Inflow Design Flood Control System Plan
Lawrence Energy Center

Inactive Units - Ash Pond Area 2, Ash Pond Area 3, and Ash Pond 4

Prepared for:

Westar Energy

Lawrence Energy Center

Lawrence, Kansas

Prepared by:

APTIM Environmental & Infrastructure, Inc.

April 2018

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LIST OF FIGURES AND APPENDICES

FIGURES

APPENDICES

Plan Review/Amendment Log §257.82(c)(2-4)

Date of Review	Reviewer Name	Sections Amended and Reason	Version

APTIM

CCR Regulatory Requirements

USEPA CCR Rule Criteria **40 CFR 257.82**	Lawrence Energy Center (LEC) Inactive Units, Ash Ponds 2, 3, and 4 Inflow Design Flood Control System Plan
§257.82(a)(1) stipulates: *(a) The owner or operator of an existing or new CCR Area 2, Area 3, and Area 4 Ponds or any lateral expansion of a CCR Area 2, Area 3, and Area 4 Ponds must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.* *(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.*	Section 5.3.1
§257.82(a)(2) stipulates: *(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.*	Section 5.3.1

APTIM

USEPA CCR Rule Criteria 40 CFR 257.82	Lawrence Energy Center (LEC) Inactive Units, Ash Ponds 2, 3, and 4 Inflow Design Flood Control System Plan
§257.82(a)(3) stipulates: *(3) The inflow design flood is:* *(i) For a high hazard potential CCR Area 2, Area 3, and Area 4 Ponds, as determined under §257.73(a)(2) or §257.74(a)(2), the probable maximum flood;* *(ii) For a significant hazard potential CCR Area 2, Area 3, and Area 4 Ponds, as determined under §257.73(a)(2) or §257.74(a)(2), the 1,000-year flood;* *(iii) For a low hazard potential CCR Area 2, Area 3, and Area 4 Ponds, as determined under §257.73(a)(2) or §257.74(a)(2), the 100-year flood; or* *(iv) For an incised CCR Area 2, Area 3, and Area 4 Ponds, the 25-year flood.*	Section 4.0
§257.82(b) stipulates: *(b) Discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.*	Section 3.3

USEPA CCR Rule Criteria **40 CFR 257.82**	Lawrence Energy Center (LEC) Inactive Units, Ash Ponds 2, 3, and 4 Inflow Design Flood Control System Plan
§257.82(c)(1) stipulates: *(c) Inflow design flood control system plan—* *(1) Content of the plan. The owner or operator must prepare initial and periodic inflow design flood control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this section. These plans must document how the inflow design flood control system has been designed and constructed to meet the requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator of the CCR unit has completed the inflow design flood control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(4).*	Sections 1.0 - 7.0
§257.82(c)(2) stipulates: *(2) Amendment of the plan. The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record as required by §257.105(g)(4). The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.*	Section 6.3

USEPA CCR Rule Criteria 40 CFR 257.82	Lawrence Energy Center (LEC) Inactive Units, Ash Ponds 2, 3, and 4 Inflow Design Flood Control System Plan
§257.82(c)(3) stipulates: *(3) Timeframes for preparing the initial plan—* *(i) Existing CCR Area 2, Area 3, and Area 4 Pondss. The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016.* *(ii) New CCR Area 2, Area 3, and Area 4 Pondss and any lateral expansion of a CCR Area 2, Area 3, and Area 4 Ponds. The owner or operator must prepare the initial inflow design flood control system plan no later than the date of initial receipt of CCR in the CCR unit.*	Section 1.0

USEPA CCR Rule Criteria **40 CFR 257.82**	Lawrence Energy Center (LEC) Inactive Units, Ash Ponds 2, 3, and 4 Inflow Design Flood Control System Plan
§257.82(c)(4) stipulates: *(4) Frequency for revising the plan. The owner or operator must prepare periodic inflow design flood control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first periodic plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed an inflow design flood control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(4).*	Section 6.3
§257.82(c)(5) stipulates: *(5) The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic inflow design flood control system plans meet the requirements of this section.*	Section 7.0

USEPA CCR Rule Criteria **40 CFR 257.82**	Lawrence Energy Center (LEC) Inactive Units, Ash Ponds 2, 3, and 4 Inflow Design Flood Control System Plan
§257.82(d) stipulates: *(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(g), the notification requirements specified in §257.106(g), and the internet requirements specified in §257.107(g).*	Section 6.0

1.0 INTRODUCTION

APTIM Environmental and Infrastructure, Inc. (APTIM, f/k/a CB&I Environmental & Infrastructure Inc., CB&I) has prepared the following Inflow Design Flood Control System Plan (Plan) at the request of Westar Energy (Westar) for the inactive Ash Pond Area 2 (Area 2 Ponds), Ash Pond Area 3 (Area 3 Ponds), and the Scrubber Supply Pond (Area 4 Pond) located at Lawrence Energy Center (LEC) in Lawrence, Kansas.

CCR regulations set forth within Title 40 Code of Federal Regulations (CFR) Part §257.82, provide guidelines for inflow design flood control systems to ensure that inactive CCR units are designed to safely manage stormwater flow during the inflow design flood. Specifically, §257.82 stipulates the following:

> §257.82:“*(a) The owner or operator of an existing or new CCR Pond or any lateral expansion of a CCR Ponds must design, construct, operate, and maintain an inflow design flood control system… (1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood… and (2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood”*

As demonstrated in this Plan, the inflow design flood control system has been designed to safely manage the inflow design flood and is in compliance with 40 CFR Part §257.82. This document provides discussion of APTIM’s professional judgement/opinion regarding specific aspects of the Rule as they pertain to the Pond which has been deemed as a regulated CCR unit at Westar’s LEC. This Plan will be placed within the Facility Operations Plan prior to April 17, 2018, in accordance with §257.100(e)(4)(ii).

2.0 REGULATORY OVERVIEW OF HYDROLOGIC AND HYDRAULIC CAPACITY REQUIREMENTS

On July 26, 2016 the United States Environmental Protection Agency (USEPA) extended the requirements of the Disposal of Coal Combustion Residuals from Electric Utilities Final Rule (CCR Rule) 40 CFR §257 and §261, for certain inactive CCR Ponds. The Ponds have been determined to be inactive by 40 CFR §257.53 and therefore have been deemed to be a regulated, inactive CCR by the USEPA through the CCR Rule. Westar is currently in the process of conducting closure activities in accordance with §257.100(d) of the CCR Rule and intends to complete closure of the Pond in the time frames required by the CCR Rule.

This Plan marks the initial analysis of the facility inflow design flood control system based on final closure conditions. Construction activities may occur at the facility that will subsequently modify the final closure conditions as described within this Plan. This Plan will be amended in accordance with §257.82(2), which stipulates:

> §257.81(2): *“The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record as required by §257.105(g)(4). The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.”*

This Plan will be amended to accurately analyze the inflow design flood control system associated with the current facility conditions. Amendments to this Plan will be documented within the Plan Review/Amendment Log immediately following the Table of Contents.

This Plan also details Westar's compliance with the recordkeeping requirements specified in Section 6.0.

3.0 LEC AREA 2, 3, AND 4 PONDS OVERVIEW

Westar owns and operates a series of clarifying ponds for process water at LEC in Douglas County, Kansas. LEC is located approximately 3 miles northwest of Lawrence, Kansas, is bounded by the Kansas River and resides in Sections 13 and 14, Township 12 South, Range 19 East. The locations of the Area 2, Area 3, and Area 4 Ponds are depicted in **Figure 1.**

The ponds are separated into three "areas", termed Areas 2, 3, and 4, as noted below:

- ❑ **Area 2 Ponds**
  - Pond 501 (CCR removed and operating)
  - Pond 502 (CCR removed and operating)
  - Pond 503 (CCR removed and operating)
  - Clear Pond (a.k.a. West Pond, CCR removed and operating)
  - Laydown Area (in the process of being dewatered, CCR removed, and incorporated into the Storm Water Settling Pond)
  - Storm Water Settling Pond (in the process of being dewatered and CCR removed)

- ❑ **Area 3 Ponds**
  - Pond 401 (CCR removed and operating)
  - Pond 402 (CCR removed and incorporated into Pond 404)
  - Pond 403 (CCR removed and incorporated into Pond 404)
  - Pond 404 (CCR removed and operating)

- ❑ **Area 4 Pond** – Scrubber Supply Pond (certified CCR removed in May 2017 and removed from service)

The Area 2, 3, and 4 Ponds are regulated impoundments under the CCR Rule and stopped receiving CCR prior to October 2015. Historically the Area 2, 3, and 4 Ponds received CCR material from the plant. The CCR material was deposited in the Area 2, 3, and 4 Ponds while overflow water was discharged to the Kansas River via Outfall 001BV, in line with Kansas NPDES Permit No. I-KS-31-PO09. As each pond was progressively filled, the ponds were dewatered and the CCR material was excavated and placed in Industrial Landfill No. 847. CCR material was distributed to different ponds within each area depending on the availability of capacity.

A perimeter impoundment dike was constructed to surround the LEC ponds and ties into the natural grades near the southern portion of the Area 2 Pond and the eastern portion of the Area 4 Pond. The crest of the perimeter dike is at approximately 839 feet Mean Sea Level (ft MSL) with side slopes at 3H:1V, providing a maximum height of 15 feet located in the northwest section. The crest width is approximately 30 feet. The perimeter dike was originally constructed of silty clay, which was obtained by excavation of existing grades in the area.

Currently the Area 2, 3, and 4 Ponds are being closed and re-purposed for plant process water. With the Area 4 Pond closed, plant process water flows from the Area 2 Ponds (with the exception of Ponds 502 and 503) to the Area 3 Ponds prior to discharge to the Kansas River through Outfall 001BV. Site topography from a 2016 survey conducted by Professional Engineering Consultants (PEC) prior to closure of the Area 2, 3, and 4 Ponds is depicted in **Figure 2**.

3.1 Existing Conditions and Operations

The original design of the LEC ponds included four areas through which stormwater and contact water moved before being discharged to the Kansas River. Following the adoption and establishment of the CCR Rule, the LEC ponds have been renamed and reconfigured. Currently, closure by removal of CCR at the LEC ponds is ongoing and is anticipated to be completed in 2018, in accordance with §257.102(c). Most of the configurations and flow patterns of the Area 2, Area 3, and Area 4 Ponds will be maintained. The Laydown Area will be reconfigured into the northern portion of the Storm Water Settling Pond. Pond 402 and Pond 403 will be reconfigured into the eastern portion of Pond 404. Closure consists of the removal of CCR material and existing clay liner, with the installation of an 18-in. clay liner, rip-rap, and aggregate base at the top of each berm. Contact water and process water is currently managed within the LEC Pond network, allowing for proper management of water during the ongoing construction process. As each pond is progressively dewatered, CCR material will be excavated and placed in the Industrial Landfill No. 847.

Following the completion of the closure activities, stormwater will continue to be directed to the Storm Water Settling Pond where it is discharged to Baldwin Creek. Contact water and process water will be directed to Pond 501, 502, and 503. From Pond 502, contact water and process water is discharged to the West Pond (Clear Pond), then Pond 404 and 401. From Pond 401, water is discharged through conveyance pipes to the Kansas River through Outfall 001BV or recycled into the plant.

3.2 Inflow Design Flood Control System

As discussed previously, Area 2, Area 3, and Area 4 Ponds are in the process of completing closure activities by removing all CCR material and existing clay liner and installing an 18-in clay liner, in accordance with 40 CFR §257.102(c). As a result of closure, the Area 2, Area 3, and Area 4 Ponds will no longer accept any CCR material or CCR laden waters. The Area 2, Area 3, and Area 4 Ponds will be repurposed to manage stormwater and process water from plant operations to be recirculated into the systems or discharged into the Kansas River in accordance with the facilities NPDES permit. The Area 2, Area 3, and Area 4 Ponds are hydraulically connected through pipe networks that are designed to distribute water across the pond network during process water surges and large storm events. As such, the pipe network performs as the inflow design flood control system to manage all water prior to discharge to the Kansas River. The inflow design flood control system and contributing subcatchment areas are depicted in **Figure 3**.

4.0 HAZARD POTENTIAL DEFINITION (§257.82(a)(3))

In accordance with §257.82(a)(3), the inflow design flood event utilized to demonstrate compliance with the Rule is determined by the hazard potential classification. Hazard potential classifications are based on potential loss or damage to the following:

- Human life
- Economic loss
- Environmental damage
- Disruption of lifeline facilities

An Initial Hazard Potential Classification Assessment has also been undertaken in line with §257.73(a)(2) and has been classified as a Low Hazard Potential closed CCR unit. The Initial Hazard Potential Classification is available on Westar's CCR Rule Compliance Data and Information website.

As defined in §257.82(a)(3), the 100-year flood event (100-year, 24-hour storm event) is utilized for inflow design flood control system analysis for low hazard potential closed CCR units. The inflow design control system will be evaluated to demonstrate the ability to adequately manage stormwater flow, per §257.82(a)(1), and collect and control the peak discharge, per §257.82(a)(2).

4.1 Emergency Action Plan

According to 40 CFR Part 257.74(a)(3), an Emergency Action Plan (EAP) is required for all CCR units that have been classified as either a high hazard potential or significant hazard potential CCR Pond. Based on the hazard potential classification, an EAP for the Ponds is not required.

5.0 INFLOW DESIGN FLOOD CONTROL SYSTEM ANALYSIS

5.1 Methodology Overview

In order to determine compliance with 40 CFR Part §257.82 for the inflow design flood control system at the Area 2, Area 3, and Area 4 Ponds, site topography and inflow design flood control system features were modeled using the computer model software HydroCAD. This computer model is used to developed discharge rates and volumes associated with the subcatchments contributing to the flow into the Area 2, Area 3, and Area 4 Ponds. Inflow design flood features were modeled to ensure that these features are capable of managing peak discharge rates and volumes associated with the inflow design flood.

5.2 Model Input Parameters

To ensure that the inflow design flood control system complies with 40 CFR Part §257.82, all elements were modeled with numerous conservative assumptions. AutoCAD Civil3D 2016 (AutoCAD) was utilized to delineate key features and the model HydroCAD was used to develop discharge rates and volumes for the inflow design flood event. HydroCAD is a computer aided design program used to model hydrology and hydraulics of stormwater using either TR-20 or TR-55 procedures developed by the Soil Conservation Services (now the Natural Resource Conservation Service).

The stormwater modeling methodology used the following analysis methods, as further describe in subsequent text:

Runoff Calculation Method:	SCS TR-20
Pond Routing Method:	Storage Indication Method (Modified-Puls)
Storm Distribution:	Rainfall Intensity Table for Kansas Counties - 1997
Unit Hydrograph:	SCS
Antecedent Moisture Condition:	2

The Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), developed methods TR-20 and TR-55 as standardized stormwater modeling. Both provide similar results; the main differentiation in methodology is based on the use of chart-based solutions vs. computer modeling. TR-55, frequently called the “tabular method” was developed prior to the widespread use or computer modeling. As such it was developed to utilize chart based solutions to use the SCS runoff equation. TR-20 is a computer based modeling approach that is more complex and generally considered more accurate than TR-55.

5.2.1 Rainfall Totals and Distributions

Rainfall intensities for the inflow design flood system analysis are determined by the hazard potential classification. The Area 2, Area 3, and Area 4 Ponds have been classified to be a low hazard potential CCR unit. The 100-year flood event (100-year, 24-hour storm event) will be utilized within the model, in accordance with 40 CFR Part §257.82(3) which states:

> §257.82(3) stipulates: *“(3) The inflow design flood is: … (iii) For a low hazard potential CCR Area 2, Area 3, and Area 4 Ponds, as determined under §257.73(a)(2) or §257.74(a)(2), the 100-year flood;”*

The rainfall depth and distribution pattern for the inflow design flood system analysis was determined using *Rainfall Intensity Tables for Kansas Counties - 1997*, developed for the Kansas Department of Transportation and authored by University of Kansas professor Bruce M. McEnroe. The rainfall depth for the modeled scenario was selected from this report and entered into HydroCAD. TR-55 outlines that an NRCS Type II 24-hour storm distribution is appropriate within this region of Kansas. The distribution pattern may be selected from a drop-down list in HydroCAD. The rainfall total and distribution table utilized within the analysis can be found in **Appendix A**.

5.2.2 Subcatchment Boundaries

Subcatchment areas (also known as watersheds) were delineated using AutoCAD based on topographic breaks within the areas to be analyzed. For the inflow design flood system analysis, direct precipitation onto the Area 2, Area 3, and Area 4 Ponds and all areas contributing to stormwater run-on into the Area 2, Area 3, and Area 4 Ponds are delineated and imported into HydroCAD. Subcatchment boundaries are depicted in **Figure 3.**

5.2.3 Run-off Coefficient Variables

Curve numbers are used to identify the runoff characteristics of an area. Curve numbers consider both the land cover that will be encountered by surface water (such as grass, CCR material, standing water, etc.) as well as the type of soil that underlies the land cover. The underlying soil is important because soil matrix has a large impact on whether water infiltrates the soil or is shed.

The SCS (NRCS) technical resource TR-55 provides lookup tables of curve numbers for combinations of various land covers and the underlying surficial soils. As further described below, APTIM developed assumptions of surficial soil types and delineated various landcovers to develop a weighted average for each modeled subcatchment area using values specified in TR-55.

Surficial Soil Types

According to the KDHE-BWM Industrial Landfill Permit No. 0847 application (Permit application) for LEC, the facility is covered with mostly silty clay loam. The Permit application defines the surficial soil type as Hydrologic Soil Group D (HSG-D) based on the high run-off potential of the native soils. Surficial soil type within the HydroCAD model was conservatively assumed to be HSG-D in all areas within the Industrial Landfill Permit boundary.

Land Covers

The land covers were determined based on a review of aerial photography and the topographic survey for the Area 2, Area 3, and Area 4 Pond boundaries and adjacent areas.

