Run-on And Run-off Control System Plan
Jeffrey Energy Center
Fly Ash Landfill

Prepared for:
Westar Energy
Jeffrey Energy Center
St. Marys, Kansas

Prepared by:
CB&I Environmental & Infrastructure, Inc.

October 2016
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## CCR Regulatory Requirements

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<td>§257.81(a)(1) stipulates:</td>
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<td>(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:</td>
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<td>(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm;</td>
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<td>§257.81(a)(2) stipulates:</td>
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<td>(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain: ...</td>
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<td>(2) A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.</td>
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<td>(b) Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.</td>
<td>Section 3.3</td>
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### USEPA CCR Rule Criteria 40 CFR §257.81

<table>
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<td>(c) Run-on and run-off control system plan—</td>
<td>Section 5.1</td>
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<td>(1) Content of the plan. The owner or operator must prepare initial and periodic run-on and run-off 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 run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator has completed the initial run-on and run-off control system plan when the plan has been placed in the facility’s operating record as required by §257.105(g)(3).</td>
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### §257.81(c)(2) stipulates:

| (2) Amendment of the plan. The owner or operator may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility’s operating record as required by §257.105(g)(3). The owner or operator must amend the written run-on and run-off control system plan whenever there is a change in conditions that would substantially affect the written plan in effect. |
| Sections 2.0 & 5.3 |
| USEPA CCR Rule Criteria | Jeffrey Energy Center (JEC)  
40 CFR §257.81 | Run-on and Run-off Control System Plan |
|-------------------------|-------------------------------------------------|--------------------------------------------|
| §257.81(c)(3) stipulates:  
(3) Timeframes for preparing the initial plan—  
(i) Existing CCR landfills. The owner or operator of the CCR unit must prepare the initial run-on and run-off control system plan no later than October 17, 2016. | Section 1.0 |
| §257.81(c)(4) stipulates:  
(4) Frequency for revising the plan. The owner or operator of the CCR unit must prepare periodic run-on and run-off 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 subsequent 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 a periodic run-on and run-off control system plan when the plan has been placed in the facility’s operating record as required by §257.105(g)(3). | Section 5.3 |
| §257.81(c)(5) stipulates:  
(5) The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section. | Section 6.0 |
<table>
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<td>40 CFR §257.81</td>
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<tr>
<td>§257.81(d) stipulates:</td>
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(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).
1.0 INTRODUCTION

CB&I Environmental and Infrastructure, Inc. (CB&I) has prepared the following Run-On and Run-Off Control System Plan (Plan) at the request of Westar Energy (Westar) for the Fly Ash Landfill (Landfill) located at the Jeffrey Energy Center (JEC) in St. Mary’s, Kansas. JEC is a coal-fired and natural gas fired power plant that has been in operation since 1980. The Fly Ash Landfill has been deemed to be a regulated coal combustion residual (CCR) unit by the United States Environmental Protection Agency (USEPA), through the Disposal of Coal Combustion Residuals from Electric Utilities Final Rule (CCR Rule) Title 40 Code of Federal Regulations (CFR) Part §257 and §261.

CCR regulations set forth within 40 CFR §257.81, provide guidelines for stormwater management controls (run-on and run-off controls) to ensure that regulated CCR units are designed to safely manage storm events up to the 25-year, 24-hour storm. Specifically, §257.81 stipulates:

§257.81: “(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain: (1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm; and (2) A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.”

As demonstrated in this Plan, the stormwater run-on and run-off controls have been designed for the 25-year, 24-hour storm and are in compliance with 40 CFR Part §257.81. This document provides discussion of CB&I’s professional judgement/opinion regarding specific aspects of the Rule as they pertain to the Fly Ash Landfill which has been deemed as a regulated CCR unit at Westar’s Jeffrey Energy Center. This Plan will be placed in the Facility Operating Record prior to October 17, 2016, per 40 CFR Part §257.81(c)(3).
2.0 REGULATORY OVERVIEW OF RUN-ON AND RUN-OFF CONTROL REQUIREMENTS

On April 17, 2015, USEPA published the CCR Rule under Subtitle D of the Resource Conservation and Recovery Act (RCRA) as 40 CFR Parts §257 and §261. The purpose of the CCR Rule is to regulate the management of coal combustion residuals in regulated units for landfill and surface impoundments. The Fly Ash Landfill has been deemed to be a regulated CCR unit at JEC.

This Plan marks the initial analysis of the facility run-on and run-off control features based on the permitted facility conditions. Construction activities may occur at the facility that will subsequently modify the conditions as described within this Plan. This Plan will be amended in accordance with §257.81(c)(2), which stipulates:

§257.81(c)(2): “(c)(2) The owner or operator may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility’s operating record as required by §257.105(g)(3). The owner or operator must amend the written run-on and run-off 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 run-on and run-off control features associated with the permitted 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 closure recordkeeping requirements specified in Section 5.0.
3.0 JEC LANDFILL OVERVIEW

3.1 Site Location and Topography

Westar owns and operates an industrial landfill at JEC in Pottawatomie County, Kansas. JEC is located approximately 4.5 miles north of Belvue, Kansas and approximately 4.5 miles west of Highway 63 and resides in Sections 1, 2, 11, and 12, Township 9 South, Range 11 East and Sections 6 and 7, Township 9 South, Range 12 East. The location of the Fly Ash Landfill is depicted in Figure 1.

The Fly Ash Landfill is located due north of the Tower Hill Lake. The Fly Ash Landfill is comprised of Fly Ash Area 1 (Area 1) which is approximately 98.8 acres and the proposed Fly Ash Area 2 (Area 2) which is approximately 59.5 acres and not yet constructed.

This Plan is designed to only address the stormwater management controls for currently operational areas. As such, only Area 1 is discussed herein. However, in accordance with Section 2.0 and §257.81(c)(2), run-on and run-off controls for Area 2 will be evaluated and appropriately described in updates to the Plan in the event that this area is constructed and becomes operational.

Area 1 currently consists of large berms and deep ravines which are being filled with fly ash. The topography varies across Area 1 between approximate elevation 1,190-1,247 ft. mean sea level (MSL). Once fly ash disposal and final cover installation/closure is complete, Area 1 will have a 1% slope from approximate elevation 1,230 ft. MSL down to a 3H:1V slope into Tower Hill Lake. Existing and permitted site topography is depicted in Figure 2 and Figure 3, respectively.

