



K. Preliminary Drainage Report

For

Williams Creek Generating Station



PROJECT NAME: Willams Creek Generating Station

PROJECT NUMBER: 20070510

CALCULATION NUMBER: 20070510-CAL-CW-001

CALCULATION TITLE: Preliminary Drainage Report

ASSUMPTIONS:

Description	Verified By	Date
1) NRCS Curve Number hydrology with DCM rainfall depths. 2) SCS Type II 24-hr distribution applied to all storm events	Johnson Rowland	8/31/26

REFERENCES:

- 1) El Paso County Drainage Criteria Manual (DCM)
- 2) El Paso County Engineering Criteria Manual (ECM)
- 3) Mile High Flood District
- 4) NOAA Atlas 14
- 5) NRCS Soil Survey
- 6) FEMA FIRM 08041C0970G (eff. 12/7/2018)



DESIGN BASIS:

- 1) SSA using NRCS TR-55 hydrograph and routing methods
- 2) Detention designed per MHFD Full Spectrum criteria.

Rev.	Prepared by, Date	Checked by, Date	Approved by, Date
A	Brent Juenemann 8/28/26	Johnson Rowland 9/2/26	Johnson Rowland 9/2/26
B	Brent Juenemann 9/25/26	Johnson Rowland 9/25/26	Jamie Smith 9/25/26

Willams Creek Generating Station
Kiewit Project No. 20070510
Preliminary Drainage Report
0/Issued for Permitting

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REVISION HISTORY

REVISION	REVISION DESCRIPTION
A	ISSUED FOR REVIEW
0	ISSUED FOR PERMITTING



PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

EXECUTIVE SUMMARY

This Preliminary Drainage Report evaluates existing and proposed drainage conditions for the Williams Creek Generating Station Project for a 1041 Permit. The project is located within the Lower Williams Creek Drainage Basin in El Paso County, Colorado. The project encompasses approximately 96 acres and drains to an unnamed tributary of Williams Creek.

Existing drainage consists of a 467-acre subbasin, producing peak discharges of $Q_5 = 320$ cfs and $Q_{100} = 805$ cfs at the primary design point.

The proposed development modifies on-site drainage patterns through open channels, storm sewers, and swales, while preserving off-site tributary flows. Proposed hydrology results are mitigated through full-spectrum detention basins designed to meet ECM historic release requirements. Water quality requirements are satisfied in accordance with DCM Volume 2. Detention storage and outlet structures have been sized to meet ECM Chapter 3 criteria.

Based on the preliminary drainage analysis, no adverse downstream impacts are anticipated. Review of available El Paso County drainage planning information and preliminary coordination did not identify an applicable Drainage Basin Planning Study for the project area. Applicability of drainage basin and bridge fees, drainage planning studies, and project-specific downstream outfall criteria will be confirmed with El Paso County and documented in the Final Drainage Report. Any resulting requirements affecting the preliminary drainage concept will be incorporated into the design.

Jurisdictional determinations associated with onsite drainage features are currently under evaluation. Applicable findings and permitting requirements will be incorporated into the final drainage design and supporting permitting documentation.

PROJECT OVERVIEW

The Williams Creek Generating Station project is located within El Paso County, Colorado, on property owned by the City of Colorado Springs. The development area encompasses approximately 96 acres situated near the central-western portion of a larger ~3,655-acre parcel currently used as a 175-megawatt photovoltaic solar facility. Solar arrays are distributed throughout the broader property, while the proposed generating station occupies a distinct portion of the site.

The project involves the construction and installation of ten (10) new natural-gas combustion turbine generators, along with the associated civil, mechanical, and electrical infrastructure required for operation. Supporting facilities within the 96-acre development footprint include two brine solar ponds, an equalization/reverse-osmosis (EQ/RO) reject pond, a zero-liquid-discharge (ZLD) process area, a water storage tank, a control building, gas gate stations, paved parking areas, engineered bypass channels, and a private storm sewer network. These facilities collectively support the generating station's operational, water-management, and utility needs.

The project area is bordered by a 1,024-acre Woodmoor Water & Sanitation parcel to the west, Substation Drive to the east, Irradiance Road to the south, and an existing solar substation to the north. The larger parcel spans multiple sections within Township 16 South, Ranges 64 and 65 West of the 6th Principal Meridian, including Sections 1, 11, 12, 13, 14, 23, 24, 25, 26, 35, and 36 in Range 65 West, and Sections 6, 7, 18, 30, and 31 in Range 64 West. The generating station site specifically lies within the northeast quarter of Section 26, Township 16 South, Range 65 West.

Existing vegetation within the development area consists of approximately 50% cover, based on field observations and aerial imagery. Vegetation primarily includes native grasses, weeds, and low shrubs typical of the region.

Major drainageways, irrigation ditches where identified, existing utilities, and other known encumbrances are presented on the drainage maps in Appendix A. These features are shown based on the best available survey, mapping, and project information at the time of preparation of this Preliminary Drainage Report.

EXISTING CONDITIONS

The project site is located in Zone X, Area of Minimal Flood Hazard per FEMA floodplain panels 08041C0970G; see Appendix C NFHL FIRMette. No regulatory floodway or special flood hazard area affects the project. The site contains mainly Midway clay loam and some Manzanola silty clay loam soils with Hydrologic Soil Group C and D classifications; see Appendix B Hydrologic Soils Map and Legend. These soils exhibit relatively low infiltration rates and contribute to higher runoff potential during storm events.

The project area consists of gently rolling terrain typical of the region, with ground elevations generally sloping from the northern portion of the site toward the south and southeast. Surface runoff is conveyed primarily as shallow overland flow before concentrating within the unnamed tributary channel. The broader 3,655-acre parcel contains solar array fields, access roads, and ancillary facilities, while the 96-acre generating station footprint remains largely undeveloped.

Vegetation within the project area consists of approximately 50 percent cover, including native grasses, weeds, and low shrubs. For hydrologic modeling, these areas were classified as pasture, grassland, or range in fair hydrologic condition, with Curve Numbers of 79 and 84 for Hydrologic Soil Groups C and D, respectively.

Table 1: Soils Data

SOIL MAP UNIT	MAP UNIT NAME	SOIL GROUP	PERCENT ON SITE
33	Heldt clay loam, 0 to 3 percent slopes	C	22.0%
126	Midway clay loam, dry, 1 to 15 percent slopes	D	74.1%
MzA	Manzanola silty clay loam, saline, 0 to 2 percent slopes	C	3.9%

Runoff generated within the larger watershed flows across natural terrain and concentrates within the unnamed tributary that crosses the project site. This tributary conveys flows south towards Williams Creek. The existing drainage system consists entirely of natural conveyance features; no public storm sewer infrastructure is present within the project limits. The existing drainage area is approximately 467 acres and produces peak discharges and volumes as shown below in Table 2.

Table 2: Existing Conditions

Drainage Area	Area (AC)	Weighted Curve Number	Q ₅ (cfs)	Volume ₅ (ac-ft)	Q ₁₀₀ (cfs)	Volume ₁₀₀ (ac-ft)
1	266.9	82.2	185	25.4	450	60.3
2	101.9	83.5	111	10.4	259	24.1
3	98.5	83.2	107	10.0	250	23.1
Peak at Design Point	467.3	82.7	320	45.4	805	106.7

PROPOSED CONDITIONS

The Williams Creek Generating Station development will modify existing drainage patterns through the construction of new facilities, grading, and stormwater conveyance improvements. Proposed conditions reflect the installation of ten natural-gas combustion turbine generators and associated infrastructure, including access roads, equipment pads, process ponds, utility structures, and stormwater management facilities. The drainage design has been developed in accordance with the El Paso County Engineering Criteria Manual (ECM), the Drainage Criteria Manual (DCM) Volumes 1 and 2, and Mile High Flood District (MHFD) criteria.

The project improvements will increase imperviousness within the development area. Impervious surfaces within developed drainage areas were assigned a Curve Number of 98 in accordance with NRCS methodology. Composite subbasin curve numbers were developed based on the proportional distribution of impervious and pervious land cover within each drainage area. Increased imperviousness will reduce infiltration and accelerate runoff concentration. The proposed drainage system is designed to mitigate these effects through engineered conveyance and detention facilities.

Under proposed conditions, stormwater runoff will be conveyed through a combination of overland flow, engineered channels, storm sewer systems, and a full-spectrum detention facility. The proposed drainage patterns include:

- **Bypass Channels:** Engineered channels will intercept and convey offsite flows and the existing intermittent tributary through the site. These channels maintain historic flow paths while preventing uncontrolled erosion and minimizing impacts to generating station infrastructure.

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- Storm Sewer Network: A private storm sewer system will collect runoff from paved surfaces, equipment areas, and structures. The storm sewer network will route flows to the detention facility and designated outfall locations.
- Detention Facilities: Two full-spectrum detention basins will provide Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and 100-year peak flow attenuation. Outlet structures will be designed using MHFD's Detention Basin Design Workbook and routed using CUHP/SWMM hydrographs.
- Defined Outfall: All flows will be discharged to the existing tributary channel in a controlled manner that meets ECM historic release requirements.

The proposed drainage system maintains the general north-to-south flow direction while improving conveyance reliability and reducing downstream peak discharges. The developed site has been divided into 7 subbasins, shown in Appendix A, based on grading, drainage divides, and the facility layout. The brine ponds and EQ/RO reject ponds are process-water, non-discharge facilities and are excluded from the stormwater hydrologic routing model. These facilities are hydraulically isolated from the proposed stormwater conveyance system. Site grading and conveyance facilities direct stormwater around the pond embankments. Process-water containment, overflow, and permitting requirements are addressed separately from this Preliminary Drainage Report. Peak discharges and volumes for the 5-year and 100-year, 24-hr storms under proposed conditions are shown below in Table 3.

Table 3: Proposed Conditions

Drainage Area	Area (AC)	Weighted Curve Number	Q ₅ (cfs)	Volume ₅ (ac-ft)	Q ₁₀₀ (cfs)	Volume ₁₀₀ (ac-ft)
1	266.9	82.2	185	25.4	450	60.3
2	75.0	83.9	87	7.8	201	18.0
3	17.6	83.9	29	1.8	66	4.2
4	10.3	84.0	18	1.1	41	2.5
5	4.5	98.0	14	0.9	25	1.6
6	34.3	82.0	46	3.3	110	7.8
7	44.2	92.5	84	7.0	160	13.8
Peak at Design Point*	452.8	83.7	255	43.6	696	103.9

**Total Study Drainage Area reduced by 14.5 acres to account for zero liquid discharge process ponds.*

Each detention basin was sized to meet all applicable water quality and peak flow attenuation criteria. The Power Block basin, Pond A, provides 1.144 acre-feet of WQCV, 3.333 acre-feet of cumulative EURV storage, and 6.061 acre-feet of total target detention storage.

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The incremental Zone 2 and Zone 3 storage volumes are 2.189 and 2.728 acre-feet, respectively. The WC Gate Station basin, Pond B, provides 0.151 acre-feet of WQCV, 0.402 acre-feet of cumulative EURV storage, and 0.709 acre-feet of total target detention storage. The incremental Zone 2 and Zone 3 storage volumes are 0.251 and 0.307 acre-feet, respectively. All basins include multi-stage outlet structures, emergency spillways sized for uncontrolled 100-year flow, and a minimum freeboard of two feet.

Conveyance improvements include storm sewer pipes sized at 18 inches or larger, engineered channels designed for stability under major storm events, culverts sized at 18 inches or larger at roadway crossings, and riprap energy dissipation at outfalls and transitions.

Overall, the proposed drainage system safely conveys onsite and offsite flows through the development, reduces peak discharges to levels at or below existing conditions, provides required water quality treatment, and meets all applicable ECM, DCM, and MHFD routing criteria. These improvements support the construction and operation of the Williams Creek Generating Station while ensuring long-term stormwater performance and regulatory compliance.

DESIGN CRITERIA

Hydrologic calculations follow the NRCS Curve Number method and TR-55 unit hydrograph procedures. Rainfall depths for the 24-hour design storms were taken directly from the DCM, attached in Appendix D. The SCS Type II rainfall distribution was applied to all hydrologic modeling and detention routing. SSA's NRCS hydrology engine was used to compute rainfall excess, generate hydrographs, and route flows through the proposed drainage system.

Hydraulic design for storm sewer and channel conveyance followed ECM Chapter 3. Storm sewer pipes must be a minimum of 18 inches in diameter, and all pipes must convey the 5-year minor storm without surcharging. Velocities within storm sewer pipes must remain between 3 fps and 12 fps to prevent sediment deposition and avoid excessive scour. Open channel design followed Manning's equation, and culvert performance will be assessed in the FDR.

Detention and water quality design followed MHFD Full Spectrum Detention (FSD) methodology and DCM Volume 2 requirements. The project includes two full-spectrum detention basins: one serving the power block and one serving the WC meter station. Each basin was sized to provide Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and 100-year peak flow attenuation. WQCV must drain down over a period of

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40 hours, and EURV storage must be released over a 52- to 72-hour period. All basins provide a minimum of two feet of freeboard above the 100-year water surface elevation.

Each detention basin includes a micropool to maintain outlet submergence and improve long-term basin performance. The micropool must be at least 2.5 feet deep, with a footprint sized to maintain stable geometry around the outlet structure. The micropool volume is not intended to provide significant detention storage; instead, it serves as a permanent pool that improves sediment capture and outlet stability.

Outlet structures were designed using the MHFD Detention Basin Design Workbook. Each outlet structure includes a low-flow orifice for WQCV release, an intermediate outlet for EURV release, and an emergency spillway sized to pass the 100-year storm while meeting ECM historic release requirements. Emergency spillways were evaluated to safely convey uncontrolled 100-year flows without overtopping basin embankments.

Downstream impacts were evaluated by comparing existing and proposed peak flows at the project outfall. ECM requires that proposed peak discharges do not exceed existing peak discharges for the 5-year and 100-year storms.

METHOD OF ANALYSIS

The following section goes into detail on the design of the stormwater system. This section includes information on the software used, soil types, groundwater, curve numbers, time of concentration, rainfall data, drainage design points and materials.

Software

All hydrologic and hydraulic modeling for the Williams Creek Generating Station was performed using Autodesk Storm and Sanitary Analysis (SSA) with the NRCS SCS TR-55 hydrology engine. SSA was used to generate rainfall-excess hydrographs using the Curve Number method, apply the SCS Type II rainfall distribution, and route flows through the proposed storm sewer network and the two full-spectrum detention basins. AutoCAD Civil 3D was used to design the site layout and grading.

Detention storage and outlet sizing were established using the MHFD Detention Basin Design Workbook in accordance with County requirements. The SSA model was subsequently utilized as a secondary evaluation tool to assess drainage system performance and detention basin operation under the project hydrologic model assumptions.

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Soils

The Web Soil Survey, attached as Appendix B, indicates the hydrologic soil group for on-site areas as predominantly type D, soils with a low infiltration rate.

Curve Number

Curve Number (CN) was determined according to the NRCS Runoff Curve Numbers Table (Appendix E). All proposed areas with pavement, foundations, buildings, or stone surfacing were assigned a CN of 98. Undisturbed areas with Grass Cover (Fair, HSG C/D) were assigned a CN of 79 and 84, respectively.

Table 4 - Curve Numbers

Category	HSG	CN
Grass Cover (Fair)	C	79
Grass Cover (Fair)	D	84
Stone surfacing	D	98
Impervious Areas – Paved parking lots, roads, laydowns	D	98

Time of Concentration

The TR-55 method was used to determine time of concentration (TOCs) for each individual drainage area, with a minimum TOC of 6 minutes.

Rainfall Data

The rainfall design depths used in this analysis were pulled from El Paso County's Drainage Criteria Manual Table 6-2, found in Appendix D. The 5-year and 100-year, 24-hour storm events of 2.70 and 4.60 inches, respectively, were used as the design rainfall depth for sizing the new stormwater collection system. The rainfall distribution is SCS Type II.

Materials

HDPE corrugated drainage pipe with a smooth interior wall was selected for use in the storm drain system based on local regulations and contractual requirements. Flared end sections are required where no headwalls are provided. Riprap will be placed at the end of every flared end section. Sizing for riprap beds will be calculated in the FDR.

FOUR-STEP PROCESS

In accordance with the Engineering Criteria Manual I.7.2.A and DCM V2, this site has implemented the Four-Step Process to minimize adverse impacts of urbanization. The Four-Step Process includes reducing runoff volumes, stabilizing drainageways, treating the water quality capture volume, and considering the need for Industrial/Commercial BMPs.

Step 1 – Runoff Reduction: Proposed development minimizes directly connected impervious area where practicable through preservation of existing pervious areas and routing of developed drainage areas to the planned stormwater facilities. Impervious surfaces were assigned a Curve Number of 98 in accordance with NRCS methodology; composite drainage-area curve numbers reflect the proportional distribution of impervious and pervious land cover. Final evaluation of applicable Undeveloped Impervious Area (UIA) and Runoff Reduction Practices (RPA) will be completed during Final Drainage Report design.

Step 2 – Stabilize Drainageways: The existing unnamed tributary drainageway has been assessed for stormwater runoff capacity and velocity. Vegetation and/or matting will be selected to stabilize the drainageways by reducing the velocity of flows and decreasing any scour. These improvements help stabilize drainageways and minimize erosion and sediment runoff. Other on-site drainageways are to be sized and stabilized with permanent erosion control mitigation measures.

Step 3 – Detention and Water Quality: Runoff from this development is treated through capture and slow release of the WQCV via full-spectrum detention ponds that are designed per current El Paso County DCM V2 and the MHFD. Proposed Pond A and Pond B provide WQCV, EURV, and 100-year detention for the respective tributary basins.

Step 4 – Industrial and Commercial BMPs: Long-term source-control BMPs will be incorporated into the generating station design and operating procedures to minimize exposure of stormwater to industrial pollutants. Applicable measures will include covered or otherwise protected material storage and handling areas, appropriate secondary containment for oil- and chemical-containing equipment and storage areas, secured waste storage, routine inspection and housekeeping, and spill prevention and response procedures. Site-specific measures will be coordinated with the responsible design disciplines and Owner and documented in the final design and applicable facility operating and maintenance plans. Construction-phase erosion, sediment, and pollutant controls will be addressed separately in the site-specific Stormwater Management Plan (SWMP) and Grading & Erosion Control (GEC) Plan prepared prior to construction.

RESULTS AND CONCLUSIONS

The hydrologic and hydraulic analysis for the Williams Creek Generating Station demonstrates that the proposed drainage improvements have been developed to comply with applicable ECM, DCM, and MHFD criteria and will be finalized through the Final Drainage Report and construction document phase.

At the primary downstream design point, the modeled 5-year peak discharge decreases from 320 cfs under existing conditions to 255 cfs under proposed conditions, a reduction of approximately 20.3 percent. The modeled 100-year peak discharge decreases from 805 cfs to 696 cfs, a reduction of approximately 13.5 percent. Proposed peak discharges therefore remain below existing-condition peak discharges for both evaluated storms. The corresponding 5-year runoff volume decreases from 45.4 acre-feet to 43.6 acre-feet, a reduction of 1.8 acre-feet, or approximately 4.0 percent. The 100-year runoff volume decreases from 106.7 acre-feet to 103.9 acre-feet, a reduction of 2.8 acre-feet, or approximately 2.6 percent.

All detention basins were sized to provide the required Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and 100-year storage. Each basin meets the 40-hour WQCV drain-down requirement, provides a minimum of two feet of freeboard, and includes a micropool designed in accordance with MHFD criteria. Results of the SSA modeling are shown in Appendix H and I. Operation and maintenance responsibilities for Pond A, Pond B, outlet structures, emergency spillways, and associated conveyance facilities are provided in the project-specific Operations and Maintenance Plan accompanying this report.

Next Steps

The preliminary drainage design will be refined during final design and documented in the Final Drainage Report. This work will include confirmation of drainage areas and hydrologic assumptions based on final grading; verification of storm sewer, culvert, and channel capacity; and refinement of detention basin geometry, outlet structures, emergency spillways, tailwater conditions, and hydraulic grade lines. Downstream conveyance, erosion protection, maintenance access, and utility conflicts will also be evaluated.

Coordination with El Paso County will confirm applicable drainage fees, planning requirements, and downstream outfall criteria. Relevant jurisdictional findings and coordination with the mechanical team regarding process-water pond drainage interfaces will be incorporated as applicable. Final documentation will address construction-phase stormwater controls and long-term inspection and maintenance requirements.

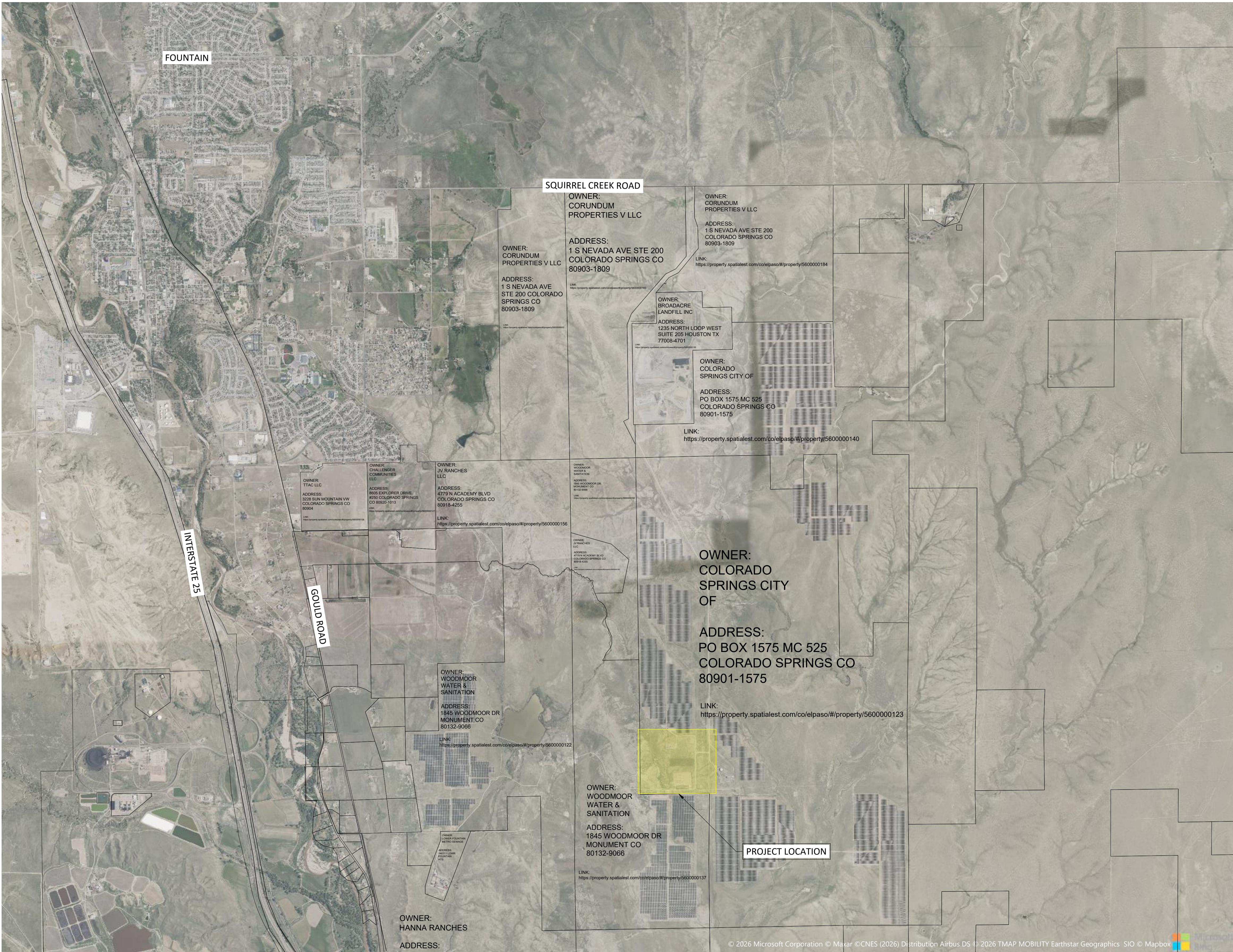


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APPENDIX A – VICINITY AND DRAINAGE MAPS

DRAWING NAME: Y:\WWE\Projects\20070510-Williams_Creek_Generating_Station\Civ\CM-Cover_Sheet-Maps-Notes_&_Legends\EXH-CIV-VICINITY_MAP-001.dwg



VICINITY MAP
SCALE: 1" = 2000'

- PRELIMINARY -
NOT FOR CONSTRUCTION

OPEN	CONCEPTUAL EXHIBIT		
	R. GROTANS	J. ROWLAND	09-25-26
REV	DESIGN BY	CHECKED BY	DATE

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION



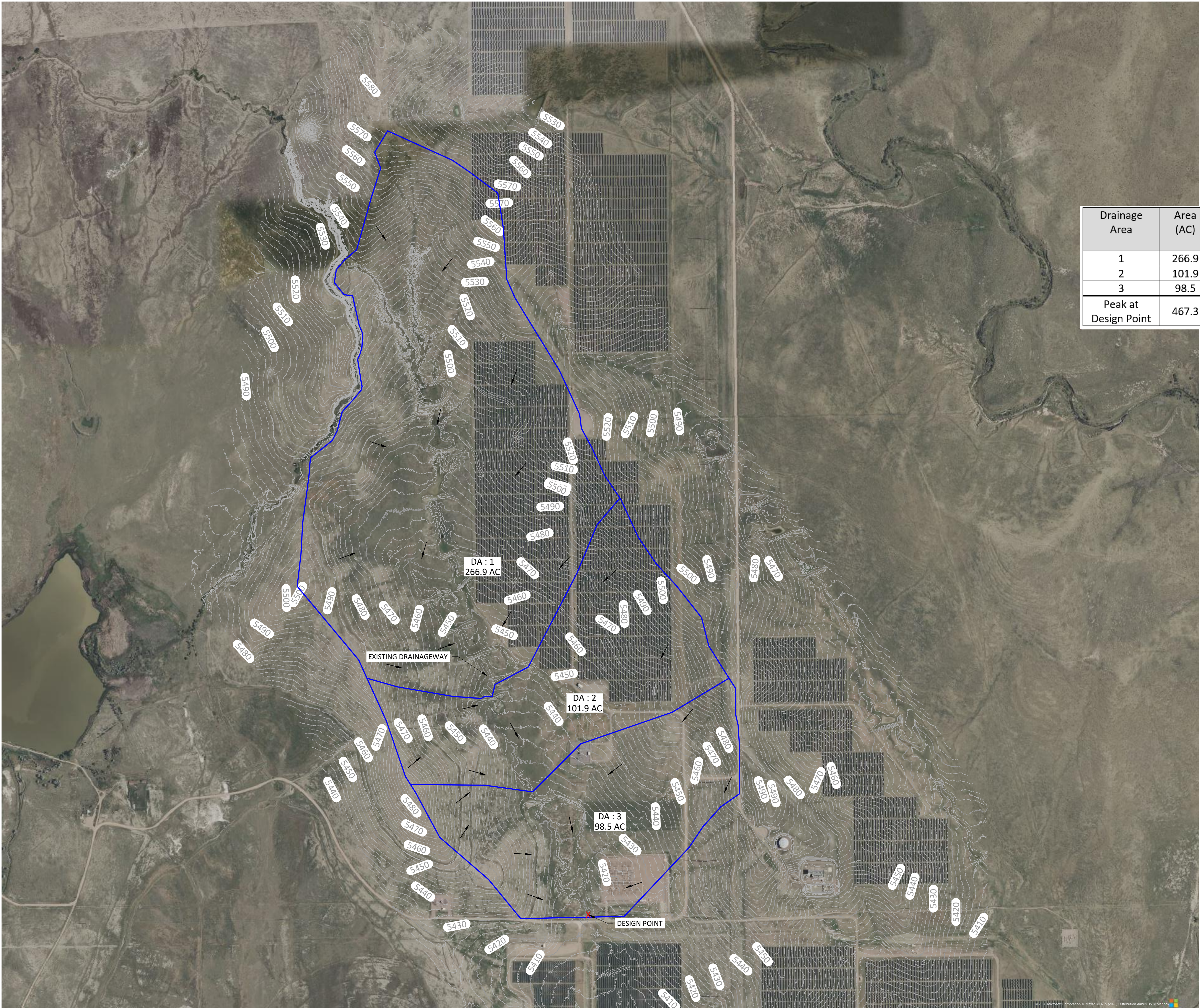
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VICINITY MAP

ENGINEER/DESIGN ORIGINATOR	R. GROTANS
LEAD ENG	J. ROWLAND
ENG MGR	D. DUBOSE
PROJ MGR	T. ROARK

DRAWING NUMBER
EXH-CIV-VICINITY_MAP-001

DRAWING NAME: V:\WWE\Projects\20070510-Williams_Creek_Generating_Station\Cvt\TEMP\BA\Stormwater\ExistingDrainageAreas.dwg



LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY

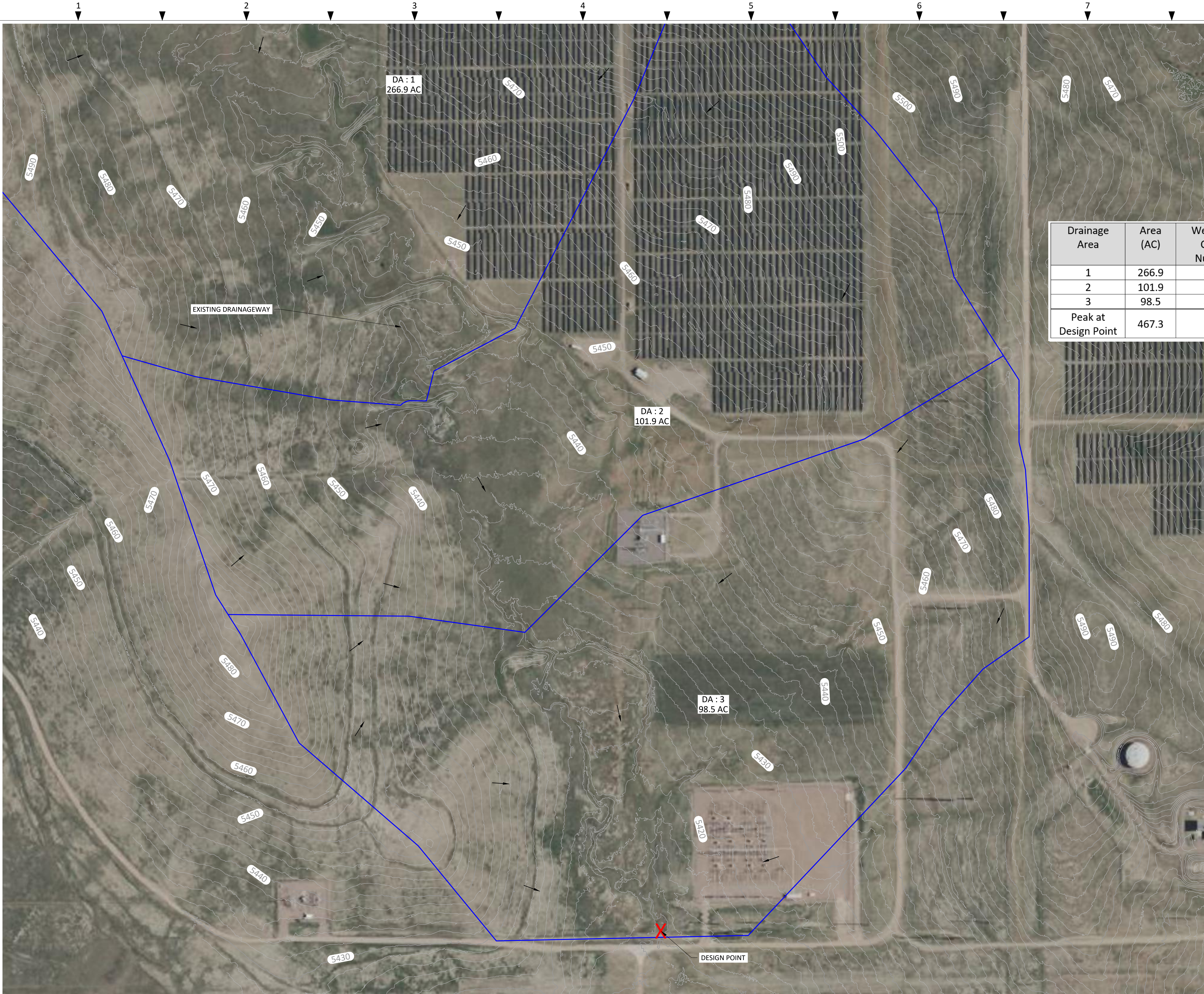
Drainage Area	Area (AC)	Weighted Curve Number	Q ₅ (cfs)	Volume ₅ (ac-ft)	Q ₁₀₀ (cfs)	Volume ₁₀₀ (ac-ft)
1	266.9	82.2	185	25.4	450	60.3
2	101.9	83.5	111	10.4	259	24.1
3	98.5	83.2	107	10.0	250	23.1
Peak at Design Point	467.3	-	320	45.4	805	106.7

- PRELIMINARY -
NOT FOR CONSTRUCTION

OPEN	CONCEPTUAL EXHIBIT		
	B. JUENEMANN	J. ROWLAND	09-25-26
REV	DESIGN BY	CHECKED BY	DATE
COLORADO SPRINGS UTILITIES WILLIAMS CREEK GENERATING STATION			
 Colorado Springs Utilities <i>It's how we're all connected</i>			
 Kiewit Kiewit Confidential & Proprietary Information. All Rights Reserved.			
PRE CONSTRUCTION - DRAINAGE AREAS			
ENGINEER/DESIGN ORIGINATOR LEAD ENG ENG MGR PROJ MGR		DRAWING NUMBER EXH-CIV-STORM-001	
B. JUENEMANN J. ROWLAND D. DUBOSE T. ROARK			

SCALE: 1" = 500'

DRAWING NAME: V:\WWE\Projects\20070510-Williams_Creek_Generating_Station\Cvt\TEMP\BA\Stormwater\ExistingDrainageAreas.dwg



LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY

Drainage Area	Area (AC)	Weighted Curve Number	Q ₅ (cfs)	Volume ₅ (ac-ft)	Q ₁₀₀ (cfs)	Volume ₁₀₀ (ac-ft)
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3	98.5	83.2	107	10.0	250	23.1
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- PRELIMINARY -
NOT FOR CONSTRUCTION

OPEN	CONCEPTUAL EXHIBIT		
	B. JUENEMANN	J. ROWLAND	09-25-26
REV	DESIGN BY	CHECKED BY	DATE

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION



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PRE CONSTRUCTION - DRAINAGE AREAS

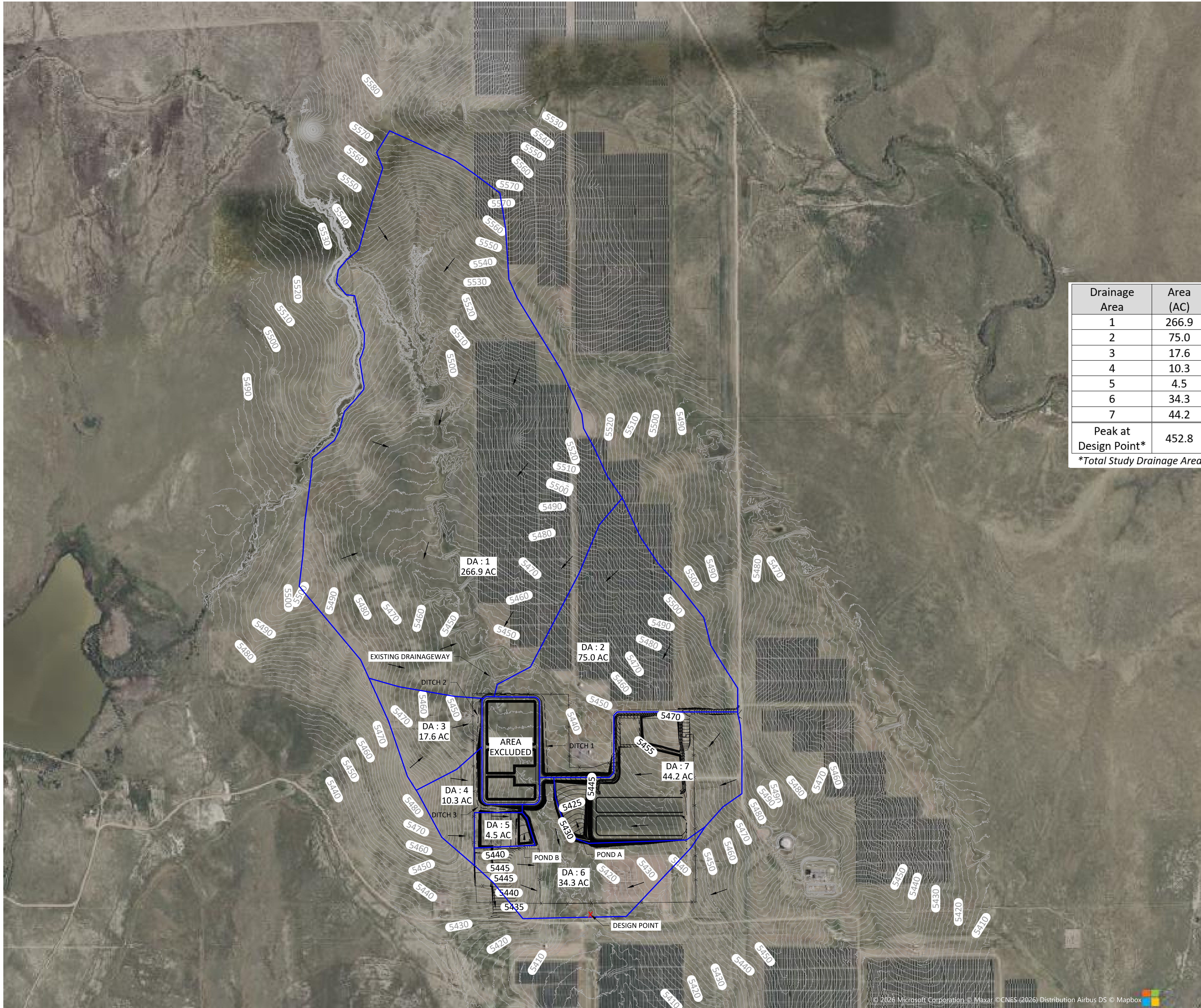
ENGINEER/DESIGN ORIGINATOR	B. JUENEMANN
LEAD ENG	J. ROWLAND
ENG MGR	D. DUBOSE
PROJ MGR	T. ROARK

DRAWING NUMBER

EXH-CIV-STORM-002

SCALE: 1" = 200'

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LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY
- PROPOSED DITCH LOCATION

Drainage Area	Area (AC)	Weighted Curve Number	Q ₅ (cfs)	Volume ₅ (ac-ft)	Q ₁₀₀ (cfs)	Volume ₁₀₀ (ac-ft)
1	266.9	82.2	185	25.4	450	60.3
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6	34.3	82.0	46	3.3	110	7.8
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Peak at Design Point*	452.8	-	255	43.6	696	103.9

*Total Study Drainage Area reduced by 14.5 acres to account for zero liquid discharge process ponds.

