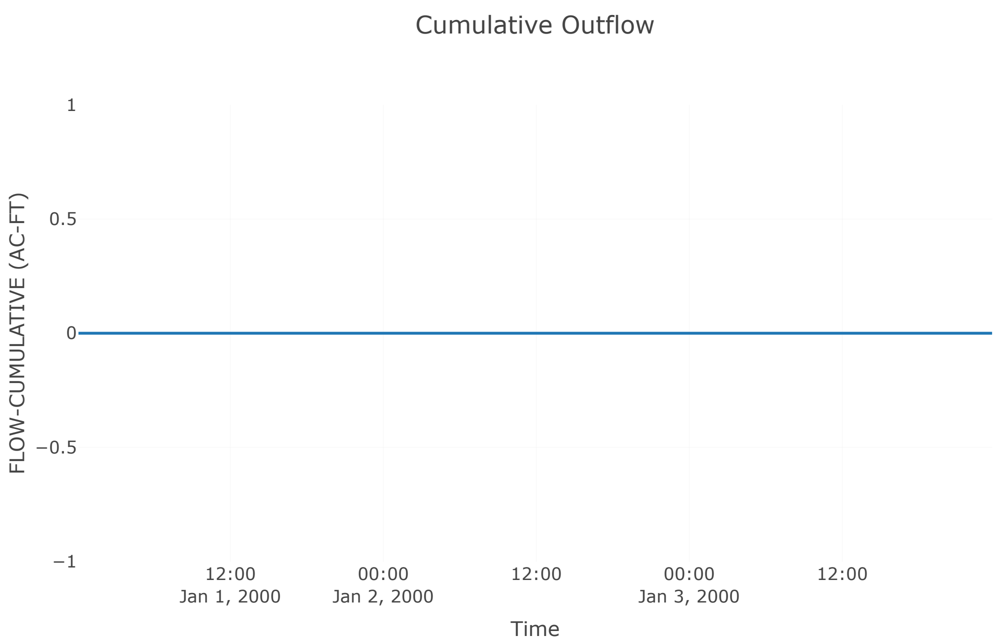

Outflow
FLOW (CFS)
600
500
400
300
200
100
0
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time

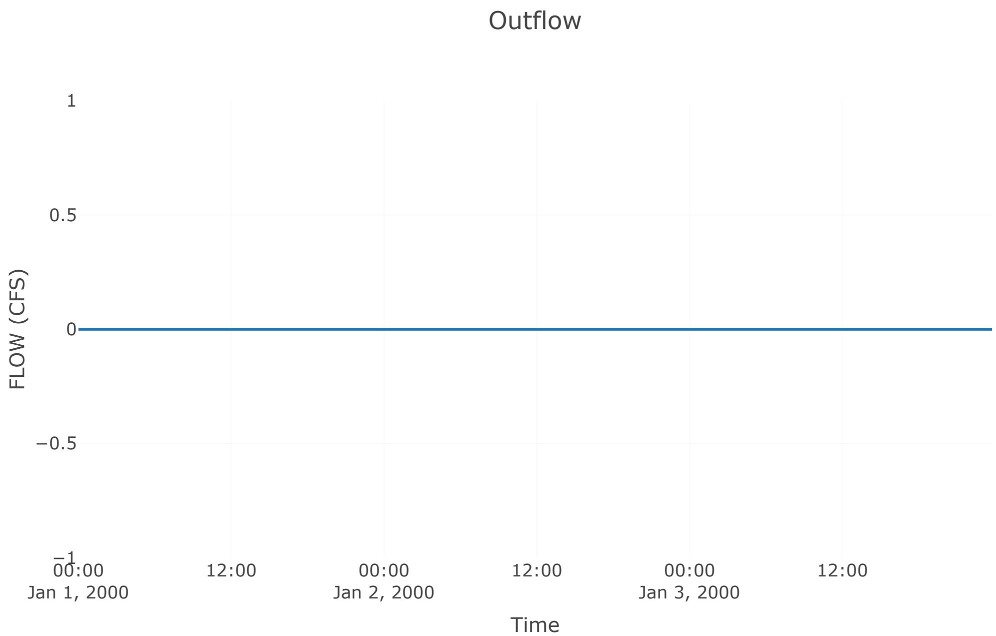
Sink: BottomAsh_ES

Results: BottomAsh_ES

Peak Discharge (CFS)	0
Time of Peak Discharge	31Dec1999, 24:00


Combined Inflow
1
0.5
0
−0.5
−1
FLOW-COMBINE (CFS)
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Cumulative Outflow
1
0.5
0
−0.5
−1
FLOW-CUMULATIVE (AC-FT)
12:00
Jan 1, 2000
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time


Outflow
FLOW (CFS)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2000
12:00
00:00
Jan 2, 2000
12:00
00:00
Jan 3, 2000
12:00
Time