Tower Hill Lake was developed in 1978 through the construction of the Tower Hill Dam. The lake was developed to provide make-up water for JEC processes, as well to manage all stormwater associated with the facility, including the Fly Ash Landfill, in accordance with Industrial Landfill Permit No. 0359. Tower Hill Lake has been designed to accept all non-contact stormwater and discharge offsite in accordance with NPDES Permit No. I-KS67-PO06 and 40 CFR Part §257.81(b). Tower Hill Lake is located downstream of the Fly Ash Landfill.

3.2 Existing Regulatory Permits and Consents

Westar Energy has been granted an Industrial Landfill Permit at JEC by the Kansas Department of Health and Environment – Bureau of Waste Management (KDHE-BWM) as the Industrial Landfill Permit No. 0359 (Industrial Landfill Permit), in accordance with Kansas Statutes Annotated (K.S.A.) 65-3407. The Industrial Landfill Permit allows CCR generated on-site at JEC to be properly disposed of within the Industrial Landfill Permit boundary, including the Fly Ash Landfill.

Westar Energy has also been granted a Kansas Water Pollution Control Permit and Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES) Permit No. I-KS67-PO06 from the KDHE-BWM. The NPDES Permit covers different outfall locations at JEC and allows the discharge of non-contact stormwater into the Kansas River and Lost Creek in accordance with effluent limitations and monitoring requirements. Non-contact stormwater within the Industrial Landfill Permit boundary discharges from the Tower Hill Lake system, which is covered under the NPDES Permit.
3.3 Stormwater Management System Overview

The existing stormwater management system at Area 1 includes perimeter berm structures constructed to minimize the flow of stormwater onto active portions of Area 1. Stormwater run-on flows towards the perimeter berm structures and follows the existing topography towards Tower Hill Lake.

Area 1 utilizes gentle slopes flowing towards Tower Hill Lake to properly manage direct precipitation and stormwater run-off at the site. Tower Hill Lake and dam structure have been designed and constructed to manage stormwater run-on and run-off within a regional subcatchment that includes the Industrial Landfill Permit boundary, including the Area 1, as well as adjacent areas outside of the Industrial Landfill Permit boundary. Direct precipitation and stormwater run-off from the regional subcatchment flow to and are managed by Tower Hill Lake. The regional subcatchment that drains into Tower Hill Lake is depicted in Figure 5.

3.3.1 Area 1 Run-on

Stormwater controls are currently used to direct “uphill” or “upstream” stormwater away from entering the operational areas of Area 1. Potential run-on stormwater comes from subcatchments (also called watersheds, or watershed areas) that are directly adjacent to the landfill boundary. A drainage channel and/or berms have been constructed around portions of the perimeter of Area 1 in order to direct stormwater run-on away from the active portions of the landfill in a controlled manner. These areas contributing to run-on are depicted in Figure 4.

3.3.2 Area 1 Stormwater Management Controls

Stormwater management controls at Area 1 will include stormwater features that will minimize stormwater flow onto active portions of the landfill and stormwater conveyance features that are designed to control stormwater flowing away from Area 1.

Direct precipitation falling on active portions of the landfill is defined as contact water. Contact water has historically been collected in depression areas within Area 1 and is utilized in landfiling operations in order to maintain the proper moisture level necessary for the wetting and hardening of fly ash as part of compaction and grading. Contact water will be managed within Area 1 and will not migrate into Tower Hill Lake. As fly ash compaction and grading operations continue at Area 1, vegetated areas will provide gentle slopes draining into Tower Hill Lake in order to preclude the probability of future ponding of stormwater on compacted fly ash.

3.3.3 Area 1 Stormwater Run-Off Location

Prior to final cover installation and closure, non-contact stormwater will flow directly into Tower Hill Lake. Contact water will be managed within depression areas and utilized during the compacting and grading process. Once fly ash disposal and final cover installation/closure is complete, non-contact stormwater captured from Area 1 will flow directly into Tower Hill Lake. Stormwater containing CCR material will not flow into Tower Hill Lake. Tower Hill Lake eventually drains into a tributary of the Kansas River. The outfall location at Tower Hill Lake is monitored to ensure that effluent limits and monitoring requirements meet the standards set by the NPDES Permit No. I-KS67-PO06 and 40 CFR Part §257.81(b).
3.4 Stormwater Management Operations and Maintenance

3.4.1 Routine Operations and Maintenance

Area 1 is actively accepting fly ash deposits from JEC. Historically, fly ash has been wetted, hardened, and graded for construction of a fly ash berm along the southern border of Area 1 to an elevation of 1,170 feet MSL. Prior to the construction of the southern berm, fly ash is deposited by trucks on the north end of the berm. After the fly ash is deposited, it is wetted, hardened, and graded to promote positive drainage towards a depression area that collects contact water.

JEC has been designated as a critical habitat by the Kansas Department of Wildlife, Parks, and Tourism for the endangered avian species, Least Tern. The Least Terns currently nest in various locations on the Fly Ash Landfill. The current Least Tern boundary fence is approximately 34.5 acres in size. Fly ash infilling is not undertaken within these designated nesting areas during the breeding season, which is from May through August. The Landfill is graded prior to the start of the nesting season and is blocked off to prohibit disturbance from vehicles once the nesting season has started. Westar Energy works closely with the U.S. Fish & Wildlife Service and the Kansas Department of Wildlife, Parks and Tourism, Ecological Services Section on protection of the Least Tern at JEC. It is not anticipated that any construction for run-on/run-off controls will be required within the Least Tern current boundary area, if for any reason, run-on/ run-off controls are required on future plan amendments construction will take place outside the nesting season and the necessary permits will be obtained prior to works being undertaken.

3.4.2 Previous Inspection Review of Run-on / Run-off Controls

Weekly maintenance inspections and annual structural integrity inspections occur at the Landfill in line with inspections requirements outlined in 40 CFR §257.84. A review of the weekly inspection reports conducted from October 2015 through May 2016 show that erosion has occurred along the south berm within Area 1. The proposed remedial action is to establish vegetation in these areas to minimize the erosion of fly ash. It was confirmed that filling and grading processes are effectively elevating the site to permitted final grades.