- PRELIMINARY - NOT FOR CONSTRUCTION

OPEN	CONCEPTUAL EXHIBIT		
	B. JUENEMANN	J. ROWLAND	09-25-26
REV	DESIGN BY	CHECKED BY	DATE

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION



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POST CONSTRUCTION - DRAINAGE AREAS

ENGINEER/DESIGN ORIGINATOR	B. JUENEMANN
LEAD ENG	J. ROWLAND
ENG MGR	D. DUBOSE
PROJ MGR	T. ROARK

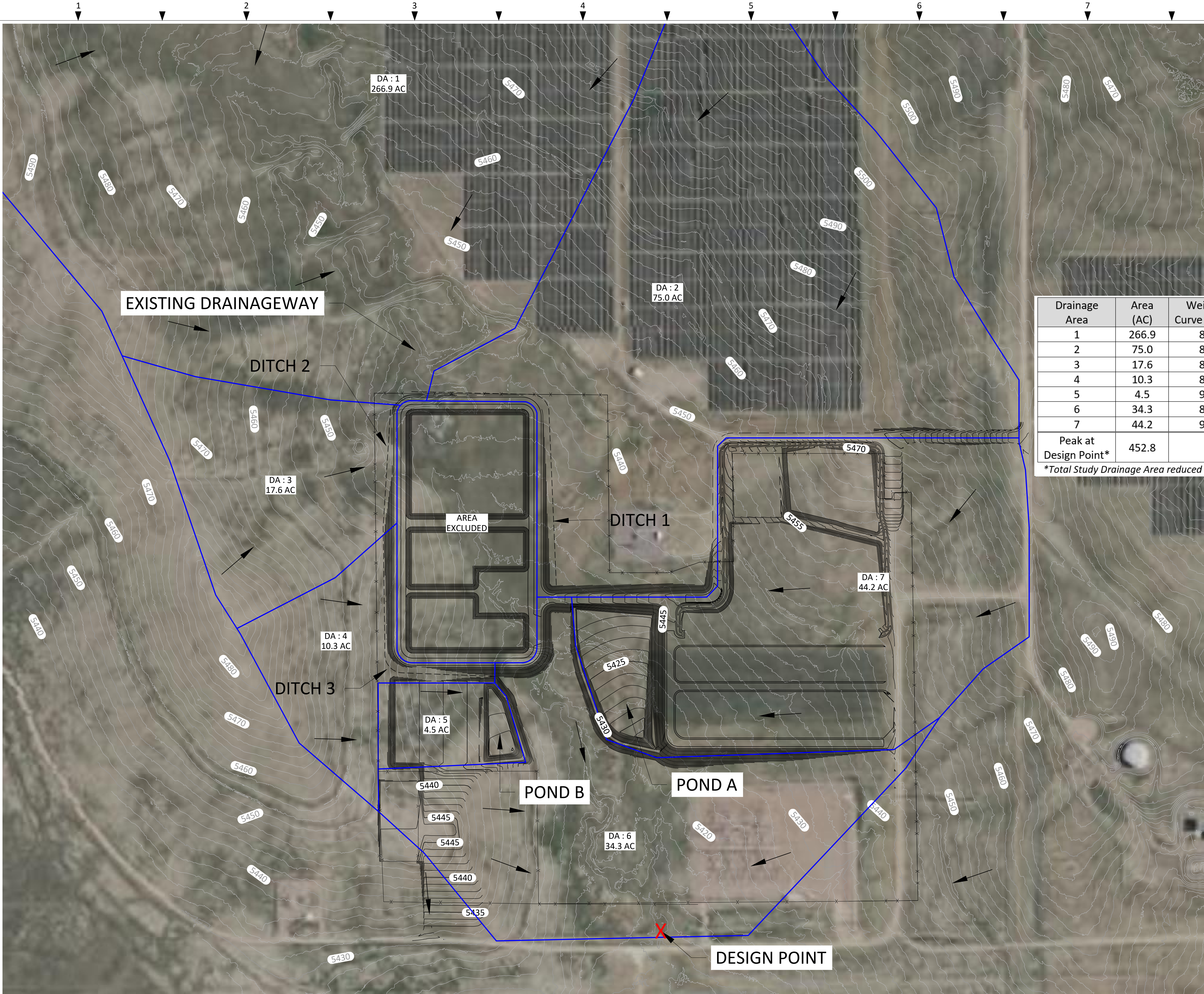
DRAWING NUMBER

EXH-CIV-STORM-003

SCALE: 1" = 500'

*Areas outside of the drainage boundary will need to be finalized in the final report

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LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- DRAINAGE FLOW PATH
- DRAINAGE AREA BOUNDARY
- PROPOSED DITCH LOCATION

Drainage Area	Area (AC)	Weighted Curve Number	Q ₅ (cfs)	Volume ₅ (ac-ft)	Q ₁₀₀ (cfs)	Volume ₁₀₀ (ac-ft)
1	266.9	82.2	185	25.4	450	60.3
2	75.0	83.9	87	7.8	201	18.0
3	17.6	83.9	29	1.8	66	4.2
4	10.3	84.0	18	1.1	41	2.5
5	4.5	98.0	14	0.9	25	1.6
6	34.3	82.0	46	3.3	110	7.8
7	44.2	92.5	84	7.0	160	13.8
Peak at Design Point*	452.8	-	255	43.6	696	103.9

*Total Study Drainage Area reduced by 14.5 acres to account for zero liquid discharge process ponds.

- PRELIMINARY -
NOT FOR CONSTRUCTION

OPEN	CONCEPTUAL EXHIBIT		
	B. JUENEMANN	J. ROWLAND	09-25-26
REV	DESIGN BY	CHECKED BY	DATE

COLORADO SPRINGS UTILITIES
WILLIAMS CREEK GENERATING STATION



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POST CONSTRUCTION - DRAINAGE AREAS

ENGINEER/DESIGN ORIGINATOR	B. JUENEMANN
LEAD ENG	J. ROWLAND
ENG MGR	D. DUBOSE
PROJ MGR	T. ROARK

DRAWING NUMBER
EXH-CIV-STORM-004

SCALE: 1" = 200'

*Areas outside of the drainage boundary will need to be finalized in the final report

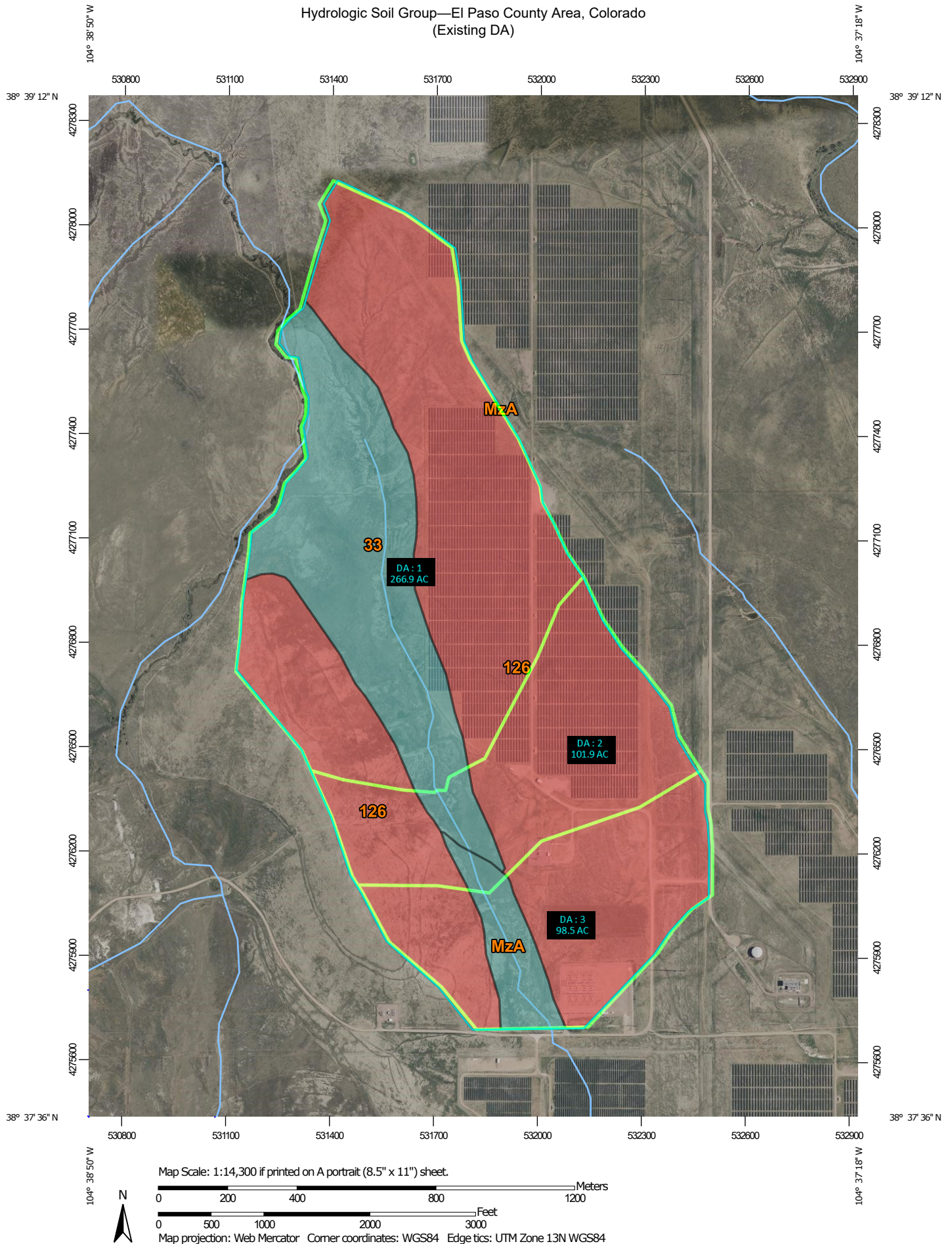


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PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX B – WEB SOIL SURVEY

Hydrologic Soil Group—El Paso County Area, Colorado (Existing DA)



Hydrologic Soil Group—El Paso County Area, Colorado (Existing DA)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 23, Aug 29, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 12, 2017—Aug 4, 2024

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
33	Heldt clay loam, 0 to 3 percent slopes	C	102.7	22.0%
126	Midway clay loam, dry, 1 to 15 percent slopes	D	346.4	74.1%
MzA	Manzanola silty clay loam, saline, 0 to 2 percent slopes	C	18.3	3.9%
Totals for Area of Interest			467.3	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

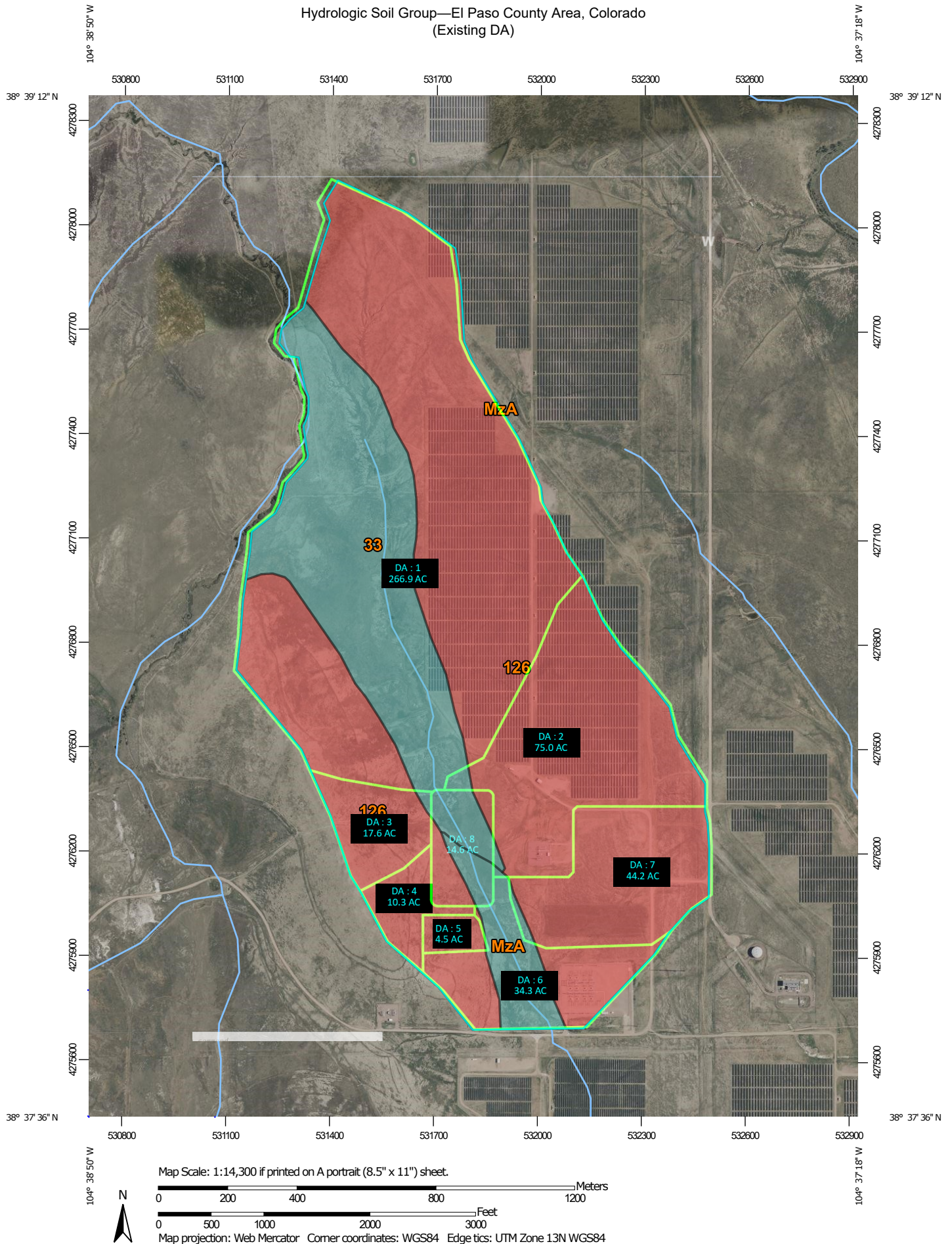
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group—El Paso County Area, Colorado (Existing DA)



Hydrologic Soil Group—El Paso County Area, Colorado (Existing DA)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 23, Aug 29, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 12, 2017—Aug 4, 2024

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
33	Heldt clay loam, 0 to 3 percent slopes	C	102.7	22.0%
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Totals for Area of Interest			467.3	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



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PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX C – FEMA FLOOD MAP

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at <http://www.ngs.noaa.gov/>.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FIMX) 1-877-336-2827 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2827) or visit the FEMA website at <http://www.fema.gov/business/nfp>.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map

This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.

THIS PANEL SHOWN AT A
SCALE OF 1"=500'
ON MAP NUMBER 08041C0966

THIS PANEL SHOWN AT A
SCALE OF 1"=500'
ON MAP NUMBER 08041C0967

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 16 SOUTH, RANGE 65 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

ZONE A

No Base Flood Elevations determined.

ZONE AE

Base Flood Elevations determined.

ZONE AH

Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO

Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR

Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decrettified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99

Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V

Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE

Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X

Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X

Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D

Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

(EL 513)

Base Flood Elevation line and value; elevation in feet*

Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

Cross section line

23

23

Transsect line

97° 07' 30.00"

32° 22' 30.00"

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4275000N

1000-meter Universal Transverse Mercator grid ticks, zone 13

6000000 FT

5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0902), Lambert Conformal Conic Projection

DX5510

Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5

River Mile

MAP REPOSITORIES

Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500

1000

2000

FEET

300

0

300

600

METERS

NFP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0970G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 970 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0970	G
FOUNTAIN CITY OF	080061	0970	G

Notice to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER

08041C0970G

MAP REVISED

DECEMBER 7, 2018

Federal Emergency Management Agency

U.S. DEPARTMENT OF COMMERCE



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PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX D – RAINFALL DEPTHS

DRAINAGE CRITERIA MANUAL COUNTY OF EL PASO, COLORADO

VOLUME 1 UPDATE

CHAPTER 6 - HYDROLOGY

2.1. - Rainfall Depths

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60
Where Z = 6,840 ft/100			



Kiewit

PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX E – NRCS CURVE NUMBERS

CN Tables

The four pages in this section are reproduced from the SCS (now NRCS) report Urban hydrology for small watersheds. This report is commonly known as TR-55. The tables provide estimates of the curve number (CN) as a function of hydrologic soil group (HSG), cover type, treatment, hydrologic condition, antecedent runoff condition (ARC), and impervious area in the catchment.

TR-55 provides the following guidance for use of these tables:

- Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A \[of TR-55\] defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.
- There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.
- Treatment is a cover type modifier (used only in Table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.
- Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. Good hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are: (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.
- The index of runoff potential before a storm event is the antecedent runoff condition (ARC). The CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The curve numbers in table 2-2 are for the average ARC, which is used primarily for design applications.
- The percentage of impervious area and the means of conveying runoff from impervious areas to the drainage systems should be considered in computing CN for urban areas. An impervious area is considered connected if runoff from it flows directly into the drainage systems. It is also considered connected if runoff from it occurs as shallow concentrated shallow flow that runs over a pervious area and then into a drainage system. Runoff from unconnected impervious areas is spread over a pervious area as sheet flow.

SCS TR-55 Table 2-2a – Runoff curve numbers for urban areas¹

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ²	A	B	C	D
<i>Fully developed urban areas</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³ :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ²	A	B	C	D
Natural desert landscaping (pervious areas only) ⁴ . .		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	12	46	65	77	82

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ²	A	B	C	D
<i>Developing urban areas</i>					
Newly graded areas (pervious areas only, no vegetation) ⁵		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c)					

¹ Average runoff condition, and $I_a = 0.2S$.

² The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

³ CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

⁴ Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

⁵ Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (imperviousness area percentage) and the CN's for the newly graded pervious areas.

SCS TR-55 Table 2-2b – Runoff curve numbers for cultivated agricultural lands¹

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment ²	Hydrologic condition ³	A	B	C	D
Fallow	Bare soil	-	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93

		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C & T)	Poor	66	74	80	82
		Good	62	71	78	81
	C & T + CR	Poor	65	73	79	81
		Good	61	70	77	80

Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C & T	Poor	61	72	79	82
		Good	59	70	78	81
	C & T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C & T	Poor	63	73	80	83
		Good	51	67	76	80

¹ Average runoff condition, and $I_a = 0.2S$.

² *Crop residue cover* applies only if residue is on at least 5% of the surface throughout the

year.

³ Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good $\geq 20\%$), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

SCS TR-55 Table 2-2c – Runoff curve numbers for other agricultural lands¹

Cover description		Curve numbers for hydrologic soil group							
Cover type and hydrologic condition	Hydrologic condition	A		B		C		D	
Pasture, grassland, or range – continuous	Poor	68	7 9		8 6		8 9		
forage for grazing. ²	Fair	49	6 9		7 9		8 4		
	Good	39	6 1		7 4		8 0		
Meadow – continuous grass, protected from	⊠	30	5 8		7 1		7 8		
grazing and generally mowed for hay.									
Brush – brush-weed mixture with brush	Poor	48	6 7		7 7		8 3		
the major element. ³	Fair	35	5 6		7 0		7 7		

	Good	30 ⁴	4 8	6 5	7 3		
Woods – grass combination (orchard or tree farm). ⁵	Poor	57	7 3	8 2	8 6		
	Fair	43	6 5	7 6	8 2		
	Good	32	5 8	7 2	7 9		
Woods. ⁶	Poor	45	6 6	7 7	8 3		
	Fair	36	6 0	7 3	7 9		
	Good	30 ⁴	5 5	7 0	7 7		
Farmsteads – buildings, lanes, driveways, and surrounding lots.	☒	59	7 4	8 2	8 6		

¹ Average runoff condition, and $I_a = 0.2S$.

² *Poor*: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: >75% ground cover and lightly or only occasionally grazed.

³ *Poor*: <50% ground cover.

Fair: 50 to 75% ground cover.

Good: >75% ground cover.

⁴ Actual curve number is less than 30; use CN=30 for runoff computations.

⁵ CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover.

Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

SCS TR-55 Table 2-2d – Runoff curve numbers for arid and semiarid rangelands¹

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition ²	A ³	B	C	D
Herbaceous – mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen – mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper – pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86

	Good	49	68	79	84
--	------	----	----	----	----

¹ Average runoff condition, and $I_a = 0.2S$.

² *Poor*: <30% ground cover (litter, grass, and brush overstory).

Fair: 30 to 70% ground cover.

Good: >70% ground cover.

³ Curve numbers for group A have been developed only for desert shrub.



PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX F – HYDRAULIC CALCULATIONS

Channel Report

DITCH-01 - 5 YR CROSS SECTION

Trapezoidal

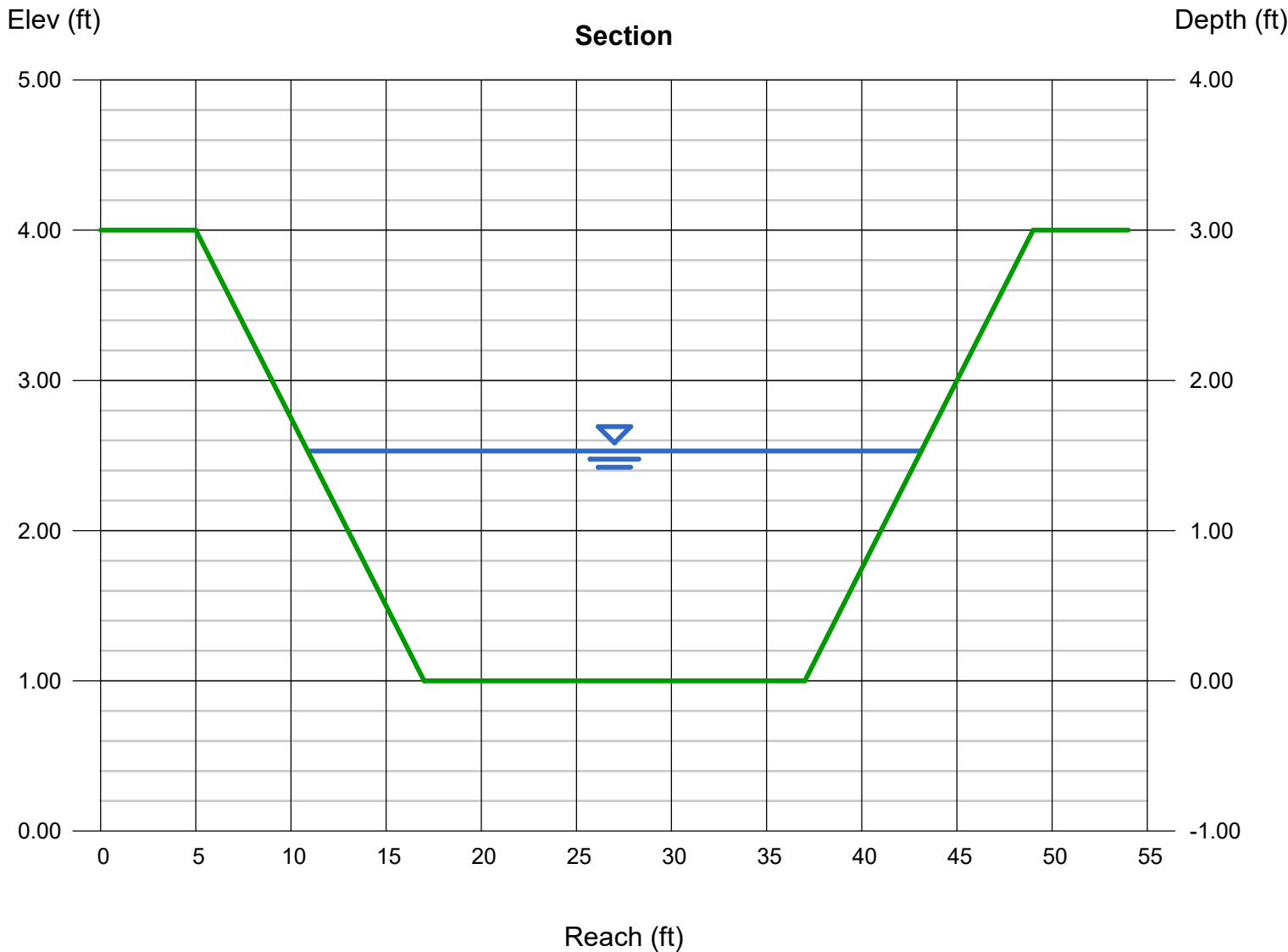
Bottom Width (ft)	= 20.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.65
N-Value	= 0.030

Highlighted

Depth (ft)	= 1.53
Q (cfs)	= 182.00
Area (sqft)	= 39.96
Velocity (ft/s)	= 4.55
Wetted Perim (ft)	= 32.62
Crit Depth, Yc (ft)	= 1.26
Top Width (ft)	= 32.24
EGL (ft)	= 1.85

Calculations

Compute by:	Known Q
Known Q (cfs)	= 182.00



Channel Report

DITCH-01 - 100 YR CROSS SECTION

Trapezoidal

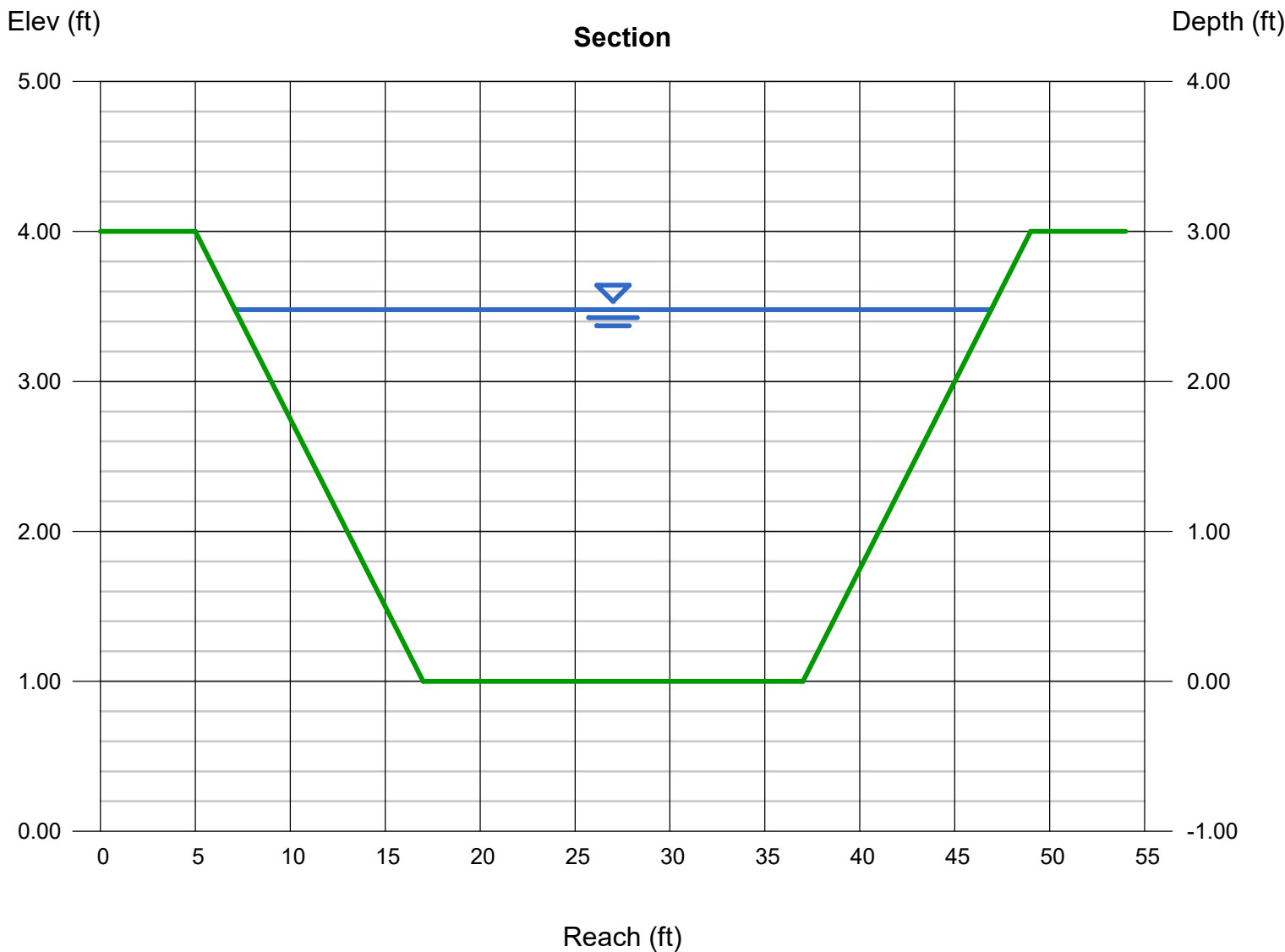
Bottom Width (ft) = 20.00
Side Slopes (z:1) = 4.00, 4.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 1.00
Slope (%) = 0.65
N-Value = 0.030

Highlighted

Depth (ft) = 2.48
Q (cfs) = 442.00
Area (sqft) = 74.20
Velocity (ft/s) = 5.96
Wetted Perim (ft) = 40.45
Crit Depth, Yc (ft) = 2.14
Top Width (ft) = 39.84
EGL (ft) = 3.03

Calculations

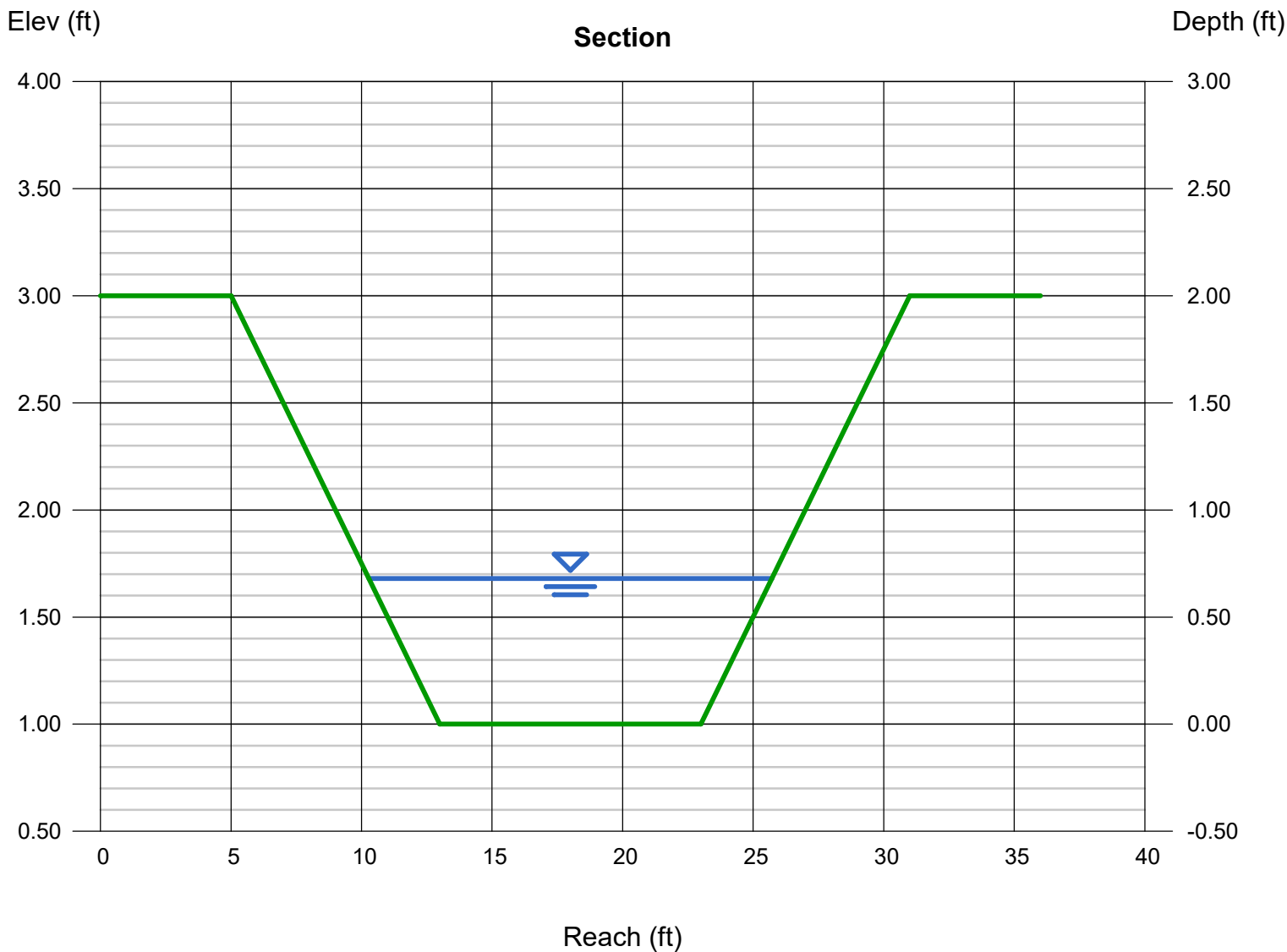
Compute by: Known Q
Known Q (cfs) = 442.00



Channel Report

DITCH-02 - 5 YR CROSS SECTION

Trapezoidal		Highlighted	
Bottom Width (ft)	= 10.00	Depth (ft)	= 0.68
Side Slopes (z:1)	= 4.00, 4.00	Q (cfs)	= 29.00
Total Depth (ft)	= 2.00	Area (sqft)	= 8.65
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 3.35
Slope (%)	= 1.05	Wetted Perim (ft)	= 15.61
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.59
Calculations		Top Width (ft)	= 15.44
Compute by:		EGL (ft)	= 0.85
Known Q			
Known Q (cfs)		= 29.00	



Channel Report

DITCH-02 - 100 YR CROSS SECTION

Trapezoidal

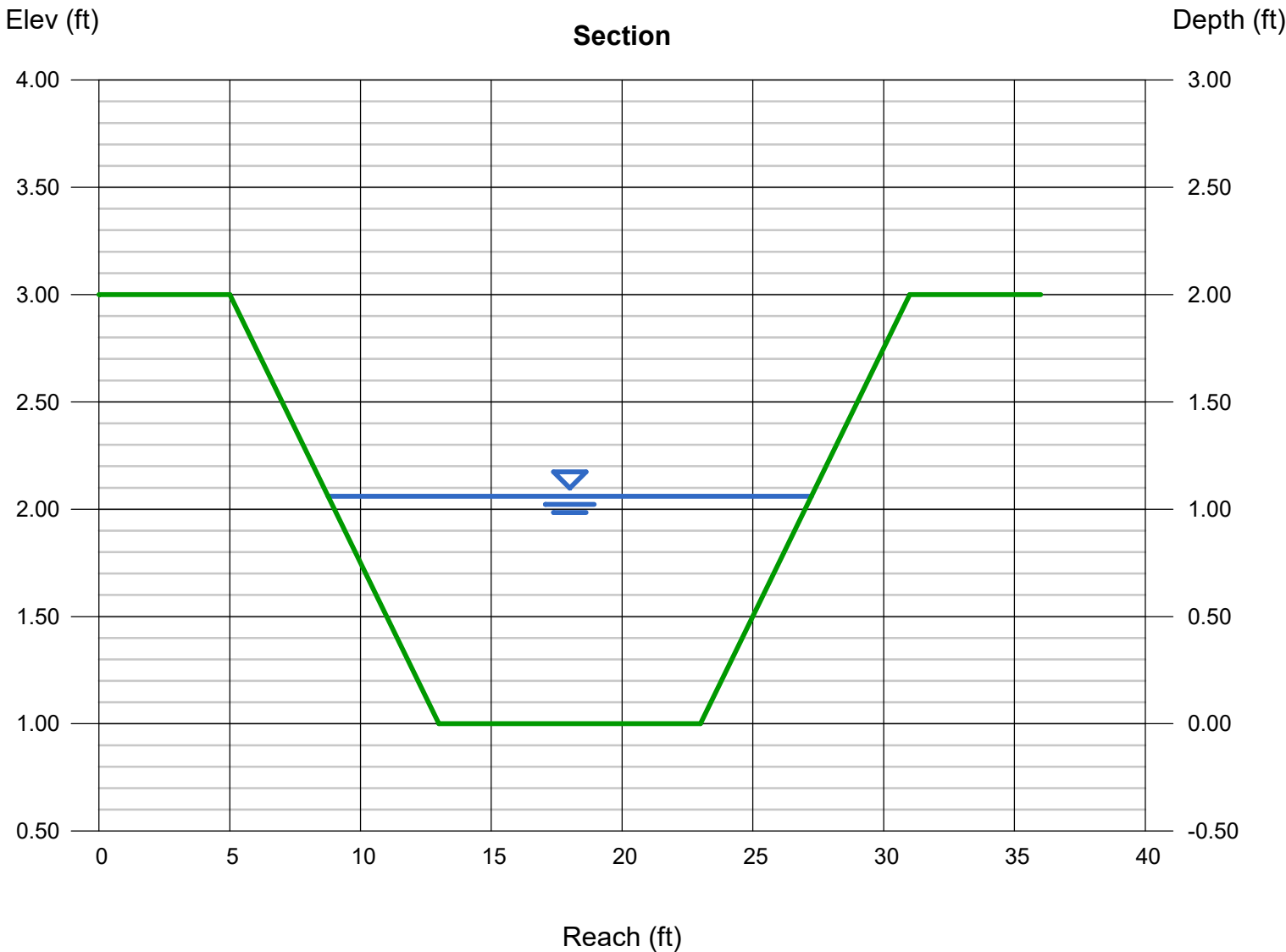
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 1.05
N-Value	= 0.030

Highlighted

Depth (ft)	= 1.06
Q (cfs)	= 66.00
Area (sqft)	= 15.09
Velocity (ft/s)	= 4.37
Wetted Perim (ft)	= 18.74
Crit Depth, Yc (ft)	= 0.97
Top Width (ft)	= 18.48
EGL (ft)	= 1.36

Calculations

Compute by:	Known Q
Known Q (cfs)	= 66.00



Channel Report

DITCH-03 - 5 YR CROSS SECTION

Trapezoidal

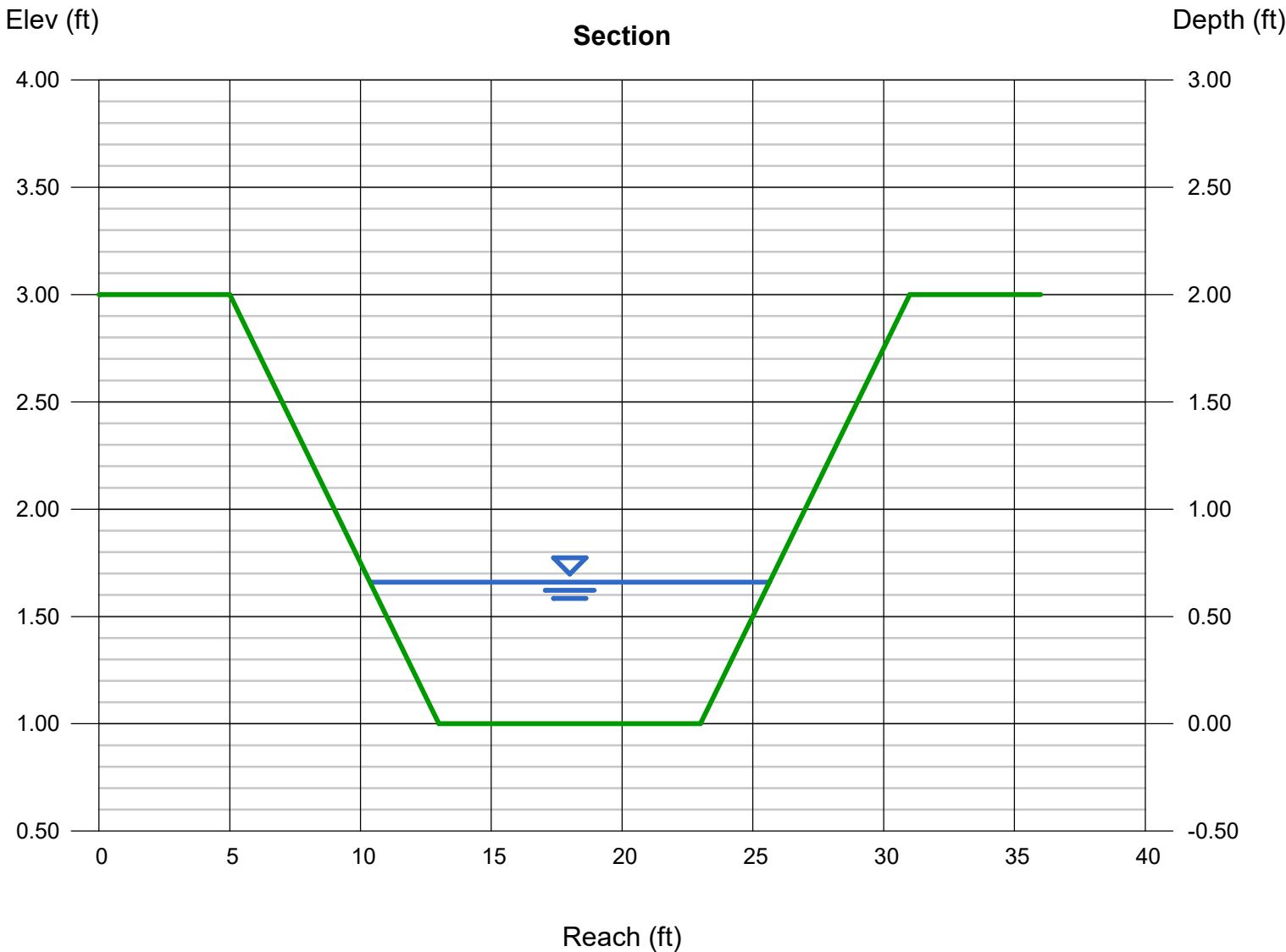
Bottom Width (ft) = 10.00
Side Slopes (z:1) = 4.00, 4.00
Total Depth (ft) = 2.00
Invert Elev (ft) = 1.00
Slope (%) = 2.44
N-Value = 0.030