Stormwater run-off from the adjacent areas draining to the Area 2, Area 3, and Area 4 Ponds were conservatively assumed to have good grass cover. The TR-55 manual designates good grass cover as grassland with greater than 75% vegetative density. For the purpose of the model, this area was defined as good grass cover in accordance with the TR-55 manual.

Direct precipitation falling onto the Area 2, Area 3, and Area 4 Ponds were conservatively assumed to be a water surface.

5.2.4 Time of Concentration

The time of concentration, defined as the longest amount of time a waterdrop would take to travel from the headwater of a subcatchment area to its downstream edge (ie. prior to being managed by a downstream element) was delineated in AutoCAD and manually entered in HydroCAD.

The following assumptions were made in the calculations:

- For each subcatchment the time of concentration, T_c, is the sum of the travel times, T_t, of various consecutive flow segments. There are three types of flow: sheet flow, shallow concentrated flow, and open channel flow.

- Sheet flow is assumed to become shallow concentrated flow at 100 feet. It is noted that TR-20 and TR-55 methods specify 300 feet, but subsequent research has generally shown 100 feet to be more accurate.

- The Manning's coefficient "n" for sheet flow was assumed to be 0.015, indicative of short grass. This number is appropriate for vegetated subcatchment areas.

- An average flow velocity of 7.0 ft/sec was assumed in shallow concentrated flow calculations for the Pond subcatchment and adjacent areas, which is considered most indicative of the vegetated areas.

- The time of concentration for the water surface area was conservatively assumed to be zero to show direct entry into the LEC Pond network.

5.2.5 Area 2, Area 3, and Area 4 Ponds

The Area 2, Area 3, and Area 4 Ponds were modeled by entering the area at major contour intervals between the normal water elevation and the top of perimeter berm elevation to determine incremental detention volumes. The normal water elevation was assumed to be the invert elevation of the outlet pipe for each pond. Proposed site conditions and pipe dimensions and elevations were obtained from the *Lawrence Energy Center CCR Impoundment Closure Design - 100% Design* completed by Black & Veatch in March 2018.

5.2.6 Stormwater Conveyance Features

Stormwater run-off from adjacent areas generally overland flows to the Area 2, Area 3, and Area 4 Ponds. A drainage ditch along the northern boundary of the adjacent landfill is used to convey stormwater from the remaining adjacent areas to the Storm Water Settling Pond prior to discharge. In addition, the LEC Pond network is hydraulically connected by a network of pipes. Dimensions, pipe material, sizing, and inlet/outlet elevations for these structures were provided by Westar. These features were manual imported into HydroCAD.

5.2.7 Base Flow from LEC Processes

Base flow rates from process water streams were modeled to ensure that the inflow design flood control systems are designed to accommodate these flows in addition to the 100-year, 24-hour storm event. Known flow rates from various processes that are discharged into the LEC Pond network were provided by Westar.

In general, three distinct process water flow rates were incorporated into the model. The following describes the each process water flow rate within the model:

- Process water from Cooling Tower 5 (CT5) is discharged directly into the Clear Pond at an approximate flow rate of 1.00 cubic feet per second (cfs). This flow was conservatively assumed to occur once per 8-hour shift.

- Process water from other facility operations including Coal Pile run-off pumps, basement sumps, boiler blowdown systems, and other miscellaneous drains and pumps were conservatively assumed to discharge into Pond 501 at an approximate flow rate of 4.40 cfs. This flow was conservatively assumed to occur once per 8-hour shift.

- Process water from the Industrial Landfill No. 847 at LEC is pumped to discharge into Pond 501 at an approximate flow rate of 0.45 cfs. This flow rate was conservatively assumed to run continuously throughout the modeled scenario.

The flow rates discussed previously reflect maximum peak flow rates at the facility. These flow rates were manually entered into HydroCAD.

5.3 Model Findings

The HydroCAD results for the 100-year flood event (100-year, 24-hour storm event) were analyzed to evaluate the inflow design flood control system at the Area 2, Area 3, and Area 4 Ponds. Results from the model indicate that the inflow design flood control system properly manages flow into and out of the Area 2, Area 3, and Area 4 Ponds. Erosion or scour is not anticipated to occur during overland flow into the Area 2, Area 3, and Area 4 Ponds. In summary, the inflow design flood control system properly manages stormwater and process water flows without overtopping or backing up.

5.3.1 Inflow Design Flood Control System Analysis (§257.82(a))

The inflow design flood control system analysis was completed to demonstrate that the existing system complies with 40 CFR Part §257.82(a), which states:

> *"(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.*
>
> *(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section."*

A review of the HydroCAD model shows that during the 100-year flood event, the Area 2, Area 3, and Area 4 Ponds drains such that the a minimum 2-foot freeboard is maintained throughout the storm event. In addition, all stormwater conveyance features are free-flowing and do not back up or cause any pond to overtop.

Results from the inflow design flood control system analysis can be found in **Appendix C.**

5.4 Engineering Evaluation of Findings

5.4.1 Design Appropriateness Based on Model Findings

Based on the model findings, it has been demonstrated that the current inflow design flood control system complies with 40 CFR Part §257.82(a) of the Rule. The inflow design flood control system has been appropriately designed to properly manage direct precipitation and stormwater run-off associated with the 100-year flood event in addition to process flows.

5.4.2 Operations and Maintenance Considerations

APTIM recommends that the LEC Ponds pipe network be maintained to ensure free-flowing conditions. Regular inspections of the inflow design flood control system are recommended in order to clear debris, repair erosion, and monitor any erosion control measures.

6.0 RECORDS RETENTION AND MAINTENANCE (§257.82(d))

6.1 Incorporation of Plan into Operating Record

§257.105(g) of 40 CFR Part 257 provides record keeping requirements to ensure that the Plan must be placed in the facility's operating record. Specifically, §257.105(g) stipulates:

> §257.105(g) stipulates*: "(g) Operating criteria. The owner or operator of a CCR unit subject to this subpart must place the following information, as it becomes available, in the facility's operating record: (4) The initial and periodic inflow design flood control system plan as required by §257.82(c)."*

This Report will be placed within the Facility Operating Record upon Westar's review and approval.

6.2 Notification Requirements

§257.106(g) of 40 CFR Part 257 provides guidelines for the notification of the availability of the initial and periodic plan. Specifically, §257.106(g) stipulates:

> §257.106(g) stipulates: "*(g) Operating criteria. The owner or operator of a CCR unit subject to this subpart must notify the State Director and/or appropriate Tribal authority when information has been placed in the operating record and on the owner or operator's publicly accessible internet site. The owner or operator must: ((4) Provide notification of the availability of the initial and periodic inflow design flood control system plans specified under §257.105(g)(4)"*

The State Director and appropriate Tribal Authority will be notified upon placement of this Report in the Facility Operating Record.

§257.107(g) of 40 CFR Part 257 provides publicly accessible Internet site requirements to ensure that the Plan is accessible through the Westar webpage. Specifically, §257.107(g) stipulates:

> §257.107(g) stipulates: *"(g) Operating criteria. The owner or operator of a CCR unit subject to this subpart must place the following information on the owner or operator's CCR Web site: (4) The initial and periodic inflow design flood control system plans specified under §257.105(g)(4)."*

This Plan will be uploaded to Westar's CCR compliance reporting website upon Westar's review and approval.

6.3 Plan Amendments (§257.82(c)(3))

This Plan has been completed in accordance with §257.82(c)(3) to provide an initial analysis of the inflow design flood control system. This Plan will continue to undergo review as the closure activities continue. Westar is required to prepare inflow design flood control system plans every five (5) years, as required by §257.82(c)(4) of the CCR Rule. The amended Plan will be reviewed and recertified by a registered professional engineer and will be placed in LEC's facility operating record as required per §257.105(g)(4). The amended Plan will supersede and replace any prior versions. Availability of the amended Plan will be noticed to the State Director per §257.106(g)(4) and posted to the publicly accessible internet site per §257.107(g)(4).

A record of Plan reviews/assessments is provided on the first page of this document, immediately following the Table of Contents.

7.0 PROFESSIONAL ENGINEER CERTIFICATION (§257.82(c)(5))

The undersigned registered professional engineer is familiar with the requirements of the CCR Rule and has visited and examined the Lawrence Energy Center or has supervised examination of the Lawrence Energy Center by appropriately qualified personnel. The undersigned registered professional engineer attests that this Inflow Design Flood Control Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and meets the requirements of §257.82, and that this Plan is adequate for the LEC facility. This certification was prepared as required by §257.82(c)(5)

Name of Professional Engineer: Richard Southorn

Company: APTIM

Signature:

Date: 04/16/18

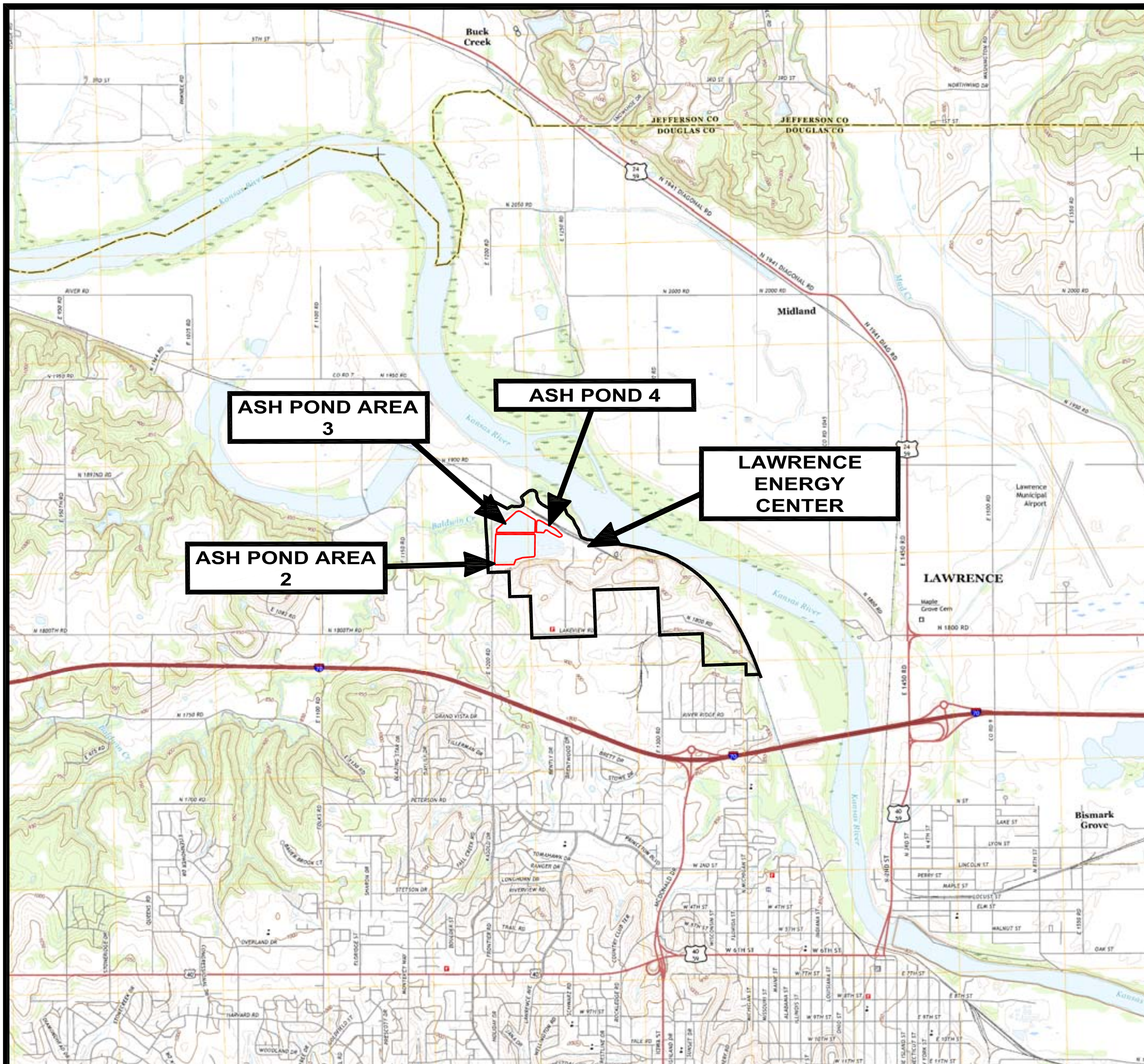
PE Registration State: Kansas

PE Registration Number: PE25201

Professional Engineer Seal:

FIGURES

APTIM



LEGEND

LAWRENCE ENERGY CENTER FACILITY BOUNDARY

CCR UNIT BOUNDARY

0 5000'

GRAPHIC SCALE

NOTES

1. AERIAL TOPO OBTAINED FROM USGS 7.5-MINUTE SERIES, LAWRENCE EAST, LAWRENCE WEST, MIDLAND AND WILLIAMSTOWN QUADRANGLE, KANSAS, 2014.

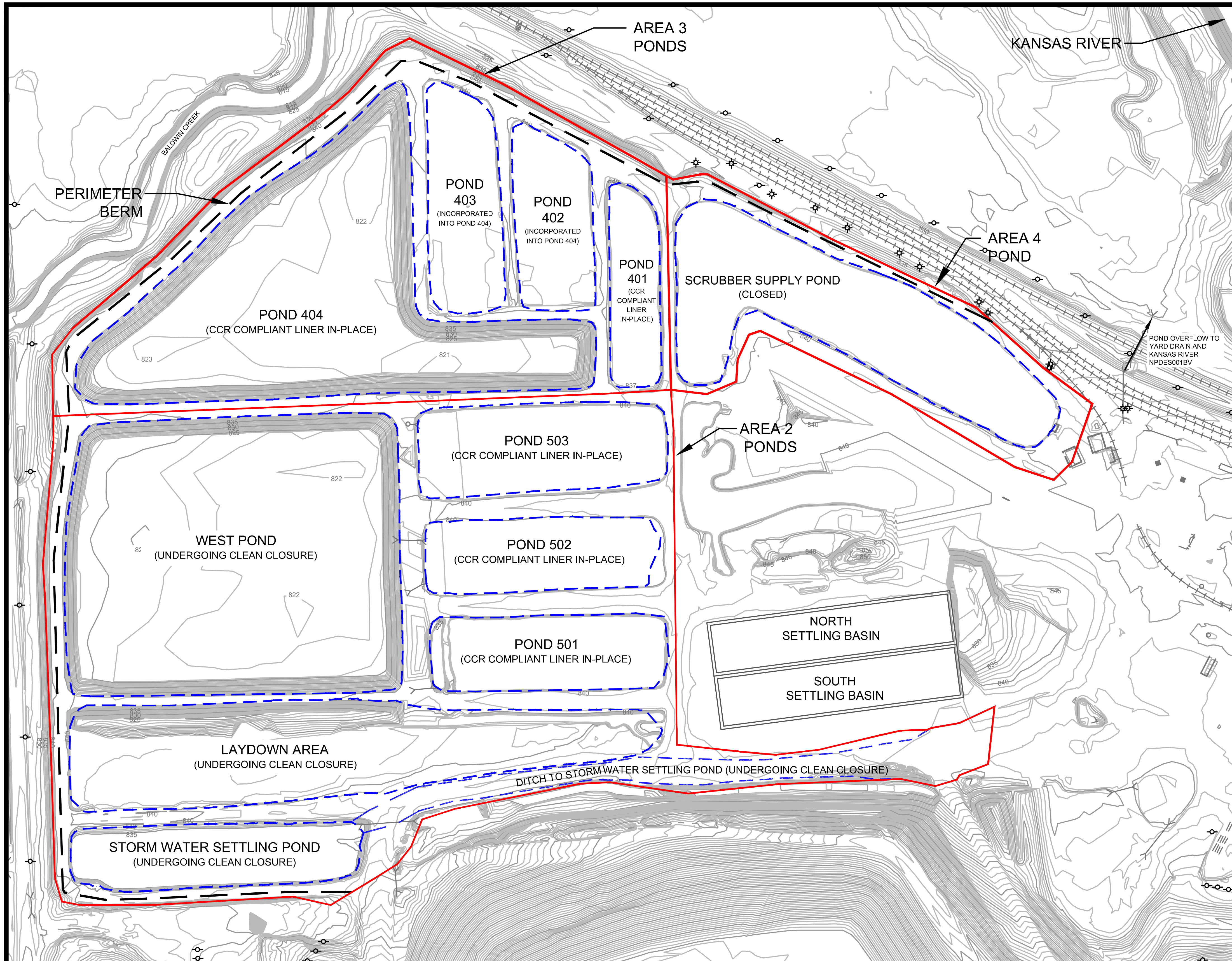
2. ALL BOUNDARIES ARE APPROXIMATE.

APTIM Environmental & Infrastructure, Inc.

LAWRENCE ENERGY CENTER
1250 N. 1800 RD., LAWRENCE, KS.

FIGURE 1
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
SITE LOCATION PLAN

APPROVED BY:	RDS	PROJ. NO.:	631232565	DATE:	APRIL 2018



LEGEND

- APPROXIMATE POND AREA BOUNDARY
- APPROXIMATE POND BOUNDARY
- APPROXIMATE PERIMETER DIKE LOCATION

NOTES

1. EXISTING CONTOURS DEVELOPED FROM SITE AERIAL TOPOGRAPHIC SURVEY BY PEC IN JUNE 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
3. ALL BOUNDARIES AND FEATURE LOCATIONS ARE APPROXIMATE.

REV. NO.	DATE	DESCRIPTION

Westar Energy

APTIM Environmental & Infrastructure, Inc.