3.4.3 Corrective Actions and Documentation

A review of both the annual and weekly Landfill inspection reports show that erosion along the south berm requires the establishment of vegetation to achieve stabilization. Documentation of this remedial action is not available to at this time. This Plan will be updated with documentation of these remedial actions as they become available.
4.0 HYDROLOGIC ANALYSES

4.1 Methodology Overview

In order to determine compliance with 40 CFR Part §257.81 regarding the management of stormwater run-on and run-off at the Area 1 Landfill, existing site topography, permitted final grades, and stormwater drainage features were modeled using the computer model software HydroCAD. This computer model is used to develop discharge rates and volumes for the 25-year, 24-hour storm event for each storm feature utilized at Area 1 to manage stormwater run-on and run-off.

4.1.1 Run-on Analysis

The purpose of the run-on analysis is to demonstrate that the run-on control system will safely convey stormwater around the permitted Area 1 boundary. The run-on analysis will determine peak discharge rates and volumes associated with the 25-year, 24-hour storm event for run-on subcatchments.

Currently, the existing perimeter drainage channel and/or berm to direct stormwater run-on away from the landfill. The existing perimeter stormwater management controls (drainage channel and berm) creates a drainage channel that utilizes the natural topography adjacent to the landfill to direct stormwater run-on flows along the toe of the berm. Stormwater run-on currently follows natural topography towards Tower Hill Lake. Gaps in the existing perimeter allow access into the landfill area. These areas will be modified such that stormwater run-on will not flow into active portions of the landfill. The run-on analysis will be utilized to determine the minimum height that the berm and drainage channel requirements to properly manage peak discharge rates and volumes without overtopping. The run-on subcatchments flowing towards the Area 1 boundary are depicted in Figure 4.

4.1.2 Run-off Analysis

The purpose of the run-off analysis is to ensure that the stormwater management features utilized by Area 1 after closure is completed are appropriately sized to collect and convey stormwater volumes associated with the 25-year, 24-hour storm event. Tower Hill Lake has been designed to manage all non-contact stormwater from a regional subcatchment, including non-contact stormwater from Area 1. The run-off analysis will determine the peak discharge rate and volume from the regional subcatchment. The model will determine if Tower Hill Lake has the available capacity to accept the non-contact stormwater run-off from the regional subcatchment. The regional subcatchment contributing to stormwater flow into Tower Hill Lake is depicted in Figure 5.
4.2 Model Input Parameters

To ensure that all stormwater run-on and run-off control features comply with 40 CFR Part §257.81, all elements were computer modeled with numerous conservative assumptions. AutoCAD Civil3D 2014 (AutoCAD) was utilized to delineate key features and the computer model HydroCAD was used to develop discharge rates and volumes for the 25-year, 24-hour storm event to evaluate regulatory compliance with 40 CFR Part §257.81 at JEC. 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
- **Reach Routing Method:** Storage Indication plus Translation Method
- **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.

4.2.1 Rainfall Totals and Distributions

Rainfall intensities and distribution patterns for both analyses were 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. Rainfall depths for the modeled scenario was selected from this report and entered into HydroCAD. It is noted that TR-55 outlines that an NRCS Type II 24-hour storm distribution is appropriate within this region of Kansas. These distribution patterns may be selected from a drop-down list in HydroCAD. The rainfall totals and distributions table utilized in both analyses can be found in Appendix A.

4.2.2 Subcatchment Boundaries

Subcatchment areas (also known as subcatchments) were delineated using AutoCAD based on topographic breaks within the areas to be analyzed. For the run-on analysis, all areas contributing to stormwater run-on into Area 1 are delineated and imported into HydroCAD. Subcatchment boundaries are depicted in Figure 4.

For the run-off analysis, the Industrial Landfill subcatchment was delineated using the United States Geological Survey (USGS) 7.5 minute topographic quadrangle for Emmett and Laclede, Kansas from 2015. The regional subcatchment is depicted in Figure 5.
4.2.3 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, road, 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 landcovers and the underlying surficial soils. As further described below, CB&I 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. 0359 application (Permit application) for JEC, the site is covered with mostly silty clay loam as well as CCR material. The Permit application defines the surficial soil type as Hydrologic Soil Group D (HSG-D) based on the high run-off potential of both the native soils and CCR material. Surficial soil type within the HydroCAD model was conservatively assumed to be HSG-D in all areas within the Industrial Landfill Permit boundary and the regional subcatchment.

Land Covers

The land covers were determined based on a review of aerial photography and the topographic survey for the Industrial Landfill boundary.

For the run-on analysis, stormwater run-on and run-off from grassland areas adjacent to Area 1 were conservatively assumed to be good grass cover. The TR-55 manual designates good grass cover as grassland with greater than 75% vegetative density. For the purposes of the model, all run-on subcatchments were defined as good grass cover in accordance with the TR-55 manual.

For the run-off analysis, land covers within the regional subcatchment were defined to accurately portray permitted facility conditions.

The Bottom Ash Pond that conveys stormwater to Tower Hill Lake was conservatively assumed to be at full capacity. This area was designated to have a land cover defined as “water surface” according to the TR-55 manual.

Based on permitted final conditions within the Industrial Landfill Permit boundary, all areas are defined to have good grass cover. The TR-55 manual designates good grass cover as grassland with greater than 75% vegetative density. For the purposes of the model, all landfill areas were defined as good grass cover in accordance with the TR-55 manual.
4.2.4 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.

For the run-on model, 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 0.15, indicative of short-grass prairie vegetative cover. This number is appropriate for the grass covered run-on subcatchments and is the HydroCAD default.

- An average flow velocity of 7 ft/sec was assumed in shallow concentrated flow calculations for the subcatchment, which is the HydroCAD default for “short grass pasture”, which is considered most indicative of the grass type that exists in these areas.

The time of concentration flow paths are depicted in Figure 4.

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- 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 0.15, indicative of short-grass prairie vegetative cover. This number is appropriate for the grass covered run-on subcatchments and is the HydroCAD default.

- An average flow velocity of 7 ft/sec was assumed in shallow concentrated flow calculations for the subcatchment, which is the HydroCAD default for “short grass pasture”, which is considered most indicative of the grass type that exists in these areas.

- The Manning’s coefficient “n” for channel flow was assumed to be 0.03, indicative of natural steams that are clean and straight. This number is appropriate for the natural drainage channel that conveys stormwater into the Tower Hill Lake and is the HydroCAD default.