Highlighted

Depth (ft) = 0.66
Q (cfs) = 42.00
Area (sqft) = 8.34
Velocity (ft/s) = 5.03
Wetted Perim (ft) = 15.44
Crit Depth, Yc (ft) = 0.74
Top Width (ft) = 15.28
EGL (ft) = 1.05

Calculations

Compute by: Known Q
Known Q (cfs) = 42.00



Channel Report

DITCH-03 - 100 YR CROSS SECTION

Trapezoidal

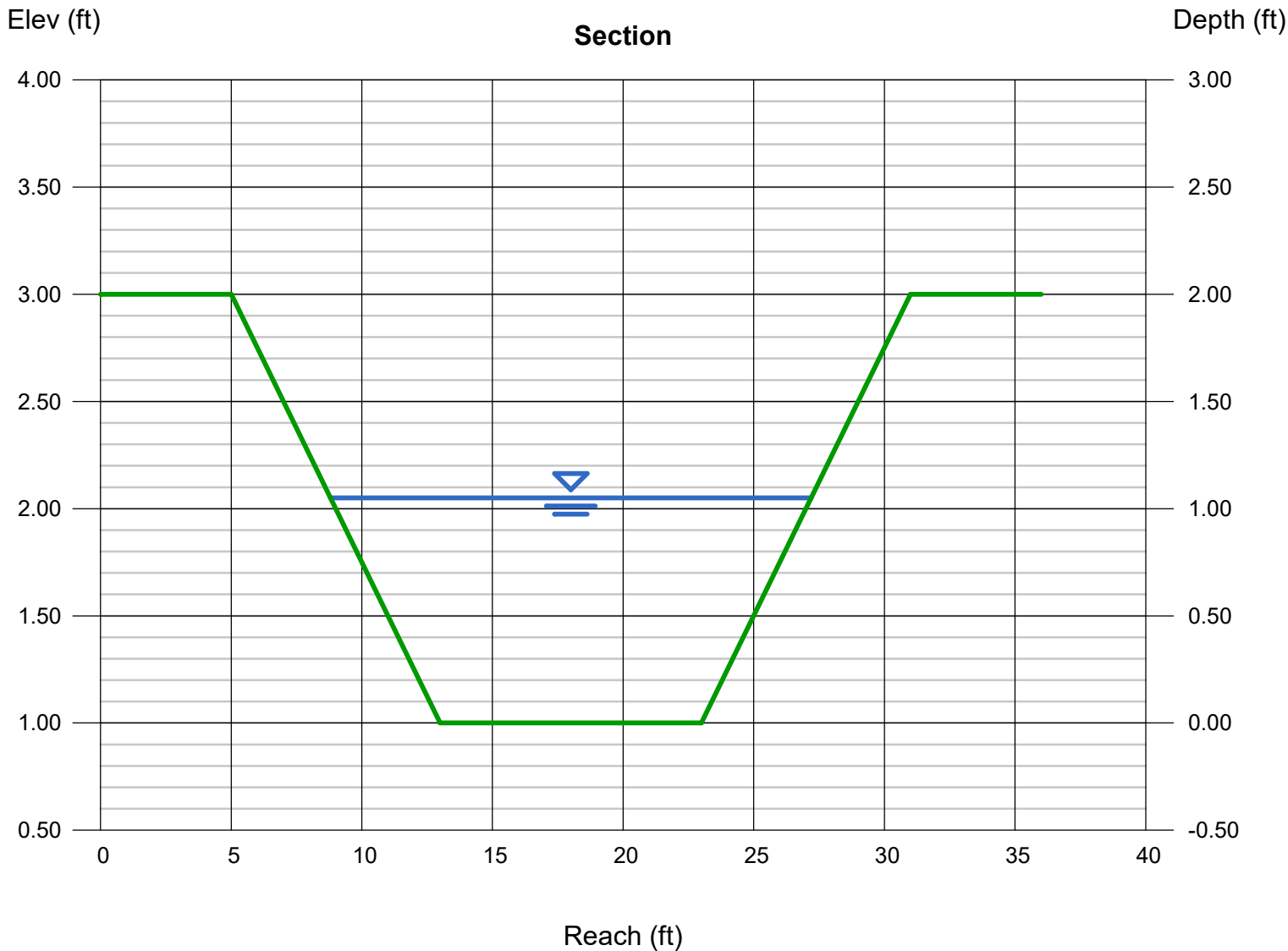
Bottom Width (ft) = 10.00
Side Slopes (z:1) = 4.00, 4.00
Total Depth (ft) = 2.00
Invert Elev (ft) = 1.00
Slope (%) = 2.44
N-Value = 0.030

Highlighted

Depth (ft) = 1.05
Q (cfs) = 99.00
Area (sqft) = 14.91
Velocity (ft/s) = 6.64
Wetted Perim (ft) = 18.66
Crit Depth, Yc (ft) = 1.23
Top Width (ft) = 18.40
EGL (ft) = 1.74

Calculations

Compute by: Known Q
Known Q (cfs) = 99.00



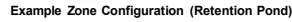


PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX G – WATER QUALITY AND DETENTION

MHFD-Detention, Version 4.08 (April 2026)

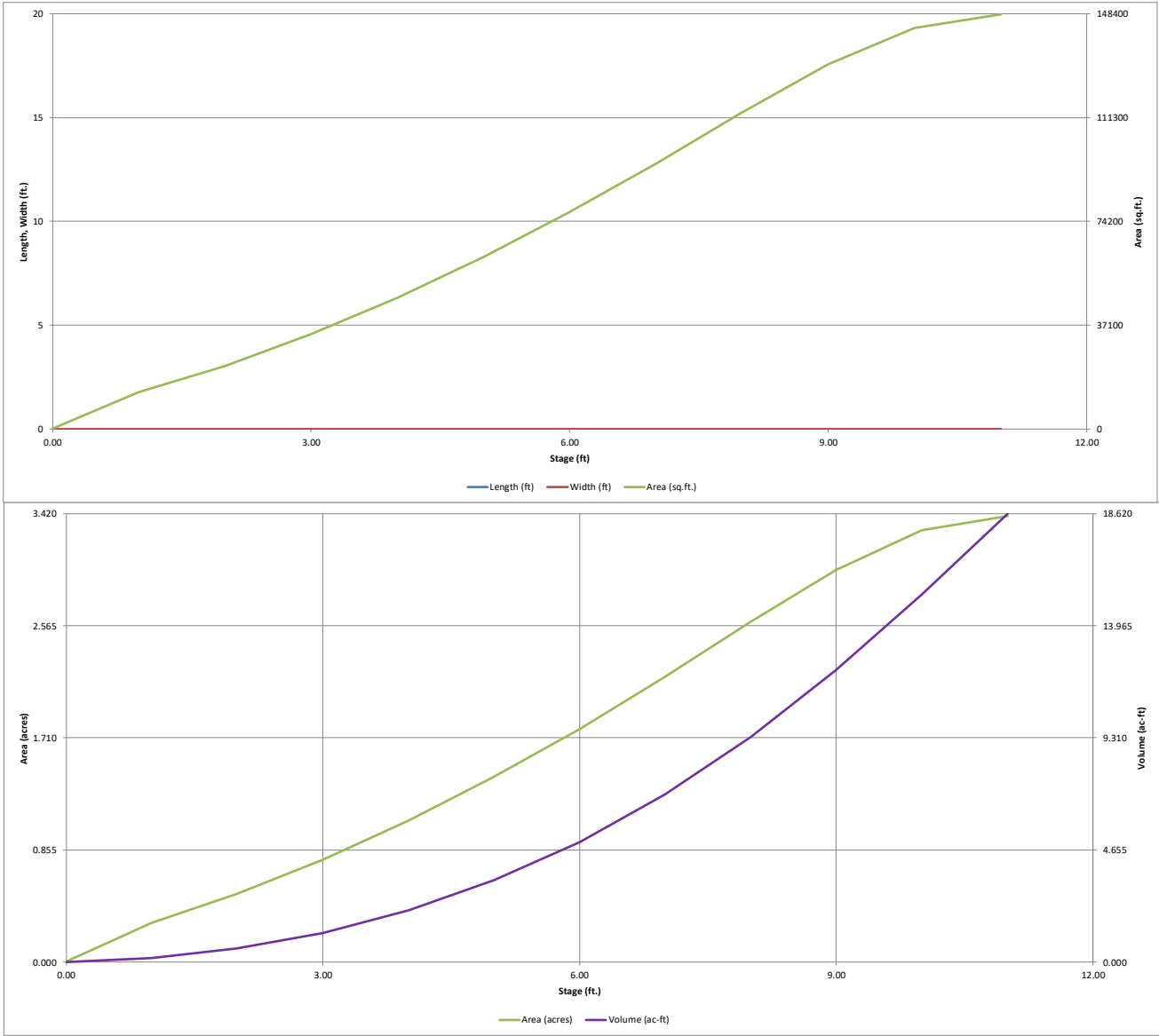
Basin ID: Pond A



8/28/2026, 2:51 PM

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.08 (April 2026)

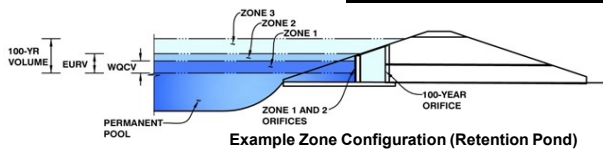


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.08 (April 2026)

Project: Williams Creek Generating Station

Basin ID: Pond A



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.92	1.144	Orifice Plate
Zone 2 (EURV)	4.97	2.189	Orifice Plate
Z3 (100+1/2WQCV)	6.58	2.728	Weir&Pipe (Restrict)
Total (all zones)		6.061	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration SCM)

Underdrain Orifice Invert Depth = ft (distance below the filtration media surface)
Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain
Underdrain Orifice Area = ft²
Underdrain Orifice Centroid = feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation SCM)

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = 4.97 ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = 19.88 inches
Orifice Plate: Orifice Area per Row = 6.58 sq. inches (use rectangular openings)

Calculated Parameters for Plate
WQ Orifice Area per Row = 4.569E-02 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A ft²

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.70	3.40					
Orifice Area (sq. inches)	6.58	6.58	6.58					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice = Not Selected Not Selected ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = N/A N/A ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = N/A N/A inches

Calculated Parameters for Vertical Orif
Vertical Orifice Area = Not Selected Not Selected
Vertical Orifice Centroid = N/A N/A

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

Overflow Weir Front Edge Height, H_o = Zone 3 Weir Not Selected ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = 7.00 N/A feet
Overflow Weir Grate Slope = 0.00 N/A H:V
Horiz. Length of Weir Sides = 7.00 N/A feet
Overflow Grate Type = Type C Grate N/A
Debris Clogging % = 50% N/A %

Calculated Parameters for Overflow W
Height of Grate Upper Edge, H_t = Zone 3 Weir Not Selected
Overflow Weir Slope Length = 7.00 N/A
Grate Open Area / 100-yr Orifice Area = 7.89 N/A
Overflow Grate Open Area w/o Debris = 34.10 N/A
Overflow Grate Open Area w/ Debris = 17.05 N/A

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

Depth to Invert of Outlet Pipe = Zone 3 Restrictor Not Selected ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = 30.00 N/A inches
Restrictor Plate Height Above Pipe Invert = 24.70 inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pl
Outlet Orifice Area = Zone 3 Restrictor Not Selected
Outlet Orifice Centroid = 4.32 N/A
Half-Central Angle of Restrictor Plate on Pipe = 1.12 N/A
Half-Central Angle of Restrictor Plate on Pipe = 2.27 N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = 7.00 ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = 52.00 feet
Spillway End Slopes = 4.00 H:V
Freeboard above Max Water Surface = 2.00 feet

Calculated Parameters for Spillway
Spillway Design Flow Depth = 0.96 feet
Stage at Top of Freeboard = 9.96 feet
Basin Area at Top of Freeboard = 3.28 acres
Basin Volume at Top of Freeboard = 15.14 acre-ft

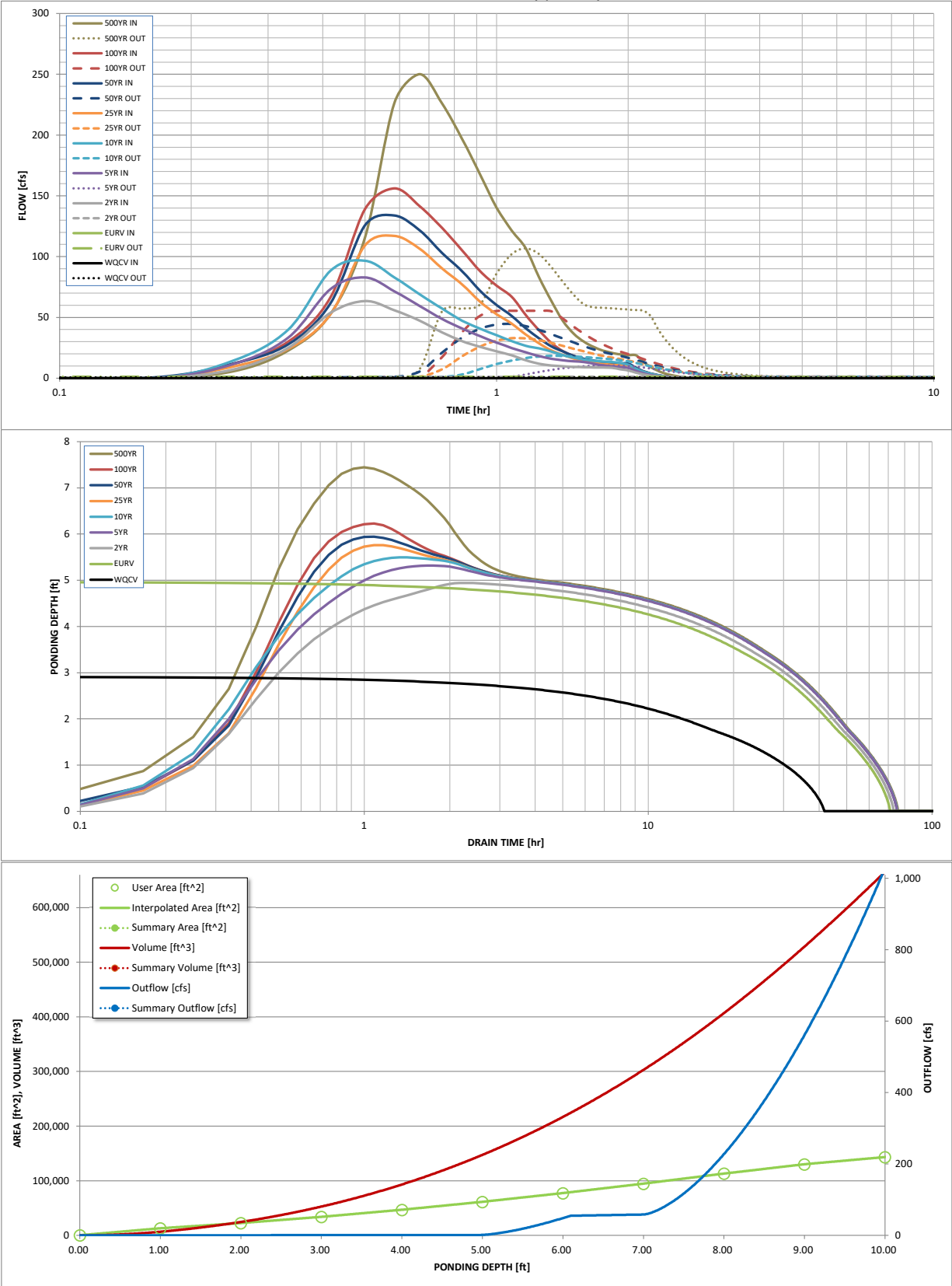
Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through A)

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Design Storm Return Period								
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft)	1.144	3.333	3.476	4.640	5.599	6.618	7.597	8.710
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	3.476	4.640	5.599	6.618	7.597	8.710
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	10.1	19.7	26.8	41.3	50.6	63.0
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.23	0.45	0.61	0.93	1.15	1.43
Peak Inflow Q (cfs)	N/A	N/A	63.4	82.8	96.6	117.0	133.8	156.1
Peak Outflow Q (cfs)	0.6	1.2	1.2	10.4	18.3	32.9	44.6	55.5
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.5	0.7	0.8	0.9	0.9
Structure Controlling Flow	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Gate 1 (fps)	N/A	N/A	N/A	0.3	0.5	0.9	1.3	1.6
Max Velocity through Gate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	38	63	65	65	63	62	60	59
Time to Drain 99% of Inflow Volume (hours)	40	68	70	71	70	69	69	68
Maximum Ponding Depth (ft)	2.92	4.97	4.94	5.32	5.49	5.76	5.94	6.22
Area at Maximum Ponding Depth (acres)	0.76	1.40	1.39	1.52	1.59	1.69	1.76	1.87
Maximum Volume Stored (acre-ft)	1.149	3.340	3.284	3.837	4.117	4.543	4.870	5.377

DETENTION BASIN OUTLET STRUCTURE DESIGN

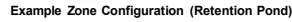
MHFD-Detention, Version 4.08 (April 2026)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

MHFD-Detention, Version 4.08 (April 2026)

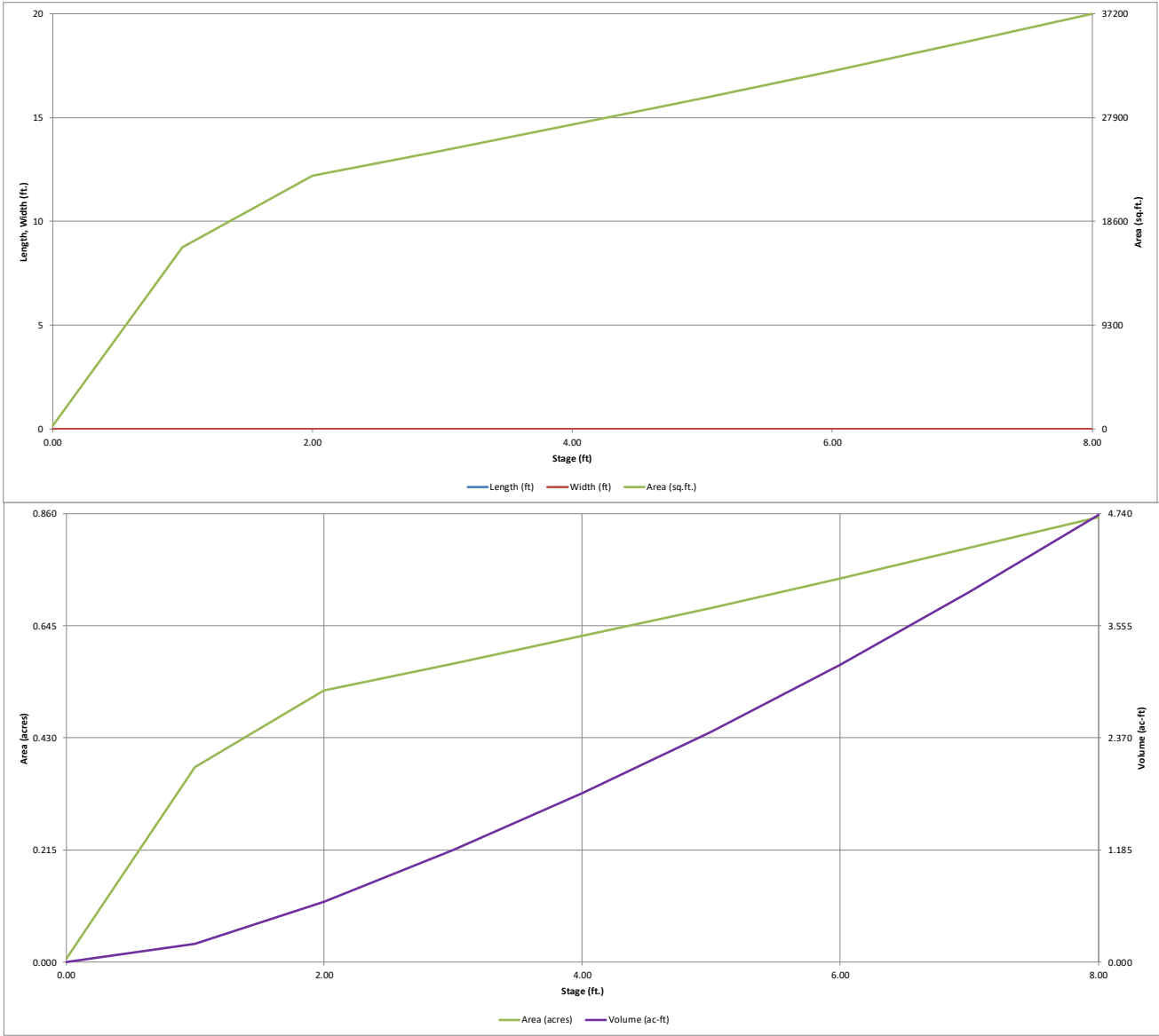
Basin ID: Pond B



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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.08 (April 2026)

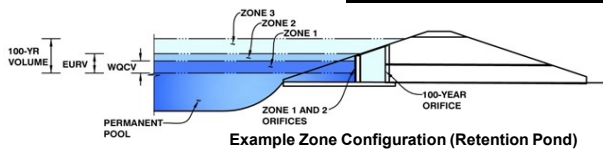


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.08 (April 2026)

Project: Williams Creek Generating Station

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.89	0.151	Orifice Plate
Zone 2 (EURV)	1.52	0.251	Orifice Plate
Z3 (100+1/2WQCV)	2.14	0.307	Weir&Pipe (Restrict)
Total (all zones)		0.709	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration SCM)

Underdrain Orifice Invert Depth = ft (distance below the filtration media surface)
Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain
Underdrain Orifice Area = ft²
Underdrain Orifice Centroid = feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation SCM)

Centroid of Lowest Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = inches
Orifice Plate: Orifice Area per Row = sq. inches (diameter = 1-3/8 inches)

Calculated Parameters for Plate
WQ Orifice Area per Row = ft²
Elliptical Half-Width = feet
Elliptical Slot Centroid = feet
Elliptical Slot Area = ft²

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00	1.50				
Orifice Area (sq. inches)	1.54	1.54	1.54	1.54				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orif
Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

Overflow Weir Front Edge Height, H_o = ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = feet
Overflow Weir Grate Slope = H:V
Horiz. Length of Weir Sides = feet
Overflow Grate Type =
Debris Clogging % = %

Calculated Parameters for Overflow W
Height of Grate Upper Edge, H_t = ft
Overflow Weir Slope Length = feet
Grate Open Area / 100-yr Orifice Area =
Overflow Grate Open Area w/o Debris =
Overflow Grate Open Area w/ Debris =

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = inches
Restrictor Plate Height Above Pipe Invert = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pl
Outlet Orifice Area = ft²
Outlet Orifice Centroid = feet
Half-Central Angle of Restrictor Plate on Pipe = degrees

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = feet
Spillway End Slopes = H:V
Freeboard above Max Water Surface = feet

Calculated Parameters for Spillway
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres
Basin Volume at Top of Freeboard = acre-ft

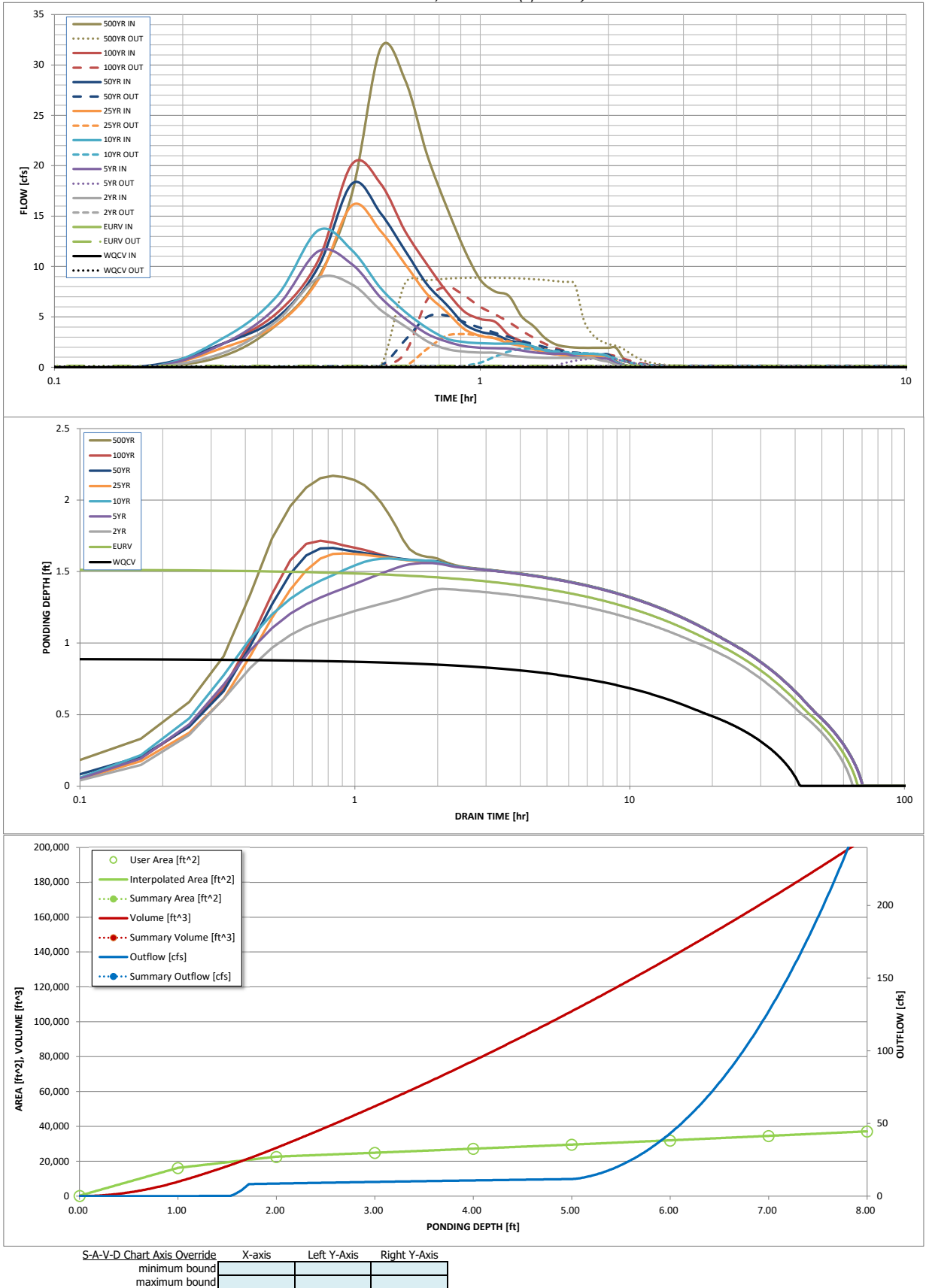
Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AI)

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Design Storm Return Period	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
One-Hour Rainfall Depth (in)	N/A	N/A	0.151	0.402	0.361	0.558	0.649	0.738
CUHP Runoff Volume (acre-ft)	N/A	N/A	0.361	0.470	0.558	0.649	0.738	0.837
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.361	0.470	0.558	0.649	0.738	0.837
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	1.5	3.0	4.1	6.1	7.4	9.0
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.34	0.67	0.92	1.35	1.64	2.01
Peak Inflow Q (cfs)	N/A	N/A	8.9	11.5	13.6	16.1	18.2	20.2
Peak Outflow Q (cfs)	0.1	0.2	0.1	0.9	1.8	3.3	5.1	8.0
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.3	0.4	0.5	0.7	0.9
Structure Controlling Flow	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Gate 1 (fps)	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.1
Max Velocity through Gate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	38	60	57	62	60	59	58	57
Time to Drain 99% of Inflow Volume (hours)	40	64	62	66	66	65	65	64
Maximum Ponding Depth (ft)	0.89	1.52	1.38	1.56	1.59	1.63	1.66	1.72
Area at Maximum Ponding Depth (acres)	0.33	0.45	0.43	0.45	0.46	0.46	0.47	0.48
Maximum Volume Stored (acre-ft)	0.151	0.404	0.338	0.418	0.431	0.450	0.468	0.492

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.08 (April 2026)





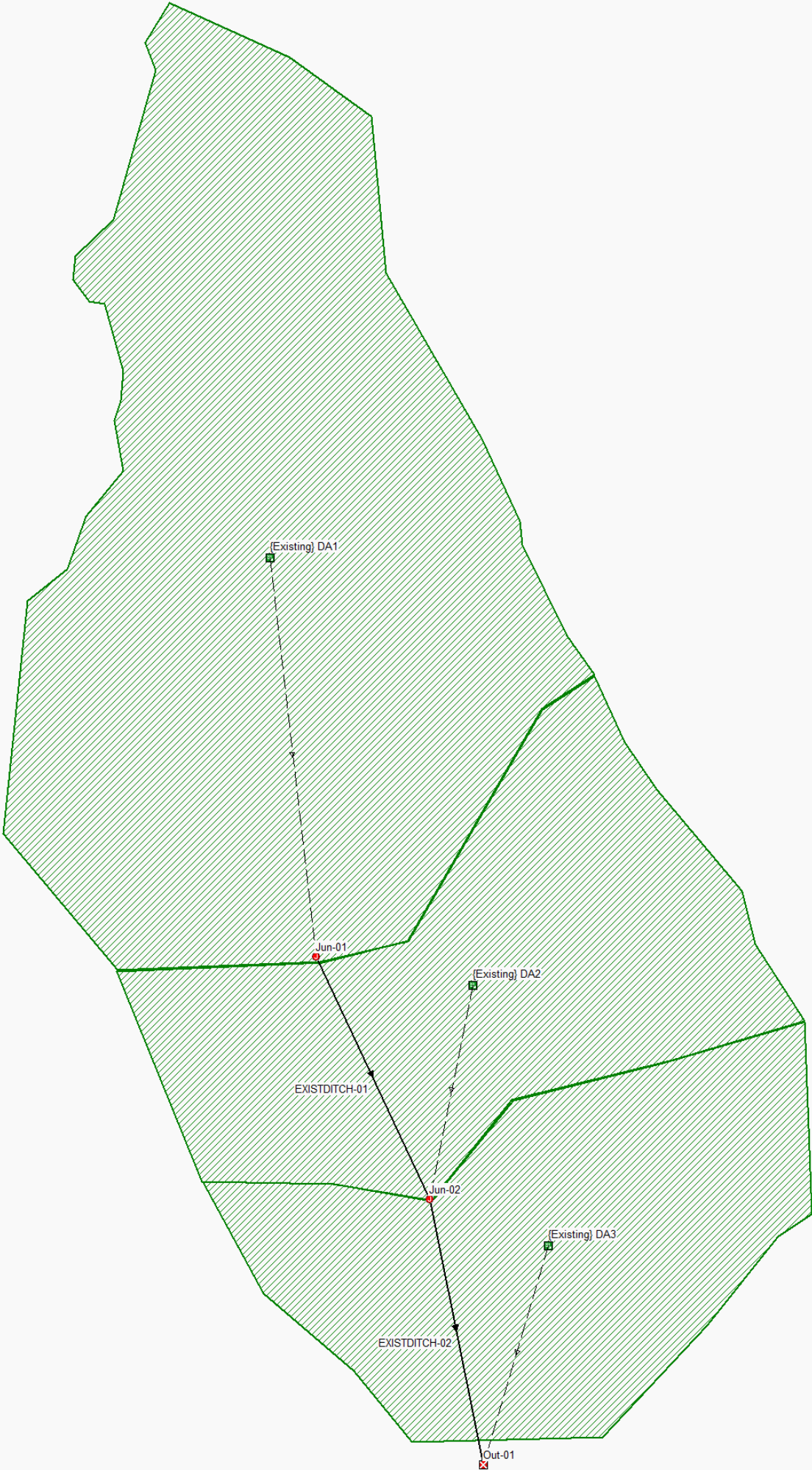
Kiewit

PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

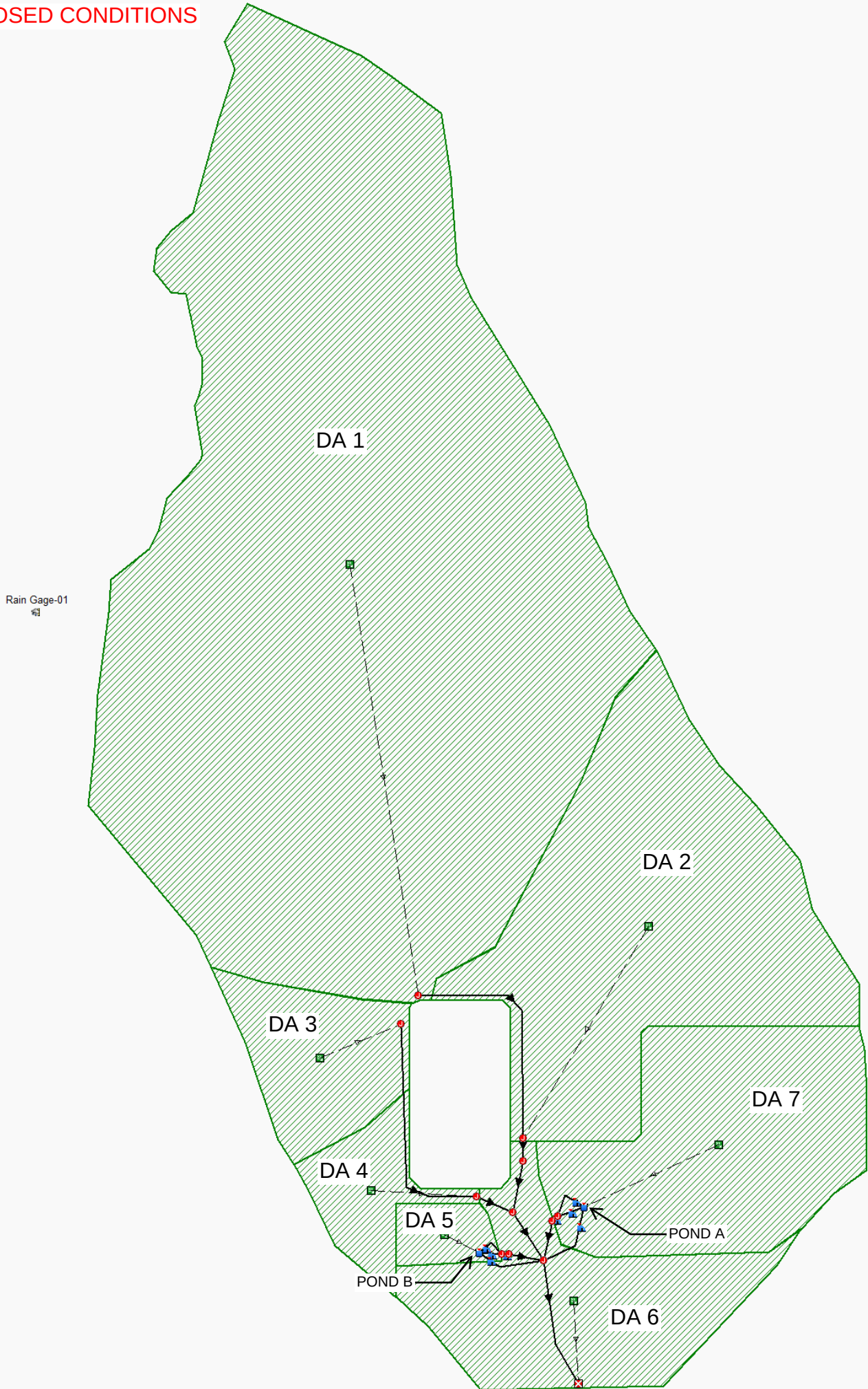
APPENDIX H – STORM AND SANITARY ANALYSIS KEY PLAN

EXISTING CONDITIONS

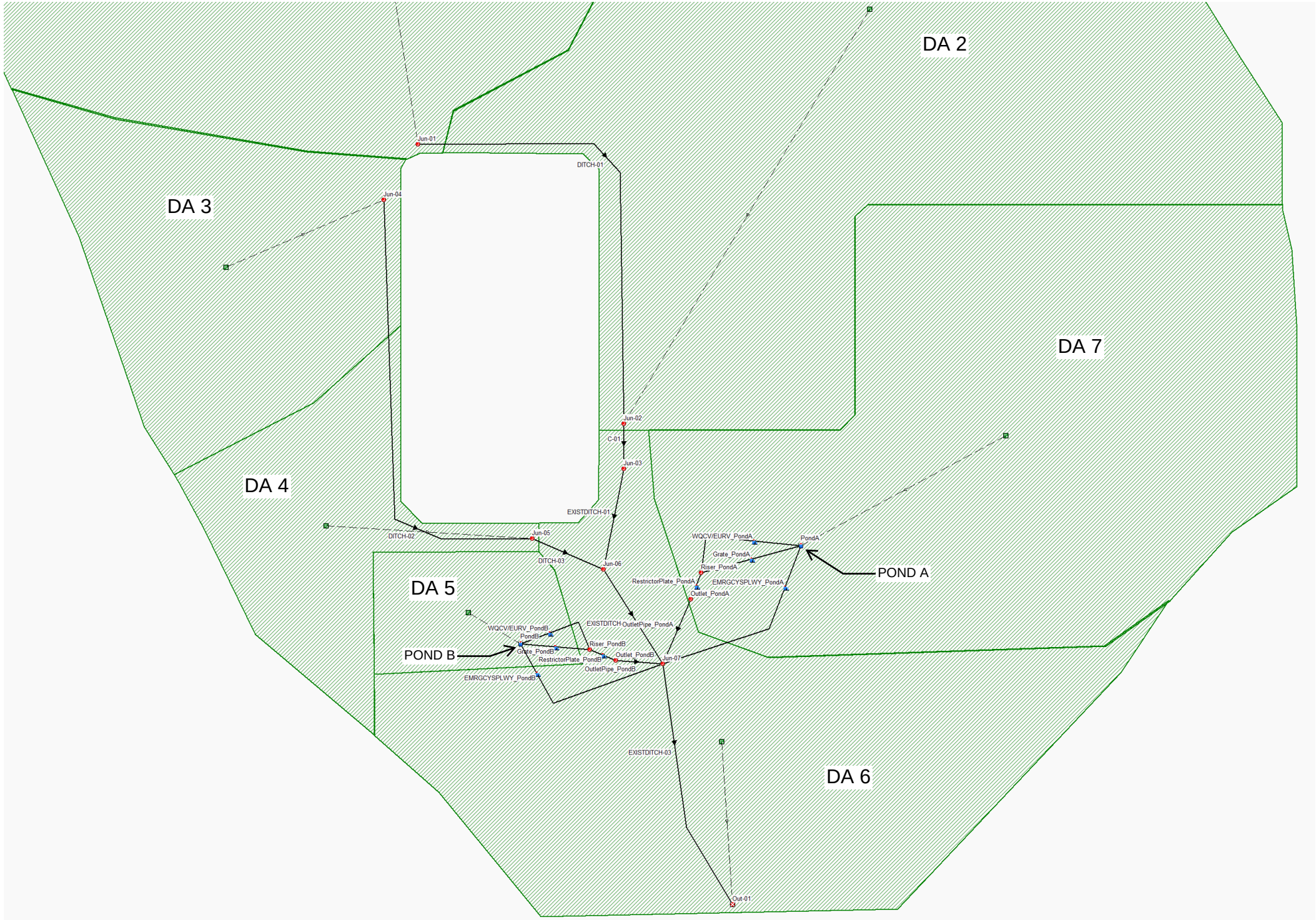
Rain Gage-01
☐



PROPOSED CONDITIONS



PROPOSED CONDITIONS





PROJECT NAME: WILLIAMS CREEK GENERATING STATION
KIEWIT PROJECT 20070510

APPENDIX I – STORM AND SANITARY ANALYSIS CALCULATIONS

Project Description

File Name	Existing Conditions.SPF
Description	Existing Conditions 5-yr Storm

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	3
Nodes.....	3
<i>Junctions</i>	2
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	0
<i>Storage Nodes</i>	0
Links.....	2
<i>Channels</i>	2
<i>Pipes</i>	0
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage	Data	Data Source	Rainfall	Rain	State	County	Return	Rainfall	Rainfall
	ID	Source	ID	Type	Units			Period	Depth	Distribution
								(years)	(inches)	
1	Rain Gage-01	Time Series	5-yr	Cumulative	inches	Colorado	El Paso	5.00	2.70	SCS Type II 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)	Factor		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 {Existing} DA1	266.90	484.00	82.22	2.70	1.16	309.87	185.43	0 00:51:56
2 {Existing} DA2	101.90	484.00	83.47	2.70	1.24	126.25	110.89	0 00:29:41
3 {Existing} DA3	98.50	484.00	83.24	2.70	1.22	120.56	106.82	0 00:29:15