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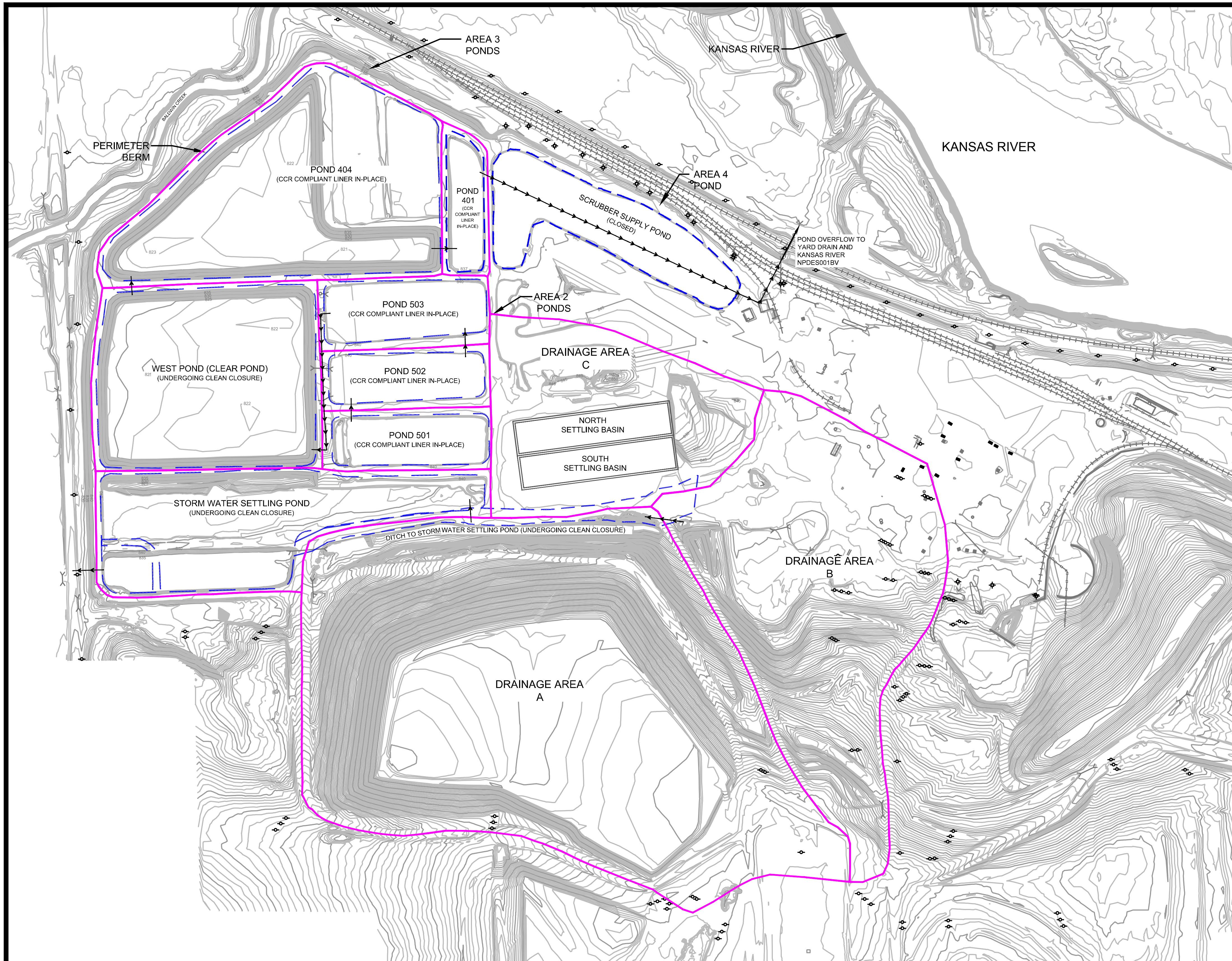
LAWRENCE ENERGY CENTER
1250 N 1800 RD. LAWRENCE, KANSAS

FIGURE 2
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
SITE TOPOGRAPHY PRIOR TO CLOSURE

DRAWN BY:	ORC	APPROVED BY:	RDS	PROJ. NO.:	631232565	DATE:	APRIL 2018



N

0 350'

GRAPHIC SCALE

LEGEND

APPROXIMATE POND BOUNDARY

APPROXIMATE INFLOW DESIGN FLOOD CONTROL SYSTEM PIPE NETWORK

APPROXIMATE SUBCATCHMENT BOUNDARY

NOTES

1. EXISTING CONTOURS DEVELOPED FROM SITE AERIAL TOPOGRAPHIC SURVEY BY PEC IN JUNE 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
3. ALL BOUNDARIES AND FEATURE LOCATIONS ARE APPROXIMATE.

REV. NO.	DATE	DESCRIPTION

Westar Energy®

APTIM

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LAWRENCE ENERGY CENTER
1250 N 1800 RD. LAWRENCE, KANSAS

FIGURE 3
INACTIVE UNITS - ASH POND AREA 2, ASH POND AREA 3, ASH POND 4
INFLOW DESIGN FLOOD CONTROL SYSTEM

DRAWN BY:	ORC	APPROVED BY:	RDS	PROJ. NO.:	631232565	DATE:	APRIL 2018

APPENDIX A

Rainfall Intensity Tables for Kansas Counties

APPENDICES

Appendix A - Rainfall Intensity Tables for Kansas Counties

Appendix B - Inflow Design Flood Control System HydroCAD Output Files

RAINFALL INTENSITY TABLES

FOR KANSAS COUNTIES

Developed for

Kansas Department of Transportation

by

Bruce M. McEnroe

Department of Civil and Environmental Engineering
University of Kansas
Lawrence, Kansas

June, 1997

RAINFALL INTENSITY TABLE

DOUGLAS COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION,	RETURN PERIOD						
HR:MIN	1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0:05	4.63	5.40	6.48	7.26	8.41	9.31	10.20
0:06	4.44	5.19	6.23	6.99	8.10	8.97	9.84
0:07	4.28	5.00	6.02	6.75	7.83	8.68	9.52
0:08	4.12	4.83	5.82	6.53	7.58	8.40	9.22
0:09	3.98	4.66	5.62	6.32	7.34	8.13	8.93
0:10	3.84	4.50	5.43	6.11	7.10	7.87	8.64
0:11	3.70	4.34	5.25	5.91	6.87	7.61	8.36
0:12	3.57	4.19	5.08	5.71	6.64	7.37	8.09
0:13	3.45	4.05	4.91	5.53	6.43	7.14	7.84
0:14	3.33	3.92	4.76	5.36	6.24	6.93	7.61
0:15	3.22	3.80	4.62	5.21	6.06	6.73	7.40
0:16	3.12	3.69	4.49	5.06	5.90	6.56	7.21
0:17	3.03	3.58	4.37	4.93	5.75	6.39	7.03
0:18	2.94	3.48	4.26	4.81	5.61	6.24	6.86
0:19	2.86	3.39	4.15	4.69	5.48	6.10	6.71
0:20	2.78	3.30	4.05	4.59	5.36	5.97	6.57
0:21	2.71	3.22	3.96	4.48	5.25	5.84	6.43
0:22	2.64	3.14	3.87	4.39	5.14	5.72	6.30
0:23	2.57	3.07	3.79	4.30	5.03	5.61	6.18
0:24	2.51	3.00	3.71	4.21	4.94	5.50	6.06
0:25	2.45	2.93	3.63	4.13	4.84	5.40	5.95
0:26	2.39	2.87	3.56	4.05	4.75	5.30	5.85
0:27	2.34	2.81	3.49	3.97	4.67	5.21	5.74
0:28	2.29	2.75	3.42	3.90	4.58	5.12	5.65
0:29	2.24	2.69	3.36	3.83	4.50	5.03	5.55
0:30	2.19	2.64	3.30	3.76	4.43	4.94	5.46
0:31	2.14	2.59	3.24	3.70	4.35	4.86	5.37
0:32	2.10	2.54	3.18	3.63	4.28	4.78	5.29
0:33	2.06	2.49	3.13	3.57	4.21	4.71	5.20
0:34	2.02	2.45	3.07	3.51	4.14	4.64	5.12
0:35	1.98	2.40	3.02	3.46	4.08	4.56	5.05
0:36	1.94	2.36	2.97	3.40	4.02	4.50	4.97
0:37	1.91	2.32	2.93	3.35	3.96	4.43	4.90
0:38	1.88	2.28	2.88	3.30	3.90	4.36	4.83
0:39	1.84	2.24	2.84	3.25	3.84	4.30	4.76
0:40	1.81	2.21	2.79	3.20	3.78	4.24	4.69
0:41	1.78	2.17	2.75	3.16	3.73	4.18	4.62
0:42	1.75	2.14	2.71	3.11	3.68	4.12	4.56
0:43	1.73	2.11	2.67	3.07	3.63	4.07	4.50
0:44	1.70	2.08	2.63	3.02	3.58	4.01	4.44
0:45	1.67	2.05	2.60	2.98	3.53	3.96	4.38

RAINFALL INTENSITY TABLE

DOUGLAS COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION, HR:MIN	RETURN PERIOD 1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0:46	1.65	2.02	2.56	2.94	3.48	3.90	4.32
0:47	1.63	1.99	2.53	2.90	3.44	3.85	4.27
0:48	1.60	1.96	2.50	2.87	3.39	3.80	4.21
0:49	1.58	1.94	2.46	2.83	3.35	3.76	4.16
0:50	1.56	1.91	2.43	2.79	3.31	3.71	4.11
0:51	1.54	1.89	2.40	2.76	3.27	3.66	4.06
0:52	1.52	1.86	2.37	2.72	3.23	3.62	4.01
0:53	1.50	1.84	2.34	2.69	3.19	3.58	3.96
0:54	1.48	1.82	2.31	2.66	3.15	3.53	3.91
0:55	1.47	1.80	2.29	2.63	3.11	3.49	3.87
0:56	1.45	1.78	2.26	2.60	3.08	3.45	3.82
0:57	1.43	1.76	2.23	2.57	3.04	3.41	3.78
0:58	1.42	1.74	2.21	2.54	3.01	3.37	3.73
0:59	1.40	1.72	2.18	2.51	2.97	3.33	3.69
1:00	1.39	1.70	2.16	2.48	2.94	3.30	3.65
1:05	1.32	1.62	2.05	2.35	2.78	3.12	3.46
1:10	1.26	1.54	1.95	2.24	2.65	2.96	3.28
1:15	1.21	1.47	1.86	2.13	2.52	2.82	3.12
1:20	1.16	1.41	1.78	2.04	2.41	2.69	2.98
1:25	1.12	1.36	1.71	1.95	2.30	2.57	2.85
1:30	1.08	1.30	1.64	1.87	2.21	2.47	2.73
1:35	1.04	1.26	1.57	1.80	2.12	2.37	2.62
1:40	1.00	1.21	1.52	1.73	2.04	2.28	2.52
1:45	0.97	1.17	1.46	1.67	1.97	2.20	2.43
1:50	0.93	1.13	1.41	1.61	1.90	2.12	2.35
1:55	0.90	1.09	1.36	1.56	1.84	2.05	2.27
2:00	0.87	1.05	1.32	1.51	1.78	1.99	2.20
2:05	0.84	1.01	1.28	1.46	1.73	1.93	2.13
2:10	0.81	0.98	1.24	1.42	1.67	1.87	2.07
2:15	0.78	0.95	1.20	1.38	1.63	1.82	2.02
2:20	0.75	0.92	1.16	1.34	1.58	1.77	1.96
2:25	0.73	0.89	1.13	1.30	1.54	1.73	1.91
2:30	0.70	0.86	1.10	1.27	1.50	1.69	1.87
2:35	0.68	0.84	1.07	1.23	1.47	1.64	1.82
2:40	0.66	0.81	1.04	1.20	1.43	1.61	1.78
2:45	0.64	0.79	1.02	1.17	1.40	1.57	1.74
2:50	0.62	0.77	0.99	1.15	1.37	1.54	1.70
2:55	0.60	0.75	0.97	1.12	1.34	1.50	1.67
3:00	0.59	0.73	0.95	1.10	1.31	1.47	1.63

RAINFALL INTENSITY TABLE

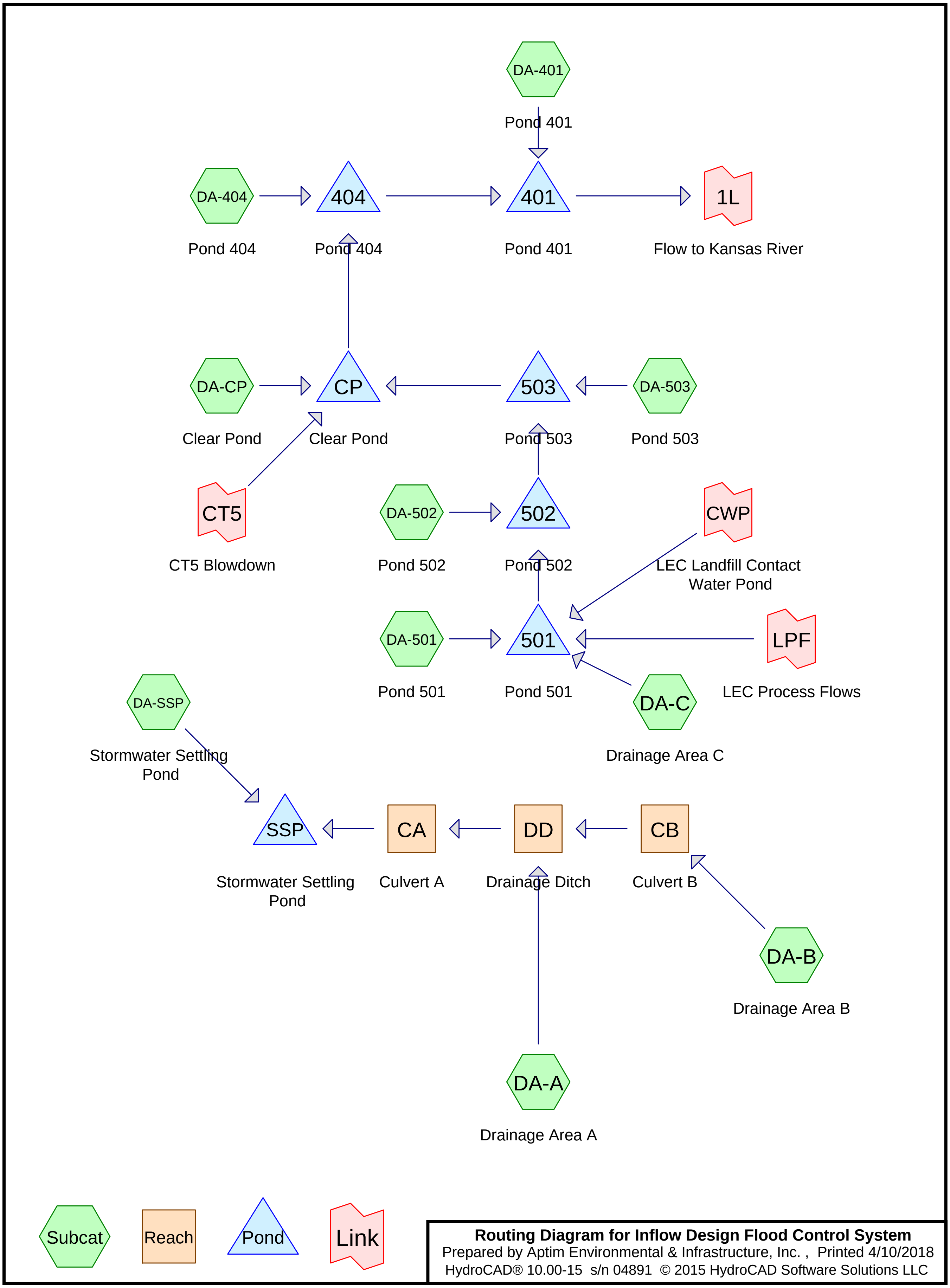
DOUGLAS COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION,			RETURN PERIOD				
HR:MIN	1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
3:15	0.55	0.69	0.89	1.03	1.23	1.38	1.54
3:30	0.52	0.65	0.84	0.97	1.16	1.31	1.46
3:45	0.49	0.61	0.80	0.92	1.10	1.24	1.38
4:00	0.46	0.58	0.76	0.88	1.05	1.18	1.32
4:15	0.44	0.56	0.72	0.84	1.00	1.13	1.26
4:30	0.43	0.53	0.69	0.80	0.96	1.08	1.20
4:45	0.41	0.51	0.67	0.77	0.92	1.04	1.15
5:00	0.40	0.49	0.64	0.74	0.89	1.00	1.11
5:15	0.38	0.48	0.62	0.72	0.86	0.96	1.07
5:30	0.37	0.46	0.60	0.69	0.83	0.93	1.03
5:45	0.36	0.45	0.58	0.67	0.80	0.90	1.00
6:00	0.35	0.43	0.56	0.65	0.77	0.87	0.97
6:30	0.33	0.41	0.53	0.61	0.73	0.82	0.91
7:00	0.31	0.39	0.50	0.58	0.69	0.78	0.86
7:30	0.30	0.37	0.48	0.55	0.66	0.74	0.82
8:00	0.28	0.35	0.45	0.52	0.62	0.70	0.78
8:30	0.27	0.34	0.43	0.50	0.60	0.67	0.75
9:00	0.26	0.32	0.42	0.48	0.57	0.64	0.71
9:30	0.25	0.31	0.40	0.46	0.55	0.62	0.69
10:00	0.24	0.30	0.38	0.44	0.53	0.60	0.66
10:30	0.23	0.29	0.37	0.43	0.51	0.57	0.64
11:00	0.22	0.28	0.36	0.41	0.49	0.55	0.61
11:30	0.21	0.27	0.35	0.40	0.48	0.54	0.59
12:00	0.21	0.26	0.33	0.39	0.46	0.52	0.57
13:00	0.20	0.24	0.31	0.36	0.43	0.49	0.54
14:00	0.18	0.23	0.30	0.34	0.41	0.46	0.51
15:00	0.17	0.22	0.28	0.32	0.39	0.43	0.48
16:00	0.17	0.21	0.27	0.31	0.37	0.41	0.46
17:00	0.16	0.20	0.25	0.29	0.35	0.39	0.44
18:00	0.15	0.19	0.24	0.28	0.33	0.38	0.42
19:00	0.15	0.18	0.23	0.27	0.32	0.36	0.40
20:00	0.14	0.17	0.22	0.26	0.31	0.34	0.38
21:00	0.13	0.17	0.21	0.25	0.29	0.33	0.37
22:00	0.13	0.16	0.21	0.24	0.28	0.32	0.35
23:00	0.13	0.16	0.20	0.23	0.27	0.31	0.34
24:00	0.12	0.15	0.19	0.22	0.26	0.30	0.33