The time of concentration flow paths are depicted in Figure 5.
4.2.5 Tower Hill Lake

Tower Hill Lake was modeled by entering the area at each minor and major contour interval to determine incremental detention volumes. The volume of the normal water elevation was also specified. Tower Hill Lake was modeled as a closed system without an outlet structure. This model parameter will provide the total available capacity without any water leaving the basin, which is conservative for this system. Site topography for the Jeffrey Energy Center was provided by Professional Engineering Consultants (PEC), was utilized to determine the available capacity for Tower Hill Lake.

4.3 Model Findings

The HydroCAD results for the 25-year, 24-hour storm duration were analyzed to evaluate run-on and run-off controls at Area 1. Results of the run-on analysis indicate that the existing perimeter berm must be modified such that there are no gaps for stormwater run-on to pass into the active portions of the landfill, as depicted in Figure 6. The modification to the existing perimeter berm is necessary to prevent flow onto the active portion of the CCR unit during the peak discharge from the 25-year, 24-hour storm event per 40 CFR Part §257.81. Results of the run-off analysis indicate that Tower Hill Lake will not overtop after accepting all non-contact stormwater from the regional subcatchment after a 25-year, 24-hour storm event.

4.3.1 Run-on Analysis (§257.81(a)(1))

The run-on analysis for Area 1 was completed to determine if the run-on control system complies with 40 CFR Part §257.81(a)(1), which states,

“(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain: (1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm;”

Peak run-on rates were determined using HydroCAD. Areas contributing to run-on for Area 1 have a total discharge rate of 101.99 cfs. At the present time, there is a perimeter berm along the facility boundary of the Area 1.

The existing perimeter berm will be modified such that there are no gaps that stormwater can pass through and/or construction of a drainage channel. Based on model findings, it was determined that the minimum height of the berm will be 1.3 ft; alternatively, a v-notch perimeter channel with 4H:1V side slopes, 2 foot depth running adjacent to the Area 1 may also be constructed to prevent flow onto Area 1, in order to comply with 40 CFR Part §257.81(a)(1). Any changes to the existing stormwater management controls will be documented in the next annual inspection.

Additionally, the flow velocity along the perimeter berm has been reviewed to determine whether scour or erosion is anticipated to occur. Erosion or scour may be anticipated to occur at flow velocities exceeding 5 ft/sec for vegetated drainage areas. Based on observed flow velocities, the perimeter berm was modeled as a ditch lined with vegetation. This modeling was selected by utilizing a Manning’s coefficient of 0.030, indicative of a vegetated liner.

Results from the run-on hydrologic analysis can be found in Appendix B.
4.3.2 Run-off Analysis (§257.81(a)(2) & (§257.81(b))

The run-off analysis for Tower Hill Lake was completed to determine if the run-off control system complies with 40 CFR Part §257.81(a)(2), which states,

“(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain: …(2) A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.”

Tower Hill Lake is designed to serve as the stormwater run-off management system for the regional subcatchment including Area 1. Tower Hill Lake was analyzed to determine if it has been designed to collect and control stormwater run-off from the regional subcatchment for a 25-year, 24-hour storm event.

For the 25-year, 24-hour storm event within the regional subcatchment, it was determined that the subcatchment contributes 327.2 acre-feet of run-off into Tower Hill Lake.

Tower Hill Lake was modeled by entering the area at each minor and major contour interval to determine incremental detention volumes. The available stormwater capacity for the Tower Hill Lake is approximately 2,805 acre-feet. Based on the model, Tower Hill Lake will not overtop from the stormwater discharge volume of the regional subcatchment. It is also noted that a freeboard of 17 feet will be achieved after the discharge volume from the 25-year, 24-hour storm event flows into the Tower Hill Lake.

Results from the run-off hydrologic analysis can be found in Appendix C.

4.4 Engineering Evaluation of Findings

4.4.1 Design Appropriateness Based on Model Findings

Area 1 is utilizing a perimeter berm and/or drainage channel system as a run-on control system at the time of this report. The existing perimeter berm will be modified to prevent flow onto Area 1 prior to the next annual inspection, in order to comply with 40 CFR Part §257.81(a)(1). The perimeter berm will have a minimum height of 1.3 ft and/or v-notch perimeter channel with 4H:1V side slopes, 2 foot depth will run adjacent to the Area 1 waste boundary. The modified stormwater controls will provide sufficient capacity to convey run-on from the 25-year, 24-hour storm event.

Tower Hill Lake has been designed and constructed to manage stormwater from a regional subcatchment which includes Area 1. Based on model findings, it was determined that Tower Hill Lake has the available capacity to accept the stormwater run-off from the regional subcatchment, including Area 1.

4.4.2 Operations and Maintenance Considerations

Regular inspections of the perimeter berm and/or drainage channel are recommended in order to clear debris, repair erosion, and monitor any erosion controls.

Operations and maintenance of Tower Hill Lake are recommended to continue as completed previously.
5.0 RECORDS RETENTION AND MAINTENANCE

5.1 Incorporation of Plan into Operating Record

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

§257.105(g): (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: (3) The initial and periodic run-on and run-off control system plans as required by §257.81(c).

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

5.2 Notification Requirements (§257.81(d))

§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): (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: (3) Provide notification of the availability of the initial and periodic run-on and run-off control system plans specified under §257.105(g)(3).

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

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

§257.107(g): (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: (3) The initial and periodic run-on and run-off control system plans specified under §257.105(g)(3).

This Plan will be uploaded to Westar Energy’s CCR Compliance reporting Website upon Westar’s review and approval.
5.3 Plan Amendments ((§257.81(c)(3) & §257.81(c)(4))

This Plan has been completed in accordance with §257.81(c)(3) to provide an initial analysis of the run-on and run-off control systems. This Plan will continue to undergo review as the Fly Ash Landfill continues phased construction activities.

Westar Energy is required to prepare periodic run-on and run-off control system plans every five (5) years, as required by §257.81(c)(4) of the Rule. The amended Plan will be reviewed and recertified by a registered professional engineer and will be placed in JEC’s facility operating record as required per §257.105(g)(3). 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)(3) and posted to the publicly accessible internet site per §257.107(g)(3).