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation	Max Surcharge Depth	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	1-Jun	Junction	5437.80	6.00	0.00	0.00	0.00	185.25	5438.52	0.00	4.28	0 00:00	0.00	0.00
2	2-Jun	Junction	5424.00	6.00	0.00	0.00	0.00	257.70	5424.95	0.00	4.05	0 00:00	0.00	0.00
3	Out-01	Outfall	5409.00					319.56	5409.94					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Reported Surcharged Condition (min)
1	EXISTDITCH-01	Channel	1-Jun	2-Jun	1241.00	5437.80	5424.00	1.1100	60.000	0.0400	183.59	5037.56	0.04	2.65	0.83	0.17	0.00
2	EXISTDITCH-02	Channel	2-Jun	Out-01	1796.00	5424.00	5409.00	0.8400	60.000	0.0400	248.73	4365.75	0.06	3.15	0.94	0.19	0.00

Subbasin Hydrology

Subbasin : {Existing} DA1

Input Data

Area (ac) 266.9
Peak Rate Factor 484
Weighted Curve Number 82.22
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	95.02	C	79
Pasture, grassland, or range, Fair	171.88	D	84
Composite Area & Weighted CN	266.9		82.22

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^{0.5}) (unpaved surface)
V = 20.3282 * (Sf^{0.5}) (paved surface)
V = 15.0 * (Sf^{0.5}) (grassed waterway surface)
V = 10.0 * (Sf^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (Sf^{0.5}) (cultivated straight rows surface)
V = 7.0 * (Sf^{0.5}) (short grass pasture surface)
V = 5.0 * (Sf^{0.5}) (woodland surface)
V = 2.5 * (Sf^{0.5}) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^{2/3}) * (Sf^{0.5})) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

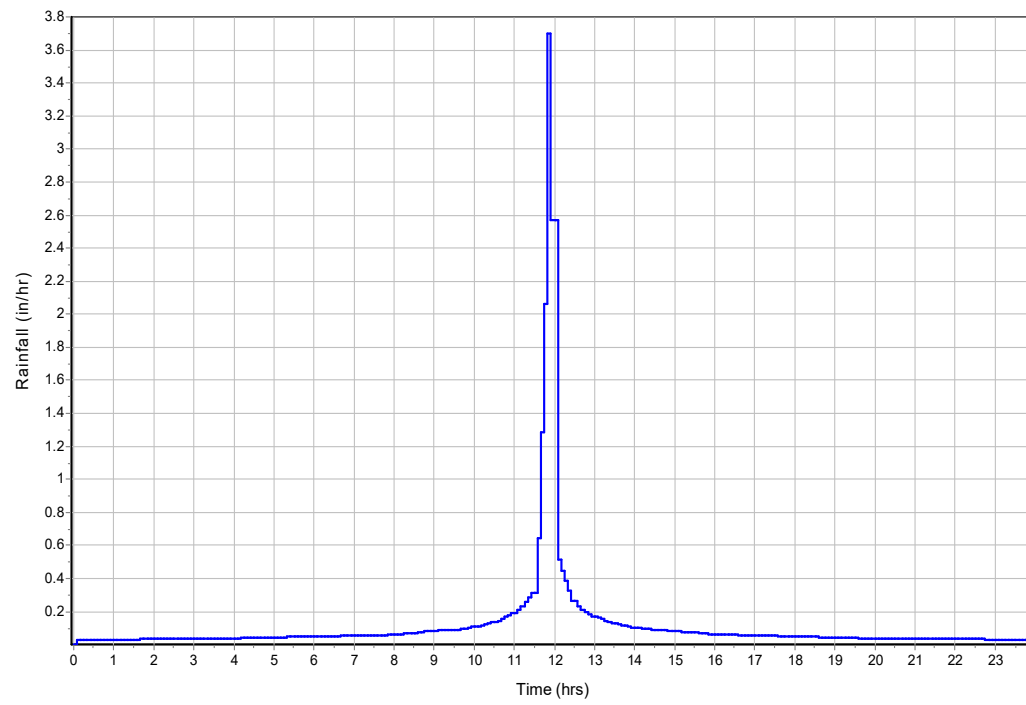
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	12.07	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	5861	0	0
Slope (%) :	2.3	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.45	0	0
Computed Flow Time (min) :	39.87	0	0
Total TOC (min)	51.94		

Subbasin Runoff Results

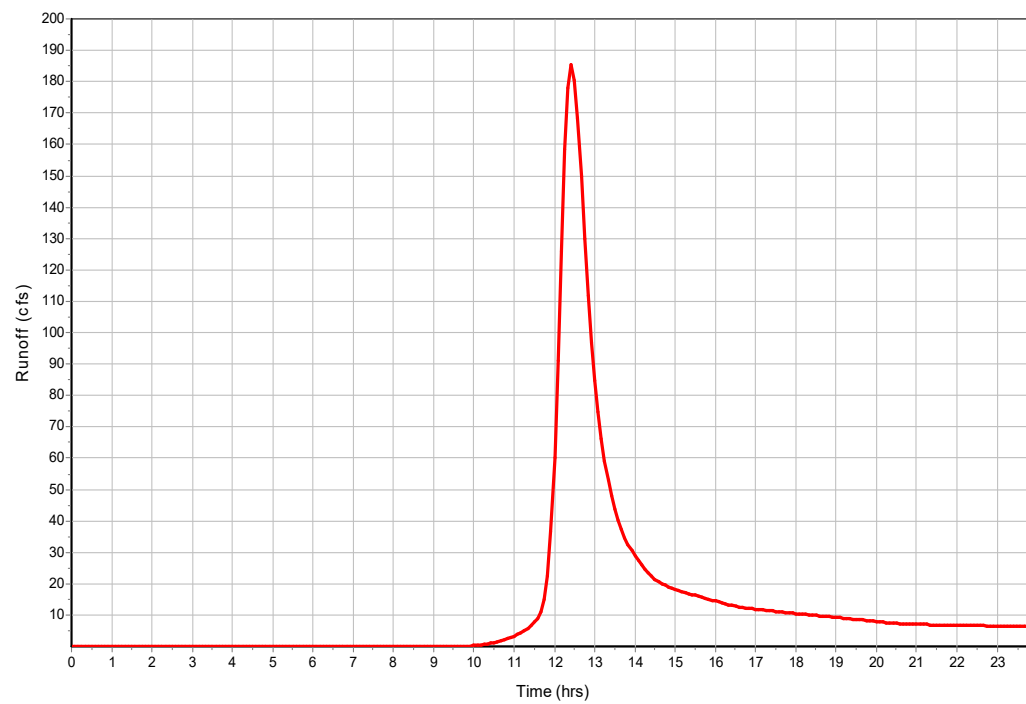
Total Rainfall (in)	2.7
Total Runoff (in)	1.16
Peak Runoff (cfs)	185.43
Weighted Curve Number	82.22
Time of Concentration (days hh:mm:ss)	0 00:51:56

Subbasin : {Existing} DA1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Existing} DA2

Input Data

Area (ac) 101.9
Peak Rate Factor 484
Weighted Curve Number 83.47
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	10.9	C	79
Pasture, grassland, or range, Fair	91	D	84
Composite Area & Weighted CN	101.9		83.47

Time of Concentration

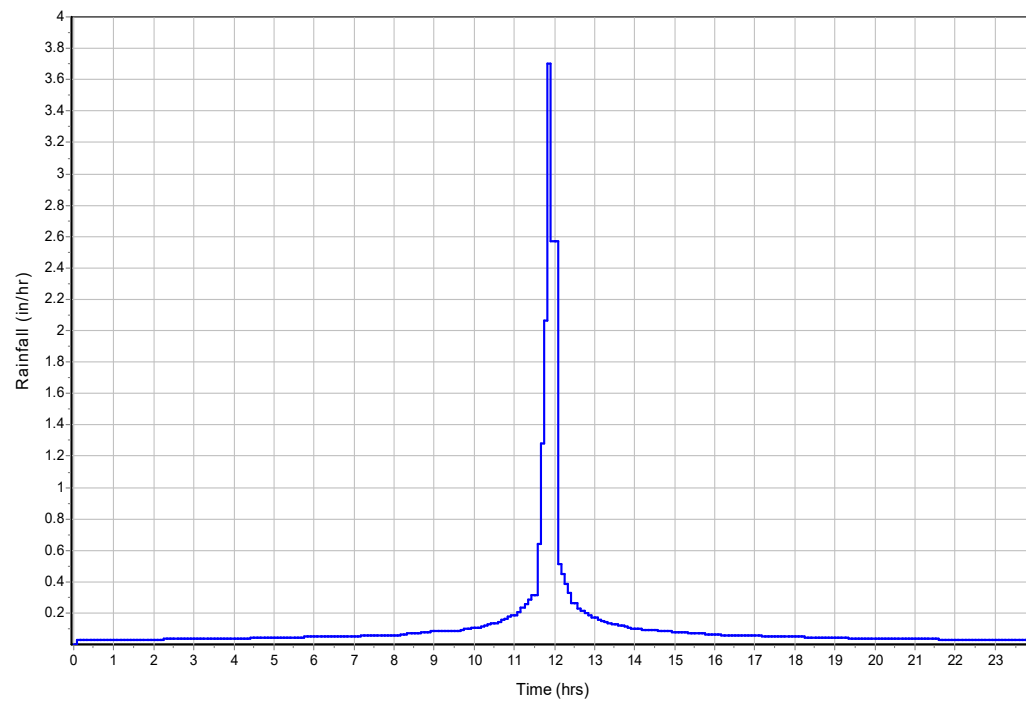
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.84	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.37	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1836	1298	0
Slope (%) :	4.14	1.49	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.28	1.97	0
Computed Flow Time (min) :	9.33	10.98	0
Total TOC (min)29.69			

Subbasin Runoff Results

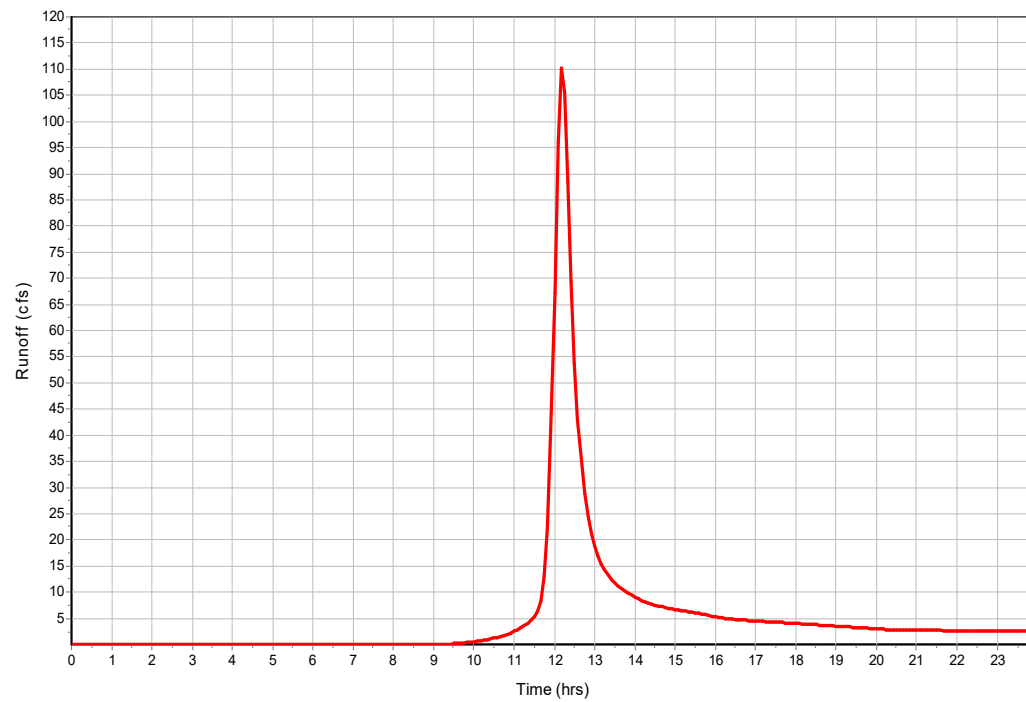
Total Rainfall (in) 2.7
Total Runoff (in) 1.24
Peak Runoff (cfs) 110.89
Weighted Curve Number 83.47
Time of Concentration (days hh:mm:ss) 0 00:29:41

Subbasin : {Existing} DA2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Existing} DA3

Input Data

Area (ac) 98.5
Peak Rate Factor 484
Weighted Curve Number 83.24
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Pasture, grassland, or range, Fair	15.07	C	79
Pasture, grassland, or range, Fair	83.43	D	84
Composite Area & Weighted CN	98.5		83.24

Time of Concentration

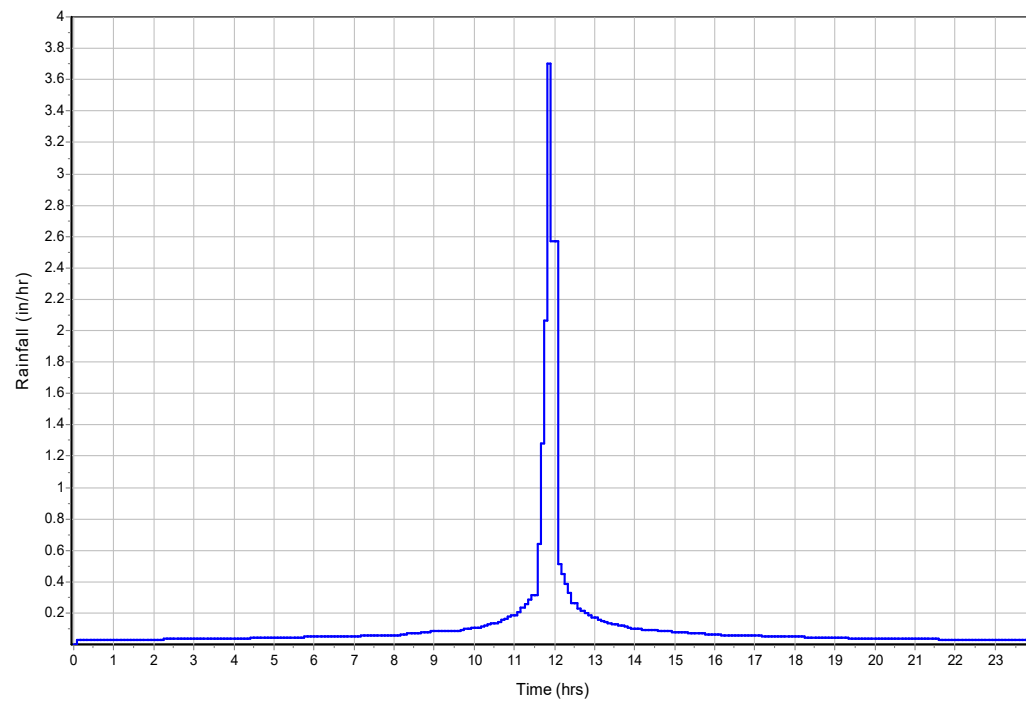
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.91	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.15	0	0
Computed Flow Time (min) :	10.99	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	2316	583	0
Slope (%) :	3.26	1.44	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.91	1.94	0
Computed Flow Time (min) :	13.26	5.01	0
Total TOC (min)29.26			

Subbasin Runoff Results

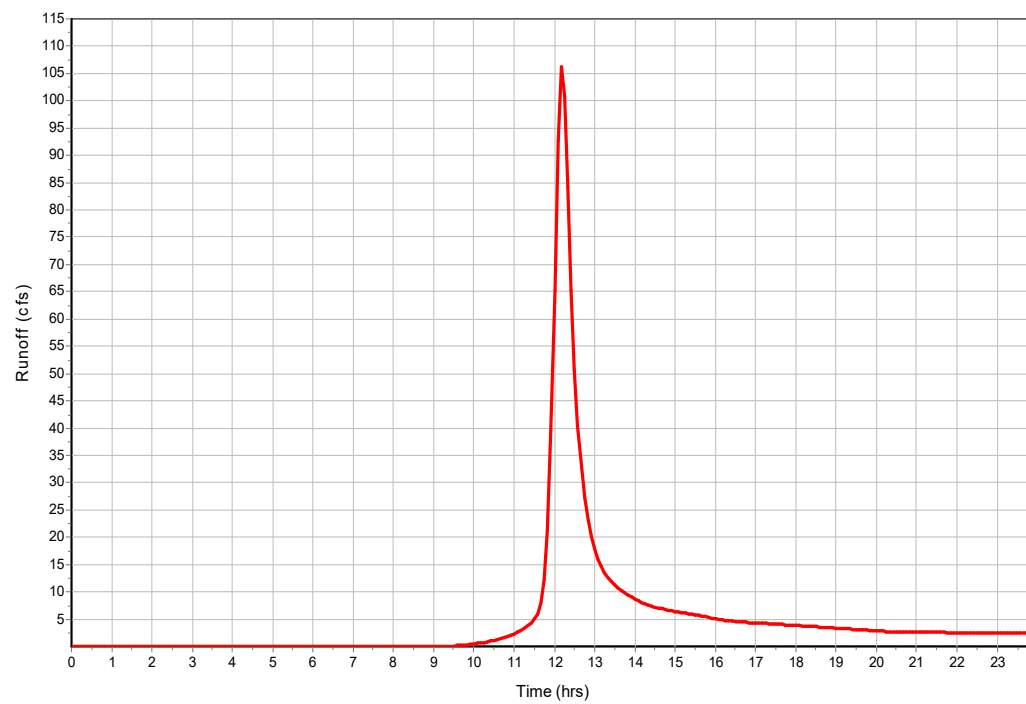
Total Rainfall (in) 2.7
Total Runoff (in) 1.22
Peak Runoff (cfs) 106.82
Weighted Curve Number 83.24
Time of Concentration (days hh:mm:ss) 0 00:29:16

Subbasin : {Existing} DA3

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN Element	Invert	Ground/Rim	Ground/Rim	Initial	Initial	Surcharge	Surcharge	Ponded	Minimum
ID	Elevation	(Max)	(Max)	Water	Water	Elevation	Depth	Area	Pipe
		Elevation	Offset	Elevation	Depth				Cover
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft ²)	(in)
1 1-Jun	5437.80	6.00	-5431.80	0.00	-5437.80	0.00	-6.00	0.00	0.00
2 2-Jun	5424.00	6.00	-5418.00	0.00	-5424.00	0.00	-6.00	0.00	0.00

Junction Results

SN	Element	Peak	Peak	Max HGL	Max HGL	Max	Min	Average HGL	Average HGL	Time of	Time of	Total	Total Time
	ID	Inflow	Lateral	Elevation	Depth	Surcharge	Freeboard	Elevation	Depth	Max HGL	Peak	Flooded	Flooded
		Inflow	Attained	Attained	Depth	Attained	Attained	Attained	Attained	Occurrence	Flooding	Volume	
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)
1	1-Jun	185.25	185.25	5438.52	0.72	0.00	4.28	5437.90	0.10	0 12:32	0 00:00	0.00	0.00
2	2-Jun	257.70	110.13	5424.95	0.95	0.00	4.05	5424.13	0.13	0 12:31	0 00:00	0.00	0.00

Channel Input

SN Element	Length	Inlet	Inlet	Outlet	Outlet	Total	Average	Shape	Height	Width	Manning's	Entrance	Exit/Bend	Additional	Initial Flap
ID		Invert	Invert	Invert	Invert	Drop	Slope				Roughness	Losses	Losses	Losses	Flow Gate
	(ft)	Elevation	Offset	Elevation	Offset	(ft)	(%)		(ft)	(ft)					(cfs)
1 EXISTDITCH-01	1241.00	5437.80	0.00	5424.00	0.00	13.80	1.1100	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00 No
2 EXISTDITCH-02	1796.00	5424.00	0.00	5409.00	0.00	15.00	0.8400	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00 No

Channel Results

SN Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Froude	Reported
ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Number	Condition
		Occurrence		Ratio				Total Depth			
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio			
1 EXISTDITCH-01	183.59	0 12:32	5037.56	0.04	2.65	7.81	0.83	0.17	0.00		
2 EXISTDITCH-02	248.73	0 12:31	4365.75	0.06	3.15	9.50	0.94	0.19	0.00		

Project Description

File Name	Existing Conditions.SPF
Description	Existing Conditions 100-yr Storm

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	3
Nodes.....	3
<i>Junctions</i>	2
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	0
<i>Storage Nodes</i>	0
Links.....	2
<i>Channels</i>	2
<i>Pipes</i>	0
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage	Data	Data Source	Rainfall	Rain	State	County	Return	Rainfall	Rainfall
	ID	Source	ID	Type	Units			Period	Depth	Distribution
								(years)	(inches)	
1	Rain Gage-01	Time Series	100-yr	Cumulative	inches	Colorado	El Paso	100.00	4.60	SCS Type II 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)	Factor		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 {Existing} DA1	266.90	484.00	82.22	4.60	2.74	732.37	450.39	0 00:51:56
2 {Existing} DA2	101.90	484.00	83.47	4.60	2.86	291.23	258.93	0 00:29:41
3 {Existing} DA3	98.50	484.00	83.24	4.60	2.84	279.44	250.63	0 00:29:15

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation	Max Surcharge Depth	Min Freeboard	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	1-Jun	Junction	5437.80	6.00	0.00	0.00	0.00	449.45	5439.02	0.00	3.78	0 00:00	0.00	0.00
2	2-Jun	Junction	5424.00	6.00	0.00	0.00	0.00	627.82	5425.63	0.00	3.37	0 00:00	0.00	0.00
3	Out-01	Outfall	5409.00					804.64	5410.61					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Reported Surcharged Condition (min)
1	EXISTDITCH-01	Channel	1-Jun	2-Jun	1241.00	5437.80	5424.00	1.1100	60.000	0.0400	447.69	5037.56	0.09	3.69	1.42	0.28	0.00
2	EXISTDITCH-02	Channel	2-Jun	Out-01	1796.00	5424.00	5409.00	0.8400	60.000	0.0400	617.94	4365.75	0.14	4.41	1.61	0.32	0.00

Subbasin Hydrology

Subbasin : {Existing} DA1

Input Data

Area (ac) 266.9
Peak Rate Factor 484
Weighted Curve Number 82.22
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	95.02	C	79
Pasture, grassland, or range, Fair	171.88	D	84
Composite Area & Weighted CN	266.9		82.22

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
 n = Manning's roughness
 L_f = Flow Length (ft)
 P = 2 yr, 24 hr Rainfall (inches)
 S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

$V = 16.1345 * (S_f^{0.5})$ (unpaved surface)
 $V = 20.3282 * (S_f^{0.5})$ (paved surface)
 $V = 15.0 * (S_f^{0.5})$ (grassed waterway surface)
 $V = 10.0 * (S_f^{0.5})$ (nearly bare & untilled surface)
 $V = 9.0 * (S_f^{0.5})$ (cultivated straight rows surface)
 $V = 7.0 * (S_f^{0.5})$ (short grass pasture surface)
 $V = 5.0 * (S_f^{0.5})$ (woodland surface)
 $V = 2.5 * (S_f^{0.5})$ (forest w/heavy litter surface)
 $T_c = (L_f / V) / (3600 \text{ sec/hr})$

Where:

T_c = Time of Concentration (hr)
 L_f = Flow Length (ft)
 V = Velocity (ft/sec)
 S_f = Slope (ft/ft)

Channel Flow Equation :

$V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$
 $R = A_q / W_p$
 $T_c = (L_f / V) / (3600 \text{ sec/hr})$

Where :

T_c = Time of Concentration (hr)
 L_f = Flow Length (ft)
 R = Hydraulic Radius (ft)
 A_q = Flow Area (ft²)
 W_p = Wetted Perimeter (ft)
 V = Velocity (ft/sec)
 S_f = Slope (ft/ft)
 n = Manning's roughness

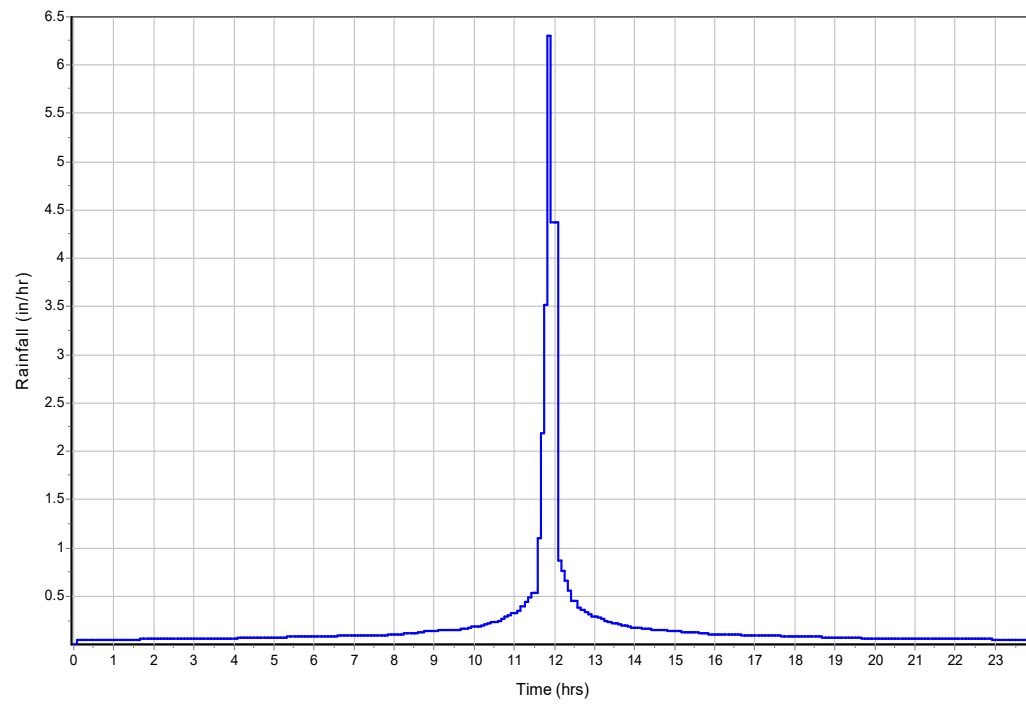
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	12.07	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	5861	0	0
Slope (%) :	2.3	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.45	0	0
Computed Flow Time (min) :	39.87	0	0
Total TOC (min)	51.94		

Subbasin Runoff Results

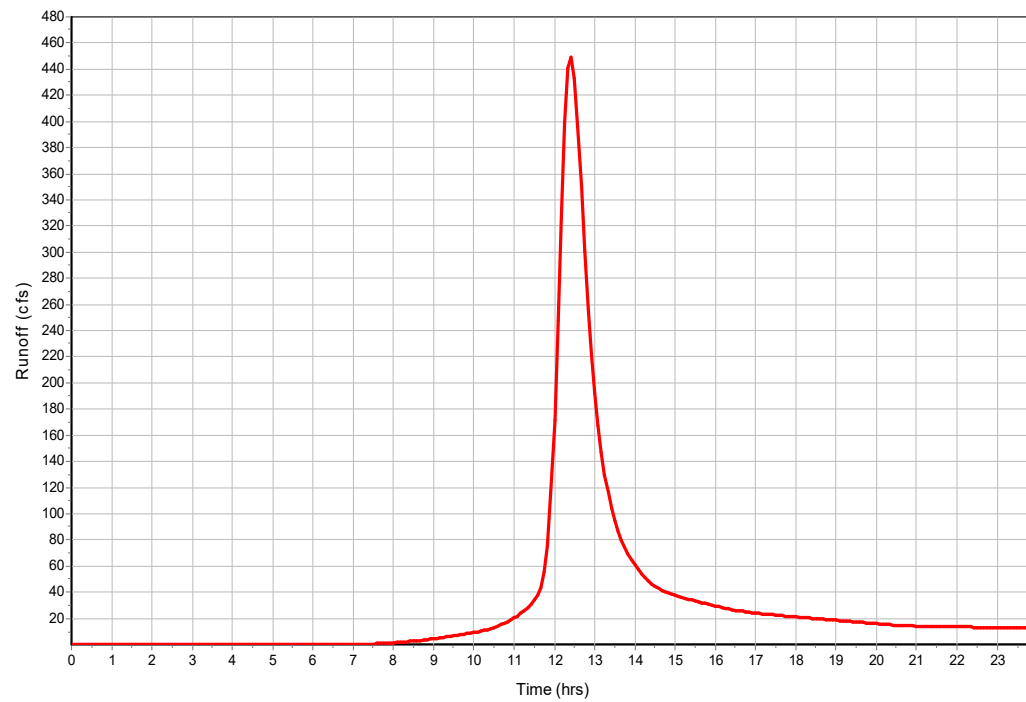
Total Rainfall (in)	4.6
Total Runoff (in)	2.74
Peak Runoff (cfs)	450.39
Weighted Curve Number	82.22
Time of Concentration (days hh:mm:ss)	0 00:51:56

Subbasin : {Existing} DA1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Existing} DA2

Input Data

Area (ac) 101.9
Peak Rate Factor 484
Weighted Curve Number 83.47
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	10.9	C	79
Pasture, grassland, or range, Fair	91	D	84
Composite Area & Weighted CN	101.9		83.47

Time of Concentration

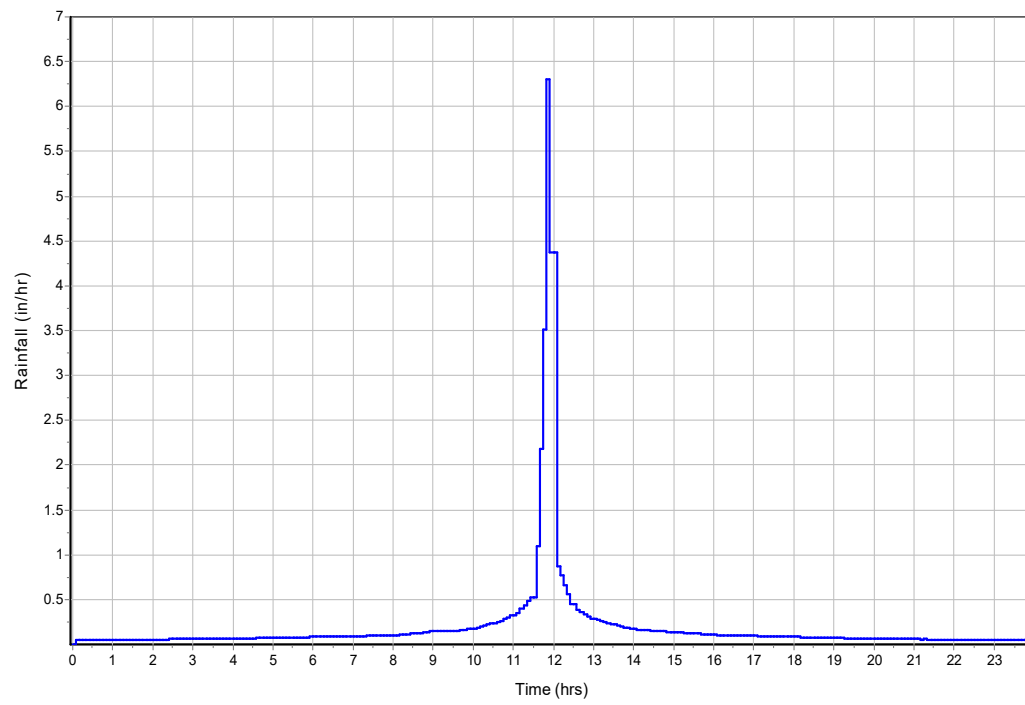
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.84	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.37	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1836	1298	0
Slope (%) :	4.14	1.49	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.28	1.97	0
Computed Flow Time (min) :	9.33	10.98	0
Total TOC (min)29.69			

Subbasin Runoff Results

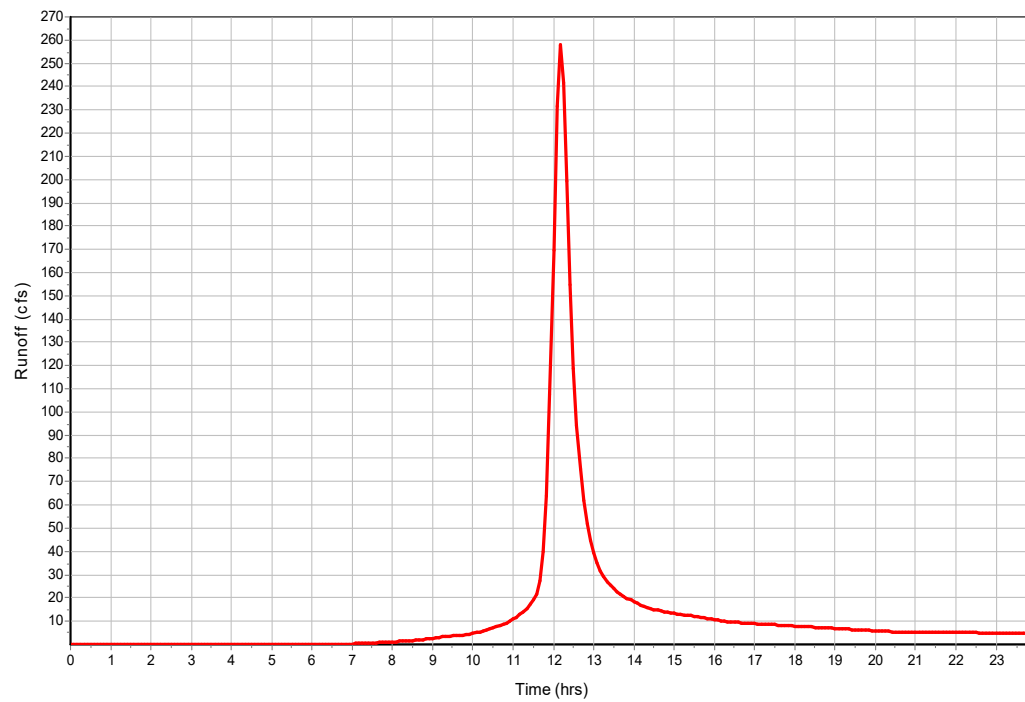
Total Rainfall (in) 4.6
Total Runoff (in) 2.86
Peak Runoff (cfs) 258.93
Weighted Curve Number 83.47
Time of Concentration (days hh:mm:ss) 0 00:29:41

Subbasin : {Existing} DA2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Existing} DA3

Input Data

Area (ac) 98.5
Peak Rate Factor 484
Weighted Curve Number 83.24
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	15.07	C	79
Pasture, grassland, or range, Fair	83.43	D	84
Composite Area & Weighted CN	98.5		83.24

Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.91	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.15	0	0
Computed Flow Time (min) :	10.99	0	0

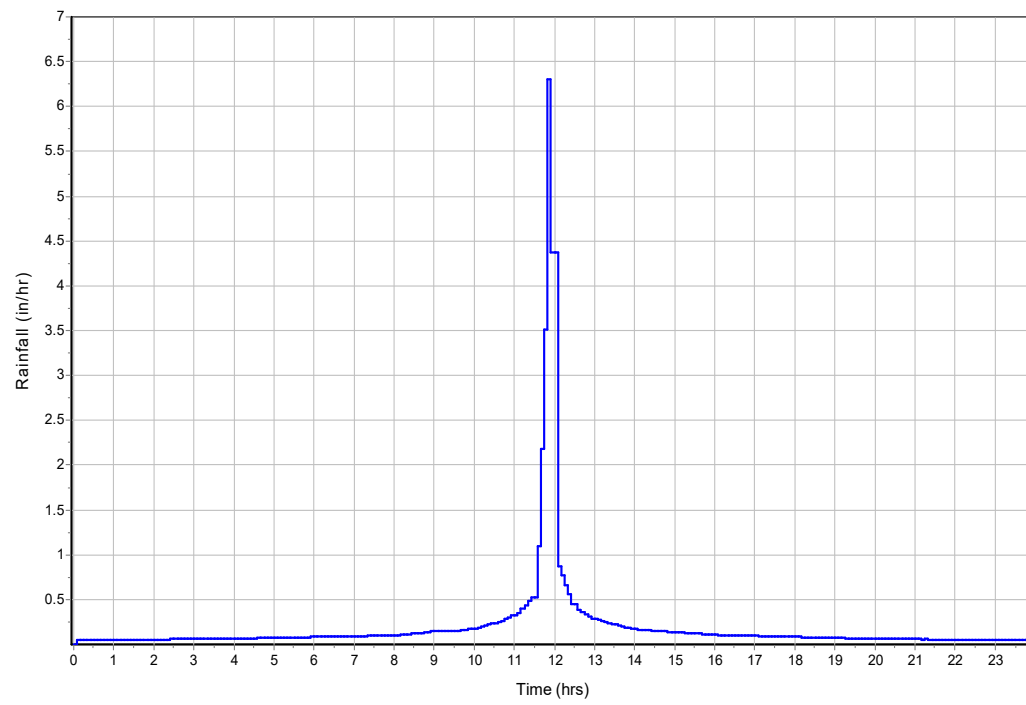
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	2316	583	0
Slope (%) :	3.26	1.44	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.91	1.94	0
Computed Flow Time (min) :	13.26	5.01	0
Total TOC (min)29.26			

Subbasin Runoff Results

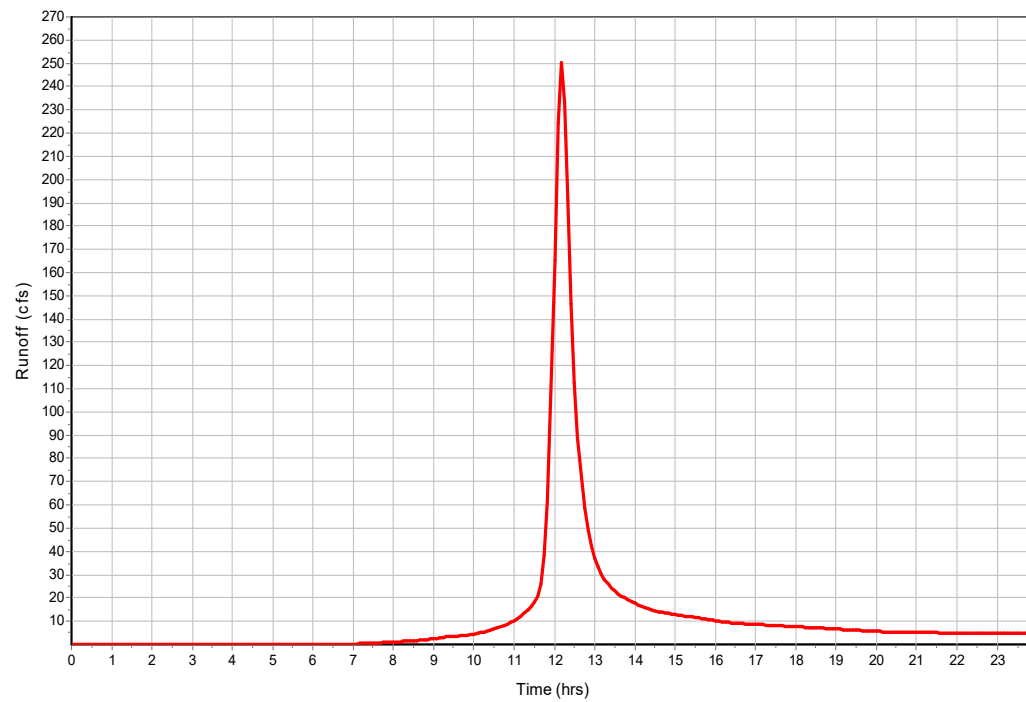
Total Rainfall (in) 4.6
Total Runoff (in) 2.84
Peak Runoff (cfs) 250.63
Weighted Curve Number 83.24
Time of Concentration (days hh:mm:ss) 0 00:29:16

Subbasin : {Existing} DA3

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN Element	Invert	Ground/Rim	Ground/Rim	Initial	Initial	Surcharge	Surcharge	Ponded	Minimum
ID	Elevation	(Max)	(Max)	Water	Water	Elevation	Depth	Area	Pipe
		Elevation	Offset	Elevation	Depth				Cover
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft ²)	(in)
1 1-Jun	5437.80	6.00	-5431.80	0.00	-5437.80	0.00	-6.00	0.00	0.00
2 2-Jun	5424.00	6.00	-5418.00	0.00	-5424.00	0.00	-6.00	0.00	0.00