APPENDX B

Inflow Design Flood Control System HydroCAD Output Files



Routing Diagram for Inflow Design Flood Control System
Prepared by Aptim Environmental & Infrastructure, Inc. , Printed 4/10/2018
HydroCAD® 10.00-15 s/n 04891 © 2015 HydroCAD Software Solutions LLC

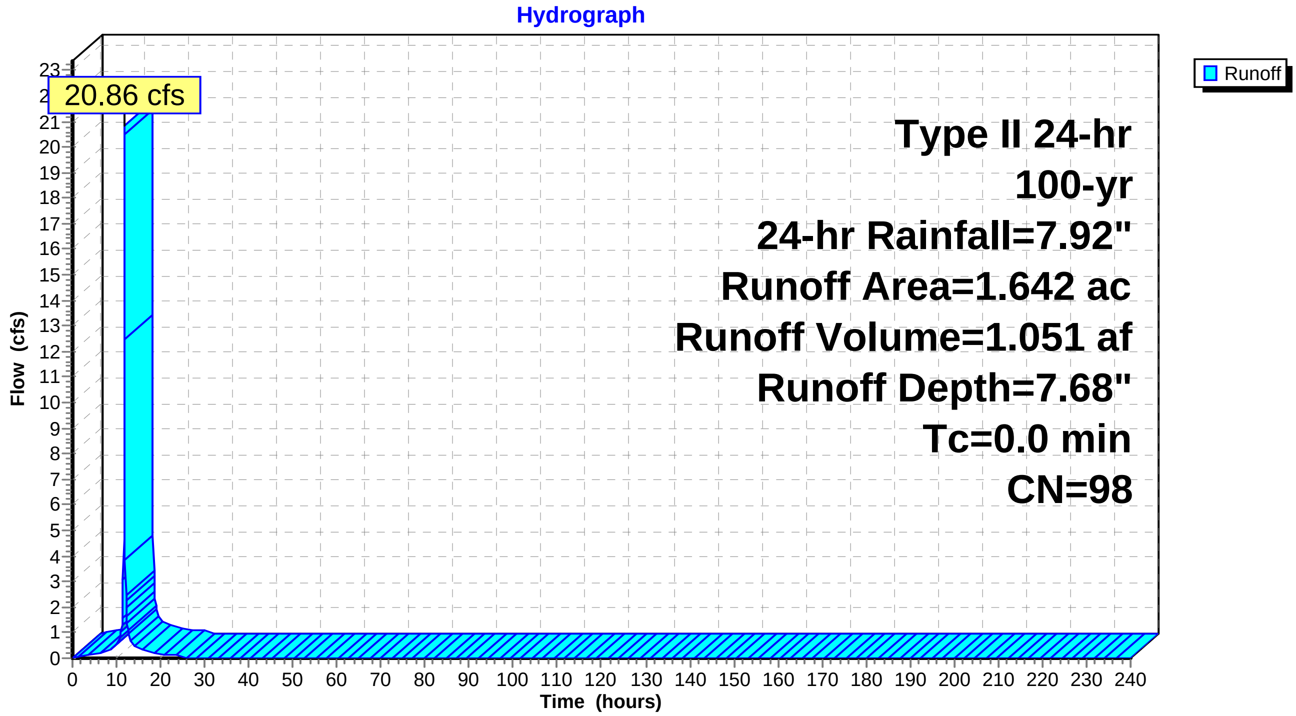
Summary for Subcatchment DA-401: Pond 401

Runoff = 20.86 cfs @ 11.89 hrs, Volume= 1.051 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
1.642	98	Water Surface, HSG D
1.642		100.00% Impervious Area

Subcatchment DA-401: Pond 401



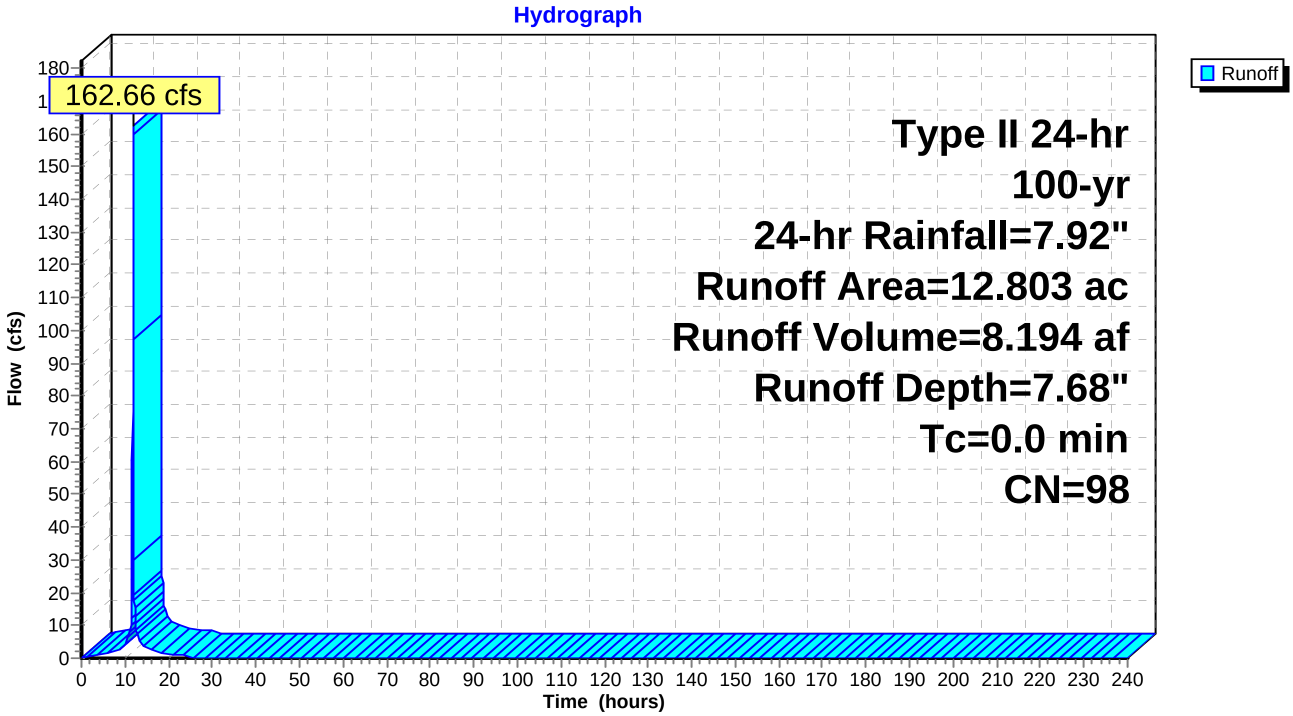
Summary for Subcatchment DA-404: Pond 404

Runoff = 162.66 cfs @ 11.89 hrs, Volume= 8.194 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
12.803	98	Water Surface, HSG D
12.803		100.00% Impervious Area

Subcatchment DA-404: Pond 404



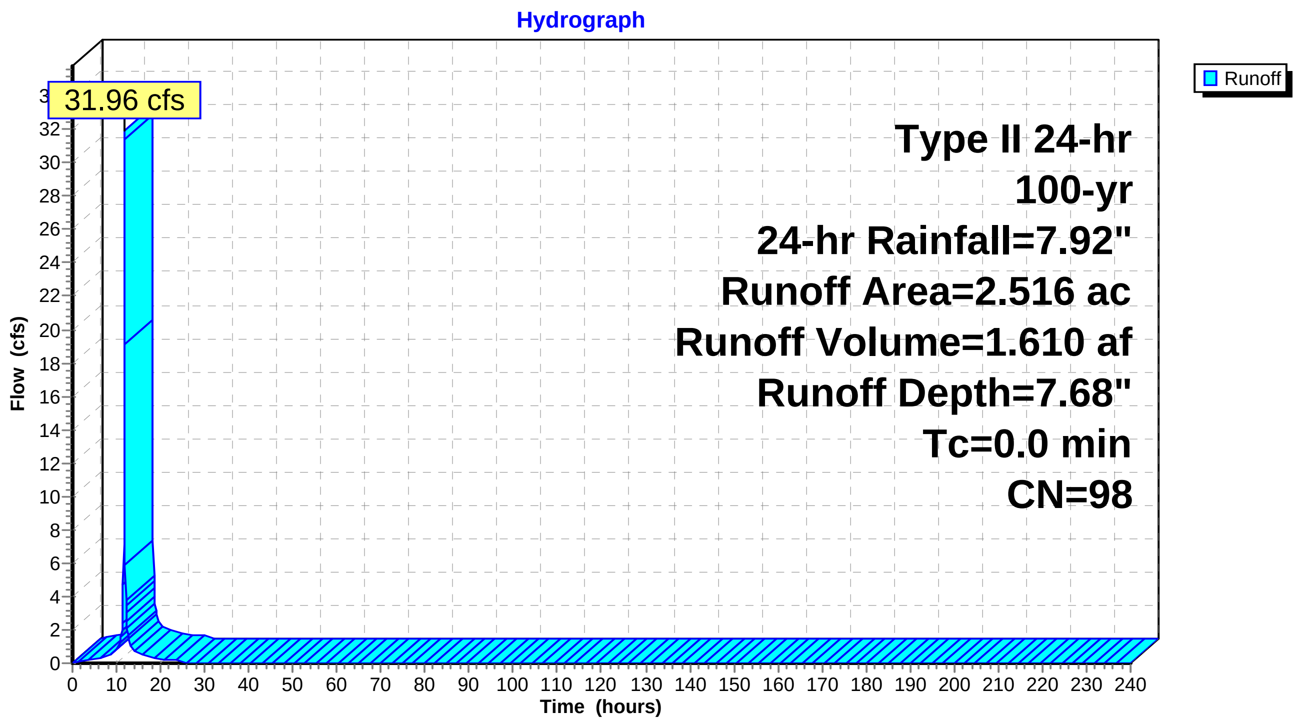
Summary for Subcatchment DA-501: Pond 501

Runoff = 31.96 cfs @ 11.89 hrs, Volume= 1.610 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
2.516	98	Water Surface, HSG D
2.516		100.00% Impervious Area

Subcatchment DA-501: Pond 501



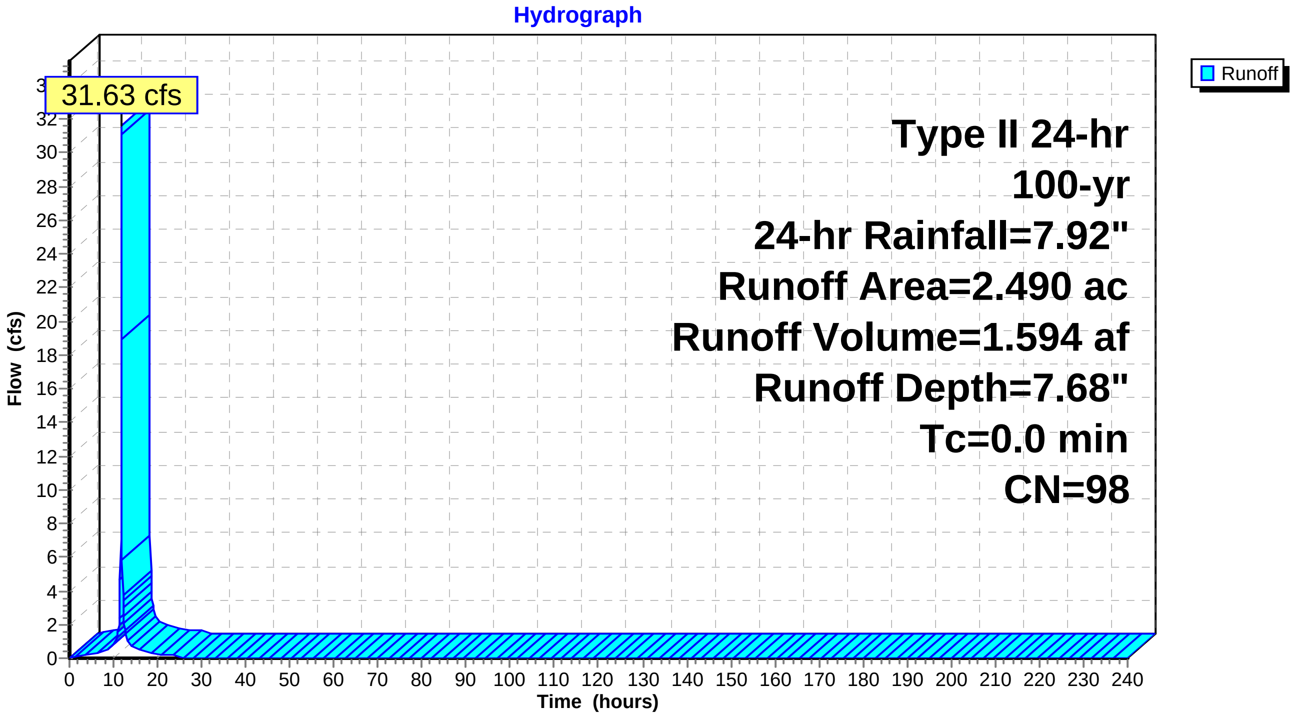
Summary for Subcatchment DA-502: Pond 502

Runoff = 31.63 cfs @ 11.89 hrs, Volume= 1.594 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
2.490	98	Water Surface, HSG D
2.490		100.00% Impervious Area

Subcatchment DA-502: Pond 502



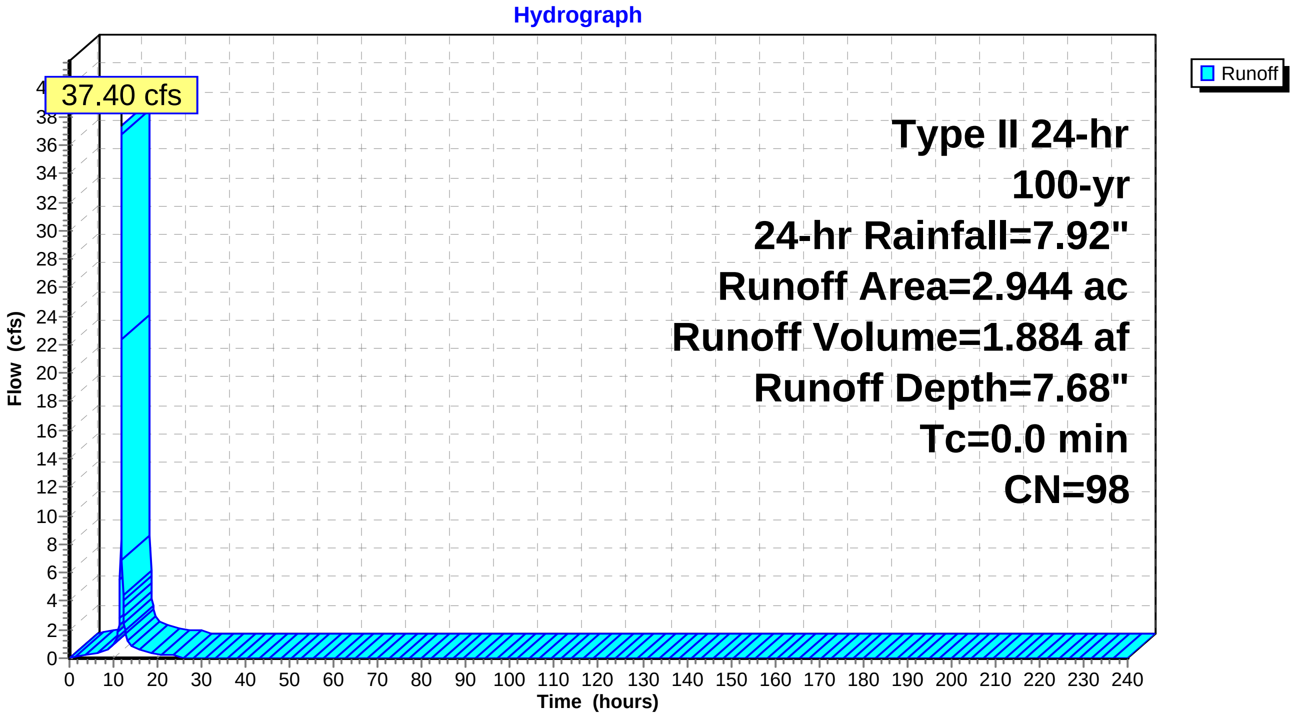
Summary for Subcatchment DA-503: Pond 503

Runoff = 37.40 cfs @ 11.89 hrs, Volume= 1.884 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
2.944	98	Water Surface, HSG D
2.944		100.00% Impervious Area