A record of Plan reviews/assessments is provided on the first page of this document, immediately following the Table of Contents.
6.0 PROFESSIONAL ENGINEER CERTIFICATION (§257.81(c)(5))

The undersigned registered professional engineer is familiar with the requirements of the CCR Rule and has visited and examined the Jeffrey Energy Center or has supervised examination of the Jeffrey Energy Center by appropriately qualified personnel. The undersigned registered professional engineer attests that this CCR Run-on and Run-off Control System Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and meets the requirements of 40 CFR Part §257.81, and that this Plan is adequate for JEC facility. This certification was prepared as required by 40 CFR Part §257.81(c)(5).

Name of Professional Engineer: Richard Southorn

Company: CB&I

Signature: [Signature]

Date: 10/4/16

PE Registration State: Kansas

PE Registration Number: PE25201

Professional Engineer Seal:

[Stamp Image]
FIGURES

Figure 1 - Fly Ash Area 1, Site Location Plan
Figure 2 - Fly Ash Area 1, Existing Site Topography
Figure 3 - Fly Ash Area 1, Permitted Final Landform
Figure 4 - Fly Ash Area 1, Run-on / Run-off Subcatchments
Figure 5 - Tower Hill Lake, Regional Subcatchments
Figure 6 - Fly Ash Area 1, Proposed Stormwater Features
1. AERIAL TOPO OBTAINED FROM USGS 7.5-MINUTE SERIES, EMMETT AND LACLEDE QUADRANGLE, KANSAS, 2014.

2. ALL BOUNDARIES ARE APPROXIMATE.
1. EXISTING CONTOURS DEVELOPED BY PEC IN APRIL 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
3. FLY ASH AREA 1 BOUNDARY IS APPROX. 98.8 ACRES.
4. ALL BOUNDARIES ARE APPROXIMATE.
1. EXISTING CONTOURS DEVELOPED BY PEC IN APRIL 2016.
2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
3. FINAL GRADES WERE TAKEN FROM KDHE-BWM INDUSTRIAL LANDFILL PERMIT NO. 0359.
4. ALL BOUNDARIES ARE APPROXIMATE.
Figure 4

Fly Ash Area 1
Run-On Subcatchments

Legend

- CCR Unit Boundary
- Time of Concentration
- Run-On Subcatchment Area

Notes
1. Existing contours developed by PEC in April 2016.
2. For clarity, not all site features may be shown.
3. All boundaries are approximate.
1. FIGURE ADAPTED FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE FROM EMMETT AND LECLEDE, KS (2015).

2. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.

3. ALL BOUNDARIES ARE APPROXIMATE.
1. EXISTING CONTOURS DEVELOPED BY PEC IN APRIL 2016.
2. DRAINAGE CHANNELS MAY BE UTILIZED IN COMBINATION WITH THE PERIMETER BERM TO MANAGE STORMWATER RUN-ON.
3. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
4. PROPOSED PERIMETER DRAINAGE CHANNEL WILL BE CONSTRUCTED WITHIN THE CCR UNIT BOUNDARY.
5. ALL BOUNDARIES ARE APPROXIMATE.
APPENDICES
APPENDIX A

Rainfall Intensity Tables for Kansas Counties
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
POTTAWATOMIE  COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

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### RAINFALL INTENSITY TABLE

POTTAWATOMIE COUNTY
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</tr>
<tr>
<td>3:00</td>
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<td>0.70</td>
<td>0.92</td>
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<td>1.28</td>
<td>1.44</td>
<td>1.60</td>
</tr>
</tbody>
</table>
## Rainfall Intensity Table

**Pottawatomie County, Kansas**

This table contains average rainfall intensities in inches per hour.

<table>
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<th>Duration, HR:MIN</th>
<th>1 YR</th>
<th>2 YR</th>
<th>5 YR</th>
<th>10 YR</th>
<th>25 YR</th>
<th>50 YR</th>
<th>100 YR</th>
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<td>0.25</td>
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<td>0.31</td>
</tr>
<tr>
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<td>0.14</td>
<td>0.18</td>
<td>0.21</td>
<td>0.25</td>
<td>0.28</td>
<td>0.31</td>
</tr>
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</table>
APPENDIX B

Fly Ash Area 1 Run-on HydroCAD Output Files
APPENDIX B.1

Perimeter Berm Design model
### Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (acres)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.506</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D (E, NE, NW, W)</td>
</tr>
<tr>
<td><strong>20.506</strong></td>
<td><strong>80</strong></td>
<td>TOTAL AREA</td>
</tr>
</tbody>
</table>
Summary for Subcatchment E: East Run-on

Runoff = 39.10 cfs @ 12.03 hrs, Volume = 2.300 af, Depth = 3.78".

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-40.00 hrs, dt = 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall = 6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>7.299</td>
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<td>&gt;75% Grass cover, Good, HSG D</td>
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<td>7.299</td>
<td>100.00% Pervious Area</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
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<td>0.23</td>
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<td>Sheet Flow,</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Grass: Short n = 0.150 P2= 3.36&quot;</td>
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<tr>
<td>4.5</td>
<td>490</td>
<td>0.0670</td>
<td>1.81</td>
<td></td>
<td>Shallow Concentrated Flow,</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Short Grass Pasture Kv= 7.0 fps</td>
</tr>
</tbody>
</table>

11.7 590 Total

Subcatchment E: East Run-on

Hydrograph

Type II 24-hr 25-yr
24-hr Rainfall = 6.00"
Runoff Area = 7.299 ac
Runoff Volume = 2.300 af
Runoff Depth = 3.78"
Flow Length = 590'
Tc = 11.7 min
CN = 80
Summary for Subcatchment NE: Northeast Run-on

Runoff = 39.04 cfs @ 12.08 hrs, Volume= 2.624 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>100.00%</td>
<td>Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
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15.9 458 Total

Subcatchment NE: Northeast Run-on

Flow Length=458'
Tc=15.9 min
CN=80

Type II 24-hr 25-yr
24-hr Rainfall=6.00"
Runoff Area=8.328 ac
Runoff Volume=2.624 af
Runoff Depth=3.78"
Flow Length=458'
Tc=15.9 min
CN=80
Summary for Subcatchment NW: Northwest Run-on

Runoff = 6.13 cfs @ 12.04 hrs, Volume= 0.371 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr  25-yr, 24-hr Rainfall=6.00"

<table>
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<th>Area (sf)</th>
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<th>Description</th>
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<td>100.00% Pervious Area</td>
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</tr>
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</table>