Junction Results

SN	Element	Peak	Peak	Max HGL	Max HGL	Max	Min	Average HGL	Average HGL	Time of	Time of	Total	Total Time
	ID	Inflow	Lateral	Elevation	Depth	Surcharge	Freeboard	Elevation	Depth	Max HGL	Peak	Flooded	Flooded
		Inflow	Attained	Attained	Depth	Attained	Attained	Attained	Attained	Occurrence	Flooding	Volume	
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)
1	1-Jun	449.45	449.45	5439.02	1.22	0.00	3.78	5437.97	0.17	0 12:30	0 00:00	0.00	0.00
2	2-Jun	627.82	258.01	5425.63	1.63	0.00	3.37	5424.23	0.23	0 12:27	0 00:00	0.00	0.00

Channel Input

SN Element	Length	Inlet	Inlet	Outlet	Outlet	Total	Average	Shape	Height	Width	Manning's	Entrance	Exit/Bend	Additional	Initial	Flap
ID		Invert	Invert	Invert	Invert	Drop	Slope				Roughness	Losses	Losses	Losses	Flow	Gate
	(ft)	Elevation	Offset	Elevation	Offset	(ft)	(%)		(ft)	(ft)					(cfs)	
1 EXISTDITCH-01	1241.00	5437.80	0.00	5424.00	0.00	13.80	1.1100	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00	No
2 EXISTDITCH-02	1796.00	5424.00	0.00	5409.00	0.00	15.00	0.8400	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Froude	Reported
ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Number	Condition
		Occurrence		Ratio				Total Depth			
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio			
1 EXISTDITCH-01	447.69	0 12:31	5037.56	0.09	3.69	5.61	1.42	0.28	0.00		
2 EXISTDITCH-02	617.94	0 12:28	4365.75	0.14	4.41	6.79	1.61	0.32	0.00		

Project Description

File Name	Proposed Conditions.SPF
Description	Proposed Conditions 5-yr storm

Project Options

Flow Units	CFS
Elevation Type	Depth
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	7
Nodes.....	14
<i>Junctions</i>	11
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	0
<i>Storage Nodes</i>	2
Links.....	17
<i>Channels</i>	6
<i>Pipes</i>	3
<i>Pumps</i>	0
<i>Orifices</i>	6
<i>Weirs</i>	2
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage	Data	Data Source	Rainfall	Rain	State	County	Return	Rainfall	Rainfall
	ID	Source	ID	Type	Units			Period	Depth	Distribution
								(years)	(inches)	
1	Rain Gage-01	Time Series	5-yr	Cumulative	inches	Colorado	El Paso	5.00	2.70	SCS Type II 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 {Proposed}.DA : 1	266.90	484.00	82.22	2.70	1.16	309.87	185.43	0 00:51:56
2 {Proposed}.DA : 2	75.00	484.00	83.89	2.70	1.27	94.95	87.26	0 00:27:41
3 {Proposed}.DA : 3	17.60	484.00	83.87	2.70	1.27	22.26	28.96	0 00:13:00
4 {Proposed}.DA : 4	10.30	484.00	84.00	2.70	1.27	13.11	17.92	0 00:10:42
5 {Proposed}.DA : 5	4.50	484.00	98.00	2.70	2.47	11.12	14.24	0 00:08:43
6 {Proposed}.DA : 6	34.30	484.00	82.04	2.70	1.15	39.45	46.24	0 00:17:07
7 {Proposed}.DA : 7	44.20	484.00	92.51	2.70	1.92	85.04	84.41	0 00:23:51

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation	Max Surcharge Depth	Min Freeboard	Time of Peak Flooding	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	1-Jun	Junction	5437.80	5441.80	5437.80	5445.80	0.00	185.21	5439.33	0.00	2.47	0 00:00	0.00	0.00
2	2-Jun	Junction	5428.92	5440.40	5428.92	5451.88	0.00	234.21	5432.15	0.00	8.25	0 00:00	0.00	0.00
3	3-Jun	Junction	5427.02	5427.02	5427.02	5427.02	0.00	228.14	5427.74	0.00	4.28	0 00:00	0.00	0.00
4	4-Jun	Junction	5441.72	5443.72	5441.72	5445.72	0.00	28.15	5442.36	0.00	1.36	0 00:00	0.00	0.00
5	5-Jun	Junction	5426.06	5428.06	5426.06	5430.06	0.00	42.38	5426.85	0.00	1.21	0 00:00	0.00	0.00
6	6-Jun	Junction	5421.00	5426.00	5421.00	5431.00	0.00	238.79	5421.88	0.00	4.12	0 00:00	0.00	0.00
7	7-Jun	Junction	5417.00	5422.00	5417.00	5427.00	0.00	247.15	5417.99	0.00	10.01	0 00:00	0.00	0.00
8	Outlet_PondA	Junction	5418.00	5420.50	5418.00	5423.00	0.00	13.81	5419.27	0.00	1.23	0 00:00	0.00	0.00
9	Outlet_PondB	Junction	5424.00	5425.50	5424.00	5427.00	0.00	1.65	5424.35	0.00	1.15	0 00:00	0.00	0.00
10	Riser_PondA	Junction	5418.00	5424.97	5418.00	5431.94	0.00	13.82	5419.73	0.00	5.24	0 00:00	0.00	0.00
11	Riser_PondB	Junction	5424.00	5427.52	5424.00	5431.04	0.00	1.65	5424.55	0.00	2.97	0 00:00	0.00	0.00
12	Out-01	Outfall	5409.60					255.01	5410.58					
13	PondA	Storage Node	5420.00	5431.00	5420.00		0.00	82.65	5425.35				0.00	0.00
14	PondB	Storage Node	5426.00	5434.00	5426.00		0.00	13.40	5427.56				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	C-01	Pipe	2-Jun	3-Jun	120.00	5428.92	5427.02	1.5800	48.000	0.0120	228.14	1002.95	0.23	7.71	1.97	0.49	0.00	Calculated
2	OutletPipe_PondA	Pipe	Outlet_PondA	7-Jun	166.00	5418.00	5417.00	0.6000	30.000	0.0120	13.81	34.49	0.40	7.18	1.10	0.44	0.00	Calculated
3	OutletPipe_PondB	Pipe	Outlet_PondB	7-Jun	303.00	5424.00	5417.00	2.3100	18.000	0.0150	1.64	13.84	0.12	5.30	0.67	0.44	0.00	Calculated
4	DITCH-01	Channel	1-Jun	2-Jun	1367.00	5437.80	5428.92	0.6500	48.000	0.0300	183.51	1119.58	0.16	2.61	2.37	0.59	0.00	
5	DITCH-02	Channel	4-Jun	5-Jun	1487.80	5441.72	5426.06	1.0500	24.000	0.0300	26.59	224.45	0.12	2.89	0.72	0.36	0.00	
6	DITCH-03	Channel	5-Jun	6-Jun	207.00	5426.06	5421.00	2.4400	24.000	0.0400	41.61	256.53	0.16	4.55	0.73	0.37	0.00	
7	EXISTDITCH-01	Channel	3-Jun	6-Jun	352.00	5427.02	5421.00	1.7100	60.000	0.0400	228.10	6247.31	0.04	3.43	0.80	0.16	0.00	
8	EXISTDITCH-02	Channel	6-Jun	7-Jun	415.00	5421.00	5417.00	0.9600	60.000	0.0400	238.52	4689.99	0.05	3.09	0.93	0.19	0.00	
9	EXISTDITCH-03	Channel	7-Jun	Out-01	1033.00	5417.00	5409.60	0.7200	60.000	0.0400	246.01	4043.26	0.06	2.98	0.98	0.20	0.00	
10	Grate_PondA	Orifice	PondA	Riser_PondA		5420.00	5418.00		48.000		12.25							
11	Grate_PondB	Orifice	PondB	Riser_PondB		5426.00	5424.00		48.000		0.48							
12	RestrictorPlate_PondA	Orifice	Riser_PondA	Outlet_PondA		5418.00	5418.00		24.700		13.81							
13	RestrictorPlate_PondB	Orifice	Riser_PondB	Outlet_PondB		5424.00	5424.00		9.600		1.65							
14	WQCV/EURV_PondA	Orifice	PondA	Riser_PondA		5420.00	5418.00		3.000		1.57							
15	WQCV/EURV_PondB	Orifice	PondB	Riser_PondB		5426.00	5424.00		6.160		1.17							
16	EMRGCYSPWLWY_PondA	Weir	PondA	7-Jun		5420.00	5417.00				0.00							
17	EMRGCYSPWLWY_PondB	Weir	PondB	7-Jun		5426.00	5417.00				0.00							

Subbasin Hydrology

Subbasin : {Proposed}.DA : 1

Input Data

Area (ac) 266.9
Peak Rate Factor 484
Weighted Curve Number 82.22
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	171.88	D	84
Pasture, grassland, or range, Fair	95.02	C	79
Composite Area & Weighted CN	266.9		82.22

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^{0.5}) (unpaved surface)
V = 20.3282 * (Sf^{0.5}) (paved surface)
V = 15.0 * (Sf^{0.5}) (grassed waterway surface)
V = 10.0 * (Sf^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (Sf^{0.5}) (cultivated straight rows surface)
V = 7.0 * (Sf^{0.5}) (short grass pasture surface)
V = 5.0 * (Sf^{0.5}) (woodland surface)
V = 2.5 * (Sf^{0.5}) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^{2/3}) * (Sf^{0.5})) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

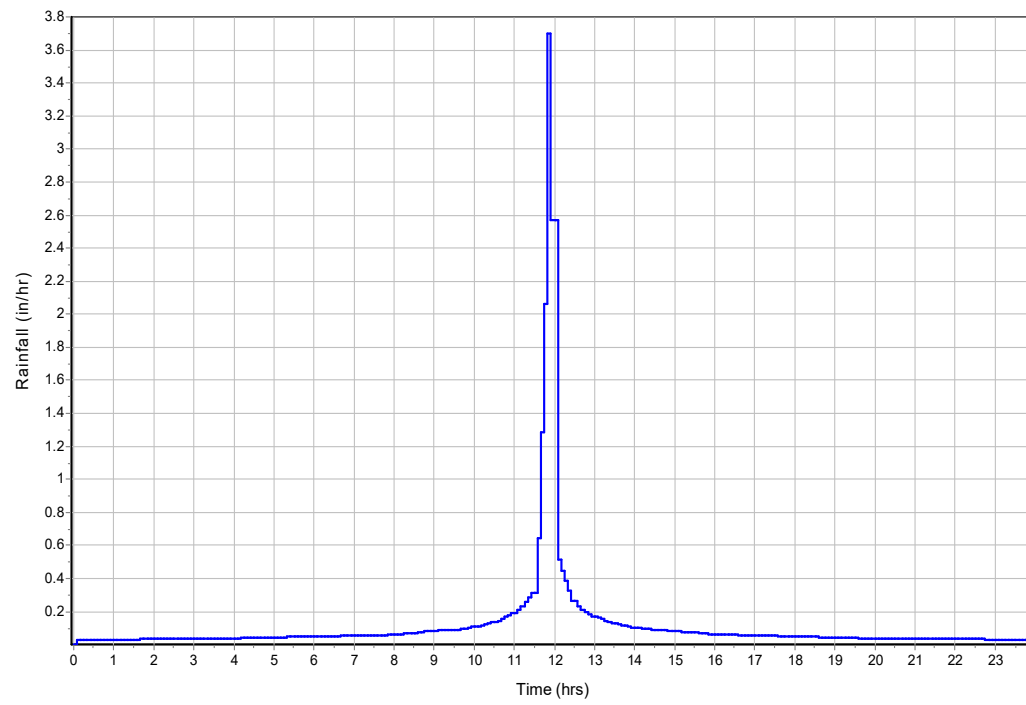
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	12.07	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	5861	0	0
Slope (%) :	2.3	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.45	0	0
Computed Flow Time (min) :	39.87	0	0
Total TOC (min)	51.94		

Subbasin Runoff Results

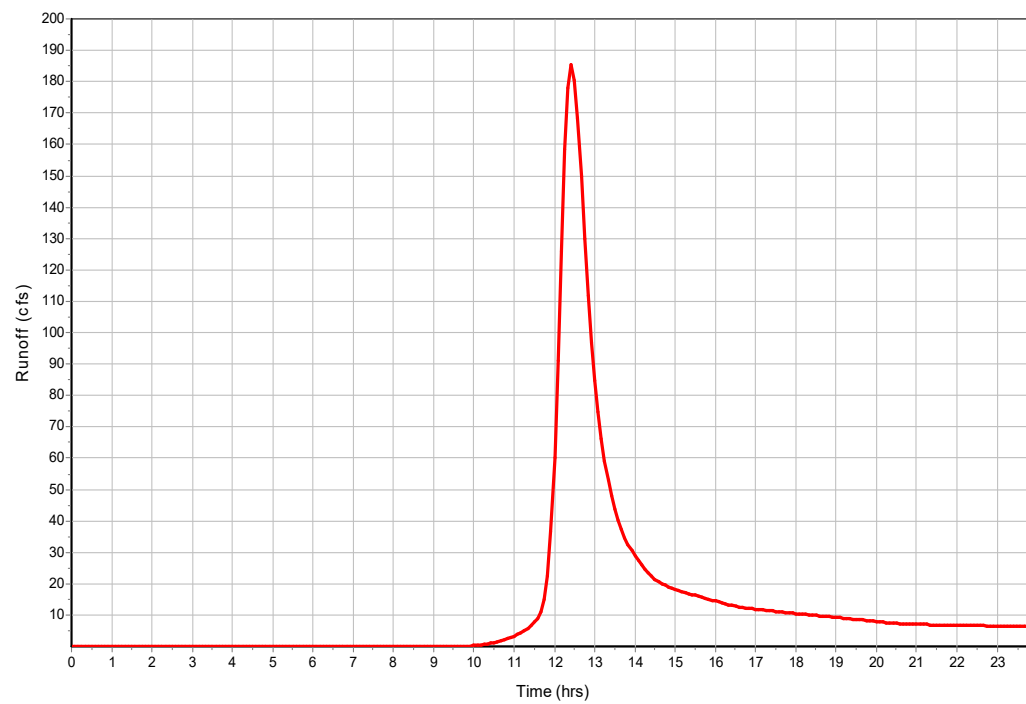
Total Rainfall (in)	2.7
Total Runoff (in)	1.16
Peak Runoff (cfs)	185.43
Weighted Curve Number	82.22
Time of Concentration (days hh:mm:ss)	0 00:51:56

Subbasin : {Proposed}.DA : 1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 2**Input Data**

Area (ac) 75
Peak Rate Factor 484
Weighted Curve Number 83.89
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	73.35	D	84
Pasture, grassland, or range, Fair	1.65	C	79
Composite Area & Weighted CN	75		83.89

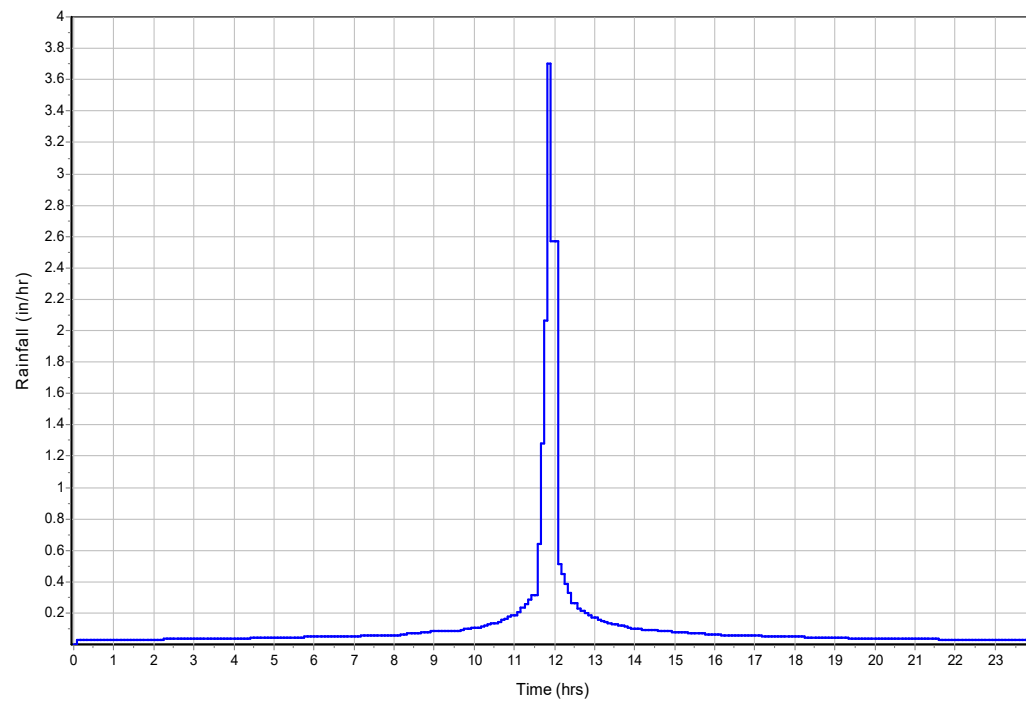
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.84	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.37	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	3055	0	0
Slope (%) :	2.96	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.78	0	0
Computed Flow Time (min) :	18.32	0	0
Total TOC (min)27.69			

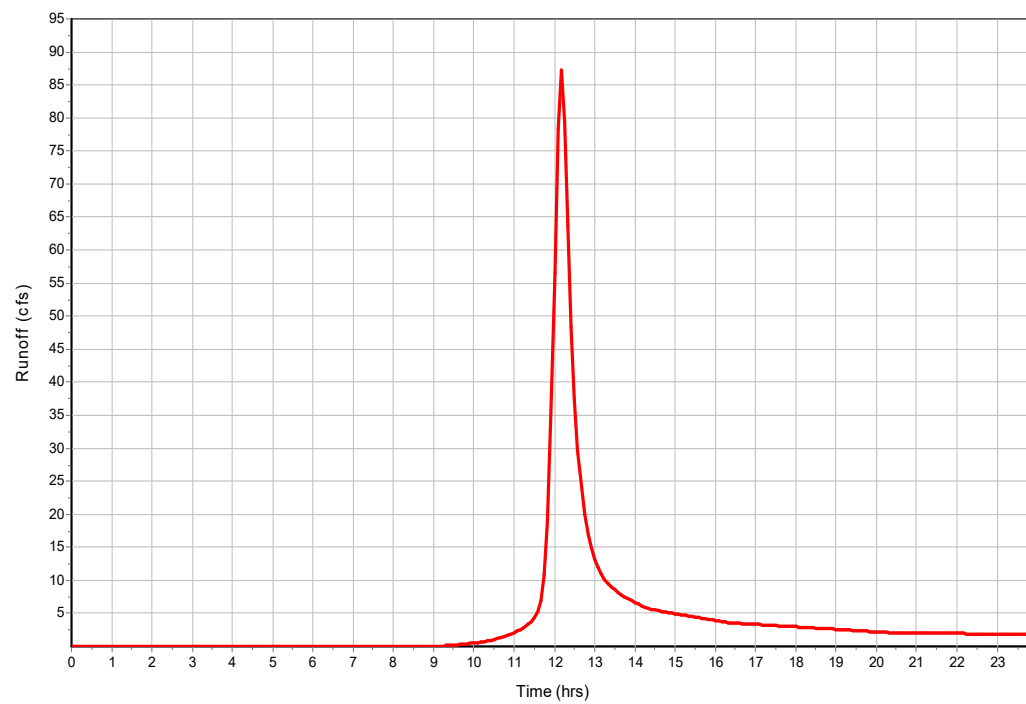
Subbasin Runoff Results

Total Rainfall (in) 2.7
Total Runoff (in) 1.27
Peak Runoff (cfs) 87.26
Weighted Curve Number 83.89
Time of Concentration (days hh:mm:ss) 0 00:27:41

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 3**Input Data**

Area (ac) 17.6
Peak Rate Factor 484
Weighted Curve Number 83.87
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	17.16	D	84
Pasture, grassland, or range, Fair	0.44	C	79
Composite Area & Weighted CN	17.6		83.87

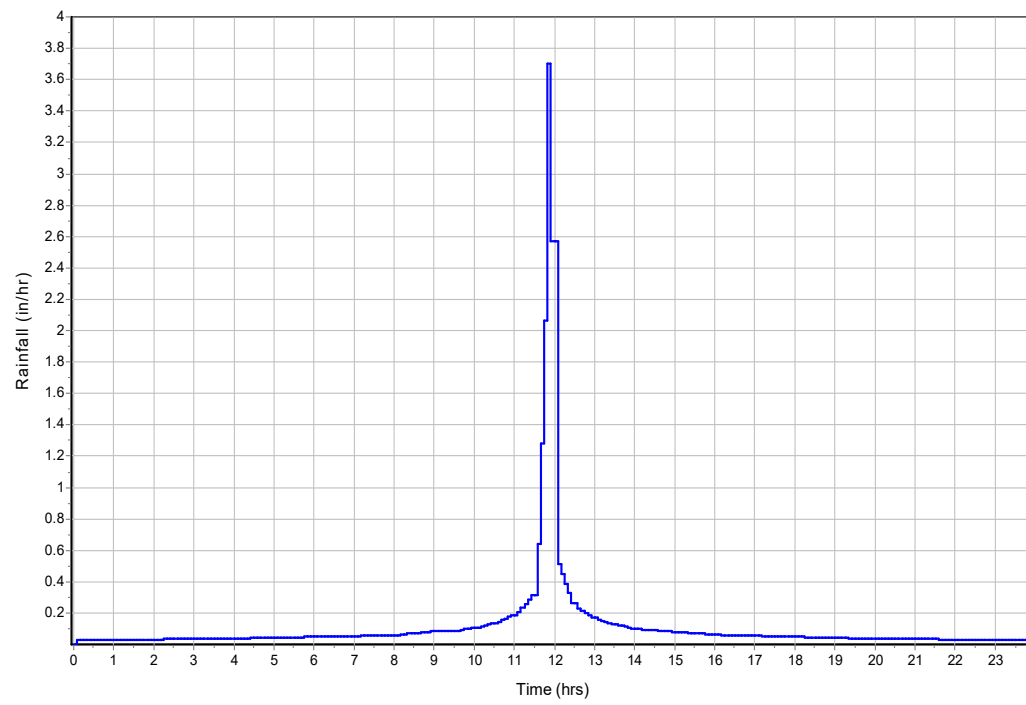
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.13	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.23	0	0
Computed Flow Time (min) :	7.4	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1052	0	0
Slope (%) :	3.77	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.13	0	0
Computed Flow Time (min) :	5.6	0	0
Total TOC (min)13.00			

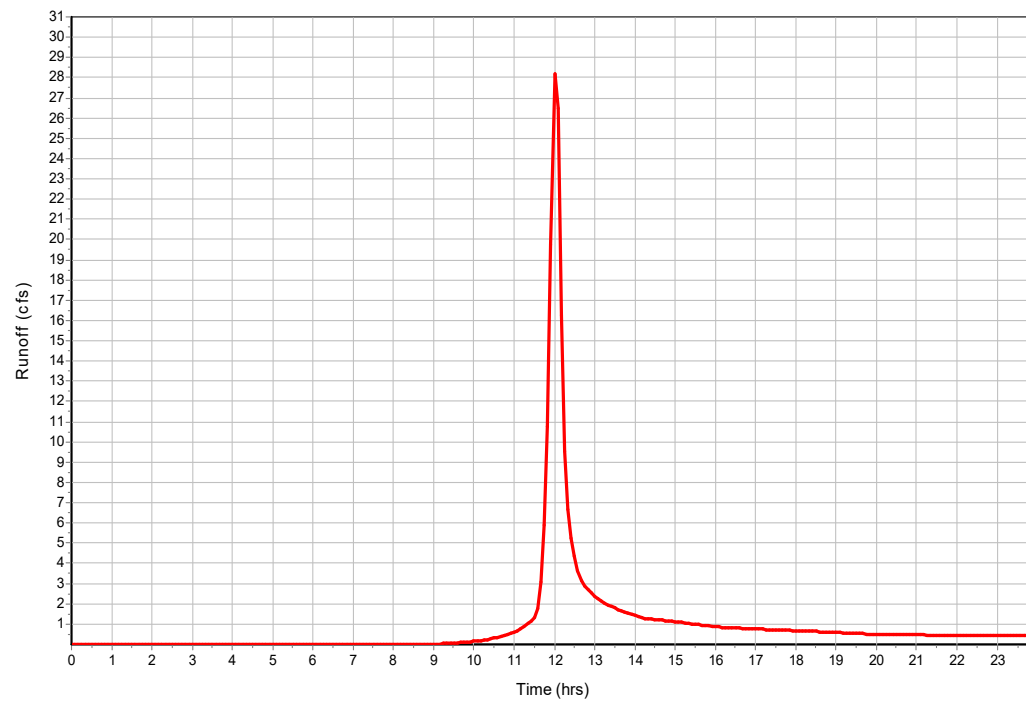
Subbasin Runoff Results

Total Rainfall (in) 2.7
Total Runoff (in) 1.27
Peak Runoff (cfs) 28.96
Weighted Curve Number 83.87
Time of Concentration (days hh:mm:ss) 0 00:13:00

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 4**Input Data**

Area (ac) 10.3
Peak Rate Factor 484
Weighted Curve Number 84
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Pasture, grassland, or range, Fair	10.3	D	84
Composite Area & Weighted CN	10.3		84

Time of Concentration

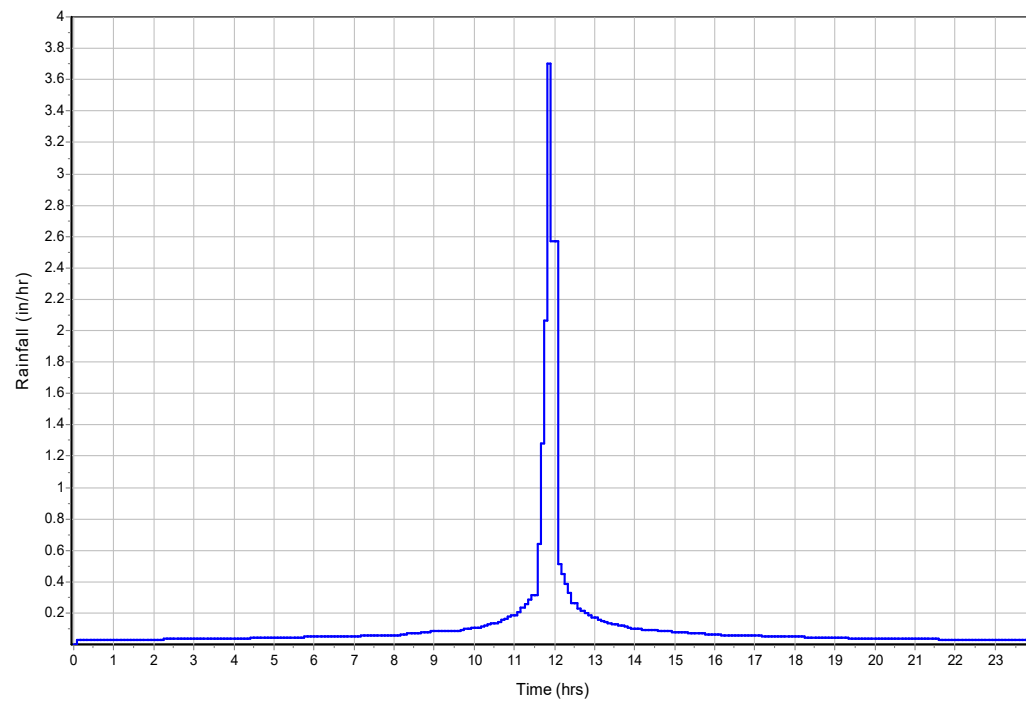
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.32	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.26	0	0
Computed Flow Time (min) :	6.42	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	974	0	0
Slope (%) :	5.52	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.79	0	0
Computed Flow Time (min) :	4.28	0	0
Total TOC (min)10.70			

Subbasin Runoff Results

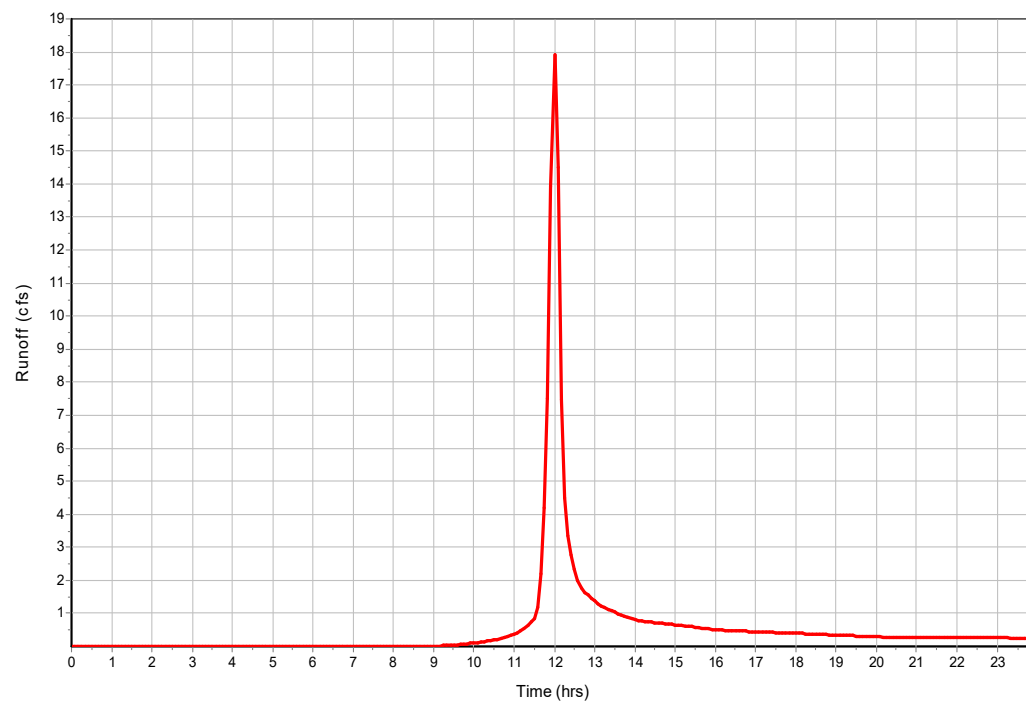
Total Rainfall (in) 2.7
Total Runoff (in) 1.27
Peak Runoff (cfs) 17.92
Weighted Curve Number 84
Time of Concentration (days hh:mm:ss) 0 00:10:42

Subbasin : {Proposed}.DA : 4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 5**Input Data**

Area (ac) 4.5
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Paved parking & roofs	4.5	D	98
Composite Area & Weighted CN	4.5		98

Time of Concentration

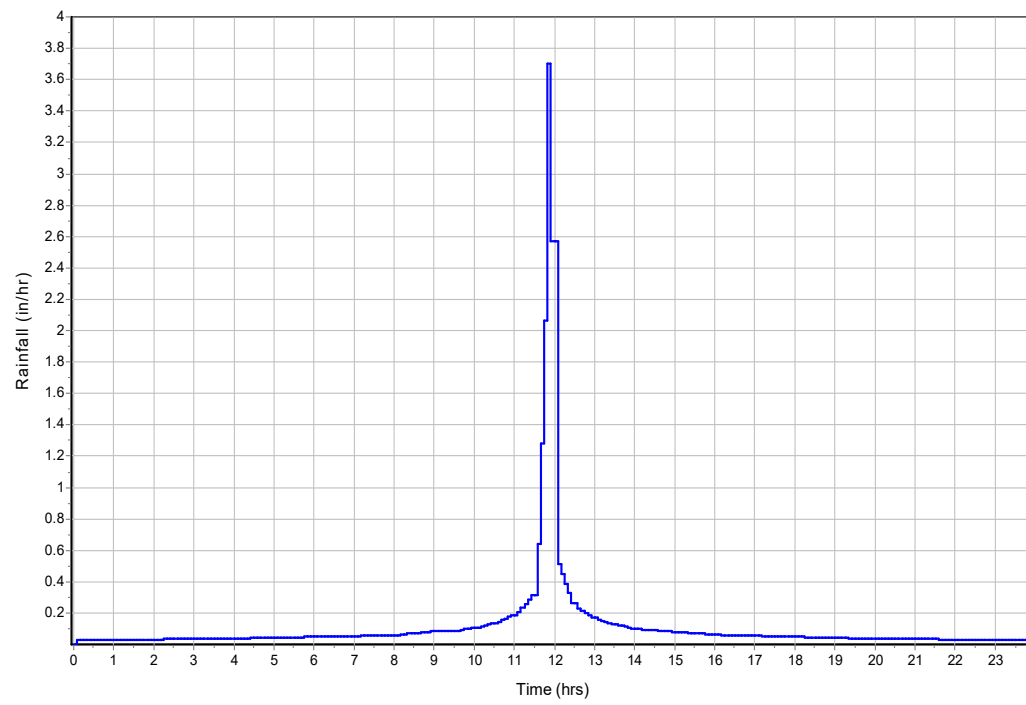
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.11	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.38	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.26	0	0
Computed Flow Time (min) :	6.35	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	306	0	0
Slope (%) :	1.12	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.15	0	0
Computed Flow Time (min) :	2.37	0	0
Total TOC (min)	8.72		

Subbasin Runoff Results

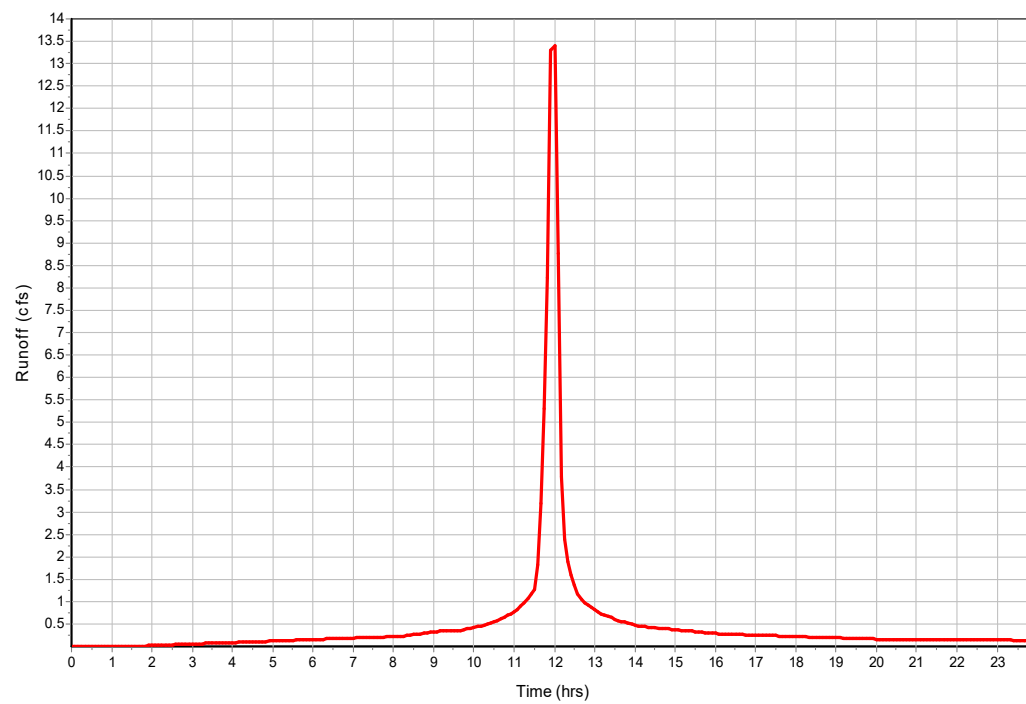
Total Rainfall (in) 2.7
Total Runoff (in) 2.47
Peak Runoff (cfs) 14.24
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:08:43

Subbasin : {Proposed}.DA : 5

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 6**Input Data**

Area (ac) 34.3
Peak Rate Factor 484
Weighted Curve Number 82.04
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	20.85	D	84
Pasture, grassland, or range, Fair	13.45	C	79
Composite Area & Weighted CN	34.3		82.04

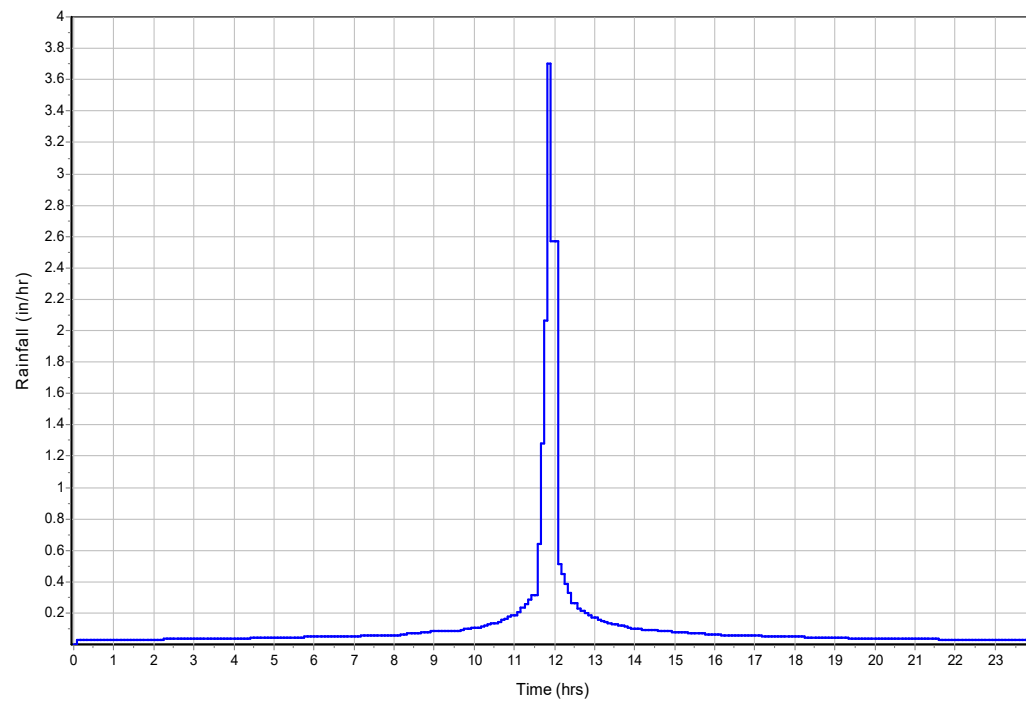
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	3.66	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.2	0	0
Computed Flow Time (min) :	8.47	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1440	0	0
Slope (%) :	2.94	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.77	0	0
Computed Flow Time (min) :	8.66	0	0
Total TOC (min)17.13			

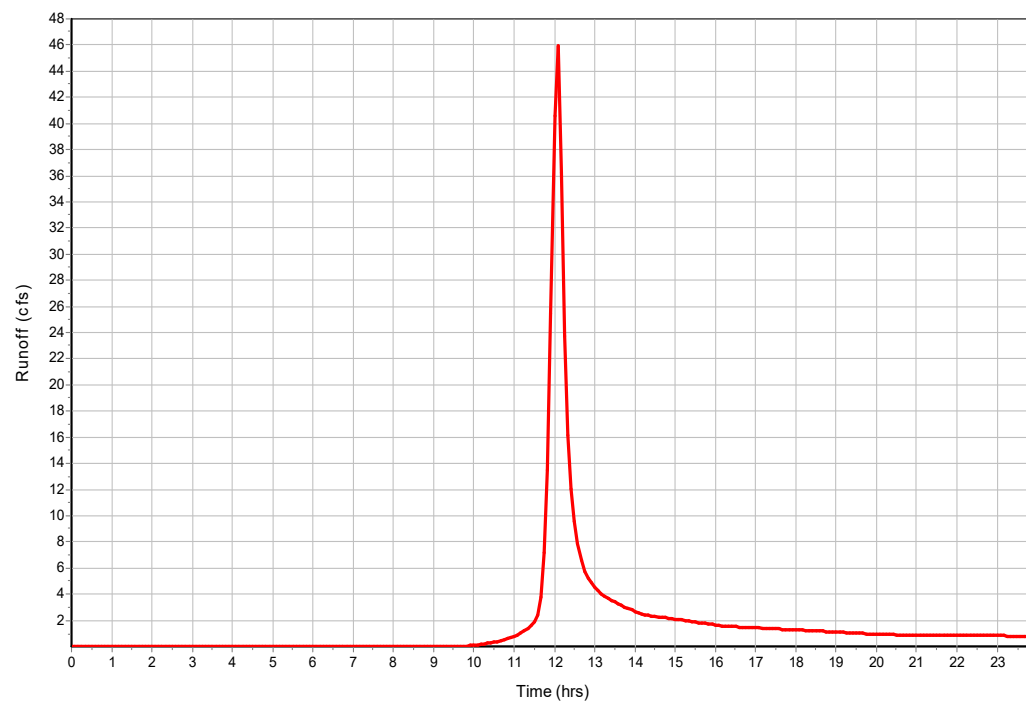
Subbasin Runoff Results

Total Rainfall (in) 2.7
Total Runoff (in) 1.15
Peak Runoff (cfs) 46.24
Weighted Curve Number 82.04
Time of Concentration (days hh:mm:ss) 0 00:17:08