Subcatchment DA-503: Pond 503



Summary for Subcatchment DA-A: Drainage Area A

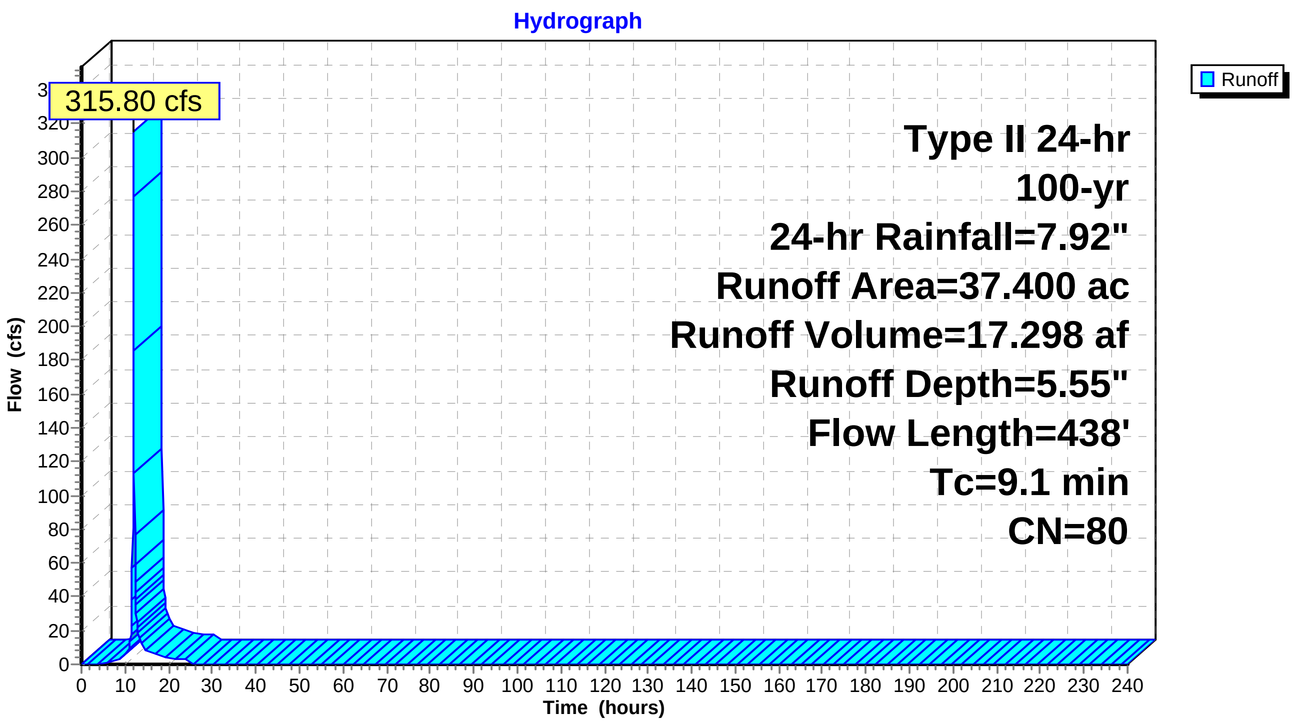
Runoff = 315.80 cfs @ 12.00 hrs, Volume= 17.298 af, Depth= 5.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
37.400	80	>75% Grass cover, Good, HSG D
37.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	300	0.2269	0.59		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.60"
0.7	138	0.2088	3.20		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.1	438	Total			

Subcatchment DA-A: Drainage Area A



Summary for Subcatchment DA-B: Drainage Area B

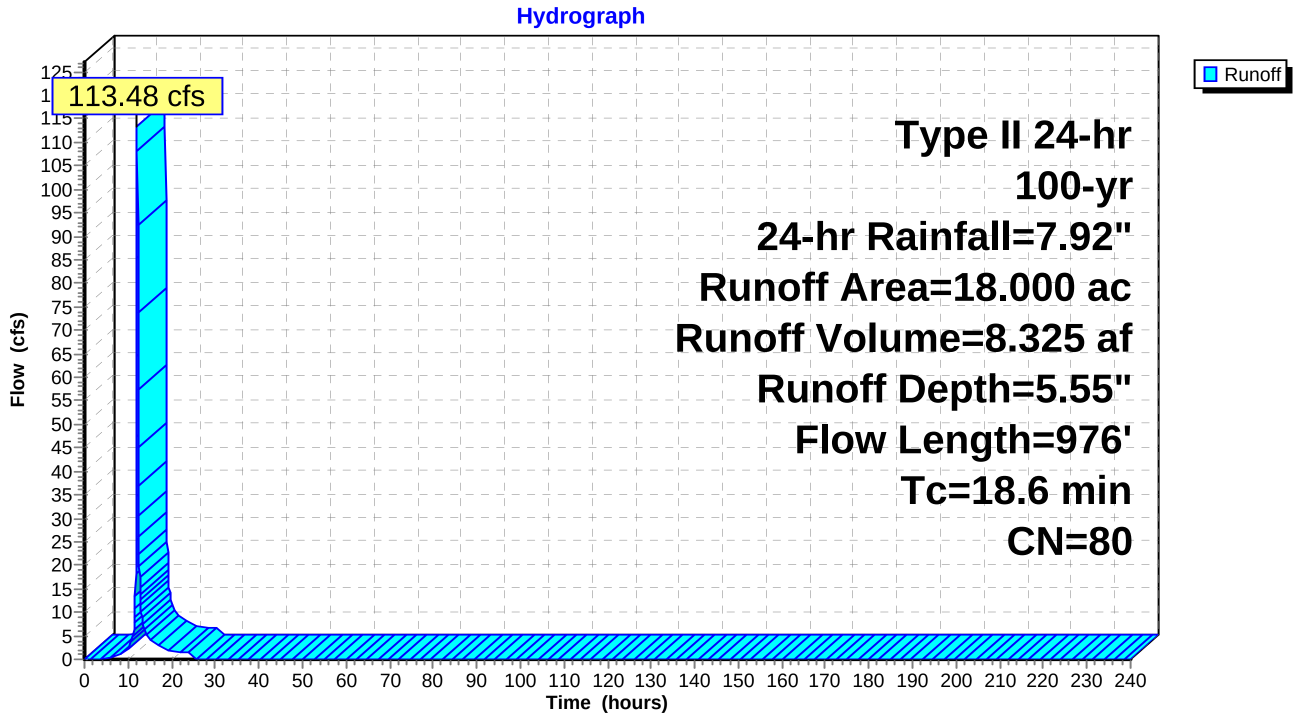
Runoff = 113.48 cfs @ 12.11 hrs, Volume= 8.325 af, Depth= 5.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
18.000	80	>75% Grass cover, Good, HSG D
18.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	300	0.1046	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.60"
7.1	676	0.0512	1.58		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
18.6	976	Total			

Subcatchment DA-B: Drainage Area B



Summary for Subcatchment DA-C: Drainage Area C

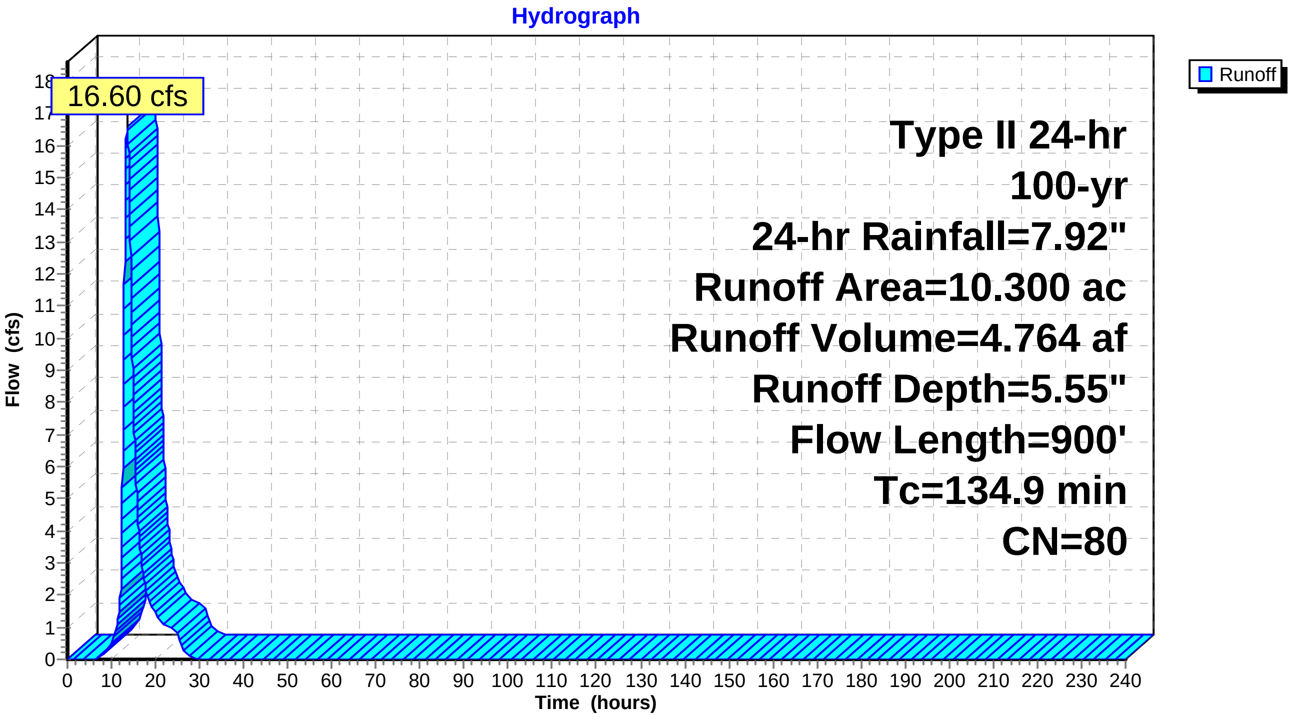
Runoff = 16.60 cfs @ 13.60 hrs, Volume= 4.764 af, Depth= 5.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
10.300	80	>75% Grass cover, Good, HSG D
10.300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.0	300	0.0011	0.07		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.60"
63.9	600	0.0005	0.16		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
134.9	900	Total			

Subcatchment DA-C: Drainage Area C



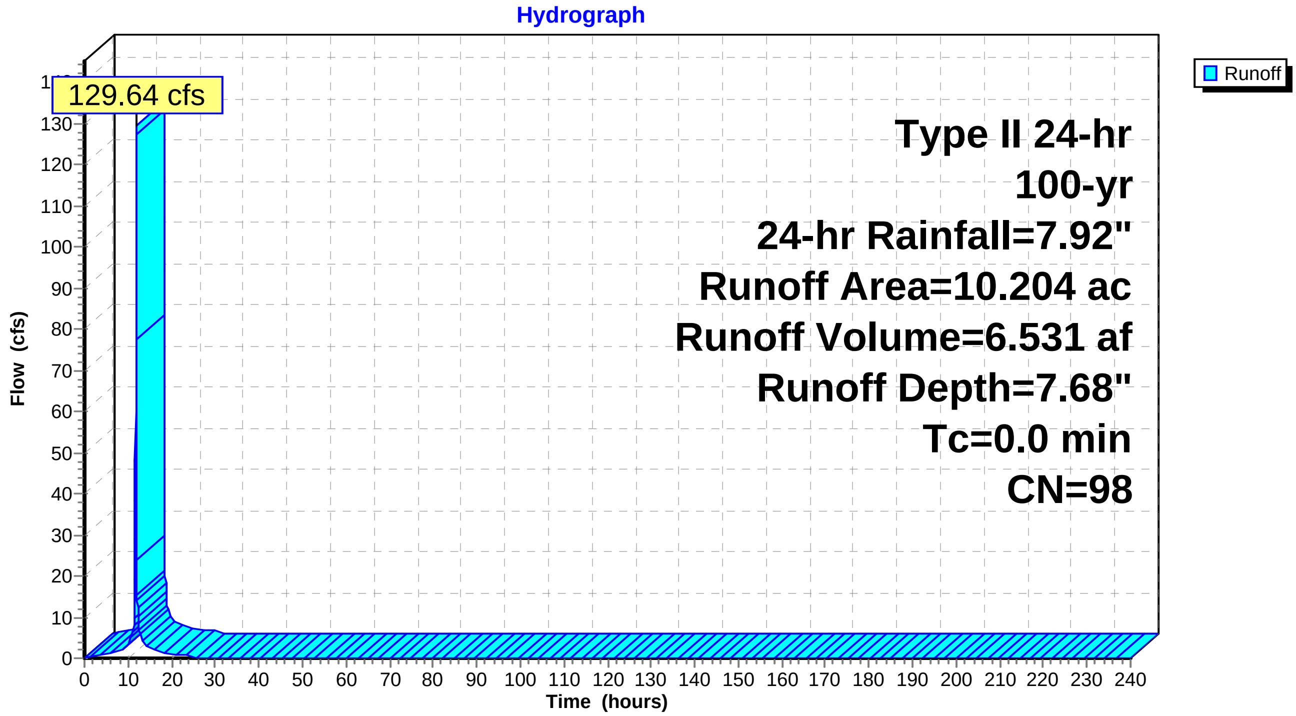
Summary for Subcatchment DA-CP: Clear Pond

Runoff = 129.64 cfs @ 11.89 hrs, Volume= 6.531 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
10.204	98	Water Surface, HSG D
10.204		100.00% Impervious Area

Subcatchment DA-CP: Clear Pond



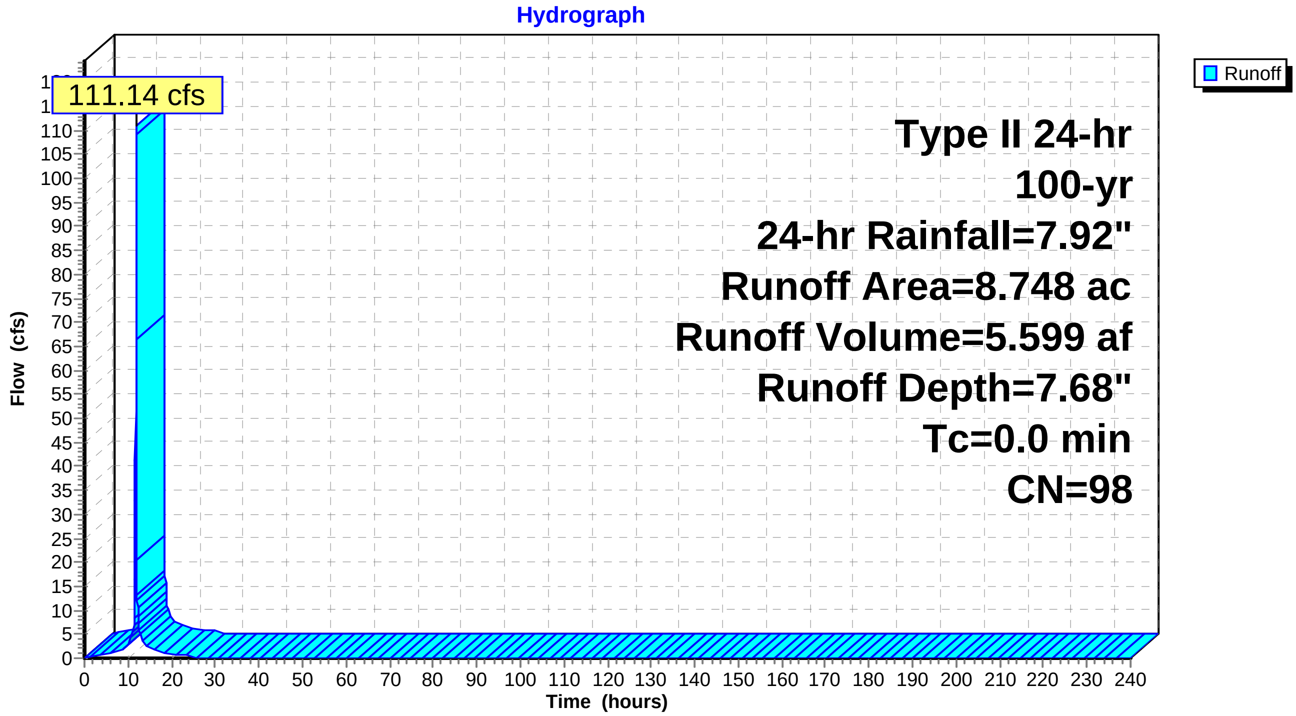
Summary for Subcatchment DA-SSP: Stormwater Settling Pond

Runoff = 111.14 cfs @ 11.89 hrs, Volume= 5.599 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.92"

Area (ac)	CN	Description
8.748	98	Water Surface, 0% imp, HSG D
8.748		100.00% Pervious Area