<table>
<thead>
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<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
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<td></td>
<td>Sheet Flow, Grass: Short n= 0.150 P2= 3.36&quot;</td>
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</table>

Subcatchment NW: Northwest Run-on

Type II 24-hr
Type II 25-yr
24-hr Rainfall=6.00"
Runoff Area=51,233 sf
Runoff Volume=0.371 af
Runoff Depth=3.78"
Flow Length=100'
Slope=0.0100 '/'
Tc=12.6 min
CN=80
Fly Ash Landfill run-on
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"
Prepared by Chicago Bridge and Iron Company
Printed 9/15/2016
HydroCAD® 10.00-15 s/n 04891 © 2015 HydroCAD Software Solutions LLC
Page 6

Summary for Subcatchment W: West Run-on
Runoff = 22.28 cfs @ 12.00 hrs, Volume= 1.167 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
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<td>100.00% Pervious Area</td>
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</table>

<table>
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<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
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<tr>
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<td>Sheet Flow, Grass: Short  n= 0.150  P2= 3.36&quot;</td>
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<td>Shallow Concentrated Flow, Short Grass Pasture   Kv= 7.0 fps</td>
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8.3 193 Total

Subcatchment W: West Run-on

Hydrograph

Type II 24-hr 25-yr
24-hr Rainfall=6.00"
Runoff Area=3.703 ac
Runoff Volume=1.167 af
Runoff Depth=3.78"
Flow Length=193'
Slope=0.0400 '/'
Tc=8.3 min
CN=80
Summary for Reach E1: East Berm 1

Inflow Area = 7.299 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 39.10 cfs @ 12.03 hrs, Volume= 2.300 af
Outflow = 30.29 cfs @ 12.25 hrs, Volume= 2.300 af, Atten= 23%, Lag= 13.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.23 fps, Min. Travel Time= 8.4 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 29.3 min

Peak Storage= 15,463 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.95'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 222.64 cfs

0.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0  12.0 '/' Top Width= 32.0'
Length= 2,140.0'  Slope= 0.0200 '/'
Inlet Invert= 1,247.00', Outlet Invert= 1,204.20'

Reach E1: East Berm 1

Hydrograph

Inflow Area=7.299 ac
Avg. Flow Depth=0.95'
Max Vel=4.23 fps
n=0.030
L=2,140.0'
S=0.0200 '/'
Capacity=222.64 cfs
Summary for Reach W1: West Berm 1

Inflow Area = 8.328 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 39.04 cfs @ 12.08 hrs, Volume= 2.624 af
Outflow = 34.84 cfs @ 12.22 hrs, Volume= 2.624 af, Atten= 11%, Lag= 8.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.51 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 16.9 min

Peak Storage= 10,912 cf @ 12.14 hrs
Average Depth at Peak Storage= 1.20'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 138.38 cfs

0.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 10.0 '/' Top Width= 28.00'
Length= 1,087.0' Slope= 0.0101 '/'
Inlet Invert= 1,247.00', Outlet Invert= 1,236.00'

Reach W1: West Berm 1

Hydrograph

Inflow Area=8.328 ac
Avg. Flow Depth=1.20'
Max Vel=3.51 fps
n=0.030
L=1,087.0'
S=0.0101 '/'
Capacity=138.38 cfs

Flow (cfs) vs Time (hours)
Summary for Reach W2: West Berm 2

Inflow Area = 9.504 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 37.22 cfs @ 12.21 hrs, Volume= 2.995 af
Outflow = 26.04 cfs @ 12.64 hrs, Volume= 2.995 af, Attenuation= 30%, Lag= 25.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.48 fps, Min. Travel Time= 16.6 min
Avg. Velocity = 0.71 fps, Avg. Travel Time= 57.7 min

Peak Storage= 26,155 cf @ 12.36 hrs
Average Depth at Peak Storage= 1.23'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 95.88 cfs

0.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 10.0 '/' Top Width= 28.00'
Length= 2,470.0 ' Slope= 0.0049 '/'
Inlet Invert= 1,236.00', Outlet Invert= 1,224.00'

Reach W2: West Berm 2

Hydrograph

Inflow Area=9.504 ac
Avg. Flow Depth=1.23'
Max Vel=2.48 fps
n=0.030
L=2,470.0'
S=0.0049 '/'
Capacity=95.88 cfs
Summary for Reach W3: West Berm 3

Inflow Area = 13.207 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 27.76 cfs @ 12.63 hrs, Volume= 4.162 af
Outflow = 26.37 cfs @ 12.82 hrs, Volume= 4.162 af, Atten= 5%, Lag= 11.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.82 fps, Min. Travel Time= 6.3 min
Avg. Velocity = 1.21 fps, Avg. Travel Time= 19.7 min

Peak Storage= 9,909 cf @ 12.72 hrs
Average Depth at Peak Storage= 0.99'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 170.45 cfs

0.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 10.0 '/' Top Width= 28.00'
Length= 1,433.0' Slope= 0.0154 '/'
Inlet Invert= 1,224.00', Outlet Invert= 1,202.00'

Reach W3: West Berm 3

Hydrograph

Inflow Area=13.207 ac
Avg. Flow Depth=0.99'
Max Vel=3.82 fps
n=0.030
L=1,433.0'
S=0.0154 '/'
Capacity=170.45 cfs
Summary for Pond THL: Tower Hill Lake

Inflow Area = 20.506 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 47.38 cfs @ 12.22 hrs, Volume= 6.461 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 1,146.06' @ 40.00 hrs Surf.Area= 5,111,240 sf Storage= 280,964 cf

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

Volume Invert Avail.Storage Storage Description
#1 1,146.00' 122,166,852 cf Custom Stage Data (Prismatic) Listed below (Recalc)

<table>
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<tr>
<th></th>
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<tbody>
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<td>1,150.00</td>
<td>5,508,510</td>
<td>10,862,992</td>
<td>21,321,835</td>
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<td>5,693,423</td>
<td>11,201,933</td>
<td>32,523,768</td>
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<td>1,156.00</td>
<td>6,053,141</td>
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<td>1,158.00</td>
<td>6,248,987</td>
<td>12,302,128</td>
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<td>1,160.00</td>
<td>6,470,577</td>
<td>12,719,564</td>
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<tr>
<td>1,162.00</td>
<td>6,716,081</td>
<td>13,186,658</td>
<td>94,222,022</td>
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<td>1,164.00</td>
<td>6,975,960</td>
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<td>1,166.00</td>
<td>7,276,829</td>
<td>14,252,789</td>
<td>122,166,852</td>
</tr>
</tbody>
</table>
Pond THL: Tower Hill Lake