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 7**Input Data**

Area (ac) 44.2
Peak Rate Factor 484
Weighted Curve Number 92.51
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Paved parking & roofs	26.88	D	98
Pasture, grassland, or range, Fair	17.32	D	84
Composite Area & Weighted CN	44.2		92.51

Time of Concentration

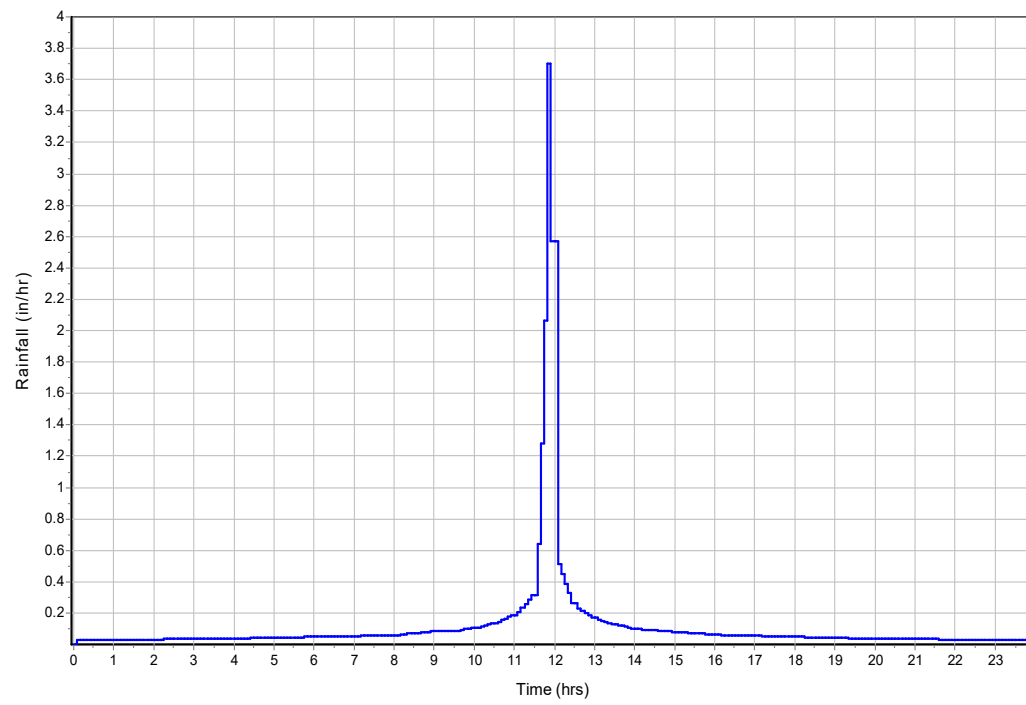
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.83	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.22	0	0
Computed Flow Time (min) :	7.58	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	992	943	0
Slope (%) :	3.66	0.5	0
Surface Type :	Unpaved	Paved	Unpaved
Velocity (ft/sec) :	3.09	1.44	0
Computed Flow Time (min) :	5.35	10.91	0
Total TOC (min)23.85			

Subbasin Runoff Results

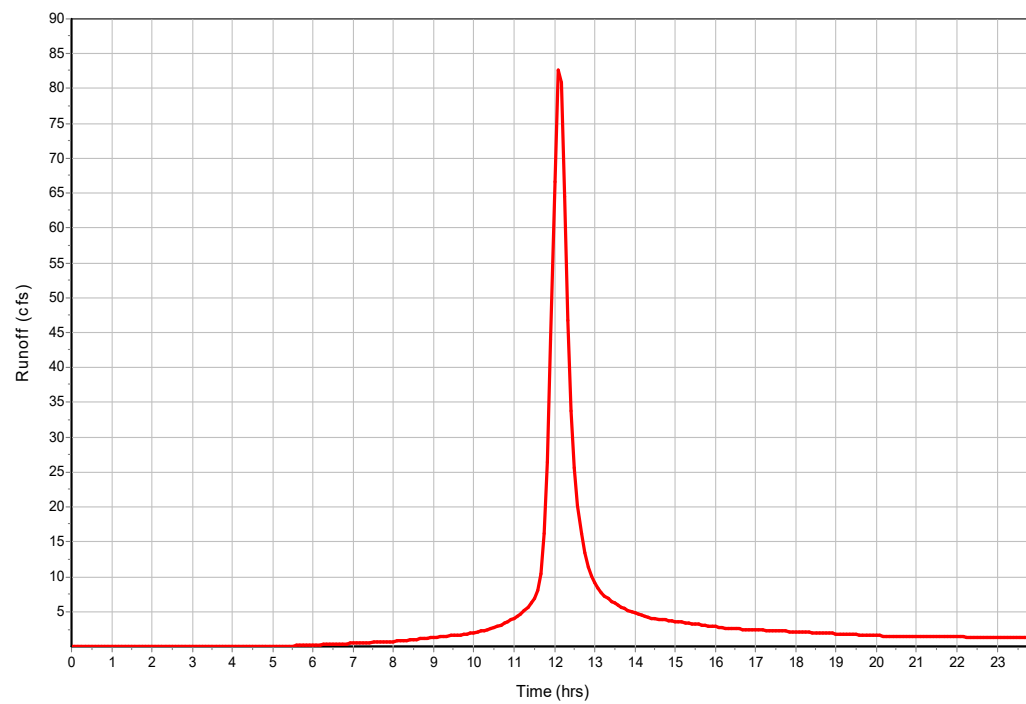
Total Rainfall (in) 2.7
Total Runoff (in) 1.92
Peak Runoff (cfs) 84.41
Weighted Curve Number 92.51
Time of Concentration (days hh:mm:ss) 0 00:23:51

Subbasin : {Proposed}.DA : 7

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim Elevation (Max) (ft)	Ground/Rim Offset (Max) (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft ²)	Minimum Pipe Cover (in)
1	1-Jun	5437.80	5441.80	4.00	5437.80	0.00	5445.80	4.00	0.00	0.00
2	2-Jun	5428.92	5440.40	11.48	5428.92	0.00	5451.88	11.48	0.00	0.00
3	3-Jun	5427.02	5427.02	0.00	5427.02	0.00	5427.02	0.00	0.00	0.00
4	4-Jun	5441.72	5443.72	2.00	5441.72	0.00	5445.72	2.00	0.00	0.00
5	5-Jun	5426.06	5428.06	2.00	5426.06	0.00	5430.06	2.00	0.00	0.00
6	6-Jun	5421.00	5426.00	5.00	5421.00	0.00	5431.00	5.00	0.00	0.00
7	7-Jun	5417.00	5422.00	5.00	5417.00	0.00	5427.00	5.00	0.00	0.00
8	Outlet_PondA	5418.00	5420.50	2.50	5418.00	0.00	5423.00	2.50	0.00	0.00
9	Outlet_PondB	5424.00	5425.50	1.50	5424.00	0.00	5427.00	1.50	0.00	0.00
10	Riser_PondA	5418.00	5424.97	6.97	5418.00	0.00	5431.94	6.97	0.00	0.00
11	Riser_PondB	5424.00	5427.52	3.52	5424.00	0.00	5431.04	3.52	0.00	0.00

Junction Results

SN	Element	Peak	Peak	Max HGL	Max HGL	Max	Min	Average HGL	Average HGL	Time of	Time of	Total	Total Time
ID	Inflow	Lateral	Elevation	Depth	Surcharge	Freeboard	Elevation	Depth	Max HGL	Max HGL	Peak	Flooded	Total Time
	Inflow	Attained	Attained	Depth	Attained	Attained	Attained	Attained	Occurrence	Occurrence	Volume	Flooded	Flooded
	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)	(min)
1	1-Jun	185.21	185.21	5439.33	1.53	0.00	2.47	5438.19	0.39	0 12:31	0 00:00	0.00	0.00
2	2-Jun	234.21	87.13	5432.15	3.23	0.00	8.25	5429.67	0.75	0 12:31	0 00:00	0.00	0.00
3	3-Jun	228.14	0.00	5427.74	0.72	0.00	4.28	5427.20	0.18	0 12:32	0 00:00	0.00	0.00
4	4-Jun	28.15	28.15	5442.36	0.64	0.00	1.36	5441.82	0.10	0 12:09	0 00:00	0.00	0.00
5	5-Jun	42.38	17.85	5426.85	0.79	0.00	1.21	5426.18	0.12	0 12:09	0 00:00	0.00	0.00
6	6-Jun	238.79	0.00	5421.88	0.88	0.00	4.12	5421.23	0.23	0 12:32	0 00:00	0.00	0.00
7	7-Jun	247.15	0.00	5417.99	0.99	0.00	10.01	5417.27	0.27	0 12:36	0 00:00	0.00	0.00
8	Outlet_PondA	13.81	0.00	5419.27	1.27	0.00	1.23	5418.49	0.49	0 12:50	0 00:00	0.00	0.00
9	Outlet_PondB	1.65	0.00	5424.35	0.35	0.00	1.15	5424.21	0.21	0 12:30	0 00:00	0.00	0.00
10	Riser_PondA	13.82	0.00	5419.73	1.73	0.00	5.24	5418.61	0.61	0 12:50	0 00:00	0.00	0.00
11	Riser_PondB	1.65	0.00	5424.55	0.55	0.00	2.97	5424.30	0.30	0 12:30	0 00:00	0.00	0.00

Channel Input

SN Element ID	Length	Inlet Invert	Inlet Invert	Outlet Invert	Outlet Invert	Total Drop	Average Slope	Shape	Height	Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flap Flow Gate
	(ft)	Elevation (ft)	Offset (ft)	Elevation (ft)	Offset (ft)	(ft)	(%)		(ft)	(ft)					(cfs)
1 DITCH-01	1367.00	5437.80	0.00	5428.92	0.00	8.88	0.6500	Trapezoidal	4.000	52.000	0.0300	0.5000	0.5000	0.0000	0.00 No
2 DITCH-02	1487.80	5441.72	0.00	5426.06	0.00	15.66	1.0500	Trapezoidal	2.000	26.000	0.0300	0.5000	0.5000	0.0000	0.00 No
3 DITCH-03	207.00	5426.06	0.00	5421.00	0.00	5.06	2.4400	Trapezoidal	2.000	26.000	0.0400	0.5000	0.5000	0.0000	0.00 No
4 EXISTDITCH-01	352.00	5427.02	0.00	5421.00	0.00	6.02	1.7100	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00 No
5 EXISTDITCH-02	415.00	5421.00	0.00	5417.00	0.00	4.00	0.9600	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00 No
6 EXISTDITCH-03	1033.00	5417.00	0.00	5409.60	0.00	7.40	0.7200	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00 No

Channel Results

SN Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Froude	Reported
ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Number	Condition
		Occurrence		Ratio				Total Depth			
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio			
1 DITCH-01	183.51	0 12:31	1119.58	0.16	2.61	8.73	2.37	0.59	0.00		
2 DITCH-02	26.59	0 12:09	224.45	0.12	2.89	8.58	0.72	0.36	0.00		
3 DITCH-03	41.61	0 12:10	256.53	0.16	4.55	0.76	0.73	0.37	0.00		
4 EXISTDITCH-01	228.10	0 12:32	6247.31	0.04	3.43	1.71	0.80	0.16	0.00		
5 EXISTDITCH-02	238.52	0 12:32	4689.99	0.05	3.09	2.24	0.93	0.19	0.00		
6 EXISTDITCH-03	246.01	0 12:37	4043.26	0.06	2.98	5.78	0.98	0.20	0.00		

Pipe Input

SN Element ID	Length	Inlet Invert	Inlet Offset	Outlet Invert	Outlet Offset	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Flap Gate	No. of Barrels
	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(in)	(in)							(cfs)
1 C-01	120.00	5428.92	0.00	5427.02	0.00	1.90	1.5800	Rectangular	48.000	60.000	0.0120	0.5000	0.5000	0.0000	0.00	No	3
2 OutletPipe_PondA	166.00	5418.00	0.00	5417.00	0.00	1.00	0.6000	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3 OutletPipe_PondB	303.00	5424.00	0.00	5417.00	0.00	7.00	2.3100	CIRCULAR	18.000	18.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	C-01	228.14	0 12:31	1002.95	0.23	7.71	0.26	1.97	0.49	0.00		Calculated
2	OutletPipe_PondA	13.81	0 12:50	34.49	0.40	7.18	0.39	1.10	0.44	0.00		Calculated
3	OutletPipe_PondB	1.64	0 12:31	13.84	0.12	5.30	0.95	0.67	0.44	0.00		Calculated

Storage Nodes

Storage Node : PondA

Input Data

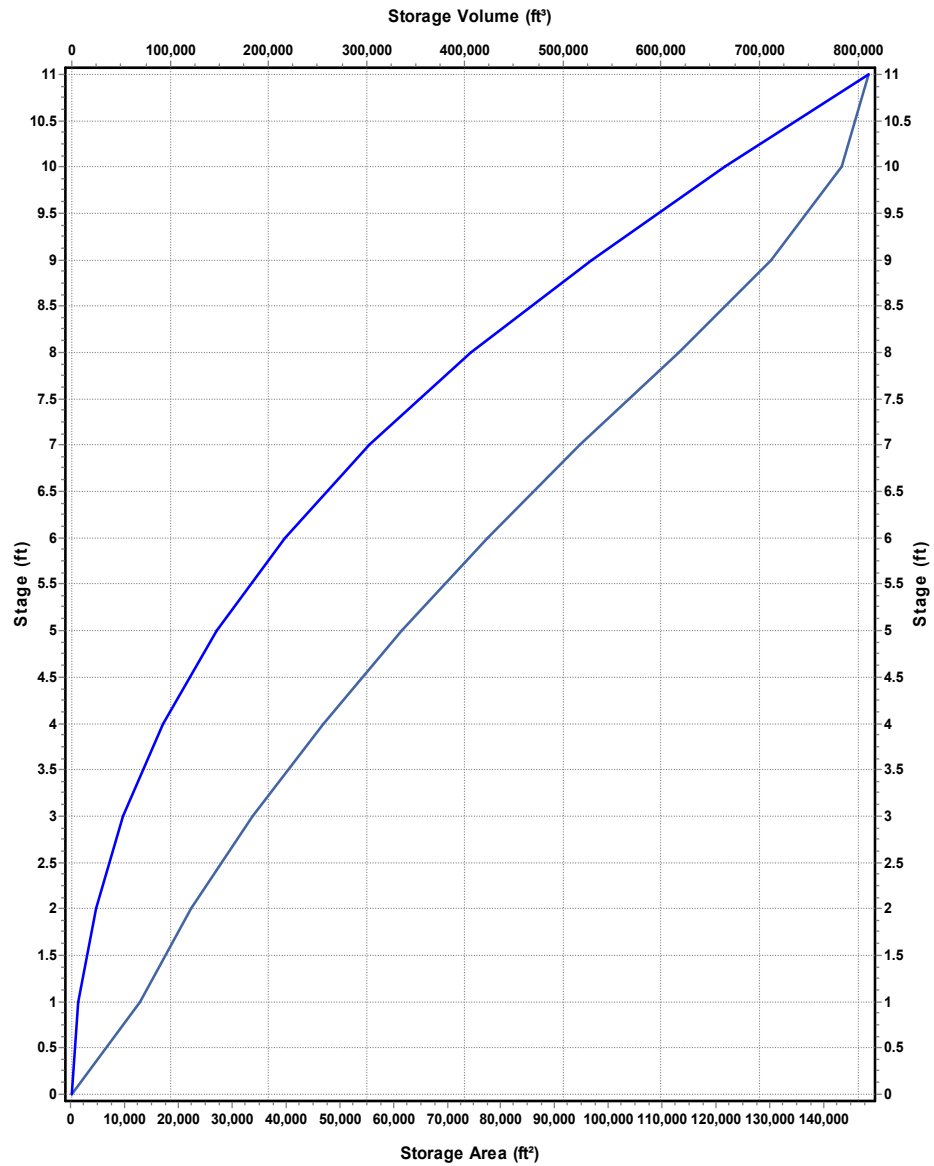
Invert Elevation (ft)	5420.00
Max (Rim) Elevation (ft)	5431.00
Max (Rim) Offset (ft)	11.00
Initial Water Elevation (ft)	5420.00
Initial Water Depth (ft)	0.00
Ponded Area (ft ²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Pond A

Stage	Storage Area	Storage Volume
(ft)	(ft ²)	(ft ³)
0	300	0
1	13044	6672
2	22565	24476.5
3	33934	52726
4	46922	93154
5	61435	147332.5
6	77447	216773.5
7	94723	302858.5
8	113114	406777
9	130230	528449
10	143348	665238
11	148268	811046

Storage Area Volume Curves



Storage Area Storage Volume

Storage Node : PondA (continued)

Outflow Weirs

SN Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1 EMRGCYSPLWY_PondA	Trapezoidal	No	5427.00	7.00	52.00	4.00	3.33

Outflow Orifices

SN Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1 Grate_PondA	Bottom	Rectangular	No		48.00	48.00	5424.97	0.63
2 WQCV/EURV_PondA	Side	Rectangular	No		3.00	6.58	5420.00	0.63

Output Summary Results

Peak Inflow (cfs)	82.65
Peak Lateral Inflow (cfs)	82.65
Peak Outflow (cfs)	13.82
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	5425.35
Max HGL Depth Attained (ft)	5.35
Average HGL Elevation Attained (ft)	5423.53
Average HGL Depth Attained (ft)	3.53
Time of Max HGL Occurrence (days hh:mm)	0 12:49
Total Exfiltration Volume (1000-ft ³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : PondB

Input Data

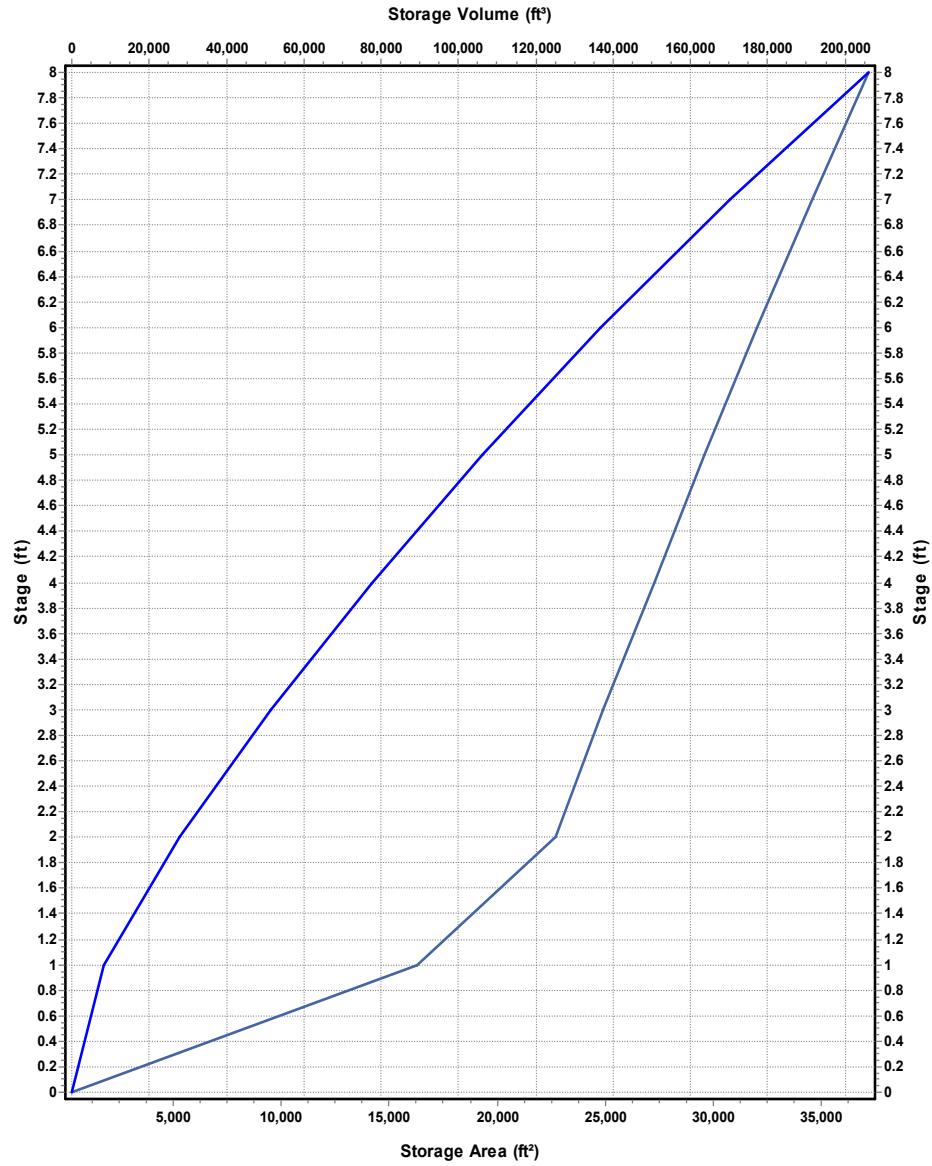
Invert Elevation (ft)	5426.00
Max (Rim) Elevation (ft)	5434.00
Max (Rim) Offset (ft)	8.00
Initial Water Elevation (ft)	5426.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Pond B

Stage	Storage Area	Storage Volume
(ft)	(ft²)	(ft³)
0	300	0
1	16257	8278.5
2	22675	27744.5
3	24922	51543
4	27243	77625.5
5	29585	106039.5
6	32047	136855.5
7	34583	170170.5
8	37192	206058

Storage Area Volume Curves



Storage Area Storage Volume

Storage Node : PondB (continued)

Outflow Weirs

SN Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1 EMRGCYSPLWY_PondB	Trapezoidal	No	5431.00	5.00	7.00	3.00	3.33

Outflow Orifices

SN Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1 Grate_PondB	Bottom	Rectangular	No		48.00	48.00	5427.52	0.63
2 WQCV/EURV_PondB	Side	CIRCULAR	No	6.16			5426.00	0.61

Output Summary Results

Peak Inflow (cfs)	13.4
Peak Lateral Inflow (cfs)	13.4
Peak Outflow (cfs)	1.65
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	5427.56
Max HGL Depth Attained (ft)	1.56
Average HGL Elevation Attained (ft)	5426.8
Average HGL Depth Attained (ft)	0.8
Time of Max HGL Occurrence (days hh:mm)	0 12:29
Total Exfiltration Volume (1000-ft ³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Proposed Conditions.SPF
Description	Proposed Conditions 100-yr storm

Project Options

Flow Units	CFS
Elevation Type	Depth
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	7
Nodes.....	14
<i>Junctions</i>	11
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	0
<i>Storage Nodes</i>	2
Links.....	17
<i>Channels</i>	6
<i>Pipes</i>	3
<i>Pumps</i>	0
<i>Orifices</i>	6
<i>Weirs</i>	2
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage	Data	Data Source	Rainfall	Rain	State	County	Return	Rainfall	Rainfall
	ID	Source	ID	Type	Units			Period	Depth	Distribution
								(years)	(inches)	
1	Rain Gage-01	Time Series	100-yr	Cumulative	inches	Colorado	El Paso	100.00	4.60	SCS Type II 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)	Factor		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 {Proposed}.DA : 1	266.90	484.00	82.22	4.60	2.74	732.37	450.39	0 00:51:56
2 {Proposed}.DA : 2	75.00	484.00	83.89	4.60	2.90	217.28	200.73	0 00:27:41
3 {Proposed}.DA : 3	17.60	484.00	83.87	4.60	2.90	50.95	65.72	0 00:13:00
4 {Proposed}.DA : 4	10.30	484.00	84.00	4.60	2.91	29.94	40.50	0 00:10:42
5 {Proposed}.DA : 5	4.50	484.00	98.00	4.60	4.36	19.64	24.55	0 00:08:43
6 {Proposed}.DA : 6	34.30	484.00	82.04	4.60	2.73	93.57	110.09	0 00:17:07
7 {Proposed}.DA : 7	44.20	484.00	92.51	4.60	3.75	165.88	159.88	0 00:23:51

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation	Max Surcharge Depth	Min Freeboard	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	1-Jun	Junction	5437.80	5441.80	5437.80	5445.80	0.00	449.45	5440.29	0.00	1.51	0 00:00	0.00	0.00
2	2-Jun	Junction	5428.92	5440.40	5428.92	5451.88	0.00	570.49	5435.27	0.00	5.13	0 00:00	0.00	0.00
3	3-Jun	Junction	5427.02	5427.02	5427.02	5427.02	0.00	570.45	5428.26	0.00	3.76	0 00:00	0.00	0.00
4	4-Jun	Junction	5441.72	5443.72	5441.72	5445.72	0.00	64.87	5442.74	0.00	0.98	0 00:00	0.00	0.00
5	5-Jun	Junction	5426.06	5428.06	5426.06	5430.06	0.00	98.80	5427.32	0.00	0.74	0 00:00	0.00	0.00
6	6-Jun	Junction	5421.00	5426.00	5421.00	5431.00	0.00	603.61	5422.52	0.00	3.48	0 00:00	0.00	0.00
7	7-Jun	Junction	5417.00	5422.00	5417.00	5427.00	0.00	658.99	5418.78	0.00	9.22	0 00:00	0.00	0.00
8	Outlet_PondA	Junction	5418.00	5420.50	5418.00	5423.00	0.00	46.89	5422.45	1.95	0.00	0 00:00	0.00	0.00
9	Outlet_PondB	Junction	5424.00	5425.50	5424.00	5427.00	0.00	9.87	5424.96	0.00	0.54	0 00:00	0.00	0.00
10	Riser_PondA	Junction	5418.00	5424.97	5418.00	5431.94	0.00	59.28	5425.74	0.77	0.00	0 00:00	0.00	0.00
11	Riser_PondB	Junction	5424.00	5427.52	5424.00	5431.04	0.00	11.81	5427.62	0.10	0.00	0 00:00	0.00	0.00
12	Out-01	Outfall	5409.60					695.98	5411.35					
13	PondA	Storage Node	5420.00	5431.00	5420.00		0.00	157.28	5426.73				0.00	0.00
14	PondB	Storage Node	5426.00	5434.00	5426.00		0.00	23.03	5427.94				0.00	0.00

Link Summary

SN Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
				(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1 C-01	Pipe	2-Jun	3-Jun	120.00	5428.92	5427.02	1.5800	48.000	0.0120	570.45	1002.95	0.57	14.51	2.62	0.66	0.00	Calculated
2 OutletPipe_PondA	Pipe	Outlet_PondA	7-Jun	166.00	5418.00	5417.00	0.6000	30.000	0.0120	46.89	34.49	1.36	11.84	2.14	0.86	0.00	> CAPACITY
3 OutletPipe_PondB	Pipe	Outlet_PondB	7-Jun	303.00	5424.00	5417.00	2.3100	18.000	0.0150	9.92	13.84	0.72	7.51	1.22	0.81	0.00	Calculated
4 DITCH-01	Channel	1-Jun	2-Jun	1367.00	5437.80	5428.92	0.6500	48.000	0.0300	447.32	1119.58	0.40	4.18	3.24	0.81	0.00	
5 DITCH-02	Channel	4-Jun	5-Jun	1487.80	5441.72	5426.06	1.0500	24.000	0.0300	61.49	224.45	0.27	3.72	1.12	0.57	0.00	
6 DITCH-03	Channel	5-Jun	6-Jun	207.00	5426.06	5421.00	2.4400	24.000	0.0400	96.80	256.53	0.38	5.68	1.25	0.64	0.00	
7 EXISTDITCH-01	Channel	3-Jun	6-Jun	352.00	5427.02	5421.00	1.7100	60.000	0.0400	570.23	6247.31	0.09	4.83	1.38	0.28	0.00	
8 EXISTDITCH-02	Channel	6-Jun	7-Jun	415.00	5421.00	5417.00	0.9600	60.000	0.0400	602.93	4689.99	0.13	4.29	1.65	0.33	0.00	
9 EXISTDITCH-03	Channel	7-Jun	Out-01	1033.00	5417.00	5409.60	0.7200	60.000	0.0400	656.72	4043.26	0.16	4.28	1.76	0.35	0.00	
10 Grate_PondA	Orifice	PondA	Riser_PondA		5420.00	5418.00		48.000		58.54							
11 Grate_PondB	Orifice	PondB	Riser_PondB		5426.00	5424.00		48.000		11.17							
12 RestrictorPlate_PondA	Orifice	Riser_PondA	Outlet_PondA		5418.00	5418.00		24.700		46.89							
13 RestrictorPlate_PondB	Orifice	Riser_PondB	Outlet_PondB		5424.00	5424.00		9.600		9.87							
14 WQCV/EURV_PondA	Orifice	PondA	Riser_PondA		5420.00	5418.00		3.000		1.61							
15 WQCV/EURV_PondB	Orifice	PondB	Riser_PondB		5426.00	5424.00		6.160		1.27							
16 EMRGCYSPWLWY_PondA	Weir	PondA	7-Jun		5420.00	5417.00				0.00							
17 EMRGCYSPWLWY_PondB	Weir	PondB	7-Jun		5426.00	5417.00				0.00							

Subbasin Hydrology

Subbasin : {Proposed}.DA : 1

Input Data

Area (ac) 266.9
Peak Rate Factor 484
Weighted Curve Number 82.22
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	171.88	D	84
Pasture, grassland, or range, Fair	95.02	C	79
Composite Area & Weighted CN	266.9		82.22

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
 n = Manning's roughness
 L_f = Flow Length (ft)
 P = 2 yr, 24 hr Rainfall (inches)
 S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

$V = 16.1345 * (S_f^{0.5})$ (unpaved surface)
 $V = 20.3282 * (S_f^{0.5})$ (paved surface)
 $V = 15.0 * (S_f^{0.5})$ (grassed waterway surface)
 $V = 10.0 * (S_f^{0.5})$ (nearly bare & untilled surface)
 $V = 9.0 * (S_f^{0.5})$ (cultivated straight rows surface)
 $V = 7.0 * (S_f^{0.5})$ (short grass pasture surface)
 $V = 5.0 * (S_f^{0.5})$ (woodland surface)
 $V = 2.5 * (S_f^{0.5})$ (forest w/heavy litter surface)
 $T_c = (L_f / V) / (3600 \text{ sec/hr})$

Where:

T_c = Time of Concentration (hr)
 L_f = Flow Length (ft)
 V = Velocity (ft/sec)
 S_f = Slope (ft/ft)

Channel Flow Equation :

$V = (1.49 * (R^{2/3}) * (S_f^{0.5})) / n$
 $R = A_q / W_p$
 $T_c = (L_f / V) / (3600 \text{ sec/hr})$

Where :

T_c = Time of Concentration (hr)
 L_f = Flow Length (ft)
 R = Hydraulic Radius (ft)
 A_q = Flow Area (ft²)
 W_p = Wetted Perimeter (ft)
 V = Velocity (ft/sec)
 S_f = Slope (ft/ft)
 n = Manning's roughness

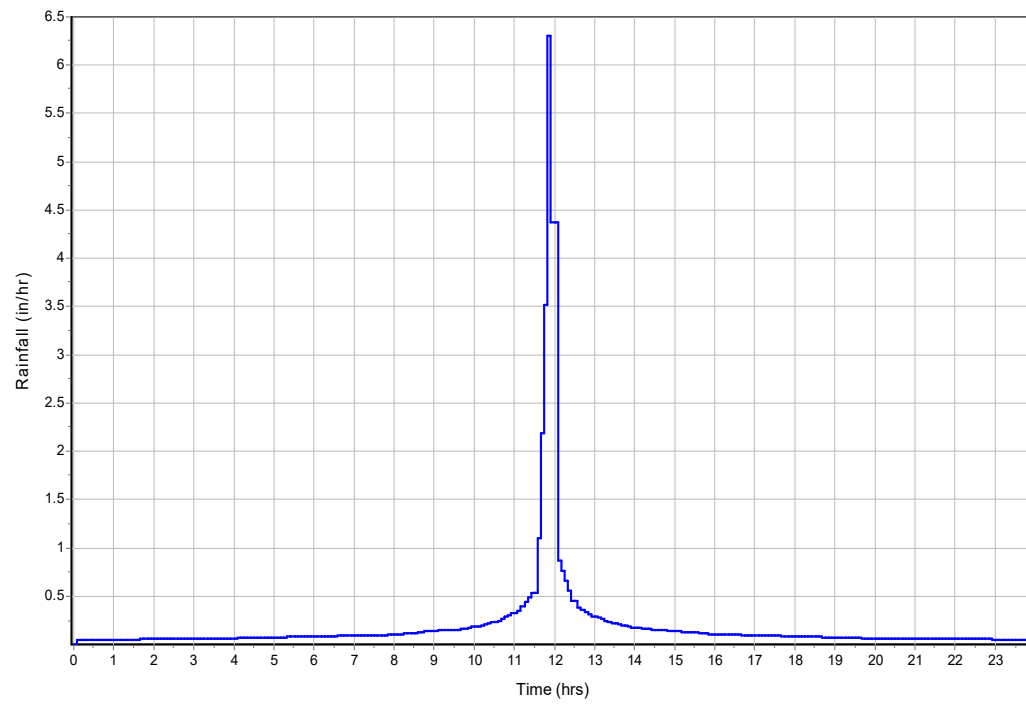
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	12.07	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	5861	0	0
Slope (%) :	2.3	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.45	0	0
Computed Flow Time (min) :	39.87	0	0
Total TOC (min)	51.94		

Subbasin Runoff Results

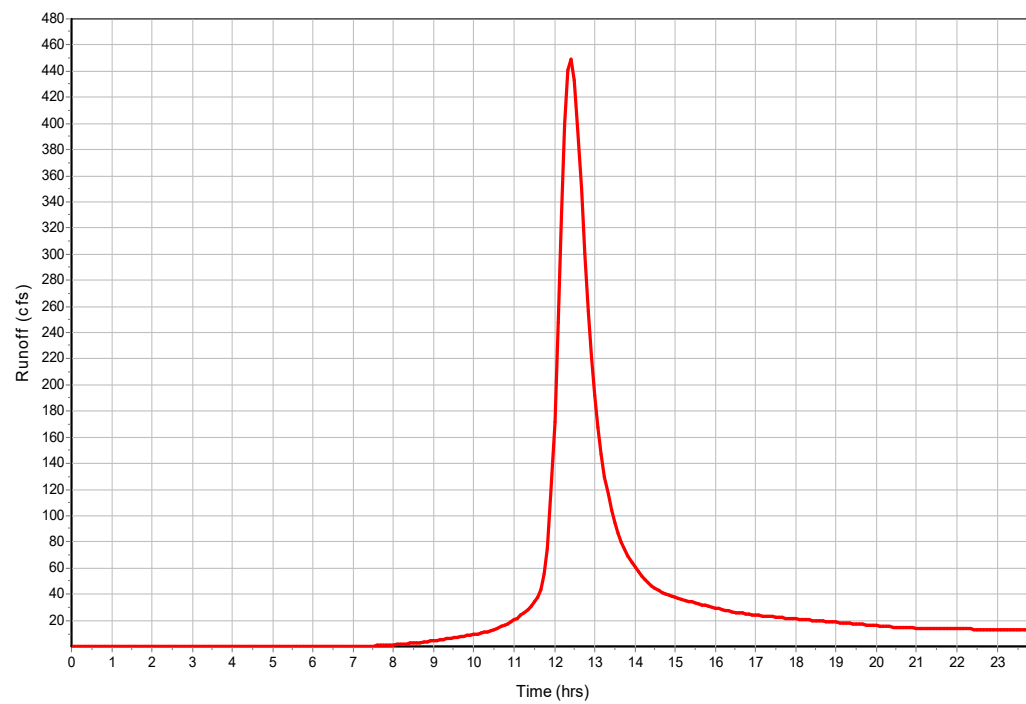
Total Rainfall (in)	4.6
Total Runoff (in)	2.74
Peak Runoff (cfs)	450.39
Weighted Curve Number	82.22
Time of Concentration (days hh:mm:ss)	0 00:51:56

Subbasin : {Proposed}.DA : 1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 2**Input Data**

Area (ac) 75
Peak Rate Factor 484
Weighted Curve Number 83.89
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	73.35	D	84
Pasture, grassland, or range, Fair	1.65	C	79
Composite Area & Weighted CN	75		83.89

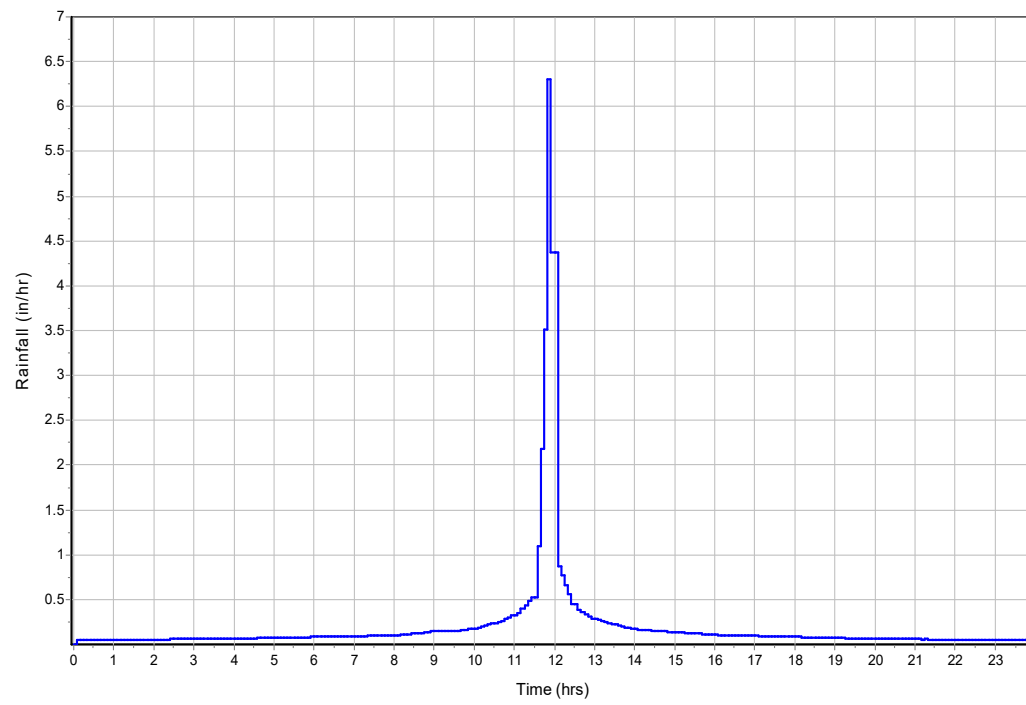
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.84	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.37	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	3055	0	0
Slope (%) :	2.96	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.78	0	0
Computed Flow Time (min) :	18.32	0	0
Total TOC (min)27.69			

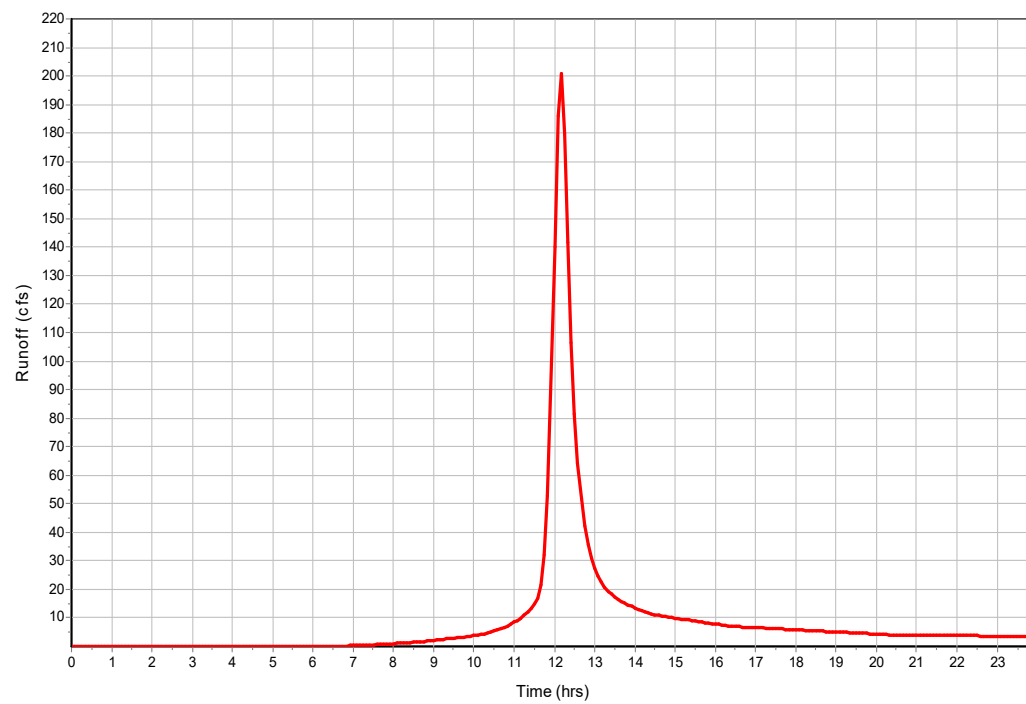
Subbasin Runoff Results

Total Rainfall (in) 4.6
Total Runoff (in) 2.9
Peak Runoff (cfs) 200.73
Weighted Curve Number 83.89
Time of Concentration (days hh:mm:ss) 0 00:27:41