Subcatchment DA-SSP: Stormwater Settling Pond



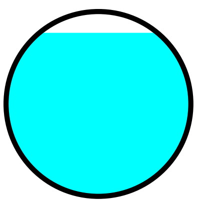
Summary for Reach CA: Culvert A

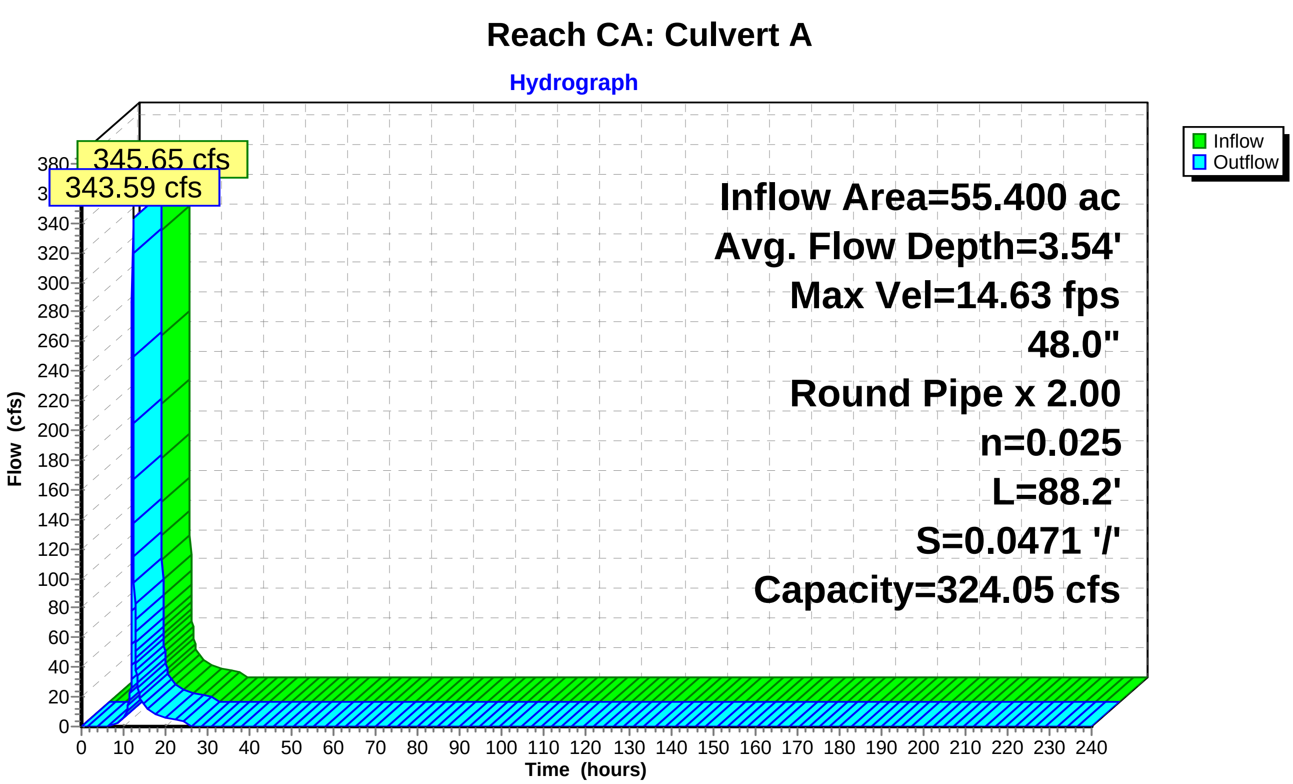
Inflow Area = 55.400 ac, 0.00% Impervious, Inflow Depth = 5.55" for 100-yr, 24-hr event
Inflow = 345.65 cfs @ 12.17 hrs, Volume= 25.623 af
Outflow = 343.59 cfs @ 12.18 hrs, Volume= 25.623 af, Atten= 1%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.63 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.92 fps, Avg. Travel Time= 0.4 min

Peak Storage= 2,078 cf @ 12.18 hrs
Average Depth at Peak Storage= 3.54'
Bank-Full Depth= 4.00' Flow Area= 25.1 sf, Capacity= 324.05 cfs

A factor of 2.00 has been applied to the storage and discharge capacity
48.0" Round Pipe
n= 0.025 Corrugated metal
Length= 88.2' Slope= 0.0471 '/'
Inlet Invert= 0.00', Outlet Invert= -4.15'





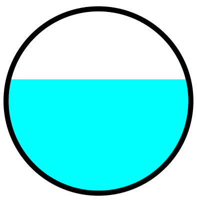
Summary for Reach CB: Culvert B

Inflow Area = 18.000 ac, 0.00% Impervious, Inflow Depth = 5.55" for 100-yr, 24-hr event
Inflow = 113.48 cfs @ 12.11 hrs, Volume= 8.325 af
Outflow = 113.12 cfs @ 12.11 hrs, Volume= 8.325 af, Atten= 0%, Lag= 0.3 min

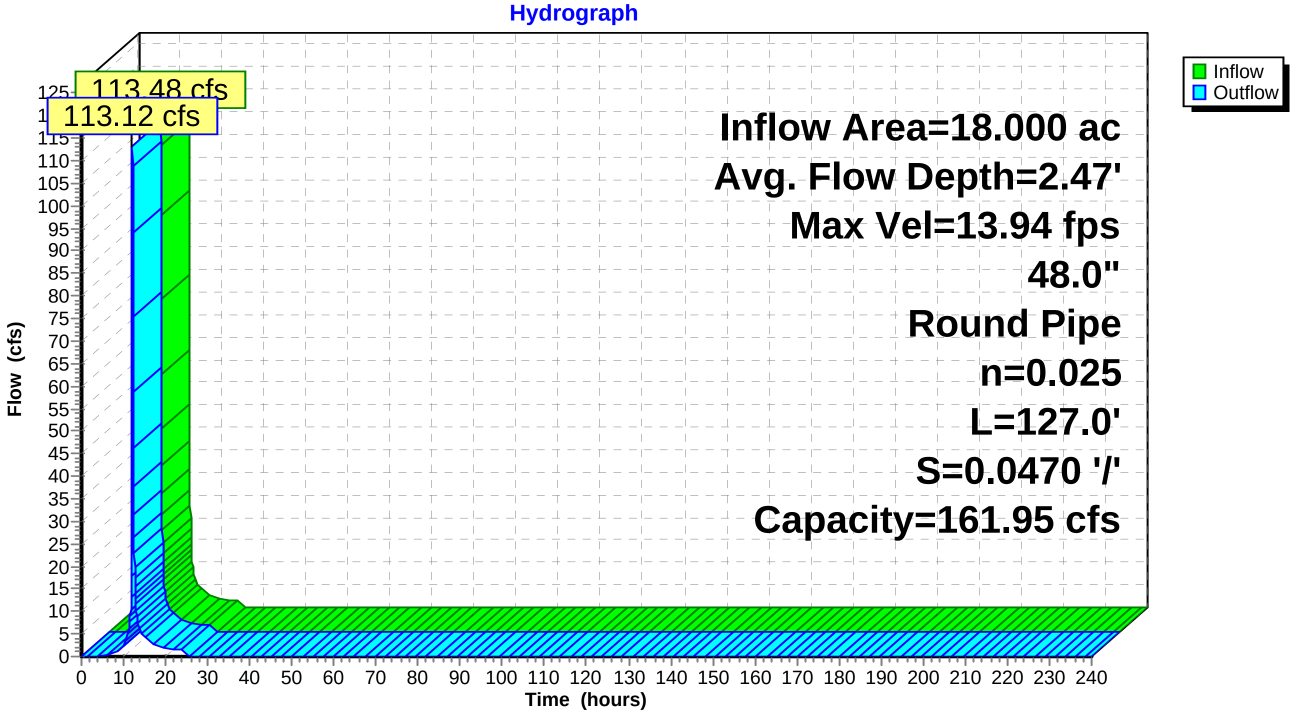
Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.94 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.67 fps, Avg. Travel Time= 0.5 min

Peak Storage= 1,033 cf @ 12.11 hrs
Average Depth at Peak Storage= 2.47'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 161.95 cfs

48.0" Round Pipe
n= 0.025 Corrugated metal
Length= 127.0' Slope= 0.0470 '/'
Inlet Invert= 0.00', Outlet Invert= -5.97'



Reach CB: Culvert B



Summary for Reach DD: Drainage Ditch

Inflow Area = 55.400 ac, 0.00% Impervious, Inflow Depth = 5.55" for 100-yr, 24-hr event
Inflow = 402.31 cfs @ 12.01 hrs, Volume= 25.623 af
Outflow = 345.65 cfs @ 12.17 hrs, Volume= 25.623 af, Atten= 14%, Lag= 9.6 min

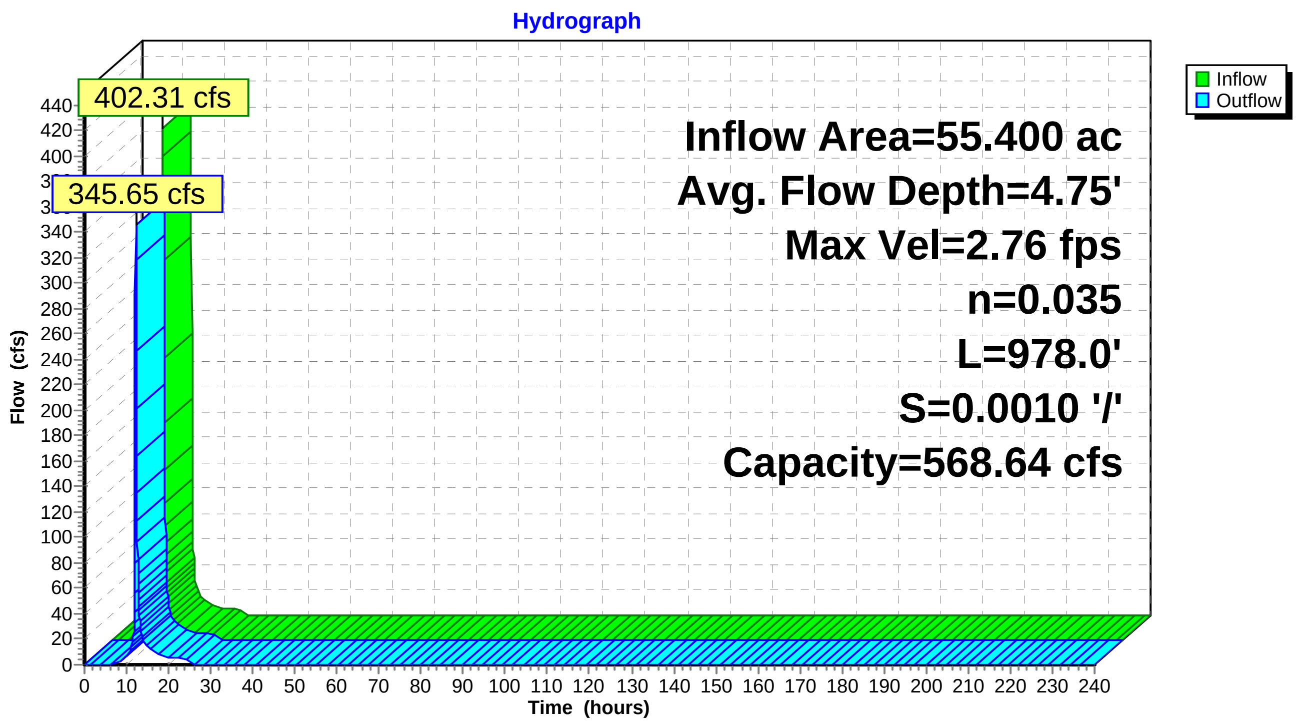
Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.76 fps, Min. Travel Time= 5.9 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 26.3 min

Peak Storage= 122,088 cf @ 12.07 hrs
Average Depth at Peak Storage= 4.75'
Bank-Full Depth= 6.00' Flow Area= 180.0 sf, Capacity= 568.64 cfs

12.00' x 6.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 48.00'
Length= 978.0' Slope= 0.0010 '/'
Inlet Invert= 0.00', Outlet Invert= -0.98'

‡

Reach DD: Drainage Ditch



Summary for Pond 401: Pond 401

Inflow Area = 42.899 ac, 75.99% Impervious, Inflow Depth > 18.91" for 100-yr, 24-hr event
Inflow = 21.65 cfs @ 11.89 hrs, Volume= 67.591 af
Outflow = 11.82 cfs @ 11.96 hrs, Volume= 67.392 af, Atten= 45%, Lag= 4.4 min
Primary = 11.82 cfs @ 11.96 hrs, Volume= 67.392 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Peak Elev= 827.53' @ 11.96 hrs Surf.Area= 11,993 sf Storage= 15,764 cf

Plug-Flow detention time= 42.8 min calculated for 67.378 af (100% of inflow)
Center-of-Mass det. time= 21.0 min (7,018.8 - 6,997.8)

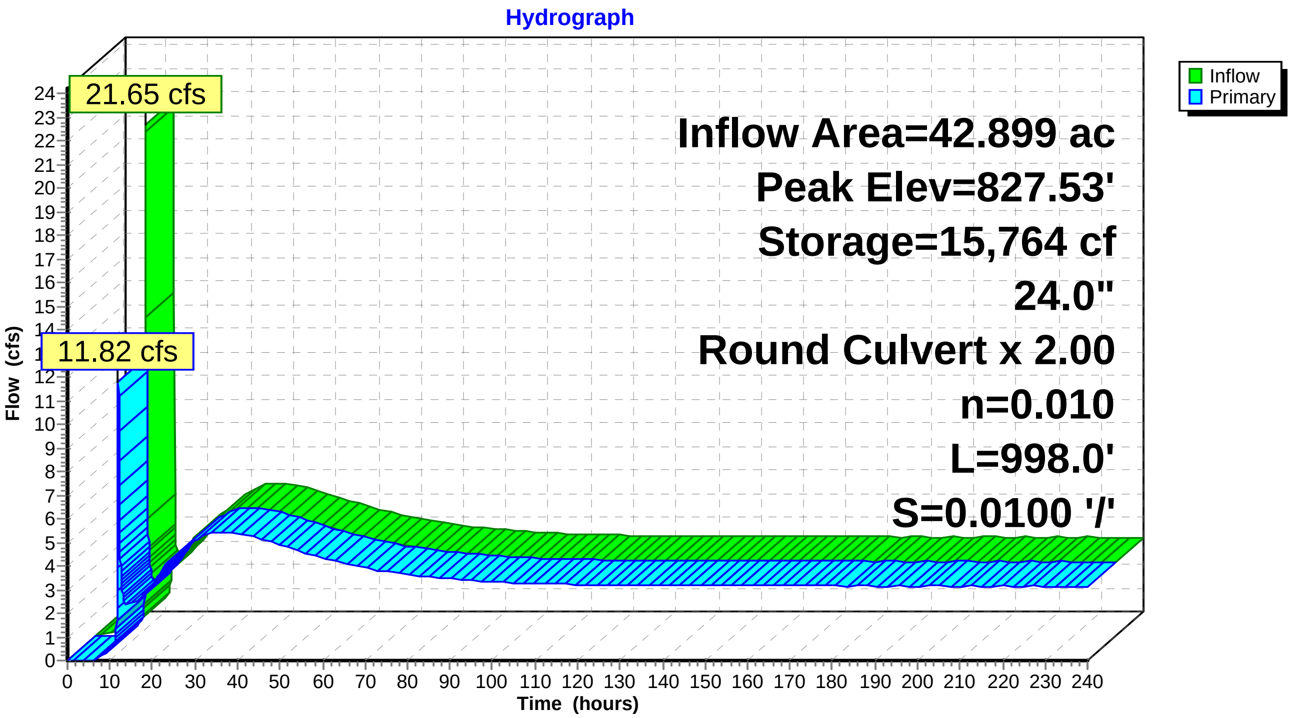
Volume	Invert	Avail.Storage	Storage Description
#1	826.00'	463,131 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
826.00	8,575	0	0
828.00	13,034	21,609	21,609
830.00	17,801	30,835	52,444
832.00	22,855	40,656	93,100
834.00	28,192	51,047	144,147
836.00	33,812	62,004	206,151
838.00	39,689	73,501	279,652
840.00	45,810	85,499	365,151
842.00	52,170	97,980	463,131

Device	Routing	Invert	Outlet Devices
#1	Primary	826.32'	**24.0" Round Culvert X 2.00** L= 998.0' Ke= 0.900 Inlet / Outlet Invert= 826.32' / 816.34' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 3.14 sf

Primary OutFlow Max=11.60 cfs @ 11.96 hrs HW=827.52' (Free Discharge)
1=Culvert (Inlet Controls 11.60 cfs @ 2.95 fps)

Pond 401: Pond 401



Summary for Pond 404: Pond 404

Inflow Area = 41.257 ac, 75.03% Impervious, Inflow Depth > 21.91" for 100-yr, 24-hr event
Inflow = 163.54 cfs @ 11.89 hrs, Volume= 75.340 af
Outflow = 5.45 cfs @ 36.55 hrs, Volume= 66.540 af, Atten= 97%, Lag= 1,479.6 min
Primary = 5.45 cfs @ 36.55 hrs, Volume= 66.540 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Starting Elev= 829.56' Surf.Area= 423,686 sf Storage= 235,945 cf
Peak Elev= 830.75' @ 36.55 hrs Surf.Area= 433,756 sf Storage= 745,937 cf (509,992 cf above start)

Plug-Flow detention time= 2,859.4 min calculated for 61.123 af (81% of inflow)
Center-of-Mass det. time= 840.5 min (7,096.8 - 6,256.3)

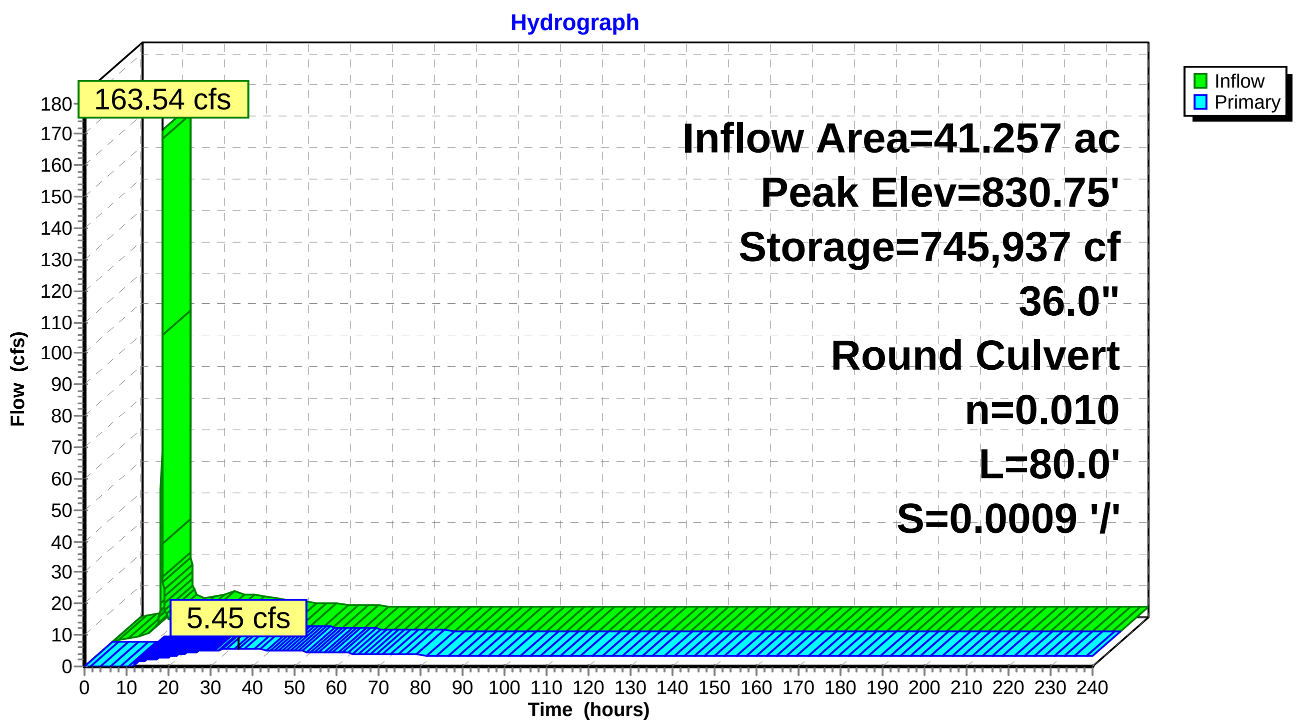
Volume	Invert	Avail.Storage	Storage Description
#1	829.00'	5,128,910 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
829.00	418,976	0	0
830.00	427,386	423,181	423,181
832.00	444,382	871,768	1,294,949
834.00	461,610	905,992	2,200,941
836.00	479,071	940,681	3,141,622
838.00	496,764	975,835	4,117,457
840.00	514,689	1,011,453	5,128,910