Hydrograph

Inflow Area=20.506 ac
Peak Elev=1146.06'
Storage=280,964 cf

47.38 cfs
APPENDIX B.2

Perimeter Drainage Channel Design model
Routing Diagram for Fly Ash Landfill run-on
HydroCAD® 10.00-15  s/n 04891 © 2015 HydroCAD Software Solutions LLC
## Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (acres)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.097</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D (E, NE, NW, W)</td>
</tr>
</tbody>
</table>
Summary for Subcatchment E: East Run-on

Runoff = 42.27 cfs @ 12.03 hrs, Volume= 2.486 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.890</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D</td>
</tr>
<tr>
<td>7.890</td>
<td>100.00% Pervious Area</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>100</td>
<td>0.0400</td>
<td>0.23</td>
<td></td>
<td>Sheet Flow,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Grass: Short n= 0.150 P2= 3.36&quot;</td>
</tr>
<tr>
<td>4.5</td>
<td>490</td>
<td>0.0670</td>
<td>1.81</td>
<td></td>
<td>Shallow Concentrated Flow,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Short Grass Pasture Kv= 7.0 fps</td>
</tr>
</tbody>
</table>

11.7 590 Total

Subcatchment E: East Run-on

Hydrograph

Type II 24-hr
25-yr
24-hr Rainfall=6.00"
Runoff Area=7.890 ac
Runoff Volume=2.486 af
Runoff Depth=3.78"
Flow Length=590'
Tc=11.7 min
CN=80
Summary for Subcatchment NE: Northeast Run-on

Runoff = 39.04 cfs @ 12.08 hrs, Volume = 2.624 af, Depth = 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-40.00 hrs, dt = 0.05 hrs
Type II 24-hr  25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>8.328</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D</td>
</tr>
<tr>
<td>8.328</td>
<td>100</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
<tr>
<td>12.6</td>
<td>100</td>
<td>0.0100</td>
<td>0.13</td>
<td></td>
<td><strong>Sheet Flow,</strong> Grass: Short n = 0.150 P2 = 3.36&quot;</td>
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<tr>
<td>3.3</td>
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<td>0.0670</td>
<td>1.81</td>
<td></td>
<td><strong>Shallow Concentrated Flow,</strong> Short Grass Pasture Kv = 7.0 fps</td>
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15.9 458 Total

Subcatchment NE: Northeast Run-on

![Hydrograph](image)

Type II 24-hr 25-yr
24-hr Rainfall=6.00"
Runoff Area=8.328 ac
Runoff Volume=2.624 af
Runoff Depth=3.78"
Flow Length=458'
Tc=15.9 min
CN=80
Summary for Subcatchment NW: Northwest Run-on

Runoff = 6.13 cfs @ 12.04 hrs, Volume= 0.371 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (sf)</th>
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<th>Description</th>
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<td>51,233</td>
<td>100.00% Pervious Area</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
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<tbody>
<tr>
<td>12.6</td>
<td>100</td>
<td>0.0100</td>
<td>0.13</td>
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<td>Sheet Flow, Grass: Short n= 0.150 P2= 3.36&quot;</td>
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Subcatchment NW: Northwest Run-on

Hydrograph

Type II 24-hr 25-yr
24-hr Rainfall=6.00"
Runoff Area=51,233 sf
Runoff Volume=0.371 af
Runoff Depth=3.78"
Flow Length=100'
Slope=0.0100 '/'
Tc=12.6 min
CN=80
Summary for Subcatchment W: West Run-on

Runoff = 22.28 cfs @ 12.00 hrs, Volume = 1.167 af, Depth = 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>3.703</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D</td>
</tr>
<tr>
<td>3.703</td>
<td>100</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>100</td>
<td>0.0400</td>
<td>0.23</td>
<td></td>
<td>Sheet Flow, Grass: Short  n= 0.150  P2= 3.36&quot;</td>
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<tr>
<td>1.1</td>
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<td>1.40</td>
<td></td>
<td>Shallow Concentrated Flow, Short Grass Pasture  Kv= 7.0 fps</td>
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Subcatchment W: West Run-on

Hydrograph

Type II 24-hr 25-yr
24-hr Rainfall=6.00"
Runoff Area=3.703 ac
Runoff Volume=1.167 af
Runoff Depth=3.78"
Flow Length=193'
Slope=0.0400 '/'
Tc=8.3 min
CN=80
Summary for Reach E1: East Channel 1

Inflow Area = 7.890 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 42.27 cfs @ 12.03 hrs, Volume= 2.486 af
Outflow = 33.04 cfs @ 12.24 hrs, Volume= 2.486 af, Attenuation 22%, Lag= 12.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.47 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 29.0 min

Peak Storage= 16,073 cf @ 12.11 hrs
Average Depth at Peak Storage= 1.37'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 92.15 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 4.0 '/' Top Width= 16.00'
Length= 2,140.0' Slope= 0.0192 '/'
Inlet Invert= 1,247.00', Outlet Invert= 1,206.00'

Reach E1: East Channel 1

Hydrograph

Inflow Area=7.890 ac
Avg. Flow Depth=1.37'
Max Vel=4.47 fps
n=0.035
L=2,140.0'
S=0.0192 '/'
Capacity=92.15 cfs
Summary for Reach W1: West Channel 1

Inflow Area = 8.328 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 39.04 cfs @ 12.08 hrs, Volume= 2.624 af
Outflow = 34.90 cfs @ 12.22 hrs, Volume= 2.624 af, Atten= 11%, Lag= 8.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.56 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 17.1 min

Peak Storage= 10,765 cf @ 12.14 hrs
Average Depth at Peak Storage= 1.57'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 66.97 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 4.0 '/' Top Width= 16.00'
Length= 1,087.0' Slope= 0.0101 '/'
Inlet Invert= 1,247.00', Outlet Invert= 1,236.00'

Reach W1: West Channel 1

Hydrograph

Inflow Area=8.328 ac
Avg. Flow Depth=1.57'
Max Vel=3.56 fps
n=0.035
L=1,087.0'
S=0.0101 '/'
Capacity=66.97 cfs
Summary for Reach W2: West Channel 2