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 3**Input Data**

Area (ac) 17.6
Peak Rate Factor 484
Weighted Curve Number 83.87
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	17.16	D	84
Pasture, grassland, or range, Fair	0.44	C	79
Composite Area & Weighted CN	17.6		83.87

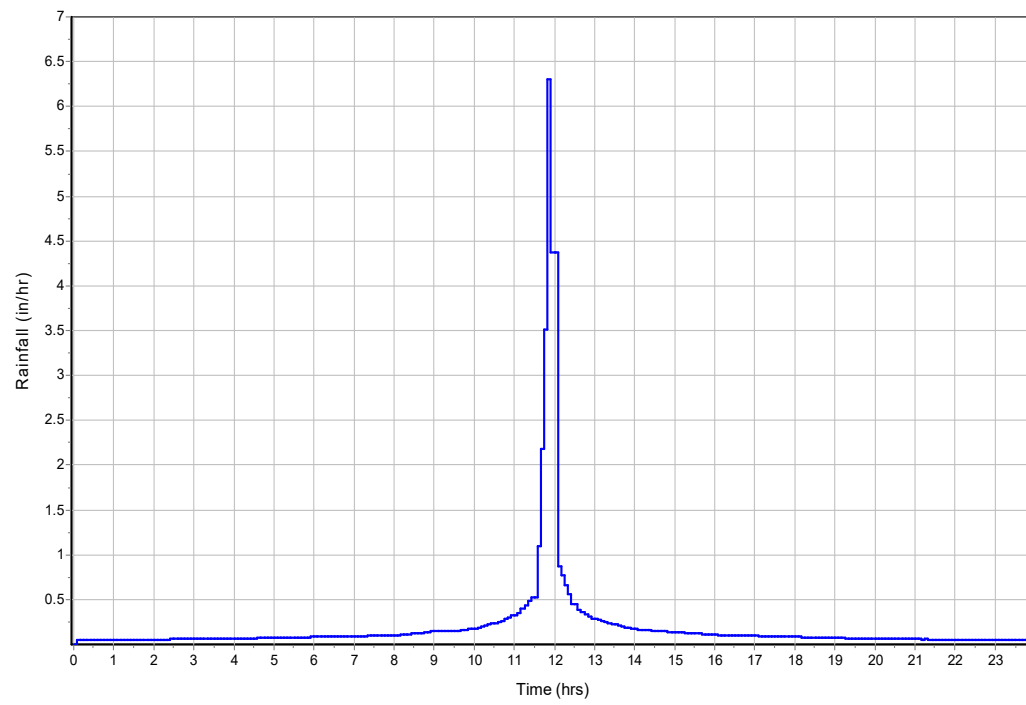
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.13	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.23	0	0
Computed Flow Time (min) :	7.4	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1052	0	0
Slope (%) :	3.77	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.13	0	0
Computed Flow Time (min) :	5.6	0	0
Total TOC (min)13.00			

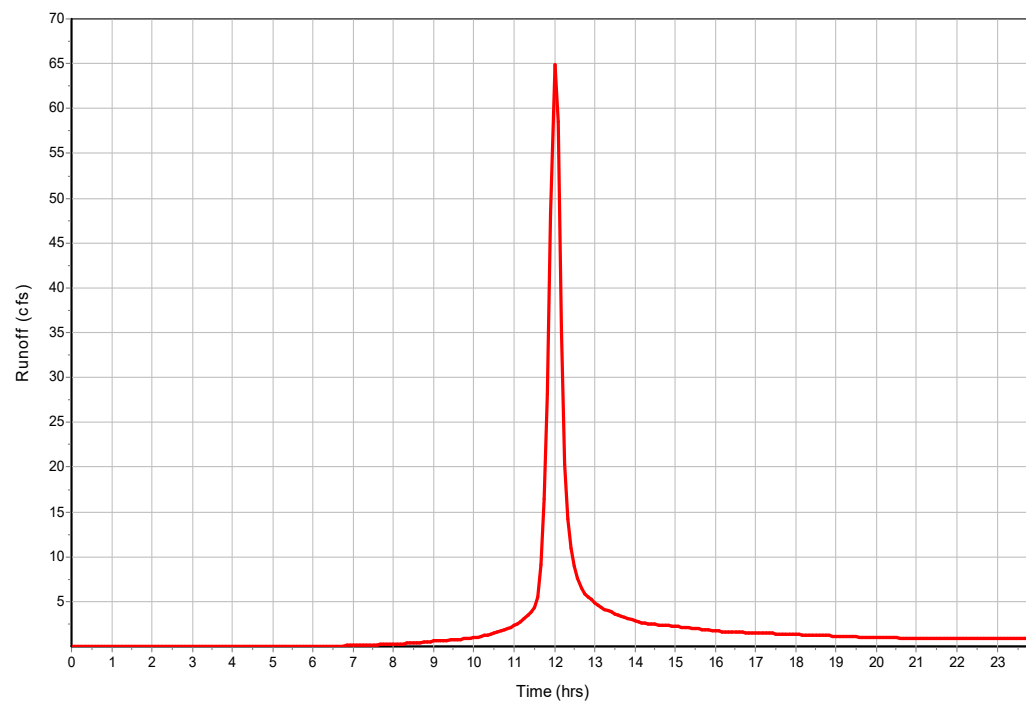
Subbasin Runoff Results

Total Rainfall (in) 4.6
Total Runoff (in) 2.9
Peak Runoff (cfs) 65.72
Weighted Curve Number 83.87
Time of Concentration (days hh:mm:ss) 0 00:13:00

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 4**Input Data**

Area (ac) 10.3
Peak Rate Factor 484
Weighted Curve Number 84
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Pasture, grassland, or range, Fair	10.3	D	84
Composite Area & Weighted CN	10.3		84

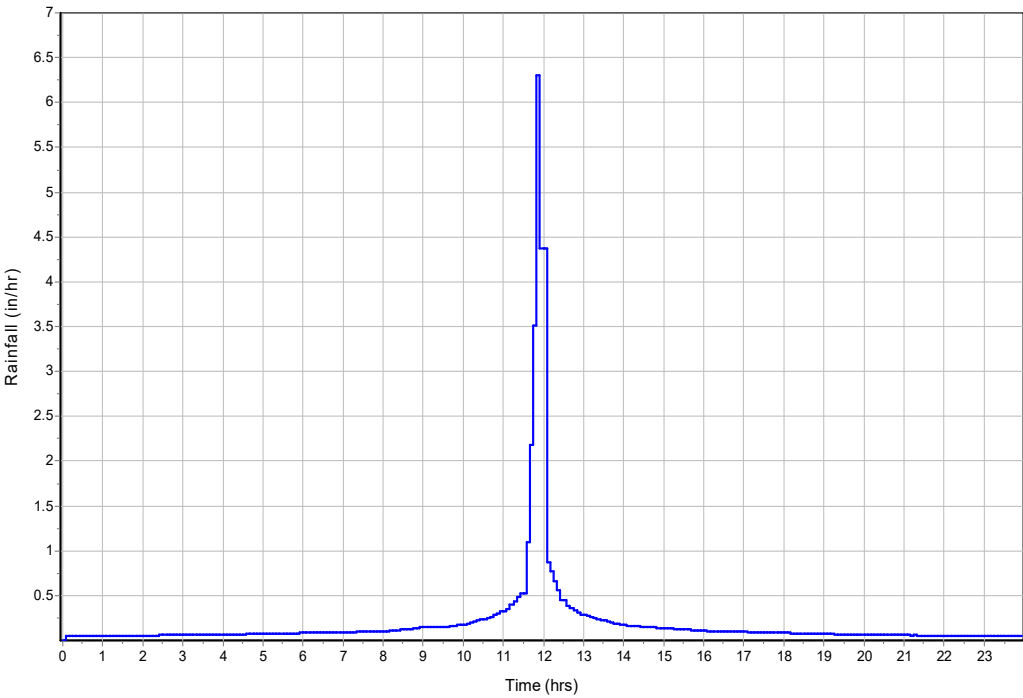
Time of Concentration

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.32	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.26	0	0
Computed Flow Time (min) :	6.42	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	974	0	0
Slope (%) :	5.52	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.79	0	0
Computed Flow Time (min) :	4.28	0	0
Total TOC (min)10.70			

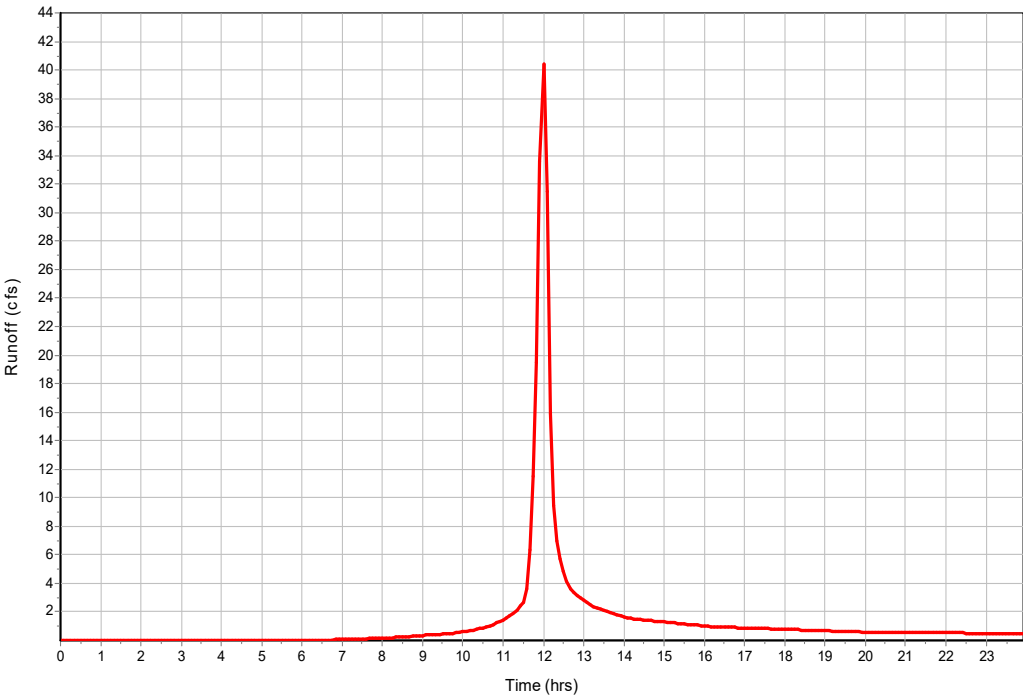
Subbasin Runoff Results

Total Rainfall (in) 4.6
Total Runoff (in) 2.91
Peak Runoff (cfs) 40.5
Weighted Curve Number 84
Time of Concentration (days hh:mm:ss) 0 00:10:42

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 5**Input Data**

Area (ac) 4.5
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Paved parking & roofs	4.5	D	98
Composite Area & Weighted CN	4.5		98

Time of Concentration

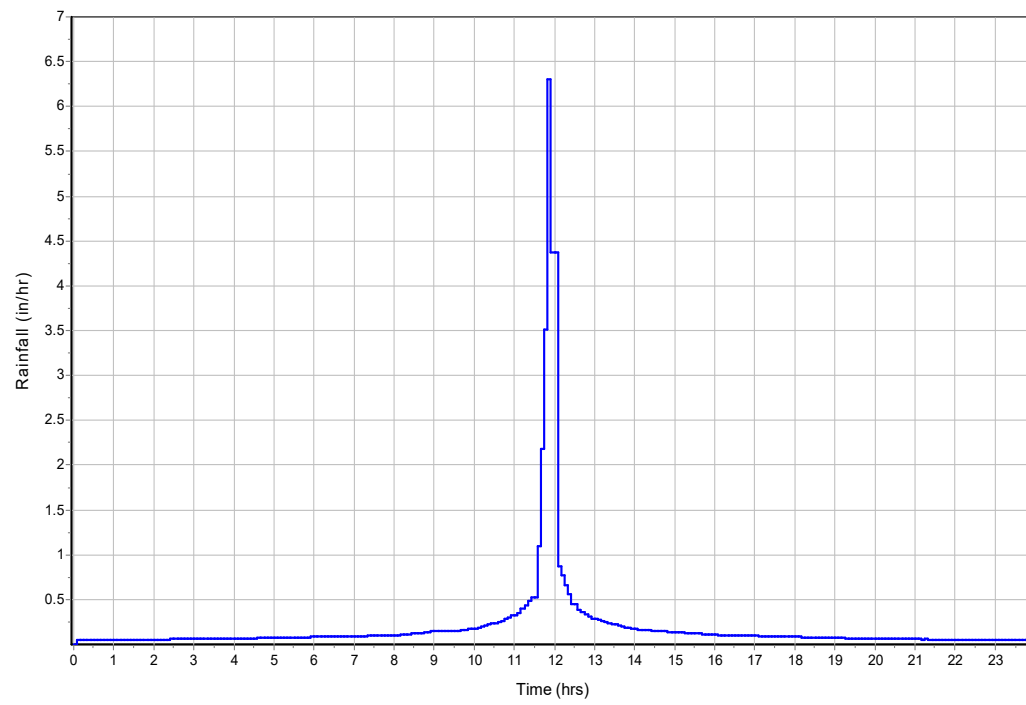
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.11	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.38	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.26	0	0
Computed Flow Time (min) :	6.35	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	306	0	0
Slope (%) :	1.12	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.15	0	0
Computed Flow Time (min) :	2.37	0	0
Total TOC (min)	8.72		

Subbasin Runoff Results

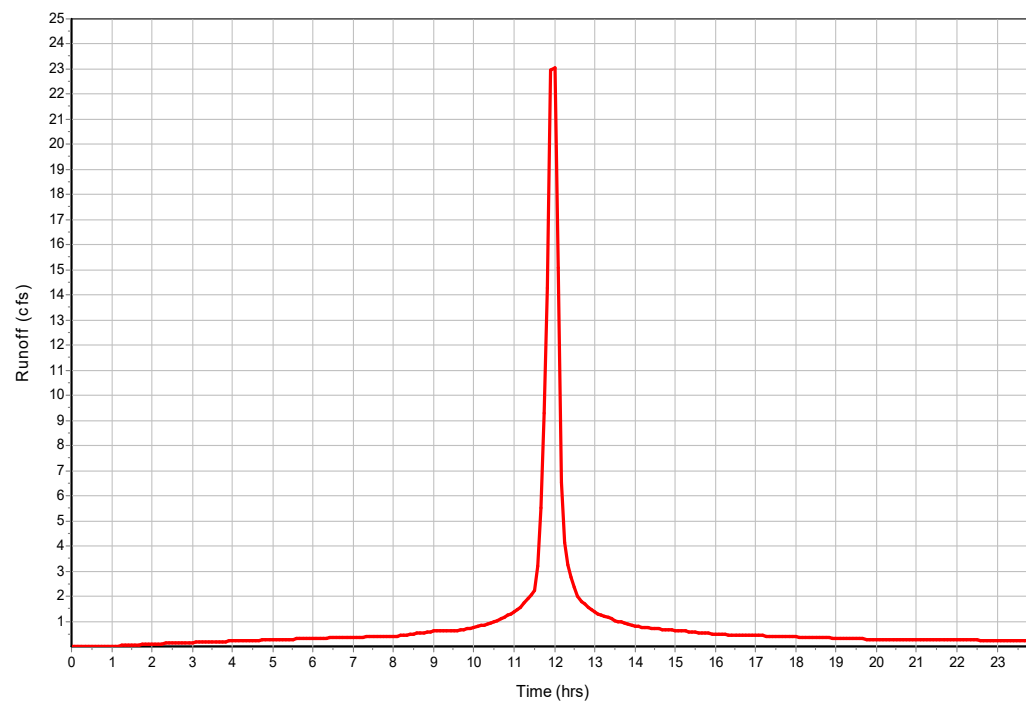
Total Rainfall (in) 4.6
Total Runoff (in) 4.36
Peak Runoff (cfs) 24.55
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:08:43

Subbasin : {Proposed}.DA : 5

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 6**Input Data**

Area (ac) 34.3
Peak Rate Factor 484
Weighted Curve Number 82.04
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Pasture, grassland, or range, Fair	20.85	D	84
Pasture, grassland, or range, Fair	13.45	C	79
Composite Area & Weighted CN	34.3		82.04

Time of Concentration

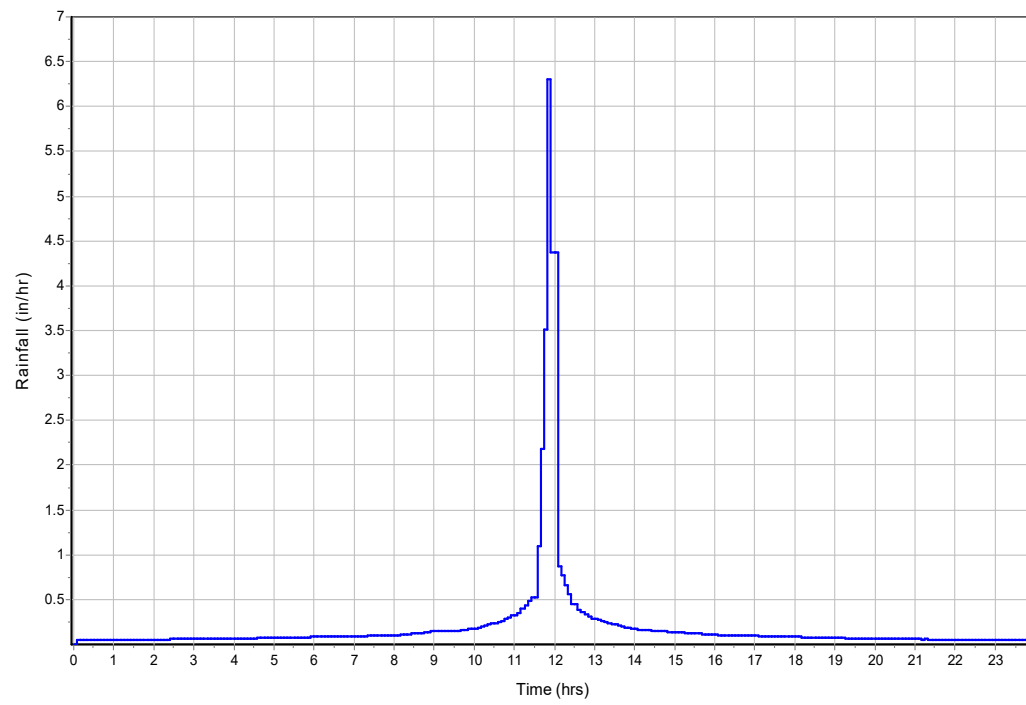
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	3.66	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.2	0	0
Computed Flow Time (min) :	8.47	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1440	0	0
Slope (%) :	2.94	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.77	0	0
Computed Flow Time (min) :	8.66	0	0
Total TOC (min)17.13			

Subbasin Runoff Results

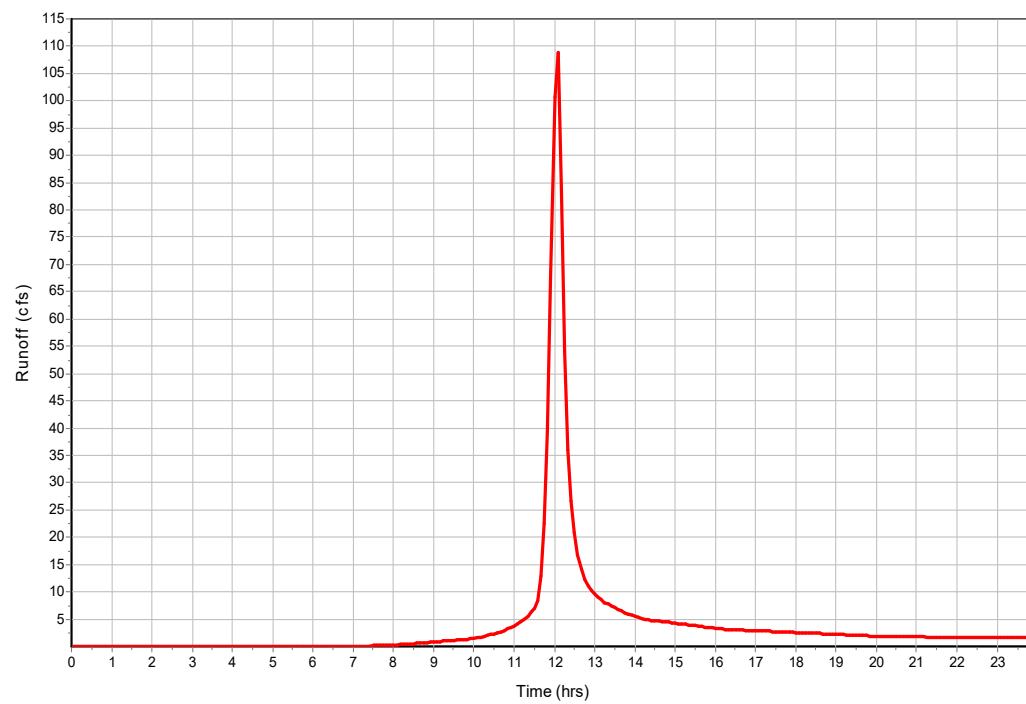
Total Rainfall (in) 4.6
Total Runoff (in) 2.73
Peak Runoff (cfs) 110.09
Weighted Curve Number 82.04
Time of Concentration (days hh:mm:ss) 0 00:17:08

Subbasin : {Proposed}.DA : 6

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : {Proposed}.DA : 7**Input Data**

Area (ac) 44.2
Peak Rate Factor 484
Weighted Curve Number 92.51
Rain Gage ID Rain Gage-01

Composite Curve Number

32	Area (acres)	Soil Group	Curve Number
Soil/Surface Description			
Paved parking & roofs	26.88	D	98
Pasture, grassland, or range, Fair	17.32	D	84
Composite Area & Weighted CN	44.2		92.51

Time of Concentration

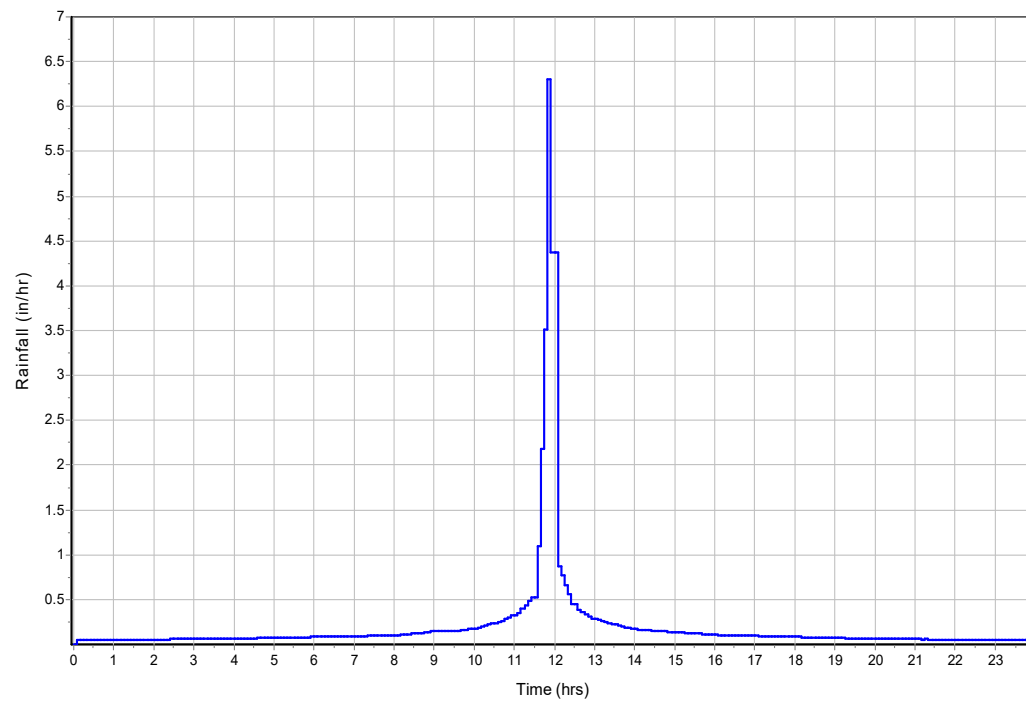
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.83	0	0
2 yr, 24 hr Rainfall (in) :	2.1	0	0
Velocity (ft/sec) :	0.22	0	0
Computed Flow Time (min) :	7.58	0	0
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	992	943	0
Slope (%) :	3.66	0.5	0
Surface Type :	Unpaved	Paved	Unpaved
Velocity (ft/sec) :	3.09	1.44	0
Computed Flow Time (min) :	5.35	10.91	0
Total TOC (min)23.85			

Subbasin Runoff Results

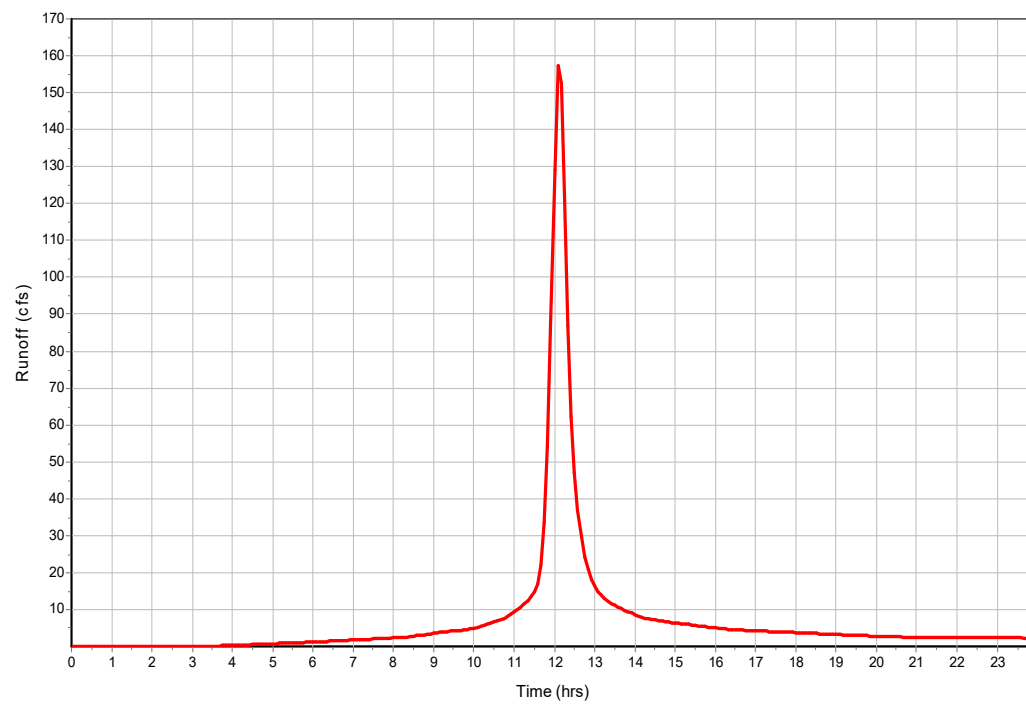
Total Rainfall (in) 4.6
Total Runoff (in) 3.75
Peak Runoff (cfs) 159.88
Weighted Curve Number 92.51
Time of Concentration (days hh:mm:ss) 0 00:23:51

Subbasin : {Proposed}.DA : 7

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft ²)	Minimum Pipe Cover (in)
1	1-Jun	5437.80	5441.80	4.00	5437.80	0.00	5445.80	4.00	0.00	0.00
2	2-Jun	5428.92	5440.40	11.48	5428.92	0.00	5451.88	11.48	0.00	0.00
3	3-Jun	5427.02	5427.02	0.00	5427.02	0.00	5427.02	0.00	0.00	0.00
4	4-Jun	5441.72	5443.72	2.00	5441.72	0.00	5445.72	2.00	0.00	0.00
5	5-Jun	5426.06	5428.06	2.00	5426.06	0.00	5430.06	2.00	0.00	0.00
6	6-Jun	5421.00	5426.00	5.00	5421.00	0.00	5431.00	5.00	0.00	0.00
7	7-Jun	5417.00	5422.00	5.00	5417.00	0.00	5427.00	5.00	0.00	0.00
8	Outlet_PondA	5418.00	5420.50	2.50	5418.00	0.00	5423.00	2.50	0.00	0.00
9	Outlet_PondB	5424.00	5425.50	1.50	5424.00	0.00	5427.00	1.50	0.00	0.00
10	Riser_PondA	5418.00	5424.97	6.97	5418.00	0.00	5431.94	6.97	0.00	0.00
11	Riser_PondB	5424.00	5427.52	3.52	5424.00	0.00	5431.04	3.52	0.00	0.00

Junction Results

SN	Element	Peak	Peak	Max HGL	Max HGL	Max	Min	Average HGL	Average HGL	Time of	Time of	Total	Total Time
ID	Inflow	Lateral	Elevation	Depth	Surcharge	Freeboard	Elevation	Depth	Max HGL	Max HGL	Peak	Flooded	Total Time
	Inflow	Attained	Attained	Depth	Attained	Attained	Attained	Attained	Occurrence	Occurrence	Flooding	Volume	Flooded
	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)	
1	1-Jun	449.45	449.45	5440.29	2.49	0.00	1.51	5438.49	0.69	0 12:30	0 00:00	0.00	0.00
2	2-Jun	570.49	200.70	5435.27	6.35	0.00	5.13	5430.41	1.49	0 12:25	0 00:00	0.00	0.00
3	3-Jun	570.45	0.00	5428.26	1.24	0.00	3.76	5427.35	0.33	0 12:25	0 00:00	0.00	0.00
4	4-Jun	64.87	64.87	5442.74	1.02	0.00	0.98	5441.89	0.17	0 12:07	0 00:00	0.00	0.00
5	5-Jun	98.80	40.40	5427.32	1.26	0.00	0.74	5426.27	0.21	0 12:07	0 00:00	0.00	0.00
6	6-Jun	603.61	0.00	5422.52	1.52	0.00	3.48	5421.42	0.42	0 12:22	0 00:00	0.00	0.00
7	7-Jun	658.99	0.00	5418.78	1.78	0.00	9.22	5417.50	0.50	0 12:25	0 00:00	0.00	0.00
8	Outlet_PondA	46.89	0.00	5422.45	4.45	1.95	0.00	5419.30	1.30	0 12:36	0 00:00	0.00	0.00
9	Outlet_PondB	9.87	0.00	5424.96	0.96	0.00	0.54	5424.30	0.30	0 12:08	0 00:00	0.00	0.00
10	Riser_PondA	59.28	0.00	5425.74	7.74	0.77	0.00	5420.00	2.00	0 12:35	0 00:00	0.00	0.00
11	Riser_PondB	11.81	0.00	5427.62	3.62	0.10	0.00	5424.58	0.58	0 12:13	0 00:00	0.00	0.00

Channel Input

SN Element ID	Length	Inlet Invert	Inlet Invert	Outlet Invert	Outlet Invert	Total Drop	Average Slope	Shape	Height	Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Flap Gate
	(ft)	Elevation (ft)	Offset (ft)	Elevation (ft)	Offset (ft)	(ft)	(%)		(ft)	(ft)					(cfs)	
1 DITCH-01	1367.00	5437.80	0.00	5428.92	0.00	8.88	0.6500	Trapezoidal	4.000	52.000	0.0300	0.5000	0.5000	0.0000	0.00	No
2 DITCH-02	1487.80	5441.72	0.00	5426.06	0.00	15.66	1.0500	Trapezoidal	2.000	26.000	0.0300	0.5000	0.5000	0.0000	0.00	No
3 DITCH-03	207.00	5426.06	0.00	5421.00	0.00	5.06	2.4400	Trapezoidal	2.000	26.000	0.0400	0.5000	0.5000	0.0000	0.00	No
4 EXISTDITCH-01	352.00	5427.02	0.00	5421.00	0.00	6.02	1.7100	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00	No
5 EXISTDITCH-02	415.00	5421.00	0.00	5417.00	0.00	4.00	0.9600	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00	No
6 EXISTDITCH-03	1033.00	5417.00	0.00	5409.60	0.00	7.40	0.7200	Trapezoidal	5.000	120.000	0.0400	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Froude	Reported
ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Number	Condition
		Occurrence		Ratio				Total Depth			
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio			
1 DITCH-01	447.32	0 12:30	1119.58	0.40	4.18	5.45	3.24	0.81	0.00		
2 DITCH-02	61.49	0 12:07	224.45	0.27	3.72	6.67	1.12	0.57	0.00		
3 DITCH-03	96.80	0 12:08	256.53	0.38	5.68	0.61	1.25	0.64	0.00		
4 EXISTDITCH-01	570.23	0 12:25	6247.31	0.09	4.83	1.21	1.38	0.28	0.00		
5 EXISTDITCH-02	602.93	0 12:22	4689.99	0.13	4.29	1.61	1.65	0.33	0.00		
6 EXISTDITCH-03	656.72	0 12:25	4043.26	0.16	4.28	4.02	1.76	0.35	0.00		

Pipe Input

SN Element ID	Length	Inlet Invert	Inlet Invert	Outlet Invert	Outlet Invert	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Flap Gate	No. of Barrels
	(ft)	Elevation (ft)	Offset (ft)	Elevation (ft)	Offset (ft)	(ft)	(%)		(in)	(in)							(cfs)
1 C-01	120.00	5428.92	0.00	5427.02	0.00	1.90	1.5800	Rectangular	48.000	60.000	0.0120	0.5000	0.5000	0.0000	0.00	No	3
2 OutletPipe_PondA	166.00	5418.00	0.00	5417.00	0.00	1.00	0.6000	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3 OutletPipe_PondB	303.00	5424.00	0.00	5417.00	0.00	7.00	2.3100	CIRCULAR	18.000	18.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	C-01	570.45	0 12:25	1002.95	0.57	14.51	0.14	2.62	0.66	0.00		Calculated
2	OutletPipe_PondA	46.89	0 12:35	34.49	1.36	11.84	0.23	2.14	0.86	0.00		> CAPACITY
3	OutletPipe_PondB	9.92	0 12:12	13.84	0.72	7.51	0.67	1.22	0.81	0.00		Calculated

Storage Nodes

Storage Node : PondA

Input Data

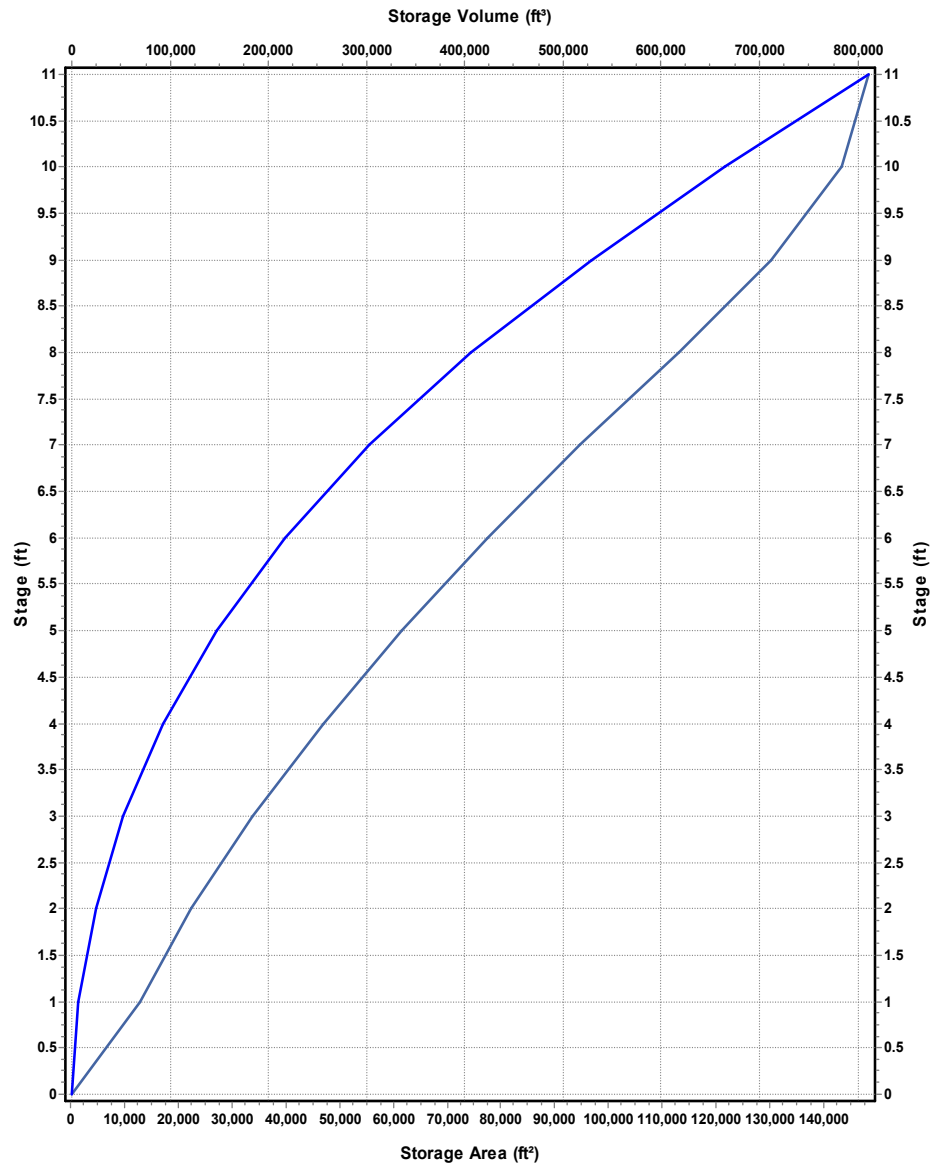
Invert Elevation (ft)	5420.00
Max (Rim) Elevation (ft)	5431.00
Max (Rim) Offset (ft)	11.00
Initial Water Elevation (ft)	5420.00
Initial Water Depth (ft)	0.00
Ponded Area (ft ²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Pond A

Stage	Storage Area	Storage Volume
(ft)	(ft ²)	(ft ³)
0	300	0
1	13044	6672
2	22565	24476.5
3	33934	52726
4	46922	93154
5	61435	147332.5
6	77447	216773.5
7	94723	302858.5
8	113114	406777
9	130230	528449
10	143348	665238
11	148268	811046

Storage Area Volume Curves



Storage Area Storage Volume

Storage Node : PondA (continued)

Outflow Weirs

SN Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1 EMRGCYSPLWY_PondA	Trapezoidal	No	5427.00	7.00	52.00	4.00	3.33

Outflow Orifices

SN Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1 Grate_PondA	Bottom	Rectangular	No		48.00	48.00	5424.97	0.63
2 WQCV/EURV_PondA	Side	Rectangular	No		3.00	6.58	5420.00	0.63

Output Summary Results

Peak Inflow (cfs)	157.28
Peak Lateral Inflow (cfs)	157.28
Peak Outflow (cfs)	59.28
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	5426.73
Max HGL Depth Attained (ft)	6.73
Average HGL Elevation Attained (ft)	5424.29
Average HGL Depth Attained (ft)	4.29
Time of Max HGL Occurrence (days hh:mm)	0 12:35
Total Exfiltration Volume (1000-ft ³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : PondB