Device	Routing	Invert	Outlet Devices
#1	Primary	829.56'	**36.0" Round Culvert** L= 80.0' Ke= 0.900 Inlet / Outlet Invert= 829.56' / 829.49' S= 0.0009 '/' Cc= 0.900 n= 0.010, Flow Area= 7.07 sf

Primary OutFlow Max=5.45 cfs @ 36.55 hrs HW=830.75' (Free Discharge)
└─**1=Culvert** (Barrel Controls 5.45 cfs @ 3.09 fps)

Pond 404: Pond 404



Summary for Pond 501: Pond 501

Inflow Area = 12.816 ac, 19.63% Impervious, Inflow Depth > 55.20" for 100-yr, 24-hr event
Inflow = 34.38 cfs @ 11.89 hrs, Volume= 58.956 af
Outflow = 13.67 cfs @ 14.66 hrs, Volume= 57.584 af, Atten= 60%, Lag= 166.3 min
Primary = 13.67 cfs @ 14.66 hrs, Volume= 57.584 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Starting Elev= 835.95' Surf.Area= 66,953 sf Storage= 61,966 cf
Peak Elev= 837.91' @ 14.66 hrs Surf.Area= 74,237 sf Storage= 200,272 cf (138,306 cf above start)

Plug-Flow detention time= 680.7 min calculated for 56.152 af (95% of inflow)
Center-of-Mass det. time= 147.4 min (6,663.2 - 6,515.8)

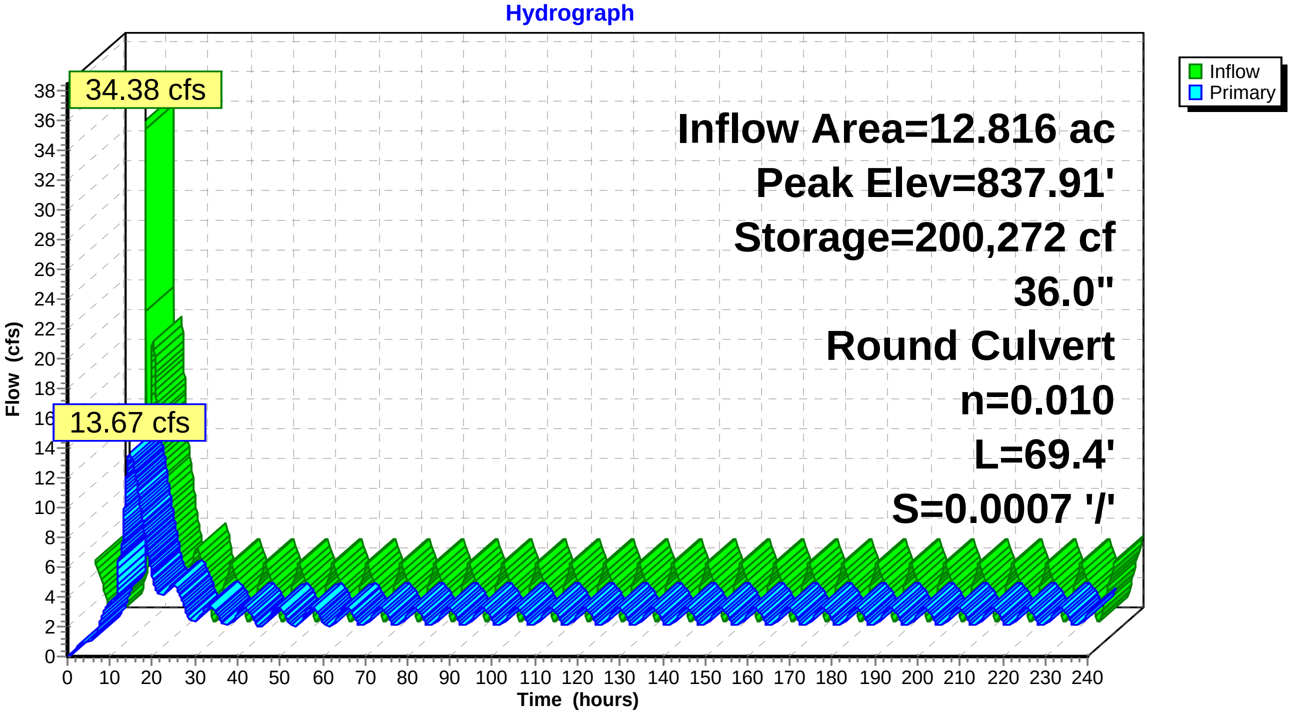
Volume	Invert	Avail.Storage	Storage Description
#1	835.00'	363,843 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
835.00	63,501	0	0
836.00	67,135	65,318	65,318
838.00	74,575	141,710	207,028
840.00	82,240	156,815	363,843

Device	Routing	Invert	Outlet Devices
#1	Primary	835.95'	**36.0" Round Culvert** L= 69.4' Ke= 0.900 Inlet / Outlet Invert= 835.95' / 835.90' S= 0.0007 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=13.67 cfs @ 14.66 hrs HW=837.91' (Free Discharge)
└─**1=Culvert** (Barrel Controls 13.67 cfs @ 3.97 fps)

Pond 501: Pond 501



Summary for Pond 502: Pond 502

Inflow Area = 15.306 ac, 32.71% Impervious, Inflow Depth > 46.40" for 100-yr, 24-hr event
Inflow = 37.36 cfs @ 11.89 hrs, Volume= 59.178 af
Outflow = 12.36 cfs @ 16.17 hrs, Volume= 57.988 af, Atten= 67%, Lag= 256.8 min
Primary = 12.36 cfs @ 16.17 hrs, Volume= 57.988 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Starting Elev= 835.85' Surf.Area= 62,264 sf Storage= 51,634 cf
Peak Elev= 837.72' @ 16.17 hrs Surf.Area= 69,098 sf Storage= 174,558 cf (122,924 cf above start)

Plug-Flow detention time= 594.0 min calculated for 56.791 af (96% of inflow)
Center-of-Mass det. time= 152.5 min (6,656.0 - 6,503.4)

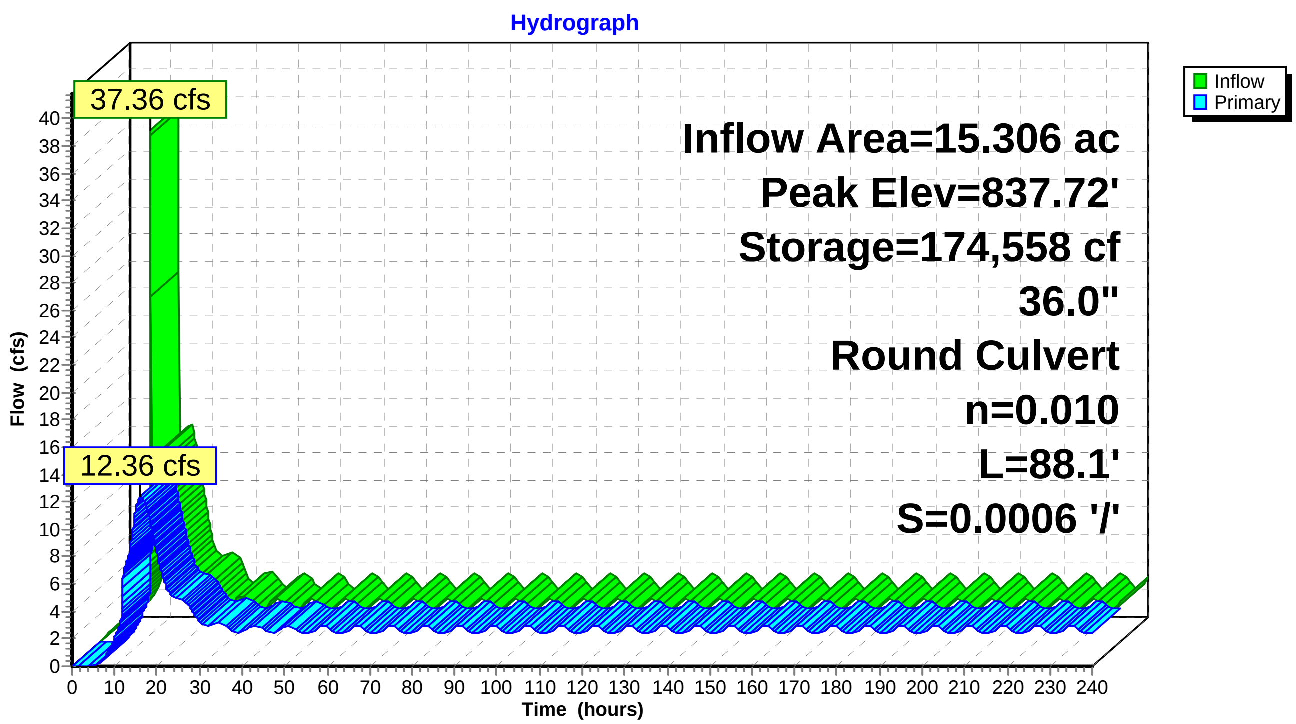
Volume	Invert	Avail.Storage	Storage Description
#1	835.00'	341,703 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
835.00	59,227	0	0
836.00	62,800	61,014	61,014
838.00	70,116	132,916	193,930
840.00	77,657	147,773	341,703

Device	Routing	Invert	Outlet Devices
#1	Primary	835.85'	**36.0" Round Culvert** L= 88.1' Ke= 0.900 Inlet / Outlet Invert= 835.85' / 835.80' S= 0.0006 '/' Cc= 0.900 n= 0.010, Flow Area= 7.07 sf

Primary OutFlow Max=12.36 cfs @ 16.17 hrs HW=837.72' (Free Discharge)
└─**1=Culvert** (Barrel Controls 12.36 cfs @ 3.81 fps)

Pond 502: Pond 502



Summary for Pond 503: Pond 503

Inflow Area = 18.250 ac, 43.56% Impervious, Inflow Depth > 39.37" for 100-yr, 24-hr event
Inflow = 43.06 cfs @ 11.89 hrs, Volume= 59.872 af
Outflow = 11.60 cfs @ 17.85 hrs, Volume= 58.497 af, Atten= 73%, Lag= 357.7 min
Primary = 11.60 cfs @ 17.85 hrs, Volume= 58.497 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Starting Elev= 835.80' Surf.Area= 81,860 sf Storage= 64,238 cf
Peak Elev= 837.40' @ 17.85 hrs Surf.Area= 88,218 sf Storage= 200,073 cf (135,834 cf above start)

Plug-Flow detention time= 694.3 min calculated for 57.011 af (95% of inflow)
Center-of-Mass det. time= 166.2 min (6,635.7 - 6,469.5)

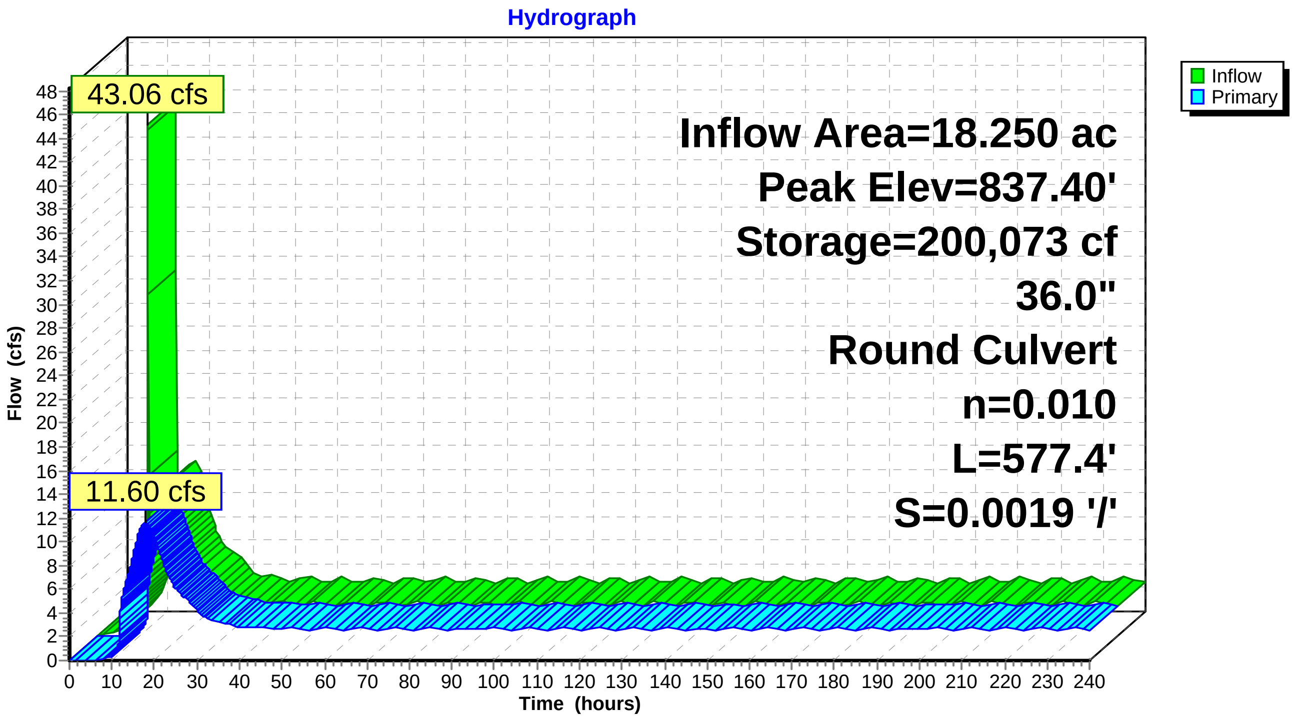
Volume	Invert	Avail.Storage	Storage Description
#1	835.00'	443,407 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
835.00	78,736	0	0
836.00	82,641	80,689	80,689
838.00	90,623	173,264	253,953
840.00	98,831	189,454	443,407

Device	Routing	Invert	Outlet Devices
#1	Primary	835.80'	**36.0" Round Culvert** L= 577.4' Ke= 0.900 Inlet / Outlet Invert= 835.80' / 834.71' S= 0.0019 '/' Cc= 0.900 n= 0.010, Flow Area= 7.07 sf

Primary OutFlow Max=11.60 cfs @ 17.85 hrs HW=837.40' (Free Discharge)
└─**1=Culvert** (Barrel Controls 11.60 cfs @ 4.40 fps)

Pond 503: Pond 503



Summary for Pond CP: Clear Pond

Inflow Area = 28.454 ac, 63.80% Impervious, Inflow Depth > 31.61" for 100-yr, 24-hr event
Inflow = 133.04 cfs @ 11.89 hrs, Volume= 74.949 af
Outflow = 7.25 cfs @ 24.48 hrs, Volume= 67.145 af, Atten= 95%, Lag= 755.3 min
Primary = 7.25 cfs @ 24.48 hrs, Volume= 67.145 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Starting Elev= 834.61' Surf.Area= 369,138 sf Storage= 223,841 cf
Peak Elev= 836.01' @ 24.48 hrs Surf.Area= 379,157 sf Storage= 746,968 cf (523,128 cf above start)

Plug-Flow detention time= 2,613.1 min calculated for 61.992 af (83% of inflow)
Center-of-Mass det. time= 734.6 min (6,930.5 - 6,195.9)