Inflow Area = 9.504 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 37.31 cfs @ 12.21 hrs, Volume= 2.995 af
Outflow = 26.24 cfs @ 12.63 hrs, Volume= 2.995 af, Atten= 30%, Lag= 25.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.52 fps, Min. Travel Time= 16.3 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 57.2 min

Peak Storage= 25,916 cf @ 12.36 hrs
Average Depth at Peak Storage= 1.62'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 46.40 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 4.0 '/' Top Width= 16.00'
Length= 2,470.0' Slope= 0.0049 '/'
Inlet Invert= 1,236.00', Outlet Invert= 1,224.00'

Reach W2: West Channel 2

Hydrograph

Inflow Area=9.504 ac
Avg. Flow Depth=1.62'
Max Vel=2.52 fps
n=0.035
L=2,470.0'
S=0.0049 '/'
Capacity=46.40 cfs
Summary for Reach W3: West Channel 3

Inflow Area = 13.207 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 28.02 cfs @ 12.62 hrs, Volume= 4.162 af
Outflow = 26.63 cfs @ 12.81 hrs, Volume= 4.162 af, Atten= 5%, Lag= 11.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.89 fps, Min. Travel Time= 6.1 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 19.5 min

Peak Storage= 9,825 cf @ 12.71 hrs
Average Depth at Peak Storage= 1.31'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 82.49 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 4.0 '/' Top Width= 16.00'
Length= 1,433.0' Slope= 0.0154 '/'
Inlet Invert= 1,224.00', Outlet Invert= 1,202.00'

Reach W3: West Channel 3

Inflow Area=13.207 ac
Avg. Flow Depth=1.31'
Max Vel=3.89 fps
n=0.035
L=1,433.0'
S=0.0154 '/'
Capacity=82.49 cfs
Summary for Pond THL: Tower Hill Lake

Inflow Area = 21.097 ac, 0.00% Impervious, Inflow Depth = 3.78" for 25-yr, 24-hr event
Inflow = 50.64 cfs @ 12.21 hrs, Volume = 6.648 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume = 0.000 af, Atten = 100%, Lag = 0.0 min

Routing by Stor-Ind method, Time Span = 0.00-40.00 hrs, dt = 0.05 hrs
Peak Elev = 1,146.06' @ 40.00 hrs Surf.Area = 5,111,438 sf Storage = 289,067 cf

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

Volume Invert Avail.Storage Storage Description
#1 1,146.00' 122,166,852 cf Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation Surf.Area Inc.Store Cum.Store
(foot) (sq-ft) (cubic-feet) (cubic-feet)
1,146.00 5,104,361 0 0
1,148.00 5,354,482 10,458,843 10,458,843
1,150.00 5,508,510 10,862,992 21,321,835
1,152.00 5,693,423 11,201,933 32,523,768
1,154.00 5,871,670 11,565,093 44,088,861
1,156.00 6,053,141 11,924,811 56,013,672
1,158.00 6,248,987 12,302,128 68,315,800
1,160.00 6,470,577 12,719,564 81,035,364
1,162.00 6,716,081 13,186,658 94,222,022
1,164.00 6,975,960 13,692,041 107,914,063
1,166.00 7,276,829 14,252,789 122,166,852
Pond THL: Tower Hill Lake

Inflow Area=21.097 ac
Peak Elev=1,146.06'
Storage=289,067 cf
APPENDIX C

Regional Run-off HydroCAD Output Files
Routing Diagram for Regional Subcatchment
HydroCAD® 10.00-15 s/n 04891 © 2015 HydroCAD Software Solutions LLC

Watershed Capacity

Tower Hill Lake
## Area Listing (all nodes)

<table>
<thead>
<tr>
<th>Area (acres)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>934.496</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D (WC)</td>
</tr>
<tr>
<td>76.350</td>
<td>98</td>
<td>Water Surface, HSG D (WC)</td>
</tr>
</tbody>
</table>
Summary for Subcatchment WC: Watershed Capacity

Runoff = 963.68 cfs @ 13.99 hrs, Volume= 327.155 af, Depth= 3.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=6.00"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>934.496</td>
<td>80</td>
<td>&gt;75% Grass cover, Good, HSG D</td>
</tr>
<tr>
<td>76.350</td>
<td>98</td>
<td>Water Surface, HSG D</td>
</tr>
<tr>
<td>1,010.846</td>
<td>81</td>
<td>Weighted Average</td>
</tr>
<tr>
<td>934.496</td>
<td>92.45% Pervious Area</td>
<td></td>
</tr>
<tr>
<td>76.350</td>
<td>7.55% Impervious Area</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>100</td>
<td>0.0400</td>
<td>0.23</td>
<td></td>
<td>Sheet Flow, Grass: Short  n= 0.150  P2= 3.36&quot;</td>
</tr>
<tr>
<td>13.5</td>
<td>1,138</td>
<td>0.0400</td>
<td>1.40</td>
<td></td>
<td>Shallow Concentrated Flow, Short Grass Pasture  Kv= 7.0 fps</td>
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<tr>
<td>147.2</td>
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<td>0.1000</td>
<td>0.54</td>
<td>16.09</td>
<td>Channel Flow, Area= 30.0 sf  Perim= 4,737.0'  r= 0.01'  n= 0.030  Stream, clean &amp; straight</td>
</tr>
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</table>

167.9 5,975 Total

Subcatchment WC: Watershed Capacity

Type II 24-hr 25-yr
24-hr Rainfall=6.00"
Runoff Area=1,010.846 ac
Runoff Volume=327.155 af
Runoff Depth=3.88"
Flow Length=5,975'
Tc=167.9 min  
CN=81
Summary for Pond THL: Tower Hill Lake

Inflow Area = 1,010.846 ac, 7.55% Impervious, Inflow Depth = 3.88" for 25-yr, 24-hr event
Inflow = 963.68 cfs @ 13.99 hrs, Volume= 327.155 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Peak Elev= 1,148.70' @ 33.65 hrs  Surf.Area= 5,408,743 sf  Storage= 14,250,505 cf

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

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<th>Volume</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>1,146.00'</td>
<td>122,166,852 cf</td>
<td>Custom Stage Data (Prismatic) Listed below (Recalc)</td>
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Pond THL: Tower Hill Lake

Inflow Area=1,010.846 ac
Peak Elev=1,148.70'
Storage=14,250,505 cf