Input Data

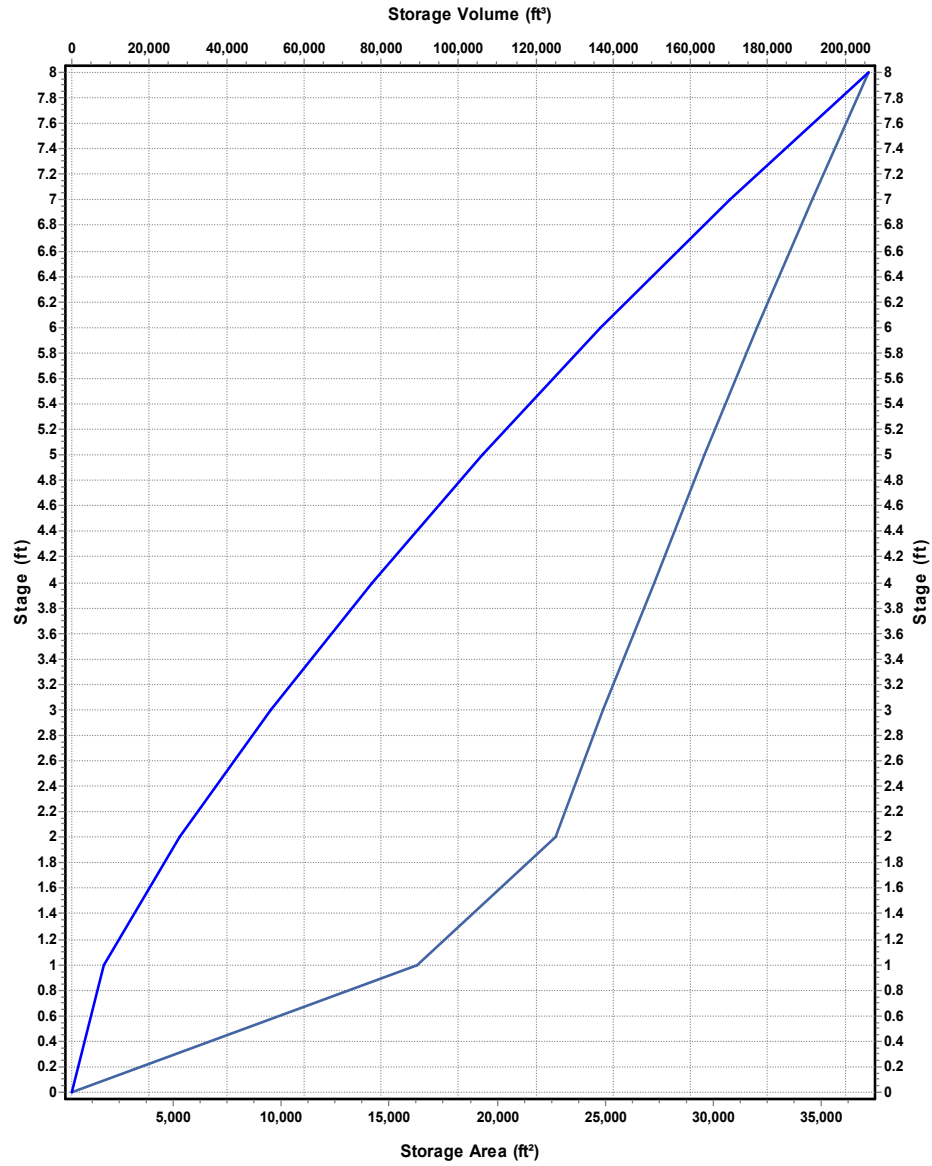
Invert Elevation (ft)	5426.00
Max (Rim) Elevation (ft)	5434.00
Max (Rim) Offset (ft)	8.00
Initial Water Elevation (ft)	5426.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Pond B

Stage	Storage Area	Storage Volume
(ft)	(ft²)	(ft³)
0	300	0
1	16257	8278.5
2	22675	27744.5
3	24922	51543
4	27243	77625.5
5	29585	106039.5
6	32047	136855.5
7	34583	170170.5
8	37192	206058

Storage Area Volume Curves



Storage Area Storage Volume

Storage Node : PondB (continued)

Outflow Weirs

SN Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1 EMRGCYSPLWY_PondB	Trapezoidal	No	5431.00	5.00	7.00	3.00	3.33

Outflow Orifices

SN Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1 Grate_PondB	Bottom	Rectangular	No		48.00	48.00	5427.52	0.63
2 WQCV/EURV_PondB	Side	CIRCULAR	No	6.16			5426.00	0.61

Output Summary Results

Peak Inflow (cfs)	23.03
Peak Lateral Inflow (cfs)	23.03
Peak Outflow (cfs)	11.81
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	5427.94
Max HGL Depth Attained (ft)	1.94
Average HGL Elevation Attained (ft)	5427.01
Average HGL Depth Attained (ft)	1.01
Time of Max HGL Occurrence (days hh:mm)	0 12:13
Total Exfiltration Volume (1000-ft ³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0



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EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT

PRELIMINARY DRAINAGE REPORT (PDR) CHECKLIST

Revised: January 2022

Preliminary Drainage Report		
The purpose of the Preliminary Drainage Report is to identify specific solutions to problems onsite and offsite resulting from proposed land development, including issues existing prior to development. The PDR shall generally conform to the following outline format and major headings, and contain the applicable information listed.		
	Applicant	PCD
Please confirm each item below has been included by placing a check mark in the "Applicant" column. See right for an example. The "PCD" column is for office use only.	✓	Office use only
Report Contents		
1	Table of contents, pages numbered	✓ p. 1
2	Existing/Historic and Developed Conditions Plans at the end of the report	✓ App. A
General Location		
1	City and County, and local streets within and adjacent to the subdivision.	✓ p. 4; A
2	Township, Range, section, 1/4 section.	✓ p. 4
3	Major drainage ways and existing facilities.	✓ p. 4
4	Names of surrounding platted developments.	✓ App. A
Description of Property		
1	Area in acres	✓ p. 4
2	Ground cover, (type of trees, shrubs, vegetation)	✓ p. 4
3	General topography	✓ p. 5
4	General soil conditions	✓ p. 5
5	Major drainageways	✓ p. 5
6	Irrigation facilities	✓ N/A
7	Utilities and other encumbrances	✓ p. 4; A
Major Basin Descriptions		
1	Reference should be made to major drainageway planning studies; Such as Drainage Basin Planning Studies; Flood Hazard delineation reports, and flood insurance studies or maps if available.	✓ p. 3; C
2	A floodplain statement shall be provided indicating whether any portion of the development is in a designated floodplain as delineated on the current FEMA mapping.	✓ p. 5; C
3	Major basin drainage characteristics.	✓ p. 3
4	Identification of all nearby irrigation facilities and other obstructions which could influence or be influenced by local drainage.	✓ N/A
Sub-Basin Descriptions		
1	Discussion of historic drainage patterns of the property in question	✓ p. 5; A
2	Discussion of offsite drainage flow patterns and their impact on the development	✓ p. 5-7



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PRELIMINARY DRAINAGE REPORT (PDR) CHECKLIST

Revised: January 2022

Drainage Design Criteria		
1	Reference all criteria, master plans, and technical information used for report preparation and design; any deviation from such material must be discussed and justified.	✓ p. 8-10
2	Discussion of previous drainage studies (i.e. PDR, drainage basin planning studies, master plans, flood insurance studies) for the site in question that influence or are influenced by the drainage design and how the studies affect drainage design for the site	✓ p. 3
Four-Step Process		
1	Runoff reduction proposed.	✓ p. 11
2	Stabilization of drainage ways proposed/discussed.	✓ p. 11
3	Proposed Stormwater Quality Capture Volume (WQCV) proposed.	✓ p. 11
4	Identify Best Management Practices (BMP's) to be used to control industrial and commercial pollutants.	✓ p. 11
Hydrologic Criteria		
1	Identify design rainfall.	✓ p. 10; D
2	Identify runoff calculation method.	✓ p. 8-10
3	Identify design storm recurrence intervals	✓ p. 7, 10
4	Identify detention discharge and storage calculation method.	✓ p. 8; G
5	Note ECM Appendix I Full Spectrum Detention (FSD) requirement.	✓ p. 8
Drainage Facility Design - General Concept		
1	Discussion of compliance with offsite runoff considerations.	✓ p. 5-7
2	Discussion of anticipated and proposed drainage patterns.	✓ p. 6-8
3	Discussion of the content of tables, charts, figures, plates or drawings presented in the report.	✓ p. 5-10
Drainage Facility Design - Specific Details		
1	Presentation of existing and proposed hydrologic conditions including approximate flow rates entering and exiting the subdivision with all necessary calculations.	✓ p. 6-7
2	Presentation of approach to accommodate drainage impacts on existing or proposed improvements and facilities.	✓ p. 6-7
3	Presentation of proposed facilities with respect to alignment, material and structure type.	✓ p. 10
4	Discussion of drainage impact of site constraints such as streets, utilities, existing and proposed structures.	✓ N/A
5	Environmental features and issues shall be presented if applicable.	✓ p. 5
6	Discussion of maintenance access and aspects of the preliminary design.	✓ p. 12
7	Discussion and analysis of existing and proposed downstream drainage facilities and their ability to convey developed runoff from the proposed development.	✓ p. 9, 12
Drawing Contents		
1	General Location Map: A map shall be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The map should be at a scale of 1"=50' to 1"=2000'. The map shall identify any major construction (i.e. development, irrigation ditches, existing detention facilities, culverts, storm sewers, etc.) that shall influence or be influenced by the subdivision.	✓ App. A
2	Drainage Plan: Map (s) of the proposed development at a scale of 1"=20' to 1"=200' shall be included to identify existing and proposed conditions on or adjacent to the site in question.	✓ App. A
3	The drainage plan shall delineate all sub-basins and proposed initial and major facilities as well as provide a summary of all initial and major flow rates at design points. All floodplains affecting the site shall be shown.	✓ App. A



Kiewit

Standard Operation Procedures for Inspection and Maintenance of Extended Detention Basin(s) Williams Creek Generating Station

Owner:
Colorado Spring Utilities

111 S. Cascade Avenue
Colorado Springs, CO 80903
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Introduction

This Operation and Maintenance (O&M) Manual addresses the inspection, operation, and maintenance requirements for the Extended Dry Detention Basins (EDBs) and associated stormwater quality facilities to be constructed as part of the Williams Creek Generating Station project located in El Paso County, Colorado.

The stormwater management facilities are intended to provide water quality treatment, sediment control, and temporary detention of stormwater runoff generated from developed areas of the site. The facilities have been designed to collect, store, and gradually release stormwater runoff through controlled outlet structures while reducing pollutant loading and minimizing downstream impacts associated with post-development runoff conditions.

Background

The State of Colorado Department of Public Health and Environment, Water Quality Control Division (CDPHE), has implemented federal regulations within the State of Colorado through permitting, and has included El Paso County as one of numerous Municipal Separate Storm Sewer Systems (MS4s) required to be permitted in compliance with National Pollutant Discharge Elimination System (NPDES) Phase 2 Regulations, as defined within Colorado's Phase 2 Municipal Guidance.

NPDES Phase 2 MS4s stormwater discharges are covered under a general permit under the Colorado Discharge Permit System (CDPS) under Regulation 61, and as a minimum require the MS4's operator (e.g., El Paso County) to develop, implement, and enforce a stormwater management program to reduce the discharge of pollutants to the maximum extent practicable to protect water quality requirements of the Colorado Water Quality Control Act, Colorado Code of Regulations [CCR] 61.8(11)(a)(i).

This Stormwater Facilities Operation and Maintenance (O&M) Plan has been prepared for the Extended Dry Detention Basin (EDB) and associated stormwater management facilities constructed as part of the Williams Creek Generating Station project located in El Paso County, Colorado. The purpose of this manual is to establish procedures for inspection, operation, maintenance, and documentation necessary to preserve the long-term functionality of the stormwater facilities and maintain their intended water quality and runoff detention performance.

Funding for and Organization of Facility Operation and Maintenance

Colorado Springs Utilities (CSU), or its designated representative, shall be responsible for the operation, inspection, maintenance, repair, and long-term management of the Extended Dry Detention Basins (EDBs) and associated stormwater management facilities upon acceptance of the facilities.

Site and Facilities Description

The Williams Creek Generating Station project is located in El Paso County, Colorado. The project includes Extended Dry Detention Basins (EDBs) and associated stormwater management facilities designed to provide stormwater quality treatment and runoff detention for developed portions of the site. The detention facilities are located within designated stormwater management areas of the project site and are intended to collect, temporarily store, and gradually release stormwater runoff through controlled outlet structures.

Access to the detention facilities is provided through internal site access roads and maintenance routes as shown on the approved construction plans and site development drawings. Maintenance personnel shall

have access to all stormwater facility components for inspection and maintenance activities.

Emergency spillways are incorporated into the detention basin design to safely convey runoff in excess of the design storage capacity. The final location, dimensions, and discharge routing of emergency spillways will be documented in the final construction plans.

The stormwater management facilities generally consist of stormwater inflow structures, drainage swales and conveyance channels, forebays (if provided), detention storage areas, outlet control structures, emergency spillways, erosion protection measures, and associated stormwater conveyance systems.

Final drainage areas, storage volumes, outlet structure details, spillway elevations, and facility identification numbers will be incorporated into this manual following completion of final drainage design and preparation of record drawings.

Extended Detention Basin (EDB) Description

The subsections below describe general EDB operations and maintenance.

EDB-1 GENERAL EDB CONCEPT

Extended Detention Basins (EDBs) are one of the most common types of permanent stormwater control measures utilized within the Front Range of Colorado. An EDB is a sedimentation basin designed to “extend” the runoff detention time, but to drain completely sometime after stormwater runoff ends. An EDB’s drain time for the water quality portion of the facility is typically 40 hours. The basins are considered to be “dry” because the majority of the basin is designed not to have a significant permanent pool of water remaining between runoff events.

EDBs are an adaptation of a detention basin used for flood control, with the primary difference being the addition of forebays, micropools and a slow release outlet design. Forebays are shallow concrete “pans” located at the inflow points to the basin and are provided to facilitate sediment removal within a contained area prior to releasing into the pond. The forebays collect and briefly hold stormwater runoff resulting in a process called sedimentation, dropping sediment out of the stormwater. The stormwater is then routed from the forebay into the concrete trickle channel and upper basin, the large grassy portion of the basin. The EDB includes an outlet structure that extends the drain time of frequently occurring runoff events to facilitate pollutant removal. An EDB also includes a small micropool just upstream of the outlet structure or built into the outlet structure. The micropool is designed to hold a small amount of water to keep sediment and floatables from blocking the outlet orifices.

EDB-2 INSPECTING EXTENDED DETENTION BASINS (EDBs)

EDB-2.1 Access and Easements

Inspection and maintenance personnel may utilize the attached stormwater facility map containing the location(s) of the access points and maintenance easements of the EDB(s) within this development.

EDB-2.2 Stormwater Management Facilities Locations

Inspection and maintenance personnel may utilize the attached stormwater facility map located in containing the location(s) of the EDB(s) within this development.

EDB-2.3 Extended Detention Basin (EDB) Features

EDBs have a number of features that are designed to serve a particular function. Many times the proper function of one feature depends on another. For example, if a forebay is not properly maintained, it could negatively affect the performance of a downstream feature (trickle channel, micropool, etc.).

Therefore, it is critical that each feature of the EDB is properly inspected and maintained to ensure that the overall facility functions as it was intended. Below is a list and description of the most common features within an EDB and the corresponding maintenance inspection items that can be anticipated:

Table EDB-1: Typical Inspection & Maintenance Requirements Matrix

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Over- grown Vegetation Removal	Standing Water (mosquito/ algae control)	Structure Repair
Inflow Points (outfalls)	X		X	X			X
Forebays	X		X				X
Low-Flow Channel	X		X	X	X		X
Bottom Stage	X	X	X	X	X	X	
Micropool	X		X		X	X	X
Outlet Works	X		X				X
Emergency Spillway			X	X	X		X
Upper Stage			X	X			
Embankment		X		X	X		

EDB-2.3.1 Inflow Points

Inflow Points or Outfalls into EDBs are the point source of the stormwater discharge into the facility. An inflow point is commonly a storm sewer pipe with a flared end section that discharges into the EDB. In some instances, an inflow point could be a drainage channel or ditch that flows into the facility.

An energy dissipater (riprap or hard armor protection) is typically immediately downstream of the discharge point into the EDB to protect from erosion. In some cases, the storm sewer outfall can have a toe- wall or cut-off wall immediately below the structure to prevent undercutting of the outfall from erosion.

The typical maintenance items that are found with inflow points are as follows:

- Riprap Displaced** – Many times, because the repeated impact/force of water, the riprap can shift and settle. If any portion of the riprap apron appears to have settled, soil is present between the riprap, or the riprap has shifted, maintenance may be required to ensure future erosion is prevented.
- Erosion Present/Outfall Undercut** – In some situations, the energy dissipater may not have been sized, constructed, or maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure(s) and sediment transport within the facility.

- c. Sediment Accumulation – Because of the turbulence in the water created by the energy dissipater, sediment often deposits immediately downstream of the inflow point. To prevent a loss in hydraulic performance of the upstream infrastructure, sediment that accumulates in this area must be removed in a timely manner.
- d. Structural Damage – Structural damage can occur at any time during the life of the facility. Typically, for an inflow, the structural damage occurs to the pipe flared end section (concrete or steel). Structural damage can lead to additional operating problems with the facility, including loss of hydraulic performance.
- e. Woody Growth/Weeds Present – Undesirable vegetation can grow in and around
- f. the inflow area to an EDB that can significantly affect the performance of the drainage facilities discharging into the facility. This type of vegetation includes trees (typically cottonwoods) and dense areas of shrubs (willows). If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate, resulting in blockage of the discharge. Also, tree roots can cause damage to the structural components of the inflow. Routine maintenance is essential for trees (removing a small tree/sapling is much cheaper and “quieter” than a mature tree). In addition, noxious weeds growing in the facility can result in the loss of desirable native vegetation and impact adjacent open spaces/land.

EDB-2.3.2 Forebay

A forebay is a solid surface (pad), typically constructed of concrete, immediately downstream of the inflow point. The forebay is designed to capture larger particles and trash to prevent them from entering the main portion of the EDB. The solid surface is designed to facilitate mechanical sediment removal (via a skid steer or shovel). The forebay typically includes a small diameter discharge pipe or weir on the downstream end, which is designed to drain the forebay in a specified period of time to promote sedimentation. Forebays vary in size and depth depending on the design and site constraints.

The typical maintenance items that are found with forebays are as follows:

- a. Sediment/Debris Accumulation – Because this feature of the EDB is designed to provide the initial sedimentation, debris and sediment frequently accumulate in this area. If the sediment and debris is not removed from the forebay on a regular basis, it can significantly affect the function of other features within the EDB. Routine sediment removal from the forebay can significantly reduce the need for dredging of the main portion of the EDB using specialized equipment (long reach excavators). Routine removal of sediment from the forebay can substantially decrease the long-term sediment removal costs of an EDB.
- b. Concrete Cracking/Failing – The forebay is primarily constructed of concrete, which cracks, spalls, and settles. Damage to the forebay can result in decreased performance and impact maintenance efforts.
- c. Drain Pipe/Weir Clogged – Many times the drainpipe or weir can be clogged with debris, and prevent the forebay from draining properly. If standing water is present in the forebay (and there is not a base flow), the forebay is most likely not draining properly. This can result in a decrease in performance and create potential nuisances with stagnant water (mosquitoes).
- d. Weir/Drain Pipe Damaged – Routine maintenance activities, vandalism, or age may cause the weir or drain pipe in the forebay to become damaged. Weirs are typically constructed of concrete, which cracks and spalls. The drainpipe is typically constructed with plastic, which can fracture.

EDB-2.3.3 Trickle Channel (Low-Flow)

The trickle channel conveys stormwater from the forebay to the micro- pool of the EDB. The trickle channel is typically made of concrete.

However, grass lined (riprap sides protected) is also common and can provide for an additional means of water quality within the EDB. The trickle channel is typically 6-9 inches in depth and can vary in width.

The typical maintenance items that are found with trickle channels are as follows:

- a. Sediment/Debris Accumulation – Trickle channels are typically designed with a relatively flat slope that can promote sedimentation and the collection of debris. Also, if a trickle channel is grass lined it can accumulate sediment and debris at a much quicker rate. Routine removal of accumulated sediment and debris is essential in preventing flows from circumventing the trickle channel and affecting the dry storage portion of the pond.
- b. Concrete/Riprap Damage – Concrete can crack, spall, and settle and must be repaired to ensure proper function of the trickle channel. Riprap can also shift over time and must be replaced/repared as necessary.
- c. Woody Growth/Weeds Present – Because of the constant moisture in the area surrounding the trickle channel, woody growth (cottonwoods/willows) can become a problem. Trees and dense shrub type vegetation can affect the capacity of the trickle channel and can allow flows to circumvent the feature.
- d. Erosion Outside of Channel – In larger precipitation events, the trickle channel capacity will likely be exceeded. This can result in erosion immediately adjacent to the trickle channel and must be repaired to prevent further damage to the structural components of the EDB.

EDB-2.3.4 Bottom Stage (Initial Surge)

The bottom stage is at least 4 inches deeper than the upper stage and is located directly in front of the outlet works structure, and typically above the permanent water surface of the micropool and the invert of the trickle channel. The bottom stage is designed to store the smaller runoff events, assists in keeping the majority of the basin bottom dry resulting in easier maintenance operations, and enhances the facility's pollutant removal capabilities. This area of the EDB may develop wetland vegetation.

The typical maintenance items that are found with the bottom stage are as follows:

- a. Sediment/Debris Accumulation – The micropool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.
- b. Woody Growth/Weeds Present – Because of the constant moisture in the soil surrounding the micropool, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate outside of the micropool, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and less disruptive than removing a mature tree).
- c. Bank Erosion – The micropool is usually a couple feet deeper than the other areas of the ponds. Erosion can be caused by water dropping into the micropool if
- d. adequate protection/armor is not present. Erosion in this area must be mitigated to prevent

sediment transport and other EDB feature damage.

- e. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the micropool. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the micropool may be necessary to reduce these impacts to adjacent homeowners.
- f. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the micropool area of the EDB. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact County Stormwater immediately. Proper removal/mitigation of contaminated soils and water in the EDB is necessary to minimize any environmental impacts downstream.

EDB-2.3.5 Micropool

The micropool is a concrete or grouted boulder walled structure directly in front of the outlet works. At a minimum, the micropool is 2.5 feet deep and is designed to hold water. The micropool is critical in the proper function of the EDB; it allows suspended sediment to be deposited at the bottom of the micropool and prevents these sediments from being deposited in front of the outlet works causing clogging of the outlet structure, which results in marshy areas within the top and bottom stages.

The typical maintenance items that are found with micropools are as follows:

- a. Sediment/Debris Accumulation – The micropool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.
- b. Woody Growth/Weeds Present – Because of the constant moisture in the soil surrounding the micropool, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate outside of the micropool, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and less disruptive than removing a mature tree).
- c. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the micropool. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the micropool may be necessary to reduce these impacts to adjacent homeowners.
- d. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the micropool area of the EDB. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact the supervisor immediately. Proper removal of contaminated soils and water in the EDB is necessary to minimize any environmental impacts downstream.

EDB-2.3.6 Outlet Works

The outlet works is the feature that drains the EDB in specified release rates and periods of time. The outlet works is typically constructed of reinforced concrete into the embankment of the EDB. The concrete structure typically has steel orifice plates anchored/embedded into it to control stormwater release rates.

The larger openings for flood control on the outlet structure typically have trash racks over them to prevent clogging. The water quality orifice plate with small diameter holes will typically have a well screen covering it to prevent smaller materials from clogging it. The outlet structure is the single-most important feature in the EDB operation. Proper inspection and maintenance of the outlet works is essential in ensuring the long-term operation of the EDB.

The typical maintenance items that are found with the outlet works are as follows:

- a. Trash Rack/Well Screen Clogged – Floatable material that enters the EDB will most likely make its way to the outlet structure. This material is trapped against the trash racks and well screens on the outlet structure (which is why they are there). This material must be removed on a routine basis to ensure the outlet structure drains in the specified design period.
- b. Structural Damage – The outlet structure is primarily constructed of concrete, which can crack, spall, and settle. The steel trash racks and well screens are also susceptible to damage.
- c. Orifice Plate Missing/Not Secure – Many times residents, property owners, or maintenance personnel will remove or loosen orifice plates if they believe the pond is not draining properly. Any modification to the orifice plate(s) will significantly affect the designed discharge rates for water quality and/or flood control. Modification of the orifice plates is not allowed without EPC approval.
- d. Manhole Access – Access to the outlet structure is necessary to properly inspect and maintain the facility. If access is difficult or not available to inspect the structure, chances are it will be difficult to maintain as well.
- e. Woody Growth/Weeds Present – Because of the constant moisture in the soil surrounding the outlet works, woody growth (cottonwoods/willows) can create operational problems for the EDB. If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate around the outlet works, which can cause problems with other EDB features. Also, tree roots can cause damage to the structural components of the outlet works. Routine management is essential for trees (removing a small tree/sapling is much cheaper and less disruptive than removing a mature tree).

EDB-2.3.7 Emergency Spillway

An emergency spillway is typical of all EDBs and designed to serve as the overflow in the event the volume of the pond is exceeded. The emergency spillway is typically armored with riprap (or other hard armor) and is sometimes buried with soil. The emergency spillway is typically a weir (notch) in the pond embankment. Proper function of the emergency spillway is essential to ensure flooding does not affect adjacent properties.

The typical maintenance items that are found with emergency spillways are as follows:

- a. Riprap Displaced – As mentioned before, the emergency spillway is typically armored with riprap to provide erosion protection. Over the life of an EDB, the riprap may shift or dislodge due to flow.
- b. Erosion Present – Although the spillway is typically armored, stormwater flowing through the spillway can cause erosion damage. Erosion must be repaired to ensure the integrity of the basin embankment, and proper function of the spillway.
- c. Woody Growth/Weeds Present – Management of woody vegetation is essential in the proper

long-term function of the spillway. Larger trees or dense shrubs can capture larger debris entering the EDB and reduce the capacity of the spillway.

- d. Obstruction Debris – The spillway must be cleared of any obstruction (man- made or natural) to ensure the proper design capacity.

EDB-2.3.8 Upper Stage (Dry Storage)

The upper stage of the EDB provides the majority of the water quality flood detention volume. This area of the EDB is higher than the micro- pool and typically stays dry, except during storm events. The upper stage is the largest feature/area of the basin. Sometimes, the upper stage can be utilized for park space and other uses in larger EDBs.

With proper maintenance of the micropool and forebay(s), the upper stage should not experience much sedimentation; however, bottom elevations should be monitored to ensure adequate volume.

The typical maintenance items that are found with upper stages are as follows:

- a. Vegetation Sparse – The upper basin is the most visible part of the EDB, and therefore aesthetics is important. Adequate and properly maintained vegetation can greatly increase the overall appearance and acceptance of the EDB by the public. In addition, vegetation can reduce the potential for erosion and subsequent sediment transport to the other areas of the pond.
- b. Woody Growth/Undesirable Vegetation – Although some trees and woody vegetation may be acceptable in the upper basin, some thinning of cottonwoods and willows may be necessary. Remember, the basin will have to be dredged to ensure volume, and large trees and shrubs will be difficult to protect during that operation.
- c. Standing Water/Boggy Areas – Standing water or boggy areas in the upper stage is typically a sign that some other feature in the pond is not functioning properly. Routine maintenance (mowing, trash removal, etc.) can be extremely difficult for the upper stage if the ground is saturated. If this inspection item is checked, make sure you have identified the root cause of the problem.
- d. Sediment Accumulation – Although other features within the EDB are designed to capture sediment, the upper storage area will collect sediment over time. Excessive amounts of sedimentation will result in a loss of storage volume. It may be more difficult to determine if this area has accumulated sediment without conducting a field survey.
- e. Below is a list of indicators:
 - 1. Ground adjacent to the trickle channel appears to be several inches higher than concrete/riprap
 - 2. Standing water or boggy areas in upper stage
 - 3. Uneven grades or mounds
 - 4. Micropool or Forebay has excessive amounts of sediment
- f. Erosion (banks and bottom) – The bottom grades of the dry storage are typically flat enough that erosion should not occur. However, inadequate vegetative cover may result in erosion of the upper stage. Erosion that occurs in the upper stage can result in increased dredging/maintenance of the micropool.
- g. Trash/Debris – Trash and debris can accumulate in the upper area after large events, or from illegal dumping. Over time, this material can accumulate and clog the EDB outlet works.
- h. Maintenance Access – Most EDBs typically have a gravel/concrete maintenance access path to

either the upper stage, outlet works, and/or forebay. This access path should be inspected to ensure the surface is still drivable. Some of the smaller EDBs may not have maintenance access paths; however, the inspector should verify that access is available from adjacent properties.

EDB-2.3.9 Miscellaneous

There are a variety of inspection/maintenance issues that may not be attributed to a single feature within the EDB. This category on the inspection form is for maintenance items that are commonly found in the EDB but may not be attributed to an individual feature.

- a. Encroachment in Easement Area – Private lots/property can sometimes be located very close to the EDBs, even though they are required to be located in tracts with drainage easements. Property owners may place landscaping, trash, fencing, or other items within the easement area that may affect maintenance or the operation of the facility.
- b. Graffiti/Vandalism – Damage to the EDB infrastructure can be caused by vandals. If criminal mischief is evident, the inspector should forward this information to the local Sheriff's Office.
- c. Public Hazards – Public hazards include items such as vertical drops of greater than 4-feet, containers of unknown/suspicious substances, exposed metal/jagged concrete on structures. If any hazard is found within the facility area that poses an immediate threat to public safety, contact the Sheriff at 911 immediately!
- d. Burrowing Animals/Pests – Prairie dogs and other burrowing rodents may cause damage to the EDB features and negatively affect the vegetation within the EDB. Consult EPC Environmental Division if this becomes an issue.
- e. Other – Any miscellaneous inspection/maintenance items not contained on the form should be entered here.

EDB-3 MAINTAINING EXTENDED DETENTION BASINS (EDBS)

EDB-3.1 Maintenance Personnel

Maintenance personnel must be qualified to properly maintain EDBs. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

EDB-3.2 Equipment

It is imperative that the appropriate equipment and tools are taken to the field with the operations crew. The types of equipment/tools will vary depending on the task at hand. Below is a list of tools, equipment, and material(s) that may be necessary to perform maintenance on an EDB:

- 1.) Loppers/Tree Trimming Tools
- 2.) Mowing Tractors
- 3.) Trimmers (extra string)
- 4.) Shovels
- 5.) Rakes
- 6.) All Surface Vehicle (ASVs)
- 7.) Skid Steer
- 8.) Backhoe
- 9.) Track Hoe/Long Reach Excavator

- 10.) Dump Truck
- 11.) Jet-Vac Machine
- 12.) Engineers Level (laser)
- 13.) Riprap (Minimum - Type M)
- 14.) Filter Fabric
- 15.) Erosion Control Blanket(s)
- 16.) Seed Mix (Native)
- 17.) Illicit Discharge Cleanup Kits
- 18.) Trash Bags
- 19.) Tools (wrenches, screw drivers, hammers, etc.)
- 20.) Chain Saw
- 21.) Confined Space Entry Equipment
- 22.) Approved Stormwater Facility Operation and Maintenance Manual

Some of the items identified above may not be needed for every maintenance operation. However, this equipment should be available to the maintenance operations crews should the need arise.

EDB-3.3 Safety

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the EDB that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

EDB-3.4 Maintenance Categories and Activities

A typical EDB Maintenance Program will consist of three broad categories of work: routine, minor, and major maintenance activities. Within each category of work, a variety of maintenance activities can be performed on an EDB. A maintenance activity can be specific to each feature within the EDB, or general to the overall facility. A variety of maintenance activities are typical of EDBs. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of drainage infrastructure. The following three sub-sections (3.5, 3.6, and 3.7) explain each of the categories and briefly describes the typical maintenance activities for an EDB, including the objectives and frequency of actions.

EDB-3.5 Routine Maintenance Activities

The majority of this work consists of regularly scheduled mowing and trash and debris pickups for stormwater management facilities during the growing season. This includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It also includes activities such as weed control, mosquito treatment, and algae treatment. These activities will normally be performed numerous times during the year. These items can be completed without any prior correspondence with the EPC Stormwater; however, completed inspection and maintenance forms shall be retained for each inspection and maintenance activity.

The Maintenance Activities are summarized below, and further described in the following sub- sections.

TABLE – EDB-2 Summary of Routine Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR	MAINTENANCE ACTION
Mowing	Twice annually	Excessive grass height/aesthetics	Mow grass to a height of 4” to 6”
Trash/Debris Removal	Twice annually	Trash & debris in EDB	Remove and dispose of trash and debris
Outlet Works Cleaning	As needed – after significant rain events – twice annually at a minimum	Clogged outlet structure; ponding water	Remove and dispose of debris/trash/sediment to allow outlet to function properly
Weed control	Minimum twice annually	Noxious weeds; Unwanted vegetation	Treat w/ herbicide or hand pull; Consult the local weed specialist
Mosquito Treatment	As needed	Standing water/ mosquito habitat	Treat w/ EPA approved chemicals
Algae Treatment	As needed	Standing water/ Algal growth/green color	Treat w/ EPA approved chemicals

EDB-3.5.1 Mowing

Occasional mowing is necessary to limit unwanted vegetation and to improve the overall appearance of the EDB. Native vegetation should be mowed to a height of 4-to-6 inches tall. Grass clippings should be collected and disposed of properly.

Frequency – Routine - Minimum of twice annually or depending on aesthetics.

EDB-3.5.2 Trash/Debris Removal

Trash and debris must be removed from the entire EDB area to minimize outlet clogging and to improve aesthetics. This activity must be performed prior to mowing operations.

Frequency – Routine – Prior to mowing operations and minimum of twice annually.

EDB-3.5.3 Outlet Works Cleaning

Debris and other materials can clog the outlet work’s well screen, orifice plate(s), and trash rack. This activity must be performed anytime other maintenance activities are conducted to ensure proper operation.

Frequency - Routine – After significant rainfall event or concurrently with other maintenance activities.

EDB-3.5.4 Weed Control

Noxious weeds and other unwanted vegetation must be treated as needed throughout the EDB. This activity can be performed either through mechanical means (mowing/pulling) or with herbicide. Consultation with the Environmental Division at 719-520-7878 is highly recommended prior to the use of herbicide.

Frequency – Routine – As needed based on inspections.

EDB-3.5.5 Mosquito/Algae Treatment

Treatment of permanent pools is necessary to control mosquitoes and undesirable aquatic vegetation that can create nuisances. Only EPA approved chemicals/materials can be used in areas that are warranted.

Frequency – As needed.

EDB- 3.6 Minor Maintenance Activities

This work consists of a variety of isolated or small-scale maintenance or operational problems. Most of this work can be completed by a small crew, tools, and small equipment. These items may require prior correspondence with EPC Stormwater and require completed inspection and maintenance forms to be submitted to EPC upon request for each inspection and maintenance activity.

Table – EDB-3 Summary of Minor Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR	MAINTENANCE ACTION
Sediment Removal	As needed; typically every 1–2 years	Sediment build-up; decrease in pond volume	Remove and dispose of sediment
Erosion Repair	As needed, based upon inspection	Rills/gullies forming on side slopes, trickle channel, other areas	Repair eroded areas Revegetate; address source of erosion
Vegetation Removal/Tree Thinning	As needed, based upon inspection	Large trees/wood vegetation in lower stage of pond	Remove vegetation; restore grade and surface
Drain Cleaning/Jet Vac	As needed, based upon inspection	Sediment build-up/ non draining system	Clean drains; Jet Vac if needed

EDB-3.6.1 Sediment Removal

Sediment removal is necessary to maintain the original design volume of the EDB and to ensure proper function of the infrastructure. Regular sediment removal (minor) from the forebay, inflow(s), and trickle channel can significantly reduce the frequency of major sediment removal activities (dredging) in the upper and lower stages. The minor sediment removal activities can typically be addressed with shovels and smaller equipment. Major sediment removal activities will require larger and more specialized equipment. The major sediment activities will also require surveying with an engineer's level, and consultation with EPC Stormwater Staff to ensure design volumes/grades are achieved.

Stormwater sediments removed from EDBs do not meet the criteria of "hazardous waste". However, these sediments are contaminated with a wide array of organic and inorganic pollutants and handling must be done with care. Sediments from permanent pools must be carefully removed to minimize turbidity, further sedimentation, or other adverse water quality impacts. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a landfill for proper disposal. Prompt and thorough cleanup is important should a spill occur during transportation.

Frequency – Nonroutine – As necessary based upon inspections. Sediment removal in the forebay and trickle channel may be necessary as frequently as every 1-2 years.

EDB-3.6.2 Erosion Repair

The repair of eroded areas is necessary to ensure the proper function of the EDB, minimize sediment transport, and to reduce potential impacts to other features. Erosion can vary in magnitude from minor repairs to trickle channels, energy dissipaters, and rilling to major gullies in the embankments and spillways. The repair of eroded areas may require the use of excavators, earthmoving equipment, riprap, concrete, erosion control blankets, and turf reinforcement mats. Major erosion repair to the pond embankments, spillways, and adjacent to structures will require consultation with EPC Stormwater Staff.

Frequency – Nonroutine – As necessary based upon inspections.

EDB-3.6.3 Vegetation Removal/Tree Thinning

Dense stands of woody vegetation (willows, shrubs, etc) or trees can create maintenance problems for the infrastructure within an EDB. Tree roots can damage structures and invade pipes/channels thereby blocking flows. Also, trees growing in the upper and lower stages of the EDB will most likely have to be removed when sediment/dredging operations occur. A small tree is easier to remove than a large tree, therefore, regular removal/thinning is preferred. All trees and woody vegetation that is growing in the bottom of the EDB or near structures (inflows, trickle channels, outlet works, emergency spillways, etc) should be removed. Any trees or woody vegetation in the EDB should be limited to the upper portions of the pond banks.

Frequency – Nonroutine – As necessary based upon inspections.

EDB-3.6.4 Clearing Drains/Jet-Vac

An EDB contains many structures, openings, and pipes that can be frequently clogged with debris. These blockages can result in a decrease of hydraulic capacity and create standing water in areas outside of the micropool. Often the blockage to this infrastructure can be difficult to access and/or clean. Specialized equipment (jet-vac machines) may be necessary to clear debris from these difficult areas.

Frequency – Nonroutine – As necessary based upon inspections.

EDB-3.7 Major Maintenance Activities

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. All of this work requires consultation with EPC Stormwater Staff to ensure the proper maintenance is performed. This work requires that the staff review the original design and construction drawings to assess the situation and assign the necessary maintenance. An ESQCP permit may be required for major maintenance activities. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.

Table – EDB-4 Summary of Major Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR	MAINTENANCE ACTION
Major Sediment Removal	As needed – based upon scheduled inspections	Large quantities of sediment; reduced pond capacity	Remove and dispose of sediment. Repair vegetation as needed
Major Erosion Repair	As needed – based upon scheduled inspections	Severe erosion including gullies, excessive soil displacement, areas of settlement, holes	Repair erosion – find cause of problem and address to avoid future erosion
Structural Repair	As needed – based upon scheduled inspections	Deterioration and/or damage to structural components – broken concrete, damaged pipes, outlet works	Structural repair to restore the structure to its original design

EDB-3.7.1 Major Sediment Removal

Major sediment removal consists of removal of large quantities of sediment or removal of sediment from vegetated areas. Care shall be given when removing large quantities of sediment and sediment deposited in vegetated areas. Large quantities of sediment need to be carefully removed, transported and disposed of. Vegetated areas need special care to ensure design volumes and grades are preserved.

Frequency – Nonroutine – Repair as needed based upon inspections.

EDB-3.7.2 Major Erosion Repair

Major erosion repair consists of filling and revegetating areas of severe erosion. Determining the cause of the erosion as well as correcting the condition that caused the erosion should also be part of the erosion repair. Care should be given to ensure design grades and volumes are preserved.

Frequency – Nonroutine – Repair as needed based upon inspections.

EDB-3.7.3 Structural Repair

An EDB includes a variety of structures that can deteriorate or be damaged during the course of routine maintenance. These structures are constructed of steel and concrete that can degrade or be damaged and may need to be repaired or re-constructed from time to time.

These structures include items like outlet works, trickle channels, forebays, inflows, and other features. In-house operations staff can perform some of the minor structural repairs. Major repairs to structures may require input from a structural engineer and specialized contractors. Consultation with EPC Stormwater Staff should take place prior to all structural repairs.

Frequency – Nonroutine – Repair as needed based upon inspections.