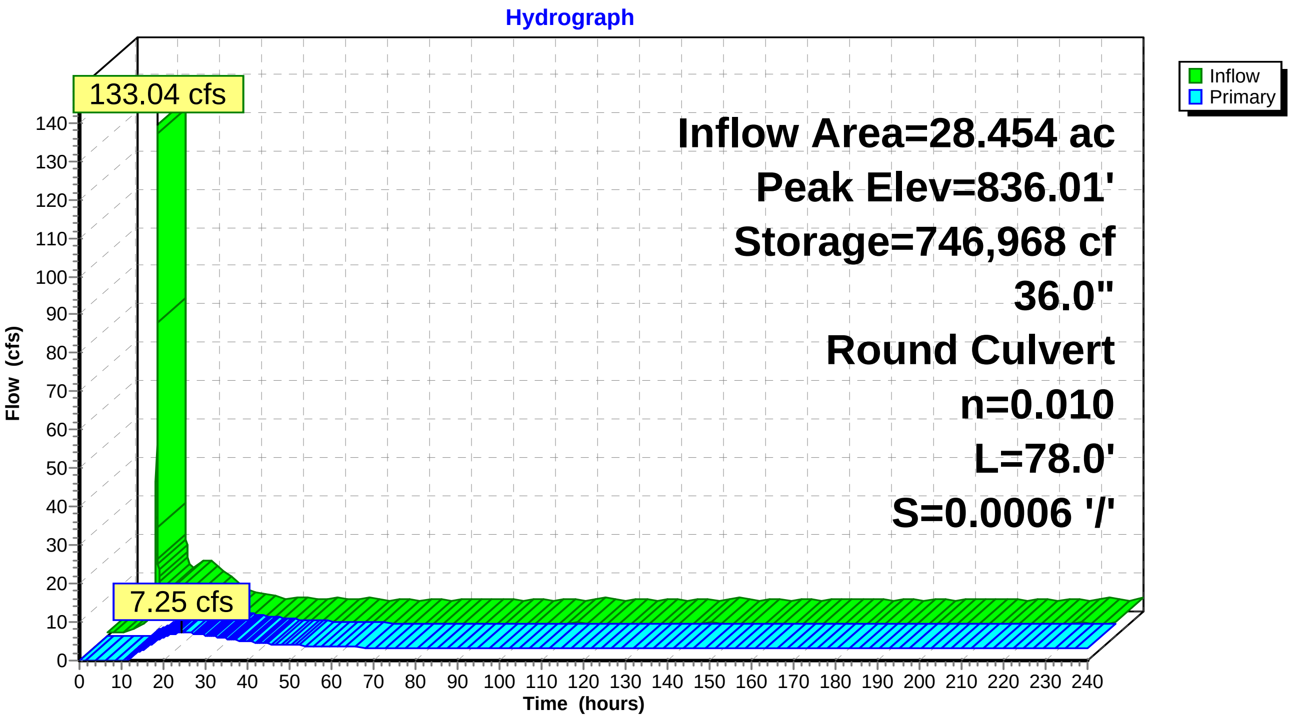
Volume	Invert	Avail.Storage	Storage Description
#1	834.00'	2,318,732 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
834.00	364,767	0	0
836.00	379,097	743,864	743,864
838.00	393,659	772,756	1,516,620
840.00	408,453	802,112	2,318,732

Device	Routing	Invert	Outlet Devices
#1	Primary	834.61'	**36.0" Round Culvert** L= 78.0' Ke= 0.900 Inlet / Outlet Invert= 834.61' / 834.56' S= 0.0006 '/' Cc= 0.900 n= 0.010, Flow Area= 7.07 sf

Primary OutFlow Max=7.25 cfs @ 24.48 hrs HW=836.01' (Free Discharge)
└─**1=Culvert** (Barrel Controls 7.25 cfs @ 3.29 fps)

Pond CP: Clear Pond



Summary for Pond SSP: Stormwater Settling Pond

Inflow Area = 64.148 ac, 0.00% Impervious, Inflow Depth = 5.84" for 100-yr, 24-hr event
Inflow = 354.80 cfs @ 12.18 hrs, Volume= 31.222 af
Outflow = 5.50 cfs @ 23.70 hrs, Volume= 27.878 af, Atten= 98%, Lag= 691.7 min
Primary = 5.50 cfs @ 23.70 hrs, Volume= 27.878 af

Routing by Stor-Ind method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Peak Elev= 834.32' @ 23.70 hrs Surf.Area= 278,719 sf Storage= 1,120,961 cf

Plug-Flow detention time= 2,566.7 min calculated for 27.878 af (89% of inflow)
Center-of-Mass det. time= 2,511.2 min (3,318.6 - 807.4)

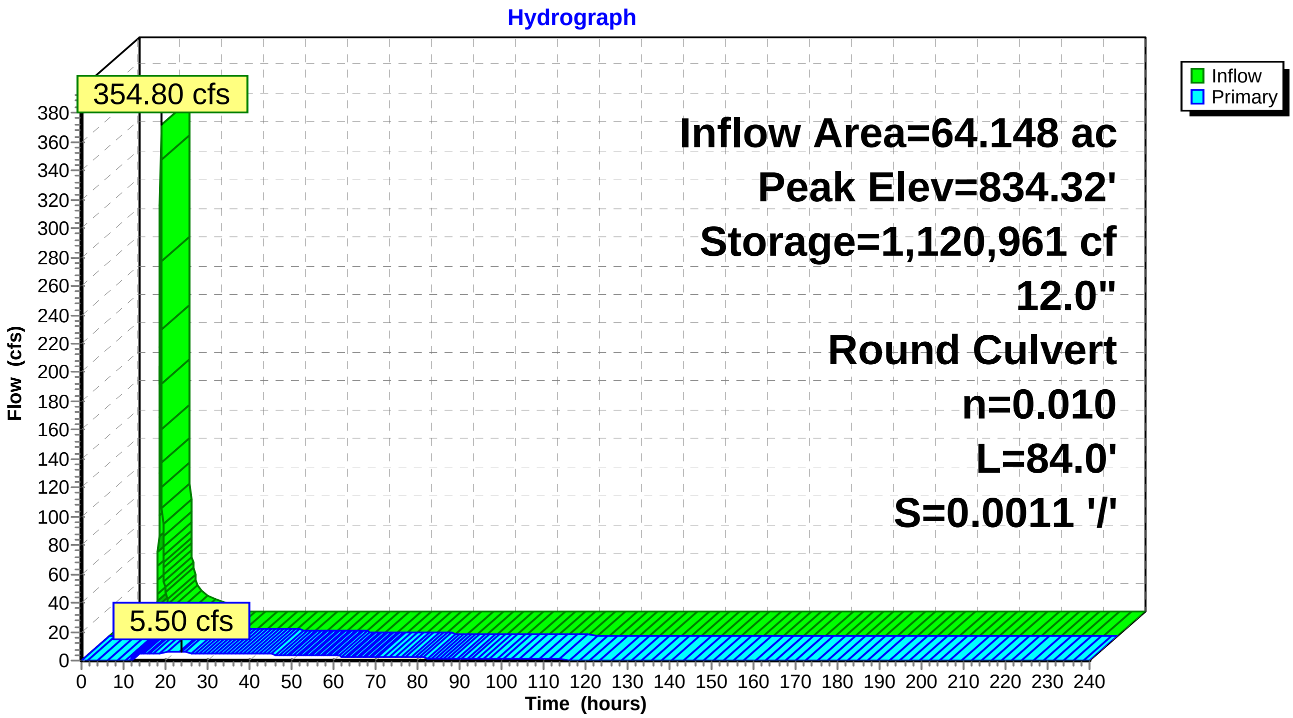
Volume	Invert	Avail.Storage	Storage Description
#1	830.00'	2,850,640 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
830.00	240,740	0	0
832.00	258,192	498,932	498,932
834.00	275,878	534,070	1,033,002
836.00	293,793	569,671	1,602,673
838.00	311,935	605,728	2,208,401
840.00	330,304	642,239	2,850,640

Device	Routing	Invert	Outlet Devices
#1	Primary	830.42'	**12.0" Round Culvert** L= 84.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 830.42' / 830.33' S= 0.0011 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=5.50 cfs @ 23.70 hrs HW=834.32' (Free Discharge)
└**1=Culvert** (Inlet Controls 5.50 cfs @ 7.01 fps)

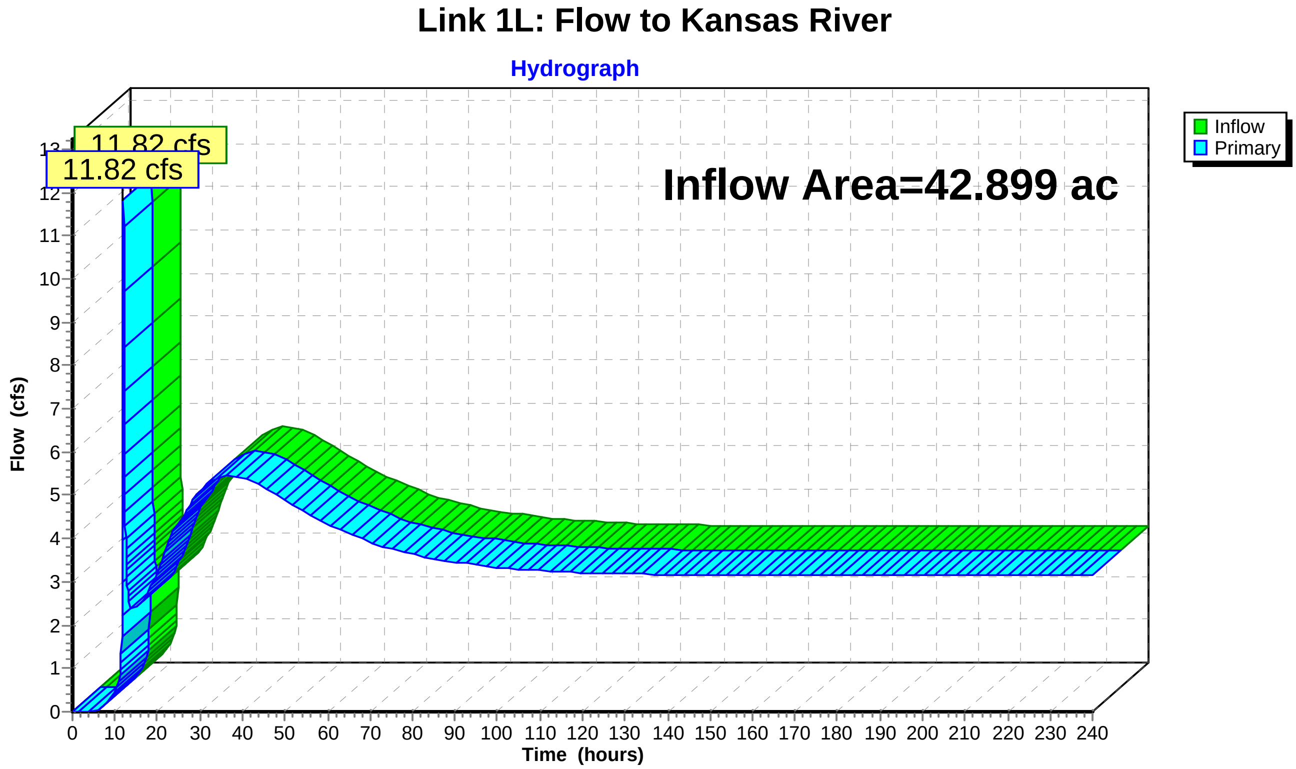
Pond SSP: Stormwater Settling Pond



Summary for Link 1L: Flow to Kansas River

Inflow Area = 42.899 ac, 75.99% Impervious, Inflow Depth > 18.85" for 100-yr, 24-hr event
Inflow = 11.82 cfs @ 11.96 hrs, Volume= 67.392 af
Primary = 11.82 cfs @ 11.96 hrs, Volume= 67.392 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs



Summary for Link CT5: CT5 Blowdown

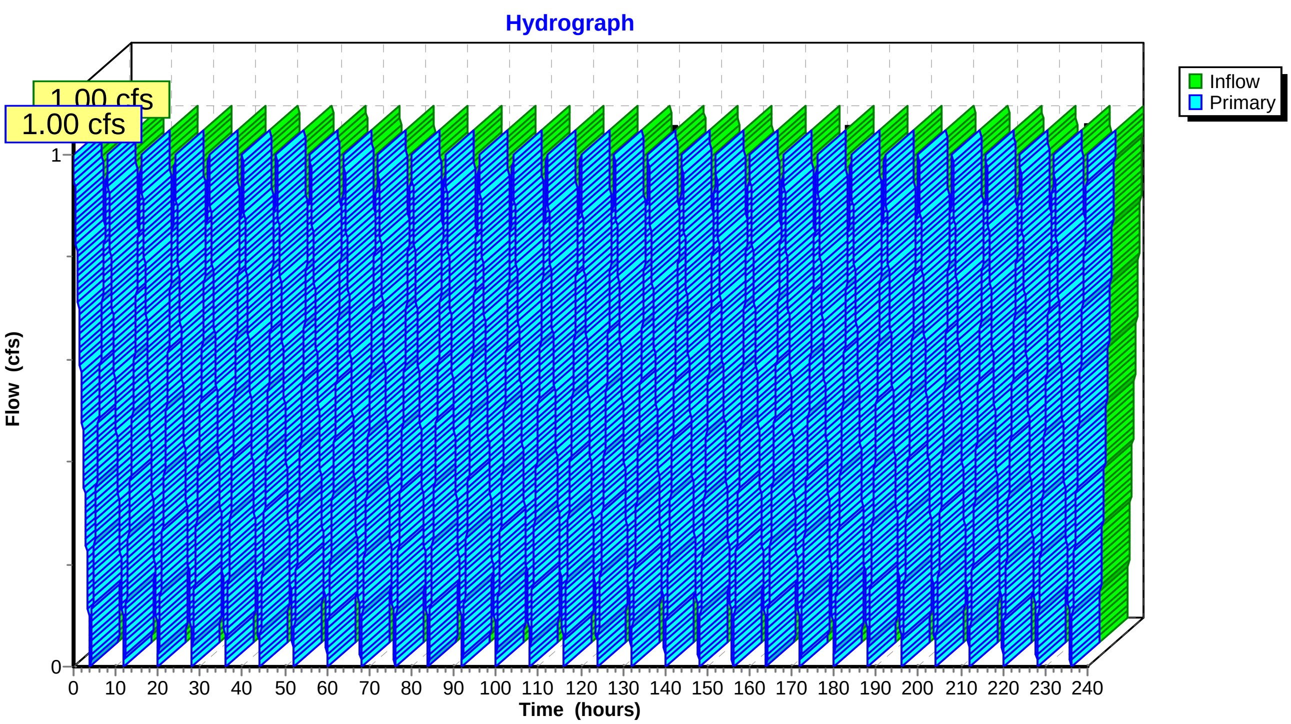
Inflow	=	1.00 cfs @	0.00 hrs, Volume=	9.921 af
Primary	=	1.00 cfs @	0.00 hrs, Volume=	9.921 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs

76 Point manual hydrograph, To= 0.00 hrs, dt= 4.00 hrs, cfs =

1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
1.00	0.00	1.00	0.00	1.00	0.00				

Link CT5: CT5 Blowdown



Summary for Link CWP: LEC Landfill Contact Water Pond

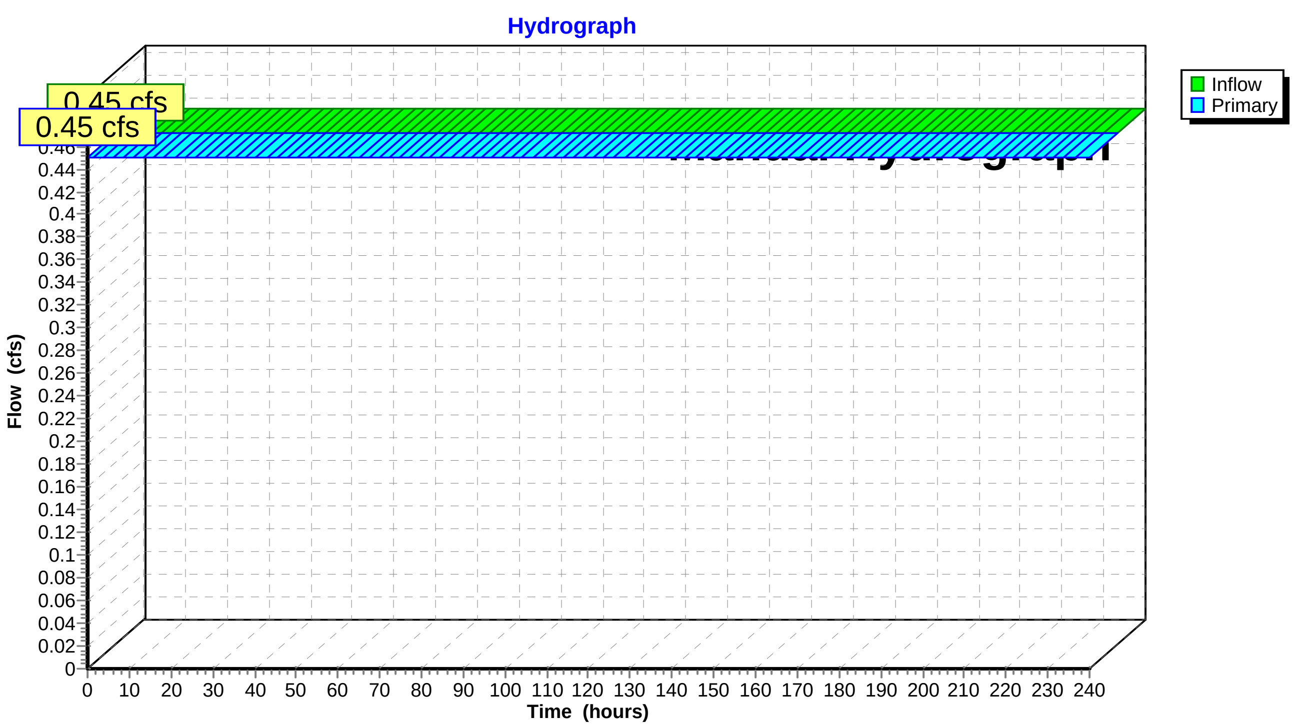
Inflow	=	0.45 cfs @	0.00 hrs,	Volume=	8.927 af
Primary	=	0.45 cfs @	0.00 hrs,	Volume=	8.927 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs

73 Point manual hydrograph, To= 0.00 hrs, dt= 10.00 hrs, cfs =

0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45							

Link CWP: LEC Landfill Contact Water Pond



Summary for Link LPF: LEC Process Flows

Inflow = 4.40 cfs @ 0.00 hrs, Volume= 43.655 af
Primary = 4.40 cfs @ 0.00 hrs, Volume= 43.655 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs

76 Point manual hydrograph, To= 0.00 hrs, dt= 4.00 hrs, cfs =

4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00
4.40	0.00	4.40	0.00	4.40	0.00				

Link LPF: LEC Process Flows